Technical Summary

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Foreword to the technical Summary

This technical summary provides an overview of the main statements of the *APCC SR Structures for Climate-Friendly Living* chapters. Based on scientific literature, the report assesses different approaches for transforming structures in order to make climate-friendly living in Austria possible and make it permanently and quickly the new status quo.

In 2018, the United Nations Intergovernmental Panel on Climate Change (IPCC) concluded in its special report "1.5 °C Global Warming" that "unprecedented, rapid changes of all aspects of society" are needed to achieve the goals of the Paris Climate Agreement and to avoid climate change with catastrophic global impacts (IPCC, 2018). As a result, human well-being and planetary health, as well as human civilization are threatened by the climate crisis (IPCC, 2022a, SPM-WGII).

The Austrian Panel for Climate Change (ACRP, 2019) has commissioned an assessment report on structures for climate-friendly living in Austria. The aim of this special report is to assess the state of research and reflect on necessary structural changes for climate-friendly living in Austria.

The focus is on (1) structures in Austria in need of change according to the current state of research and (2) how they need to be shaped in order to make climate-friendly living possible and self-evident quickly and permanently. These questions are addressed in the respective chapters based on four sub-questions:

1. How does the literature relevant to the chapter describe the status quo as well as current dynamics, and what specific goals and challenges arise from the climate crisis according to the literature?
2. What changes does the literature relevant to the chapter considered (absolutely) necessary to enable a climate-friendly mode of living?
3. According to the literature relevant to the chapter, who or what are the driving and inhibiting forces, structures or actors for and against the necessary changes for climate-friendly living? Which conflicts are mentioned?
4. What space of manoeuvre and which options for shaping structures can be found in the literature relevant to the chapter for implementing necessary changes for a climate-friendly mode of living?

This technical summary targets the scientific community and reproduces the report in a highly abridged form. In Part 1 of the report, the introduction explains the understanding of basic terms and gives an overview of emission trends.

C. Görg et al. (Hrsg.), *APCC Special Report: Strukturen für ein klimafreundliches Leben*, https://doi.org/10.1007/978-3-662-66497-1_4

Chap. 2 presents four perspectives for shaping structures. Part 2 examines (after an introduction) climate-friendly living in six different fields of action. Part 3 summarises (after a brief overview) the analysis of twelve different structural conditions, and Part 4 summarises current research on transformation pathways as well as scenarios and systematises approaches to shape structures along different transformation pathways and leverage points.

Development of the report

This report is an "Assessment Report" at the interface between science and policy (Science-Policy Interface – SPI). The aim of the Assessment Report is to summarise and evaluate the current state of knowledge on a specific issue and, in addition to assessing statements on the respective topic, identify research gaps.

The report was developed in a three-stage process, which included peer reviews, author-, and stakeholder workshops. The respective versions (zero-, first-, second-order drafts) were commented and reviewed by national and international scientists and stakeholders. The incorporation of the comments was approved by review editors at the end of the process. In total, about 160 reviewers wrote about 4000 comments. The stakeholder process comprised three workshops with more than 100 participants and decision-makers from various sectors of society. This part of the project was carried out by a separate team. The workshops aided the authors in identifying relevant issues and thus in better contributing to the public debate on climate-friendly living with the assessment of the literature.

The special report evaluates scientific literature, whereby research results from political science, economics and cultural studies, sociology, law and other social and natural sciences were included. The assessment of statements in the report was made along two criteria: (1) whether the relevant literature agrees in its assessments of a statement (low, medium, high agreement), and (2) how extensive and high quality the literature is (weak, medium, strong literature base) (Fig. TS.2). In this report, the term "literature base" is used instead of the previously used term "evidence base", as it is compatible with all perspectives represented in this report. The literature base includes not only the quantity of literature, but also assesses – in relation to the evidence base – the quality of the respective literature. The combination of the two criteria results in the confidence in a statement, though *confidence* as such is not stated separately.

Part 1: Climate-friendly living and perspectives

Chapter 1: Introduction: Structures for climate-friendly living

The introduction first describes the key concepts (climate-friendly living, structures as well as the shaping of structures) that mediate between different milieus, discourses, values and disciplines (Star & Griesemer, 1989). Furthermore, the introduction gives an overview of the role of different social actors. This is followed by a summary of current developments and the distribution of climate-damaging emissions based on different measures (production-based and consumption-based) and distributions (economic sectors, goods, activities and income distribution).

Climate-friendly living, structures and shaping of structures

The report is based on the following understanding of climate-friendly living: Climate-friendly living permanently ensures a climate that enables a good life within planetary boundaries. When climate-friendly living becomes the norm, it leads to rapid reduction of direct and indirect GHG emissions and does not burden the climate in the long term. Climate-friendly living strives to achieve a high quality of life for all while respecting planetary boundaries. It is about a good and safe life not only for a selected few, but for all – in Austria and globally. In this sense, justice as well as meeting all needs are both part of climate-friendly living. Similarly, the relations to other social and environmental goals (e.g., UN Sustainable Development Goals) are essential.

In this report, structures are the framework conditions and relations in which daily life takes place. In the literature the concept of structure is understood and defined in different ways; extensive and lengthy social science discussions cover this topic (compare Archer, 1995; Bhaskar et al., 1998). Each theory uses its own concepts and methods to identify structures, analyse them and evaluate their effects (compare Bhaskar et al., 1998). Generally, structures tend to be permanent phenomena with long-term effects. While they are maintained by social actions, they have an independent existence, meaning that in many cases they persist independently (e.g., regardless of whether individuals heat with gas, there are pipelines) and are relatively stable over time. The literature on climate-friendly living contains a variety of theories and mechanisms on how structures affect action and how they persist and change (Røpke, 1999; Schor, 1991; Shove, Trentmann, & Wilk, 2009; Stoddard et al., 2021). Among other things, a distinction can be made between immaterial (e.g., institutions, compare Gruchy, 1987; Hodgson, 1989; Vatn, 2005) and material structures (e.g., pipelines, roads, buildings).

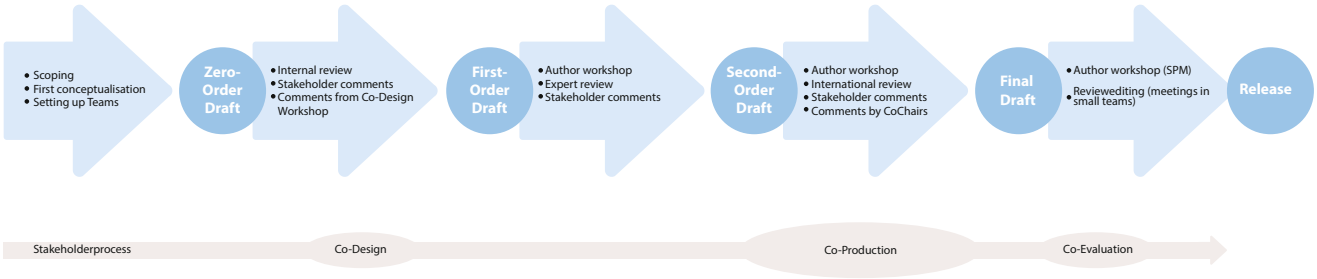

Fig. TS.1 Development process of the progress report and stakeholder process. {Chap. 1}

Shaping structures for climate-friendly living means targeted and coordinated action oriented towards a common good, being aware of the conflictual nature of social conditions, negotiating interests and implementing changes with democratic legitimacy. Shaping structures for climate-friendly living presupposes the problematization of existing structures that promote climate-damaging living and hinder climate-friendly living (compare Chap. 2, Governance and part 5). However, due to comprehensive challenges, continuous change, and reshaping of structures over the next decades is necessary (IPCC, 2022b). This must include integrated measures in order to achieve the desired results (Plank et al., 2021a). Binding decisions that actively exclude any climate-damaging structures and corresponding routines and practices are necessary (Hausknost & Haas, 2019).

Climate policy challenges in the context of other policy objectives

In order to achieve climate policy goals, such as the goal of climate neutrality by 2040 set in the Austrian government programme 2020–2024, the EU climate goals or the GHG emission reduction pledges under the Paris Climate Agreement, it is crucial to transform the structures in order to favour climate-friendly living. If current emission trends persist and comprehensive measures are disregarded, these objectives will fail (European Environment Agency, 2019; 2022b; Kirchengast & Steininger, 2020; Tagliapietra, 2021; Umweltbundesamt, 2020a).

In Austria in 2019 according to the territorial or also called production-based emission perspective, around 80 megatonnes of CO_2-equivalent (CO_2-eq) were generated (Fig. TS.3). The peak of territorial or production-based

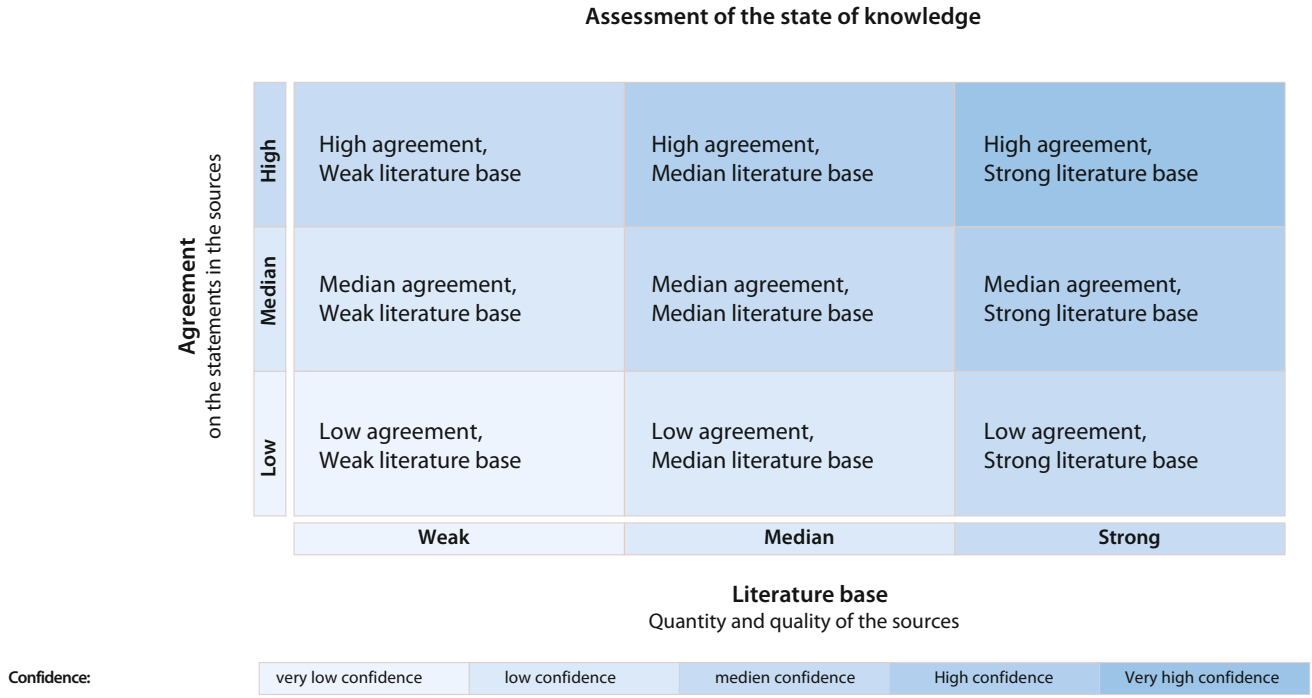

Fig. TS.2 Assessment of the state of knowledge in the assessment report (APCC, 2018). {Chap. 1}

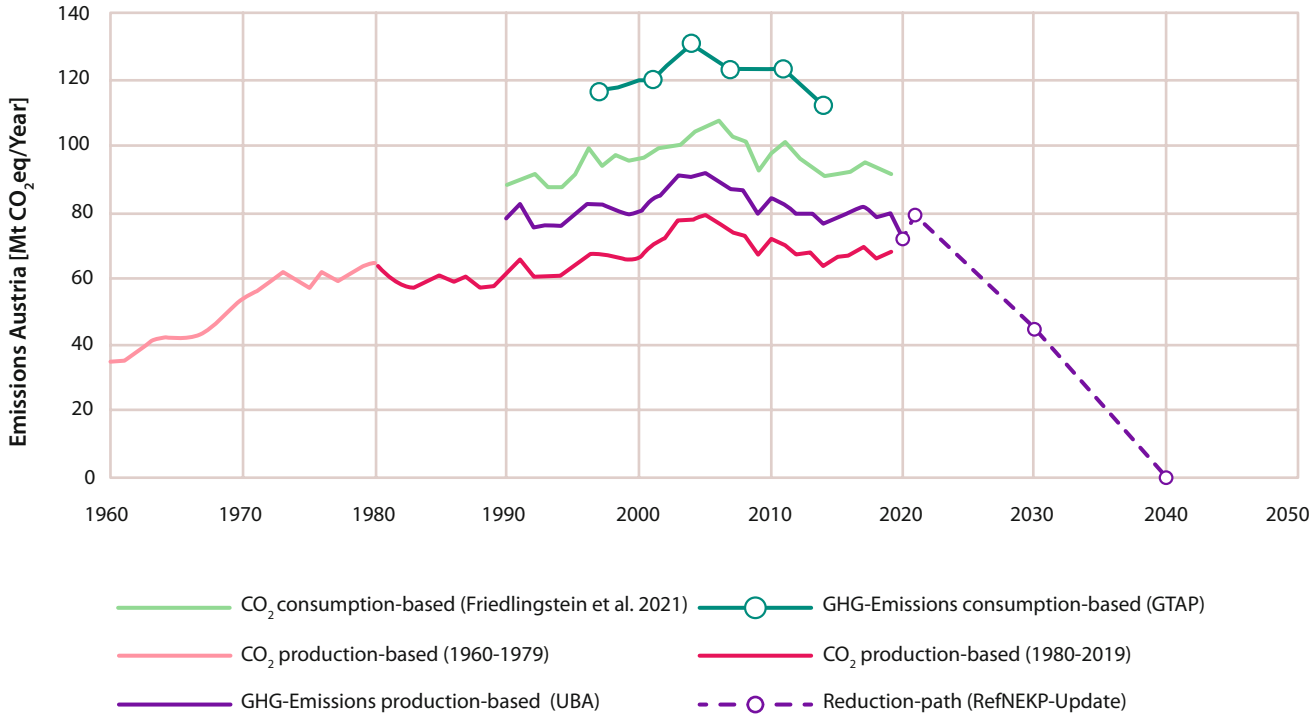

Fig. TS.3 Dynamics of Austria's climate-damaging emissions in territorial (production-based) and consumption-based methods ("footprint"). (Meyer and Steininger, 2017; Anderl et al., 2021; Nabernegg, 2021; Steininger et al., 2018, Friedlingstein et al., 2021). {Chap. 1}

emissions was around 90 megatonnes CO_2-equivalent in the mid-2010s. CO_2 emissions largely mirror GHG emissions in Austria. The ratio of consumption-based to production-based GHG emissions has also been stable in Austria over the last two decades.

Historically and currently occurring climate-damaging emissions can be attributed to different societal groups or actors, depending on the accounting approach used (Steininger et al., 2016; Williges et al., 2022, Steininger et al., 2022). For production-based accounting, a total of 76 megatonnes of CO_2 equivalent were produced in Austria in 2014; of these, about 20 per cent were produced directly by households, 30 per cent can be attributed to goods consumed in Austria, and 50 per cent were produced for exported goods (see Fig. TS.3). For the end-use or so-called consumption-based calculation, emissions in 2014 were about 112.5 megatonnes CO_2 equivalent and thus 47 percent higher than the production-based emissions. About 40 megatonnes of CO_2 equivalent incurred for goods that are produced and consumed in Austria or are generated by direct combustion of energy sources in households.

The method (production or consumption-based) of emissions account also affects their distribution across economic sectors, i.e. goods and services in case of consumption-based accounting (Fig. TS.4): In terms of production-based emissions by economic sector, about one third of emissions occur in the manufacturing industry (25 megatonnes CO_2 equivalent). More than half of these can be attributed to the steel industry and metal processing (14 megatonnes CO_2 equivalent), although the production of cement (4 megatonnes CO_2 equivalent) and computer and electronic products (4 megatonnes CO_2 equivalent) also have a significant share. Looking at consumption-based emissions by type of goods, emissions are primarily generated in goods production (41 megatonnes CO_2 equivalent), construction and housing (14 megatonnes CO_2 equivalent), private services (12 megatonnes CO_2 equivalent), public services (9 megatonnes CO_2 equivalent) and transport (8 megatonnes CO_2 equivalent). However, a significant part of these emissions occurs abroad.

Household consumption accounts for almost two-thirds (62 per cent) of Austria's consumption-based emissions (Nabernegg, 2021; Muñoz et al., 2020; Steininger et al., 2018). Consumption-based emissions are also unevenly distributed among households (Ivanova et al., 2018; Wiedenhofer et al., 2018) which can be explained by both quantity and composition of demand. The income of respective households has a significant influence on the level of emissions (Fig. TS.6b), also the spatial distribution – consumption-based emissions in the urban hinterland are particularly high (Munoz et al., 2020). With the analysis of time use, the climate relevance of everyday life can be better understood and potentials as well as limits for time- and demand-side contributions to decarbonisation can be analysed (Creutzig et al., 2021; Jalas & Juntunen, 2015; Wiedenhofer et al., 2018).

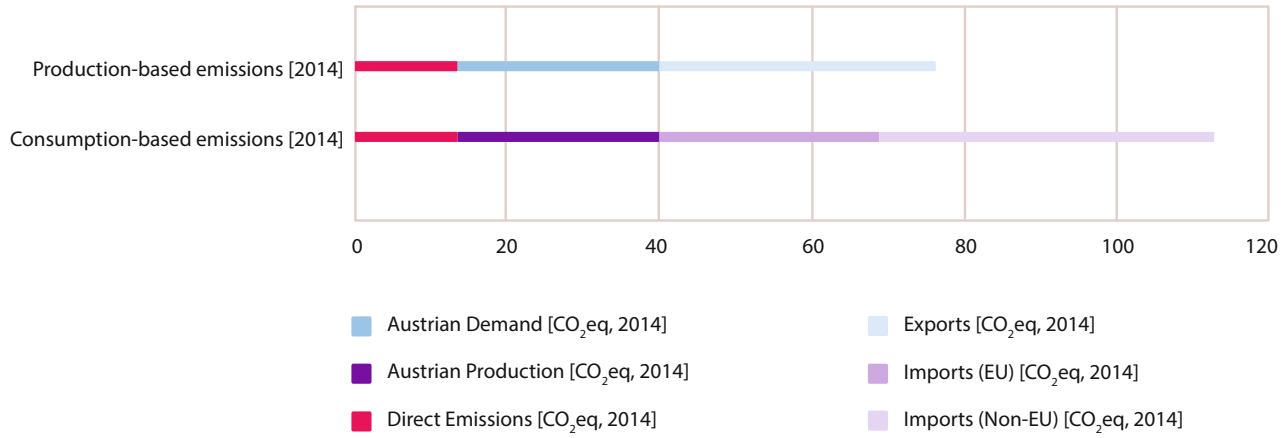

Fig. TS.4 Direct emissions, Austrian demand as well as imports and exports of climate-damaging emissions in Austria. *Top* Production-based emissions (Austrian demand and export). *Bottom* Consumption-based emissions (Austrian production, EU imports, non-EU imports). (Nabernegg et al., 2023, Steininger et al., 2018). {Chap. 1}

Chapter 2: Perspectives on the analysis and Shaping of structures for climate-friendly living

Chap. 2 systematises theories widely used in the social sciences, which analyse and shape structures of climate-friendly living along four perspectives. The chapter aims to make readers of the report aware of the fundamentally different approaches researchers use to analyse structures of climate-friendly living. This is important to understand that there is never only one, but always several perspectives on structures of climate-friendly living. This helps to grasp the complexity of the social sciences and thus the complexity of the task – to shape structures for climate-friendly living. Acknowledging different approaches also means developing a better understanding of conflicting problem diagnoses, goal horizons and options for shaping and – ideally – being able to deal with them.

Problem diagnoses, target horizons and design options with regard to the climate crisis are diverse, yet four main perspectives can be identified against the background of economic, social and cultural science debates: Market, Innovation, Provision and Society-Nature perspectives (medium agreement, strong literature base). There are no theories, models and heuristics that adequately capture all dimensions of change towards structures of climate-friendly living as well as their counterparts. However, in recent years, numerous social science approaches have opened up for the analysis of climate-unfriendly living (especially practice theory, innovation theories and theories of provisioning systems) and for questions of actively shaping structures for climate-friendly living. Therefore, the report offers the chance to juxtapose scientific findings from different disciplines with different foci, assumptions, tools and values. In this way, many dimensions of structures of climate-unfriendly living, as well as their transformation, can be captured.

Market perspective

From a Market perspective, price signals that encourage climate-friendly consumption and investment decisions are central to climate-friendly living. If there are appropriate framework conditions that regulate markets in a climate-friendly way, then the polluter pays principle and true costs contribute to decarbonisation (high agreement, strong literature base).

In this perspective, design as coordinated action is the setting of climate-friendly economic policy framework conditions, especially through incentive systems (Baumol & Oates, 1975). Research in behavioural economics also emphasises the importance of suitable framework conditions, i.e., structures for climate-friendly choices. These should provide incentives for changes in the direction of climate-friendly living by making lower-emission behaviour more preferable (Thaler & Sunstein, 2008) or by establishing this as the initial state ("default") in the first place.

Further changes in the framework conditions therefore result from altered choice architectures (including bans) changing the availability and hierarchy of options (e.g., through longer-term phase-out plans for fossil products or production). The approaches of behavioural economics increasingly complement the rational choice model, where the fully informed "homo economicus" is replaced by people with values and habits who include environmental knowledge in their calculations of costs and benefits (Daube & Ulph, 2016).

All this leads to less clear predictions about market outcomes. Calls for sustainable consumption as a core component of climate-friendly living are based on this perspective, as are calls for the internalisation of external effects and for an eco-social tax reform (*"to get the prices right"*) (see Akerlof et al. (2019) on CO_2 pricing).

Studies also show that decarbonisation occurs through the substitution of climate-damaging technologies and macroe-

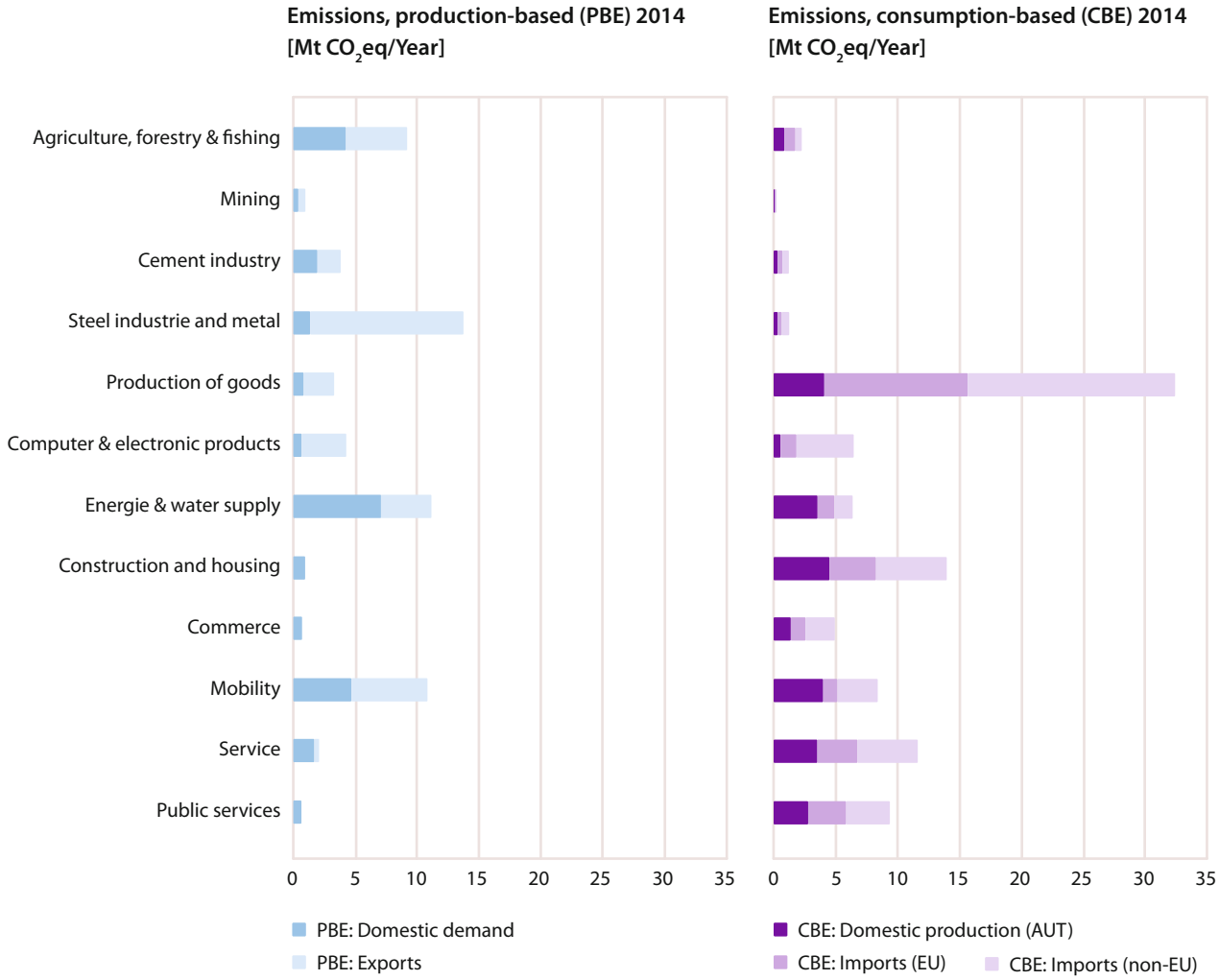

Fig. TS.5 Climate-damaging emissions by economic sector in Austria. *Left* Production-based emissions (Austrian demand and export). *Right* Consumption-based emissions by sector (Austrian production, EU imports, non-EU imports). (Nabernegg et al., 2023, Steininger et al., 2018). {Chap. 1}

conomic efficiency improvements as soon as investments in lower-emission technologies and change in consumption patterns are beneficial for individual decision-makers (Kaufman et al., 2020). According to this perspective, correct pricing also enables decoupling CO_2 emissions and economic growth.

Innovation perspective

The Innovation perspective focuses on the impact of different forms of innovation and their application on social and economic practices and thus on the environment, on climate (un)friendly living and economic activity. Focusing on socio-technical renewal of production and consumption systems (food, mobility, energy, housing, etc …), different approaches examine how (radical) innovations affect structures, how innovation systems enable innovations for sustainable development, and how innovations affect social and economic practices and associated environmental impacts (Avelino et al., 2017; Kivimaa et al., 2021; Köhler et al., 2019; Shove & Walker, 2014).

Leverage points of the Innovation perspective are innovation theories and theories of technological change: techno-economic paradigm shifts, technological or socio-technical system innovations, radical and incremental innovation and also actor-network theory (Dosi et al., 1988; Freeman & Perez, 2000; Köhler, 2012; Köhler et al., 2019; Latour, 2019; Malerba & Orsenigo, 1995). In light of today's societal challenges, scientific discourse is shifting from an almost exclusive emphasis on economic goals towards a normative orientation in line with the UN Sustainable Development Goals (Daimer et al., 2012; Diercks et al., 2019).

This perspective includes approaches to technological, entrepreneurial, organisational, product, process, marketing and system innovation as well as social, environmental, sustainability innovation and exnovation. The latter is a special

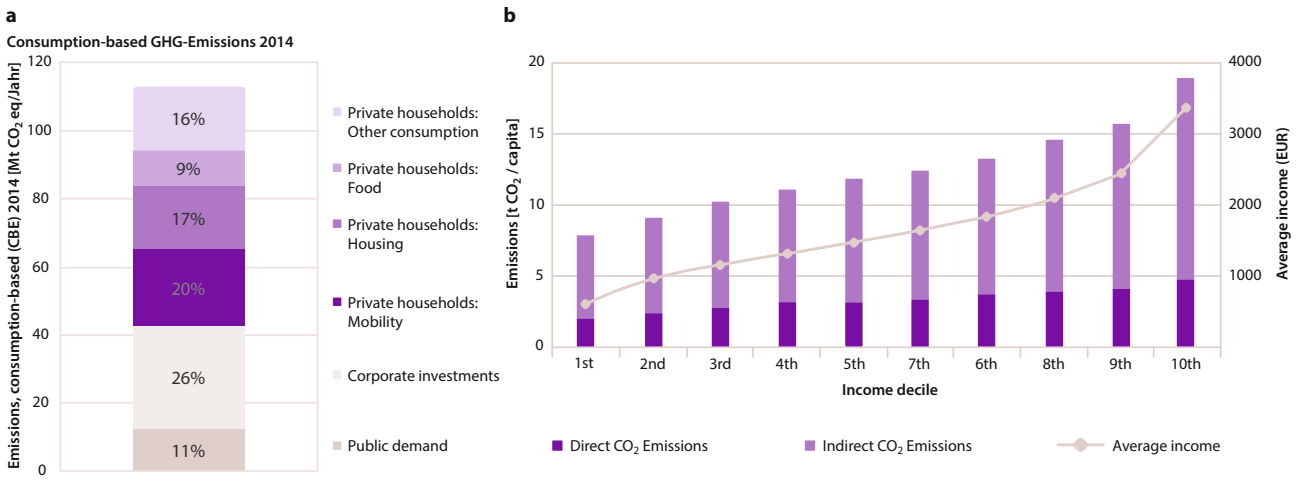

Fig. TS.6 Consumption-based CO_2 emissions of Austria. **a** Distribution of consumption-based emissions (CO_2-eq) from fossil energy and industrial processes by sector (private, corporate, public) and areas (mobility, housing, remaining consumption, food) for the year 2014 (Nabernegg et al. 2023). **b** Per capita CO_2 emission footprint in the respective income decile of monthly average income for the year 2004/5. (Muñoz et al., 2020). In the used data set emissions from global Landuse are under-reported, hence the climate-relevance of food and bioenergy are underestimated. {Chap. 1}

case as it focuses less on creating something new but on ending unsustainable solutions (Arnold et al., 2015).

Innovations serve not only entrepreneurial but also societal interests. They contribute to overcoming climate crisis if they improve the framework conditions for climate-friendly living and lead to sustainable economic and social practices. Innovation has the potential – intentionally or unintentionally – to change price structures, market structures, infrastructures, actor constellations, governance structures, organisational structures or entire socio-technical production and consumption systems (see part 5).

In the innovation perspective, shaping means consciously bringing about change through innovation (Godin, 2015). In particular, it is argued that both socio-technical or social innovations, legal frameworks and infrastructures (Bolton & Foxon, 2015), actor networks (Latour, 2019), governance processes (Köhler et al., 2019) and mental models such as images of the future (Grin et al., 2011; Schot & Steinmueller, 2018) can be shaped sustainably. In order to create structures and processes for change, new governance mechanisms (Köhler et al., 2019) are needed from an Innovation perspective that enable coordinated action across and between several administrative levels and involve actor groups and actor networks of production and consumption systems (e.g., through participation processes, roadmapping).

Provisioning perspective

From a Provisioning perspective, provisioning systems that facilitate sufficiency and resilience practices and forms of life, and thus make them the new status quo, are central to climate-friendly living. The Provisioning perspective is based on a broad understanding of economics, according to which economics concerns the joint organisation of livelihoods (Polanyi, 1944).

As theories of the Provisioning perspective combine material and cultural dimensions (Bayliss & Fine, 2020), social metabolisms with political economy approaches (Schaffartzik et al., 2021), and biophysical with social processes (O'Neill et al., 2018; Plank et al., 2021a), they create knowledge about the social (e.g., inequality, exclusion) and ecological (e.g., in terms of CO_2 emissions, land use and biodiversity) consequences of prevailing modes of providing certain goods and services. The aim is to ensure that long-term climate change mitigation and adaptation are compatible with securing basic services, i.e., the universal satisfaction of human needs, and protection against natural hazards (Jones et al., 2014; Mechler & Aerts, 2014; Schinko, Mechler, & Hochrainer-Stigler, 2017).

Due to their legal competence and resource endowment, public actors are essential for shaping services of general interest, climate protection and climate change adaptation. Important actors from this perspective are therefore political decision-makers who set the rules for provision in a political terrain, as well as public institutions, administrations and (public) companies developing climate-friendly business models or actively engaging in basic services and the social economy. If public institutions and other actors permanently change infrastructures, institutions and legal regulations, climate-friendly habits can take hold more quickly (high agreement, medium literature base).

Necessary changes to make climate-friendly practices commonplace include creating and promoting provisioning systems that encourage collective consumption (FEC, 2018), and making climate-friendly practices legally possible, culturally acceptable and economically affordable, e.g.,

decarbonised public mobility system for urban and rural areas (ILA Collective et al., 2017).

Following the Provisioning perspective, services of general interest (Krisch et al., 2020; Vogel et al., 2021), the foundational economy (FEC, 2020), universal basic services (Coote & Percy, 2020) and social-ecological infrastructures (Novy, 2019; Armutskonferenz et al., 2021) need to be strengthened and made more climate-friendly, while unsustainable infrastructures and economic sectors need to be deconstructed (Millward-Hopkins et al., 2020; O'Neill et al., 2018).

Society-Nature perspective

From the Society-Nature perspective, knowledge about key drivers of the climate crisis (e.g., human-nature dualisms, capital accumulation, social inequality) is essential for climate-friendly living. Theories in the Society-Nature perspective do not consider the social and (biophysical) nature as independent from each other, but as closely intertwined (Becker & Jahn, 2006; Brand, 2017; Foster, 1999; Görg, 1999; Haberl et al., 2016; MacGregor, 2021; Oksala, 2018; Pichler et al., 2017).

This perspective highlights that every challenge has social and biophysical implications (e.g., agricultural land becomes built environment). Conversely, it emphasises that biophysical nature also affects society (e.g., flood events are favoured by certain forms of development such as land sealing and undermine everyday actions). The structures made visible by the Society-Nature perspective include traditional ways of thinking embedded in science, but also in everyday life (e.g., disciplinary separation of the natural and social sciences, solving the climate crisis through technology, etc.) and economic logics and principles of order that underlie modern, capitalist societies (e.g., compulsion to grow including exploitation of nature and social inequality, modern institutions such as statehood, individualistic understanding of freedom, etc.).

The relevance of the Society-Nature perspective for designing climate-friendly structures lies in the analysis and assessment of conditions and solutions offered, especially with regard to their implications and scope (Becker & Jahn, 2006; Fischer-Kowalski & Erb, 2016; Fraser, 2014; Görg, 2011; McNeill, 2000; McNeill & Engelke, 2016). It also has the potential to increase the reflexivity of actors (see e.g., Bashkar, 2010), specifically with regard to deep-seated drivers of the climate crisis.

The term "society" is often equated with civil society in everyday life, but the Society-Nature perspective is not limited to civil society in this report, but also includes science, public institutions (government, administration, legislature) and political parties. Knowledge production, medialisation, problematisation and protest, ecotopias, but also law are instruments for shaping climate-friendly structures; however, they often evoke strong resistance (Brand, 2017).

Only if climate policies also reflect their relationship to drivers of the climate crisis (e.g., capital accumulation, Western domination of nature) it is possible to deal with the climate crisis subtantially (high agreement, medium literature base).

Perspectivism to analyse structures

This report relies on perspectivism to consider current challenges in their diversity with regard to problem diagnoses of climate-unfriendly structures as well as target horizons and design options of transformation paths. We thus acknowledge that cognition is always dependent on frames of reference (such as market logics, innovation discourses, socio-theoretical discourses) (Giere, 2006; Sass, 2019).

If only one perspective is taken as a leverage point (e.g., the one that is most socially compatible which is currently the Market perspective), then only certain problem diagnoses, target horizons and design options are considered (medium agreement, medium literature base). Each of the four perspectives has strengths and weaknesses, which must be recognised and named.

All four perspectives address structures. One of the strengths of the Market perspective is that it is particularly socially compatible due to the prominence of market logics. One of its weaknesses is its insufficient theorizing of individual behavior and strong focus on pricing. From a Provisioning and a Society-Nature perspective, on the other hand, both the focus on the individual and on market logics are drivers of the climate crisis rather than feasible solutions (Pirgmaier & Steinberger, 2019). One of the strengths of the Innovation perspective presented in this report is that it understands the concept of innovation as neither purely technological nor primarily market-oriented, but always considers innovations according to their social-ecological added value. One of its weaknesses is that it makes few clear statements about who and how decisions about the success or failure of innovations are made. The fact that the latter is always (also) a political process is only partially taken into account.

The following applies to shaping climate-friendly living: If several perspectives are taken into account, then the probability is highest that problem diagnoses, target horizons and design options can be understood in a differentiated manner, informed priorities can be set and incompatibilities as well as synergies can be identified (high agreement, medium literature base).

Part 2: Fields of action

Chapter 3: Overview fields of action

In order to achieve the climate goals agreed in Paris, changes are needed in people's everyday lives and in their daily behaviour. These changes cannot be triggered primarily by appeals to individual responsibility. Rather, adequate structures such as regulation, fiscal incentives, infrastructural changes and bans are needed to limit activities with high emissions or increase those with low emissions. Climate-friendly structures are needed to make climate-friendly actions easier to integrate into everyday life and to provide an attractive alternative to existing unsustainable practices (high consensus, strong literature base).

Part 2 provides a comprehensive overview of all areas of life by analysing the climate impacts of different fields of action. The climate impacts in the areas of housing, mobility and nutrition as well as for the fields of action of paid employment, provision, care and nursing work and the freely available time for recreation and social activities are examined. Individualistic and rationalistic theories of action focus on the behaviour of autonomous and constantly deliberating individuals. However, research approaches that focus on practices are gaining relevance (Røpke, 2015). Practices are more than daily routines. They are shaped by competence (ability e.g.: How do I borrow a book?), possibility (existing structure, e.g., public library, affordable and accessible) and the meaning to carry them out (time well-wealth, time sovereignty) (compare provision perspective in Chap. 2).

Currently, structures exist that prevent people at different levels from living in accordance with climate policy goals. Therefore, it is not enough to remove individual barriers. Shaping structures requires changing the structural contexts (both inhibiting and facilitating factors) within individual fields of action (high agreement, strong literature base). The coordination of measures between fields of action is crucial for successfully design structures. This requires an integrative and systemic approach to define framework conditions for individual behaviour. Conflicting measures that create conflicts or disadvantages in one or more fields of action jeopardise the achievement of climate policy goals. For example, it is not enough to simply improve the spatial infrastructure. In order to facilitate the switch from individual transport to public transport, the spatial distribution of mobility goals and the time economy in everyday life and of different mobility modes must also be taken into account (high agreement, strong literature base).

Different population groups (by gender, age, income) are affected differently by climate change and contribute to climate change to different extents through their GHG emitting activities. A good life for all can only be made possible if measures are taken to minimise inequalities. Redesigning time structures is central to this (high agreement, strong literature base). Calculating carbon footprints per daily activity enables the analysis of differences in population groups and per field of action (Smetschka et al., 2019) (Table TS.1). The personal time spent caring for oneself is relatively low-carbon, while both household and leisure activities show large differences in terms of CO_2 footprint per hour. The traditional gender division of labour shapes women's and men's time use patterns, which affect their CO_2 footprints.

A systematic review summarised the international emission avoidance and reduction potential of 60 consumption options from primary studies and several reviews from different countries (Ivanova et al., 2020) (Fig. TS.7). All options include both direct and indirect emissions in the production and provision of goods and services ("footprint").

It can be seen that a few options in the areas of mobility, food and housing have very high to medium potentials. Classic "environmentally friendly behaviour", such as separating waste, using less paper or optimising the use of household appliances, show rather low avoidance potentials when compared to, for example, using self-produced green electricity or giving up pets. The mobility sector shows the greatest potential for emission reductions, especially giving up the car, followed by switching to electric mobility and avoiding long-distance flights. Both automobility and air travel increase strongly with higher income. Therefore, the design of these mobility options is particularly important in a rich country like Austria. In the area of nutrition, the advantages of vegan to vegetarian diets or a very strong reduction of meat consumption are clearly evident. In the area of housing, investments in the expansion of renewable energies show the greatest potential, followed by the renovation and refurbishment of residential buildings, where again framework conditions and standards are decisive.

For consumption options with high avoidance potential, structural measures are necessary that remove infrastructural, institutional and behavioural barriers so that the realisation of avoidance potential is structurally enabled and preferred (Ivanova et al., 2020). Achieving good living with a high quality of life and less need for resources must start in all fields of action. The different ways to achieve this are, for example, concepts of using instead of owning or repairing instead of throwing away and focus on sharing services instead of accumulating material and waste (high agreement, strong literature base): Public awareness of the need for comprehensive climate policy measures is increasing. An active public debate, civil society movements as well as education and consciousness raising form the basis of a democratic public sphere as a prerequisite and goal of a climate-just transformation. It can be assumed that climate policy is a concern with a high level of acceptance, for which a large part of the population can be won over to the climate policy transfor-

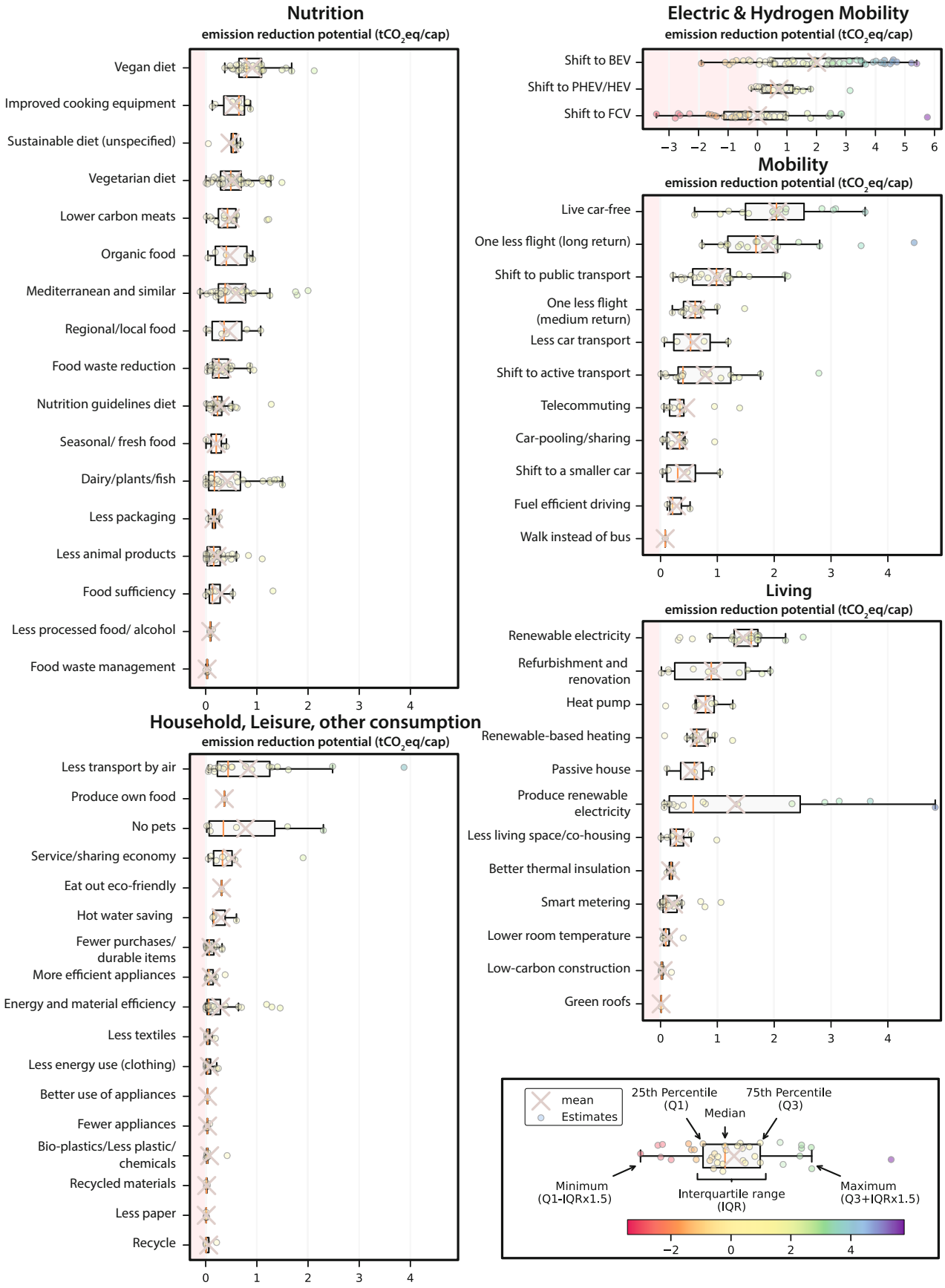

Fig. TS.7 The international emission avoidance and reduction potentials of 60 consumption options. Own representation adapted from Ivanova et al. (2020). {Chap. 3}

Table TS.1 Systems, time categories, activities and CO_2 footprint according to functional time use analysis. (Own representation according to Ringhofer & Fischer-Kowalski (2016); Wiedenhofer et al. (2018)). {Chap. 3}

Re-/production in system	Category of functional time-use	Entails the these activites in time-use studies	And CO_2e-Footprint of … (examples)	% CO_2e-footprint household
Person	Personal time	Sleeping, eating, personal care	Food, warm water, heating, hygiene products	**39 %**
Household	Locked time	Household work, provisioning for other people	Cooking, loundry, cleaning, furniture, repairs	**14 %**
Economy	Contractual time	Wage-labour, education	*In wage-labour good and services are produced as well as income is created, that finance and enable other activities*	**–**
Community	Free-time	Freetime, recreation	Culture, entertainment, sport, hobbies, …	**31 %**
Mobility *This time allows for other activities that people do in different places*		Different types of mobility	Direct emissions of fuels, and indirekt emissions from production of means of transport and infrastructure	**16 %**

mation. For a high acceptance and positive climate impact, it is crucial that this transformation does not create any new inequalities or that disadvantages and losses for some parts of the population are compensated accordingly by (social) policies (high agreement, strong literature base).

Chapter 4: Housing

In order to understand the structures of climate-friendly housing, an integrative view of the Austrian housing system is helpful. This includes all actors, activities and structural conditions involved in the field of housing, from land use and production to use and recycling. In the following, the literature on climate-friendly housing is presented along these dimensions.

Housing as a basic and existential need is an activity that extends beyond one's own living space into the neighbourhood and open spaces. It consists of a multiple network of relationships between ecological, economic, social and cultural aspects. Residential buildings comprise 82 per cent of the total Austrian building stock (Statistik Austria, 2019c). Of these, 65.8 per cent are single-family houses (Statistik Austria, 2013). In 2019, the buildings sector produced around 8.1 million tonnes of GHG emissions in operation alone, which corresponds to a share of the buildings sector operation of 10.2 per cent of all GHG emissions in Austria in 2019 (Umweltbundesamt, 2021c), with residential buildings dominating in this with a share of 8.2 per cent (Statistik Austria, 2019c). A reduction in GHG emissions from the operation of buildings was observed from 1990 to 2014, although these emissions increased again between 2014 and 2017 (Umweltbundesamt, 2021c).

The average living space per person in a main residence in Austria is 45.3 m^2 per person, in Vienna it is 36.1 m^2 per person, in Burgenland 54 m^2 per person (Statistik Austria, 2019c). The increase in land consumption for residential and commercial areas is 23 km^2 in Austria in 2020 (Umweltbundesamt, 2021a). Vacancy plays a central role in avoiding land consumption in the residential sector. However, a complete and comprehensive vacancy survey for Austria is currently not available (Schneider, 2019) (high agreement, weak literature base).

Compared to housing estates and multi-storey residential buildings, single-family houses have a significantly worse balance. Grey emissions, i.e., the total energy required for the production, installation and demolition of structural building elements, but also vacancies play a major role here. The continued use of vacancies could help to curb the construction of new single-family houses, which as a form of housing have the highest land consumption and go hand in hand with the provision of extensive infrastructure investments (especially in the area of transport). In addition, it is a matter of making the building volume more energy-efficient. In Vorarlberg, for example, refurbishment in the form of energy-efficient building upgrades with ecological materials could reduce the global warming potential of buildings from the 1970s by 72 per cent compared to pure maintenance without thermal refurbishment (Energieinstitut Vorarlberg, 2020). However, the renovation rate has declined by a quarter across Austria since 2010 (Global 2000, 2021; IIBW, Umweltbundesamt, 2020) (high agreement, strong literature base). The switch to renewable energy in the residential sector is poor, with the renewable share of district heating generation and consumption in 2018 at only 48 per cent (Umweltbundesamt, 2022) (high agreement, medium literature base). New technical solutions are easier to implement in new buildings, but there should be

a clear focus on the existing stock and its retrofitting (Amann & Mundt, 2019).

Due to federalism, knowledge and responsibilities of decision-making are fragmented in housing construction in Austria. Minimum standards for residential construction (e.g., green space factor, sealing factor, energy efficiency standards, etc.) are mainly set by the building regulations of the nine states (Länder). Since 2021, all residential buildings must meet the minimum requirement for a low-energy building as defined in the EU Buildings Directive (Article 2, Clause 2 of Directive 2010/31/EU). Housing subsidies are regulated at the state level according to the Austrian federal distribution of competences. Building permit procedures are enforced at the municipal level.

The greening of the residential construction sector concerns both building biology (e.g., toxins in building materials) and building ecology (land, resource and energy consumption in construction, ongoing operation and recycling). An important goal is to promote the certification of ecological building materials. The use of new – partly low-tech, insofar old – construction methods is often hindered by cost-intensive approval and testing procedures. When resources are lacking to initiate testing processes for alternative building materials and elements, the use of industrial products becomes entrenched regardless of the ecological qualities and benefits of alternative building materials (Bauer, 2015; Reinhardt et al., 2019) (high agreement, medium literature base). In the context of social-ecological construction, urban mining increases resource efficiency and promotes a recovery of secondary raw materials. This reduces the consumption of primary raw materials and enables to a large extent independence from imports; also using resource inventories to identify anthropogenic stockpiles (Allesch et al., 2019; Kral et al., 2018) (high agreement, medium literature base). The use of recycled building materials and material-conscious design enables circular construction (Kakkos et al., 2020; Brunner, 2011) (high agreement, low literature base).

In the currently dominant market-based system, sufficient housing supply for lower and middle income groups in urban regions is becoming increasingly difficult (Kadi et al., 2020) (high agreement, low literature base). The lower and middle income groups can hardly contribute to a climate-friendly society, as they have to rely on cheaper housing with poorer construction quality and therefore poorer energy efficiency in low-supply neighbourhoods (Weißermel & Wehrhahn, 2020) (high agreement, low literature base). Around 20 per cent of all Austrians and around 45 per cent of Viennese live in a municipal or cooperative flat today (Schwarzbauer et al., 2019; Van-Hametner et al., 2019). The privatisation or capitalisation of formerly public and/or non-profit assets of the housing sector bears the risk of playing off social concerns against climate protection and other ecological concerns (Weißermel & Wehrhahn, 2020) (high agreement, low literature base). The most recent surveys on Austria from 2016 put the number of households affected by energy poverty at 117,100. Representatives of the Austrian Anti Poverty Network assume much higher numbers (Armutskonferenz, 2019, 2020) (high agreement, strong literature base).

There is potential in the binding coordination and cooperation of urban and rural regional planning. A major barrier is the competence of mayors as building authorities of first instance. Currently, there is no national monitoring system to record all thermal-energy relevant renovation activities (Umweltbundesamt, 2020a) (high agreement, strong literature base). There is a need to merge responsibilities at the federal level in the form of a national coordination and monitoring body for housing. Responsibilities would be the establishment of housing research that, among other things, develops an Austrian model of housing and examines the social conditions and possibilities for housing supply as well as future-oriented, sustainable and socially just forms of housing, and pushes for a stronger earmarking of housing subsidies to ecological and social requirements by means of object subsidies (Alliance of Sustainable Universities, 2021) (high agreement, strong literature base). An area-wide vacancy survey is important for a resource-saving housing policy. Activation and mobilisation of existing housing stock should be prioritised over new construction (Koch, 2020) (high agreement, low literature base).

Activating and making the housing stock more attractive reduces new construction activities and prevents the further expansion of settlement areas in the form of increasing soil sealing. These climate-friendly potentials can unfold through preserving, repairing and rethinking cross-urban approaches and public welfare-oriented cooperation as well as participation concepts in combination with life cycle considerations and circular, ecological use of materials (Ebinger et al., 2001) (high agreement, low literature base). The refurbishment of private rental housing could be supported by a shortened tax deduction of refurbishment costs or alternatively with investment premiums (Amann, 2019). Low-income earners can be offered the alternative of claiming a negative tax. With the increased focus on the existing stock and thus on renovations, a shift in the professional-technical as well as in the craft sector of the construction industry will begin, including adequate instruments for retraining as well as related support mechanisms, as well as a shift in economic performance. This also requires better pay and higher social status for construction workers (Amann, 2019) (high agreement, low literature base).

Detaching housing provision from the logics of the market (decommodification) requires small-scale mapping of the territorial distribution and price development of existing housing. Availability of communal land and housing stock is particularly important for this, which is why a decom-

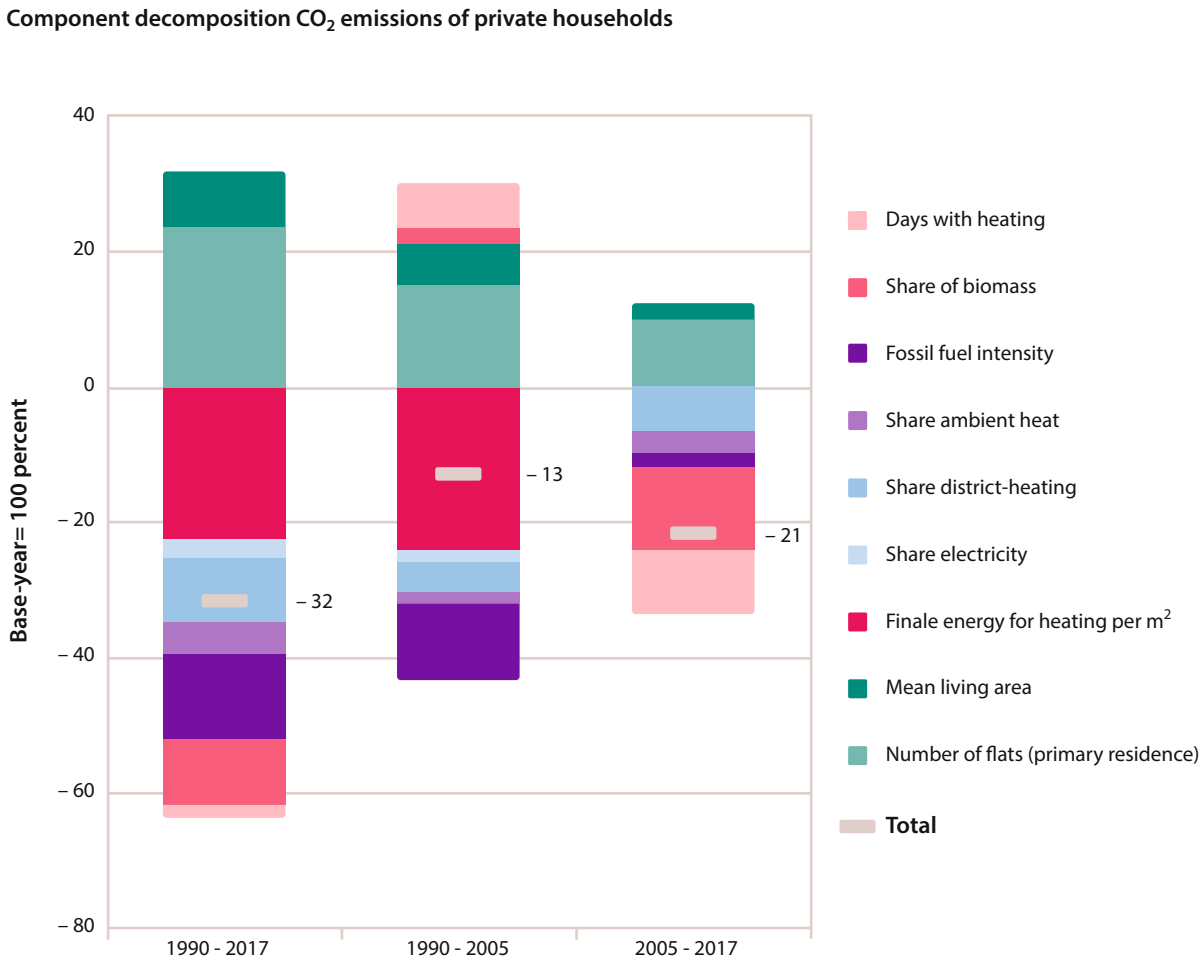

Fig. TS.8 Component decomposition of carbon dioxide emissions from private households. (Federal Environment Agency, 2019a). {Chap. 4}

modification policy with such a goal cannot be limited to housing alone, but must also include land as a finite resource. Non-profit forms of organisation are called for to further develop land allocation for housing purposes (Kaltenbrunner & Schnur, 2014) (high agreement, low literature base). Instruments such as temporary dedication, re-dedication, expropriation, building land reallocation or the municipality's right of first refusal are also mentioned (ÖROK, 2017) (high agreement, strong literature base). In the province of Salzburg, active land policy is pursued by means of reserved areas "to secure land for the construction of subsidised rental, hire-purchase or owner-occupied flats" (Land Salzburg, 2008) and in Tyrol by means of "reserved areas for subsidised housing" (Land Tyrol, 2016). In order to enable decarbonised, social-ecologically just housing construction in the sense of the common good, it is above all necessary to regain more scope for disposal and action for public and municipal authorities. Similarly, alternative housing concepts, e.g., in the form of cohousing, eco-villages, Mietshäusersyndikat, etc., can promote novel and inclusive approaches in economic, ecological and social terms for general housing (Lang & Stoeger, 2018; Höflehner, Höflehner, 2019; Jany, 2019; van Bortel & Gruis, 2019) (high agreement, strong literature base).

Chapter 5: Food

In order to understand the structures of climate-friendly nutrition, it is helpful to take an integrative view of food systems. This includes all actors, activities and structural conditions involved in nutrition, from production to food waste. In the following, the literature on climate-friendly food is reviewed along these dimensions.

Worldwide, food systems are responsible for about one third of all anthropogenic GHG emissions; one third each is accounted for by land use changes, direct emissions from agriculture and the further processes of the food system up to disposal (Crippa et al., 2021). A cross-sectoral analysis attributes around 10 percent of all Austrian GHG emissions to agriculture (Umweltbundesamt, 2021c). Since 1990, GHG emissions from agriculture have been reduced by 14.3 percent due to more efficent fertiliser use and a decrease in

livestock (Umweltbundesamt, 2021c). In recent years, however, they have remained constant. A further reduction of GHG emissions in agriculture is not a priority on the political agenda. Measures are only insufficiently implemented.

From a scientific point of view, animal husbandry holds great emission reduction potential (IPES, 2019; SAPEA, 2020) (high agreement, strong literature base). In Austria, this potential is not addressed in agricultural policy. With regard to food consumption, research points to high synergies between climate protection and health goals in the case of a reduction in the consumption of animal products (APCC, 2018; Willett et al., 2019) (high agreement, strong literature base). However, the potential for reducing the consumption of animal products has so far been ignored in climate change strategies. Dietary practices reflect social inequality structures. There is also high potential for reducing greenhouse gas emissions by avoiding food waste (IPES, 2019; SAPEA, 2020). If this is to be realised, actors along the entire value chain must be held responsible (high agreement, strong literature base).

Processing and retail are important parts of the value chain in terms of climate policy. Characterised by a very high level of concentration, food retailing has expanded the range of climate-friendly products on the market, but this does not mean that climate-damaging structures in the food system are being dismantled. Political regulations of the retail sector have so far been limited to measures of low effectiveness. Alternative distribution channels beyond the supermarkets are offered in the form of direct marketing practices by farmers, which are widespread in Austria. These can contribute to reducing transport-related GHG emissions by shortening the distances between production and consumption and by designing logistics in a climate-friendly way. However, the climate relevance of "food miles" is often overestimated (Enthoven & Van den Broeck, 2021; Paciarotti & Torregiani, 2021). Organic food production is often associated with climate friendliness in the public perception. Nevertheless, studies here provide very context-specific results (Seufert & Ramankutty, 2017) (low agreement, weak literature base). Due to the lower yields per hectare in organic farming, expansion potentials in organic farming for a more climate-friendly diet are often linked to a simultaneous reduction in the consumption of animal products (e.g., Hörtenhuber et al., 2010; Niggli, 2021; Schlatzer et al., 2017; Theurl et al., 2020).

Necessary changes, barriers and conflicts in the field of climate-friendly nutrition are primarily expressed in four fields: (1) in the contested transformation of policy areas, (2) in the conflict topic of meat, (3) in labour conflicts and (4) in conflicting forms of knowledge. First, an integrative food policy geared towards climate goals is called for by civil society actors and academia; this can combine different policy areas such as climate, environmental and health policies (APCC, 2018; IPES, 2019) (high agreement, medium literature base). It conflicts with interests of agrarian advocacy, agri-food industry and trade, which predominantly want to maintain the status quo of the current trade system, as well as with the current design of the European Union's Common Agricultural Policy (Nischwitz et al., 2018). Secondly, our economic system pushes production, processing, consumption and a comparatively low appreciation of animal products, as it is based on providing cheap products and exporting them (Plank et al., 2021c). This is culturally supported by routines. For example, meat is seen as essential (Oleschuk et al., 2019) and lack of time contributes to food waste (Devaney & Davies, 2017; Plank et al., 2020b) (high agreement, strong literature base). Thirdly, labour conflicts are visible in the field of harvesting, the processing industry, supermarkets and food delivery, as well as through farm abandonment, which calls for the valorisation of human labour to ensure the social dimension of climate-friendly structures (Behr, 2013; Möhrs et al., 2013) (high agreement, medium literature base). Finally, research questions do not address the realities of farmers' lives (Laborde et al., 2020; Nature, 2020). Important research gaps are evident in the role of the processing industry, agriculture, upstream agribusiness and food retailing. These need to be better addressed in future research on the provision of structures for climate-friendly living in order to be able to make more concrete statements about their responsibilities (medium agreement, low literature base).

Transition paths towards a climate-friendly food system are controversially and often simplistically discussed in dichotomous terms: "bioeconomy" versus social-ecological transformation of production and consumption practices in an "ecoeconomy" (Ermann et al., 2018; Horlings & Marsden, 2011); agroecological versus industrial systems (IPES, 2016); food as a commodity versus food as a common good or human right (Jackson et al., 2021; SAPEA, 2020) (low agreement, weak literature base). Although such an either-or perspective may be analytically useful, change processes can gain from a "both/and" approach: technical AND social innovations, agro-ecological AND industrial approaches, centralised AND decentralised approaches, production-side AND consumption-side measures (Ermann et al., 2018). Reduction targets could be pushed through higher prices (e.g., local feeding or full pasture, higher animal welfare standards, organic) or taxes on climate-damaging foods such as meat. These would hit socially disadvantaged groups harder. However, there are great synergies here with health goals, as socially disadvantaged groups in particular are disproportionately affected by the diet-related health consequences of current dietary patterns with high meat content and highly processed foods (Brunner, 2020; Fekete & Weyers, 2016).

Climate-friendly nutrition aims at socially inclusive, inequality-reducing diets. The acceptance of changes towards a climate-friendly agri-food policy depends not least

on an effective social policy and a balancing of territorial imbalances between urban and rural areas or agricultural areas with favourable or unfavourable conditions (SAPEA, 2020). A nutritional turnaround can be supported by more transparency regarding origin, environmental and animal welfare standards as well as legal restrictions on advertising or promotional offers for climate-damaging and unhealthy foods, as well as by expanded access to knowledge, for example through direct interactions between consumers and producers (Ermann et al., 2018; IPES, 2019; SAPEA, 2020). In public discourse, the linear, fossil fuel-driven production model of cheap mass-produced goods could be replaced by a circular economy with a focus on quality, waste reduction, nutrient cycling and carbon sequestration (SAPEA, 2020). Climate-related standards in trade agreements, effective emissions trading and international CO_2 pricing (including a carbon boarder tax adjustment) support national efforts (European Commission, 2020b; SAPEA, 2020). Climate-friendly and circular agri-food systems open up new business models and investment opportunities, for example in connection with the use of food waste, carbon sequestration, biorefineries, biofertilisers or bioenergy (European Commission, 2020b; Hörtenhuber et al., 2019; Zoboli et al., 2016). In order to be able to react flexibly to the uncertainties – inherent in the food system – adaptive, inclusive and cross-sectoral approaches that rely on decentralised self-organisation, entrepreneurship and social learning and are strongly promoted by governmental and financial policy incentives seem to be particularly promising (IPES, 2016, 2019; SAPEA, 2020) (high agreement, medium literature base). As technological innovations with a focus on eco-efficiency are not sufficient to achieve climate and environmental goals, these should be complemented by sufficiency approaches and measures to reduce energy and material turnover (Haberl et al., 2011, 2020; Theurl et al., 2020) (high agreement, low literature base).

Chapter 6: Mobility

In order to understand the structures of climate-friendly mobility, an integrative perspective on mobility systems is necessary. In the following, the literature on climate-friendly mobility, the actors involved and structural conditions is reviewed.

Transport and mobility is one of the biggest challenges both for Austria and globally in achieving climate goals (EASAC, 2019; Kurzweil et al., 2019) (high agreement, strong literature base). GHG emissions from the transport sector account for over 30 per cent of total emissions in Austria. In 2019, these reached 24.0 megatonnes CO_2 equivalent in road transport, caused by the increase in mileage (see Fig. TS.9).

In addition, there are around 3.0 megatonnes of CO_2 due to international air traffic (high agreement, strong literature base). The number of car trips and the degree of motorisation in Austria also continue to increase. The modal split share for car trips increased from 42 per cent in 1983 to 51 per cent in 1995 (Sammer, 1990; Herry et al., 2012) and to 58 per cent in 2014 (Follmer et al., 2016). The level of motorisation increased by more than 10 per cent between 2000 and 2019 to 562 cars per 1000 inhabitants (Statistik Austria, 2019a, 2019b). Energy use in transport (including fuel export in tanks, i.e., when trucks in particular tend to refuel in Austria due to the comparatively lower fuel prices in international transit) amounted to 401 petajoules (PJ) in 2018 and doubled compared to 1990 (Statistik Austria, 2021). 90 per cent of energy use is based on fossil fuels. Transport performance (= "transport expenditure") in passenger transport across all transport modes increased from 76.7 billion to 115.3 billion passenger kilometres (+50 per cent) between 1990 and 2019 (Anderl et al., 2021). Between 2000 and 2017, passenger transport in Austria grew by around 23 per cent, more than twice as fast as the population in the same period (Anderl et al., 2020). At the same time, the average occupancy rate across all routes for passenger cars fell from 1.40 to 1.14 persons per car since 1990 (Anderl et al., 2021) (high agreement, strong literature base).

In freight transport, transport performance is closely linked to economic performance and increased by 149 percent between the years 1990 and 2018 to 84.3 billion tonne-kilometres (tkm); 73 percent of transport performance was provided via road in 2019 (Anderl et al., 2021). Domestic truck mileage (light and heavy commercial vehicles) increased by about 91 per cent since 1990, and transport performance (in tkm) by 168 per cent (Anderl et al., 2020). In the same period, the relative share of rail in modal split of total freight transport fell from 34 percent to 27 percent (Anderl et al., 2021).

For passenger and freight transport, it should be noted that efficiency improvements in vehicle propulsion technology are offset by increasing mileage (= "driving effort") and the trend towards larger, heavier and more powerful vehicles (Helmers, 2015). It is also worth mentioning the share of fuel exports in GHG emissions from road transport, which was reported to be 5.8 megatonnes CO_2 equivalent in 2019, quadrupling since 1990 due to price differences with foreign countries (Anderl et al., 2021) (high agreement, strong literature base). The global goal is to gradually decarbonise mobility by 2050 (United Nations General Assembly, 2015) and in Austria by 2040 (BMK, 2021a). To achieve the European Green Deal targets, a 90 per cent reduction in transport-related GHG emissions by 2050 would be necessary (European Commission, 2020d) (high agreement, strong literature base).

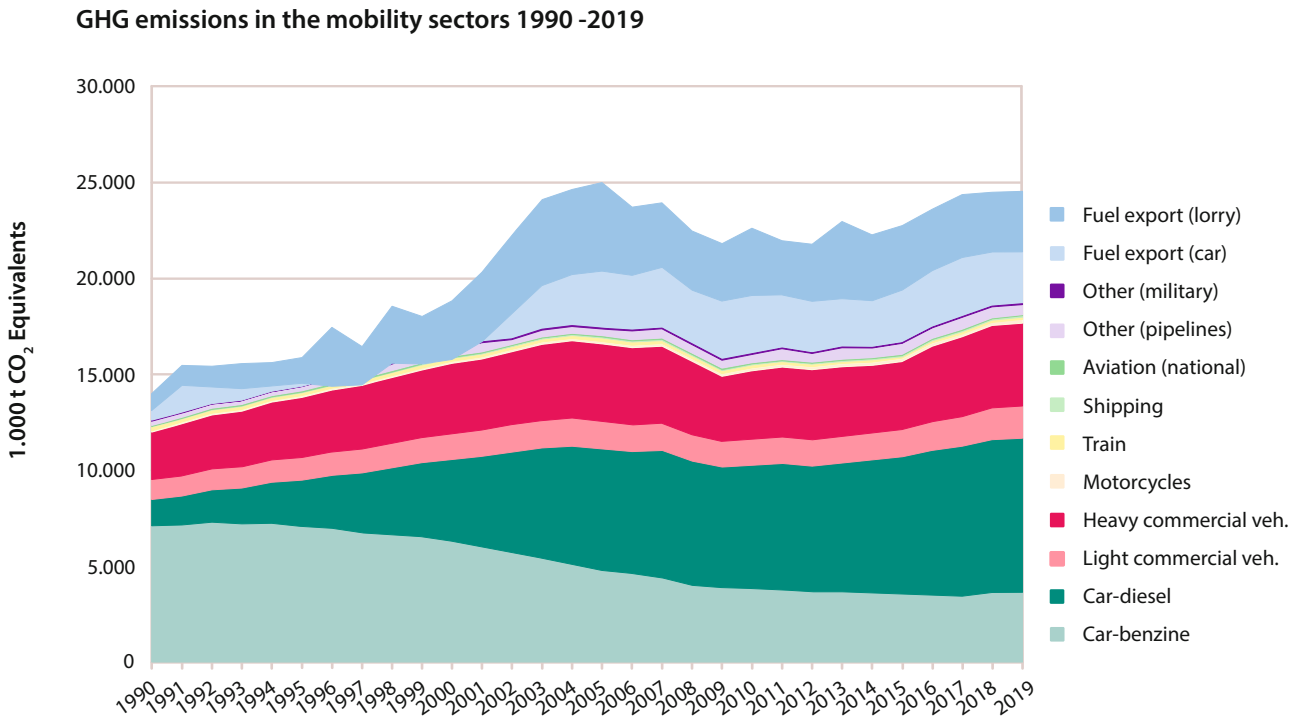

Fig. TS.9 GHG emissions of the transport sector (in 1000 tonnes CO_2 equivalent) (Umweltbundesamt, 2021d). Note: Mobile devices, machinery (tractor, building machines), and international aviation are not considered to be part of the transport sector. Classification according the Kyoto-CRF-Format. {Chap. 6}

These goals were explicitly stated in a series of (transport) political declarations of intent (BMNT, 2018; Heinfellner et al., 2019; BMK, 2021b; ÖVP & Grüne, 2020) and measures to achieve these goals were formulated. The proposed measures range from the expansion of walking and cycling, strengthening and expanding public transport to shifting freight transport to rail, using agricultural fuels and increasing e-mobility (Heinfellner et. al. 2019). Other sensible and effective measures mentioned include increasing fossil fuel and motor-related insurance tax, reducing the general speed limit on motorways and on rural roads to 100 and 80 km/h respectively, introducing city tolls, a quality offensive for walking, cycling and public transport, and including environmental and climate policy in spatial planning in the area of passenger transport (Heinfellner et. al. 2019) (high agreement, strong literature base). In freight transport, measures in the area of electrification, levying of a nationwide toll, measures for introducing true costs and digitalisation initiatives are identified as promising (Heinfellner et. al. 2019) (high agreement, medium literature base).

The scientific evidence (EASAC, 2019; Heinfellner et al., 2019; BMK, 2021b) shows that the goal of "zero GHG emissions" from motorised transport by 2040 is not achievable with the above-mentioned measures alone. Further measures influencing transport behaviour are needed (high agreement, strong literature base). Measures and concepts such as "the city of short distances", the redistribution and attractiveness of public space and new forms of traffic calming (e.g., superblocks) are mentioned. Furthermore, the internalisation of external costs, e.g., within the framework of an eco-social tax reform (CO_2-pricing) and a technically relatively easy-to-implement kilometre-based tax are proposed, adequately pricing costs of infrastructure, accident consequences, congestion, noise, CO_2 – and other external costs of motorised goods and individual transport (Kirchengast et al., 2019). This area-wide road user charge could be expanded to include time-of-day, road type and vehicle type-dependent components in order to have a targeted steering effect on transport demand.

Other effective measures mentioned are: (1) the abolition of "counterproductive" subsidies in the transport sector, e.g., commuter tax allowance, framework conditions for company cars, tax concessions for diesel, standard consumption tax, vehicle insurance tax law, fiscal trucks, etc. (Kletzan-Slamanig & Köppl, 2016a); (2) introducing traffic polluter-pay tax (Schopf & Brezina, 2015, p. 42 ff); (3) adjusting building regulations with regard to the number and spatial arrangements (keyword "equidistance") of car parking spaces at workplaces and residential complexes (Knoflacher, 2007); and (4) redistributing road space in favour of pedestrians and cyclists (Knoflacher, 2007) (high agreement, strong literature base). It should be noted that a social balance must be ensured when implementing transport policy measures presented above, as monetary measures in particular could place

a greater burden on lower income groups if increased taxes and charges are not adequately redistributed (Dugan et al., 2022) (high agreement, strong literature base).

Structural measures in the field of transport, like changes in responsibilities of local authorities, implementation processes, construction of infrastructures and in overall objectives (e.g., ensuring access while remaining within planetary boundaries instead of satisfying the seemingly unlimited demand for motorised individual mobility), amendment and adaptation of laws, etc., require long time periods (5 to 20 or even 30 years) to become effective. Only when these structural changes have been implemented can behavioural changes be noticed – again with a time lag – in society and in the associated economic system (Emberger, 1999, p. 89 ff). Since Austria has committed itself in the context of the Paris Climate Agreement to keeping global warming to no more than 1.5 degrees, aiming for a decarbonised transport system by 2040, targeted, ambitious, and rapid action by all actors involved is necessary (high agreement, strong literature base).

Chapter 7: Employment

The chapter deals with structural conditions for climate-friendly employment. This includes on the one hand the employment as well as working conditions and how they allow for climate-friendly behaviour at the workplace. On the other hand, it deals with the question of how wage-labour must be shaped so that people can also live climate-friendly beyond their employment.

Wage-labour is central to people's lives. It is not only a source of individual subsistence and material security, but also enables social integration, the creation of meaning and the development of identity. At the same time, wage-labour is highly relevant for climate policy, as it involves countless activities and processes that are associated with energy and resource consumption (Table TS.2). There is a broad consensus in the literature that employment is a significant element of a climate-friendly transformation of the economy and society (Bohnenberger, 2022; Seidl & Zahrnt, 2019).

Large areas of wage-labour currently do not meet the requirements for climate-friendly living (Hoffmann & Spash, 2021). Therefore, structural conditions of employment need to change fundamentally (high agreement, strong literature base). Achieving the decarbonisation goals at the European and national level requires fundamental changes, especially in the production sector (Meinhart et al., 2022; Steininger et al., 2021; Streicher et al., 2020). Work in the service sector causes lower emissions on average compared to other sectors. However, the service sector is based on the upstream production of goods. In addition, emission-intensive services also exist, especially in transport (Hardt et al., 2020, 2021).

Employment is an important aspect in structuring daily lives and thus has a significant influence on the extent to which employees can live climate-friendly beyond work. The amount of work, stresses and strains, but also experiences of meaningfulness and social recognition related to employment have an impact on the actions and conduct of employees in their non-working time. Four conceptual approaches to employment-related climate policies can be identified in the literature: (1) Green Jobs (Janser, 2018); (2) Just Transition (ILO, 2015; TUDCN, 2019;) (3) Sustainable Work (Barth et al., 2016; Littig et al., 2018; UNDP, 2015); and (4) Post-Work (Frayne, 2016; Hoffmann & Paulsen, 2020).

In some sectors, climate-friendly work can be achieved through the conversion to renewable energy and other (technological) innovations. Other sectors require terminations or the conversion to more climate-friendly products and services (high agreement, strong literature base) (UNDP, 2015). Potential impacts on employment have been explored, for example, for the phase-out of the internal combustion engine (Sala et al., 2020; Wissen et al., 2020). In the transformation phase, the volume of paid work is likely to remain constant due to the necessary reconstruction of infrastructure (medium agreement, medium literature base) (Aiginger, 2016). In the longer term, a reduction in the volume of work might be necessary in order to prevent exceeding ecological limits (medium agreement, weak literature base) (Hoffmann & Spash, 2021; Seidl & Zahrnt, 2019).

In order for the necessary structural change to succeed, liberal democracies need to involve all major social forces and take into consideration different interests. Companies and their interest groups, as well as trade unions, can be both inhibiting and driving forces of structural change (high agreement, medium literature base). There is an awareness of the need for transformation both on the part of employees (including Littig, 2017; Niedermoser, 2017a; see also "AK Klimadialog": https://wien.abeiterkammer.at) and on the part of companies (e.g., BMK, 2021a; GLOBAL 2000, Greenpeace and WWF Austria, 2017). Structural change should be actively designed and combined with other measures. From the perspective of workers, safeguarding material security and the fair distribution of transformation costs are crucial (Laurent, 2021; ISW, 2019; ÖGB, 2021; Wissen et al., 2020) (high agreement, weak literature base).

Employment is an important driver of economic growth. Employment loss that originates from productivity increase can be avoided through economic growth (Antal, 2014; Seidl & Zahrnt, 2019). At the individual level, the interrelation between income, social security, recognition, participation and employment restricts the scope for shaping climate policy (high agreement, medium literature base) (Bohnenberger & Schultheiss, 2021; Hoffmann & Paulsen, 2020).

Technological developments such as digitalisation are ambivalent and can either support or hinder the social-

Table TS.2 Sectors with the highest CO_2 emissions in Austria (in absolute terms, 2016). CO_2 emissions, employees and gross value added by sector (2016). (Source: Statistics Austria, WIFO calculations, quoted from Meinhart et al. (2022: Annex), own presentation). {Chap. 7}

ÖNACE 2008 Classification		Employees	Gross Value Added (GVA) 2016	Total	CO_2 emissions (t) per employee	Per 1000 € GWA
Class	Name	Total	Mio. €			
C24	Metal production and processing	37,714	3916.2	22,847,738.72	605.82	5.83
D35	Energy supply	24,478	5725.0	14,566,354.29	595.08	2.54
C23	Manuf. of glassware, ceramics, etc.	31,383	2466.6	5,535,402.81	176.38	2.24
C19	Coke and refined petroleum products	1315	514.4	2,451,397.67	1864.18	4.77
H49	Land transport	121,982	7596.8	1,810,837.74	14.85	0.24
C20	Manuf. of chem. and chem. products	18,412	2877.3	1,601,497.85	86.98	0.56
C17	Manuf. of paper and paper products	16,536	1853.0	1,220,098.84	73.78	0.66
A01	Agriculture and hunting	109,163	2781.6	1,011,454.20	9.27	0.36
C10	Manuf. of food prod. a. animal feeds	72,420	4344.5	708,616.90	9.78	0.16
G46	Wholesale	210,106	18,228.9	520,280.79	2.48	0.03
C27	H.v. electrical equipment	45,861	3953.1	487,039.82	10.62	0.12
F43	Other Construction	204,066	10,423.3	462,420.85	2.27	0.04
C25	Manuf. of fabricated metal products	78,609	6017.1	380,285.53	4.84	0.06
C16	Manuf. of wood and wood products	32,230	2386.7	351,683.83	10.91	0.15
H51	Aviation	8597	702.8	345,887.10	40.23	0.49

ecological transformation (Kirchner, 2018; Santarius et al., 2020). In order for digitalisation to be harnessed for more climate-friendly and decent employment, political design is needed (medium agreement, weak literature base). The design of climate-friendly structures for employment is facilitated by the value change towards a work-life balance, changing demands for meaningful work (Aichholzer, 2019) and desires for shorter working hours (Csoka, 2018; FORBA & AK, 2021) (medium agreement, weak literature base).

To create climate-friendly employment opportunities, investments in environmentally friendly and circular production processes are necessary (high agreement, strong literature base). Investments in public infrastructures and services (services of general interest) can help to (1) strengthen climate-friendly employment, (2) meet societal needs and (3) ensure a socially acceptable transformation (medium agreement, medium literature base) (Krisch et al., 2020; Schultheiß et al., 2021). Furthermore, shifting the tax burden from labour to energy and resources could enhance employment and reduce environmental consumption (Köppl & Schratzenstaller, 2019). Workplace co-determination and participation are a prerequisite for implementing necessary changes together with employees. More participation, however, does not automatically lead to more climate-friendly conduct, but requires additional political and company measures (high agreement, medium literature base).

In order to manage structural change and enable climate-friendly employment, workers must have access to the necessary qualifications (high agreement, medium literature base). An action plan for key areas of the energy transition is being developed for Austria, as well as at the global level (IRENA & ILO, 2021). If economic activity and thus labour volume decline as a result of environmental policy, social goals can only be achieved if income and social security are (at least partially) decoupled from employment (Kubon-Gilke, 2019; Petschow et al., 2018). Proposals for this include an unconditional basic income (Mayrhofer & Wiese, 2020), the provision of universal basic services (Büchs, 2021; Coote & Percy, 2020) or greater self-sufficiency (Littig & Spitzer, 2011; Paech, 2012).

An important policy to enable climate-friendly employment is the reduction of working hours. This is considered a suitable measure to (1) facilitate a climate-friendly life outside of employment (medium agreement, weak literature base) (Schor, 2005, Knight et al., 2013) and to (2) distribute the volume of work, which might possibly decline in the long run, more evenly (high agreement, medium literature base) (Figerl et al., 2021).

Chapter 8: Caring for oneself, household, family and society

In the following, the literature on care work in the context of climate-friendly living is presented. Caring for oneself, the household, the family and society are indispensable even for survival, vital, but often invisible activities. On the one hand, they receive little attention in everyday life, and on the other hand, they are often ignored in economic and ecological analyses (high agreement, strong literature base). The relevance of

this unpaid care work for a climate-friendly life depends on the extent to which goods, services and mobility are required and used for these activities and how emission-intensive they are provided (high agreement, strong literature base).

Making unpaid care and voluntary work visible is a prerequisite to prepare the necessary structural changes to enable a climate-friendly everyday life for all. Less time pressure, deceleration and reduced multiple burdens are important levers to ensure climate-friendly decisions in everyday life. Thus, framework conditions are needed that help to alleviate time pressure, reduce commuting and offer support in caring for children and family members (high agreement, medium literature base). The current unequal distribution of paid and unpaid work for necessary care (children, elderly, those in need of care) is still strongly influenced by a gender-specific division of labour. Time pressure due to paid work and unpaid care work and acceleration in working life and everyday life burden both quality of life and climate (high agreement, strong literature base). More gender and care justice also promotes climate justice (high agreement, strong literature base). The climate impact of unpaid care work often shows up as a synergy effect with other fields of action: The more time is available for necessary care work, the more likely climate-friendly practices can be developed (high agreement, weak literature base).

"Fair sharing" of unpaid and paid work as redistribution between genders, but also towards the public sector, leads to higher social balance and enables more climate-friendly modes of living. Reduced working hours and equitable distribution of paid and unpaid work reduce stress and make climate-friendly practices more attractive (high agreement, strong literature base). In households, shared and reduced consumption of goods and energy is an important factor in reducing emissions, along with dwelling size, energy mix, renovation levels and energy-saving technologies (high agreement, strong literature base) (see Table TZ.1). Sufficient time, good information and existing skills are necessary for climate-friendly shopping, food production and preparation, and sustainable choices when eating out (high agreement, strong literature base). Accessible and affordable mobility infrastructure for all is important to allow for more sustainable decisions when making the necessary journeys to care for other people, e.g., care visits, journeys to school, etc. (high agreement, strong literature base). If care work and thus also leisure time are distributed more equally, the emissions caused by time pressure are reduced, as are those caused by time and income prosperity (high agreement, strong literature base).

Acceleration (Rosa, 2005) and time pressure (Sullivan & Gershuny, 2018) are determinants of quality of life and climate impacts of everyday behaviour, especially in the area of unpaid care work and care (Schor, 2016; Shove et al., 2009). Time cultures, e.g., the handling of speed and waiting times and the evaluation of the durability of products, are seen as important factors for sustainable resource use (Rau, 2015) and are also important factors in care and domestic work. Sufficient time is necessary to lead a healthy life with recreation, exercise and sport (APCC, 2018). Time well-wealth as an intangible form of well-being contributes to more climate-friendly choices (Großer et al., 2020; Rinderspacher, 1985; Rosa et al., 2015).

Unpaid care work is also an issue in approaches to "caring economics" (Biesecker, 2000; Biesecker & Hofmeister, 2006). In the recent debate on feminist post-growth ideas, the need to link the different strands of feminist and degrowth approaches is pointed out (Bauhardt, 2013; Dengler & Lang, 2019, 2022; Knobloch, 2019; Kuhl et al., 2011). The need for a feminist complement to the Green Deal is perceived in some countries (e.g., Cohen & MacGregor, 2020). Gender budgeting approaches also exist in Austria. If they aim to examine public spending for gender and climate justice, there is an opportunity to achieve emission savings in the care sector as well (Schalatek, 2012). Spatial, urban and transport planning must consider about care work if it wants to enable emission reductions. In a "city of short distances", neighbourhoods should be planned in such a way that there are short distances between the place of residence and, above all, kindergartens/schools as well as retailing and, if possible, employment opportunities, which can be covered on foot or by bicycle. According to this concept, public transport should be more strongly oriented towards the times and needs of care work and urban development and be conceptualized as advancing from the car-oriented city towards the people-oriented city (Bauhardt, 1995).

In addition to care work, there are also other activities that lie outside of economic considerations. Voluntary activities that serve to build and maintain community and society, but also all activities with the aim of self-sufficiency are part of caring for society and nature. These activities also contribute to building community, producing goods and services and possibly reducing climate impacts. For example, the trend towards growing one's own vegetables or "urban gardening" as low-emission food production helps to reduce CO_2 emissions (Cleveland et al., 2017). Spending time on voluntary and alternative subsistence activities, which is then not available for paid employment and market-based economic production, also contributes indirectly to emission savings and climate-friendly living; especially since large parts of paid employment in Austria do not meet the requirements for climate-friendly living (compare chapter on paid employment). Time banks, for example, show a possibility to relate care work and paid employment and thus create more socially and climate-friendly working time quotas (Bader et al., 2021; Schor, 2016).

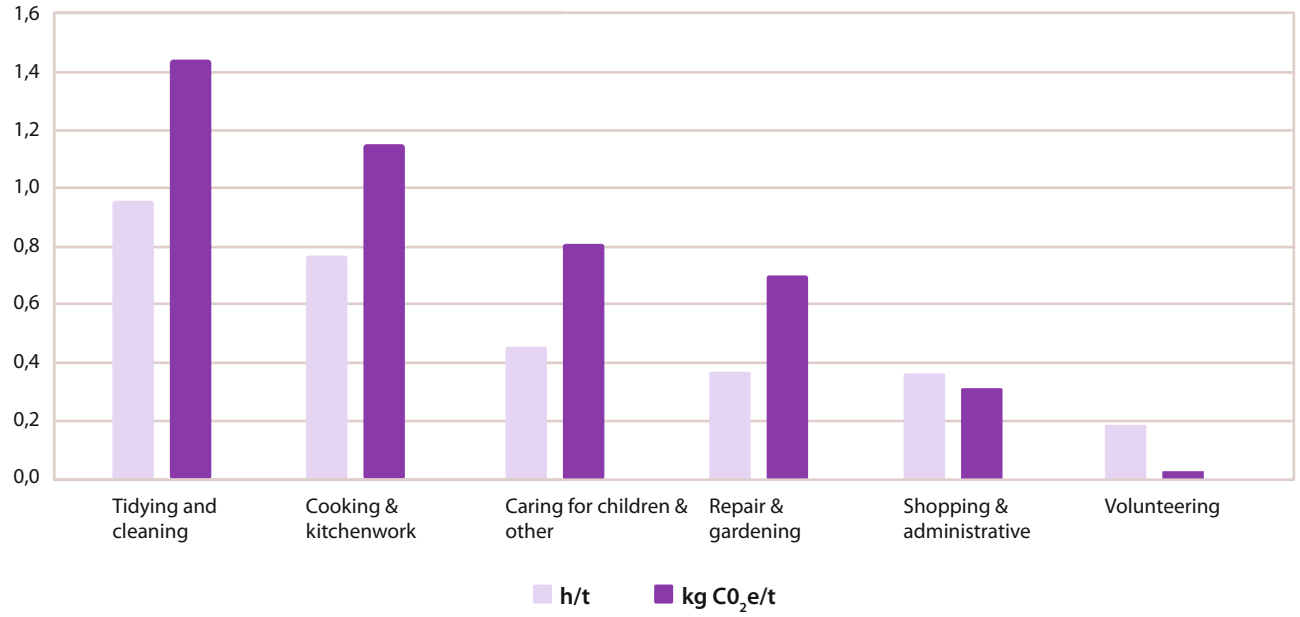

Fig. TS.10 Household activities by hours per day and kilograms of CO_2 equivalent per day, excluding emissions from mobility, for the year 2010 and the Austrian average. (Own illustration according to Smetschka et al. (2019)). {Chap. 8}

Care work and the quality of care work depend on human interaction and thus on time. Structural constraints lead to a shortage of time or a lack of time sovereignty. This requires – as far as financially possible – consumption with increased resources and energy use. At the same time, higher incomes lead to higher demands, e.g. in the household sector (kitchen equipment, higher hygiene standards, increasing wellness demands). Climate-friendly time policy (Reisch & Bietz, 2014) and care-oriented time policy (Heitkötter et al., 2009) focus on time as a lever for political design and combine the two concerns: If people have more time and care work is distributed more equitably (between genders), they could act in a more climate-friendly way (Hartard et al., 2006; Rau, 2015; Schor, 2016).

A time perspective helps to analyse social-ecological interactions and to redefine and expand the concept of work (Biesecker et al., 2012; Biesecker & Hofmeister, 2006). The re-evaluation of different forms of work, paid and unpaid, for production and reproduction of social subsystems of person, household, economy and society leads to more gender justice and a caring society. Better taking care for these subsystems reduces social inequalities and the related time pressure and overload for one part and (too) high consumption for another part of society: "If it were possible to create greater leeway in the use of time through time prosperity, it would be conceivable that resource-intensive practices would be substituted with time-intensive ones in many lifeworlds" (Buhl et al., 2017, original in German). Freed-up capacities can be used for more care for nature (Hofmeister & Mölders, 2021) and for building structures for a more just and climate-friendly life (Winker, 2021) and thus represent valuable co-benefits.

Chapter 9: Leisure and holidays

Chap. 9 provides an assessment of the literature on climate-friendly leisure and holiday activities in Austria. The climate-friendliness of leisure activities and holidays depends on how climate-friendly the mobility used for them, the premises chosen and their energy supply are, how emission-intensive the material goods and services used for leisure activities and holidays are provided and which specific activities are pursued (high agreement, strong literature base). The GHG emission footprint of leisure activities is unevenly distributed along income groups, as wealthier households tend to be more mobile and have a more consumption-intensive leisure and holiday pattern (high agreement, strong literature base). Emissions caused by information- and communication-technologies as well as digitalisation of leisure activities are continuously increasing. To assess the climate impacts of digital or non-digital options, it is necessary to systematically compare the entire product life cycle (high agreement, medium literature base). Outdoor leisure activities are already affected by climate change (high agreement, strong literature base).

Leisure and recreation serve regeneration purposes and are of great importance for quality of life in Austria. Therefore, it is important to find climate-friendly alternatives with recreational value to reduce resource- and energy-intensive activities for all income categories. The emission intensity of mobility dominates overall leisure emissions. However, goods and services are also crucial for the climate friendliness of recreational activities and holidays (high agreement, strong literature base) (Table TS.3). Services can be more

Table TS.3 CO_2 footprint of consumption by Austrian households in 2010 by consumption categories in the leisure sector. (Own representation according to Smetschka et al.). {Chap. 9}

Field of consumption	Thousand tons (kt) CO_2e/Year	Share of household footprint
Gastronomy	5139	6 %
Sport, leisure and cultural happenings	3798	4 %
Holiday	3547	4 %
Clothing (incl. shoes)	3061	4 %
Accomodation	2309	3 %
Electronics (entertainment, film, photo, information technology)	2156	2 %
Sports, hobbies, and leisure goods & household animals, gardening	1070	1 %
Printmedia, paper and stationary supplies	315	0 %
Large scale durables and freetime and sport activities	33	0 %

climate-friendly than material goods. However, this requires production networks, provision of service and energy supply to be climate-friendly. For their assessment, information from the life cycle analysis is necessary (high agreement, weak literature base). Everyday time pressure due to paid employment and care work, as well as the acceleration in everyday life can make climate-damaging leisure behaviour appear as more convenient (high agreement, strong literature base). Social norms are structuring leisure practices along the (often gender-specific) division of labour of paid work time and care work (high agreement, strong literature base).

Socially widespread practices of leisure are shaping what is considered "normal" or acceptable activities and how they are carried out, e.g., long-distance tourism versus local/regional recreation or cycling versus motorcycling as a hobby (high agreement, strong literature base). Leisure is an area of life with diverse individual options for action, which is nevertheless strongly subject to structural conditions. Hence, social norms and widespread practices or the available infrastructures and opportunities have a strong effect on individual choices. The main drivers of everyday time use patterns are the arrangements around paid and unpaid work and education as well as place of residence and existing (mobility) infrastructures and the spatio-temporal accessibility of leisure activities. The amount of hours worked and their timing as well as the operating hours of educational institutions and the time needed for commuting shape, limit and enable other time use activities.

Time scarcity due to operating hours, low work-life balance and double burden influence the CO_2 intensity of other activities through choices on transport use (individual transport versus public transport) and consumption patterns (e.g., fast food). Focusing on time well-being for all offers the opportunity to define climate-friendly living with the goal of *spending a lot of free time in a self-determined way and with climate-friendly activities* instead of emphasising that individuals abstain and dispose of the expertise in order to *consume less and differently* (Schor, 2016). Time policies (Reisch, 2015) can offer cross-sectoral solutions to social and economic problems. If they include environmental issues, they can also contribute to climate-friendly developments.

Efficient, high-quality, durable, shareable and repairable products are necessary for climate-friendly leisure. It is equally important to move away from business models based on accelerating product life cycles, e.g., *fast fashion* or rapid obsolescence in smartphones (high agreement, strong literature base). Time sovereignty and more leisure time could lead to less time pressure and more well-being with a lower GHG emissions footprint if these practices require little or zero-emission mobility, homes are operated without emissions and other products involved are efficient and used or repaired for a long time (high agreement, strong literature base). Providing infrastructure and services for recreation in public spaces that are free and within walking distance contributes to changes in recreation practices. Public services and communal infrastructure – e.g., green spaces, sports and recreational facilities with low costs and CO_2 emissions that are accessible by public transport in a short time – enable more CO_2-efficient recreational practices (Druckman & Jackson, 2009; Jalas & Juntunen, 2015; Rau, 2015).

Since the climate problem of leisure, holidays and other consumption, aside from mobility and housing, mainly arises indirectly through the production of goods and services, a combination of measures is needed. Clearly, the provision of goods and services and their production must be made more climate-friendly. A re-evaluation of work and leisure with a focus on deceleration and time prosperity makes it possible to decelerate leisure and to live less consumption-intensively, thus causing lower emissions and resource consumption (Creutzig et al., 2021). There is agreement in the literature that a mix of measures (true costs, emissions pricing, resource taxes, binding standards and requirements) is necessary to achieve these goals:

- structural changes that promote deceleration and a good life for all,
- a rapid decarbonisation of energy supply and mobility,

- a rapid decarbonisation of the globalised production of goods and services,
- increasing energy and resource efficiency of products,
- more products with decelerated and extended product life cycles and
- innovative products that (can) be repaired and used by several people.

Part 3: Structural conditions

Chapter 10: Integrated perspectives on structural conditions

Structures affect everyday actions in many ways and their adequate design is therefore necessary to enable climate-friendly behaviour in the long term. The structures discussed in part 3 significantly promote or hinder a transformation towards climate-friendly living and are relevant across all fields of action. The analysis pays special attention to the specific conditions in Austria and addresses different areas that are affected by structural changes: Law, governance, structures of public decision-making in discourse, in media, in education and knowledge production as well as economic activities including their technical dimensions and the associated innovation systems. Areas such as spatial inequality and spatial planning as well as social security systems are also considered. The part also looks at the supply of goods and services in general, but also places an emphasis on globalised commodity chains and monetary and financial systems in order to address interdependent structures beyond Austria's borders. The structuring role of the built environment is discussed in the concluding chapter on networked infrastructures.

Existing structures are not suitable for promoting climate-friendly living for all people in Austria. Internal dynamics, strong inertia, lock-in effects and path dependencies hinder necessary changes. In order to achieve climate goals, transforming or creating new structures is considered essential. Focusing on interactions between different structures across specific fields of action (Part 2), but also on interrelationships of structures with each other, enables action-relevant insights into how and with which measures existing structures can actually be shaped – in the sense of effective climate protection.

Transforming structural conditions enables actors to lead their lives (work, consumption, leisure) in an effective, sustainable and climate-friendly way without unreasonable effort. With regard to designing structural changes, the extent to which individual and collective actors (e.g., associations) are able to preserve or change current structures according to their power potential, resource endowment or organisational capacity must be taken into account. On the one hand, this part of the report deals with structures directly relevant to action (e.g., in law, network infrastructures, production, etc.) with their changes having a direct impact on possibilities for climate-friendly behaviour. On the other hand, structures that have an indirect effect and create the preconditions for the development of climate-friendly structures (e.g., governance, education and science, innovation system, etc.) are also dealt with. An important finding of this part of the report is that both directly and indirectly effective structures are of great importance for implementing climate-friendly living and shaping them through democratic and coordinated action is essential if the objectives of the Paris Climate Agreement and the corresponding goals of the Austrian Federal Government are to be achieved.

Chapter 11: Law

Measures for climate-friendly living are legally implemented and orchestrated in numerous fields of action. Law creates structures for climate-friendly living. However, law is characterised by diverse cross-connections and relationships of superordination and subordination, which in turn enable, restrict or render impossible decisions to design structures. Law thus has a structuring effect on climate-friendly living. Legal matters that are of structural importance for climate-friendly living go beyond environmental and climate protection law and include other areas of law, such as constitutional law, international trade law or housing law (Madner, 2015a; Schulev-Steindl, 2013) (high agreement, strong literature base).

Law relevant to climate-friendly living is shaped and enforced at several levels. It creates a structure that on the one hand offers opportunities for legislation and enforcement, but on the other hand also contains restrictions (Peel et al., 2012; Scott, 2011). In many cases, the legal framework sets limits to legislation, e.g., through fundamental rights (Kahl, 2021). Some design conditions can only be changed under more difficult legal conditions, e.g., the distribution of competences in the Austrian federal state, which can only be redesigned by amending the constitution. In general, competence delimitation complementarity and coordination from the international to the European and federal to the local level is needed (Schlacke, 2020; Ennöckl, 2020; Raschauer & Ennöckl, 2019; Ziehm, 2018; Horvath, 2014; Madner, 2010, 2005a) (high agreement, strong literature base).

There is no explicit fundamental right to environmental or climate protection in Austria, nor does the European Convention on Human Rights (ECHR), which has constitutional status in Austria, contain a fundamental right to protecting the environment "as such". However, environmentally relevant duties to protect can be derived from its guarantees (Grabenwarter & Pabel, 2021; Schnedl, 2018; Ennöckl & Painz, 2004; Wiederin, 2002) (high consensus, strong literature base). In some European countries, courts

have upheld lawsuits concerning stronger climate targets, citing the guarantees of the European Convention on Human Rights (ECHR) or state objectives (see e.g., BVerfG 24.03.2021, 1 BvR 2656/18). Currently, several cases are pending before the European Court of Human Rights, which concern both the question of climate protection obligations of states and explicitly the question of a right to effective complaint in connection with the lack of climate protection measures (Duarte Agostinho u. a. v. Portugal u. a., pending; Verein KlimaSeniorinnen Schweiz u. a. v. Switzerland, pending; Mex M. v. Austria, pending).

Union law also strongly shapes the scope of action of national legislators in climate protection legislation. The use of market-based instruments is prescribed by EU law with emissions trading (ETS) for emissions- and energy-intensive industry and parts of the energy sector, also for Austria (Madner, 2005b; Schulev-Steindl, 2013). National scope for legislative action exists primarily in the non-ETS sector (waste management, agriculture and energy, as well as currently for the buildings and transport sectors, where inclusion in the emissions trading system is, however, planned in the medium term) (Fitz & Ennöckl, 2019) (high agreement, strong literature base).

The National Climate Change Act (KSG) is intended to coordinate climate policy in the non-ETS sector (waste management, agriculture and energy, and currently buildings and transport), but its steering and enforcement power is currently considered to be low. It is considered to be in need of updating. There is a broad consensus on the need for a climate protection law that contains strategic targets in line with Paris climate goals as well as effective sanction mechanisms (Ennöckl, 2020; Schulev-Steindl et al., 2020) (high agreement, medium literature base). An effective national climate protection law should also contain an improvement requirement to safeguard Austria's climate targets against regressions (Schulev-Steindl et al., 2020; Kirchengast & Steininger, 2020) (high agreement, medium literature base).

In the Austrian Federal Constitution there is no uniform competence with regard to the "environment" or "climate" (Horvath, 2014). Introducing a specific competence (Bedarfskompetenz) for climate protection at the federal level is considered a necessary structural condition to enable comprehensive regulations for climate protection and to create uniform climate protection standards (Schulev-Steindl et al., 2020) (high agreement, medium literature base). In the literature, measures in the area of financial-, tax- and subsidy law are also considered necessary structural levers; thus, in particular, an adequate CO_2 pricing, but also an ecological restructuring of tax and subsidy law (e.g., redesign of municipal tax), linking housing subsidies with ecological criteria and, in general, the orientation of fiscal transfers according to spatial and climate-relevant parameters are discussed (Mitterer, 2011, Madner & Grob, 2019a, Kanonier, 2019 jew mwN) (high agreement, medium literature base).

Internal departmental conflicts shape environmental and climate policy at European and national level (Hahn, 2017; Madner, 2007; Bohne, 1992). The "silo-shaped" design of the Austrian administration, which is structured according to the departmental principle, is seen as inhibiting handling of cross-cutting issues such as climate protection (Hahn, 2017). The European Commission has an important role in designing European climate protection law (e.g., European Green Deal) with the right of initiative to legislature. In relation to member states, the Commission's role in climate policy is characterized, for example, by its review rights when drawing up national climate protection plans, but also by its power to initiate infringement proceedings. At the same time, as guardian of the internal market and initiator of far-reaching liberalisations, the collegial body Commission is often perceived as promoter of interests running in opposition to climate protection (Bürgin, 2021) (high agreement, medium literature base).

Strengthening environmental organisations in environmentally relevant approval procedures is seen as particularly beneficial for climate protection, although the assessment in connection with projects for expanding renewable energy is differentiated (Berger, 2020; Schwarzer, 2018; Schmelz et al., 2018; Sander, 2017; Schmelz, 2017a). From the perspective of project operators, increased public participation by environmental organisations is often qualified as an obstacle in locational competition (Bergthaler, 2020; Schmelz, 2017a, 2017b; Niederhuber, 2016) (high agreement, strong literature base).

In the context of climate lawsuits, courts are also considered to have an important function for climate protection. Through their control function, they can identify deficient climate protection legislation and insufficient consideration of best available techniques and the state of the art in science, and can define existing obligations of the legislator more specifically (Schulev-Steindl, 2021; Schnedl, 2018; Krömer, 2021). This role of courts in climate change mitigation is dependent on fundamental rights or other enforceable rights and access to justice (Krömer, 2021; Peel & Osofsky, 2018; Colombo, 2018). With the separation of powers, such an attribution of roles is also partly viewed critically in the literature (Wegener, 2019, Saurer, 2018) (high agreement, strong literature base).

A fundamental right to climate protection would enable individuals (and, where appropriate, legal entities) to challenge decisions and measures conflicting with climate protection before the courts and thus hold decision-makers more accountable (Ennöckl, 2021). In order to achieve this, such a fundamental right would have to be combined with adequate provisions on access to justice (Krömer, 2021;

Schulev-Steindl, 2021). In addition to the fundamental right to climate protection, a fundamental duty to protect resources or the climate could limit the (growing) use of resources (Winter, 2017). Part of the literature understands the introduction of rights of nature as a necessary step to avoid the instrumentalisation of nature or even as an opportunity to completely rethink legal instruments (Epstein & Schoukens, 2021; Kauffman & Martin, 2021; Darpö, 2021; Krömer et al., 2021; Fischer-Lescano, 2020) (high agreement, medium literature base).

In the discussion on design options at national level, anchoring a fundamental right to climate protection (medium agreement, medium literature base), a separate competence "climate protection" (high agreement, medium literature base), an effective climate protection law (high agreement, medium literature base) and an ecological tax reform (high agreement, medium literature base) are highlighted as particularly relevant in accordance with the identified necessary structural conditions.

Climate protection measures taken at the international, EU and/or national level are often in tension with the trade liberalisation-oriented goals of WTO law (Du, 2021; Mayr, 2018; Müller & Wimmer, 2018) (high agreement, strong literature base). As a central concern of the European economic constitution, safeguarding competition shapes the orientation of the Austrian economic constitution and the scope for national legislation, including in the area of services of general interest (Madner, 2022; Müller & Wimmer, 2018; Griller, 2010; Hatje, 2009) (high agreement, strong literature base). In order to overcome fragmentation in international law and to place world trade law more strongly in the service of sustainability goals, global trade policy needs to be realigned with the overarching goals of social and economic stability and ecological sustainability (Ruppel, 2022; Neumayer, 2017; Vranes, 2009; Bernasconi-Osterwalder et al., 2005; Weinstein & Charnovitz, 2001) (high agreement, medium literature base).

A number of civil society actors and broad civil society alliances (e.g., the Seattle to Brussels network), think tanks (e.g. the International Institute for Sustainable Development (IISD), cf. International Institute for Sustainable Development, 2021) but also the United Nations Conference on Trade and Development ("Geneva Principles for a Global Green New Deal", cf. Gallagher & Kozul-Wright, 2019) have put forward proposals for fundamentally transforming international and European trade policy, which are considered necessary to tackle the environmental and climate crisis and to counteract the adverse effects of globalisation (eg. Gallagher & Kozul-Wright, 2019) (high agreement, medium literature base).

The following options are highlighted as particularly important: Ensuring the right to use state regulation to protect health, social and environmental issues ("right to regulate"); establishing binding corporate obligations to respect human rights; ensuring space for local and regional economies; and strengthening social-ecological public procurement (Krajewski, 2021a; Schacherer, 2021; Eberhardt, 2020; Petersmann, 2020; Schill & Vidigal, 2020; Strickner, 2017; Attac, 2016; Kube & Petersmann, 2018; Schmidt, 2021; Bernasconi-Osterwalder & Brauch, 2019) (high agreement, medium literature base).

Chapter 12: Governance and political participation

This chapter assesses the literature on the governance of climate crisis in Austria. It examines which actors and structures shape climate policy in Austria. Both state and non-state aspects of social governance are relevant. In Austria, there is a special feature at the interfaces between state, economy and society that exists in a similar form only in a few countries: the social partnership as a central component of a corporatist system of government. Chap. 12 of the report analyses how the state and social partnership actors shaped Austrian climate policy until 2019, what role the EU played and the changes occurred since 2019.

The climate policy of the federal governments was put forward in three climate strategies (2002, 2007 and 2018), a climate protection law and corresponding amendments (2011, 2012, 2017) and two programmes of measures for 2013/2014 and 2015 to 2018. Although these are different approaches to coordinating and implementing climate policy measures, none of these approaches succeeded in reducing greenhouse gas emissions in line with the objectives of the federal government. As Fig. TS.11 shows, with one pandemic-related exception, all climate targets have been missed so far. Thus, Austria is also one of the few northern countries in Europe not having reduced domestic emissions since 1990 (Steurer & Clar, 2015; Clar & Scherhaufer, 2021) (high agreement, strong literature base).

This climate policy failure in Austria is also due to the federal structure, the social partnership and a long time passive civil society, failing to oppose the prevailing priority setting until 2019 (high agreement, strong literature base).

Austria's federal system shows a high degree of divergence in terms of target and decision-making structures, scope of action and time horizons. The distribution of competences for spatial planning, transport and buildings makes federal decision-making and thus goal-oriented decarbonisation more difficult. The federal states have important competences for spatial planning, transport and buildings, but are not themselves bound by the climate targets agreed between the federal government and the EU. This is another reason why climate protection often has only a low priority for the state governments (Steurer et al., 2020).

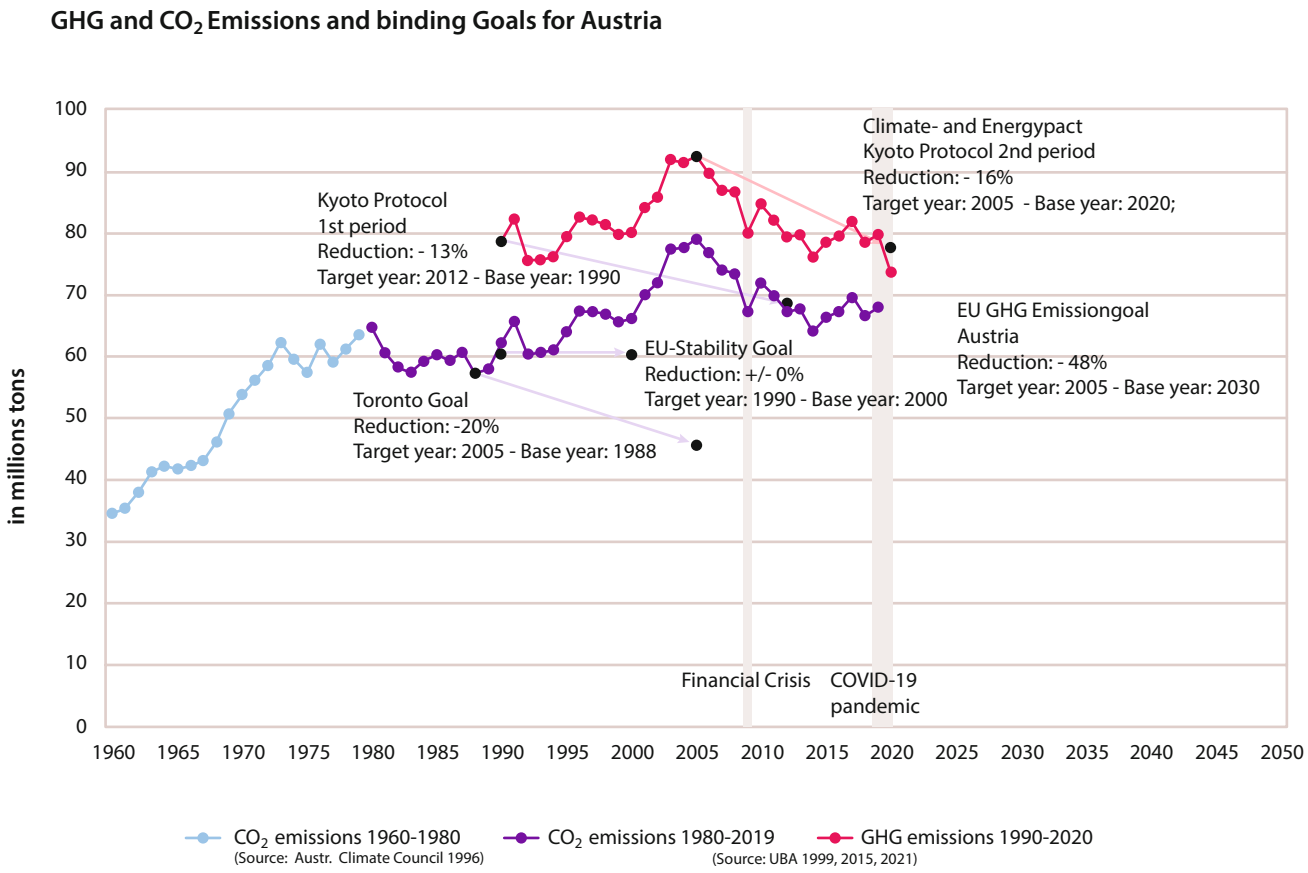

Fig. TS.11 CO_2 emissions (*blue* and *purple*) and greenhouse gas emissions GHG emissions (*magenta*) compared to reduction targets of the German government (*dots* mark base and target years). (Hochgerner et al., 2016, p. 6, updated by Willi Haas, 2021). {Chap. 12}

The four social partners, including especially the Chamber of Commerce as well as the Federation of Austrian Industries, have repeatedly weakened, delayed or completely prevented climate policy progress (Pesendorfer, 2007; Steurer & Clar, 2015; Niedermoser, 2017; Brand & Niedermoser, 2019; Clar & Scherhaufer, 2021). Even in the 1970s, environmental policy was usually only possible without significant resistance if it served economic interests in the sense of ecological modernisation (Pesendorfer, 2007).[1] This environmental policy tradition still dominates the policy field of climate today (Steurer & Clar, 2015; Clar & Scherhaufer, 2021). Only the Chamber of Labour and the trade unions have shown a slow process of rethinking in recent years, which is, however, quite controversial within the trade unions (Brand & Niedermoser, 2019; Niedermoser, 2017; Segert, 2016; Soder et al., 2018; cf. Chap. 14).

Since 2019, two aspects of governance have changed: Social movements such as Fridays for Future have brought a new dynamic to the policy field of climate in 2019. Encouraged by this momentum, a climate change ministry was established in 2020, trying to push forward goal-oriented climate policies, but often encountering internal governmental, social partnership and/or federal resistance (high agreement, weak literature base; Clar & Scherhaufer, 2021).

The structurally shaped interplay of restraining climate policy forces has resulted in Austria losing its role as an environmental policy pioneer. Since Austria's accession to the EU in 1995, environmental progress has been possible mainly due to EU requirements or in cases where short-term economic benefits were expected. Since climate protection was not associated with economic benefits for a long time, all federal governments have deliberately accepted the failure to meet climate policy targets (Pesendorfer, 2007; Pfoser, 2014). Austria had to pay almost 700 million euros for missing the Kyoto target (Steurer & Clar, 2014). Missing the target for the 2030 trajectory would likely cost many times more, given the expected high CO_2 prices. While there were similar developments in many other countries (Nash & Steurer, 2019), hardly any country in the EU had targets and actual emissions diverging as drastically as in Austria (Rechnungshof, 2021).

Appropriate climate policy in Austria has only begun in a few areas (e.g., the expansion of renewable energy sup-

[1] Studies on Germany show that this is not specific to Austria (Bohnenberger et al., 2021).

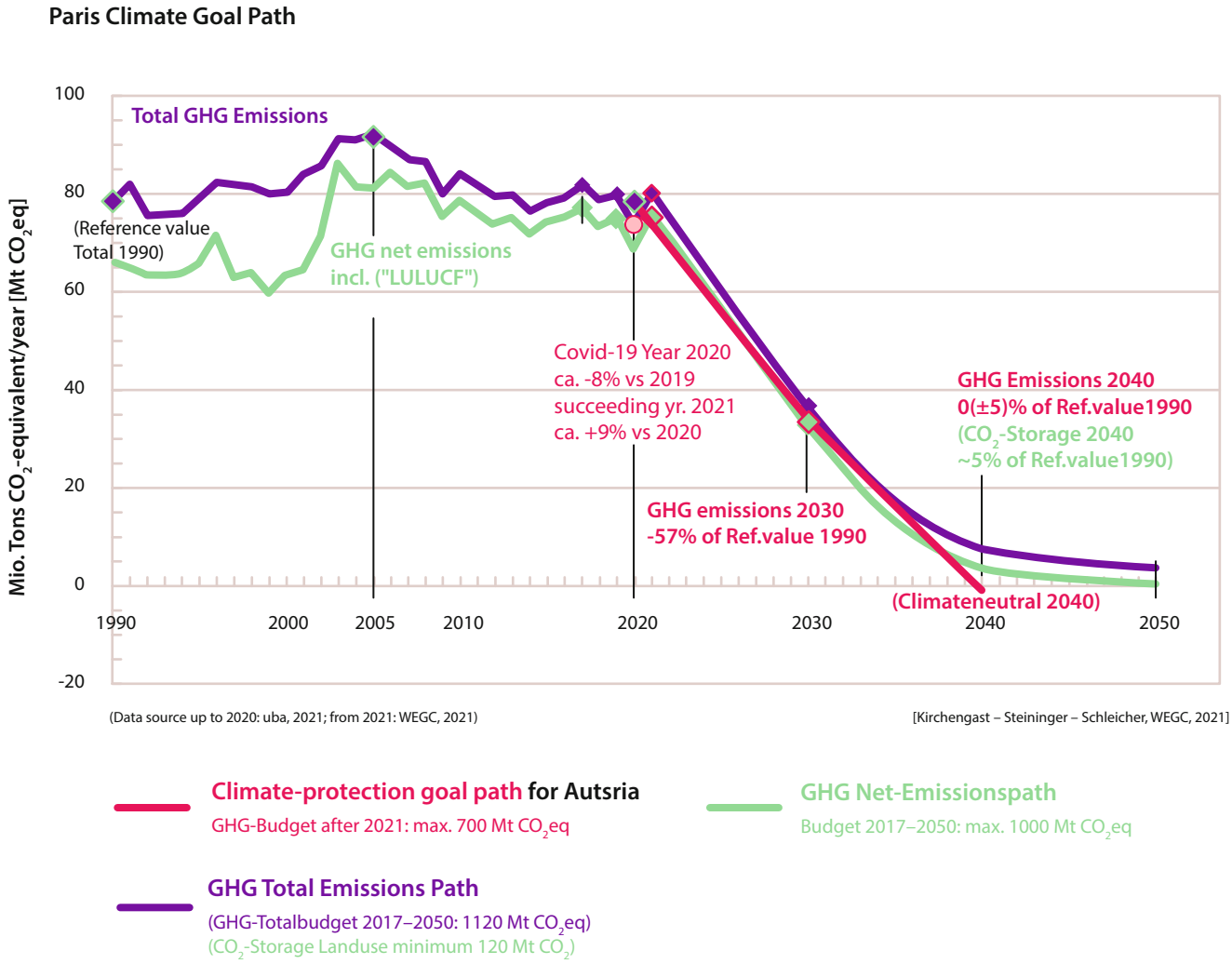

Fig. TS.12 Emission reduction pathway to achieve the Paris climate target in Austria. (https://wegcwww.uni-graz.at/publ/downloads/RefNEKP-TreibhausgasbudgetUpdate_WEGC-Statement_Okt2020.pdf, 30 April 2021). {Chap. 12}

ply). Thus, Austria still deviates far from the targeted vision it has set itself of becoming climate neutral by 2040 (cf. Fig. TS.12). The challenge of a societal transformation that now lies ahead will only succeed if the "vicious circle of inaction" that has prevailed until 2019 is permanently transformed into a "virtuous circle of climate action" (Climate Outreach, 2020).

Chapter 13: Innovation system and policy

Structural and political-institutional conditions for innovation form the framework for the ability of our society to produce technological, organisational, and social innovations, guide itself along them, and enable their dissemination. They are thus of central importance for transforming our society towards a sustainable way of life and economy. The following is a review of the literature on innovation policy for a climate-friendly innovation system.

The innovation system comprises actors, their relationships and institutional and structural conditions that shape their innovation behaviour. Innovation policy plays an important role, understood here in a broad sense as the sum of policy fields that influence research and innovation needs and opportunities. With regard to system change through innovation, a variety of other sectoral and cross-sectoral policies are therefore addressed beyond research, technology and innovation policy in a narrower sense.

New technological and non-technological developments and related socio-technical innovations play a central role in achieving transformations towards a more climate-friendly society (Schot & Steinmueller, 2018; Joly, 2017). With regard to societal goals to be pursued with the help of innovation, a shift can be observed in the scientific debate moving away from an almost exclusive emphasis on economic goals towards more directional, directive goals in line with UN Sustainable Development Goals (Daimer et al., 2012; Diercks et al., 2019). Particularly in highly climate-relevant

areas such as mobility, energy production, supply and use, or food supply and nutrition, linking new technological options with organisational and social innovations and behavioural changes is essential to initiate and enable societal changes to overcome climate crises. Only with interaction between these different dimensions of innovation are system changes possible (Wanzenböck et al., 2020; Wittmayer et al., 2022). This shift has also been apparent in Austrian research and innovation policy for several years. Embedded in a programmatic further development of European policy goals (European Commission, 2019d, 2020), the first steps at the Austrian level are manifested in the introduction of new programmatic, instrumental and governance elements in research and innovation policy, as an expression of transformative policy goals and corresponding mission-oriented policy concepts. In this context, with the 2030 climate targets of the Austrian federal government in mind, implementation-oriented measures are currently emphasized, including supply- and demand-side elements (Federal Chancellery, 2020; BMBWF et al., 2021). Despite these changes, non-directed R&I policies continue to dominate public funding for research and innovation (BMBWF et al., 2021; OECD, 2018) (high agreement, strong literature basis).

Tensions still exist between sustainability goals and a growth-oriented approach in innovation policy (Schot & Steinmueller, 2018; Lundin & Schwaag-Serger, 2018). Due to current crises (e.g., COVID-19, Ukraine war), there are also new policy goals (e.g., crisis resilience, sovereignty, defence). Besides innovation, conditions for exiting unsustainable practices ("exnovation") play an important role in overcoming the climate crisis ("destabilisation of the dominant socio-technical regime"). These two aspects have so far only played a minor role in the discussion on innovation systems and policies (David, 2017; Sengers et al., 2021). The typical characteristics of innovations, such as uncertainty and complexity, pose considerable difficulties in estimating and ex ante evaluating innovations. Radical and systemic innovations in particular can only be estimated very inadequately ("Collingridge dilemma"); a problem that is also exacerbated by rebound effects and other complexity phenomena ("wicked problems") (Polimeni et al., 2009; Collingridge, 1980; Tuomi, 2012). Innovation, meaning the introduction of new solutions, is the first step towards climate-friendly system change. Only the diffusion, scaling and replication-adaptation of these new solutions in all their dimensions ("generalisation") makes system change possible (Sengers et al., 2021). Thus, mobilising established actors with their resources and capacities is important (high agreement, medium literature base).

Anchoring an expanded understanding of innovation is one of the central challenges of innovation policy in the context of climate change, i.e., the expansion to social, institutional and system innovations as well as their generalisation (Howaldt et al., 2017; Wittmayer et al., 2022). Measures such as (tertiary) education, new curricula, higher recognition for inter- and transdisciplinary research at universities, recruiting and human resource development, incentive systems for more risk- and innovation-friendly behaviour are called for (high agreement, strong literature base).

Changes are also needed in governance structures and processes based on systemic changes – first and foremost, the coherent interaction of actors and instruments from different policy fields and levels ("policy coordination", "alignment"), through which effective impulses for systemic change can be achieved (Kuittinen et al., 2018; OECD, 2019, 2021). The silo-structures of political responsibilities and public administration or the lack of overarching competences (e.g., policy competence for innovation and system change), lack of coordination processes (currently first attempts in the framework of the RTI Strategy 2030 and the EU Missions Working Group) as well as the complex interplay between nation-state and federal state levels are key obstacles on the path to well-coordinated and climate-friendly governance. A shift towards experimental approaches embedded in longer-term monitoring/assessment and forward-looking learning processes offers opportunities for testing and broad implementation of new systemic approaches under conditions of uncertainty. These experimental practices and learning processes also extend to institutional conditions for innovation (Sengers et al., 2021; Veseli et al., 2021) (high agreement, medium literature base).

This goes hand in hand with a necessary change in understanding the role of politics, whose priority task lies in moderating and setting the direction and framework for innovation and system change. However, the assumption of such roles requires corresponding capabilities and resources in public administration ("Capacities & Capabilities") (Borrás & Edler, 2020; Kattel & Mazzucato, 2018) in the sense of further development of New Public Management towards "agile innovation policy" and reversal of the erosion of public administration in terms of personnel. Opening up discursive spaces for normative questions and controversies in connection with innovation and system change can also contribute to greater coherence and common orientation for various actors in the innovation system (i.e., in a broad sense, civil society as well as research, business and politics) (Schlaile et al., 2017; Stirling, 2007) by involving citizens' councils and upgrading parliament as a place of normative discourse. If it is made possible to establish transformative systemic failure as a basis of legitimacy for state action also in other innovation- and transformation-relevant policy areas, the range of instruments for political co-design of systemic transformations could be expanded. By taking directional elements into account in fundamentally non-directional innovation policy instruments (especially structural measures, open-topic programmes and tax

incentives for R&D), their climate effectiveness could be increased (high agreement, medium literature base).

Demand-side instruments such as public procurement and regulation are available but have so far only been used and become effective to a limited extent. A broader use of public procurement initiatives in particular could induce more climate-friendly innovation impulses. Clear strategic orientations from policy-makers, supportive structural and institutional conditions and early involvement of stakeholders concerned would reduce uncertainties in future investments and support a long-term and coherent orientation of innovation strategies of companies, research organisations and other innovation actors towards climate-friendly solutions. In the public sphere of influence, the multi-year performance agreements could be adapted in this regard. The currently discussed proposals for transformative and mission-oriented policies (e.g., with regard to the five EU missions) further strengthen the need for coordination between policy fields and levels and extend well beyond the area of RTI policy. Further development of policy coordination in terms of transformative and mission-oriented approaches can contribute to intensifying interministerial cooperation for climate-friendly strategies (medium agreement, medium literature base).

In order to establish more agile organisational structures and processes within the framework of transformative innovation policy, institutional innovations could be tested experimentally, both with regard to operational handling of policy measures and in upstream strategic decision-making processes. By building appropriate competencies and capacities in the areas of foresight, formative monitoring, evaluation and adaptation of policy strategies, conditions could be created to accompany and readjust comprehensive transformation processes, both at the level of individual measures and systems (e.g., energy transition, mobility transition, etc.) (high level of agreement, strong literature base).

Chapter 14: The provision of goods and services

Chap. 14 takes a comprehensive look at the provision of goods and services and various economic actors involved in its design and implementation in Austria. GHG emissions can occur both in the use of goods and services and along the entire value creation process from resource extraction and energy generation to the provision and ongoing maintenance of goods. The possibilities of a climate-friendly living are thus directly linked to the footprints of goods and services required for such a life. The focus of this chapter is on that part of provision that is produced in Austria. Austrian production that is exported (about 50 percent) and consumption that is imported (about 30 percent) will be discussed in the next chapter.

Comprehensive changes in national structures of provision are necessary to achieve climate goals. This requires profound transformations in dominant business models and value creation processes with a reorientation along central needs such as health or nutrition (high agreement, strong literature base) (Köppl & Schleicher, 2019; Schleicher & Steininger, 2017). A comprehensive transformation of energy systems through a complete switch to renewable energies, increases in energy productivity and reduction in direct energy demand in building, mobility, industry and agriculture sectors can make a significant contribution to reducing GHG emissions (high agreement, strong literature base). As Fig. TS.13 illustrates, achieving climate targets is also very likely to require changes along the circular economy as well as a more extensive shift to resource sharing or common use models (high agreement, medium literature base) (Cantzler et al., 2020; Eisenmenger et al., 2020; Jacobi et al., 2018; Kirchengast et al., 2019; Köppl & Schleicher, 2019; Meyer et al., 2018; Schleicher & Steininger, 2017).

The failure to date of a comprehensive transformation to climate-friendly supply structures can be attributed primarily to a poorly consistent design of the economic policy framework from a climate perspective (high agreement, medium literature base) (Niedertscheider et al., 2018; Plank et al., 2021b; Steurer & Clar, 2015). A climate policy focus on "soft" policy instruments to scale up or increase market penetration of more climate-friendly technologies, products and services contrasts with "hard" financial and regulatory frameworks in Austria generating only little pressure to change and sometimes even encourage climate-damaging activities (high agreement, strong literature base) (Hausknost et al., 2017; Kletzan-Slamanig & Köppl, 2016a; Köppl & Schratzenstaller, 2015; Schaffrin et al., 2015; Schnabl et al., 2021; Wurzel et al., 2019). These climate policy-unfavourable frameworks are underpinned by corporatist and federal governance structures that have given short-term economic interests opposing a consistent climate policy great influence (high agreement, medium literature base) (Brand & Pawloff, 2014; Niedertscheider et al., 2018; Seebauer et al., 2019; Steurer et al., 2020; Steurer & Clar, 2015, 2017; Tobin, 2017; Wissen et al., 2020).

Only with respect to energy efficiency, a rising share of renewable energies and an expansion of waste management could aid significant progress in decarbonising structures of provision in Austria over the last three decades (high agreement, strong literature base) (Anderl et al., 2020). This has facilitated a more climate-friendly life, especially in the provision of energy. In the same period, a dynamic economic sector for environmentally oriented goods and services was

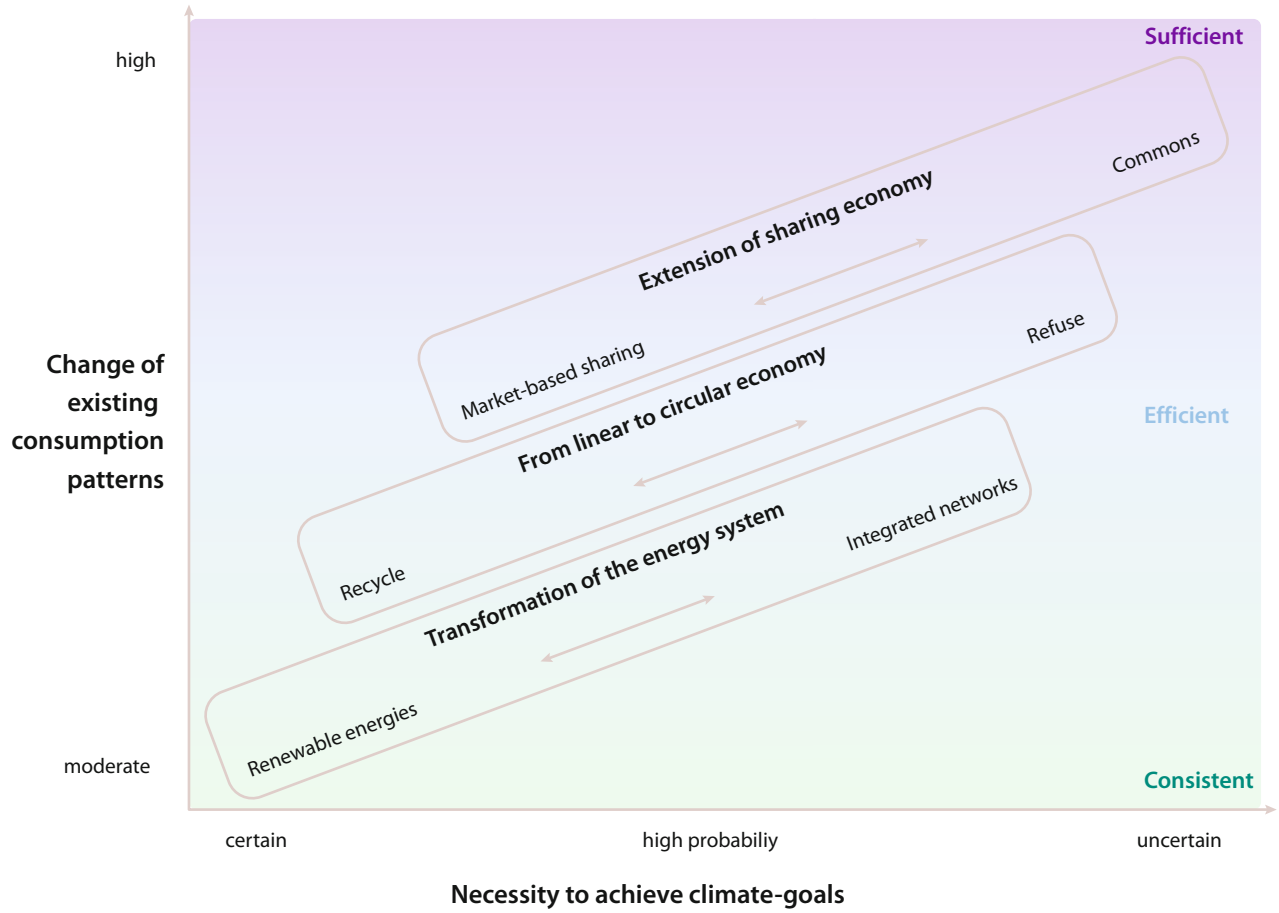

Fig. TS.13 Models of climate-friendly supply structures and the need for change. (Source: own representation). {Chap. 14}

able to emerge in Austria, which is gaining importance both domestically and abroad (high agreement, strong literature base) (Gözet, 2020; Schneider et al., 2020) (see Fig. TS.14).

These successes are contrasted by opposing trends in transport and industry as well as insufficient implementation of more climate-friendly processes in the majority of companies operating in Austria (high agreement, strong literature base) (Anderl et al., 2020; Dorr et al., 2021; European Commission, 2016, 2020c; Kiesnere & Baumgartner, 2019; Kofler et al., 2021; Schöggl et al., 2022). While companies are relatively advanced in areas such as waste management and operational energy consumption, more profound changes in business models and the range of products and services have only been implemented by a minority so far (high agreement, strong literature base) (ibid.).

In order to achieve the climate targets, a significant expansion of the range of measures beyond previous climate policy focus on the promotion of new products and services is required (high level of agreement, strong literature base) (Bachner et al., 2021; Dugan et al., 2022; Großmann et al., 2020; Kirchengast et al., 2019; Stagl et al., 2014; Steininger et al., 2021; Weishaar et al., 2017). Instruments to set market-based framework conditions, such as tax reform consistently aligned with climate goals, the abolition of climate-damaging subsidies and the introduction of environmental standards for production processes, products and public procurement, can make a significant contribution to achieving climate goals (high agreement, medium literature base) (Bittschi & Sellner, 2020; Goers & Schneider, 2019; Großmann et al., 2020; Kettner-Marx et al., 2018; Kirchner et al., 2019; Kletzan-Slamanig & Köppl, 2016a; Mayer et al., 2021; Schleicher & Steininger, 2017; Steininger et al., 2021). Appropriate climate policies should be accompanied by social compensation measures if social acceptance for such measures is to be maintained (high agreement, medium literature base) (Feigl & Vrtikapa, 2021; Großmann et al., 2020; Högelsberger & Maneka, 2020; Keil, 2021; Kettner-Marx et al., 2018; Kirchner et al., 2019; Mayer et al., 2021; Pichler et al., 2021). To ensure long-term compliance with planetary boundaries, the promotion of alternative modes of supply and the setting of upper limits may be necessary (medium agreement, weak literature base) (Bärnthaler et al., 2020; Brand et al., 2021; Brand & Wissen, 2017; Exner & Kratzwald, 2021; Novy, 2020; Spash, 2020a).

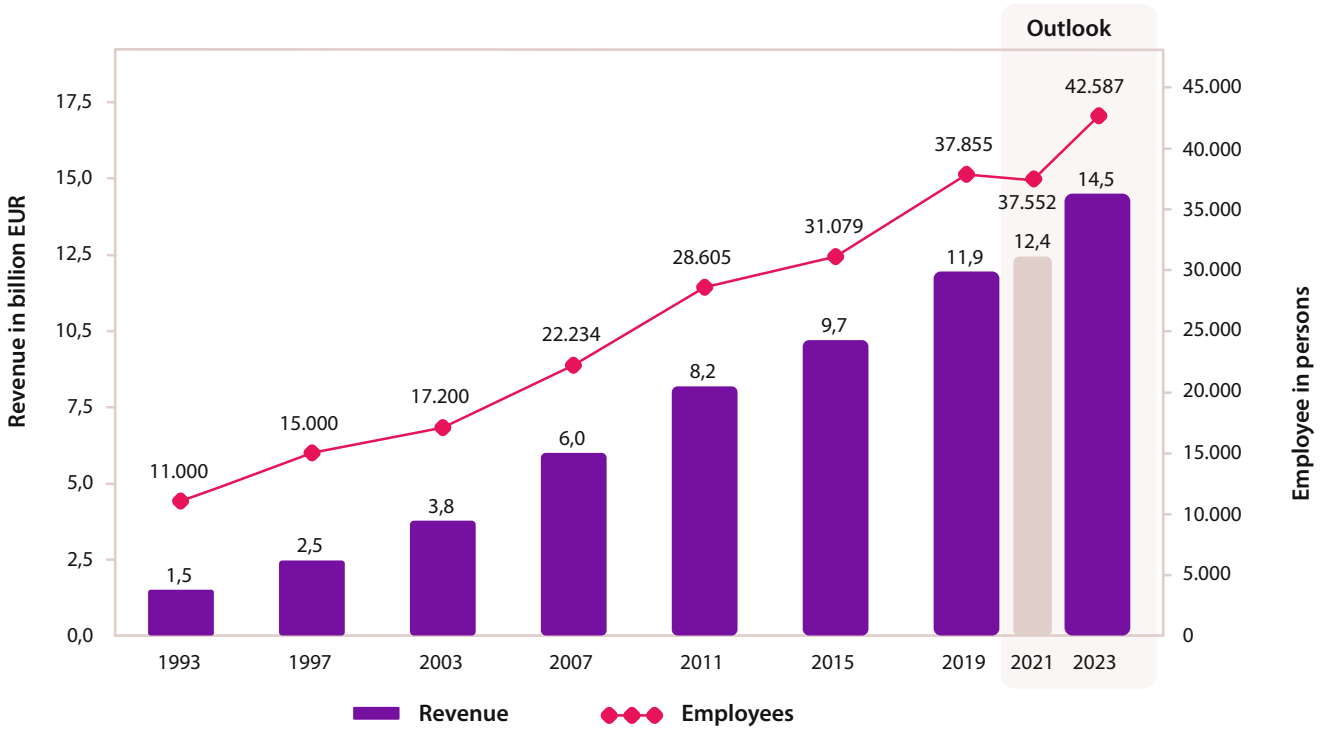

Fig. TS.14 Development of turnover, exports and employment figures in the Austrian environmental technology industry since 1993. (Source: Schneider et al., 2020). {Chap. 14}

Chapter 15: Globalisation: Global commodity chains and division of labour

To understand Austria's role in the climate crisis, its embeddedness in global economic structures needs to be analyzed (high agreement, medium literature base). This chapter provides this analysis by means of the "global commodity chains" concept (Fischer et al., 2021). The chapter presents a literature-based analysis of the ways in which Austria is involved in global commodity chains in terms of its production locations and final consumption. As far as possible with the available data, the chapter assesses the resulting environmental impacts. The chapter evaluates, on the basis of scientific literature and policy proposals being discussed at the international, European and national levels, new ways of organizing global commodity chains to promote a climate-friendly restructuring of transnational production networks.

As an open economy, Austria is deeply integrated in transnational commodity chains both in terms of production and final consumption (OECD-WTO, 2015; WTO, n. d.; Kulmer et al., 2015; Giljum et al., 2017; Stöllinger et al., 2018; Eisenmenger et al., 2020) (high agreement, medium literature base). The structure of transnational commodity chains partially separates places of production and final consumption. This means that GHGs of goods and services produced and consumed in Austria, are to a great extent emitted in other places. As is the case for other high-income countries, Austrian imports of goods and services create high emissions in economies that are on average poorer than Austria (Jakob & Marschinski, 2013; Chancel & Piketty, 2015; Eisenmenger et al., 2020; Jakob, 2021; IPCC, 2022b; Dorninger et al., 2021; Duan et al., 2021) (high agreement, strong literature base). In order to achieve the climate goals, a cross-border, sector-wide approach to Austrian production and consumption patterns [Chap. 1] is thus needed (Plank et al., 2021a) (high agreement, medium literature base).

The chapter distinguishes between several strategies to promote climate-friendly transformation of global commodity chains. These include responsible consumption and resource-efficient lifestyles. However, individual lifestyle changes are not sufficient to reduce the negative consequences of global production and consumption patterns to the required extent [Chap. 1] (Akenji, 2014) (medium agreement, medium literature base). Other possible measures include "rescaling" economic activities towards lower spatial levels (New Economics Foundation, 2010; Bärnthaler et al., 2021; Raza et al., 2021a; Raza et al., 2021b) and resource-efficient production processes involving the entire commodity chain (Eder & Schneider, 2018; Pianta & Lucchese, 2020; Pichler et al., 2021; Denkena et al., 2022). This requires sector-wide, in some cases cross-sectoral, transnationally oriented restructuring and conversion strategies that do not only focus on Austria (high agreement, medium litera-

ture base). So far, there has hardly been any applied research on this.

Several cross-border initiatives with direct and indirect effects on the structure and organisation of global commodity chains have been implemented at the EU level. Examples include the Emissions Trading System ETS as well as measures within the framework of the European Green Deal such as the EU Industrial Strategy, the Bioeconomy Strategy and the Circular Economy Action Plan (European Commission 2019a, 2019b, 2019c, 2020a, 2020b, 2021). In this context, commitments/pledges to transform global commodity chains according to ecological/climate criteria have either been subordinate or non-existent (high agreement, medium literature base). In Austria, the Federal Ministry of Digital and Economic Affairs has set up a working group on "Sustainability and Value Chains" as part of the development of the "Standortstrategie 2040" ("Locational Strategy 2040") (BMDW, 2021). In the field of bioeconomy and circular economy, the strategy aims at setting up national platforms to coordinate actors, but – at least for now – the ministry has no strategies of its own. The approach is predominantly market- and innovation-oriented, and the national industrial policy is less ambitious in terms of climate policy than that of the EU (high agreement, weak literature base).

In order to achieve the climate goals, market and innovation-oriented measures are not sufficient (Beckmann & Fisahn, 2009; Plank et al., 2021a) (high agreement, strong literature base). Proposed measures include binding rules for market activities, bans on extremely environmentally harmful products and production processes (Pichler et al., 2021) and greening public provision systems (Bärnthaler et al., 2021) (high agreement, medium literature base). Existing EU initiatives in the field of carbon pricing and industrial strategies offer the opportunity for improvements (Landesmann & Stöllinger, 2020; Pianta & Lucchese, 2020; Polt et al., 2021; Paul & Gebrial, 2021) (high agreement, medium literature base). Current proposals among others demand more ambitious regulation within the current EU ETS and the EU carbon border adjustment mechanism (Krenek et al., 2018; Stöllinger, 2020) (medium agreement, medium literature base). Climate-friendly regulation of global commodity chains can also be achieved through supply chain laws that impose legally binding environmental due diligence obligations on transnationally operating corporations (De Schutter, 2020; Kunz & Wagnsonner, 2021) (high agreement, high literature base). However, monitoring and sanctioning environmental harm requires the development of new legal remedies (Krebs et al., 2020; Schilling-Vacaflor, 2021) (high agreement, weak literature base). Currently, a directive proposal of the EU Commission for a supply chain law is being discussed (European Commission, 2022). To avoid unfair competitive conditions for companies as well as rebound effects (Barker et al., 2009; Wei & Liu, 2017) and carbon leakage (Birdsall & Wheeler, 1993; Jakob & Marschinski, 2013; Jakob, 2021; IPCC, 2022b), the suggested measures should be implemented at the international level (high agreement, strong literature base). Furthermore, in high-income countries like Austria, consumption will most likely have to sink in absolute terms in order to achieve global and national climate goals (Brand et al., 2021) (high agreement, strong literature base).

The interventions described above point to additional complementary measures for the path towards a just transition (Steffen & Stafford Smith, 2013). Social and economic compensation mechanisms need to be considered both at the national and global level ("global climate justice"), as an increase in inequality between poor and rich countries hampers climate efforts (Sovacool & Scarpaci, 2016; Baranzini et al., 2017; O'Neill et al., 2018; Korhonen et al., 2018; van den Bergh et al., 2020; Eicke et al., 2021; Paul & Gebrial, 2021; IPCC, 2022b) (high agreement, strong literature base).

Due to the complexity of global commodity chains, a large number of different actors is involved in forming and structuring them, both nationally and internationally (Fischer et al., 2021) (high agreement, strong literature base). On the one hand, this makes it possible to formulate several leverage points for climate-friendly action; on the other hand, it makes it very difficult to establish a broad and stable consensus. In addition, the actors involved in Austria (and beyond) have different power resources. Lines of conflict also exist within the different groups of actors. This applies, for example, to public institutions, the corporate sector and workers and their interest groups (high agreement, weak literature base). In this complex situation, it is key to recognize that the interests of these different actors – for different reasons – can come together in an "alliance for a climate-friendly life" to work towards a joint goal. Other actors must, however, shift interests and attitudes towards a more climate-friendly way of production and living.

In general, (re)regulation and ecological restructuring of global commodity chains requires a coordinated multi-level strategy (national, regional, European, international), whereby each level faces its own challenges (Dreidemy & Knierzinger, 2021) (high agreement, medium literature base). In addition to currently prevailing market- and innovation-oriented strategies, public provision systems (Bärnthaler et al., 2021) and raising awareness in society for changing of everyday routines (Göpel, 2016) form complementary strategies for achieving climate goals (medium agreement, strong literature base). Overall, the literature-based review shows that much more accompanying research is needed to provide information on the impact of existing initiatives and to plan future strategies. Furthermore, there is a lack of broader research exploring opportunities for transforming global commodity chains.

Chapter 16: Monetary and financial system

This chapter assesses the extent to which incentive structures of the monetary and financial system favour or hinder the transformation to a climate-friendly and sustainable mode of living in Austria. It also makes a literature-based assessment of the larger economic and social structures in which the monetary and financial system in Austria is embedded. Already initiated and potential future reforms of the financial system and changes to the existing monetary system are reviewed to understand the extent to which they can mobilise capital flows necessary for financing structures for a climate-friendly way of life.

The design of incentive structures of the monetary and financial system reflects guiding social patterns of thought and action, the given social institutions as well as the existing physical capital stock (Aglietta, 2018; Eisenstein, 2021; Graeber, 2014; J. Lent, 2017; Schulmeister, 2018) (low agreement, medium literature base). Money was long considered neutral, that is, having no repercussions on real, often physical, economic production – this paradigm has been transformed since the 2008/09 financial crisis (Ball, 2009; Malkiel, 2003; Maloumian, 2022). The primary aim of monetary policy was to prevent high rates of inflation. Until the discursive shift, it was not considered to make a significant contribution to addressing the climate crisis (Aglietta, 2018; Dikau & Volz, 2018, 2021) (low agreement, strong literature base). In the sense of a green finance paradigm, financing climate-friendly investments is now to take place primarily via financial markets and asset owners – and be motivated with corresponding incentives (Alessi et al., 2019; Breitenfellner et al., 2020; Factscheck Green Finance, 2019; Monasterolo, 2020; Sustainable Finance Advisory Council, 2021; UNCTAD, 2019) (medium agreement, strong literature base). The green finance paradigm is widely seen as dominant, and deeper, structural problems of the financialised growth paradigm are increasingly prioritised in other strands of literature – partly due to insufficient climate-friendly investments in recent decades (Hache, 2019a, 2019b; Jäger, 2020; Jäger & Schmidt, 2020; J. Lent, 2017; Reyes, 2020).

Long-term, secure and profitable returns for financing investments in emission-neutral or low-emission capital stock (i.e. "green investments") are central for the certainty of investors' expectations, while returns on other (e.g., fossil-based) financial products should decrease. There should be clarity that the CO_2 price will rise steadily, substantially and in the long term (Aglietta, 2018; Edenhofer et al., 2019; IEA, 2021; IPCC, 2018; Pahle et al., 2022; Schulmeister, 2018) (high agreement, strong literature base). From an innovation perspective, more public (funding) resources as well as financial innovations are needed to finance innovative research for climate-friendly technologies (Balint et al., 2017; Mazzucato, 2014; Shiller, 2009) (medium agreement, medium literature base). Another strand of literature explains the move away from financialisation, i.e., increased decoupling of finance and the real economy, and a stronger focus on investment in climate-friendly provision as necessary for climate-friendly living (Aglietta, 2018; Crotty, 2019; Keynes, 1936; Malm, 2013, 2016; Schulmeister, 2018) (low agreement, strong literature base). Degrowth and a stronger use-value orientation are at the forefront (Eisenstein, 2021; Georgescu-Roegen, 1971; Hickel, 2021; Hickel & Hallegatte, 2021; Hickel & Kallis, 2020; Kallis et al., 2012, 2018; Keyßer & Lenzen, 2021; Meadows et al., 1972; Schröder & Storm, 2020) (low agreement, strong literature base).

The state will be a central actor to exercise power to effectively redesign incentive structures in financial markets in an emissions-reducing way (Aglietta, 2018; Breitenfellner et al., 2021; DiEM25, 2020; Edenhofer et al., 2019; Kelton, 2019; Novy, 2020; Pahle et al., 2022; Schulmeister, 2018) (medium agreement, strong literature base). The Oesterreichische Nationalbank (OeNB) as part of the European central banking system and the Austrian Financial Market Authority (FMA) as the regulating authority for financial markets can create structures for climate-friendly living (Battiston et al., 2020; Breitenfellner et al., 2019; NGFS, 2021; Pointner, 2020; Pointner & Ritzberger-Grünwald, 2019). On the one hand, they can reduce climate-finance risk through regulation and monetary policy, which endangers financial market stability through insufficient pricing of climate-related physical and transition risks. On the other hand, they can help ensure the emissions effectiveness of green and sustainable finance. This can be done, for example, through appropriate self-investment (green investment strategies of the central bank itself), the design of banks' capital ratios and through macroprudential measures (Battiston, Dafermos, et al., 2021; Battiston et al., 2020; Battiston, Monasterolo, et al., 2021; Bolton et al., 2020; Breitenfellner et al., 2019; Dörig et al., 2020; Monasterolo, 2020; NGFS, 2021; Pointner, 2020; Pointner & Ritzberger-Grünwald, 2019; Rattay et al., 2020) (high agreement, strong literature base). Green Growth – enabled by green and sustainable financing – will be the key approach in this regard. Relevant initiatives include the EU Green Deal, Sustainable Finance (Taxonomy) and Green Recovery, sovereign venture capital for innovative green investments, and divestment strategies (Alessi et al., 2019; Breitenfellner et al., 2020; Green Finance Fact Check, 2019; Monasterolo, 2020; Sustainable Finance Advisory Council, 2021; UNCTAD, 2019). If these measures are to be effective, "greenwashing" must be avoided (Alessi et al., 2019; The GLOBAL 2000 Banking Check, 2021; Hache, 2019a, 2019b; Reyes, 2020) (medium agreement, strong literature base). Deep and effective reform of financial incentive structures and taxation to establish true costs in production and consumption will be crucial. Profound tax reform and ac-

companying green industrial policy would include effective CO_2 taxes, financial transaction taxes, property taxes and credit steering towards green investment (Aglietta, 2018; DiEM25, 2020; Edenhofer et al., 2019; Novy, 2020; Pahle et al., 2022; Pettifor, 2019; Piketty, 2014; Schulmeister, 2018; UNCTAD, 2019) (high agreement, strong literature base).

An other strand of literature emphasises that commodification and monetisation of nature is not a sustainable solution as long as financialised economies seek to balance social tensions by means of growth based on exploitation of nature for systemic reasons – when financial markets are characterised by structural bubble development, instability and growth expectations (Bracking, 2020; Hache, 2019b; Harvey, 2011; Kemp-Benedict & Kartha, 2019; Maechler & Graz, 2020; Spash, 2020a, 2020b; Sullivan, 2013) (low agreement, strong literature base). If planetary, biophysical limits are to be respected, restricting growth or economic shrinkage (degrowth) in economies with high incomes and (especially) with high consumption levels is an essential condition in this perspective (Eisenstein, 2021; Georgescu-Roegen, 1971; Hickel, 2021; Hickel & Hallegatte, 2021; Hickel & Kallis, 2020; Kallis et al., 2012, 2018; Keyßer & Lenzen, 2021; Meadows et al., 1972; Schröder & Storm, 2020; Spash, 2020a) (low agreement, strong literature base). De-commodification, de-monetarisation as well as strengthening of use value in the context of degrowth are about unfolding people as a social beings, enabled and promoted by restructuring of our value, social and economic system to respect biophysical limits. This unfolding would expand and transcend a materialist value system and enable a good life for all aside from current monetarisation tendencies inherent in modern capitalism (Eisenstein, 2011, 2021; Hickel, 2021; Hickel & Hallegatte, 2021; Hickel & Kallis, 2020; Kallis et al., 2012, 2018; J. Lent, 2017; J. R. Lent, 2021; C. L. Spash, 2020a, 2020b) (low agreement, medium literature base).

According to this latter perspective, if financial markets are to be made serviceable for climate-friendly living, it will be necessary to initiate a de-commodification and de-monetarisation of economic activity (Harvey, 2011; O'Connor, 1998; Polanyi, 1944; Smessaert et al., 2020) and to recognise the nature of money as a commons through a democratisation of financial markets and monetary system (Eisenstein, 2011, 2021; Hockett, 2019; Mellor, 2019) (low consensus, strong literature base). The climate crisis could become a pivot for the monetary and financial system around which a new international monetary cooperation is formed, tying the creation and deployment of international finance to addressing the climate crisis (Aglietta, 2018; Eisenstein, 2011, 2021; Schulmeister, 2018) (low agreement, medium literature base). In this view, monetary systems and financial markets would need to be regulated via increased national and international democratisation in order to democratically establish and regulate money in its actual status as a common good (Eisenstein, 2011, 2021; Hockett, 2019; Mellor, 2019) (low agreement, medium literature base).

In summary, the structural social and economic changes proposed here would aim at creating, directing and deploying money flows for the purpose of financing the socio-ecological transformation for the common good (Aglietta, 2018; Cahen-Fourot, 2020; Eisenstein, 2011, 2021; Felber, 2018; Hache, 2019b; J. Lent, 2017; J. R. Lent, 2021) (low agreement, medium literature base).

Chapter 17: Social and spatial inequality

Chap. 17 assesses the literature on the link between social and spatial inequality and climate-friendly living and identifies existing structural conditions of inequality that obstruct climate-friendly living. The chapter focuses on mobility and housing as fields of action and suggests changes necessary to enable a "good" life for all within the ecosocial limits of the planet.

Income and wealth are the most powerful factors influencing household emissions behaviour. As income and wealth are increasingly unequally distributed, emissions behaviour is also characterised by strong inequality (high agreement, strong literature base). In this context, climate-damaging consumption by high-wealth and high-income groups poses a particular problem for addressing the climate crisis (Rehm, 2021; Wiedmann et al., 2020) (medium agreement, high literature base). Low-income groups are more financially burdened by climate protection measures and are often unable to finance them. Burdens are increased or alleviated depending on where they live (Chancel, 2020; Laurent, 2014) (high agreement, medium literature base). Monetary redistribution alone would not solve this problem, however, as income and related consumption would only be redistributed and not reduced. An expanded concept of income that includes the societal provision of and access to social and material infrastructure is necessary to even out social and spatial inequalities and enable climate-friendly living for all people regardless of their monetary income and place of residence (low agreement, medium literature base).

Mobility (30 percent) and housing (including heating, cooking, utilities) (27 percent) are among those sectors that are responsible for a large share of the total CO_2 emissions in Austria (Munoz et al., 2020). Structural conditions for the promotion of climate-friendly action are mainly dependent on these fields of action (high agreement, strong literature base). Socio-spatial differences in mobility behaviour (e.g. increased car ownership and use in rural areas and in upper

income groups) play a significant role in emission reduction measures. In order to ensure and promote climate-friendly mobility for all, public transport services that are accessible and attractive for all (eg. a "mobility guarantee") and targeted financial tax or redistribution measures (eco-social tax reform in the transport sector, eco/mobility bonus, etc.) are needed. International best practice examples can be found, among others, in Switzerland (ecological commuter fund from parking revenues), Belgium (kilometre allowance for cycling) or Canada (socially graduated eco-bonus) (Commuter Fund, n. d.; VCÖ, 2014, 2018, 2021; Frommeyer, 2020; Harrison, 2019) (high agreement, medium literature base).

In the housing sector, energy consumption related to housing type and living environment is a key driver of GHG emissions and is a structural feature that can massively promote or restrict climate-friendly living. The energy efficiency of buildings is largely determined by the respective heating system. Relevant trends are the above-average use of coal as an energy source in the first two income deciles and the significant increase of alternative energy sources with higher incomes (Lechinger & Matzinger, 2020). Heating costs are unequally distributed in Austria: Low-income households (household income < 60 percent of the median) spend four percent of their income on heating; high-income households (> 180 percent of the median) only two percent. Hence, the avoidance of a large financial burden for lower income deciles entailed by the departure from coal, oil and gas poses a central challenge for the path to climate neutrality (Plumhans, 2021) (high agreement, medium literature base).

For mobility as a field of action, the following actors can be identified emblematically: (1) Public and civil society institutions and organisations, such as the Austrian Conference on Spatial Planning (ÖROK). The planning of a nationwide public transport system for all and its legal anchoring is an essential lever for promoting climate-friendly mobility behaviour. (2) Interest groups such as the car lobby and transport clubs (ÖAMTC, ARBÖ, VCÖ) or the bicycle lobby (radlobby, ARGUS). While representatives of the automotive industry do not support the dismantling and restructuring of fossil-based transport structures, other public interest-oriented transport and cycling clubs actively promote and expand sustainable mobility (Haas & Sander, 2019). (3) Public and private transport service providers and transport companies (ÖBB, Wiener Linien, bike rental companies, etc.) as well as transport associations (e.g. VOR) are among those that can practically implement climate-friendly mobility concepts (medium agreement, weak literature base). For housing as a field of action, the relationship between owners and tenants plays an important role: tenants have little to no influence on their heating system (Allinger et al., 2021). Ownership limits the ability to act in favour of climate-friendly housing and represents a socially unevenly distributed structural feature of climate-friendly living (Friesenecker & Kazepov, 2021). The Tenancy Act (Mietrechtsgesetz) and especially the Non-Profit Housing Act (Wohnungsgemeinnützigkeitsgesetz, WGG) are said to have the potential to make housing in Austria more sustainable and inclusive through ecological and social standards (Litschauer et al., 2021). However, mechanisms enshrined in the WGG, such as high down payments, can act as a barrier for low-income households and have a marginalising effect, structuring the possibilities of climate-friendly living along social dividing lines (Kadi, 2015; Friesenecker & Kazepov, 2021). Finally, project developers and construction companies, social partners (especially the Chamber of Labour), tenants' associations, trade unions and NGOs can be mentioned as relevant actors (medium agreement, medium literature base).

Monetary incentives and costs in the form of taxes, tax concessions and charges on climate-damaging activities (e.g. CO_2 tax, petroleum tax, motorway tolls, tax concessions on bicycle purchases, etc.) represent a way of internalising externalities. However, these measures have distributional consequences. If the consumption of high-income households is supposed to be reduced and the participation in social life maintained for low-income households, it is important to consider these distributional effects (Humer et al., 2021; Köppl & Schratzenstaller 2021) (medium agreement, high literature base). The expansion of social-ecological infrastructure can reduce environmentally harmful emissions and at the same time generate progressive distribution effects. Higher income and wealth taxes could therefore be earmarked for the expansion of social-ecological infrastructure rather than monetary transfers in order to create structures for climate-friendly living (Froud & Williams, 2019; Gough, 2017; Lechinger & Matzinger 2020) (high agreement, medium literature base).

Innovations in the energy, transport and construction sectors can support market-based measures and public provision of social-ecological infrastructure to guarantee minimum social standards for all people. "Mission-oriented" innovation policy is an approach to break down "wicked problems" of the eco-social crisis into smaller problems to which private and public research institutions contribute solutions (high agreement, medium literature base). Social acceptance of these proposals can be achieved through far-reaching societal changes that need to be supported and clearly communicated by policy makers. For example, to decouple individual notions of freedom from the satisfaction of unlimited "wants" and to proceed to an understanding of social justice where all people can satisfy their basic needs requires a profound but necessary societal shift which enables a "good" life for all within the ecosocial limits of the planet (Gough, 2017;

O'Neill et al., 2018; Wiedmann et al., 2020) (medium agreement, high literature base).

Chapter 18: Welfare state and climate change

Social protection and social cohesion act as structural preconditions for the transformation towards a climate-friendly society. Chap. 18 reviews and evaluates the literature that sees welfare state structures and activities as interdependent with climate change and climate policy. There are links with respect to the welfare state's services, production and financing. They form starting points for the climate-friendly design of the health and social system, which avoid negative trade-offs between climate and social policy and create synergies in the sense of an eco-social policy.

Welfare state services are directly challenged by climate change. Climate change causes health and economic damages that are unequally distributed (Austrian Panel on Climate Change (APCC), 2018; BMSGPK, 2021; Steininger et al., 2020) (high agreement, strong literature base). The potential for harm is greater for population groups that are more exposed to climate impacts and have more limited response options (Austrian Panel on Climate Change (APCC), 2018; BMSGPK, 2021; Papathoma-Köhle & Fuchs, 2020) (high agreement, strong literature base). Individual vulnerability characteristics, which partly overlap, include pre-existing conditions and health restrictions in everyday activities, being affected by (multidimensional) poverty and social exclusion, a low level of education or single parent status (BMSGPK, 2021; Papathoma-Köhle & Fuchs, 2020) (high agreement, strong literature base). The consequences of increasing risks and vulnerability of the Austrian population to climate change are high and further increasing burdens on social and health care systems (see e.g. Aigner & Lichtenberger, 2021; Schoierer et al., 2020; Steininger et al., 2020) (high agreement, medium literature base). Combating climate change, especially climate-damaging emissions, therefore benefits the Austrian social and health care system (Steininger et al., 2020). However, negative side effects of specific climate policy measures on welfare are possible and can be observed. Depending on the chosen instrument and its design, this justifies additional need for social policy action (BMSGPK, 2021; Lamb et al., 2020) (high agreement, medium literature base).

Analogously, social policy can generally support climate policy, but this is not automatically the case for all measures. The Austrian welfare state ensures the acceptance of climate policy measures through the benefits it provides (see e.g. Fritz & Koch, 2019; Koch & Fritz, 2014; Otto & Gugushvili, 2020) (high agreement, medium literature base). The country comparison as well as the comparison of different ideal-typical welfare state systems prove that potential synergies between the two policy fields are used to varying degrees (Zimmermann & Graziano, 2020). This shows that institutional conditions are essential for making societies less vulnerable to climate impacts. The institutional resilience of the Austrian welfare state to the impacts of climate change and its contribution to climate-friendly living can be increased in particular by the following measures:

- preventive policy is strengthened, especially in relation to health, new demands on the labour market and extreme natural events and weather conditions,
- the CO_2 footprint of the health and social sector is fully recorded and consistently reduced by means of climate-friendly provision processes,
- the interfaces of social with climate policy are systematically recorded and – building on this – measures from both policy fields are better bundled into eco-social programmes,
- the different actors cooperate in an evidence-based manner across federal levels, regional action areas and policy fields.

The budgetary framework for health promotion and health prevention in Austria is currently tight. Prevention accounts for about nine per cent of current public health expenditure, which mainly finances preventive measures for people with already manifest health problems (BMASGK, 2019). Strengthening care in the community-based sector can avoid more emission- and cost-intensive treatments in hospitals (Renner, 2020). Overall, health promotion and health prevention are structurally underfunded, and it is expedient in terms of climate and social policy to allocate more funds to health policy as an interministerial field of action (Haas, 2021; Weisz et al., 2019) (high agreement, weak literature base). The level and distribution of the economic and social consequences of unavoidable, extreme natural events depend on how the disaster fund is financially equipped, whether financial compensation is systematically provided in a socially differentiated manner and whether the funds are used sustainably, in the sense of avoiding consequential damage (Papathoma-Köhle et al., 2021; Papathoma-Köhle & Fuchs, 2020).

The health and social sector is an economically important sector. How climate-friendly production and employment are in this sector can therefore have a noticeable influence on climate change and its mitigation. So far, the CO_2 footprint is only known for the health sector, but not for the social sector. According to this, the Austrian health sector's share of 6.7 percent of national CO_2 emissions is above average in international comparison (Pichler et al., 2019; Weisz et al., 2019). The Austrian health sector could reduce its CO_2 footprint by optimising the spatial supply structure, procurements, use of medicines and equipment and treat-

ment routines (Alshqaqeeq et al., 2019; Renner, 2020; Weisz et al., 2019) (high agreement, medium literature base). The use of digital technologies also offers opportunities to avoid climate-damaging emissions, e.g. telecare in mobile care (AWO Bundesverband e. V., 2022; Care about Care, 2022) (high agreement, weak literature base). A consistent ecologically oriented procurement policy in the entire health and social sector can accelerate the use and development of sustainable production methods among providers of the required goods and services (Peñasco et al., 2021), e.g. through climate-friendly and at the same time health-promoting food offers in canteens of youth, old people's and nursing homes, day care centres or social administration (illustrated for Sweden: Lindström et al., 2020) or electrification of the vehicle fleets of mobile social services (Bach et al., 2020) (high agreement, weak literature base). Also related to its role as a major employer, the health and social care sector can be a pacesetter to implement climate-friendly working models (Bohnenberger, 2022) (high agreement, medium literature base).

With regard to the interfaces between climate and social policy and the need for integrated, eco-social packages of measures, CO_2 pricing, a weakened labour-centredness of social security and climate-friendly investment of pension assets are discussed. There are a number of recent findings on CO_2 pricing that refer to Austria (Kirchner et al., 2019; Six & Lechinger, 2021; Mayer et al., 2021). A CO_2 tax can have a positive effect on both social and climate policy goals (Kirchner et al., 2019; Six & Lechinger, 2021; Mayer et al., 2021) (medium agreement, medium literature base). Whether and which concrete compensation measures (refunds in the form of flat-rate or income-oriented cash benefits, reductions in other taxes, reduced social security contributions) are meaningful and particularly effective in achieving goals is assessed differently depending on the scenario and the research approach (Kirchner et al., 2019; Six & Lechinger, 2021; Mayer et al., 2021) (medium agreement, medium literature base). The strong employment-centredness of the Austrian social system is a structural barrier to the transition to a climate-friendly society. Climate policy aims at an equal distribution of employment and care work (with less employment overall), less resource-intensive lifestyles (renunciation of high earnings and status consumption) and re-qualification of employees in climate-damaging fields of activity. If this is to be flanked by social policy, access to benefits and the level of benefits would have to be improved in individual branches of social security for people who are not, or not continuously, in full-time employment (Bohnenberger, 2022). Whether, for example, an ecological basic income, a maximum income or universal benefits in kind can be used effectively in Austria, cannot be answered at present due to existing research gaps.

Institutional investors in the Austrian social security system still contribute significantly to climate change through their investments (and thus increase their climate-related investment risks) (Semieniuk et al., 2021). At just under 44 billion euros, a substantial sum is invested by Austrian occupational pension funds and occupational employee provision funds. In 2019, at least 30 per cent of the investments of Austria's inter-company pension funds (€ 25 billion in 2021) were in five sectors that are considered to be particularly GHG intensive (European Insurance and Occupational Pensions Authority, 2019). For Europe as a whole, there is a significant need for additional investment to achieve the ambitious emission reduction targets, which is difficult to meet from public funds alone (Brühl, 2021; van der Zwan et al., 2019). Institutional investors in the Austrian social security system could contribute by shifting from emission-intensive to climate-friendly investments ("divest-invest") (high agreement, weak literature base).

If social and climate policies are to be coordinated, it is necessary to institutionalise cooperation or to rethink tasks and the corresponding responsibilities (e.g. in disaster control) (BMSGPK, 2021; Papathoma-Köhle et al., 2021). Overall, there is a great need for research on how ecosocial policy in Austria can be designed effectively and efficiently in terms of institutions and instruments. Some systematic reviews are available that summarise the results of international scientific studies with a focus on this issue (Alshqaqeeq et al., 2019; Lamb et al., 2020; MacNeill & Vibert, 2019; Mayrhuber et al., 2018; Peñasco et al., 2021). However, Austrian interventions are often not included in these reviews or only as part of multi-country studies. There can be three main reasons for this: (1) either no ecosocial interventions are yet implemented in the relevant fields of action (policy action gap), (2) measures in the field of ecosocial policy have not yet been researched across the board and according to the usual scientific quality standards (research gap), and/or (3) the available evidence is not publicly accessible (transparency gap). If evidence-based ecosocial policy is to be pursued that achieves rapid learning effects, these gaps must be reduced (evaluation culture in the political and administrative system, investment in data infrastructure, data access for independent scientific research, targeted research funding programmes, public access to commissioned and already available studies).

Chapter 19: Spatial planning

This chapter assesses the extent to which spatial planning and land use planning facilitate or hinder the transformation to a climate-friendly mode of living in Austria. A literature-based assessment is made regarding the effectiveness of

spatial planning instruments and necessary changes towards climate-friendly living.

In Austria, spatial development in many places hinders climate-friendly living. Land consumption is high in international comparison. Urban sprawl and fragmentation of the landscape – the drifting apart of housing, work, supply, leisure and mobility – are becoming increasingly visible and noticeable. Patchy settlement areas, fraying settlement edges, trade and commercial agglomerations with large-scale car parks at town and city borders, as well as remote tourism facilities lead to long journeys mainly made by car. Sealing of land and overbuilding contribute to overheating and increased surface runoff and thus to the risk of flooding. Even if growth rates in land use and motorised private transport have decreased noticeably in recent years – Austria's built structure and transport situation continue to exacerbate the climate crisis (Kurzweil et al., 2019; Österreichische Raumordnungskonferenz, 2021; Umweltbundesamt, 2020a, 2021a, 2021b; ; Zech, 2021c) (high agreement, strong literature base).

Despite numerous efforts, spatial planning praxis and spatial development in cities and municipalities, as well as through (voluntary) inter-municipal cooperation, does not sufficiently succeed in creating a spatial framework for climate-friendly behaviour in the built environment, the economy, in services of general interest and in mobility. In many cases, political will to steer and problem awareness of public and private developers and infrastructure providers are lacking for consistently counteract or reverse climate-hostile spatial developments. In contrast to other countries (e.g., Switzerland, Germany), the Austrian constitution does not provide a "framework competence" for spatial planning at federal level; nor are expert and funding agencies appropriately equipped for spatial planning and spatial development at national level. These factors make it difficult to enforce overarching climate goals in planning (Dollinger, 2010; Ertl, 2010; Franck et al., 2013; Kanonier & Schindelegger, 2018a; Österreichische Raumordnungskonferenz, 2021) (high agreement, medium literature base). Although in the (non-binding) Austrian Spatial Development Concept (ÖREK) and in the planning and building laws of the federal states, the principles and objectives of spatial planning and spatial development in terms of climate protection and climate change adaptation are formulated or at least open to interpretation, their steering effect is limited. The federal states exercise their influence and control instruments for spatial development (state and regional planning) differently and often only hesitantly. Although current regional development programmes and concepts can be understood as thoroughly climate-conscious guiding principles and declarations of intent, they hardly contain any binding specifications (Kanonier & Schindelegger, 2018b; Österreichische Raumordnungskonferenz, 2021; Svanda & et al., 2020) (medium agreement, medium literature base).

As a cross-sectional matter, spatial planning and development is constantly challenged with steering problems in coordinating and integrating divergent interests. For example, a multitude of material issues influence settlement development, such as transport, mining, water law, commercial law and tourism. Compared to sectoral goals, interests and technical standards, overall, integrated and thus less concrete qualitative requirements of spatial planning and spatial development can only partially prevail and thus ensure climate-friendly decisions (Dollinger, 2010; Kanonier & Schindelegger, 2018b). Coordinated and integrative spatial development requires political will to steer and at the same time openness and resources for participatory planning processes in order to raise awareness and define and create spatial framework conditions for climate-friendly behaviour of residents, companies and planning authorities when they make decisions on location, use of space and mobility. Spatial planning needs to be strengthened in its core competencies of regulatory planning, setting the framework for location, development and design of settlement areas, business locations and landscapes and green spaces in a climate-conscious manner, integrated into cooperative and participatory planning processes (Baasch & Bauriedl, 2012; Dollinger, 2010; Schindegger, 2012; Svanda et al., 2020) (medium agreement, medium literature base).

Spatial planning and land use planning enable and promote climate-friendly modes of living in a sustainable manner if

- settlement and commercial areas in cities and municipalities are compact and greened (space-saving building density, low sealing, climate-impacting planting);
- Living, working, utilities, leisure facilities and green spaces are close to each other (functional mix).
- and conveniently accessible by foot, bicycle or public transport (city and place of short distances).

Climate-friendly living in regions is possible if

- the train system forms the backbone of settlement development and is attractively linked with other means of public transport,
- Business, cultural, educational, consumer and administrative facilities are distributed and interconnected in the most suitable locations that can be reached in a climate-friendly manner and are shared by communities, residents and businesses of the region, and
- Landscape and green spaces as well as water bodies – green and blue infrastructure – are attractive for local recreation and contribute to biodiversity, production of healthy regional food, generation of renewable energy and climate change adaptation (temperature compensation,

flood retention) (Austrian Conference on Spatial Planning, 2021) (high agreement, medium literature base).

Ways and means for an urgently needed trend reversal from climate-damaging to climate-friendly spatial structures that enable and promote climate-friendly living are shown. Essential success factors are:

- Taking existing spatial planning instruments seriously, i.e., zoning and development plans, local and regional development concepts, spatial concepts and plans of the states ("Länder") and the Austrian Spatial Development Concept with the associated land strategy as well as land policy instruments, use them and make them more climate-friendly (Kanonier & Schindelegger, 2018b; Österreichische Raumordnungskonferenz, 2021),
- a cooperative planning culture, i.e., increased use of governance approaches in instruments (guiding principles, strategies) and in the process design (interaction of interest groups, citizen participation) (Heinig, 2022; Madner, 2015a; Selle, 2005; Zech, 2015),
- integrated development planning that communicates with different sectors and disciplines (Einig, 2011; Österreichische Raumordnungskonferenz, 2021),
- obligation of sectoral planning – especially in transport planning – to contribute to climate-friendly spatial structures (Danielzyk & Münter, 2018; Stöglehner, 2019; Zech et al., 2016), and
- targeted use of fiscal instruments to reform taxes (such as real estate income tax, property tax, etc.) or subsidies (such as housing subsidies, economic subsidies, commuter allowances, etc.) that have so far been levied in a mostly "spatially blind" manner – without taking into account their possible positive (e.g., use for inner development) but also negative spatial effects (e.g., urban sprawl) or subsidies (such as housing subsidies, economic subsidies, commuter allowances, etc.) and to provide comprehensible and easy-to-use tools for inter-municipal fiscal transfer (Bröthaler, 2020; Mitterer et al., 2016; Mitterer & Pichler, 2020; ÖROK, 2017; Zech et al., 2016) (high agreement, medium literature base).

Chapter 20: Media discourses and media structures

Media (both traditional mass media and social media) are central forums in which climate crisis, including need for transformation to a climate-friendly life, is discursively constructed and negotiated (Reisigl, 2020). Due to their effect on recipients, which will only be discussed to a limited extent in this chapter, media are central to creating imaginary spaces and actions dealing with climate crisis (e.g., Arlt et al., 2010; Gavin, 2018; Kannengießer, 2021; Neverla et al., 2019; Wiest et al., 2015). Media construction of those problem areas is an important factor for successfully implementing many transformation needs that are elaborated in other chapters of this report. Two media-analytical subareas are addressed in the following: Media discourses (both in mass media and on social media) and media structures, including both media technologies (e.g., Kannengießer, 2020b) and underlying political-economic and cultural institutions (Fuchs, 2017; Knoche, 2014).

Scientific literature at the intersection of media and climate crisis, often contains studies on journalistically produced content, with the role of online and social media receiving increasing attention (e.g., Kirilenko & Stepchenkova, 2014; Newman, 2017; Veltri & Atanasova, 2017; Pianta & Sisco, 2020). Overall, very few studies are available for the Austrian context. Scientific literature at international level shows that media attention on different aspects of the climate crisis has clearly increased over the last three decades, but at the same time remains at a low to medium level (own calculations based on M. Boykoff et al., 2022; Daly et al., 2022). Established media practices such as occasion-based reporting (M. T. Boykoff & Roberts, 2007; Brüggemann et al., 2018; Grundmann & Scott, 2014; M. S. Schäfer et al., 2014) as well as competition with other topics (Barkemeyer et al., 2017; M. T. Boykoff et al., 2021; Lyytimäki et al., 2020; Pearman et al., 2020) and the ideological orientation of media houses play a central role (high agreement, strong literature base) (Barkemeyer et al., 2017; Bohr, 2020; M. T. Boykoff, 2008; M. T. Boykoff & Mansfield, 2008; Brüggemann et al., 2018; Pianta & Sisco, 2020; M. S. Schäfer et al., 2014; Schmidt et al., 2013). As a long-term, global, highly complex process with few possibilities for personalisation and not being directly perceptible via individual senses, the climate crisis does not offer an ideal object for journalistic reporting. Only events that fulfil a "news value" and can be linked to the climate crisis – be they political, scientific or weather- and nature-related – provide occasions for reporting (Brüggemann & Engesser, 2017; Neverla & Trümper, 2012).

On a discursive level, a broad consensus for the existence of the human-made climate crisis can be found in journalistic media (high agreement, strong literature base) (Brüggemann & Engesser, 2014; Brüggemann et al., 2018; Grundmann & Scott, 2014). In some contexts (especially when certain media houses are ideologically close to right-wing conservative political elites or also in social media), the persistence of climate crisis-sceptical positions is quite relevant (high agreement, medium literature base) (Elsasser & Dunlap, 2013; Forchtner et al., 2018; Kaiser & Rhomberg, 2016; McKnight, 2010a, 2010b; Painter & Gavin, 2016; Petersen et al., 2019; Ruiu, 2021; Schmid-Petri & Arlt, 2016; Schmid-Petri, 2017). An analysis for Austria shows in this context that the online blog unzensuriert.at as well as the me-

dia outlets Zur Zeit and Die Aula, all three of which are close to the Austrian Freedom Party, predominantly disseminate climate crisis-sceptical positions (Forchtner, 2019).

Reporting tends to be dominated by market and innovation perspectives and measures embedded therein to avert the climate crisis (high agreement, medium literature base) (Diprose et al., 2018; Koteyko, 2012; Lewis, 2000; Shanagher, 2020; Yacoumis, 2018). For example, previous research shows that market-centred policies, technocratic solutions, corporate social responsibility and sustainable consumption are at the forefront of news coverage – regardless of the ideological orientations of newspapers (high agreement, medium literature base) (Diprose et al., 2018; Koteyko, 2012; Lewis, 2000; Yacoumis, 2018). Transformative perspectives tend to play a minor role (high agreement, medium literature base) (Carvalho, 2019; Diprose et al., 2018; Dusyk et al., 2018; Lehotský et al., 2019; Lohs, 2020; Schmidt & Schäfer, 2015; Vu et al., 2019).

Studies on the role of online and social media in climate crisis discourse are on the rise. Due to available data, there is a clear focus on the microblogging service Twitter (Pearce et al., 2014, 2019). Social media are forums for negotiating climate crisis discourses, especially for detailed scientific questions, (lay) discussions and emerging issues (Brüggemann et al., 2018; Lörcher & Neverla, 2015). Research also points to the relevance of social media for agenda-setting and public mobilisation of civil society actors, such as NGOs and activists (Askanius & Uldam, 2011; Greenwalt, 2016; Holmberg & Hellsten, 2016; M. S. Schäfer, 2012). Research on the dynamics of online discussions (in social media and on online blogs) suggests that affirmation of social group identity is often paramount, leading to polarisation of positions, echo chambers and fragmentation of debates (Brüggemann et al., 2018; Pearce et al., 2019; Treen et al., 2020).

At the level of media content, there are transformation requirements, especially with regard to challenging hegemonic growth- and technology-optimistic as well as market-centred positions. At the same time, a stronger focus on alternatives to the current organisation of economies, positive scenarios and transformative approaches to solutions that make the notion of a climate-friendly way of life tangible and imaginable is necessary (high agreement, medium literature base) (D. Holmes & Star, 2018; M. S. Schäfer & Painter, 2020).

At the level of media structures the following issues are in the foreground of requirements of a transformation: the restructuring of inhibiting factors such as journalistic practices (Brüggemann & Engesser, 2017; Krüger, 2021; M. S. Schäfer & Painter, 2020), business models and advertising market dependence (Beattie, 2020; D. Holmes & Star, 2018; M. S. Schäfer & Painter, 2020) – also of public advertising (Kaltenbrunner, 2021) –, ownership (Lee et al., 2013; McKnight, 2010a) and regulatory frameworks of the media sector (M. T. Boykoff & Roberts, 2007; Kääpä, 2020) (high agreement, medium literature base).

There are calls to reduce the high dependency of strategic communication from "elite sources", as these tend to justify existing power relations as well as production and consumption patterns and thus tend to oppose a profound transformation (Bacon & Nash, 2012; Bohr, 2020; Brüggemann & Engesser, 2017; Schmid-Petri & Arlt, 2016). As this dependency tends to increase with the crisis and transformation of the media sector, there is also a need to review existing media funding regimes and requirements (Friedman, 2015; Gibson, 2017; M. S. Schäfer & Painter, 2020; A. Williams, 2015). Moreover, the media sector as a relevant CO_2 emitter requires emission reduction pathways (also due to growing digital infrastructure), which have not been sufficiently formulated so far (high agreement, weak literature base) (Kannengießer, 2020a; van der Velden, 2018). The production of media content is embedded in context-specific, institutional structural conditions that inhibit a proactive role of the media for a transformation towards climate-friendly living (Fuchs, 2020; Fuchs & Mosco, 2012; Pürer, 2008).

There is little research on relevant actors in the Austrian context. Therefore, the role of central actors in the Austrian media landscape in terms of their contributions to bring about a climate-friendly mode of living is unclear. Some actors in the Austrian media sector have little to no discernible activities on the climate crisis so far; others can be classified as tending to promote it (low agreement, weak literature base). Our research on possible facilitating actors indicates that climate crisis specialised research networks and new forms of journalism are highly relevant for the discursive construction of the climate crisis that is conducive to a climate-friendly way of life. Options for design and action can be located in the following areas: alternative approaches to journalism (Howarth & Anderson, 2019; Neverla, 2020) that contribute to discourses of climate-friendly living (e.g., transformative journalism (Krüger, 2021)); changing approaches to science, environmental and climate journalism in newsrooms (Drok & Hermans, 2016; Le Masurier, 2016); media regulation (targeting media funding) (Pickard, 2020); moving away from fossilistic advertising markets; devising new funding models (Kiefer, 2011; Meier, 2012); and restructuring ownership (Lee et al., 2013; McKnight, 2010a) (medium agreement, weak literature base).

Chapter 21: Education and science for climate-friendly living

This chapter builds on literature on education and science (ES) for sustainable development and climate change. It focuses on concepts that put education at the forefront. Science is seen as the interplay between research and education. In

this respect, aspects of research for climate-friendly living are also taken up, although this is deliberately not the focus of the chapter. The assessment of what dimension can be attributed to the role of ES structures for climate-friendly living also remains unresolved. In particular, it seems to be the "structures in the heads" of involved people that ultimately generate patterns of thought and action hindering or favoring sustainability and climate friendliness.

Education and science (ES) in their current objectives and structures do not contribute enough to sustainable development and thus also to climate-friendly living (high agreement, strong literature base). The high urgency to respond to systemic crises of the Anthropocene – first and foremost the climate and biodiversity crises – is still opposed by forces of inertia and ES remain relatively unchanged in their content (especially teaching content), objectives, concepts and basic systemic structures (Elkana & Klöpper, 2012; Imdorf et al., 2019; Kläy et al., 2015; O'Brien, 2012; WBGU, 2011).

Inter- and transdisciplinarity (ITD), i.e. cross-disciplinary cooperation as well as cooperation between science and societal actors, are underrepresented in ES. The call for an expansion of ITD is becoming louder in context of sustainable development and climate change in particular (Future Earth, 2014; ProClim Forum for Climate and Global Change, Swiss Academy of Science, 1997; Scholz & Steiner, 2015; WBGU, 2011, 2014). Focusing on the reproduction of existing knowledge in the education system (Davidson, 2017; R. M. Ryan & Deci, 2016) stands in the way of independent, responsible learning oriented towards sustainability values and thus co-production of new knowledge (Botkin et al., 1979; UNESCO, 2017a) (high agreement, strong literature base).

If ES is to be aligned with challenges of sustainable development as well as climate-friendly living, the assumption of social responsibility and a fundamental paradigm shift towards holistic, integrated and transformative approaches is required (among others: International Commission on the Futures of Education, 2021; Sachs et al., 2019; Wayne et al., 2006; WBGU, 2011) (high agreement, strong literature base). This requires new objectives (e.g., orientation towards the Sustainable Development Goals (SDGs) of the United Nations, addressing real-world socially relevant problems, improving the quality of life for all) and comprehensive structural reforms (e.g., education plans, curricula, education concepts for sustainable development, career models, research funding) (high agreement, strong literature base) (Coelen et al., 2015; Leiringer & Cardellino, 2011; Martens et al., 2010; J. Ryan, 2011; Sachs et al., 2019; Saltmarsh & Hartley, 2011).

Sustainability and climate-friendly concepts in ES (e.g., Education for Sustainable Development (ESD) (UNESCO, 2021), climate change education and research, ITD (Future Earth, 2014; ProClim Forum for Climate and Global Change, Swiss Academy of Science, 1997; Scholz & Steiner, 2015; WBGU, 2011), transformative ESD (WBGU, 2011, 2014)) support the facilitation of knowledge acquisition and the development of values and competences to achieve climate-friendly and sustainable modes of living (high agreement, strong literature base). Appropriate approaches exist, however they need to be further developed and implemented on a broad basis in ES (high agreement, strong literature base).

Options for action draw on international examples and pilot projects in Austria that show how corresponding changes could be initiated in ES. The impact of individual options must remain open, as corresponding research is not available. If the scientific literature base on the effects of novel approaches in ES is to be increased, accompanying research for and evaluation of climate research and education programmes are necessary (high agreement, strong literature base).

Some policy papers already underline the need for sustainability and climate friendliness in the Austrian ES system: e.g., Memorandum of Understanding of the initiative "Mit der Gesellschaft im Dialog" – Responsible Science (Alliance for Responsible Science, 2015); Policy Decree Environmental Education for Sustainable Development (BMBF, 2014); Teaching Principle Civic Education, Policy Decree 2015 (BMBF, 2015); System Goal 7 of the Overall Austrian University Development Plan (BMBWF, 2020b); Austrian Strategy "Education for Sustainable Development" (BMLFUW et al., 2008); Action Plan for a Competitive Research Area (BMWFW, 2015); Uniko Manifesto for Sustainability (Austrian University Conference, 2020); for further initiatives, see also BMBWF (2019). At the same time, they are contrasted by only selective and in no way fundamental and systemic changes. If a fundamental paradigm shift in ES to support climate-friendly living and sustainable development is to be achieved, the transdisciplinary elaboration and practical implementation of comprehensive ES concepts that map the above-mentioned needs for change is a priority (high agreement, strong literature base).

If competences necessary for a climate-friendly life are to be promoted extensively, climate change education and ESD should form the basis of curricula and education plans at all levels of the formal education system (school and university), in particular also curricula of teacher training, and should be strengthened as a task of actors in informal and non-formal education (such as municipalities, museums, libraries, etc.) (UNESCO, 2021) (high agreement, strong literature base).

If science for climate-friendly and sustainable living is to be promoted, the creation of specific cooperative structures for inter- and transdisciplinarity in ES is necessary (e.g., the establishment of corresponding professorships, institutes, research centres, career positions, study programmes, textbooks, journals, societies, research networks), in addition to

a fundamental discussion of prevailing goals, contents and structures (e.g., incentive systems, tender criteria) and resulting power and competition relations (Climate Change Centre Austria – Klimaforschungsnetzwerk Österreich, 2018; Hugé et al., 2016; Kahle et al., 2018; UNESCO, 2017b; Yarime et al., 2012, p. 201) (high agreement, strong literature base).

If sustainability and climate friendliness are to be comprehensively and structurally anchored (UNESCO, 2012, p. 71) in all areas (e.g., Bormann et al., 2020; Kohl & Hopkins, 2021; UNESCO, 2014) at ES institutions in the sense of a holistic approach (Whole-Institution Approach), they need support in the form of strategic instruments (e.g., framework strategies) as well as corresponding performance assessment systems and incentives (high agreement, strong literature base).

When ES institutions implement GHG emission reduction measures at operational level, they can serve as living labs and pioneers of social-ecological transformation (Bassen et al., 2018; Bohunovsky et al., 2020) (high agreement, strong literature base).

This chapter has started to look at ES in the context of sustainable and climate-friendly living. The resultant discussion on this should be continued with scientists and social actors.

Chapter 22: Networked infrastructures

This chapter assesses the literature on networked infrastructure systems, such as electricity, data, road or rail networks, water or gas pipelines, and their contribution to the transformation towards a climate-friendly mode of living in Austria. Networked infrastructures form the central basis for everyday life and economic activity (European Commission, 2021). They structure behaviour in the long term and thus set the course for a climate-friendly mode of living. Due to European law, an organisational and economic unbundling has been established for networked infrastructure systems in Austria (with a few exceptions such as heating grids and smaller municipal utilities) between the operation of infrastructures (e.g., APG as electricity grid operator, ÖBB Infrastruktur as rail network operator) and the provision of concrete services (e.g., electricity supply, public transport) as market-related activities of services of general interest. In particular, European legislation solidified that energy supply, transport and telecommunication services of general interest are subject to specific public service obligations imposed by the Member States (high agreement, strong literature base).

Infrastructure systems are characterised by path dependencies and inertial forces (e.g., long life-span, institutional agreements, complex organisational structures, high investment costs, technical developments, monopoly positions of existing networks), which often make it difficult to build or change socio-technical infrastructures (Ambrosius & Franke, 2015; Tietz & Hühner, 2011; Frantzeskaki & Loorbach, 2010; Bos & Brown, 2012). As long as the use and maintenance of networked infrastructures is dependent to fossil fuels (e.g., energy input for vehicles, distribution and use of natural gas, etc.), resulting actions cannot be climate-friendly (high agreement, strong literature base).

There is consensus that without appropriate steering measures, further expansion of networked infrastructures through use of fossil energies will lead to more GHG emissions (high agreement, strong literature base). For example, two-thirds of energy supply is currently based on fossil fuels (BMK, 2020), but also expansion of road-based transport infrastructure with a simultaneous decline in rail-based transport infrastructure is in many cases associated with a negative impact on GHG emissions (Winker et al., 2019; Kropp, 2017; Banko et al., 2022). Regulatory frameworks indisputably have a major influence on the design of organisational structures of infrastructure systems. In particular, there is consensus that liberalisation of markets within the framework of the EU shapes the status quo (high agreement, strong literature base).

The share of grey energy (indirect energy for production, transport and distribution as well as destruction processes) is a substantial factor in infrastructure systems that has a direct impact on how emission-intensive the expansion of networked infrastructures is. This has been proven by studies, for example on rail infrastructure and residential construction (Latsch et al., 2013; Kanton Zürich, 2012; Bußwald, 2011). Since settlement density in particular has a major influence on infrastructure, spatial planning decisions in terms of climate-friendly living are of great importance (high agreement, medium literature base).

Profound changes in networked infrastructure, accompanied by changes in actor networks of infrastructure systems, are necessary to promote and enable climate-friendly living (Berggren et al., 2015; Geels, 2014). Sector coupling between different infrastructure systems (especially power-to-heat, power-to-gas, power-to-mobility) plays an increasingly important role (van Laak, 2020; Büscher et al., 2020). In innovation research, it is often pointed out that, building on new legal foundations (e.g., Renewable Expansion Act 2021), new organisational and actor models should be developed and tested within the framework of regulatory experiments and sandboxes (medium agreement, weak literature base).

In Austria, the shaping role of the public sector as majority owner of central infrastructure providers is particularly important at national and municipal level. The influence of the public sector on public service obligation of the operators of networked infrastructures in energy and mobility clearly exists due to responsibilities regarding services of general interest. On this basis and as the majority owner of central infrastructure providers such as ÖBB, ASFINAG, APG,

Wiener Netze and many other operators in the federal states, the public sector has a wide range of creative possibilities (including investment decisions and specifications of strategic objectives) (high agreement, medium literature base).

Independent regulators increasingly have the legal mandate to contribute to the transformation of networked infrastructure systems and to maintain a balance between interests of consumers, other market participants and stakeholders, in addition to their previous predominantly competition law tasks, while additional tasks to achieve climate policy objectives fall upon them (Bolton & Foxon, 2015). It remains to be seen how this will affect the future design of rules of the game for actors (e.g., in the energy sector, possibilities for citizens to actively contribute to energy transitions) (high agreement, medium literature base).

With regard to climate-friendly transformation of networked infrastructures, the public sector in particular, as legislator, but also as procurer, has significant design options. Through its framework-setting influence, it can influence the design of networked infrastructures and actively steer investments and financing of new construction, conversion or decommissioning of infrastructures. Changes in objectives and tasks of public agencies (e.g., E-Control) can also create additional scope for shaping networked infrastructures in line with climate-friendly living. It is also undisputed that the public sector can make decisive contributions to a change towards climate-friendly living as part of its activities in administration (high agreement, medium literature base).

In order to take into account the necessary orientation of technical infrastructures towards climate neutrality and increasing interconnectedness (e.g., energy-ICT, transport-ICT, energy-water, etc.), the public sector has the opportunity to shape procurement towards innovative solutions for achieving sustainable missions. In scientific RTI policy discourse, there is a broad consensus on the importance of functional tendering (Directive 2014/24/EU), in which the procurer defines functions and suppliers propose suitable technical or other solutions (high agreement, weak literature base) (Edquist et al., 2018; Edquist & Zabala-Iturriagagoitia, 2021).

There is broad consensus that long-term strategies, sound investment plans, reliable legal frameworks, international and national coordination, but also regional and local spatial planning instruments as well as mission-oriented research and development are necessary to change networked infrastructures towards climate friendliness (high agreement, weak literature base). In this context, socio-cultural innovations play a major role, which go beyond a purely technology-centred solution to also consider social conditions and their architectural and infrastructural contexts of emergence (Kropp et al., 2021). This goes hand in hand with a necessary change in planning culture (Frantzeskaki & Loorbach, 2010) in order to develop sustainable strategies in spatial planning that integrate an understanding of diverse interrelationships between built environment, human activity and social life (Næss, 2016).

The complexity associated with the design of networked infrastructure systems requires a high degree of coordination between public, private and civil society actors. In research on egalitarian governance approaches, horizontal and vertical multi-level governance mechanisms are considered important instruments to align strategy, planning processes and measures with climate-friendly living and in using sectoral and spatial intersections (high agreement, strong literature base) (Markard et al., 2020; Thaler et al., 2021).

Part 4: Pathways to transformation

Chapter 23: Pathways to transform structural conditions for climate-friendly living

Design options in relation to transformation pathways

Based on an extensive literature review and with reference to the perspectives presented in Chap. 2, four transformation paths relevant for Austria were derived:

1. Guard rails for a climate-friendly market economy (pricing of emissions and resource consumption; abolition of climate-damaging subsidies, openness to technology)
2. Climate protection through coordinated technology development (state-coordinated technological innovation policy to increase efficiency)
3. Climate protection as public provision (state-coordinated measures to enable climate-friendly living, e.g., through spatial planning, investment in public transport; legal regulations to restrict climate-damaging practices).
4. Climate-friendly quality of life through social innovation (social reorientation, regional economic cycles and sufficiency)

The design options of Chaps. 3 to 22 were analysed and evaluated with regard to their correspondence with the four pathways. There is a very high level of agreement with the "public provision" pathway and with the "social innovation" pathway. The correspondence with the technology pathway is somewhat lower, and some incompatibilities arise for the market pathway.

Analysis of the systemic penetration depth

With the help of a "leverage points" analysis (Abson et al., 2017), an assessment can be made how far-reaching the envisaged measures are, i.e., whether they are aimed at small incremental changes or comprehensive system change. This shows that the design options contained in the present

	Path Dominant elements	1 Guard rails for a climate-friendly market economy	2 Climate protecti on through coordinated technology development	3 Climate protection as public provision	4. Climate-friendly quality of life through social innovation
Actors	State	●	●	●	○
	Social partners	○	○	●	○
	Economy	●	●	●	
	Consumer	●	○	○	◦
	Civil society			●	●
	Science	◦	●	◦	●
Affected structural conditions	Taxes	●	○	○	○
	True cost Pricing	●	◦	○	◦
	Consumer information	●	◦	○	○
	Subsidies		○	●	○
	Legal regulations	○	○	●	○
	Infrastructure and institutions	◦	◦	●	◦
	Business models	○	○	●	◦
	Technological Innovation promotion	○	●	○	
	Social innovations		◦	○	●
	Sufficiency oriented strucural conditions			◦	●
	Societal cohesion			◦	●
	Local self-sufficiency			○	●

Fig. TS.15 Characterisation of the pathways based on the relevance of actors and characteristic design options for them; *dots* – very relevant, *circles* – moderately relevant, *small circles* – little relevant, *no dot* – not relevant (own representation). {Chap. 23}

Assessment Report would bring about more far-reaching systemic changes than, for example, those measures listed in the current National Climate and Energy Plan (NEKP).

The literature reviewed clearly shows that a transformation towards climate-friendly living can only be successful if the implemented measures address all dimensions of a system. Low-penetration measures can be implemented quickly and can prepare the ground for deeper system changes. Given the pressure to act, it will be necessary to take the vast majority of available design options immediately and in a well-coordinated manner if the set climate goals are to be achieved (Kirchengast et al., 2019). In any case, effective climate policy requires an expansion of current measures to include those with greater systemic penetration.

Synergies and tensions between different transformation paths

The design options of this report correspond in particular with the pathway "Public provision" and, somewhat less strongly, with the pathway "Social innovation". However,

it can be seen that the majority of the design options are at least not completely incompatible with the other paths. This means that regardless of which path is favoured, a large number of design options that also address different system dimensions can be used without leading to profound conflicts between fundamentally different transformation paradigms. This should ease the political decision-making process.

Some design options prove to be conflictual and fraught with tension in relation to the path "guard rails for a climate-friendly market economy". In this case, a clear political positioning is necessary to avoid frictions in the establishment and implementation of the design options.

From the discussion of the presented transformation pathways, it can be deduced that the development of a new "mixed pathway" promises a high degree of effectiveness, as synergies between the pathways can be used and weaknesses of individual pathways can be avoided. Only in the case of contested design options are path-shaping political decisions necessary if the socio-economic system is to be aligned with the achievement of the climate goals.

Addressing a wide range of actors

In the presented transformation paths, actors take on different roles at different spatial levels. Due to the strong focus on institutional and material structures, the state has a key role: In the market path and the technology path, the role of the state is that of the framework-setting institution, which in particular sets clear planning horizons. The state thus acts as an active shaper of innovation-promoting research, technology and innovation policy. In the path of public provision, the state assumes an even stronger provisioning and enabling role, while in the path of social innovation it offers free spaces and niches for social innovations and supports their upscaling and broadening at the regime level.

At the same time, it becomes clear that all four pathways are significantly shaped by different actors in different roles and in different interactions, in addition to the state in its respective key role: In view of the necessity to apply as many available design options as possibe to all four system dimensions in a coordinated manner, it is indispensable to bring a large number of different actors (e.g., social partners, companies, NGOs, civil society movements, etc.) on board, to ask for their possible contributions and at the same time to integrate them in an appreciative manner. When developing a transformation path to achieve the climate goals, not only the effectiveness of structural changes in the socio-economic system must be considered, but also the acceptance of design options at the societal and political level. The various political parties understandably have a closeness to those transformation paths that best correspond to their basic political orientation. The urgency of the need for action requires finding transformation paths that, on the one hand, achieve the desired climate goals according to scientific assessment and, on the other hand, can be agreed to by a large number of societal actors in order to generate the momentum that the upcoming far-reaching transformation requires.

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