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Designing “good practice” policy packages for achieving carbon neutrality in Austria

Assessment and factors to consider

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1. Introduction and motivation

Austria has been one of the first countries to ratify the Paris Agreement. It is also a party to the Kyoto-Protocol and – as a member of the European Union – is bound by EU climate policies. Austria is a wealthy country, with ample renewable energy resources, an educated and generally eco-minded population. Despite these favourable conditions and a thirty plus year period of climate policy-making[1], GHG emission levels in Austria today are still above 1990 levels – and rising.[2] It appears that Austria has not been able to deliver the desired emission reduction results.

While the country has committed broadly to the global goal of limiting warming to 1.5 degrees Celsius, the details of the policies and changes required in institutions to achieve that goal have not been fully assessed, with most analysis up to now dealing with physical and technological dimensions – a knowledge gap motivating the work of the SHIFT project. The project will identify a set of instruments which will enable that change, according to Paris agreement targets, via the use of modeling and evaluation tools and stakeholder interaction.

A prerequisite to this work, then, is to determine a package of policies which are deemed plausible in both the physical and institutional sense. Concurrent to this, more specific objectives, elaborating upon "Paris-compatibility" are necessary, in order to compare individual policies and packages and move towards determination of a "best practice" policy package. To inform future work in this regard, a set of evaluation criteria is established in the following, defining a basis for assessing policy packages, as well as highlighting the issues and barriers (or alternatively, complementary or synergistic) effects which may occur when using an array of different policy options to address multiple climate and energy policy goals.

This paper provides an overview of what policies and measures are likely required in order to achieve a low-carbon transition. We begin with an initial assessment of what feasible policy scenarios exist, which may drive Austria towards Paris compliance, specifying policy instruments both currently implemented and those which would be required in the future, based off of a proposed set of policies from the Umweltbundesamt (2017) aimed at the low carbon transition. We use the latter to establish a benchmark for what a low carbon Austria should look like from a policy perspective, including regulatory, economic, as well as planning and informational measures, in order to capture to some degree changes which are currently seen as institutionally feasible.

This benchmark is not enough on its own to reduce Austria's emissions and stay within the likely carbon budget required, as shown via top-down analysis in the vein of the Climate Action Tracker (Höhne et al 2011) project. However, it does provide a blueprint for likely measures necessary to proceed further and achieve deeper decarbonization. In order for further work in the project to assess such policy packages and make recommendations, we need to outline possible interactions which occur between (i) policies between various classes of instruments, (ii) policies focused on different climate objectives and (iii) policies at different governance levels.

[1] Niedertscheider/Haas/Görg: Austrian climate policies and GHG- emissions since 1990, in: Environmental Science and Policy 81 (2018) 10–17

[2] Umweltbundesamt: Treibhausgasbilanz 2016, 2017 (http://www.umweltbundesamt.at/aktuell/presse/lastnews/news2018/news_180116/)

The result is an overview of the ability of low carbon policies to achieve the transition in Austria, and a definition of the key components of evaluation and interactions between instruments to be utilized going forward.

Section 2 presents an inventory of the current policies in effect in Austria, relevant to Paris goals. We follow with section 3, which assesses if – under varying assumptions relating to climate budgets – current policies or a proposed low-carbon transition package will likely enable the country to meet its obligations. Section 4 moves beyond existing measures and outlines such a transition package designed to reach decarbonization. Section 5 highlights key interactions between policies and section 6 provides concluding remarks and ways forward.

2. Inventory of climate policy instruments in Austria

The objective of this project is to assist Austrian policy-makers developing ever more effective climate policy. Knowing which policies and actions Austria has implemented to date to reduce greenhouse gas emissions is an important prerequisite for raising the effectiveness of climate action. An overview of Austria's current status of climate policy covering all sectors and instrument types will provide the basis for a discussion of ever more effective and efficient policy packages.

2.1 Scope and approach of the analysis

In a stock-taking exercise existing climate policy instruments in Austria that have (or could have) an impact on reducing greenhouse gas emissions are compiled in an inventory (Table 1). The inventory also includes policy instruments that are counter-productive from a climate perspective in that they act (or could act) as a barrier to reducing emissions.

This climate policy 'stock-take' attempts to be as broad as possible, reflecting the diversity of policies contributing to climate policy from the many sectors and actors involved, yet seeking a balance between comprehensive and manageable. We only included policy instruments and barriers that are considered likely to trigger significant reductions in greenhouse gas emissions. The relevance of a policy instrument was determined by whether or not the measure had been reported in Austria's official submission to the European Commission under regulation (EU) 525/2013 and included in the 'With Existing Measures' (WEM) scenario. With the exception of some (additional) planning and strategy instruments, only those policy measures reported as required under the United Nations Framework Convention on Climate Change (UNFCCC) were included in the inventory. Some policy instruments that were reported have not been included in the inventory as their funding had been discontinued at the time of writing.[3] The assessment of relevance of barriers was carried out on the basis of literature review.

[3] This includes the building renovation initiative for private buildings to improve energy performance (‚renovation cheque') and the funding for wood heating systems and solar heating systems

Information on policies has been gathered from the following sources:

- BMLFUW: Maßnahmenprogramm des Bundes und der Länder nach Klimaschutzgesetz zur Erreichung des Treibhausgasziels bis 2020. Zweite Umsetzungsstufe 2015-2018, 2015
- Christian/Kerschner/Wagner (Hrsg): Rechtsrahmen für eine Energiewende Österreichs (REWÖ), 2016
- Kletzan-Slamanig, Köppl: Umweltschädliche Subventionen in den Bereichen Energie und Verkehr, 2016
- Niedertscheider, Haas, Görg: Austrian climate policies and GHG-emissions since 1990: What is the role of climate policy integration?, Environmental Science and Policy, 2018.
- Truger: Instruments for a low carbon energy transformation in Austria, Working Paper, 2017
- Umweltbundesamt: Energiewirtschaftliche Szenarien im Hinblick auf Klimaziele 2030 und 2050 – Szenario WEM, 2015
- Umweltbundesamt: GHG Projections and Assessment of Policies and Measures in Austria, Reporting under Regulation (EU) 525/2013, 2017

Following the methodology of Höhne et. al (2015) this inventory focuses on the existence of the policy instruments, not on their effectiveness, ambition, interactions with other instruments, or other criteria one might apply to determine the quality of a given policy package. While this focus allows no qualitative interpretation of existing climate policy, it helps to identify gaps, where no policy instruments exist, and hence more activity could be desirable. Moreover, the inclusion of barriers in this inventory points to where climate policies' impacts may be partially or fully cancelled out by other activities.

Defining key terms: we outline here for clarity the working definitions we use for key terms going forward

economic instruments: market-based approaches employing prices in policies; examples include taxes and subsidies (price instruments) and emissions trading schemes (quantity instruments) (Somanathan, 2014)

regulatory instruments: regulations and standards that establish rules and/or objectives and impose penalties for non-compliance; examples include emission, technology and product standards (ibid)

information and awareness-raising: commonly referred to as information instruments, these attempt to remedy a lack or asymmetric distribution of relevant information among firms and consumers, e.g. eco-labeling, certification schemes for products, and disclosure of GHG emission data (Krarup and Russell, 2005)

strategy and planning: this category includes short- and long-term strategic plans, framework legislation and sector-specific planning *(Wittneben et al., 2009)*

incentives: policies implemented aimed at reducing GHG reductions

barriers: policies and other constraints that (unintentionally) hinder the effectiveness of the policy aimed at GHG reduction. Barriers can be of legal, fiscal or another nature

A large part of climate policy-making takes place at the subnational level. For manageability's sake we only consider *national* policy instruments as well as the most important *federal* instruments. Commune-level activity has not been covered in this inventory.

With the above limitations in mind, this inventory provides a birds-eye view of existing climate policy in Austria. This structured menu of instruments will help researchers and policy-makers to identify information gaps, barriers and opportunities to a low-carbon pathway.

2.2 Structure of the inventory

Instruments have been organised according to sector and instrument types. All sectors that require emission reductions were included. The sector classifications – Energy & Industry[4], Buildings, Transport, Agriculture & Forestry, Waste & Fluorinated Gases - were used as per the Austrian Climate Act 2011.[5] Additionally a sector "cross-cutting" was inserted as an own category for instruments and barriers that impact more than one sector. This is the case for the Austrian Climate and Energy Fund (including the programme "klimaaktiv"), the Domestic Environmental Support Scheme ('Umweltförderung im Inland') as well as the National Climate Strategy and the Climate Change Act. Where an instrument or barrier influences predominantly one sector but may have a minor impact on other sectors as well it was included where its main influence is assumed.

Instruments were classified into to following categories: strategy and planning, regulatory, economic and information and awareness-raising.[6]

[4] includes emissions that are regulated under the Emission Trading Scheme (ETS)

[5] Bundesgesetz zur Einhaltung von Höchstmengen von Treibhausgasemissionen und zur Erarbeitung von wirksamen Maßnahmen zum Klimaschutz (Klimaschutzgesetz – KSG)

[6] Bemelmans-Videc et. al 1998.

Table 1 Inventory of climate policy instruments (as per Austria's reporting under regulation (EU) 525/2013) - incentives and barriers

SECTOR		POLICY INSTRUMENT TYPE				
			strategy & planning	regulatory instruments	economic instruments	information & awareness raising
Cross-cutting	incentive		• Climate and Energy Strategy 2017 • Energy Efficiency Action Plan 2011	• Climate Change Act 2011 ('Klimaschutzgesetz')	• Austrian Climate and Energy Fund ('Klimafonds') • Domestic Environmental Support Scheme ('Umweltförderung im Inland')	• awareness-raising programmes ('Klimaaktiv')
	barrier				• support for R&D in the energy sector for fossil fuels • failure to earmark ETS revenue for climate investments • free allocation of emissions under ETS	
Energy & Industry	incentive			• Energy Efficiency Act 2014 ('Energieeffizienzgesetz')	• EU Emission Trading Scheme (ETS) • Green Electricity Act 2017 ('Ökostromgesetz') • promotion of combined heat and power ('Kraftwärmekopplungs-Gesetz')	
	barrier				• energy-tax refund to energy-intensive industry • energy-tax relief for non-energy related use of fossil fuels • energy-tax relief for own-use of energy producers	
Buildings	incentive			• OIB guideline 6 - energy savings & thermal insulation • Energy Efficiency Act 2014 • Eco-design Ordinance ('Ökodesign-VO')	• Housing support Scheme ('Wohnbauförderung') • Austrian Climate and Energy Fund • District heating and cooling Act ('Wärme- und Kälteleitungsausbaugesetz') • support for thermal retrofitting ('Sanierungscheck')	• Recast of the Energy Performance of Buildings Directive ('Energieausweis-Vorlage-Gesetz') • energy saving & renewable energy awareness raising ('klimaaktiv') • Energy Labelling of household appliances ('Produkte-Verbrauchsangabenverordnung')
	barrier			• parking space requirement in construction regulation ('Stellplatz-VO') • legal barriers to thermal refit in property law	• inadequate climate criteria in housing support programmes	
Transport	incentive		• Master Plan cycling • Mater Plan walking	• air quality induced speed limits ('Immissionsschutzgesetz-Luft') • implementation of the Biofuels Directive	• fuel tax increase in 2011 ('Mineralölsteuer-Erhöhung') • greening the truck toll ('Ökologisierung Lkw-Maut') • implementation plan for electric mobility ('Umsetzungsplan Elektromobilität') • promotion of rail connections for freight transport ('Anschlussbahnförderung')	• mobility management & awareness raising ('klimaaktiv mobil') • fuel saving initiative ('Spritspar-Initiative')
	barrier				• diesel tax rebates • tax deduction for commuters and commercial vehicles • tax exemptions for shipping and aviation fuel • various tax rebates for certain vehicles	
Agriculture & Forestry	incentive		• LULUCF Action Plan	• Implementation of Common Agricultural Policy • Austrian Forest Act ('Forstgesetz')	• Programme for rural development 2014-2020	
Waste & F-Gases	incentive			• Landfill Ordinance ('Deponieverordnung') • Reduction of emissions from waste treatment • prohibition & restriction of fluorinated hydrocarbons • quota system for the production and import of F-gases • reducing HFC emissions from air conditioning in motor vehicles		

2.3 Conclusions

A total number of 39 important climate policy measures have been or are being implemented in Austria at the national level, most of which in the transport (10) and buildings (10) sector. The most frequently used instrument type is economical, followed by regulatory. Strategy and planning instruments are almost exclusively used in the cross-cutting sector. Sub-sector climate strategies on a national level only exist for transport and agriculture (LULUCF).

Barriers are dominant among the economical instruments and exist in the sectors Energy & Industry, Building, Transport and Cross-Cutting.

Blank areas where no policies exist are found in each sector and under all instrument types, with the exception of regulatory instruments.

Interpreting only the *completeness* (and not the *quality*) of policy coverage the following conclusions can be drawn:

- There are a number of blank or almost blank areas in the inventory, where no or few national policies with quantifiable emission reduction effects are listed. Notably, the sectors agriculture and forestry, waste & F-gases appear to receive little attention from policy-makers. Given that the challenge is to achieve complete carbon net neutrality, measures need to be in place for all sectors – however small their contribution to overall national emissions may be (Hood 2011). New and additional policy measures are needed to fill those gaps in the Austrian climate policy landscape.

- More attention must be paid to instrument interaction, which can support and undermine each other. Fossil fuel-subsidies provide a significant barrier to greenhouse gas emission reductions, particularly in the transport and energy & industry sectors. Those subsidies exist in the form of rebates, refunds and exemptions from tax regimes as well as direct funding for research purposes in the fossil fuel sector. The removal of some or all of these subsidies has high potential to increase the effectiveness of existing climate policy instruments in those sectors. Moreover, it would free up financing opportunities with which to address some of the policy gaps identified.

- Strategy and planning instruments are underused in Austrian climate policy making with respect to the objective of achieving carbon neutrality by 2050 in all sectors. The recently presented integrated climate and energy strategy only covers a time span until 2030. International experience shows that strategy and planning are key to achieving cost-effective greenhouse gas emissions reductions by determining the way we eat, live, consume and travel.[7] While some sub-sectoral planning exists (Master Plan cycling and walking) strategies that offer an integrated approach to key areas, like urban/spatial planning are notably absent from the Austrian policy menu. Cross-sectoral as well as sectoral strategies covering both the mid- as well as the long-term perspective have a potential to advance Austria's climate performance.

[7] See, for example, Henry and Gordon (2002), Noblet et al (2006)

As a first step this chapter gathered information on policy instruments in Austria that reduce GHG emissions as well as on barriers to those efforts across all sectors and policy instrument classes. There are a number of limitations to this approach.

First, policy coverage may be underestimated, as a large part of policy-making in Austria happens at the sub-national level. For reasons of manageability and because the impact of many of those (often small) initiatives is very hard to assess, we focused on national policies (and some federal policies that exist across all nine *Bundesländer* and are coordinated at national level) that are included in Austria's official reporting under the UN Climate Framework Convention.

Secondly, as described earlier, this chapter neither analyzed the ambition nor the effectiveness of the individual climate policy instruments. Our emphasis here was on the existence (and gaps) of instruments through a clustering according to instrument class and emission sector. However, a sector that is heavily regulated with instruments across the policy menu may not necessarily perform better than a sector just served by a single very effective instrument. We included barriers in this inventory to address this shortfall as they are an unambiguous indication of instruments not realizing their full potential, recognizing that there may be other important societal reasons for some of those barriers to exist. There is, however, a need for an assessment of *quality and ambition-level* of policies in each sector as well as an estimate to their contribution to emission reductions.

3. Top-down assessment of benchmark

The work undertaken by the Austrian Umweltbundesamt (2015 & 2017) provides what it suggests is a suite of measures which will lead Austria through its low-carbon transition; in this section we address to what degree current and proposed policies will reach goals set in international commitments. Following the Paris agreement, the Climate Action Tracker moved from assessing benchmarks on a bottom-up basis to a simplified, top-down approach, assessing the commitments of countries to decarbonization via (I)NDC submissions, compared with the likely carbon budget allocations necessary to reach 1.5 degrees of warming. However, the European Union has been assessed as a single bloc, with no individual country analysis. In terms of the effort exhibited by the EU, the CAT approach has rated the Union as "Insufficient", described in more detail as the following: "Commitments are not consistent with holding warming below 2 degrees, and are barely within a country's fair share range. If all countries reached this level, warming would approach 3 degrees." (Climate Action Tracker, n.d.)

We adapt the approach taken by the CAT method in order to separate Austria from the EU assessment. Previously, Meyer and Steininger (2017) assessed the maximum carbon emission path possible for Austria – while still meeting global "well-below 2 degrees" climate goals – to decline to just over 10 million tonnes CO_2 equivalent per year by the year 2050. While the path and speed of emissions reductions is an integral part of meeting climate targets, estimating the anticipated cumulative emissions from now until 2050 can provide a first impression of how likely it is that Austrian climate policies will be sufficient to meet its commitments.

Additional work (Williges et al. 2018) has elaborated on the possible *global* budget distributions across all countries of the world for 1.5 and 2 degree scenarios, allowing us to assess how Austria's intended reductions compare to a range of plausible budgets, based on various global distribution mechanisms and normative criteria. The results can be found in Figure 1. For a 1.5 degree scenario, the average carbon budget available to Austria in aggregate for the period 2016-2050 would be just

over 0.5 gigatonnes, with the maximum possible budget of ~1.12 gigatonnes. A 2 degree scenario would increase the mean and maximum budgets to ~1.1 and ~1.63 gigatonnes, respectively. The solid horizontal line, indicating the cumulative emissions for Austria under the WEM scenario (Umweltbundesamt 2015), is just under 2.5 gigatonnes of carbon equivalent, far above any allocations of either 1.5 or 2 degree-compatible budgets. The Transition scenario (Umweltbundesamt 2017, with additional measures (WAM)) performs better at 1.75 gigatonnes, but still falls outside the range of both 1.5 and 2 degree budgets. However, it does begin to approach the allocations in a 2 degree budget, but only nearly, and even then not approaching the mean budget allocation.

While not a perfect analogue to the CAT approach, this first assessment does show that Austria is performing essentially at a similar level to the EU as a whole and should be classified as "Insufficient" in regard to the CAT classification. This result indicates that the Transition scenario needs to be expanded in order to reach the yearly threshold of 10 million tonnes CO_2 equivalent per year, and that the transition needs to happen more rapidly than currently described. Total cumulative emissions between now and 2050, currently estimated at 1.75 gigatonnes for the Transition scenario, need to be at least halved, in order to approach 1.5 degree or better targets.

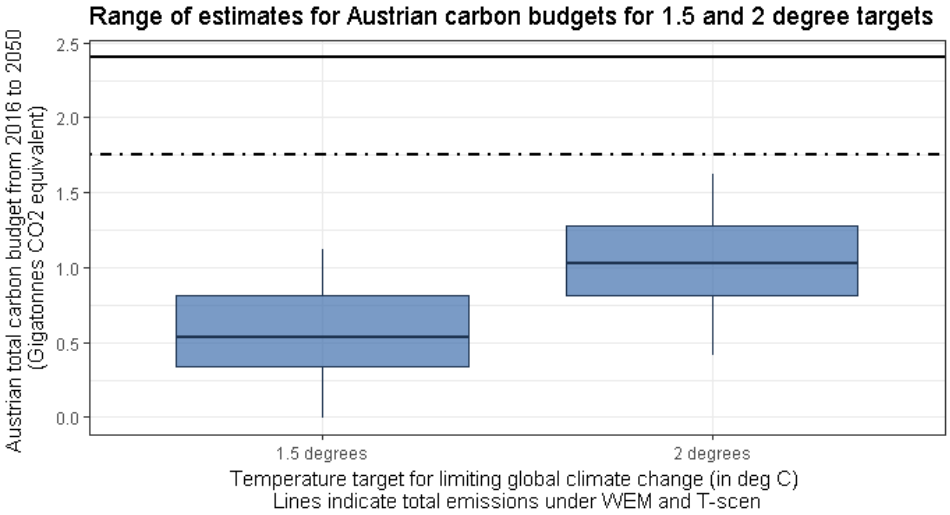

Figure 1. Comparing plausible carbon budgets for Austria for a 1.5 and 2 degree target (Williges et al. 2018) and total cumulative emissions of two Austrian emission scenarios. In terms of emission scenarios, the upper one (the solid line just under 2.5 gigatonnes) indicates the cumulative emissions for the WEM scenario by 2050 (Umweltbundesamt 2015), with lower (dotted) line indicating the Transition scenario (Umweltbundesamt 2017)..

However, while the Transition scenario may not be sufficient to reach Austria's fair share burden, it is illustrative of the developments expected, compared to currently-existing measures. As seen in Figure 2, by 2050 the Transition scenario is envisioned to see Austria's yearly emissions reduced by ~81% compared to 2050, and two-thirds lower than expected emissions in 2050 with only existing measures. The largest change is the assumption of an emissions-free transport sector, and a vast reduction in the emissions from energy and industry, although emissions from the latter sector will maintain close to its current proportion of total national emissions, (around 45% of total in 2050). In a second departure from existing measures, the agriculture and forestry sector is reduced almost 33% from current emissions under the transition scenario, compared to an increase in emissions by 2050 without new regulation.

While the Transition scenario is not projected to reduce yearly emissions to Paris-compatible levels at a fast-enough rate to keep cumulative emissions within budgets, it does provide a useful blueprint

for a vision of the policies necessary across different domains to achieve that goal. The scenario can serve as a useful jumping-off point for further work in SHIFT by providing a skeleton of necessary measures, to be optimized to result in the highest emissions reductions at least cost, while limiting issues which might jeopardize success (e.g. requiring high feasibility). In the following section, we further define a benchmark for good practice policies, building off of the WEM and Transition scenarios.

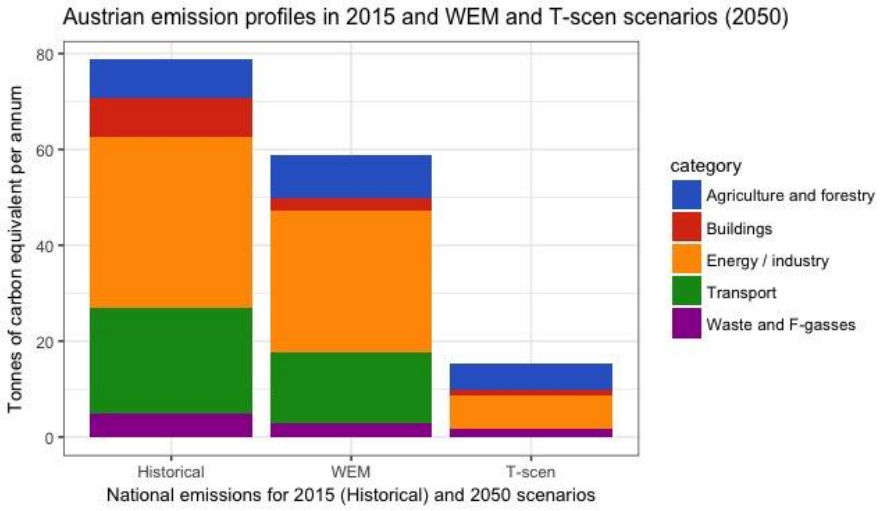

Figure 2. Comparison of sectoral emissions in 2015 (left) versus in 2050 with existing policies scenario (WEM, middle) and under a transition scenario (T-scen, right).

4. Benchmarks for good practice policy packages in Austria

Low-carbon trajectories for Austria show that massive emissions reductions in most areas are possible with known technology (APCC 2014[8], Umweltbundesamt 2017). The challenge lies in making sure that all technologies are deployed at the necessary scale and in the necessary timeframe, to trigger technology improvements and cost reductions through investment in R&D and strategic infrastructure. (IEA/OECD 2018).

The goal of this chapter is to assess whether Austria's climate policies in place are likely to trigger such a shift to a long-term low-carbon pathway. Taking the most ambitious low-carbon trajectory for Austria to date (Umweltbundesamt 2017) and its underlying assumptions ("Storylines and Measures") as a basis we will propose a framework vision of a low carbon future for all sectors to assess the policy adequacy of Austria's climate policy menu.

The purpose of this framework vision is to establish a set of criteria to assess policy adequacy when designing future instrument packages. Applying an adapted methodology developed by Hoehne et. al (2011) we will define and cluster policy benchmarks to assess whether Austria is implementing a comprehensive and economy-wide integrated set of instruments that can deliver on the climate commitments made.

[8] For an overview of available trajectories see the section "energy scenarios" in Volume 3/Chapter 3 of the Austrian Assessment Report of the APCC (APCC 2014)

Hoehne et al. identified the following common major features of low-carbon scenarios for their Climate Action Tracker, a tool to compare international climate mitigation efforts country by country:

- Ambitious energy efficiency improvements realising all existing energy efficiency potentials
- 100% carbon free energy supply by 2050
- Wide application of zero emission buildings in all new and renovated buildings
- Paradigm shift in industrial production focusing on material efficiency and long-lasting, almost 100% recyclable products
- Almost fully decarbonised mobility including a massive shift away from individual energy-based mobility
- New options to reduce emissions in agriculture
- Comprehensive land use strategies solving potential conflict in use of land
- Halting deforestation
- Prompt action leading to a peaking of global emissions no later than around 2020 to set the world on a pathway consistent with 2 and 1.5°C warming limits.

The Climate Action Tracker was developed as a tool for a multi-country comparison of climate policy progress. We found that for the purpose of analysing one country in-depth, focusing on policy interaction in more detail was needed. Accordingly, the methodology was adapted to include additional detailed criteria for each sector.

For a general definition of "good practice policies", this paper starts from a definition proposed by Fekete et al. (2015) and adapts it to the following:

"Good practice policies are climate and energy policies that have been - or are being - implemented in various countries, have proven their feasibility and generally agreed in the literature to contribute directly or indirectly to reduce GHG emissions and contribute to a development towards a net zero emission path overall or in specific (sub-) sectors, while possibly generating co-benefits that contribute to meeting (other) national development goals."

Additional benchmarks and indicators for good policy practice are based on general climate change literature as well as on the low-carbon scenario developed by the Environmental Agency Austria (Umweltbundesamt, 2017).

4.1 Qualitative sectoral benchmarks for assessing Austrian climate policy adequacy

Good practice policy benchmarks for each sector are descriptive. We do not aim to include an evaluation of expected effectiveness (e.g. in terms of quantified emission reductions foreseen). The reason for this approach is, that existing low-carbon scenarios for Austria already serve as quantitative benchmarks for the overall policy effectiveness measuring Austria's policy adequacy in terms of emission reduction units over specific time-frames. To enhance the understanding of specific policy instrument package design we feel a need for additional qualitative benchmarks that policy packages can be compared against.

Not every effective climate policy instrument can always be assigned a corresponding concrete measurable emission reduction effect. Some policy measures might only lead to relatively small emission reductions, albeit perhaps in a crucial area, or the resulting emission reductions might only develop at a later stage. Other instruments may not reduce emissions but prevent dangerous carbon lock-in in the long run. Instruments like monitoring and evaluation processes have no direct emission

effect and yet, if implemented successfully will feed-back into future policy instruments potentially significantly increasing emission reductions further down the line. Hence, formulating qualitative benchmarks will allow us to better evaluate those intricate components for effective climate policy-making in Austria.

4.2 Framework vision for a shift to a low-carbon pathway for Austria

Above we have tried to show how good practice policy-making could be defined for individual aspects of decarbonisation efforts in Austria. However, no single policy can deliver the whole-scale shift needed. Given the complexity of low-carbon transition well-functioning, carefully calibrated policy packages are needed which cover all sectors of the economy and all policy areas.

To support the development of those comprehensive policy responses we are again mapping the benchmarks into a matrix of low-carbon policy development. Benchmarks are clustered according to the sector that they concern and the area where policy change needs to be achieved. Whole-economy transformation towards a low-carbon pathway concerns the entire range of the policy landscape including many areas of complex policy overlap, where policies addressing different objectives cover the same emission sources. For those areas of significant policy overlap, as well as for assessing framework-regulation, strategy and planning we will include a category “cross-cutting”.

Again, we will build on the methodology developed by Hoehne et al. for this mapping exercise.

For sectors we use the same set as used for the climate instrument inventory above. Instead of instrument classes, we cluster the benchmarks according to the policy area, to which they are serving as a measurement for ambition level:

- **Activity** – here we are including benchmarks to assess whether a given policy will influence demand side in the different sectors.
- **Energy Efficiency** – includes benchmarks for the sectors involving energy use.
- **Renewable Energy** – here benchmarks are listed to assess whether renewable energy technology is deployed in the energy using sectors at the necessary scale and speed.
- **non-energy** – covers benchmarks regarding emissions not directly linked to energy.

By grouping benchmarks in this framework we are hoping to identify the key elements to consider when designing climate policy packages.

Table 2. Good-practice policy matrix for Austria to reach a low carbon economy (by sector and policy area)

	activity	efficiency	renewables	non-energy
cross-cutting	❖ ambitious binding greenhouse gas reduction target consistent with Paris Agreement pathway ❖ comprehensive consistent long-term strategy for 2030 and 2050 ❖ comprehensive framework legislation for 2030 and 2050 ❖ internalization of external costs for energy sources ❖ socio-ecologic tax reform including a carbon pricing element for the non-ETS sector ❖ compact, space efficient and multifunctional settlement structures to prevent urban sprawl ❖ incentives/better coordination to encourage greater uptake of co-generation and waste heat opportunities ❖ removal of subsidies that act as barrier to climate policy ❖ removal of non-economic barriers to climate policy			
Energy & Industry	❖ more rigorous implementation of EU ETS leading to corresponding price rise ❖ CO2-labelling schemes and carbon price for products	❖ reduce energy use by half until 2050 ❖ circular economy, durability of products, modular construction ❖ policies to achieve material efficient industry ❖ policies to reduce distribution losses	❖ production change in high-emission industry: ○ direct reduction in steel sector ○ electric furnaces for glass production ○ increase in production of RES ❖ incentives to increase renewable energy	❖ reduced share of clinker in cement and alternative construction materials
Buildings	❖ policies to advance compact housing settlement structures (prevent urban sprawl) ❖ cost assessments are done on a life-cycle basis	❖ multi-story buildings and buildings with higher volume/qm-ratio ❖ reduced m2/person in new buildings ❖ mandatory high-quality retrofit requirements ❖ accelerated renovation rate ❖ zero-energy efficiency standards for new buildings	❖ decrease options to replace oil with gas heating system ❖ prohibit new oil heating systems (starting 2018) ❖ replacement of existing oil heating systems (by 2030)	❖ renewable resources ('nachwachsende Rohstoffe') used in construction
Transport	❖ policies to avoid transport or move to non-motorized ❖ shift of modal split for passenger and freight from road/plane to rail ❖ investment in infrastructure for cyclists and pedestrians	❖ freight transport peaks in 2030 ❖ investment in public or non-motorized transportation takes priority over other transport modes ❖ investments in over-head cables and rail infrastructure	❖ ensure 100% CO2-emission-free new vehicles (by 2030 for passenger, 2035 for light and 2040 for heavy duty road transport ❖ keep biofuel production at current level	N.A.
Agriculture & Forestry	❖ sustainable and healthier food consumption practices ❖ reduced food waste ❖ raised share of organic agriculture ❖ alternative sources of low-carbon protein	❖ reduced use of mineral fertilizers (-50% in 2050)	N.A.	❖ gradual decrease in livestock ❖ capped milk production ❖ increased share of grazing- and dual-purpose cattle
Waste & F-Gases	❖ sustainable consumption practices and reduced waste	N.A.	N.A.	❖ reduced CH4 from waste ❖ reduced emissions of f-gases

5. Instrument interactions

In assessing packages of instruments comes the added challenge of determining if and how policies will interact with one another, either positively or negatively. These interactions can occur in a number of ways. Firstly, interactions can occur *between different types of instruments*, e.g. an economic policy and an awareness-raising measure, both focused on the same goal or sector. Further, interactions may occur *between instruments focused on two different aspects of climate policy*, e.g. between a measure encouraging renewable energy development and another focused on energy efficiency (known as *internal* interaction) or alternatively, between climate and non-climate policy (*external* interaction)(Oikonomou and Jepma, 2007). Lastly, interactions can occur *between policies implemented at different levels of governance*, with an EU policy such as the ETS interacting with national mitigation policy, or national and sub-national policy interactions.

It is important to note that such interactions are highly context-specific. Contextual factors surrounding policymaking (for an extensive overview of contextual factors involved in European national and supranational policymaking, see CARISMA Deliverable 6.3 (Fujiwara, Williges, and Tuerk 2017) can have an outsized effect on the success or failure of a policy, and if and how policies interact with one another. Thus, the results assembled here should be seen as indicative, but require further investigation as to their occurrence within the Austrian system and its unique contextual factors.

5.1 Interactions between policies with differing objectives

Climate policies can have either positive or negative impacts on non-climate objectives, with the reverse also being true, with positive impacts being referred to as co-benefits. A recent example in the Austrian context is the work of Wolkinger et al (2018), who evaluate the possible co-benefits of climate-related urban mobility on health via improved air quality, finding substantial economic co-benefits and decreased morbidity and mortality. More broadly, Duval (2008) highlights four key areas in which non-climate policies can enhance the overall cost-effectiveness of a climate policy package, namely by reforming policies which encourage an increase in emissions or distort incentives, such as:

- Energy policies: fuel tax rebates and energy price regulations (as social policy in e.g. developing countries) in effect lower the incentives for energy efficiency, thus distorting the incentives of mitigation instruments and resource allocation throughout the economy
- Trade policies: tariffs and barriers to imports of emission-reducing goods and services can limit the efficacy of abatement policies
- Agricultural policies: While not as immediately obvious, agricultural support policies can distort relative prices and contribute to increasing emissions via increased agricultural output (e.g. more methane from more livestock) and via more pervasive use of pesticides and fertilizers
- Legal frameworks: Lack of enforcement of property rights and unsustainable land use practices can lead to deforestation; stronger frameworks for land use and emissions monitoring could lead to inexpensive emissions reductions

5.2 Interaction between instruments within a policy domain

In terms of interaction within a single policy domain (e.g. policies focused on energy efficiency), we differentiate between interactions between multiple measures of a single type (e.g. multiple subsidies, such as the case of Austria and energy efficiency), and interactions of e.g. regulatory and

information measures. While the literature is extensive in regard to policy interactions at different levels of government, and between different sectors, the empirical assessment of how different policy types (e.g. economic and information-provision measures) interact is less pronounced.

For the first example of multiple measures of the same type, take the Austrian energy efficiency policy landscape. In order to meet the goals of the National Energy Efficiency Action Plan, Austria aims to reduce its total final energy consumption to 1,050 PJ by 2020 (bmwfw 2017). To do so, it has established four main instruments:

1. Renovation check: a subsidy provided at federal level to assist households with home renovation
2. Federal housing subsidy law: provides general guidelines to provincial governments for energy efficiency improvement measures, as well as responsibility of allocating subsidies
3. Subsidies of the Energy and Climate Fund: focused on energy conservation and GHG emission reduction measures (e.g. help purchasing an efficient stove for a household)
4. Federal law on energy efficiency: requires energy providers to implement efficiency measures

Except for the law on energy efficiency, the instruments are all subsidies or investment incentives and subsidized loans. The federal law on efficiency requires suppliers to implement 40% of measures at a household level, which overlaps with subsidies of the energy and climate fund. The multiple subsidy mechanisms led to unavoidable overlaps and the implication that government funds were used inefficiently, and it has been recommended to redesign the policy package to include energy and environmental standards (rather a regulatory policy) instead of multiple economic policies. (Bößner et al., 2017)

In terms of instruments from different approaches (e.g. information and awareness-raising and economic incentives or regulation), less evidence exists. Most assessments of information campaigns assess the efficacy of such a campaign, but independent of interaction effects with other policies, or they see a lack of information as a *barrier* to policymaking, rather than a lack of a policy. (Lyytimäki et al., 2012; Mees et al., 2018). Others assess the ability of information and awareness-raising campaigns to *substitute* for different policies, such as Adler and Pittle (1984) and Noblet et al. (2006), who find that information campaigns on eco-labeled vehicles had a significant influence on the purchasing of new cars, but also led to an increasing public view that vehicle emissions were a smaller contributor to state air quality problems, and increased the perception that “green” vehicles were more expensive and had poor performance.

5.3 Interactions between policies at different governance levels

Interaction of instruments at different levels of jurisdiction has already been shown to lead to inefficiencies due to having to fine-tune federal policies to be compatible with all nine provinces in Austria. However, policy interaction between jurisdictions are not exclusively negative; local policies may reinforce national goals, such as urban planning and infrastructure for modern public transport by cities complementing energy taxation. Local governments can also try new experimental approaches, which once proven, could be up-scaled to regional or national levels.

In terms of relevant interactions for Austria and the EU, the most widely covered in the literature is the interaction between the EU ETS (commonly equated to climate policy) and national policies of EU states (usually renewable energy or energy efficiency policies). A good example of the negative effect

of such an interaction is emissions leakage, as brought up by Böhringer and Rosendahl (2009), highlighting the interaction of a national policy such as renewable energy support quotas, which would be expected to reduce output from fossil-fuel producers. But if that country was a part of the ETS, the reductions resulting from the increased renewables would be offset by increased emissions elsewhere in the EU, as overall European emissions are determined by the Europe-wide cap under the ETS (Böhringer et al 2008, Philibert, 2011).

In terms of interactions between the ETS and national policies, Antonioli et al. (2014) summarize by saying that generally, if a national policy overlaps with the ETS, effectiveness and efficiency of the national instruments may be affected; specifically, promotion of renewables and energy efficiency, if applied to sectors covered by the ETS. Conversely, applying them to non-ETS sectors would avoid such an effect and contribute to further reductions of emissions (Sorrell et al. 2009, Convery et al 2014).

6. Conclusions, limitations and further research

In chapter 2 we developed a comprehensive overview of existing climate change instruments providing insights into the specific design and implementation currently used in Austria.

Chapter 3 rated current Austrian policy landscape, as well as the proposed Transition-Scenario, against expected country contributions to Paris climate goals, and found that while the Transition scenario would greatly reduce Austria's overall carbon emissions relative to current measures, it still would fall short of its commitments. However, the Transition scenario forms a basis to build from and to make suggestions towards an optimal policy package for Austrian decarbonization.

In chapter 4, we defined good policy practice benchmarks for each sector. We then clustered those benchmarks according to policy areas and sectors where change needs to be effected, creating a matrix for good practice policy for Austria to make an economy-wide shift to a low carbon economy

Chapter 5 highlighted potential issues which arise due to instrument interactions. These effects can occur between policies at different jurisdictional levels, between different types of policies, or across sectors, and can – depending heavily on contextual factors – have small or large, beneficial or negative effects. We highlight recent research in terms of observed or modelled interaction effects of Austrian policies, and hint at gaps in the research for further investigation.

The rationale for this mapping exercise – both of the status quo and of a good practice policy menu - was to lay the ground-work to develop ever more efficient and effective climate policy packages.

We believe that the above objective has been partly achieved but more attention must be given to the following aspects in future work:

- Limiting the instrument discussion to the national level was necessary for a whole-economy perspective and hence a good starting point, but detailed discussion needs to also integrate interactions at different administrative levels, including the "on-the-ground" implementation stage.

- The above is also true to analyze key instrument-interaction effects dealing with questions like instrument complementarity. Many of the expected synergies, constraints and blockages only become visible on a level of greater detail. Looking into instrument interaction in

greater detail might help to identify model instrument combinations for an ideal pathway with measures reinforcing each other.

- Optimal policy packages are a useful and important benchmark for any policy-makers to strive towards. Ultimately, an effective policy mix, however, will depend not only on what might be ideal, but also on what is possible based on other national policy objectives and constraints. Developing alternative modules and packages to choose from might be helpful to assist policy makers in facilitating the low-carbon transition on the basis of or including "second best options".

- In a country with strong sub-national authority over energy transition, such as Austria, more attention needs to be paid to the institutional level and governance issues. Future work should deal with the question of how to balance regional autonomy and flexibility with national policy co-ordination.

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Abstract:

Austria has been one of the first countries to ratify the Paris Agreement. It is also a wealthy country, with ample renewable energy resources, an educated and generally eco-minded population. Despite these favourable conditions and a thirty plus year period of climate policy-making, greenhouse gas emission levels in Austria today are still above 1990 levels – and rising. It appears that Austria has not been able to deliver the desired emission reduction results.

This paper provides an overview of what policies and measures are likely required in order to achieve a low-carbon transition. It begins with an initial assessment of what feasible policy scenarios exist, which may drive Austria towards Paris compliance, specifying policy instruments both currently implemented and those which would be required in the future based on the most ambitious emission scenarios available to date. The latter are used to establish a benchmark for what a low carbon Austria should look like from a policy perspective, including regulatory, economic, as well as planning and informational measures.

The paper then discusses interactions which occur between policies between various classes of instruments, policies focused on different climate objectives and policies at different governance levels. The result is an overview of the ability of low carbon policies to achieve the low carbon transition in Austria, and a definition of the key components of evaluation and interactions between instruments to be utilized going forward.