Publizierbarer Endbericht

A) Projektdaten

Allgemeines zum Projekt	
Kurztitel:	INNOVATE
Langtitel:	Innovative climate policy instruments to reduce consumption-based emissions to complement territorial emission reduction efforts
Zitiervorschlag:	Steininger, K.W., Bachner, G., Bednar-Friedl, B., Kammerlander, M., Karstensen, R., Munoz, P., Nabernegg, S., Omann, I., Peters, G., Stickler, T., Strohmaier, R., Titz, M., Vogel, J., Wossink, A. (2018), Innovative klimapolitische Instrumente zur Reduktion konsumbasierter Treibhausgasemissionen, Endbericht an das Austrian Climate Research Programme ACRP, Graz und Wien, Juli 2018.
Programm inkl. Jahr:	ACRP 7
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KoordinatorIn/ ProjekteinreicherIn:	Universität Graz, Wegener Center für Klima und Globalen Wandel
Kontaktperson Name:	Ao.Univ.-Prof. Dr. Karl Steininger
Kontaktperson Adresse:	Brandhofgasse 5, A-8010 Graz
Kontaktperson Telefon:	+43 316 380 8411
Kontaktperson E-Mail:	karl.steininger@uni-graz.at
Projekt- und KooperationspartnerIn (inkl. Bundesland):	Sustainable Europe Research Institute (SERI), Wien Umweltbundesamt GmbH, Wien *Internationale Kooperationspartner:* International Human Dimensions Programme on Global Environmental Change (IHDP), UN Campus, Bonn, Germany Center for International Climate and Environmental Research – Oslo (CICERO), Norway University of Manchester, UK
Schlagwörter:	Consumption-based greenhouse gas accounting; consumption-oriented policy; carbon leakage; sectoral greenhouse mitigation policy;

Allgemeines zum Projekt	
	Konsumbasierte Treibhausgasbilanzierung; konsum-orientierte Klimapolitik; sektorale Klimapolitik
Projektgesamtkosten:	298.564 €
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B) Projektübersicht

1 Kurzfassung

Treibhausgasemissionen können entweder dem Ort ihres Auftretens in Produktionsprozessen zugerechnet werden, oder dem Endverbrauch von Gütern und Dienstleistungen, denen ebendiese Produktionsprozesse vorangehen. In einer Welt mit Klimapolitik ohne globalen Gleichklang führt das Fehlen von Politik in einem dieser Bereiche (Produktion bzw. Endverbrauch) dazu, dass ein wichtiger Politikbereich ungenutzt bliebe, wodurch die Klimapolitik ineffizient und potenziell ineffektiv wäre.

Während die Emissionsbilanzierung selbst auch über die Verbrauchszurechnung mittlerweile bereits breit verfügbar ist, zeigen wir hier, wie ihre detailliertere Analyse nach sektoralen Bestimmungsorten (welche Endnachfragebereiche sie erklären), sektoraler Quelle (in welchen Sektoren auf der Welt diese Emissionen tatsächlich auftreten) und der geografischen Lage letzterer für einen ergänzenden verbrauchsbezogenen klimapolitischen Ansatz eingesetzt werden kann. Am Beispiel des EU-Mitgliedslandes Österreich stellen wir fest, dass mehr als 60% seiner verbrauchsbezogenen Emissionen außerhalb seiner Grenzen und 34% sogar außerhalb der EU auftreten. Die Spitzensektoren unter verbrauchsbezogener Bilanzierung (Baugewerbe, öffentliche Verwaltung (einschließlich Verteidigung, Gesundheit und Bildung) und Groß- und Einzelhandel) sind ganz andere als jene unter einer produktionsbasierten Bilanzierung (Elektrizität, Eisen und Stahl und nichtmetallische Mineralien wie Zement). Während für einige Sektoren (z. B. Strom) produktionsbasierte Ansätze in der Klimapolitik gut funktionieren können, hängt die Emissionsreduktion in anderen Sektoren (z. B. elektronische Ausrüstung) entscheidend vom Einsatz verbrauchsbezogener Politikansätze ab, wie eine strukturelle Pfad-Analyse zeigt.

{Eine ausführlichere Zusammenfassung dieses Projektteils ist verfügbar (open access) in: Steininger, K.W., Munoz, P., Karstensen, J., Peters, G., Strohmaier, R. Velazquez, E. (2018), Austria's consumption-based greenhouse gas emissions: Identifying sectoral sources and destinations, *Global Environmental Change* 48: 226–242.}

Selbst wenn Klimapolitikziele national für Länder wie Großbritannien in Form einer Senkung der national bilanzierten Emissionen erreicht werden, steigen die globalen Emissionen weiter an. Die endverbrauchs-bilanzierten (auch: konsumbasierten) Emissionen erklären, inwiefern eine Konsumsteigerung in entwickelten Ländern, wie zum Beispiel in Österreich, zu steigenden Emissionen in Ländern des Südens führt. Dieser Effekt ist direkt auf die Globalisierung und dem damit einhergehenden Auslagern der Produktion von Gütern zurückzuführen. In anderen Worten heißt das, dass ein großer Teil unserer alltäglich konsumierten Produkte importiert sind und graue Emissionen beinhalten (d.h. direkte und indirekte Emissionen die durch die Herstellung, Handel und Vertrieb in den Ursprungsländern entstehen).

Dementsprechend bedarf es für die Entwicklung von effektiven Politikmaßnahmen zur Reduktion von konsum-basierten Emissionen, sowohl KonsumentInnen-orientierte Instrumente (die auf den Endverbrauch abzielen) als auch ProduzentInnen-orientierte Instrumente (die auf die industrielle Herstellung abzielen). Da sich ein Großteil unseres alltäglichen Konsumverhaltens in Routinen und Gewohnheiten determiniert (z.B.: Kochen, Arbeiten oder Einkaufen), bietet sich hier die Theorie der Sozialen Praktiken als sehr geeigneter Ansatz an um konsum-basierte Emissionen zu analysieren. Dabei gibt es drei Hauptansätze um soziale Praktiken zu ändern bzw. auf die Ausführungen derselben einzuwirken: Umgestalten (re-crafting), Ersetzen (substituting) oder das Lösen von

miteinander verflochtenen Verhaltensweisen wie beispielsweise Wohnen und Arbeiten (interlocking). Vor diesem theoretischen Hintergrund wird die Entwicklung von effektiven Politikinstrumenten, die auf eine Reduktion der konsum-basierten Emissionen abzielen, in den drei Emissions-Hotspot-Bereichen Österreichs (Bauwesen, Mobilität und dem Gesundheitssektor) diskutiert.

{ Eine ausführlichere Zusammenfassung dieses Projektteils wird verfügbar in:
Kammerlander, M., Omann, I., Gerold, S., Moch, M., Stocker, A. (2018), How do social practices influence the development of policy instruments to reduce consumption-based indirect CO_2 emissions in Austria?, - in submission preparation}

Ein Set von 15 Politikinstrumenten zur Minderung der österreichischen konsumbasierten Emissionen in diesen drei Emissions-Hotspot-Bereichen wurde entwickelt und qualitativ evaluiert. Das Design der Instrumente baut auf einem Survey internationaler Good-Practice-Beispiele auf und berücksichtigt österreichspezifische Gegebenheiten hinsichtlich Wirtschaft, Demographie und Wohnungswesen sowie Verkehrs-, Gesundheits- und Wohlfahrtssystem. Die Politikinstrumente wurden anhand der folgenden Kriterien bewertet: Umwelt- bzw. Klimaeffektivität, Kosteneffektivität, Verteilungseffekte, Umsetzbarkeit und Flexibilität. SektorexpertInnen des Umweltbundesamtes und externe Stakeholder aus Landesregierungen, NGOs und Interessensvertretungen wurden sowohl in das Design als auch in die Evaluierung der Instrumente mit einbezogen. Ihre Vorschläge zur Verbesserung von Umsetzbarkeit und öffentlicher Akzeptanz flossen in die Ausarbeitung ein.

Die Ergebnisse der qualitativen Evaluierung deuten darauf hin, dass anreizbasierte Instrumente - wie zum Beispiel eine sogenannte Carbon-Added Tax auf Baumaterialien oder eine stärkere Besteuerung emissionsintensiver Fahrzeuge - ebenso wie Instrumente, die auf Infrastrukturbereitstellung und den Gesundheitssektor abzielen, am effektivsten hinsichtlich der Reduktion konsumbasierter Emissionen sind. Regulatorische Instrumente, wie zum Beispiel die verpflichtende Meldung von Leerstand oder regulatorische Änderungen im Gesundheitsbereich, sind hingegen am ehesten kosteneffektiv, ebenso wie anreizbasierte Instrumente. Informationsbasierte Instrumente wie Zertifizierungen sind am ehesten umsetzbar und flexibel.

{Für eine ausführliche Darstellung der Ergebnisse dieses Projektteils siehe Umweltbundesamt (2018): Kammerlander, M., Omann, I., Titz, M., Vogel, J.: Which national policy instruments can reduce consumption-based greenhouse gas emissions? A qualitative evaluation for Austria. Umweltbundesamt Report, im Erscheinen. Wien.}

In einer klimapolitisch fragmentierten Welt kann nationale Politik konsumbasierte CO_2 Emissionen nur bedingt reduzieren. In einer quantitativen makroökonomischen Analyse in den drei emissionsintensiven Politikfeldern Bau von Gebäuden, Gesundheitswesen und Mobilität zeigt sich folgendes Bild. Für den Bau von Gebäuden erweist sich eine Carbon Added Tax (Steuer auf CO_2-intensive Inputs im Bausektor) als sehr effektiv während eine Informationsverpflichtung für freistehende Wohnungen weniger wirksam in der Reduktion von konsumbasierten Emissionen ist. Verpflichtende Energieeffizienzverbesserungen im Gesundheitswesen und im Verkehrsbereich reduzieren konsum- und produktionsbasierte Emissionen in etwa gleich effektiv. Insgesamt hängt die Effektivität der Instrumente von den sektoralen Verflechtung des von der Politik primär betroffenen Sektors sowie von den Substitutionsmöglichkeiten der Endnachfrage ab.

{Für eine ausführliche Darstellung der Ergebnisse dieses Projektteils siehe:
Nabernegg, S., Muñoz, P., Bednar-Friedl, B., Titz, M., Vogel, J. (2018), National policies for global emission reductions: Effectiveness of carbon emission reductions in international supply chains. Graz Economics Papers 2018-10, University of Graz, Department of Economics.}

2 Executive Summary

Greenhouse gas emissions can be addressed at the points of both production and consumption of goods and services. In a world of inhomogeneous climate policy, missing out policies on either production or consumption leaves an important policy area idle, rendering climate policy inefficient and potentially ineffective.

While consumption-based emissions accounts have become readily available at the national level, we here show how their more detailed analysis by sectoral destination (which final demand sectors account for them), sectoral source (in which sectors across the globe those emissions are actually occurring) and the geographical location of the latter can inform a complementary consumption-based climate policy approach. For the example of the EU member country Austria, we find that more than 60% of its consumption-based emissions occur outside its borders, and 34% even outside the EU. The top sectors are a very different list under a consumption-based accounting perspective (construction, public administration (including defense, health and education), and wholesale and retail trade) than under a production-based one (electricity, iron and steel, and non-metallic minerals, such as cement). While for some sectors (e.g. electricity) production-based approaches can work well, emission reduction in other sectors (e.g. electronic equipment) is crucially dependent on consumption-based approaches, as a structural path analysis reveals.

{A more detailed summary of the results from this part of the project is available in the open access publication
Steininger, K.W., Munoz, P., Karstensen, J., Peters, G., Strohmaier, R. Velazquez, E. (2018), Austria's consumption-based greenhouse gas emissions: Identifying sectoral sources and destinations, *Global Environmental Change* 48: 226–242.}

While current policies aiming at a reduction of CO2 emissions (e.g. Kyoto protocol) seemed to be successful from a territorial perspective of industrialised countries such as UK, emissions are still increasing at the global level. The term weak carbon leakage describes a situation where an increase of consumption in developed countries leads to growing emissions in less developed countries. This effect is strongly related to phenomena like globalisation and outsourcing of production. As a consequence, a large part of daily consumed products are imported and include embodied emissions (i.e. direct and indirect emissions that occur in the regions of production). For the development of effective policy instruments addressing consumption-based emissions embodied in these international products and processes, it is essential to apply a consumption-based approach (CBA), including both consumer-oriented policies, focusing on final demand, and producer-oriented policies, focusing on industry. Since a considerable share of consumption behavior is performed by routines and habits (cooking, working or shopping), consumption-based emissions due to consumer behavior are analysed by applying the social practices (SP) approach. Based on this approach the development of effective policy instruments addressing a reduction of consumption-based emissions by three types of interventions (re-crafting, substituting and interlocking) are discussed for the main hotspots of Austria's consumption-based emissions: construction, mobility and public healthcare.

{A more detailed summary of the results from this part of the project will be available in: Kammerlander, M., Omann, I., Gerold, S., Moch, M., Stocker, A. (2018), How do social practices influence the development of policy instruments to reduce consumption-based indirect CO2 emissions in Austria?, - in submission preparation}

A set of 15 policy instruments suitable for mitigating Austrian consumption-based emissions in the three emission hotspots was developed and evaluated qualitatively. The design of the policies builds on a survey of international good-practice examples of policy instruments and takes into account Austria's specific circumstances in terms of its economy, demography, housing, transport, welfare and healthcare systems. The policy instruments are then evaluated according to the following criteria: environmental (climate) and cost effectiveness, distributional impact, political feasibility and flexibility. Environment Agency Austria's sector experts as well as external stakeholders from regional governments, NGOs and other interest groups were involved both at the policy design and the evaluation stage and provided suggestions for improving the policies' implementation and public acceptance.

The results of the qualitative evaluation suggest that of the 15 policies studied, incentive-based instruments - such as a carbon-added tax on construction materials and higher vehicle taxes for emission-intensive cars - as well as instruments targeting infrastructure provision and the healthcare sector are most effective in terms of emissions reduction. The most cost-effective instruments tend to be regulatory - such as an information obligation on vacant dwellings and regulatory changes regarding the healthcare sector - but also incentive-based. Information-based instruments like certification schemes perform best in terms of feasibility and flexibility.

{For more details on this project part see: Umweltbundesamt (2018): Kammerlander, M., Omann, I., Titz, M., Vogel, J.: Which national policy instruments can reduce consumption-based greenhouse gas emissions? A qualitative evaluation for Austria. Umweltbundesamt Report, forthcoming. Vienna.}

In a world with diverging emission reduction targets, national climate policies might be ineffective in reducing consumption-based CO_2 emissions (carbon footprints), i.e. emissions of final demand that are embodied across the whole supply chain, including international fractions. A quantitative macroeconomic analysis in the three emission hotspots of building construction, public health, and mobility shows the following picture. For construction of buildings we find that a carbon added tax is highly effective in reducing consumption-based emissions whereas an information obligation on vacant dwellings combined with a penalty payment when vacant buildings are not made available is ineffective because of reallocated investment capital. Mandatory energy efficiency improvements in public health and mobility are found equally effective in reducing consumption- and production-based emissions while a decarbonization of domestic logistics stronger reduces production-based emissions. Overall, the effectiveness of policies, to mitigate consumption-based emissions, is therefore determined by the backward and forward linkages of the sector addressed by the policy as well as the substitution effects within final demand.

{For more details on this project part see:
Nabernegg, S., Muñoz, P., Bednar-Friedl, B., Titz, M., Vogel, J. (2018), National policies for global emission reductions: Effectiveness of carbon emission reductions in international supply chains. Graz Economics Papers 2018-10, University of Graz, Department of Economics.}

3 Hintergrund und Zielsetzung / Background and objectives

A. Background

The recent strong growth in global GHG emissions has prevailed despite ongoing developments in global climate policy and respective efforts at national levels. The United Nations Framework Convention on Climate Change (UNFCCC) established the objectives and set the framework for global climate policy, and its Kyoto Protocol implemented specific emission reduction targets for developed countries. Industrialised countries broadly succeeded to meet their objective of stabilising territorial CO_2 emissions in the developed countries, but global emissions in 2012 were 60% higher than the emissions in 1990. The major growth in global CO_2 emissions has been from emerging economies, where emissions in 2011 were 2.6 times higher than in 1990 (Peters et al., 2013).

In the case of the EU27, territorial emissions (1990-2010) have *decreased* at a rate of 0.4%/yr, while consumption-based emissions have *increased* at around 0.1%/yr (Peters et al., 2012); the differential growth rates are much higher in the 1995-2005 period which is not influenced by the collapse of the former Soviet Union in the early 1990's or the global financial crisis in 2008-2012. For Austria, territorial emissions (1997-2004) have *increased* at a rate of 2.4%/yr, while consumption-based emissions have increased at a rate of 3.3%/yr (Munoz and Steininger, 2010; APCC, 2014). Similar trend differentials are found in most developed countries.

A critical issue with the current territorial perspective on GHG emissions is that it fails to capture the broader role of consumption and international trade in driving global emission trends, thereby missing many important areas for policy intervention. The stabilisation of territorial emissions in many developed countries is countered by an increase in consumption-based emissions which is driven by increased levels of consumption and the changing global division of labour to regions with less environmentally efficient production.

It is thus increasingly clear that it is necessary to develop consumption-based policy instruments to complement the current production-based policy instruments (c.f., House of Commons, 2012, Points 61-62 of European Parliament, 2012). Applying these instruments in addition to the current production-based policy instruments will then enable to reverse the current trend of rising GHG emissions, that industrial countries such as Austria are responsible for worldwide (i.e. will allow to address globally induced emissions).

B. Objectives

In developing policy instruments one has to start from what we observe with current emissions across the full supply chains of products. Most recent work (Andrew and Peters, 2013) split the distribution of global GHG emissions for household consumption in 129 different countries and regions, showing the share between direct household and indirect (embodied) domestic and foreign emissions. The smallest share of emissions is for the direct emissions from households (such as driving a private car or using natural gas to heat). These direct emissions represent on average 15% of the associated global total, thus 85% of emissions occur in industries to produce the products consumed by the households. Globally averaged, 63% of the emissions occur in industries located in the country of consumption while 22% (country range 2% to 73%) occur in industries located in foreign countries. The foreign share is generally larger for smaller countries such as Austria (Peters and Hertwich, 2008a) and is growing rapidly over time (Peters et al., 2011). INNOVATE focused on consumption patterns that influence national and global GHG levels and trends, with particular attention on international flows of carbon.

An advantage of consumption-based emissions is that they allow for a detailed analysis of the international supply chain and carbon regulation. From identification of supply chains for the UK it was found that emissions allocated to consumption are intricately linked to emissions that occur in production, and that the structure of the supply chain for different products can be complex and quite different. For, example, for UK meat consumption (Peters and Hertwich, 2006) the largest share of emissions (84%) occurs on the cattle farm, while for clothing 26% of emissions occur in China in the electricity, textiles, and chemicals sectors. We can readily identify that for these two common categories of consumer goods, very different policy interventions may be appropriate.

The general concept and objectives of INNOVATE thus were:

- first, identify key points for policy intervention in the global supply chain originating from Austrian consumption;
- second, review and develop policy instruments appropriate for these intervention points;
- third, assess economic efficiency and environmental effectiveness of the policy instruments;
- fourth, assess political and public acceptance of the policy instruments.

So far consumption-based approaches to climate policy had focused on the rather controversial tool of border measures, which are unlikely to be much used in practice. This project thus focused – well beyond this instrument – on the broad range of options and assessed them.

4 Projektinhalt und Ergebnis(se) / Project Content and Results[1]

4.1 Objectives of the project

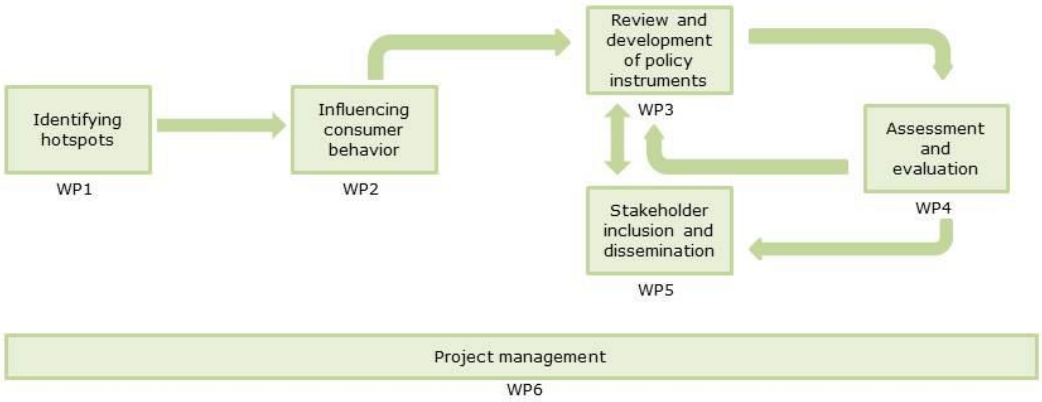
Whilst an improved quantification of consumption-based emission inventories remains an important and necessary exercise to both quantify and manage the recent growth, the major gap in the literature that this project was devoted to address pertains to identifying economically efficient, environmentally effective, and politically as well as publically acceptable policy instruments to address global emission trends. INNOVATE targeted these knowledge gaps, delivering rigorous systematic assessments for a better understanding of virtual GHGs emission flows embedded in Austrian consumption and trade flows, that can help policy makers assess sustainable and climate friendly development on a global level.

4.2 Project structure

The INNOVATE project was structured in 4 research WPs, one WP addressing stakeholder inclusion and dissemination, and one project management WP. WP1 was concerned with the international supply chains triggering the major shares of Austrian consumption-based emissions. Further, WP2, WP3, WP4, and WP5, worked in unison (cf. Figure 1) to develop effective, efficient, and feasible consumption-based policy instruments. WP2 identified how consumer behaviour can be addressed by policy instruments, WP3 initially performed a review of existing policy instruments relevant for consumption-based emissions and based

[1] Project results both text and figures, draw closely on the (journal) publications that this project resulted in, as listed in section 8, i.e. Steininger et al., 2018, Kammerlander et al., forthcoming, and Nabernegg et al., 2018.

on feedback from WP4 and WP5 iteratively improved existing, and developed new policy instruments. WP4 performed quantitative economic analyses of the policy instruments developed in WP3. WP5 used the results of WP3 and WP4 to frame and assessed political and public feasibility as well as acceptability.



4.3 Austria's Consumption-Based Greenhouse Gas Emissions: Identifying sectoral sources and destinations

With ongoing economic specialization and the growth of international trade having outpaced growth in global GDP for many decades, production supply chains are spanning many countries, and final consumption in one country is increasingly connected to GHG emissions in other countries, governed by a complex, global web of internationally linked activities. The question of which emissions each country can address can thus be answered alternatively. One could consider final consumption to ultimately drive GHG emissions, and thus allocate all emissions along the (international) supply chains to final consumption and to the country where this final consumption occurs in. The corresponding alternative indicator system is Consumption-Based Accounting (CBA) of emissions (Munksgaard and Pedersen 2001, Lenzen et al. 2004; Peters and Hertwich, 2008; Davis and Caldeira, 2010), often also referred to as Carbon Footprints (CF). Corresponding emission inventories are thus based on CBA and record emissions induced by residents' consumption irrespective of where in the world those induced emissions take place. Since production and consumption occur very often in different geographical locations, these two distinct emission accounting frameworks tend to show different pictures of the amount of emissions allocated to a nation which could potentially serve as a policy base.

The policy instrument among those that can be considered a consumption-based policy instrument that to date has been subject to probably most extensive empirical analysis is border carbon adjustment (or border tax adjustment) (for a model comparison of results see e.g. Böhringer et al. (2012)). More comprehensively, Girod (2016) screens EU directives under the consumption-based perspective, and Barrett and Scott (2012) and Scott and Barrett (2015) analyse instruments for the UK case. We contribute to this literature – a literature still comparatively small in addressing the national scale – by a sectorally detailed analysis. Many policies addressing consumption-based emissions cannot be specified at the macro level (such as border carbon adjustment is), but need to be more specific – addressing the peculiarities of particular sectors.

Austria's GHG responsibility by agents

Breaking down the results for consumption-based emissions of Austria for 2011 by the different agents of final demand, the analysis shows that households were the main inducer of GHG emissions from a CBA perspective. This category accounts for 68 percent of total emissions; of which 13 percent were released directly and 55 percent indirectly through consumption of goods and services that induce emissions upstream. Direct household emissions can be further broken down into transport, housing (including utilities) and other activities, as illustrated in Figure 4. Households are followed by firms' investments (21%), government (8%), and global transport (3%). Furthermore, the share of emissions attributed to the different agents of final demand evolved along similar trends between 1997 and 2011.

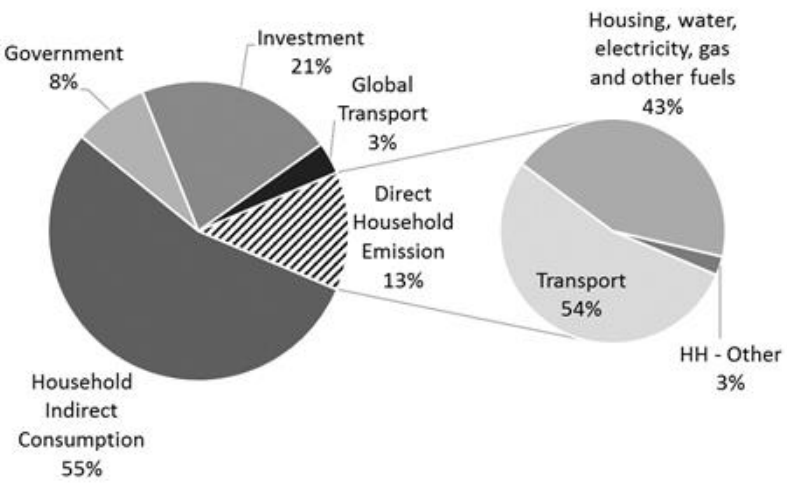


Figure 2: Shares of the Austria's CBA emissions across different agents (2011).
Source: Steininger et al. (2018)
Note: 'Global transport' covers emissions embodied in imports of international transportation services, which cannot be distinguished by purchasing region.

Regional breakdown of consumption-based emissions

The MRIO analysis also provides an overview of the most affected world regions in terms of GHG emissions (source regions) as a consequence of Austria's final demand. Figure 5 depicts the source regions grouped into Austria, rest of EU-28 (i.e. EU-28 excluding Austria), and non-EU countries. Interestingly, 62 percent of the emissions to satisfy Austria's final demand occur abroad, with 34 percent in non-EU countries – mainly in China, Russia and the United States – and 28 percent within other countries of the EU-28. Further, 35 percent of the total emissions embodied in final demand take place on Austrian territory. The remaining emissions due to international transport related to import activities are estimated at 3 percent.

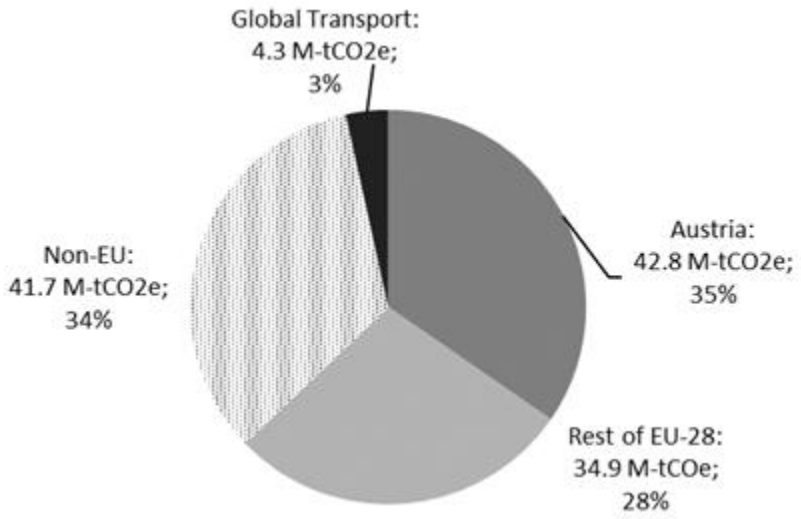


Figure 3: Regional sources of emissions induced by Austrian final demand (year 2011).
Source: Steininger et al. (2018)
Note: 'Global transport' subsumes emissions embodied in international transport which cannot be assigned to imports by region.

The regional breakdown is also relevant for the architecture of future climate policy design in Austria, as those emissions occurring in non-EU countries are subject to different, potentially less strict emission regulations. Yet, as we indicated above, reductions across the globe take place at often quite different speeds, and can be subject to domestic policy reversals. They also may focus on very different sectors across countries. For these reasons as well as for the UNFCCC principle of mitigation according to respective capabilities, any country in the world, also Austria, may be interested in not just reducing emissions within its own borders or those it induces in other EU countries, but very much also those it induces outside the EU (the large dotted slice of the pie chart in Fig. 3).

Effective instruments within consumption-based approaches differ across sectors

Price and market based mechanisms for internalization charge extra for the carbon content of a good or service (or intermediate input). For goods with a high carbon intensity per unit value, they imply a larger policy induced difference for their prices, and thus will in general work best for these goods. We can identify these sectors by depicting carbon intensity per value.

Figure 4 shows the relation between the absolute level of consumption-based emissions (plotted on the x-axis), CBA intensity (plotted on the y-axis), and final demand (given by the size of the bubble). Sectoral absolute consumption-based emissions can be driven either by carbon intensity (such as for electricity), or – even when carbon intensity is pretty low – by the sheer size of the sector, i.e. its turnover as indicated by bubble size (such as for public administration or for construction). Price and market based instruments – as the first type of instruments that we distinguished in the introduction – will work best for the former (indicated by black bubbles, including the hotspot sector identified earlier, electricity).

Sectors depicted on the bottom right hand-side are highly relevant for absolute emissions – we have identified three of them as hotspots in earlier sections of this paper (indicated by grey shades in the figure). They require instruments that fall under the other three types.

For construction, instruments of the second type (financial mechanisms to promote the development and deployment of climate-friendly goods and technologies) can be suggested when new structures are to be developed or dissipated, such as wooden structures instead of emission intensive concrete ones. More generally, instruments of this type are always relevant when an earlier phase of product development is concerned.

For public administration, public procurement programs can do a good job, which is an instrument out of the third type (technical requirements to promote the use of climate-friendly goods and technologies (standards)). More general, whenever carbon free products are available at a mature state, this type of instruments lends itself to application.

Finally, in sectors where household consumption accounts for a large share of final demand, such as in retail trade, instruments of the fourth type (information; i.e. labels) have been employed successfully.

By means of Figure 4, however, we can identify a further group of sectors, depicted as patterned bubbles, that might not immediately draw the attention of policymakers, but could represent opportunities for more balanced and effective policy interventions. These sectors are (in descending order of total emissions): ‘other machinery and equipment’, ´land transport´, ‘motor vehicles’, ‘other manufacturing’, ’petroleum and coal products’, ‘electronic equipment’ and ‘chemical, rubber and plastic products’. Particularly the industries belonging to medium-tech manufacturing, which has been a key sector of the Austrian economy, are noteworthy, as they offer high emission reduction effectiveness per unit value and are still relevant at over-all emission levels, and thus may play a decisive role for targeting long-term mitigation. Depending on the development stage, respectively maturity, of carbon-free products (or substitutes) in each of these sectors financial instruments to promote their development, or standards to promote their use can be suggested, or – when household demand accounts for a significant share of final demand – also information instruments (labels) are an option.

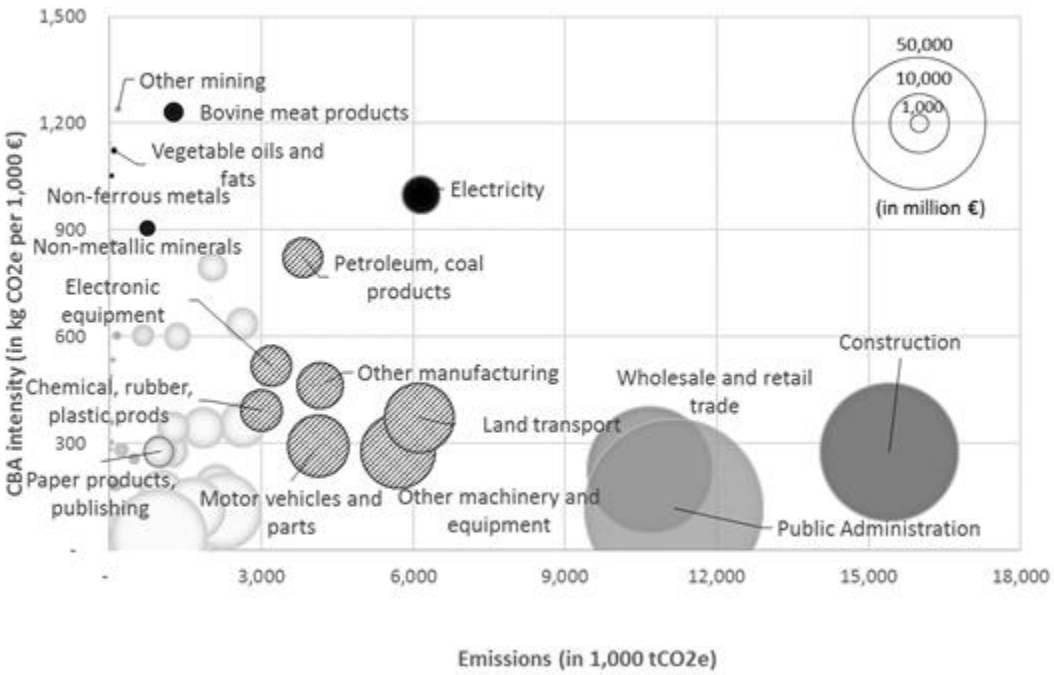


Figure 4: Identification of sectors for policy intervention along the criteria CBA GHG intensity, total CBA GHG emissions, and sector activity level (volume of final demand).
Source: Steininger et al. (2018)

More comprehensively, we can combine information on consumption-based emission intensity, the absolute amount of sector emissions, and the regional source of emissions to identify effective policy types by target sector. For representative destination sectors, Figure 5 depicts GHG emissions, again across the dimensions of consumption based emission intensity and absolute amount. However, in this case bubble size corresponds to total emission amount, split by source region (domestic, rest-of-EU, non-EU), and additionally includes emissions embodied in Austrian exports of that sector, such that the full scope that policy can address is covered. The vertical axis again identifies sectors which are CBA emission-intensive (e.g. electricity) and thus for which price instruments (e.g. environmental charges) have a higher potential, as carbon charges account for a larger share in respective final demand product prices. With the additional consideration of the source regions of emissions, we see that for electricity the sources are predominantly Austrian and rest-of-EU, such that a production-based policy (addressing Austrian and EU emissions) will in principle address emissions equally as well as consumption-based policies, as both ultimately address the same emission total.

For other sectors, where CBA emission intensity is low, e.g. electronic equipment or construction, a price-based instrument tends to be less effective, but alternative types of instruments (instruments to promote development or use, or information instruments) are more promising. Here, too, we can differentiate by source region of emission. For sectors where CBA emissions and emissions embodied in exports are predominantly originating nationally (or within the EU, if the relevant policies are those implemented at the EU level),

such as paper products and publishing, both production- and/or consumption-based instruments can address emissions equally well. If, however, emissions predominantly originate from outside the EU, such as with electronic equipment or wearing apparel, only instruments that address consumption-based emissions can effectively reduce emissions globally that are implied by final demand in those sectors. Thus, the applicable instruments out of each of the categories available (fostering development or use or ensuring information) have to clearly relate to consumption based accounting of emissions. E.g. if development is fostered by R&D, if use is fostered by performance standards or public procurement strategies, or if information is supplied by product labels, each of these necessarily need to relate to consumption-based emission accounts, i.e. needs to be specified in a way that addresses all GHG emissions along the full supply chain (beyond their traditional application based on production-accounting only) to render these policies effective in terms of emission reduction.

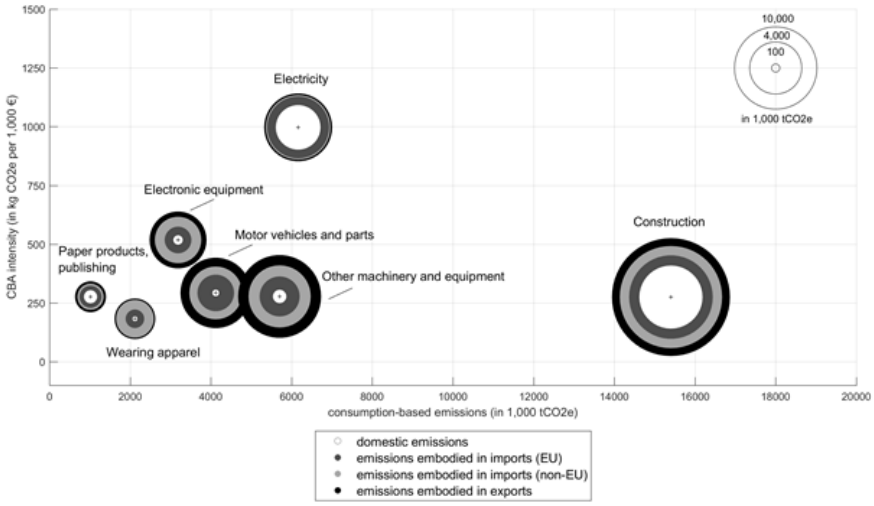


Figure 5: Consumption-based emissions for selected Austrian destination sectors, by carbon intensity, absolute amount and source region (2011).
Source: Steininger et al. (2018)

4.4 Social practices and their relevance in policy design to reduce consumption-based indirect CO2 emissions in Austria

Policy measures to reduce emissions are often based on behavioural approaches, trying to address consumer choices, related attitudes and environmental awareness. These policies are based on the principle of rational consumers choosing products based on price, quality and usefulness. Furthermore, they assume that consumer choices depend on their attitudes and values. These ideas are strongly contrasted by the widely acknowledged value-action-gap declaring that pro-environmental values and attitudes are not matched by their behaviours (Blake, 1999 and Barr, 2006). A considerable share of human behaviour is characterised by habits due to performing daily routines and practices rather unconsciously (e.g. cooking, working, grocery shopping) and on a regular basis. In this context the social practices approach (Shove et al., 2012; Hargreaves, 2011; Røpke, 2009; Warde, 2005, Spaargaren, 2003 and Schatzki, 1996) represent an innovative option to overcome the challenging “value-action gap” in consumer behaviour by shifting the focus from its motivations (i.e. behavioural intentions) to the frame and settings in which a certain

behaviour is performed. The performance of practices is characterised by aspects such as the application of competences (knowledge and skills to consume products or using tools), the re-construction of social meanings (cultural conventions, social norms and roles) and the use of materials (e.g. resources, objects, tools or infrastructure).

The persistence of a practice depends on its "circuit of reproduction" (illustrated by the lines between the elements in Figure 6). This is the regular performance and continuous reproduction of its elements (Shove et al., 2012): a repeated use (material), ascription (meanings) and application (skills) of the practice elements' assembly (Røpke, 2009; Warde, 2005; Reckwitz, 2002).

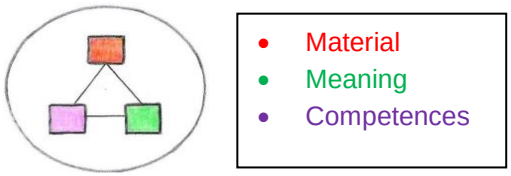


Figure 6: Social practices as performed behaviour and as entity (Spurling and McMeekin, 2015 and Jäger-Erben et al., 2014)

As shown in Figure 7, the particular quality and availability of the elements making up social practices is pre-determined and embedded in a certain system of provision (Spaargaren, 2003), providing infrastructure and tools that enable the consumption of goods and the performance of certain lifestyles. For instance, eating can be understood as a practice that consists of a bundle of interdependent acts that are sequentially structured and historically and normatively predetermined. This becomes tangible if we think of what we eat, how it is prepared and consumed.

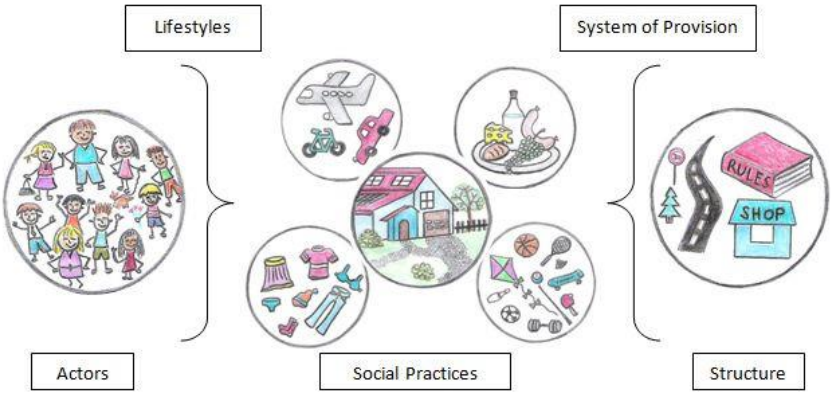


Figure 7: The social practices setting (oriented on Spaargaren, 2003)

While psychological approaches mainly address an entirely behavioural change, SP leave more space for a behavioural adjustment by mitigating or decreasing harmful aspects of a certain practice. Since indirect emissions are often consumed with "by-products" or as parts of certain practice or systems of provision, the social practice approach offers the opportunity to address particularly those parts (e.g. the use of certain vehicles and materials or certain skills required) within and across different consumption domains. Thereby it is possible to bypass the unlikely option of changing entire behaviours or lifestyles but enabling the change of single parts of the practice/behaviour as well as of the way in which the particular practice is performed. In this regard technological progress plays a central role in this context as it provides new materials or objects that can change practices over time (Røpke, 2009). But also social processes (e.g. social innovations or movements) can lead to the breaking of links between elements that form part of practices (Shove et al., 2012).

Intervention approaches of social practices

In contrast to behavioural approaches which highlight self-reflection and self-awareness as triggers of pro-environmental behavioural change, SP approaches assume that a “disruption” of the practice-performing-process or a change of settings will lead to a reflection on current behaviour or habit (Jäger-Erben et. al., 2011). Following Spurling and McMeekin (2015), the performance of SPs can be changed in three ways:

1. Re-crafting practices
   Re-designing and re-configuring of existing practices in order to achieve reduced emission intensity by the “same” practice (e.g. more efficient ways to perform a practice).

2. Substituting practices
   Formerly unsustainable parts of the practice become exchanged by more sustainable parts enabling a less emission-intensive performance of the “same” or even newly created practice (e.g. replacing the car by public transport or other sustainable forms of mobility).

3. Changing how practices interlock
   Often the performance of one practice is related, embedded or interdependent with other practices (e.g. the interlocking between housing-mobility-work). Inter-ventions towards one practice might require or release changes among the other practices as well (e.g. commuting).

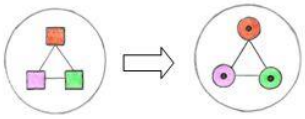


Figure 8: Recrafting of practices

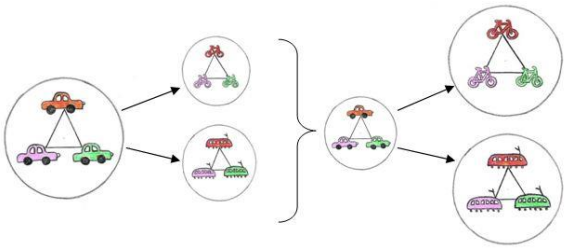


Figure 9: Substituting of practices

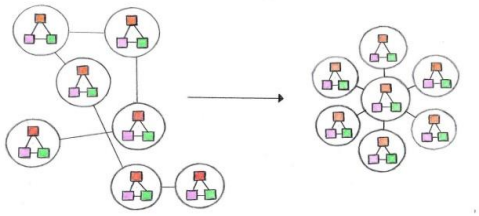


Figure 10: Interlocking of practices (for Figures 8-10 Spurling and McMeekin, 2015).

Social practice interventions in Austria's Consumption-based emission hotspot sectors

In general, policies targeting on a reduction of consumption-based emissions demand multi-criteria approaches that address particularly related practices on various levels such as on a regulatory, economic, information and infrastructural level. Against this background 117 good-practice examples from the three hotspot sectors identified were reviewed for their usability and applicability for the Austrian case: this means their feasibility to the Austrian geography, topography and in addressing Austria's present socio-economic situation, societal realities, geographical features and areas of high indirect resource consumption-based behaviour and practices. Finally, 21 good-practice examples fulfilled these requirements well and were chosen as basis for the development of policy instrument recommendations for Austria's hotspot sectors. For the analysis both private and commercial performance of practices were considered: (1) residential (dwelling) and non-residential (business) buildings for construction, and (2) private mobility (travelling) and logistics or service based mobility (delivering).

Overall, the principle of avoidance is predominant in approaching a reduction of consumption-based emissions, as the lion's share of emission consumption results from the demand-based production of goods (buildings, vehicles, materials) rather than from their actual performance (dwelling, driving, using). For example in the case of car-based mobility, it is not sufficient to tackle "driving" only in a direct way by reducing the frequency of use. Instead, this should be done indirectly by reducing the need for vehicles by supplementing and re-crafting mobility practices in the long-term (e.g. expansion of public transport or sharing schemes). On the other hand, macro-level trends and developments have to be taken into account. For example, a lack of attractive local job opportunities leads to commuting and drives the boom in construction in urban areas and city centres.

Construction

Currently, the construction sector is booming in urban areas, but in an unsustainable and short-term focussed way, neglecting future-oriented, climate-friendly urban planning. In line with global trends, construction activities are increasing in Austria, causing urban densification and sealing of landscape (e.g. undeveloped and green areas by buildings and transportation infrastructure) (Deloitte, 2017). Among others, these processes are reinforced by the medium-term effects of the economic crisis triggering urbanisation (job-supply driven regional depopulation) and causing low interest rates that lead to disproportionate investments in the construction-sector (concrete-gold). While it is hardly possible to influence global economic trends to reduce investment in real estate, it is, however, feasible to steer these processes into a more sustainable direction for the local society. By shifting the focus on the gathering of data on existing housing stock, fostering retrofitting and the intermediary use of space, large emission consuming new construction projects can be avoided or better matched with actual demand. In this context, macro-level phenomena have to be taken into account as well: measures to stimulate attractive local job opportunities can help reduce urbanisation and commuting (i.e. the more people move to a city the more demand for affordable living space is given).

Mobility

Technological innovations, multi-modal transport infrastructures and increasing affordability enable a high level of individual mobility (business and leisure). As a result we struggle with air pollution (Kiesewetter et al., 2015), increasing associated health problems (EEA, 2016)

and declining quality of life in urban areas (Zhao et al., 2015). Due to the spatial expansion of urban areas in Western Europe over the last decades, private vehicle use has also increased dramatically (Li, 2011). In particular, Austria has a relatively high rate of car ownership (6th highest in Europe) and a high share of individual, motorised commuting. Additionally, increasing logistics-based mobility due to the rise of e-commerce and a preference for online shopping add to urban traffic volumes. In this regard, a good example of a mobility practice intervention is an obligation for large companies to implement sustainable employee mobility plans (EMPs) for their staff and customers: in materials offered (e.g. company bikes or public transport tickets), skills needed (e.g. bike training or sharing) and meanings communicated (e.g. sustainable mobility modes are smart). Moreover, for some practice performers, the practice becomes re-crafted (e.g. car-pooling or more affordable PT), for others substituted (using bike and public transport instead of the car). Similarly, regulations to implement "green" delivery options such as combined delivery or sustainable "last-mile" deliveries by cargo bikes or bike couriers can add to a reduction of consumption-based emissions in mobility practices. In light of the high overall emission intensity of road transport compared to rail, a modal shift from road to rail in logistics would be desirable as well. This target mainly addresses businesses and logistics companies. However, also consumers can contribute to declining indirect emissions related to the logistics sector, by reducing online shopping.

Health

Globally activity in the health sector is increasing, driven by increasing wealth, technological development and living standards, the service becomes more and more requested and thus requires additional resources. Accordingly, the health sector is usually an area of rather high absolute resource use and thus emission production, independent of cultural or local specifics. Hospitals are huge institutional building complexes accommodating and hosting many people as well as providing a resource intensive service. Once entities such as hospitals consume high shares of energy and resources even single or comparable small measures can have a large impact on the reduction of emission consumption. Accordingly, policies targeting a reduction of consumption-based indirect emissions could be addressed to operational processes (e.g. food provision) and institutional procurement practices as well as issues of equipment use and recycling (i.e. side processes of the practice). For instance, food management is often performed inefficient (causing a lot of food waste) which can be changed comparatively easily. Since changes of food provision practices in hospital canteens effect hundreds of customers and employees, already minor changes such as preparing smaller portions or matching dishes with day-times and demand are easy to implement and contribute immediately to a noticeable reduction of emission-consumption.

Interlockings

Finally, practices like living/shelter and work are often connected in systems, meaning that changing how a certain practice is organised has implications for all other practices it is linked to. Mobility is a very appropriate example: Patterns of mobility are heavily interrelated with how households are supplied by (technical and social) infrastructure, where schools, shops, public transport opportunities and nurseries are located, how work and leisure are organised etc. For instance, work-related mobility (i.e. commuting) is mostly related to either spatial (e.g. distance between the living and work locations) and infrastructural issues availability of public transport or other sustainable mobility infrastructure (such as safe bicycle routes) or to habits (e.g. convenience of an already adopted mode and route of travel – habitualised behaviour). Changing these conditions of work-related travel could release a

series of new behaviours and performance of new practices that might lower indirect emissions in various ways (spill-overs).

4.5 Policy instruments to reduce Austria's consumption-based emissions: Evaluation and Adaptation

The evaluation of policy instruments is a key component of the policy design process. In the early stages of this process, ex-ante evaluation supports the initial selection of suitable policy instruments according to a stated set of criteria; interim evaluation helps to identify and improve implementation issues; and ex-post evaluation provides a final judgement on the success or otherwise of the chosen policy based on data gathered after implementation. Evaluation therefore serves, among others, the goals of accountability (demonstrating whether the policy "works" and the resources on it were well-spent) as well as learning and policy improvement (fixing what "doesn't work"). The practice of evaluating public policies, initially was established in the second half of the 20th century in the United States and Canada, and has by now become an integral part of EU policy-making (e.g. EC, 2015; EC, 2013).[2]

Defining criteria for consumption-based policy instruments

First, a set of criteria was established for evaluating the strengths and weaknesses of potential policy instruments to mitigate consumption-based emissions in Austria. For our purposes, a consumption-based policy instrument is defined as one that influences consumption patterns in such a way that both national and global GHG emissions are reduced.

The list of criteria includes both minimum requirements for suitable policy instruments and additional beneficial principles that facilitate the instrument's successful implementation. Following the literature on environmental policy evaluation (e.g. Perman et al., 2011; Goulder and Parry, 2008; Mickwitz, 2006) the minimum requirements are:

- Environmental (climate) effectiveness: Can the proposed policy instrument achieve the objective of reducing (or at least not increasing) Austria's consumption-based emissions?
- Cost effectiveness (in lieu of economic efficiency): Can the policy instrument achieve this objective at minimum cost?
- Good governance: Are the costs and benefits of the policy instrument *distributed equitably* across all social groups that are affected by the policy?

Additional beneficial criteria considered are:

- Feasibility: Is the instrument likely to be implemented in current circumstances?
- Flexibility: Can the policy instrument adjust to changing circumstances?

The first two criteria on effectiveness and the distributional consequences of the policy can be assessed using data on emissions, costs and benefits. The remaining criteria require qualitative judgements obtained through interviews with experts and stakeholders, for example.

When selecting the shortlist of policies suitable for addressing consumption-based emissions in Austria (WP2 in collaboration with WP3), care was taken to include different types of instruments: incentive-based (or economic) instruments, like taxes and subsidies - the EU emissions trading system ETS also belongs to this category; regulatory (or command-and-

[2] See also http://ec.europa.eu/smart-regulation/evaluation/index_en.htm.

control) instruments, such as standards for abatement technologies (technology standards) or emission output (performance standards); and information-based instruments, e.g. labelling or information schemes and platforms; infrastructure provision was considered as an additional instrument in the mobility sector.

Choosing an instrument may require accepting significant trade-offs between the criteria: regulatory instruments generally do well on climate effectiveness and distributional impact but may not be cost-effective; taxes are effective along both the cost and environmental dimensions but come at the cost of a possibly negative (regressive) distributional impact. Regarding feasibility, regulations and subsidies are easier to implement than taxes and are likely more distributionally equitable, but this also comes at the price of forgoing cost effectiveness.

Evaluating the strengths and weaknesses of consumption-based policy instruments, adapting existing instruments and developing new instruments

The minimum and additional criteria outlined above were then applied to the 15 policy instruments for mitigating consumption-based emissions in Austria developed in collaboration between WP2 and WP3 of the project. Several of the instruments are hybrid instruments, combining different instrument classes. They address consumption-based emissions in the Austrian hotspot sectors construction (policies #1 to #6), mobility (#7 to #12) and healthcare (#13 to #15).

The minimum criteria - the instruments' climate effectiveness, cost effectiveness and good governance (distributional impact) - were evaluated using data from case studies and official statistics where available. A full, model-based quantitative evaluation of a selection of the instruments according to these criteria - including general equilibrium feedback effects - is provided in WP4 of the project and reported below. The analysis in WP3 can be understood as an appraisal of the instruments' direct effects at the level of individual (economic or emission) sectors regarding cost and climate effectiveness and should be seen as complementary to the work in WP4.

The additional, "softer" criteria - feasibility and flexibility - were evaluated qualitatively. Overall, a descriptive approach is employed, using a simple evaluation scale ranging from ++ (criterion met fully) to - - (criterion not met at all). The evaluation was reviewed by Umweltbundesamt's sector experts in October 2016 and by external stakeholders at a workshop in March 2017.

Table 1: Summary of evaluation results

Evaluated Policies	Climate effectiveness	Cost effectiveness	Good governance: distributional	Feasibility	Flexibility
#1 Change in the safety and fire regulations for construction materials raising the maximum admissible building height for wood frame structures	+	+	+	+	+
#2 Information obligation on vacant dwellings tied to a renovation subsidy	+	+ +	0/+	+	+
#3 Directive on proportional share of dedicated	0	-	-	-	0

spaces for co-housing projects combined with a subsidy					
#4 Subsidy for retrofitting and redesign of vacant commercial buildings tied to energy-efficient refurbishment	+	+	0/+	+	+
#5 Labelling scheme on consumption-based emissions for conventional and sustainable construction materials	0	0	0	- -	+ +
#6 Carbon-added tax (CAT) on construction materials	+ +	0/+	0/+	- -	0
#7 Obligation to implement employee mobility plans, joint with public subsidies and other support measures	+ +	+	0	0	+
#8 Higher vehicle taxes for emission-intensive cars, linked to consumption-based CO_2 labels	+ +	+ +	+	- -	+
#9 Infrastructure investment to expand and improve Park + Ride facilities and their accessibility	+ +	+	+	+	-
#10 Integrated transport ticket across regions, linked with comprehensive online information platform	+ +	0	+	-	-
#11 Certification scheme for online retailers offering a sustainable (green) delivery option	0	0	0	+ +	+ +
#12 Increased subsidies for purchasing and using cargo bikes along the entire transport chain	+	0	0	0	+
#13 Obligatory Environmentally Preferable Purchasing Programmes (EPP) for hospitals and health institutions	+ +	+ +	0/+	+	+
#14 Change in regulations to allow the reprocessing and re-use of single-use medical tools and equipment	+ +	+ +	+	-	+
#15 Voluntary commitment by hospitals to reduce food waste, with label and tracking	+	+	0	+ +	+ +

++ … highly
+ … moderately
0 … neutral
- … less
- - … not at all

Overall, ranking the policy instruments according to the criteria considered, the following conclusions can be drawn (see also Table 1). Regarding climate impact, the instruments considered most effective in reducing Austrian consumption-based emissions are incentive-based instruments like the carbon-added tax (policy #6) and higher vehicle taxes for emission-intensive cars (#8); and those instruments that target infrastructure (#9 and #10) and the public health sector (#13 and #14), where the potential for emission reduction is considered large in Austria. In general however, these instruments score less highly on feasibility and flexibility, because they would either induce substantial changes in consumer behaviour and production structures; or require considerable public and private expenditures; or require international policy co-ordination in order to work effectively (especially the carbon-added tax).

The most cost-effective instruments tend to be regulatory but also incentive-based. These include the information obligation on vacant dwellings (#2), the vehicle tax for emission-

intensive cars (#8), and the regulatory changes regarding the health sector (#13, mandatory EPPs, and #14, allowing reprocessing and re-use of single-use medical tools and equipment). Particularly the last two measures are thought to bring large cost savings for hospitals while incurring comparatively small administrative costs, making them particularly cost-effective from a social point of view.

Regarding the "soft" criteria feasibility and flexibility - where the former is often influenced by a policy's distributional impact - it is information-based instruments that perform best. These include the certification scheme for online retailers offering a sustainable delivery option (#11) and the voluntary commitment by hospitals to reduce food waste in the form of a label or other certification scheme (#15). Their advantage is that they cost little and are voluntary, but the disadvantage is that they are also relatively ineffective in reducing emissions.

Macroeconomic assessment and evaluation of consumption based policy instruments

Based on the literature review and the stakeholder review of the 15 policy instruments, we conducted a macroeconomic assessment of a subset of eight policies for which sufficient emission reduction and cost data was available (Table 2). In particular, the goal was to assess the reduction in consumption-based emissions each of these policies could achieve, by considering emission reductions within the target sector, in all other sectors, and by final demand. Due to consumption based accounting, emissions were considered both within Austria, in the Rest of the European Union, and in the Rest of the World.

Table 2: Overview of analyzed consumption based policies.

		Policy type	Market agent	Mechanism
Building construction				
#1: Building code	Change in the safety and fire regulations for construction materials	Regulatory	Supply	Production technology
#2: Vacancies	Information obligation on vacant dwellings and penalty payments	Regulatory, Incentive-based	Demand	Investment demand
#6: Carbon added tax	Carbon-added tax on construction materials	Incentive-based	Supply	Input tax increase
Mobility				
#7: Mobility plans	Obligation to implement employee mobility plans	Regulatory	Demand	Final demand
#8: Vehicle tax	Higher vehicle taxes for emission-intensive cars	Incentive-based	Demand	Output tax increase
#9: Park and Ride	Infrastructure investment to expand and improve Park and Ride facilities	Infrastructure provision	Demand	Intermediate and final demand
#12: Cargo bikes	Increased subsidies for purchasing and using cargo bikes along the entire transport chain	Incentive-based	Supply	Production technology
Public health				
#13: Environmentally Preferable Purchasing Programs	Obligatory Environmentally Preferable Purchasing Programmes for hospitals and health institutions	Regulatory	Supply	Production technology

Figure 11 shows exemplarily the result for one policy in each area. In the policy field of construction, an increased tax on emission intensive construction materials (**carbon added tax**) induces a switch to less emission intensive inputs in the construction sector. It also increases the costs for construction activities and therefore final household demand for construction declines. Since the additional tax revenues are recycled back to households, their overall consumption level increases marginally.

The carbon added-tax leads to a significant reduction in consumption based emissions of 278 10^3 tons. 51% of this effect originates in the Cement sector (grey bars in Figure 11a). In terms of location, major consumption-based emission reductions are found within Austria and the EU. Further reductions in consumption-based emissions arise due to the increased costs for Construction as intermediate input to other non-Construction sectors and by households (around 20% of the total effect). The effect on production-based emission is much smaller: This is due to the fact that the tax rate is set based on inputs in the Construction sector which are intensive in consumption-based emissions but to a lesser degree intensive in production-based emissions. Moreover, we find for the carbon added tax not only a reduction of domestic emissions but also of exported emissions as increased prices reduce the export demand. Therefore, also emissions embodied in exports decline.

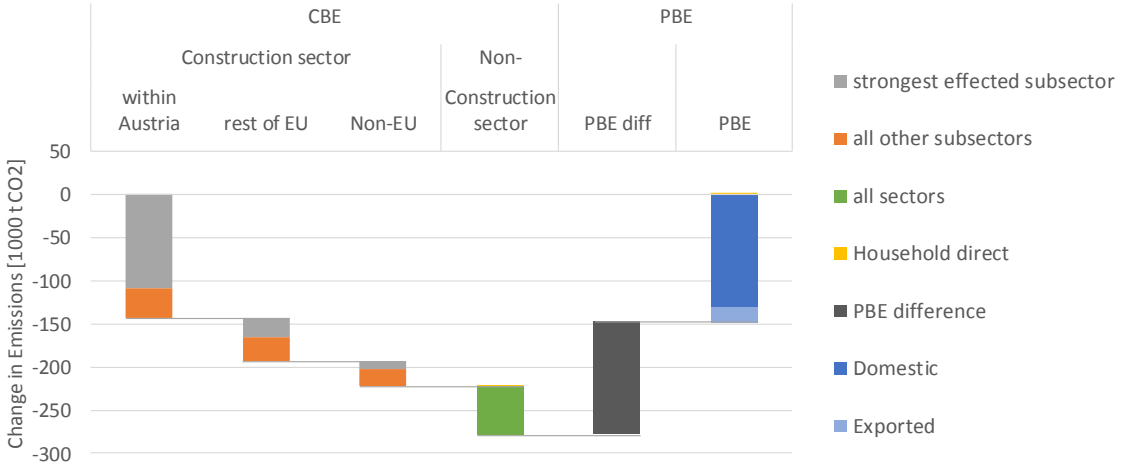
In public health, an obligation on **environmentally preferable purchasing programs** for hospitals and health institutions leads to reductions of energy, fuel and material use. Moreover, labour and capital inputs, necessary for implementing these programmes, increase. Overall costs are assumed to level out and therefore household demand for health services (included in the Public service sector) and output of Public Services increase only slightly.

These reductions in intermediate inputs lead to a relatively high consumption-based emission reduction (-133 10^3 tons), 87% of which arise within the Public service sector (see Figure 11b), mostly from reductions in direct emissions from fuel use. The largest share of emission reductions occurs within Austria and the policy has only minor emission implications within other EU and non-EU countries. Effects in other sectors are small but negative, household direct emissions are basically unchanged. As the policy affects primarily sectoral direct emissions and Austrian electricity emissions, total consumption-based and total production-based emission reductions are almost equivalent.

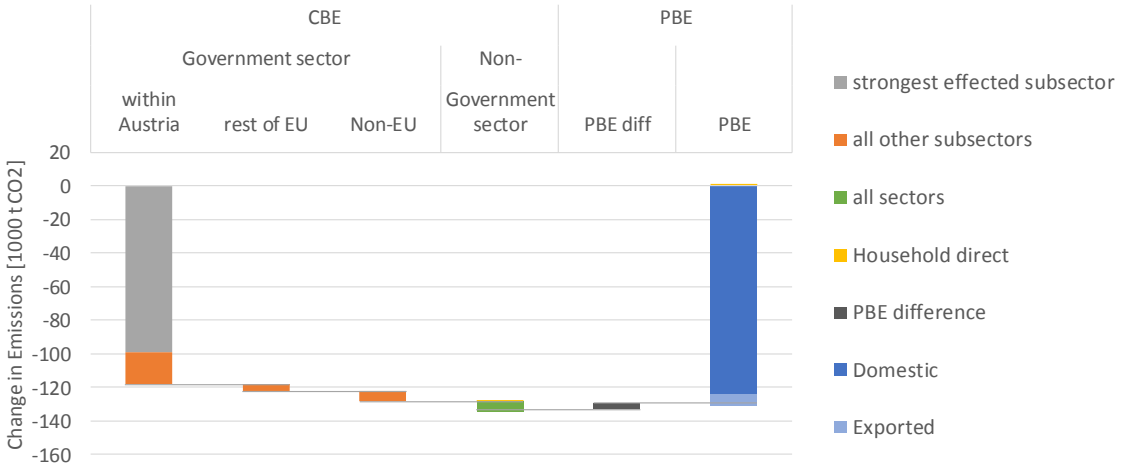
The exemplary policy in the area of mobility imposes an **obligation to implement employee mobility plans**. The resulting switch in transport modes leads to reductions in household demand for motor vehicles and parts, trade, insurances (service sector) and most notably petroleum products. Transport services are at the same time demanded more.

In Figure 11c we summarize exactly these five sectors under transport related sectors in the first three columns. The largest reduction within these sectors comes from the Electricity sector (32%), and these reductions occur mainly outside Austria and outside the EU. The largest emission reduction arises from direct household emissions due to lower petroleum use (82% of total CBE-effect). Consumption-based emissions from other sectors slightly increase because of demand shifts of the private and government household. But since this effect is comparatively small, total consumption-based emissions decline significantly by -70 10^3 tons. Because household direct emissions are included in both accounting principles equally and since household direct emissions reductions contribute most to the overall emission reductions, there is no significant difference between the decline in total consumption-based and production-based emissions. Reductions from domestic and export changes contribute 16% of the total production-based emission effect.

a) CONSTRUCTION: Carbon-added tax



b) PUBLIC HEALTH: Environmentally preferable purchasing programs



c) MOBILITY: Mobility plans

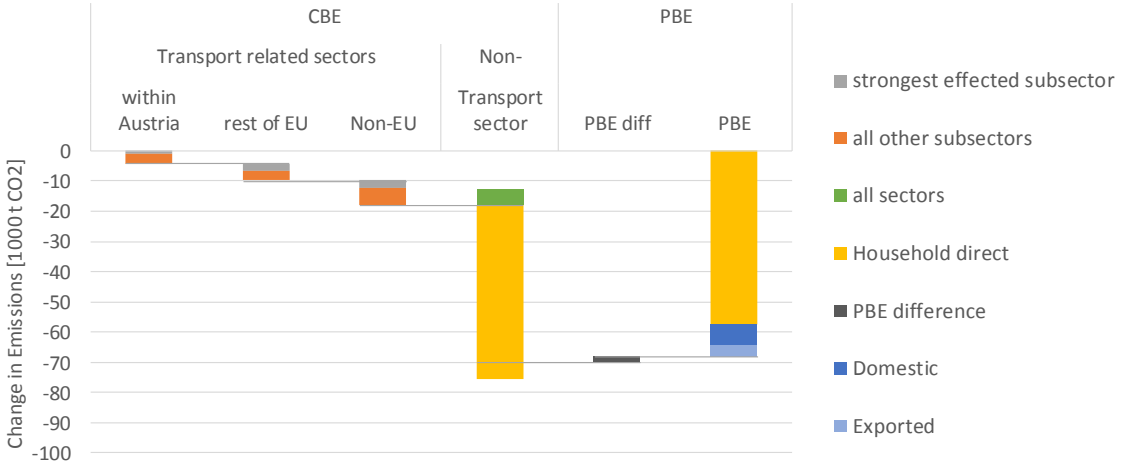


Figure 11: Change in consumption-based and production-based emissions in Austria from consumption based policies implementation in 1000 t CO_2, difference to Benchmark.

Source: Nabernegg et al. (2018)

4.7 Stakeholder inclusion and dissemination

A core focus of the INNOVATE project was the successful interaction with stakeholders as well as dissemination activities. The stakeholders were selected by a two-step stakeholder analysis and informed about the project progress at least every 6 months to keep them in the loop and to continually ensure their interest in the project. In addition to providing feedback e.g. concerning the usability of the elaborated fact sheets, during the course of a half-day workshop, the stakeholders provided valuable input on improving the policies developed in WP3, especially on enhancing their feasibility and flexibility. This was integrated into the final design of the policies.

The fact sheets were written in German and English using a clear and easily comprehensible language to ensure a scientifically correct but also broadly understandable message for policy makers, NGOs, intermediary institutions and the public.

5 Schlussfolgerungen und Empfehlungen / Conclusions and Recommendations

Given the extensive linkages via international trade, there is a strong deviation between production based (territorial) and consumption based emissions of a country. Consumption based emissions are those emissions arising in a country – we here analyse in particluar Austria – and abroad that can be attributed to final consumption in that country (here: to Austria).

For Austria, consumption based emissions in 2011 are 124 Mt CO_2e as compared to 80 Mt CO_2e for production based emissions (Steininger et al. 2018). This difference is due to several facts: GHG emissions are contained in products consumed in Austria also because of intermediate and final goods that are produced abroad. Austria tends to import goods that have a higher GHG intensity per output value than the goods produced in Austria. This higher GHG intensity in imports is due to both (a) higher emission intensities abroad (particularly in less developed countries) and (b) Austria importing different goods than those which are produced domestically.

Across products and sectors, the – in absolute terms – highest consumption based emissions in Austria arise for construction, public services, and transport related sectors as manufacturing of motor vehicles and parts. These are very different sectors than the most emission generating activities from a production based perspective, where electricity is the most important sector. Moreover, sectors and products differ also substantially in their emission contribution across the world: while electronic equipment or motor vehicles causes emissions mostly outside the European Union (67% resp. 52% of their total consumption based emissions), construction contributes mostly to emissions in the European Union (67% of their total emissions) and to a lesser degree elsewhere. One reason for this different contribution is how easy commodities and products can be transported across long distances at low costs and how deeply nested the supply chain is.

For climate policy in a fragmented world, the question therefore arises how effective domestic, or European policy can be. European wide policy is needed to address GHG emissions caused by Austrian consumption in Europe. This is particularly important since more than half of Austrian imports originate in their last production stage from Europe. The most comprehensive effort in that respect is the EU Emissions Trading Scheme, addressing emissions in energy intensive industries. But this needs to be further developed, and

additional policies are needed for the remaining sectors, in particular transport. There is also a need for policy instruments which have been successful in other areas (such as labor standards), but have not been used sufficiently in climate policy yet. One such instrument is standardization, e.g. for electric charging stations.

For emissions caused outside of the European Union, a mostly academic discussion on carbon tariffs for carbon intensive products (or border carbon adjustment when combined with export rebates) has evolved. But given the recent development particularly in China where coal has been reduced substantially and renewable energy (mostly solar) increased, there also seems to be less need for such carbon tariffs. On the contrary, collaboration in technology development and (international) penetration could be much more effective in achieving ambitious mitigation targets.

Taking into account sectoral consumption based emissions, climate policies within Austria can be designed to address also the emissions originating outside of Austria and the European Union. Focusing on the sectors of high absolute consumption based emissions in Austria, the introduction of a carbon tax on the consumption based emissions content (e.g. for construction materials) shows a large potential for reducing emissions within and outside the EU. This potential is similarly given when considering carbon requirements in national health procurement and public procurement in general (best offer vs. cheapest offer). Further, domestic policies for increasing energy efficiency and reducing fossil fuel use in domestic activities (such as environmental friendly commuting programs) are equally effective from a domestic production based as from a global consumption based perspective (Nabernegg et al. 2018).

In terms of cost-effectiveness, regulatory instruments like an information obligation on vacant dwellings do well. Extending the criteria of policy evaluation also to feasability and flexibilty, information-based and voluntary instruments perform best, such as a certification scheme for online retailers offering a sustainable delivery option or voluntary commitment by hospitals to reduce food waste in the form of a label or other certification scheme (Kammerlander et al. 2018a).

In general the reduction of emissions caused by Austrian consumption along the global supply chain needs to acknowledge technological developments and aspects of human behavioral change to identify reduction potentials and possible lower effectiveness due to rebound effects. Policy development therefore can be informed by social practice theory, that considers human behaviour as largely habitual, consisting of routines and practices that are performed unconsciously and shaped by infrastructure, social norms and knowledge (Kammerlander et al. 2018b), and policy accordingly addressing these explicitely.

C) Projektdetails / Project Details

6 Methodik / Methodology

Consumption-Based Accounting

Linking the production and consumption activities of countries by international trade flows facilitates the analysis of the location and source of global emissions. The prevalent established method to account for a country's emissions is the so-called Production-Based Accounting (PBA), which attribute the emissions to the country *releasing* the carbon to atmosphere, regardless where these commodities are eventually consumed (see Fig. 12). The emissions accounted as country m´s under this scheme are made up of those released in home production for both domestic consumption and foreign export (Fig. 12). An alternative way is to consider the consumption activities in a country and the associated emissions released along the whole production chain satisfying this demand, regardless where the production of the respective commodities (and the associated emissions) took place. The latter is referred as Consumption-Based Accounting (CBA). In this case country n´s (consumption-based) emission account – in addition to emissions from home production for home consumption – contains emissions released in the production of its imports, but no longer those of its exports (see Fig. 12). Following trade linkages over the entire production chain – from the industries that supply their output for production up to the industries that produce the final good or service – allows the allocation of global emissions from a consumption perspective.

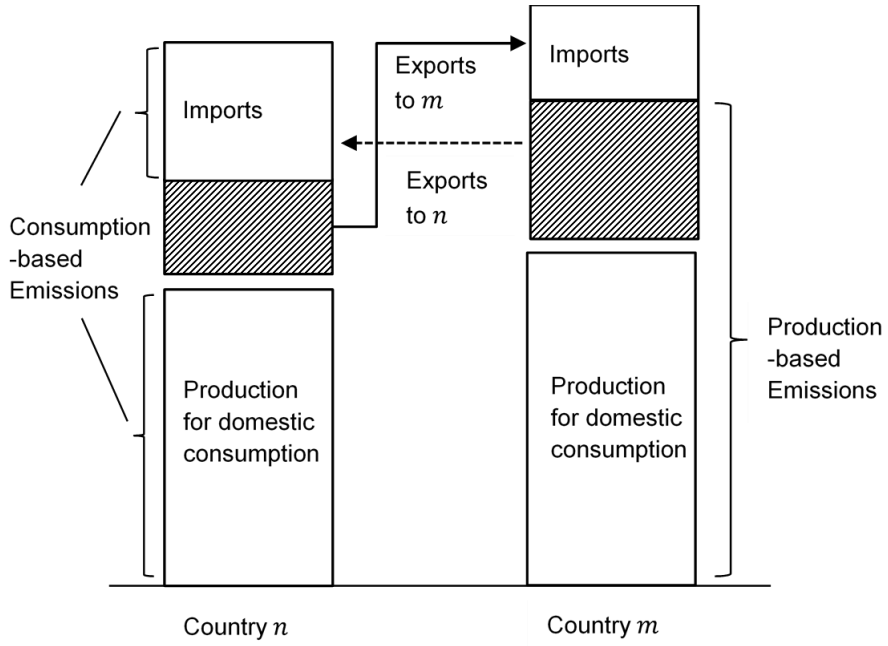


Figure 12: Consumption vs. production-based accounting concepts. Scheme adapted from Steininger et al. (2014).

Multiregional Input-Output Model

In the present analysis, the CBA concept is implemented by means of a global environmentally extended Multiregional Input-Output (MRIO) model depicting global trade

flows and corresponding emissions. This type of model is often featured in the literature on emission accounting as the underlying methodology already well established, not only in the academic community (see for example Lenzen et al., 2004; Lenzen et al, 2007; Peters and Hertwich, 2008; Davis and Caldeira, 2010; Muñoz and Steininger, 2010; Steininger et al., 2016), but also among international organizations (OECD, 2016; Eurostat, 2016). MRIO applications have been fostered further by the development of new databases, such as GTAP (Aguiar et al. 2016*)*, EXIOBASE (Tukker et al. 2013; Wood et al. 2015), Eora (Lenzen et al., 2012; 2013), WIOD (Timmer et al. 2015) and OECD (2016). For comparative studies of these databases, see Inomata and Owen (2014) – and within this special journal issue in particular the work of Moran and Wood (2014) and Arto et al.(2014) – as well as Tukker et al. (2013).

The MRIO analysis allows tracing both direct and indirect emissions ($\boldsymbol{E}$) induced by final consumption ($\boldsymbol{Y}$) through production linkages ($\boldsymbol{A}$) between industries and countries:

$$\boldsymbol{E} = \boldsymbol{\rho}(\boldsymbol{I} - \boldsymbol{A})^{-1}\boldsymbol{Y}$$

The block matrix $\boldsymbol{A} = [a_{ij}]_{\boldsymbol{NMxNM}}$ depicts the multiregional production coefficients where element a_{ij}^{km} of submatrix $\boldsymbol{A}_{km}$ reflects the intermediate demand (per unit of gross output) of industry j in country m from industry i in country k, with $i, j = 1, \dots, N$ and $k, m = 1, \dots, M$. The element y_{ic}^{km} of the final demand matrix $\boldsymbol{Y}$ denotes industry i's output produced in country k and consumed by final users in country m, with index c denoting the different economic agents (i.e. private households, government and investment demand). The Leontief inverse $(\boldsymbol{I} - \boldsymbol{A})^{-1}$ thereby captures the direct and indirect inputs necessary to produce one unit of a final commodity. Finally, vector $\boldsymbol{\rho}$ depicts for all industries and countries the level of GHG emissions per unit of output. By introducing $\boldsymbol{\rho}$, total inputs required along the international production chain of final demand are translated into environmental pressures from consumption (in form of GHG emissions). The specification of the model further allows the assignment of these impacts to destination (i.e. the sectors in country m responsible for the respective emissions domestically and elsewhere) and source (i.e. the sectors across all k countries where these emissions actually take place).

With the MRIO system constructed, there are several complementary ways to attribute emissions to sectors and countries. For a given final consumption, ***Y***, it is possible to allocate emissions to the sectors and regions where the consumption occurs (the destination sector),

$$\boldsymbol{E}_{\boldsymbol{destination}} = \boldsymbol{\rho}(\boldsymbol{I} - \boldsymbol{A})^{-1}\widehat{\boldsymbol{Y}}$$

where the hat symbol, ^, converts the vector ***Y*** into a matrix with the elements of ***Y*** on the diagonal. It is also possible to allocate emissions to the sectors and regions where the emissions occur (the source sector)

$$\boldsymbol{E}_{\boldsymbol{source}} = \widehat{\boldsymbol{\rho}}(\boldsymbol{I} - \boldsymbol{A})^{-1}\boldsymbol{Y}$$

It is possible to link the source and destination attributions using Structural Path Analysis (SPA, Peters and Hertwich 2006). SPA is done by first expanding the The Leontief inverse using a power series approximation (Waugh, 1950)

$$\boldsymbol{E} = \boldsymbol{\rho}(\boldsymbol{I} - \boldsymbol{A})^{-1}\boldsymbol{Y} = \boldsymbol{\rho I Y} + \boldsymbol{\rho A Y} + \boldsymbol{\rho A^2 Y} + \boldsymbol{\rho A^3 Y} + \boldsymbol{\rho A^4 Y} + \cdots$$

where $\boldsymbol{\rho A^t Y}$ represents the impact from the *t*-th production layer (or tier). For instance, if $\boldsymbol{Y}$ represents a demand on the production of one car, then $\boldsymbol{\rho I Y}$ is the direct pollution emitted in the production of the car by the car manufacturer. To produce the car, inputs $\boldsymbol{Ay}$ from other industries are required; these industries emit $\boldsymbol{\rho A Y}$. In turn, these industries require inputs of $\boldsymbol{A(AY)}$ with emissions of $\boldsymbol{\rho A^2 Y}$. This process continues through the infinite expansion of the power series. The SPA can be displayed with a tree structure (Peters and Hertwich 2006), as is done in Figures 8 and 9, with further interpretation in our analysis.

Data preparation

We base our analysis on the Global Trade Analysis Project (GTAP) database due to the time span and regions covered, and complement our findings with EXIOBASE because of its higher level of sectoral disaggregation.

GTAP: We used the following GTAP versions: GTAP v.9 (base year 2011, 2007 and 2004); GTAP v.6 (base year 2001); and GTAP v.5 (base year 1997). The most recent GTAP database (Aguiar et al., 2016) includes a global representation of 140 regions, 120 single countries and 20 country groups, and 57 sectors. The method of converting GTAP into an MRIO table can be found elsewhere (Peters et al., 2011; Andrew and Peters, 2013). GTAP has a unique method of treating international transport that warrants further discussion. On the one hand, international transport services are specified as intermediate sectors supplying the different modes of transportation – by air, water, and other (land) transport for passengers and freight. For these transport services the provider and user of the transport service are known. On the other hand, the GTAP database additionally provides a *global* international transport pool which pools together the supply of international shipping services for exported commodities when those services cannot be assigned to the individual countries/regions that demand those services (a third country provides transport services between two other countries). These imports of international transport are thus also presented as a further – though fictional - agent of final demand in the scope of this paper. For more detailed information on the treatment of trade and transport margins see Hertel (2013) and Aguiar et al. (2016).

EXIOBASE: Since the GTAP database only has 57 sectors, we perform some more detailed analysis using EXIOBASE with 163 industries for the year 2007. We decided for this two-step analysis – GTAP as primary data source and the complementary use of EXIOBASE – because (1) albeit a higher sectoral resolution in comparison to GTAP, EXIOBASE includes only 48 world regions of which 43 are individual countries; (2) GTAP has provided updates on a regular basis, with the latest version comprising the year 2011 versus 2007 in the case of EXIOBASE. In addition, in a sensitivity analysis at the aggregate level, we compare results with those from the WIOD and Eora data bases.

GHG emission sources

The emissions data is derived from a combination of sources covering the same year, regions and sectors as the GTAP dataset. While the GTAP database provides GHG emission data in most years, previous research has shown that the data is not necessarily

the most accurate (Peters et al., 2011; Andrew and Peters, 2013). Because of this, we use a variety of complementary emission datasets to 1) complete the database for all species in all years and 2) use the most accurate data available for each country. We then use the same emission data consistently across all MRIOs. The sources, in order of priority, include EUROSTAT's NAMEA dataset which is reported directly by countries and is the most reliable (CO_2, CH_4, N_2O, fluorinated gases (FGAS); European Commission (2015)), the UNFCCC dataset (CH_4, N_2O, FGAS; UNFCCC (2013)), the GTAP dataset (CO_2, CH_4, N_2O, FGAS; Aguiar et al. (2016)) and CDIAC dataset (cement and flaring CO_2 emissions; Le Quéré et al. (2015)). The NAMEA dataset covers most European countries, while UNFCCC includes further large economies (such as Australia, Canada, US, Russia and Japan), while GTAP provides emissions for the rest of the regions. CDIAC cement and flaring emissions are applied to regions where GTAP CO_2 emissions are used, as the latter does not include cement emissions (while NAMEA does). We use the global warming potential metric with 100-year time horizon (GWP100) with parameters from IPCC's fourth assessment report (AR4; IPCCC (2007)), apart from FGAS which use parameters from the second assessment report (SAR; IPCCC (1996)) since it is hardwired from the source. While different emission datasets are a leading cause of the absolute uncertainty between different consumption-based emission estimates (Peters et al., 2012; Karstensen et al., 2015), the relative results within a single dataset are less effected. For example, the share of the net import, or the share of consumption on food, is more stable across datasets.

Social Practices

A considerable share of human behaviour is characterised by habits due to performing daily routines and practices rather unconsciously (e.g. cooking, working, grocery shopping) and on a regular basis. In this context the social practices approach (Shove et al., 2012; Hargreaves, 2011; Røpke, 2009; Warde, 2005, Spaargaren, 2003 and Schatzki, 1996) represents an innovative option to overcome the challenging "value-action gap" in consumer behaviour by shifting the focus from its motivations (i.e. behavioural intentions) to the frame and settings in which a certain behaviour is performed (i.e. associated meanings, materials used and skills required). While psychological approaches mainly address an entirely behavioural change, social practices leave more space for a behavioural adjustment by mitigating or decreasing harmful aspects of a certain practice. Since indirect emissions are often consumed with "by-products" or as parts of certain practice or systems of provision, the social practice approach offers the opportunity to address particularly those parts (e.g. the use of certain vehicles and materials or certain skills required) within and across different consumption domains. Thereby it is possible to bypass the unlikely option of changing entire behaviors or lifestyles but enabling the change of single parts of the practice/behavior as well as of the way in which the particular practice is performed. In this regard phenomena such as new technological or social innovations and value changes play a crucial role.

The practice-based thinking has already been applied to various fields of pro-environmental change, such as daily consumption of food (Brunner, 2007) or energy (Gram-Hanssen, 2011; Jaeger-Erben, 2010; Jackson, 2005); recycling (Hargreaves, 2011), and sustainable housing (Shove, 2003).

Qualitative evaluation of policies' strengths and weaknesses

To evaluate the policies' strengths and weaknesses, a set of criteria was developed based on the policy evaluation literature: firstly, minimum criteria that the policies should fulfil, and secondly, desirable additional criteria. The minimum criteria - the instruments' climate effectiveness, cost effectiveness and good governance (distributional impact) - were evaluated using data from case studies and official statistics where available. While a full model-based quantitative evaluation of a selection of the instruments according to these criteria - including general equilibrium feedback effects - is provided in WP4 of the project, the initial evaluation provided here can be understood as an appraisal of the instruments' direct effects at the level of individual (economic or emission) sectors regarding cost and climate effectiveness. The additional, "softer" criteria - feasibility and flexibility - were evaluated purely qualitatively. Overall, a descriptive approach was employed, using a simple evaluation scale ranging from ++ (criterion met fully) to - - (criterion not met at all). The evaluation was reviewed by Environment Agency Austria's sector experts in October 2016 and by external stakeholders at a workshop in March 2017.

Assessment of policy effectiveness in reducing consumption-based emission

While several studies on consumption-based emission accounting emphasize the importance of analysing the effectiveness of national climate policies beyond national boundaries, only few highly stylized models exist that perform such policy assessment. One potential reason for this research gap might be that the evaluation of national policies with regard to consumption-based emissions along the full global supply chain requires non-trivial model simulations that combine different methodological frameworks.

In this work we aim at closing this gap by using two interlinked methodologies: the first one consisting of a Computable General Equilibrium (CGE) model that assesses the changes induced by national climate policies in terms of supply, demand, prices, substitution effects, and carbon intensities across economic sectors; and the second methodology which comprises the development of a Multi-Regional Input-Output (MRIO) model, considering multi-directional trade linkages and full feedback loops, as described above. The MRIO framework allows calculating consumption-based emission responsibilities (or country's carbon footprint) before and after a climate policy simulation is conducted within the CGE model, measuring how effective a policy is to reduce emissions along the international supply chain.

Figure 13 illustrates the model linkage and how it can be used to evaluate the effectiveness of national climate policies in reducing consumption-based and production-based emissions. Both methods rely on national macroeconomic and international trade data disaggregated by sectors, as well as emission data with a global coverage. The database on the sectoral economic structure of countries comes from the Global Trade Analysis Project (GTAP) 9, as it contains all the necessary information for performing CGE and MRIO models, and has been widely used in the literature. We aggregate the regions into 4 European clusters, 4 Asian countries and 7 larger world regions according to Austrian's most relevant trade partners, as well as Austria as the country of national climate policy implementation. On the sectoral scale we aggregate into 25 sectors to reduce complexity and computational intensity in our analysis.

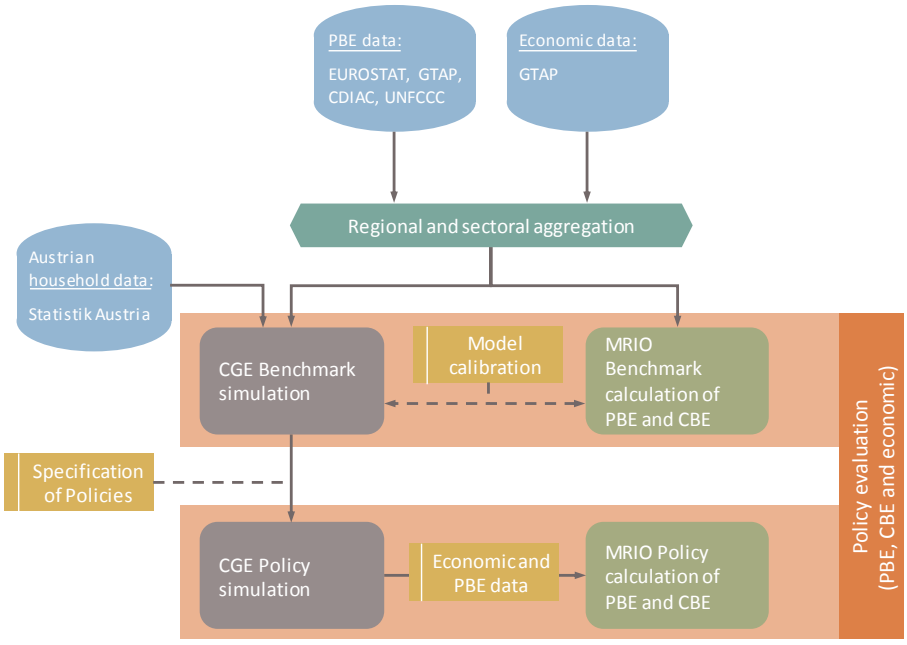


Figure 13: Methodological proceeding and model linking for the analysis.
Source: Nabernegg et al. (2018)

Stakeholder inclusion and dissemination

The stakeholders (representatives from ministries, provincial governments, interest groups e.g. chambers, NGOs, energy suppliers, hospitals, consultants, science and applied research) were identified in a two-step approach using a set of criteria that ensured the inclusion of the core stakeholders during the project design phase and still provided enough flexibility to invite additional persons if necessary after the hotspots became clear. To reach the goal of including stakeholder input continuously and not only in the starting and final phases of the project, while also keeping the information flow manageable for the stakeholders, they were informed about the project progress once every six months per e-mail. This approach proved ideal for both avoiding large information gaps and keeping the interest in the project alive at the same time.

The stakeholders were invited to a half-day interactive workshop, were they discussed in breakout groups, facilitated by experienced moderators, the policies developed in WP2 and WP3 and gave feedback, especially on enhancing the feasibility and flexibility of the measures proposed for the different sectors. This feedback was integrated into the final version of the policies.

To present the project results to target groups like politicians, NGOs but also the broader public, several easy to comprehend Fact Sheets in German and English were developed.

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7 Arbeits- und Zeitplan / Time and Work Plan

Kurze Übersichtsdarstellung des Arbeits- und Zeitplans

Tasks per Work package	**Finalisation (MM/YY)**
WP 1: Identifying hotspots and global critical links of Austrian consumption-based GHG emissions	
Task 1.1: Hotspots	06/16
Task 1.2: Critical Links	06/16
WP 2:	
Task 2.1: Identification of barriers	02/16
Task 2.2: Literature analysis	02/16
Task 2.3: Identification of instruments of high relevance	09/16
WP 3: Review and development of policy instruments	
Task 3.1: Definition of criteria for adequate consumption-based policy Instruments	10/16
Task 3.2: Application of criteria to the policy shortlist from Task 2.3	02/17
Task 3.3: Identify an exemplary future trend and develop relevant policy Options	03/17
Task 3.4: Adapt existing and develop new consumption-based policies	03/17
WP 4: Assessment and evaluation of consumption based policy instruments	
Task 4.1: Model refined and new developments implemented for first cycle of evaluation	12/16
Task 4.2: Evaluation of instruments analysed in the first cycle of evaluation	03/17
Task 4.3: Report on carbon and economic impact analysis of producer and consumer side consumption-based climate policies	10/17
Task 4.4: Consumption-based emissions quantified for core policy packages	02/18
Task 4.5: Quantification of consumption-based emissions after-policy	04/18
WP 5: Stakeholder inclusion and dissemination	
Task 5.1: Stakeholder analysis as input for instrument development	03/15
Task 5.2: Instrument discussion with stakeholders	03/17
Task 5.3: Dissemination	05/18
WP 6: Project management	
Task 6.1: Project team meetings	05/18
Task 6.2: International advisory board	10/17
Task 6.3: Publications	05/18
Task 6.4: Interim and final activity reports	06/18

8 Publikationen und Disseminierungsaktivitäten

	Peer-reviewed Journal Publication	Dissemi-nation	Presen-tation
1. Steininger, K.W., Lininger, C., Meyer, L., Munoz, P., Schinko, T. 2016. Multiple carbon accounting to support just and effective climate policies, Nature Climate Change 6 (1), 35-41. doi: 10.1038/nclimate2867	X		
2. Vogel, J. and Svehla-Stix, S. (2016), "Umweltpolitik ist sozial gerecht gestaltbar", Wirtschaft und Umwelt, 3/16, pp. 14-17, http://www.ak-umwelt.at/media/filer_public/2016/10/26/ak_wirtschaftundumwelt_0316_lowres_final.pdf	X		
3. Steininger, K.W., Munoz, P., Karstensen, J., Peters, G., Strohmaier, R. Velazquez, E. (2018), Austria´s consumption based greenhouse gas emissions: Indentifying sectoral sources and destinations. Global Environmental Change 48: 226-242. https://doi.org/10.1016/j.gloenvcha.2017.11.011	X		
4. Nabernegg, S., Muñoz, P., Bednar-Friedl, B., Titz, M., Vogel, J. (2018), National policies for global emission reductions: Effectiveness of carbon emission reductions in international supply chains. Working paper version: Graz Economics Papers 2018-10, University of Graz, Department of Economics.	under review with peer-reviewed journal		
5. Kammerlander, M., Omann, I., Gerold, S., Moch, M., Stocker, A. (2018), How do social practices influence the development of policy instruments to reduce consumption-based indirect CO2 emissions in Austria?	in submission		
6. Nabernegg, S. (2018), Incidence and effectiveness of national mitigation policies: A macroeconomic analysis for Austrian households	to be submitted		
7. Umweltbundesamt (2018): Kammerlander, M., Omann, I., Titz, M., Vogel, J.: Which national policy instruments can reduce consumption-based greenhouse gas emissions? A qualitative evaluation for Austria. Umweltbundesamt Report, forthcoming, Vienna		x	
8. Innovative Climate Policy Instruments to Reduce Consumption-Based Emissions to Complement Territorial Emission Reduction Efforts, INNOVATE Fact Sheet 1, published March 2015 (INNOVATE webpage)		x	
9. Munoz and Steininger (2015), Konsum-basierte Emissionen Österreichs, INNOVATE Fact Sheet 2, published December 2015 (INNOVATE webpage)		x	
10. INNOVATE project team. Austrian carbon trade, INNOVATE workshop, Environmental Agency Vienna, Austria, March 2016		x	
11. INNOVATE project team. ExpertInnen-Workshop zu den Ergebnissen von INNOVATE: Innovative climate policy instruments to reduce consumption-based emissions, 7. März 2017, DemoCenter, Treustraße 35-43, 1200 Wien		x	
12. INNOVATE project team, International Symposium „Consumption Based Greenhouse Gas Accounting: From		x	

Assessments to Policy", October 13, 2017, Vienna, KPC			
13. Kammerlander, Moritz, Omann, Ines, Gerold, Stefanie, Links between Consumption-Based Emissions and Social Practices in Austria, INNOVATE Fact Sheet 3, published June 2018 (INNOVATE website)		X	
14. Bednar-Friedl, Birgit, Karl Steininger, Stefan Nabernegg, Johanna Vogl, Moritz Kammerlander, Ines Omann, Michaela Titz, INNOVATE POLICY BRIEF: Recommendations for climate policy to address consumption-based emissions, published July 2018 (INNOVATE webpage)		x	
15. Steininger, K.W., invited plenary keynote, Austria´s Consumption-Based Emissions: Identifying Sectoral Origins and Destinations, Österreichischer Klimatag, Graz, Austria, April 2016			x
16. Steininger, K.W., invited paper presentation, Austria´s Consumption-Based Emissions: Identifying Sectoral Origins and Destinations, Annual Meeting of the European Association of Environmental and Resource Economists, Zurich, Swiss, June 2016			x
17. Kammerlander, M. and Omann, I. invited paper presentation at the 2nd Conference (Symposium) of „Konsum neu denken" on "Multiperspektivische Verbraucherforschung – theoretische und praktische Perspektiven auf Konsum und Verbraucherpolitik im Dialog", Karl-Franzens University, Graz, September 2016			x
18. Steininger, K. W., (with P. Munoz, B. Bednar-Friedl, M. Kammerlander, J. Karstensen, I. Omann, G. Peters, S. Nabernegg, R. Strohmaier, M. Titz, J. Vogel, and A. Wossnik) invited presentation, Greenhouse gas embodied in international trade: From accounting to policy, presented at the Österreichischer Klimatag, Vienna, Austria, May 2017			x
19. Nabernegg, S., (with P. Munoz, B. Bednar-Friedl, M. Titz, and J. Vogel), invited presentation, Effective national mitigation policies for reductions in production and consumption based emissions, presented at the International Conference on Economic Modeling, Ljubljana, Slovenia, July 2017			x
20. Steininger, K. W., (with P. Munoz, J. Karstensen, G. Peters, R. Strohmaier, and E. Velazquez), invited presentation, Austria's Consumption-Based Greenhouse Gas emissions: Identifying sectoral sources and destinations, presented at the ECOMOD Annual Conference, Ljubljana, Slovenia, July 2017			x
21. Nabernegg, S., invited presentation, Incidence and effective of consumption based emission policies: A macroeconomic analysis for Austrian households, presented at the Explaining Inequality, its Causes and Consequences: Analytical Advances and Remaining Challenges, Graz. Austria, September 2017			x
22. Nabernegg, S., (with P. Munoz, B. Bednar-Friedl, M. Titz, and J. Vogel), Effective national mitigation policies for reductions in production and consumption based emissions, presented at the Symposium on Consumption Based Greenhouse Gas Accounting: From Assessments to Policy, Vienna, Austria, Oct. 2017			x
23. Nabernegg, S., (with Bednar-Friedl, B., Munoz, P., Titz, M., Vogel, J.) Production and Consumption Based Emissions - Effectiveness of national mitigation policies in Austria,			x

Green Food for Purple Thought Seminar, Tyndal Centre for Climate Change Research, University of Manchester, UK, January 2018.			
24. Nabernegg, S., (with B. Bednar-Friedl, P. Munoz, M. Titz, and J. Vogel), National Policies for Global Emission Reductions: Effectiveness of national mitigation policies for reductions in production- and consumption-based emissions in Austria, presented at the Economics & Policy for Sustainability research group seminar, University of Leeds, February 2018			x
25. Nabernegg, S., Incidence and effectiveness of national greenhouse gas mitigation policies: A macroeconomic analysis for Austrian households. International Workshop on the Economics of Climate Change and Sustainability, Bertinoro, Italy, April 2018			x
26. Steininger, K, Invited Presentation, Austria's Consumption-Based Greenhouse Gas Emissions: Identifying sectoral sources and destinations, Annual Meeting of the Austrian Economic Association, , Vienna, May 2018			x
27. Nabernegg, S., Incidence and effectiveness of national greenhouse gas mitigation policies: A macroeconomic analysis for Austrian households. Annual Meeting of the Austrian Economic Association (NOeG), Vienna, Austria, May 2018			x
28. Nabernegg, S., Incidence and effectiveness of national greenhouse gas mitigation policies: A macroeconomic analysis for Austrian households. EcoMod2018 - International Conference on Economic Modeling, Venice, Italy, July 2018			x
29. Steininger, K., Umweltkostenrechnung – Ö1, Dimensionen, 23. Juli 2018, 19:05-19:30.		x	

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