# Publishable End Report

Gilt für Studien aus der Programmlinie Forschung

## A) Project data

| Allgemeines zum Projekt | |
|---|---|
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| **Langtitel:** | Household GHG footprints and Austrian climate policy: identifying leverage points for demand-side mitigation |
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| **KoordinatorIn / ProjekteinreicherIn:** | BOKU University Wien, Dept. für Wirtschafts- und Sozialwissenschaften, Institut für Soziale Ökologie |
| **Kontaktperson Name:** | Univ. Prof. Simone Gingrich |
| **Kontaktperson Adresse:** | Schottenfeldgasse 29<br>1070 Wien |
| **Kontaktperson Telefon:** | +43 1 47654-73724 |
| **Kontaktperson E-Mail:** | simone.gingrich@boku.ac.at |
| **Projekt- und KooperationspartnerIn (inkl. Bundesland):** | Institut für Politikwissenschaft, Universität Wien, Wien, Österreich<br>Prof. David James Abson, Leuphana Universität Lüneburg, Deutschland |
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# B) Project overview

## 1 Kurzfassung

Österreich wird seine Klimaziele nicht allein über produktions- und angebotsseitige Maßnahmen erreichen. Auch nachfrageseitige Klimaschutzmaßnahmen sind notwendig, denn die Haushaltsnachfrage, z.B. nach Mobilität oder Wohnen prägt einen großen Teil der Emissionen. Auch die Nachfrage wird politisch gestaltet, allerdings haben diese Maßnahmen bisher wenig wissenschaftliche Beachtung gefunden. FOCAL-points untersuchte existierende und mögliche nachfrageseitige Beiträge zum Klimaschutz in Österreich: Mit einer verteilungssensitiven Datenbank zu Treibhausgasfußabdrücken der österreichischen Haushalte, einer mehrstufigen Politikanalyse, einem ‚Suffizienzrat' zur Prüfung der gesellschaftlichen Machbarkeit und einer Integration über das Konzept der „Hebelpunkte" („leverage points"), um Potentiale von Interventionen zu bewerten.

Die Zahlen zu den Treibhausgasfußabdrücken zeigen langsame, ungleichmäßige Fortschritte beim Klimaschutz. Der Haushaltsfußabdruck (also die Summe der Emissionen, die durch Österreichs Haushalte weltweit verursacht wurden) sank lediglich von 73 Mt CO2e im Jahr 2000 auf 67 Mt 2020, also um 8 Prozent. Haushaltsnachfrage bedingt im Schnitt 66 Prozent des gesamten konsumbasierten THG-Fußabdrucks Österreichs, den Rest verursachen beispielsweise Kapitalinvestitionen oder staatliche Ausgaben. 2020 entfielen 33 Prozent des Haushaltsfußabdruckes auf Mobilität und 26 Prozent auf Wohnen (inklusive Heizen). Direkte Emissionen durch Wohnen sanken 2000–2020 um etwa 3,4 Mt, Mobilität blieb annähernd stabil. Im Längsschnitt ist das Ungleichgewicht deutlich: 2022 lagen wohnbezogene Fußabdrücke rund 29 Prozent unter dem Wert von 1995, mobilitätsbezogene etwa 18 Prozent darüber. Die $CO_2$-Ungleichheit zwischen ärmeren und reicheren Haushalten ist dabei ausgeprägt: 2020 emittierte das reichste Dezil pro Kopf etwa 3,4-mal so viel wie das ärmste, in der Mobilität ca. 4,8-mal so viel. Von 2005 bis 2020 stieg die Ungleichheit in der Mobilität (Gini 0,46 auf 0,51) und bei Waren (0,51 auf 0,56), während sie beim Wohnen sank. Wichtige Treiber von Haushaltsemissionen neben Einkommen sind Wohnfläche pro Kopf, Autobesitz und Urlaubsreisen.

Die Politikanalyse erfasst nachfrageseitige Klimaschutzmaßnahmen von 1995–2024 und zeigt ein Ungleichgewicht sowie teilweise einen Mangel an umgesetzten Maßnahmen. Erfasst wurden 356 nachfrageseitige Maßnahmen im Bereich Verkehr und Wohnen auf EU-, Bundes- und, für Wien und Niederösterreich, auf Landesebene, davon 236 im Bereich Verkehr und 120 im Bereich Wohnen. Beim Verkehr dominieren die sogenannten Verlagerungs- (shift) und Verbesserungsmaßnahmen (improve) (64,4 bzw. 31,7 Prozent), Vermeidung (avoid) bleibt marginal (3,8 Prozent). Schwerpunkt sind die Verteuerung ineffizienter Verbrenner-PKWs, jüngst starke Impulse für Batterieelektrofahrzeuge, kombiniert mit Impulsen für öffentliche Verkehrsmittel sowie Radfahren, am konsequentesten in Wien. Die Nachfrage nach Flügen hingegen wird kaum adressiert. Gegenläufige Anreize wie Pendlerpauschale, Dieselprivileg und Firmenwagenvorteile schwächen die Wirkung. Wo Systemumgestaltung genutzt wurde, etwa kompakte Strukturen, kurze Wege und Parkraumbewirtschaftung, sanken Mobilitätsfußabdrücke stärker, wie der Vergleich Wien–Niederösterreich zeigt. Im Bereich Wohnen entfallen 55 Prozent der Maßnahmen auf Verlagerung (shift) und 38,3 Prozent auf Verbesserung (improve), Vermeidungsmaßnahmen (avoid) wie Begrenzung von Neubau oder Wohnflächenwachstum erreichen nur 6,7 Prozent. Subventionslastige Förderungen für erneuerbare Heizungen und höhere Effizienz sowie schrittweise Verbote fossiler Heizungen prägen den Mix.

Die gesellschaftliche Akzeptanz von nachfrageseitigen Klimaschutzmaßnahmen hängt von der Ausgestaltung ab. Der getestete ‚Suffizienzrat' bestätigte, dass hoch wirksame Maßnahmen wie Straßenbenutzungsgebühren besonders sensible Bereiche sind, insbesondere wenn Einnahmen nicht sichtbar rückverteilt werden und Alternativen fehlen. Breite Zustimmung gibt es etwa zur Aktivierung von Wohnungs-Leerstand, wobei sich hier THG-Einsparungen erst zeitverzögert realisieren lassen. Gestaltungsdetails können Akzeptanz schaffen: Bspw. Sanierungspflichten mit Mieterschutz und fairer Kostenaufteilung oder stufenweises Verbot von Neuzulassungen für Verbrenner im Einklang mit EU-Zeitplänen und Übergangshilfen. Als zentral angesehen wird Fairness durch Design, mit Fokus auf hoch emittierende, einkommensstarke Praktiken. Symbolische Elemente wie Werbeverbote für Fossile oder Beschränkungen für emissionsintensive Fahrzeuge können Debatten beeinflussen, wenn sie Teil glaubwürdiger Maßnahmenpakete sind.

Die Hebelpunkte-Perspektive kann dabei helfen, Potenziale im Klimaschutz sichtbar zu machen: Sowohl die Tiefe als auch die Vielfalt der Eingriffe in Zielbereiche oder -systeme ist entscheidend, nicht nur die reine Anzahl an Maßnahmen. Wo neben Preisen/Standards auch Rückkopplungseffekte, Systemstrukturen und Ziele verändert werden, sinken THG-Fußabdrücke deutlicher und dauerhaft. Im Bereich Wohnen korrelieren Effizienz, technischer Austausch und Regulierung, etwa Heizungsverbote, mit klaren Rückgängen. Im Verkehr fehlen solche tiefen Hebel häufiger, entsprechend bleiben Mobilitätsfußabdrücke hartnäckig hoch. Der Kontrast Wien–Niederösterreich belegt die große Wirkung von Raumordnung und integrierter Verkehrspolitik als Systemhebel. Dort, wo Interventionen diverse und auch tiefere Hebelpunkte adressieren, insbesondere beim Wohnen und im Wiener Verkehrsbereich, sinken THG-Haushaltsfußabdrücke schneller. Wo Maßnahmen oberflächlich, fragmentiert oder ungerecht bleiben, stockt der Fortschritt und die CO2-Ungleichheit wächst. FOCAL-points liefert Zahlen, Politikevidenz und Co-Design-Formate, um wirksame Ansätze zu skalieren und Suffizienzlücken mit fairen Maßnahmen zu schließen. Damit stellt es Informationen für nachfrageseitigen Klimaschutz bereit, der effektiv und zugleich sozial gerecht ist.

# 2 Executive Summary

Austria will not meet its climate targets with supply-side fixes alone. Household demand for mobility and housing/heating drives a large share of emissions, and these patterns are shaped by infrastructures, rules and social norms that policy can change. The project set out to make demand-side mitigation tangible, fair and politically workable by grounding it in a distribution-sensitive database of household greenhouse gas footprints, by mapping real policy mixes across levels of governance, by testing social feasibility through a ‘Sufficiency Council’, and by integrating results with a leverage points lens to assess policy depth and diversity.

The quantitative backbone shows slow, uneven progress. Household footprints fell only from 73 Mt CO2e in 2000 to 67 Mt in 2020, an 8 percent decline, while households consistently accounted for about two thirds of Austria’s consumption-based footprint, on average 66 percent. Within household emissions, mobility and housing and heating dominate. In 2020 mobility made up 33 percent and housing and heating 26 percent. Direct emissions from housing and heating dropped by about 3.4 Mt between 2000 and 2020, but mobility remained stubborn. Over a longer horizon the imbalance is stark. By 2022, housing-related household footprints were about 29 percent below 1995, while mobility-related footprints were still roughly 18 percent above 1995 and had grown in share from 26.5 percent to 33 percent.

Carbon inequality is pronounced and persistent. In 2020 the richest income decile emitted about 3.4 times more per person than the poorest. Gaps are widest in mobility, about 4.8 versus 1.0 t CO2e per capita. From 2005 to 2020, inequality increased within mobility, Gini 0.46 to 0.51, and goods, 0.51 to 0.56, while it declined in housing and heating. Income matters, but so do floor space per capita, car ownership and vacations.

Policy mapping across 1995 to 2024 reveals imbalance and partly absence of measures. The project identified 356 demand-side measures in transport and housing at EU, federal and provincial levels, 236 in transport and 120 in housing. Shift and improve options dominate, avoid options remain marginal. In transport, 64.4 percent of measures are shift and 31.7 percent improve, while only 3.8 percent are classified avoid measures. Private cars are the primary focus, with a long trajectory of making inefficient combustion engines more expensive and, recently, strong incentives for battery electric vehicles, alongside push and pull packages for public transport and cycling that are most consistent in Vienna. Air travel demand is barely addressed.

In housing, 55 percent of measures are shift and 38.3 percent improve. Subsidy-heavy support for renewable heating and energy efficiency is complemented by progressive bans on fossil heating systems, while avoid options such as limiting new construction or curbing dwelling size growth make up only 6.7 percent. Economic instruments and subsidy regimes are prominent and often more accessible to high-income households. Countervailing incentives, the commuter allowance, diesel tax privileges and company car benefits, blunt the steering effect. Where system design levers were engaged, compact form with short distances and consistent parking management, household mobility footprints fell more decisively, as seen in Vienna compared with Lower Austria.

Social feasibility hinges on careful design. The ‘Sufficiency Council’, tested in the stakeholder interaction phase, confirmed a common trade-off. Measures with high mitigation potential, such as road pricing, are seen as socially risky unless revenues are visibly recycled and high-quality alternatives are guaranteed. Measures like vacancy activation enjoy broad support despite smaller immediate savings. Several measures occupy a middle ground where design reconciles effectiveness and acceptance, for example speed limits framed as safety and health, renovation obligations that protect tenants through rent caps and fair cost sharing, and a phased ban on new internal combustion engine registrations aligned with EU timelines and coupled with transition support. Participants repeatedly stressed fairness by design, concentrating burdens on high-emitting, higher-income practices, and framed climate policy as delivering reliable services, security and time prosperity within planetary boundaries. Symbols, such as bans on fossil advertising or registrations for extremely high-emitting vehicles, can shift discourse when embedded in substantive packages.

A leverage points perspective helps explain why housing progressed while transport lagged. Coding policies for the leverage points addressed indicates that policy depth and diversity matter more than the number of measures. Where parameters and feedbacks are adjusted, and system structures and goals shift, footprints fall more and stay down. In housing, combinations of improved heating efficiency, technological substitution and regulatory steps such as fossil heating bans correspond with clearer declines. In transport, deeper leverage points are less evident, which aligns with stubbornly high mobility footprints. The Vienna and Lower Austria contrast underlines that spatial planning and integrated transport policy function as system design levers with outsized effects.

Where interventions have been more diverse in terms of leverage points addressed, most visibly in housing and in Vienna’s transport and planning, household GHG footprints have decreased faster. Where measures remained shallow, fragmented or inequitable, progress stalled and carbon inequality partly increased. FOCAL-points provides the numbers, policy evidence and co-production formats needed to scale what works, close gaps with sufficiency-oriented measures designed for fairness, and keep the focus on everyday life.

# 3 Background and objectives

Austria has set ambitious climate targets, including net zero by 2040, yet recent inventories and footprint accounts indicate that absolute emission reductions remain insufficient to meet these goals. While supply-side measures and technological improvements are essential, the services that households demand in mobility and housing, including heating, still drive a large share of emissions through domestic and international supply chains. International assessments have highlighted the mitigation potential of demand-side options that avoid, shift and improve consumption. However, Austria lacked an integrated empirical basis to understand how household consumption-based emissions are distributed and have changed over time, how existing policies have addressed demand, and how socially feasible sufficiency-oriented measures could be designed. This gap hampers targeted, fair and politically feasible climate change mitigation policy.

Three shortcomings motivated FOCAL-points. First, Austria did not have a high-resolution, longitudinal database of household GHG footprints linked to detailed household characteristics. Available studies pointed to unequal carbon footprints and large contributions from mobility and housing, but they covered single years or lacked product-group detail and distributional analysis over time. Without such evidence, it is difficult to prioritize interventions, assess equity implications, or monitor progress in ways that are relevant for policy and public debate.

Second, although the policy debate increasingly acknowledges demand-side climate-change mitigation, there was no systematic mapping of implemented demand-side climate policies in Austria across levels of governance and over time. Fragmented evidence suggested that policy mixes were skewed towards efficiency and technological substitution, with avoid options underused, and that some fiscal and regulatory instruments ran counter to climate objectives. However, a consistent inventory and classification of policies by sector, target and instrument was missing, which limited the ability to identify gaps, assess coherence and learn from effective combinations.

Third, social acceptance emerged as a decisive bottleneck. Measures that could reduce GHG-intensive demand, such as parking management, speed limits or restrictions on high-emitting practices, are often perceived as unpopular or unfair. Conversely, subsidies and incentives can be socially selective and risk backlash if costs and benefits are distributed inequitably. There was a need to bring scientific evidence and stakeholder experience together to test which measures can be designed to be both effective and fair, to identify narratives that build support, and to surface design principles that do not disadvantage vulnerable groups.

Against this background, FOCAL-points pursued a clear objective: to identify feasible and effective leverage points for demand-side climate mitigation in Austria’s transport and housing sectors by combining quantitative evidence, policy analysis and stakeholder co-production within a coherent systems perspective. The project framed demand-side mitigation not as a set of individual lifestyle choices but as the outcome of provisioning systems, infrastructures, rules and norms that can be shaped by policy.

The tasks followed from this objective. The first was to establish a novel, comprehensive database of household GHG footprints from 2000 to 2020, aligned with Austria's official emission accounts and disaggregated by consumption category, income group and selected socio-economic characteristics. This required integrating environmentally extended input–output (EEIO) modelling with household budget surveys (HBS) and microcensus data on direct energy use in households, and then analysing trends, inequality and determinants at national and regional scales.

The second task was to conduct a multilevel policy analysis of demand-side mitigation in transport and housing from 1995 to 2024. The project compiled and coded policies and major public investment decisions at the EU, federal and provincial levels (with a focus on Vienna and Lower Austria), classified them by avoid, shift and improve options, by policy target and instrument, and validated the corpus through interviews with policy makers and peer feedback. This established what has actually been tried and implemented in Austria's demand-side policy space and how it evolved.

The third task was to co-produce knowledge with stakeholders involved in and affected by demand-side policies. Building on a pilot at the BOKU Sustainability Day, the project designed and ran a full-day "Sufficiency Council" that brought together environmental NGOs, social NGOs, governance actors, labour representatives and housing practitioners. Grounded in the evidence from the footprint analysis and the policy mapping, participants assessed a set of representative measures for their mitigation potential, social compatibility and redesign options. This process aimed to identify where and how sufficiency can be organised in ways that are democratically and socially acceptable.

The fourth task was to integrate these strands through a systems lens. The project operationalised the leverage points framework to code the "depth" and "breadth" of policy interventions along the "leverage points scale". This scale discerns "shallower" interventions, addressing parameters and feedbacks, from "deeper" interventions into system structures and goals. Relating the evidence from this policy mapping to the observed household footprint trends at national and provincial levels enabled the identification of blind spots for future effective policy interventions.

In sum, FOCAL-points addressed a clear need in Austria's climate policy landscape: to make demand-side climate-change mitigation empirically visible, politically intelligible and socially workable. By building a distribution-sensitive footprint database, mapping and classifying implemented policies, testing social feasibility in a structured dialogue, and integrating results through a systems perspective on leverage points, the project delivered actionable insights on where and how Austria can reduce household emissions in transport and housing while maintaining public support.

# 4 Project Content and Results

## WP1: Modelling and analysis of Austrian household GHG footprints

Completed tasks:

1.1 "Modelling of Austrian household GHG footprints"
1.2 "Analysis of patterns and trends in household GHG footprints and their drivers"
1.3 "Identification of GHG hotspots in focal sectors and areas"

Key publication:

Dorninger, C., Gingrich, S., Haas, W., Brad, A., Schneider, E., & Wiedenhofer, D. (2025). Slow and unequal reduction in Austrian household GHG footprints between 2000 and 2020. *Journal of Industrial Ecology*, *29*(5), 1651-1665. https://doi.org/10.1111/jiec.70074

In Dorninger et al. (2025) we quantify how Austrian household GHG footprints evolved between 2000 and 2020, how footprints are distributed across income groups and product groups, and which socio-economic factors explain per-capita differences. The study builds a high resolution, distribution sensitive database that aligns household consumption with global supply chain emissions and the official Austrian GHG inventory. The evidence shows a slow aggregate decline of household footprints, a persistent and partly rising carbon inequality concentrated in mobility and goods, and strong roles for floor space per capita, car ownership, vacations, and household size beyond income.

Empirically, we combine three pillars: a multi-regional input-output model, five Household Budget Survey (HBS) waves, and official national GHG inventory data. EXIOBASE v3.8.2 (Stadler et al., 2018) is used to capture direct and indirect supply chain emissions attributable to Austrian final demand, while the Austrian environmental extensions in EXIOBASE are replaced with Environment Agency Austria and Statistics Austria inventory data (Anderl et al., 2024) under the residence principle to ensure consistency with national accounting for six greenhouse gases converted with AR6 GWP100 factors (IPCC, 2023, 2021). Five HBS waves covering 6,000 to 8,000 households each are harmonized to a common 108 item expenditure classification (COICOP) and then aggregated to five product groups: food, mobility, housing and heating, services, and goods. Direct household emissions for mobility and heating are allocated to households proportionally to recorded expenditures using microcensus energy use data.

The household footprint is calculated with standard environmentally extended input-output analysis. Let $\boldsymbol{Y}$ be final demand, $f$ be the greenhouse gas satellite accounts, $\boldsymbol{A}$ be the technology matrix, $\boldsymbol{I}$ be the identity matrix, and $\boldsymbol{L} = (\boldsymbol{I} - \boldsymbol{A})^{-1}$ the Leontief inverse. The total footprint is $f\boldsymbol{LY}$. For Austrian households specifically, $GHG\ footprint_{hh} = f\boldsymbol{LY}_{hh}$, where $\boldsymbol{Y}_{hh}$ is the final demand vector of private households (Lenzen et al., 2012; Leontief, 1936; Miller and Blair, 2009). Household level footprints are obtained by multiplying harmonized household expenditures with a concordance matrix that links to EXIOBASE product groups and allocating the resulting category footprints back to each household. Inequality is quantified with Lorenz curves and Gini coefficients for 2005, 2010, 2015, and 2020 using survey weights . Drivers are assessed with weighted multiple linear regressions of log per capita footprints on eight predictors: residence ownership, population density class, number of cars owned, household size, number of vacations per year, heating system, income per capita (log), and floor space per capita (log). Standardized coefficients facilitate comparison, and robust standard errors address heteroscedasticity (Behrendt, 2023; R Core Team, 2023; Signorell, 2024; Zeileis, 2004; Zeileis et al., 2020).

From 1995 to 2022, the national consumption-based footprint stayed far above residence principle production-based emissions and declined only modestly. It peaked at 123 Mt CO2e per year in 2005 to 2006 and reached 109 Mt in 2022, an 11 percent decline from the peak, but only 2 percent below 1995. On average, households induced 66 percent of the national consumption-based footprint, while capital investments contributed 23 percent, government expenditures 8 percent, non-profits 2 percent, and inventories 1 percent. Household footprints fell by 7 percent from 77 Mt in 1995 to 72 Mt in 2022. Within household footprints, 56 percent on average originated within Austria when direct and indirect sources are combined. Direct household emissions from fuels for mobility and heating averaged 17 Mt per year, about 23 percent of household footprints, and fell from 19 Mt in 2005 to 15 Mt in 2014, and then plateaued. Emissions embodied in imports from other EU countries and extra EU sources were relatively stable with slight increases after 2016 (Figure 1).

The five survey waves show a slow decline in household footprints from 73 Mt CO2e in 2000 to 67 Mt in 2020, a reduction by 8 percent. In 2020, mobility was the largest component at 33 percent or about 22 Mt, followed by housing and heating at 26 percent or about 17.7 Mt, and food and beverages at 17 percent or about 11.1 Mt. The largest absolute reduction from 2000 to 2020 was in direct housing and heating emissions, down by about 3.4 Mt. Other components saw small declines or increases. The top income quintile consistently induced more emissions than the bottom two quintiles combined. The ratio of the top to bottom quintile increased from 2.2 in 2000 to 2.7 in 2020 because the lowest quintile's absolute reduction was the largest.

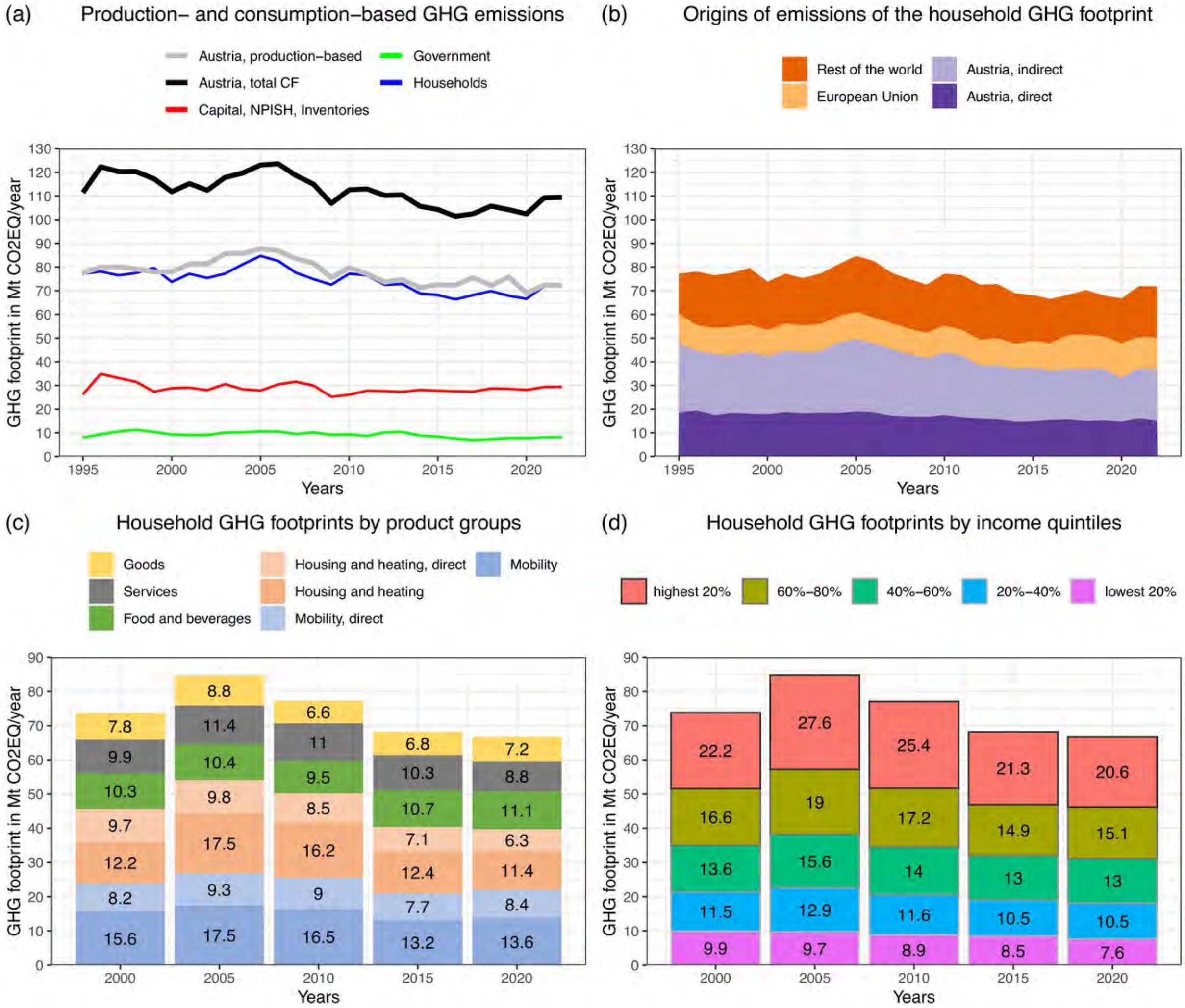


**Figure 1:** The development of Austrian GHG footprints from 1995 to 2022. Panel (a) shows the Austrian GHG footprint in total and split by final demand category, as well as the territorial emissions at residence principle; (b) differentiates the GHG footprint of households per year according to the origin of emissions; (c) shows product group composition of the GHG footprint of households for the 5 years for which we can distinguish individual household shares; (d) illustrates the same GHG footprints but broken down by shares of household per capita income groups (quintiles).

Per capita household footprints correlate positively with income in every survey wave, but dispersion within deciles is large. In the top decile the median ranges between 13 and 18 t $CO_2$e per year, yet some top decile households have footprints near lower decile medians below 5 t. In 2000, mobility and housing and heating dominated in every decile and were highly unequal. Mobility ranged from 1.8 t to 5.0 t per capita across deciles, a factor of 2.8. Housing and heating ranged from 1.3 t to 4.9 t per capita, a factor of 3.8. Goods and services also showed inequality, while food was most evenly distributed. In 2005, inequality widened. The top decile reached 20 t per capita while the lowest decile was 5.7 t per capita, an increase in the ratio from 2.8 in 2000 to 3.5 in 2005, with growth driven by mobility and services. Between 2005 and 2015, average per capita footprints decreased by roughly 11 to 12 percent across deciles, and the inequality ratio fell to 3.0 as housing and heating footprints declined for high income households. In 2020, overall per capita footprints were slightly lower than in 2015, but the top to bottom ratio rose again to 3.4. Mobility inequality widened from a factor of 3.9 to 4.7, about 1.0 t versus 4.8 t per capita for the lowest and highest decile respectively, while housing and heating inequality increased only slightly. Notably, from the 2005 peak to 2020, the top decile reduced its per capita footprint by almost 7 t in absolute terms (Figure 2).

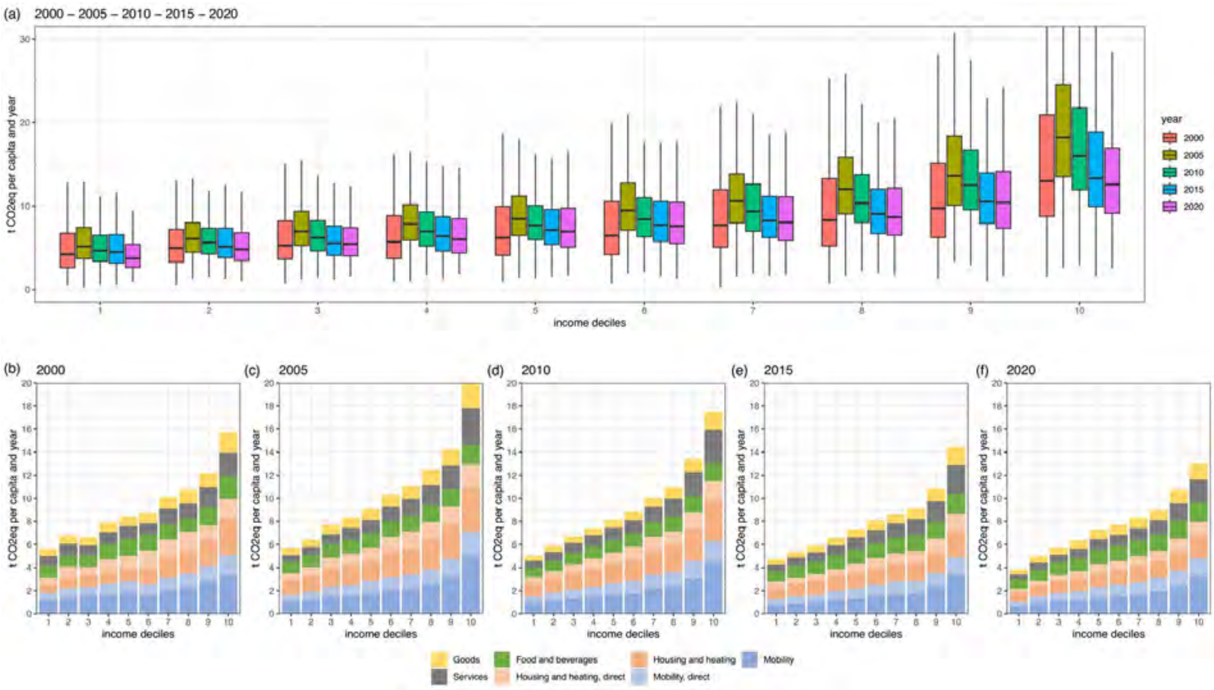


**Figure 2:** Distributions of per capita GHG household footprints across income deciles in Austria. (a) Boxplots of the GHG footprint of household income deciles for every 5 years between 2000 and 2020 next to each other (the y-axis is limited to 30 t CO2eq per capita and year; outliers are not shown); (b–f) the average GHG footprint per capita for income deciles as stacked bar plots of product groups for the years 2000, 2005, 2010, 2015, and 2020, respectively. Note that there are slight deviations when comparing the median and distribution from (a) with the aggregate means of (b)–(f) because for the latter all footprints for each decile and product group have first been aggregated and then divided by the total weighted population of each decile, whereas for (a), to keep the necessary variance in the dataset for the boxplots, the division by weighted population took place at the household level.

Despite strong absolute reduction in the household footprints of the top decile since 2005, overall household footprint inequality remained relatively stable. Gini coefficients increased from 0.32 in 2005 to 0.33 in 2020, similar to the stability of income inequality in the same data (0.31 to 0.33). Inequality within product groups diverged. The Gini for mobility increased from 0.46 to 0.51 and for goods from 0.51 to 0.56 between 2005 and 2020, levels commonly interpreted as severe inequality, while the Gini for housing and heating declined and food and services stayed nearly constant. The slight increase in overall carbon inequality is therefore driven by those categories that were already most unequal in 2005, namely mobility and goods (World Bank, 2022) (Figure 3).

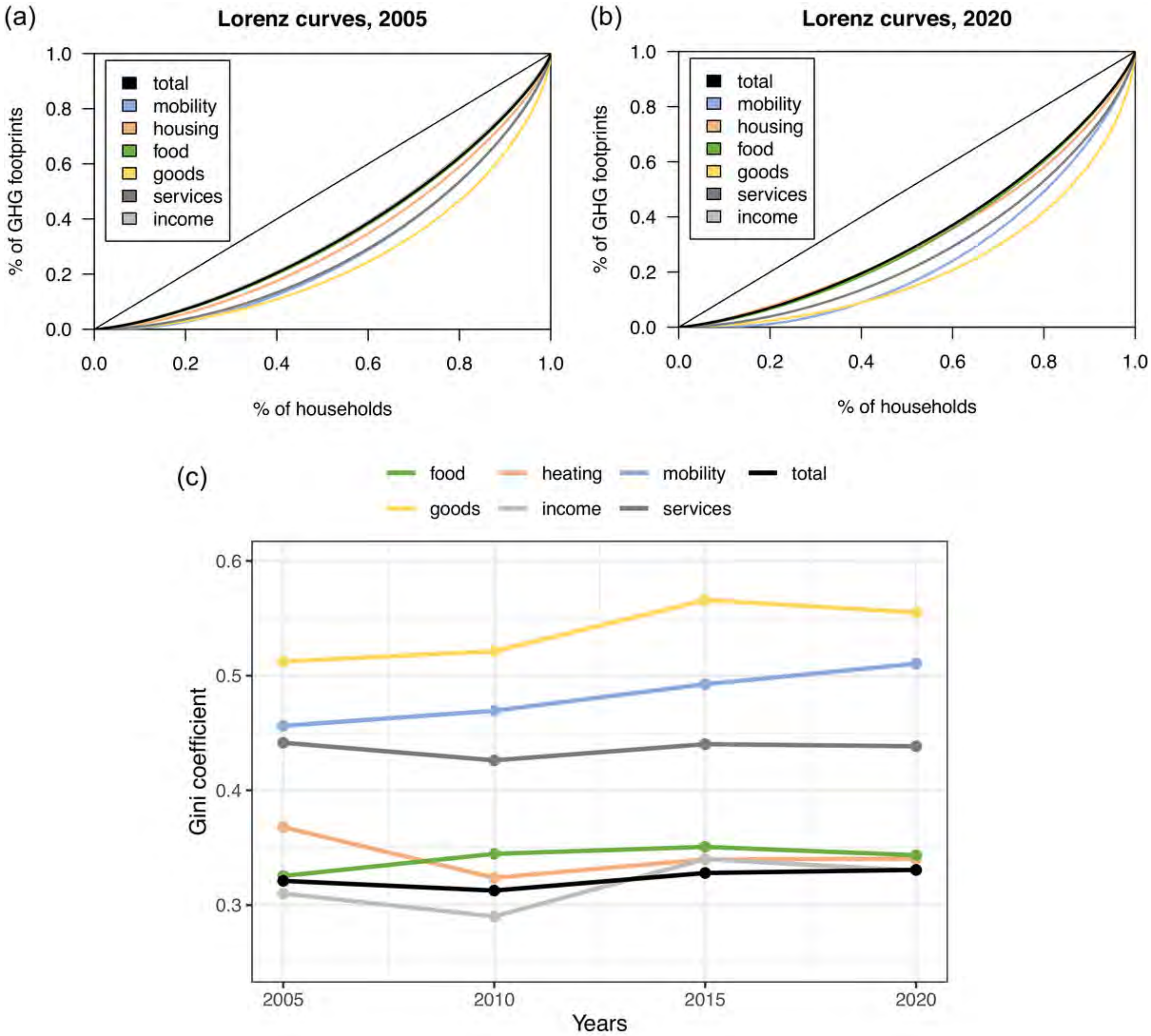


**Figure 3**: Inequality of GHG footprints associated with household consumption in Austria, 2005–2020. (a,b) Lorenz curves of the distribution of GHG footprints across the population of households for each product group, in total, and for household income in 2005 (a) and 2020 (b); (c) the development of the corresponding Gini coefficients for the years 2005, 2010, 2015, and 2020, which are also listed in (d).

The correlation between population density and per capita footprints was insignificant and changed over time (Figures 4a and 4b). In 2005 households in high density areas showed higher per capita footprints than those in medium and low-density areas mainly due to indirect emissions, despite lower direct emissions. By 2020, urban households had slightly lower per capita footprints than semi urban or rural households, but the differences were not statistically significant. Across federal states, temporal changes were stronger than spatial differences at a given point in time. Vienna had the highest per capita footprint in 2005 at 11.6 t due to high indirect mobility and housing and heating emissions, yet reduced to 7.0 t by 2020, the largest decline among states at about 40 percent, while Carinthia declined by about 15 percent. Vienna had the lowest direct emissions from mobility and heating in both 2005 and 2020 and also differs in household attributes such as lower car ownership and smaller floor space per person. These patterns indicate that governance choices, infrastructure, and provisioning systems can shift consumption-based outcomes even where jurisdiction over production-based emissions is limited (Figure 4).

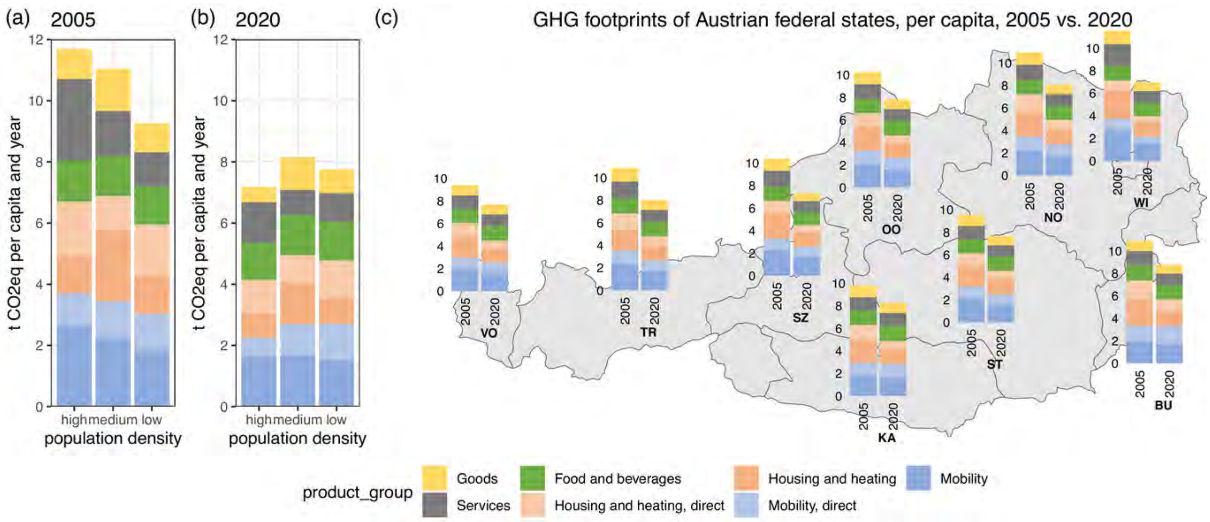


**Figure 4**: Regional variation of GHG household footprints per capita in Austria, comparing 2005 and 2020. (a,b) Per capita household GHG footprints for three different types of population density in 2005 and 2020, respectively. (c) A map of Austria and its federal states with footprints for 2005 and 2020 plotted on them. VO, Vorarlberg; TR, Tyrol; SZ, Salzburg; OO, Upper Austria; KA, Carinthia; ST, Styria; NO, Lower Austria; WI, Vienna; BU, Burgenland.

For the total population in 2005, income per capita, number of cars, household size with a negative sign, heating system (especially gas and oil), floor space per capita, and vacations per year were significant predictors of per capita footprints, with adjusted R squared of 0.55. Population density and residence ownership were weak or insignificant. In 2020, income per capita, floor space per capita, and household size remained the largest contributors, with number of cars and vacations also significant. Population density explained little and was not significant. Within income quintiles, income per capita naturally loses explanatory power due to reduced variance, which reveals other determinants. In the top income quintile in 2005, heating system, number of cars, household size, vacations, and floor space per capita were more decisive than income, and in 2020 floor space, household size, vacations, and cars continued to explain variance, while heating system mattered less than in 2005. In the bottom income quintile in 2020, floor space per capita was the strongest predictor, followed by number of cars and household size. Heating system, population density, and residence type were not significant for this group. Across the multiple regression models employed, the number of vacations per year was a consistent positive correlate of per capita footprints, and household size consistently reduced per capita footprints. These results identify levers that are not reducible to income alone. Reducing car ownership and use, high frequency travel, and average floor space per person would reduce footprints across income groups, and especially in higher income groups where these correlations are strongest.

Aligning household microdata with an MRIO model anchored to the national inventory produces a robust picture of slow aggregate progress and deep distributional heterogeneity. By 2020, Austrian household footprints remain dominated by mobility and housing and heating, with the former both large and increasingly unequal. From 2000 to 2020, the largest absolute reduction occurred in direct housing and heating emissions. Carbon inequality is persistent in aggregate and increases within mobility and goods, while declines within housing and heating and stability in food and services indicate that subsistence-oriented categories are less unequal. Within group regressions show that floor space per capita, car ownership, vacations, and household size help explain per capita footprints beyond income, and that differences across federal states correlate with governance and infrastructural choices rather than with population density alone. The database and methods support ongoing monitoring of per capita footprints by product group and socio-economic group, enabling policies that target the most stubborn categories and drivers and that evaluate distributional outcomes over time.

## WP2: Policy analysis of demand-side climate policies in Austria

Completed Tasks:

2.1 "Identify relevant policies and public investment programs and compile policy data"

2.2 "Systematic coding and classification of policies and public investment programs"

2.3 "Identify trajectories of demand-side mitigation policy"

Key publication:

Existing demand-side climate change mitigation policies neglect avoid options. Summary of Brad, A., Schneider, E., Dorninger, C., Haas, W., Hirt, C., Wiedenhofer, D., Gingrich, S. (2025), Communications Earth & Environment 6, 773. https://doi.org/10.1038/s43247-025-02800-5

In Brad et al., (2025) we mapped demand-side policy longitudinally to assess how implemented measures co-evolved with household GHG footprint trajectories. Policies and public infrastructure investment decisions are included if they aimed to influence household investments, consumption, or behaviour in ways that reduce household GHG emissions in transport and housing. The time frame starts in 1995 to match the availability of EXIOBASE data and the emergence of EU climate policy as a distinct field. A multilevel perspective captures EU regulations and directives, federal Austrian policies, and provincial policies in Vienna and Lower Austria, chosen due to their population size and contrasting urban-peri urban profiles with associated differences in tenure, settlement patterns, and mobility.

Policy identification and coding used seven complementary strategies: (1) a systematic literature review in Scopus and Google Scholar, (2) targeted web searches for policy texts and time spans, (3) systematic screening of ministry and provincial websites and press releases, (4) backward tracing of measures mentioned in policy documents, (5) four semi-structured interviews with federal and Vienna officials to validate and fill gaps, (6) presentation and feedback at a stakeholder workshop with policy makers and NGOs, and (7) two rounds of peer feedback from the Austrian climate policy research community. This triangulation yielded 356 policies in total, 236 in transport and 120 in housing.

Policies were coded along three dimensions: the policy target, the type of instrument, and the ASI category, using an operationalization of the established ASI framework that distinguishes improve, shift, and avoid options in both sectors. To retain fidelity to the diversity of policy mixes, multi-target and multi-instrument policies received multiple codes. Subsidy schemes were counted as one policy across years unless there was a substantial expansion, information campaigns were counted as one policy for repeated waves, and strategies and plans were included and coded as such if no implementable measures could be verified. Transport policies were classified as avoid if they primarily reduced or avoided mobility demand, as shift if they promoted transitions away from private car use to public transport, cycling, walking, or car sharing, and as improve if they increased vehicle efficiency or adoption of electric cars. Housing policies were classified as avoid when reducing service demand through passive building, behavioural energy saving, avoiding new construction, or aligning dwelling size with household size; as shift when supporting access to or switching to renewable energy; and as improve when raising energy efficiency of buildings and appliances. Instrument types were coded based on their mechanism of action on household choices: for example, parking management was coded as economic because it changes the user cost of car trips.

To mitigate the fact that counting policies compares measures of different scope and potency, the study complemented the policy mapping with semi-structured interviews, an expert survey among peer researchers, and stakeholder engagement to identify more and less consequential measures and to inform interpretation of results and the selection of illustrative policies in figures (Ejelöv et al., 2022; Rogge et al., 2017). Household GHG footprints used were calculated in Dorninger et al., (2025) through environmentally extended input–output analysis based on EXIOBASE v3.8.2 with Austrian production-based GHG accounts replaced by official residence-principle inventory data from Statistics Austria and the Environment Agency Austria.

Across the 356 policies, improve and shift measures dominate while avoid measures are rare. In transport, 64.4 percent of measures aim at shifting modes and 31.7 percent at improving vehicle or driving efficiency. Only 3.8 percent aim at avoiding travel demand. In housing, the skew is similar: 55 percent shift and 38.3 percent improve versus 6.7 percent avoid. The instrument mix in both sectors is heavily economic, especially in transport where parking charges, taxes, and subsidies are prominent. The transport policy focus is on private cars, which are targeted by 47.4 percent of all transport measures. Early improve measures raised the relative cost of inefficient internal combustion engine cars by adjusting fuel taxes, adding $CO_2$ components into the registration tax, and calibrating insurance taxation to engine performance. From the mid-2010s onward, improve measures increasingly encouraged battery electric vehicles through purchase premia, tax exemptions, regulatory privileges, and deployment of charging infrastructure. Shift measures in transport frequently aimed at disincentivizing private car use, exemplified by Vienna's phased introduction and expansion of short-term parking zones and fees since 1995, and at incentivizing alternatives via investments in public transport, cycling, and park and ride facilities, cargo e-bike subsidies, and the 365-Euro annual public transport ticket in Vienna. Since 2021, the KlimaTicket introduced a nationwide flat-rate public transport ticket. Avoid measures in transport are conspicuously scarce and are often programmatic rather than operational, for example, declarations to explore reducing mobility needs through spatial planning or teleworking. Only four demand-side climate policies were identified that directly address air travel. Policies specifically increasing long-distance rail attractiveness beyond urban public transport are few, although some investments were identified (Figure 5).

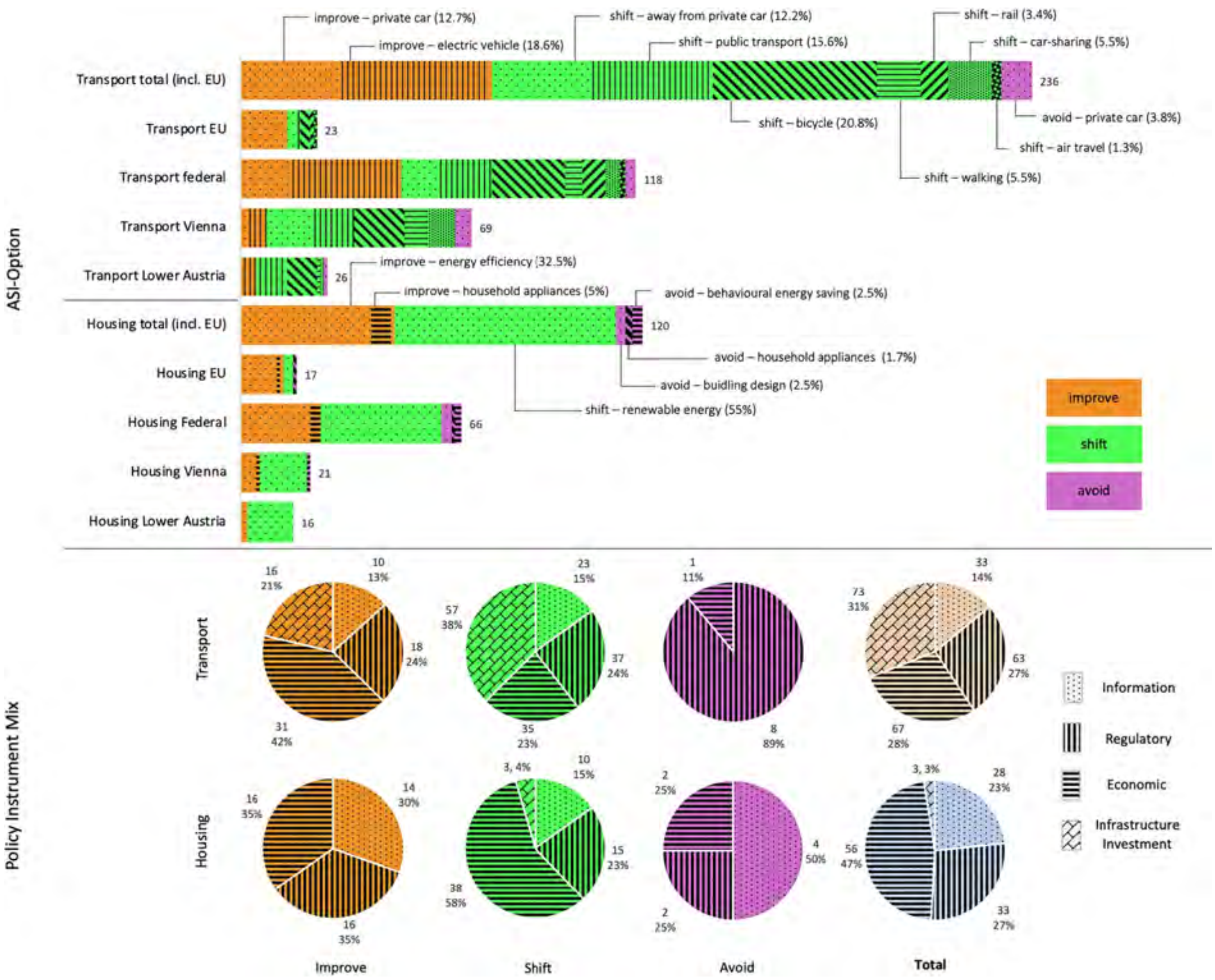


**Figure 5:** Policies are categorized based on the avoid-shift-improve framework and policy target addressed (upper part), and policy instrument type for different demand-side options and the total policy mix (lower part).

The housing policy mix also leans toward shift and improve. Shift is dominated by subsidy-heavy support for photovoltaic systems, solar thermal, heat pumps, and biomass heating, often reissued annually in the mid to late 2000s and later. Progressive prohibitions on fossil heating systems started with coal and oil and have more recently encompassed natural gas. Regulations and enabling measures, such as building standards, energy performance certificates, and streamlining aim at easing renewable heating uptake, reinforcing shifting. Improve measures focus on efficiency upgrades via EU and federal building codes and appliance information campaigns. Avoid measures are the least represented and are typically limited to energy-saving awareness campaigns or promotion of passive houses through standards and subsidies. Newer avoid measures include repair incentives introduced since 2022. No measures were found that directly target avoiding new construction. This omission is notable given evidence about embodied emissions in construction materials and the mitigation potential of right-sizing dwelling space and reusing existing stock (Cohen, 2021; Huebner and Shipworth, 2017; Novy et al., 2024).

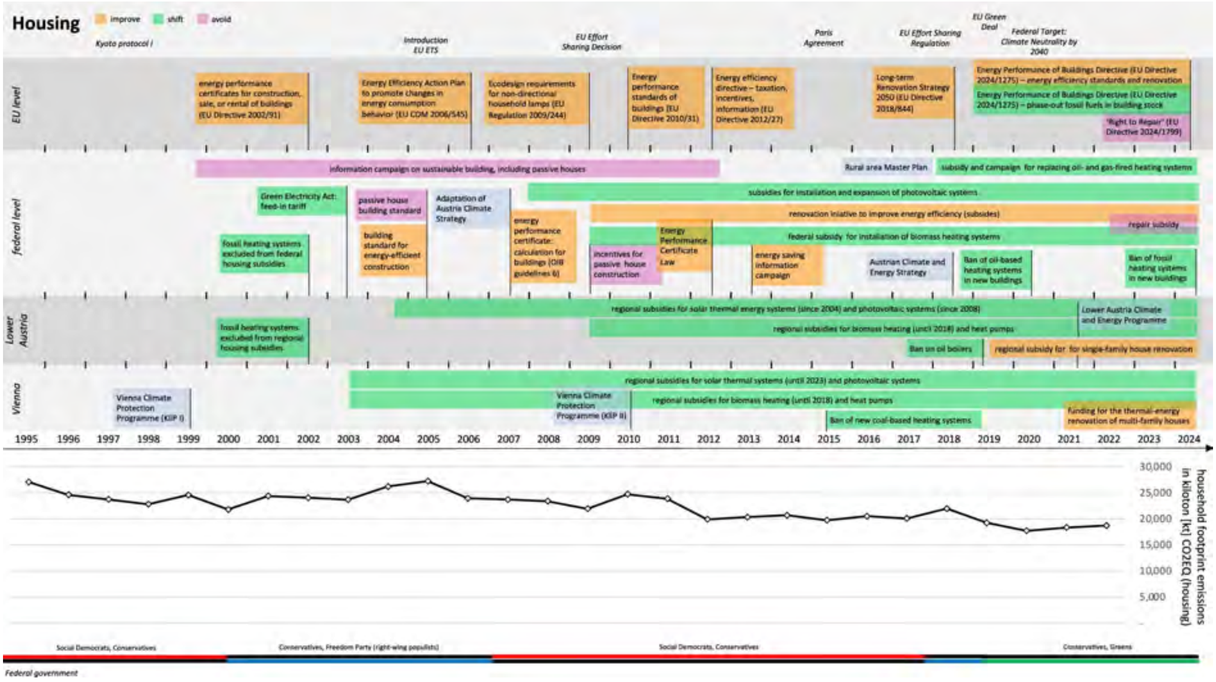


**Figure 6:** The upper part presents selected demand-side policies. Note that many policies included in the policy dataset are contained in strategy documents and are not displayed individually here. Strategies containing multiple demand-side measures are shown in light grey, i.e., not assigned to the avoid, shift, or improve colour code. The lower part shows the development of the household GHG footprint emission in the housing sector, including direct and indirect GHG emissions. Data are based on own calculations using EXIOBASEv.3.8.2 and data from the Environment Agency Austria.

Figure 6 and Figure 7 overlay representative policies with household GHG footprint trajectories for transport and housing. Mobility-related household footprints in 2022 were still 17.6 percent above 1995, despite a dense policy mix in transport. Housing-related household footprints fell 29.4 percent below 1995, with direct housing-related emissions down 33.6 percent and the direct share of the household footprint falling from 13.1 percent of total household footprints in 1995 to 9.3 percent in 2022. The share of mobility, by contrast, rose from 26.5 percent in 1995 to 33 percent in 2022. In housing, shift and improve measures that enable and require renewable heating and higher efficiency appear to have translated into consistent declines, even in the presence of some counterproductive subsidies, for example past industry-funded oil heating support. In transport, the dominance of car-focused shift and improve measures, together with countervailing incentives and gaps in avoid measures, is consistent with stubborn mobility footprints.

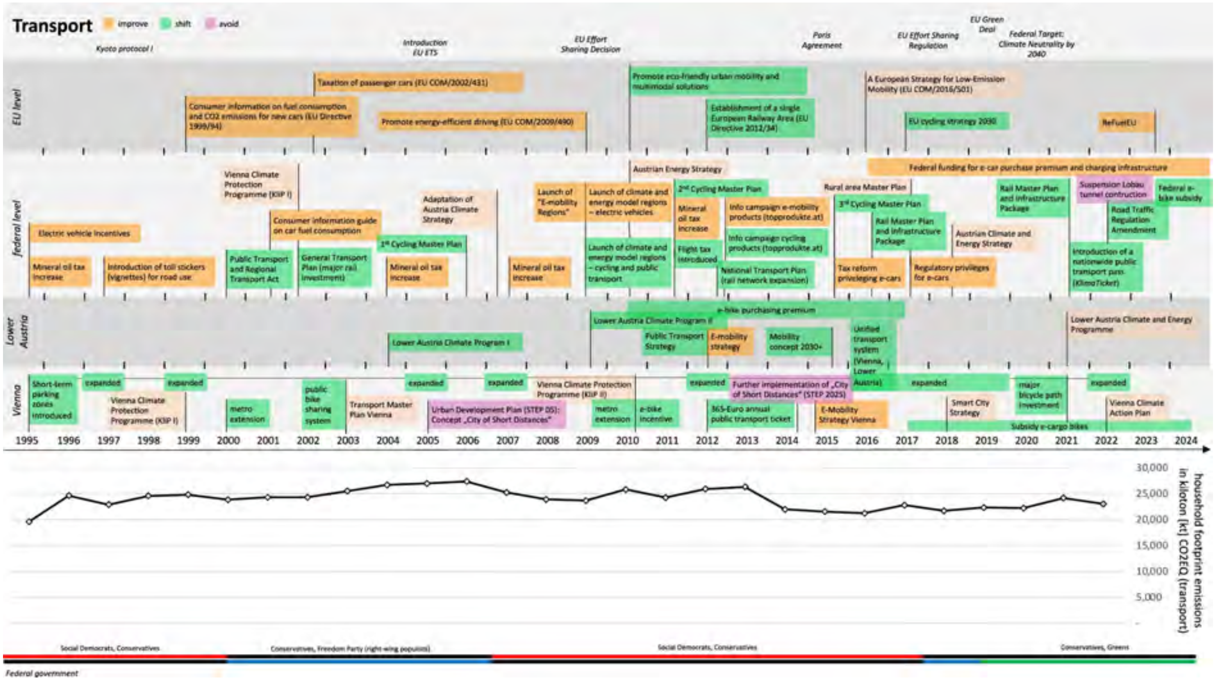


**Figure 7:** The upper part presents selected demand-side policies. Note that many policies included in the policy dataset are contained in strategy documents and are not displayed individually here. Strategies containing multiple demand-side measures are shown in light beige, i.e., not assigned to the avoid, shift, or improve color code. The lower part shows the development of the household GHG footprint emission in the transport sector, including direct and indirect GHG emissions. Data are based on own calculations using EXIOBASEv.3.8.2 and data from the Environment Agency Austria.

Countervailing incentives and multilevel dynamics help explain these patterns. The authors document persistent economic incentives that blunt the steering effects of demand-side policy, notably the commuter allowance design, diesel tax advantage, and tax benefits for company cars, which distort mode and vehicle choices and partly neutralize car cost signals (Kletzan-Slamanig et al., 2022; Niedertscheider et al., 2018). Spatial planning competencies fragmented across levels have promoted dispersed settlement patterns outside Vienna, reinforcing car dependence and long trip distances. Vienna is a partial exception where an explicit compact city strategy, integrated into planning over decades, promoted mixed-use districts and short distances, and was combined with push and pull policies for modal shift. This multilevel context is reflected in the provincial contrast between Vienna and Lower Austria and mirrors household footprint evidence that Vienna achieved stronger reductions in per-capita household mobility and housing emissions than other states, even as commuter inflows from other states increased (Brenner et al., 2024).

Political drivers also influenced the timing and form of measures. Interview evidence suggests that EU-level policies, including binding targets and sanctions under the Effort Sharing Decision since 2009, were pivotal in prompting national and provincial subsidy schemes in the housing sector and other demand-side measures. Subsidy-centric shifts allowed Austrian policy makers to meet EU obligations while avoiding more contested regulatory or avoid-focused measures in a corporatist and federalist political setting where consensus-building is the norm. The national climate ambition uplift since 2019 led to a significant expansion of demand-side subsidies, which was cut back in early 2025 during a fiscal consolidation. This pattern of subsidy-led policy adds to exposure to distributional critiques because households with higher incomes access capital-intensive shift and improve measures more readily, particularly for electric vehicles and renewable heating, while lower-income rural households may face higher costs for emission-intensive practices without viable alternatives (Lichtenberger et al., 2024).

The systematic neglect of avoid options, especially in transport, is inconsistent with the mitigation potential of demand reductions identified in the literature and evident in Austria's household footprint trends where mobility remains both large and persistent. High income elasticity of mobility demand and documented carbon inequality in Austria point to avoid measures that concentrate on high-emitting practices among affluent households, for example frequent-flyer levies, short-haul and private jet flight restrictions, or performance-based taxation on high-power vehicles, as politically more feasible and more impactful per capita than broad-based measures (Dorninger et al., 2025; Oswald et al., 2023). Avoid options that deliver co-benefits, such as compact urban design or teleworking, can target wider constituencies while reducing mobility needs. Also in housing, avoid potentials remain underused. Policies that support life-course matching of households to dwelling size, relocation grants for downsizing, and the activation of underused stock through vacancy fees, together with measures that avoid new construction and the embodied emissions of carbon-intensive materials, can complement shift and improve (Aigner et al., 2023; Huebner and Shipworth, 2017).

The dominance of economic instruments that raise the cost of emission-intensive practices and subsidize low-carbon alternatives risks regressive effects if access to subsidies is biased toward higher-income households with capital and property. Policy design needs to broaden access through up-front grants and zero-interest finance, target areas with limited modal alternatives, and pair price signals with service improvements, especially outside metropolitan cores. At the same time, visible rebalancing of policy effort toward avoid measures, together with careful design that concentrates costs on high-emitting practices, can mitigate backlash risks documented in European contexts and improve social acceptability (Patterson, 2023). Evidence of public support for sufficiency and degrowth elements in some contexts suggests that narrative framing around well-being, reliability, and time security, and strategic coalition-building can expand the set of policy winners and limit the influence of veto players (Lage et al., 2023; Meckling and Karplus, 2023; O'Dell et al., 2025).

Beyond the core research conducted in WP2, described above, the project fed into the MA thesis by Laura Schleißheimer supervised by Simone Gingrich at BOKU (full reference see section 8. The thesis explores the climate-change mitigation strategies by three major actors in the Austrian transport sector: ÖAMTC, VCÖ and the responsible ministry. Her findings stress that across actors and documents analysed, efficiency-oriented measures (i.e., "improve") dominate mitigation strategies. She further identifies neoliberal argumentation as a key obstacle to sufficiency measures and argues that a paradigm shift is necessary towards conceiving of mobility as a public good.

# WP3: Knowledge co-production through stakeholder process

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| Completed tasks (with modifications):<br>3.1 “Constitute stakeholder group”<br>3.2 “Design and prepare intensive stakeholder interaction phase”<br>3.3 “Perform and document co-production meetings during intensive stakeholder interaction phase”<br><br>Key Outcome: documentation of workshop “Sufficiency Council” shared with participants (see Annex) |

The project collaborated with a diverse group of stakeholders at varying degree of intensity. While we largely pursued the process planned according to the tasks, we deviated slightly to make use of windows of opportunity and accommodate the needs and capacities of the involved stakeholders.

We started out identifying 12 persons for more intensive interaction with whom we had initial contacts at the project start, either per email, phone, or in personal meetings. This stakeholder group comprised 4 members of the climate council (diverse in terms of age, activities and rural/urban), 4 persons from public administration, 1 person from an interest group, and 4 NGO representatives.

Beyond what was originally planned in the project, the project staged a 2.5-hour workshop at BOKU’s sustainability day on Nov 7, 2023, which importantly advanced our stakeholder interactions. The workshop was publicly announced and open to the interested public. During the workshop, we made a test-run with a format we called “sufficiency council”. The question we focused on was “How can sufficiency work democratically?”. 40 people attended the workshop, reflecting the high interest in the question raised. Participants included students and people who deal with sustainability (or democracy) issues at a civic or professional level. We firstly briefly presented project results. Based on Austrian household GHG emissions quantified in WP1, we argued that the Austrian fair share of planetary boundaries was already transgressed and the development of sufficiency measures, including final consumption, was therefore imperative. Secondly, participants worked in three groups that simulated local meetings either hosted by a mayor from a rural municipality or a political district head in an urban setting. The task was to think about how 5 million € could be spent at local level to foster climate mitigation issues focusing on sufficiency. For the discussion, participants received a description of a persona (i.e., a role) they had to represent during the discussion (e.g., the mayor, a car salesperson). Results of the discussions were very promising: ideas put forward were innovative, and compromises between groups were feasible (e.g. a low-heat dividend was proposed for reduced room temperatures). The final discussion highlighted the need for elaborating concrete measures and their GHG reduction potential to enable an informed discussion on how they would impact specific individuals, particularly vulnerable groups, and what the respective climate-change mitigation impact would be. Specifically, we established contact to a representative from the social NGO “Armutskonferenz”. This contact (and the participation at an Armutskonferenz event) shaped our focus to combine issues of sufficiency with the challenge of social compatibility and inclusion.

Inspired by this event we decided to modify the phase of intensive stakeholder interaction into one stakeholder workshop which we conceptualized around the issue of sufficiency, with the overarching question of social compatibility. We identified further stakeholder groups for this event that we considered qualified to bring in the needed perspectives. These were two persons from environmental NGOs, citizens (unfortunately they were unable to attend, one because of illness), three people from social NGOs and people we assigned to governance, which were a public official from the climate ministry, two people from the chamber of labour, one person from the trade union, one person from an association of non-profit housing developers and a person from an organization for community work in municipal housing. The full-day event was held at the Institute of Social Ecology on November 14, 2024. The title of the event was “Sufficiency Council on climate policy: Where can sufficiency be organized in a socially acceptable way?”. Based on our learnings from the last event and given progress made in the other work packages of FOCAL-points, we could provide a sound base to the participants. In preparation of the workshop, we sent participants results on the carbon footprint of Austrian households for different income groups.

The narrative at the workshop was that based on a report of the court of auditors Austria has to buy emission certificates if the 2030 EU targets can’t be met. Instead of paying for certificates, money can be spent to make sufficiency or demand-side measures socially acceptable. To make the group apt for this discussion, in the workshop we provided information on the carbon footprints of households for different consumption areas, with a focus on transport and housing, for the last 20 years (WP1). We showed them which climate mitigation measures address the demand-side; focussing on avoid, shift and improve, we could detect and point at the low number of avoid/sufficiency measures. Finally, we presented 20 often-discussed demand-side measures for transport and buildings in terms of how they are specifically designed and what GHG-reduction potential they might have in the year 2030. Measures had a smaller or bigger sufficiency dimension. Participants worked in three more or less homogeneous working groups (i.e., one consisting of environmental NGO representatives, one consisting of representatives of social NGO’s, and one consisting of representatives of governance institutions). Each group selected three measures for an in-depth discussion (opportunities and risks, specific changes in design for social compatibility, available budget due to GHG reductions in 2030 and accompanying measures). The results of the working groups were presented in plenary. In a following poster walk participants added comments using post-its on whether they agreed with the measure or whether they saw negative effects for vulnerable groups due to a particular aspect of the measure (social compatibility). The final discussion focused on a better understanding of the confirmations and disagreements expressed from the different perspectives.

In sum, there appeared to be a negative correlation between mitigation potentials and social acceptability. Some measures were highly effective but had questionable social effects (e.g., road pricing) while others had a lower mitigation potential but high social benefits (e.g., activation of unused floor space). However, all seven measures selected seem to be worth pursuing. Generally, it was interesting that there were hardly conflicting views that can be related to the different perspectives. Views on the measures were diverse but without contradictions.

Further conclusions that were drawn during the final discussion included the following:

- The importance of framing and narratives was highlighted. Emphasizing the benefits of climate policies could enhance public acceptance. Similarly, the need for new narratives that could help support policies that challenge entrenched narratives was underscored. An example for this was countering the narrative of “a right to property” with “a right to living space” in order to advance policies such as activating vacant private properties to increase the available living space within existing buildings. In this context, also the importance of symbolic impacts of policies was mentioned. The banning of SUVs, for example, which was considered to have only medium impacts on emission reduction and social compatibility, or the banning of fossil advertising (as was brought up by one participant) should not be underestimated in their symbolic impacts.
- The need for fundamental reorientation in production systems was addressed. The purpose of production must align with sustainable and equitable principles, moving away from a profit-maximization paradigm. This also requires a restriction of fossil lobbying activities, which was identified as a major risk for the advancement of socially acceptable sufficiency measures and the necessary shift in discourse. Such, it was seen that sufficiency and production systems need to be seen together considering negative and positive feedbacks.
- The fundamental challenge of balancing the holistic, systemic view with the necessary attention to concrete measures and details was discussed, as isolated considerations of specific measures raise doubts regarding political feasibility. At the same time, systemic perspectives must consider specific and contextual circumstances of measures.
- The discussion emphasized the importance of shifting focus form the pursuit of continuous improvements in quality of life (“what else could make life better?”) towards the fundamental question “What is truly necessary for a good life?”.
- For the project FOCAL-points, this co-production workshop was an effective outreach to stakeholders making the project visible. It provided very productive guidance on what kind of project outputs resonate and could receive support from organizations concerned with adverse impacts on vulnerable groups, from environmental NGOs to people dealing with governance issues.

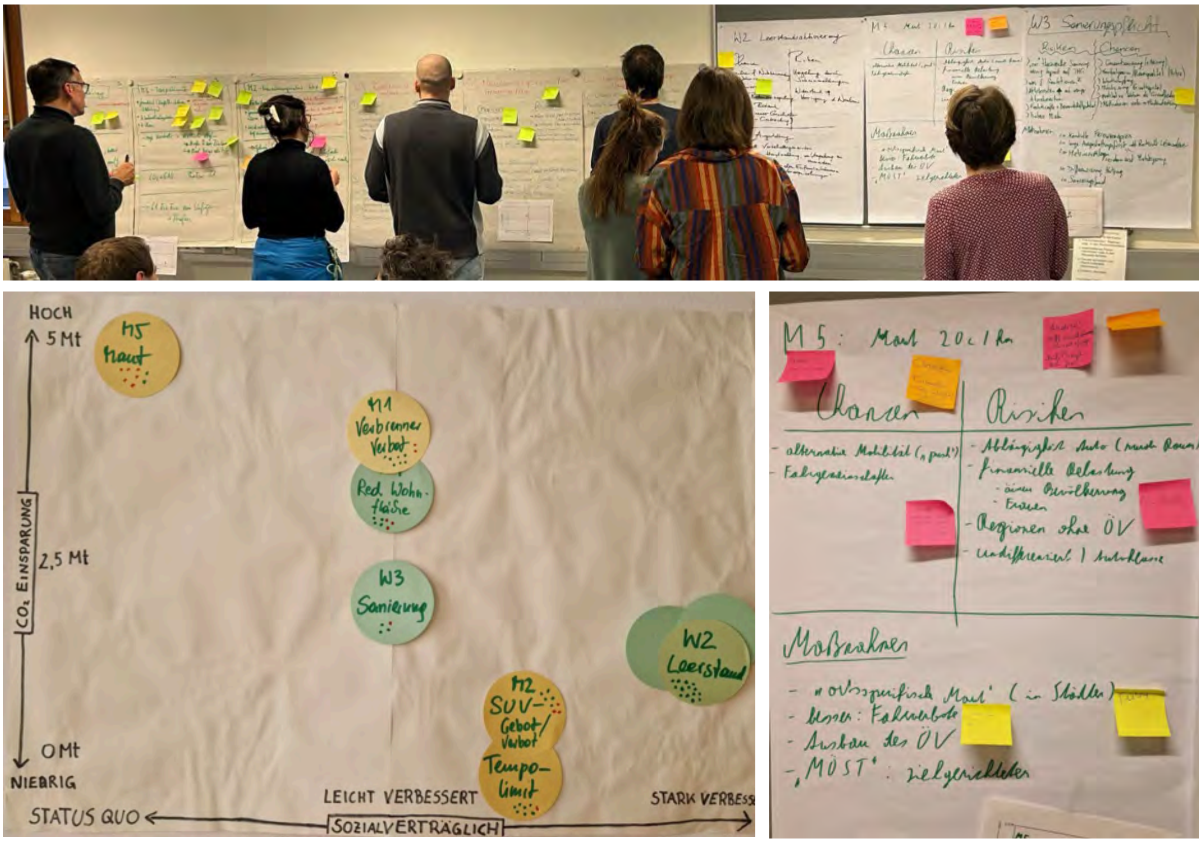


**Figure 8:** Top: poster walk; bottom left: Climate mitigation measures positioned according to their CO2e emission savings and their social compatibility according to the working group – red and green dots state disagreement respectively agreement by other participants; bottom right: Format for working group assessment of mitigation policies, here the example of road pricing.

Rather than writing a synthesis document as planned in the project proposals, we decided to provide participants with the detailed description of demand-side climate-change mitigation options that was prepared for the workshop. In addition, participants received a flip chart protocol of the workshop.

WP3 further fed into the MA thesis written by Ronja Mutschmann-Sanchez and supervised by Willi Haas at BOKU (for full reference, see section 8). In her MA thesis, Ronja Mutschmann-Sanchez explores the potential of demand-side sufficiency policies to advance a just transition, based on her preparatory work for the stakeholder workshop as well as the workshop itself. Her research finds that distributive justice plays a major role if policies aiming at sufficiency are to be successful. Her work further highlights the importance of narratives, participation and mutual responsibility if sufficiency is to contribute to a just transition.

# WP 4: Integrating footprints and policies from a leverage points perspective

Completed Tasks:
4.1. “Leverage points mapping”
4.2 “Integrative leverage points assessment”
4.3 “Identification of leverage points for further policy intervention”

The integration of household GHG footprints from WP1 with the climate policy analysis of WP2 took place via a leverage points coding and analysis. We updated the household GHG footprint time series using the environmentally-extended multi-regional input-output (EEMRIO) tables of GLORIA (Lenzen et al., 2022, 2017).

The development of GHG footprints for different household and product groups in Austria, Vienna, and Lower Austria were analysed looking at the climate change mitigation policies implemented in the past: Is there (for any specific product/household group and policy type) a correlation between policy implementation and GHG footprint data recognizable? If yes, how (much) and where did reductions take place, and can we propose a connection to one more or policies implemented? If not, what are the reasons mitigation policies are not mirrored in GHG footprint development?

To relate specific policies to trends in GHG footprints, we created a product-policy mapping as shown in the table 1 below.

**Table 1: Product-policy matches between the policy mapping of WP2 and the sectoral resolution (for mobility and heating/housing) of the GLORIA (Lenzen et al., 2022, 2017) input-output tables.**

| | Mobility | | | Housing/heating | |
|---|---|---|---|---|---|
| | Product type | Policy type | | Product type | Policy type |
| 1 | fuels and lubricants (indirect) and motorfuels (direct) | fuel; gasoline and diesel, biofuels, renewable fuels | 1 | gas (direct and indirect) | heating natural gas (smaller shares of cooking) |
| 2 | motor cars and other vehicles | fossil motor vehicles **electric cars; electric motor vehicles** | 2 | heating oil (direct and indirect) | heating oil |
| 3 | maintenance and repair of vehicles, plus spare parts | | 3 | solid heating (direct and indirect) | heating biomass/renewables; coal |
| 4 | public transport (train, bus, ship) | public transport (railway, metro, bus, ship) | 4 | electricity (incl. district heating) | devices/energy efficiency electricity; electricity renewables; district heating/cooling |
| 5 | passenger air transport | passenger air transport | 5 | construction, maintenance, operation, repair (via – imputed – rent) | *no direct attribution possible* |

| | | | | | |
|---|---|---|---|---|---|
| 6 | other mobility (road construction/maintenance; transport support services; other transport equipment) | *no direct attribution possible* | 6 | other housing/heating (water, waste, material recovery) | *no direct attribution possible* |
| 7 | *no direct attribution possible* | bicycles; e-bikes, active mobility; walking, shared mobility | 7 | *no direct attribution possible* | energy efficiency, renovation heating efficiency, heating/electricity efficiency consumption behaviour, heat pumps, solar heating |

WP2 provides more than 300 different policies which were mapped along the leverage points scale introduced by Donella Meadows (1999) and further developed by Abson et al. (2017) to explore if and how different intervention points were addressed and if they led to actual mitigation results or not. The leverage points hierarchy orders twelve points of system interventions with varying depth and potential for initiating change. Compare Figure 9 below.

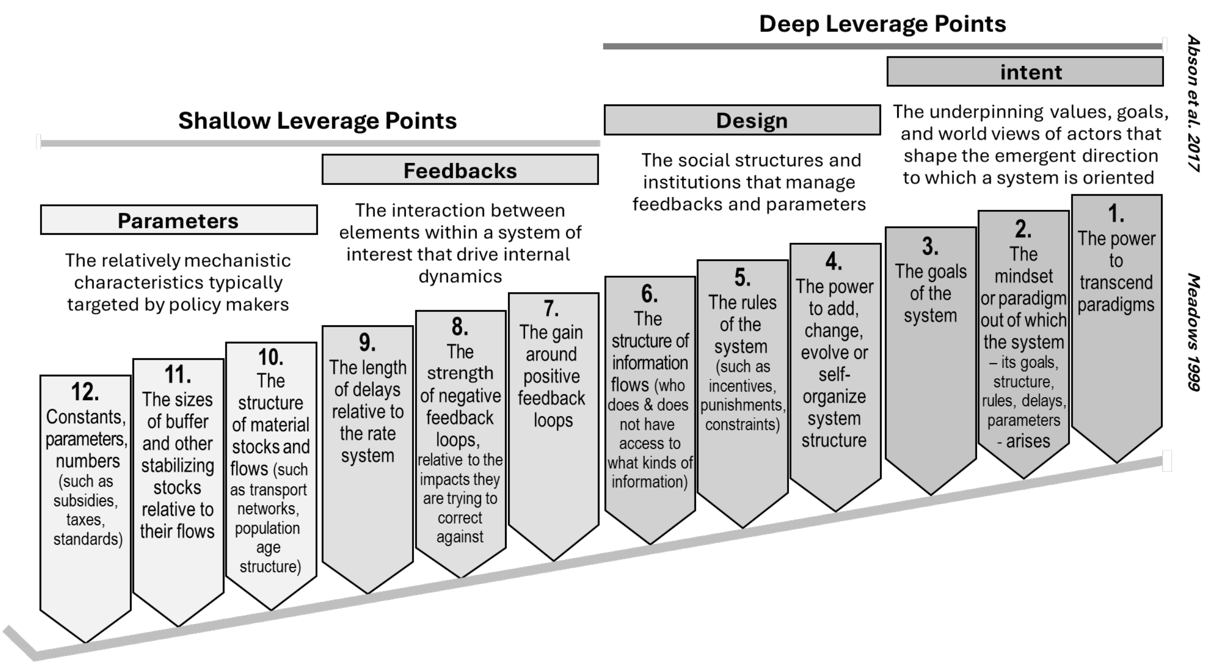


**Figure 9: The leverage points scale according to Meadows (1999) integrated into four system properties by Abson et al. (2017) in hierarchical order. Adapted from Haas et al. (2026).**

As an example, we here show and compare the leverage coding and GHG footprint results for the mobility sector Lower Austria and Vienna. We used the inverse Simpson diversity index (called N2) to measure how many categories of leverage points are effectively represented in the policy dataset, combining richness (how many categories) and evenness (how balanced they are). If all weight is in one category, N2 ≈ 1 (no diversity). If weight is evenly split across the twelve leverage points categories, N2 ≈ 12 (maximal diversity). If a few categories dominate, N2 lies between 1 and 12. The pool aware Simpson index (called N2_pool) is normalized and ranges from 0 (least diversity) to 1 (highest possible diversity).

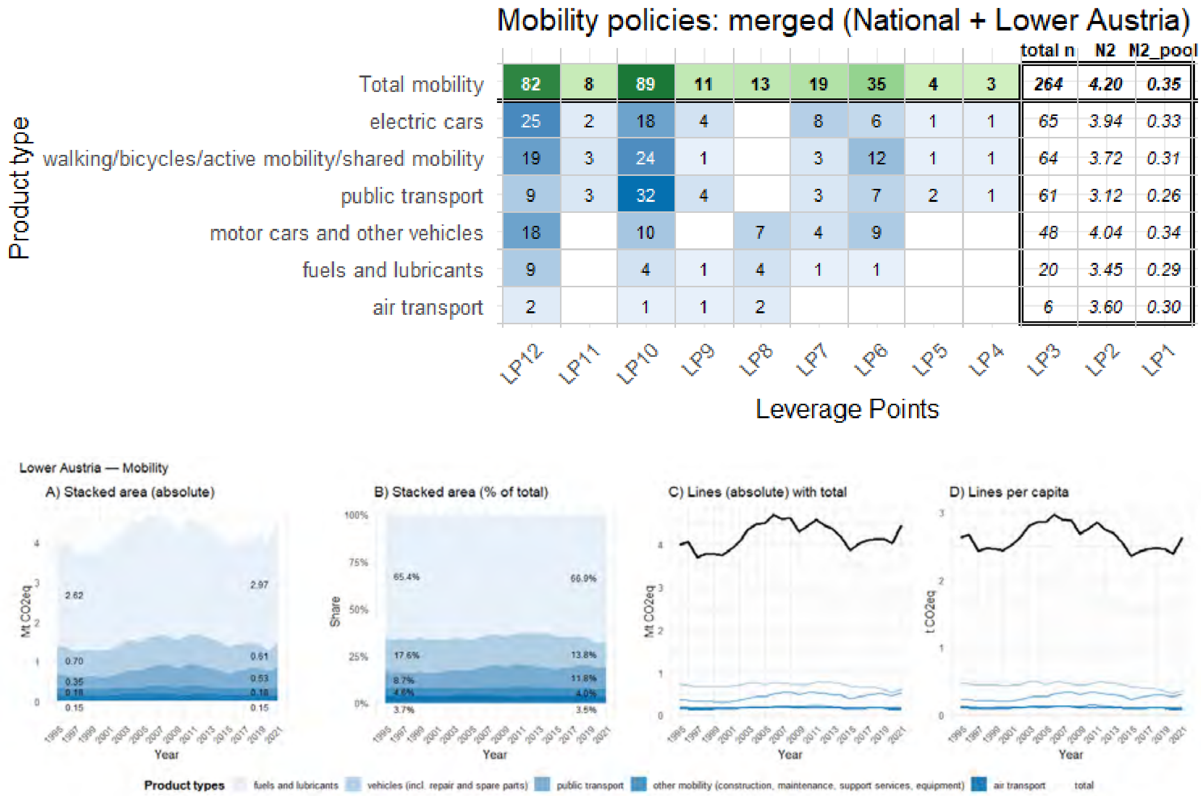


**Figure 10: Leverage points coding in a heatmap for each product category in the mobility sector including the Simpson diversity index (top). Development of the Lower Austrian household GHG footprint in housing/heating in absolute values, percentages, by product, and by capita (bottom, from left to right).**

217 distinct policy interventions have been identified for the mobility sector on the national level which have been implemented between 1995 and 2021. During this time period, 47 additional demand-side mitigation policies have been implemented in Lower Austria in the mobility sector, which yields a total of 264 policies. The pool aware Simpson diversity index yielded a score of 0.35 for the overall sector, which is below the Austrian national result of 0.37. This indicates that the additional Lower Austrian policy interventions did not increase the diversity with regards to leverage points addressed. The overall mobility related household GHG footprint did not decrease in Lower Austria from 1995 to 2021 but even slightly increased from around 4 Mt in 1995 to 4.4 Mt in 2021. Most emissions stem from the use of gasoline and diesel in private vehicles.

The results for Vienna differ both with regards to the leverage points mix as well as to the GHG reductions achieved. Vienna implemented not only more than twice as many additional mobility-related demand-side mitigation policies (101) as compared to Lower Austria (yielding a total of 318), but the additional interventions also addressed a larger variety of leverage points, indicated by a higher pool-aware Simpson diversity index of 0.42. This larger diversity (as compared to Lower Austria) mostly stems from additional policies in the so-called walking/bicycles/active and shared mobility category as well as from interventions addressing public transportation. Mobility-related GHG emissions fell from 4.7 Mt in 1995 to 3.7 Mt in 2021. While emissions from public transport increased, they decreased more sharply in the private vehicle use category.

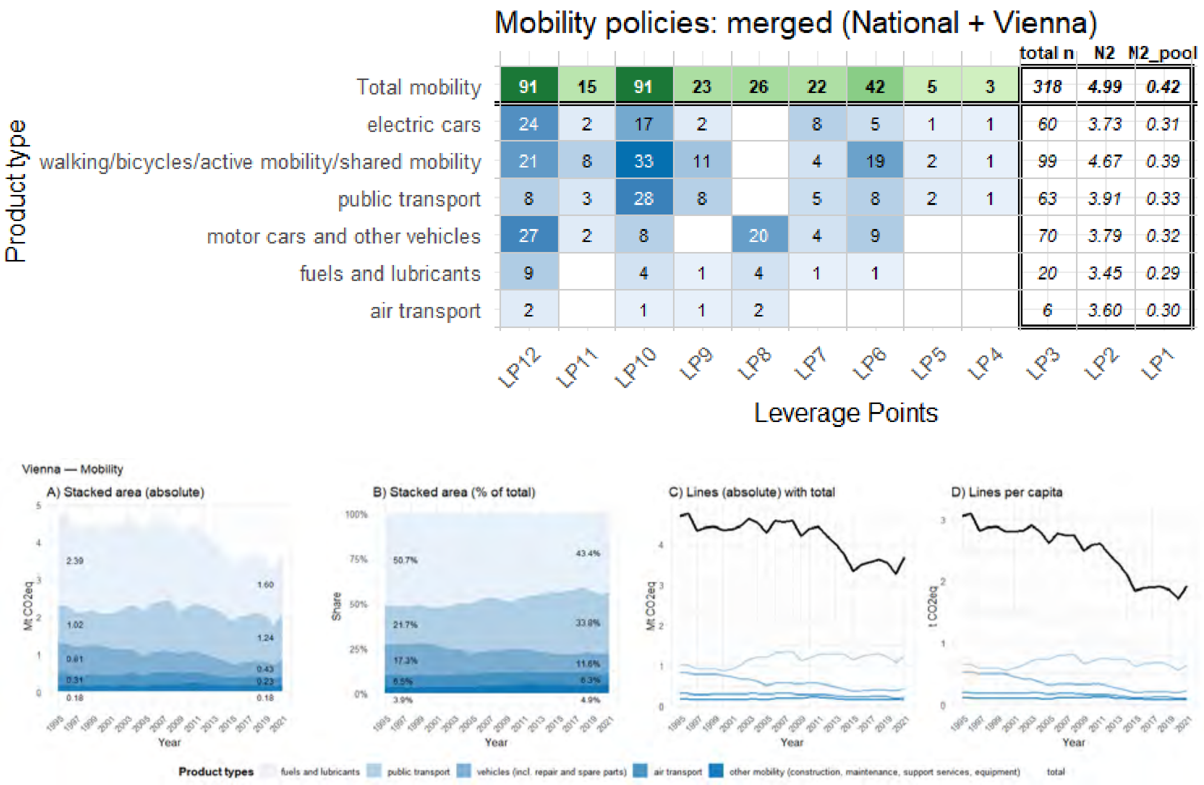


Figure 11: **Leverage points coding in a heatmap for each product category in the mobility sector including the Simpson diversity index (top). Development of the Viennese household GHG footprint in housing/heating in absolute values, percentages, by product, and by capita (bottom, from left to right).**

Overall leverage points and GHG emission trends in the housing/heating sector are more similar. Lower Austria records a pool-aware Simpson diversity of 0.38, Vienna 0.36, and both show a decrease in the housing/heating related GHG footprint, i.e., a reduction of 0.7 Mt (Lower Austria) and 0.9 Mt (Vienna) respectively.

These initial results support the hypothesis that interventions into more diverse leverage points have a greater impact on GHG emissions trends than interventions into just a few distinct leverage points. Final analyses will be conducted in the manuscript that is currently in preparation. The results from this comparative analysis will, then, be contrasted by suggested policy interventions from different mitigation reports to investigate if other types of leverage points are suggested to address and discuss if such interventions might have had more significant mitigation potential. Results on social feasibility of interventions from the project's knowledge co-production will feed into this integration.

## WP 5: Knowledge integration, dissemination and project management

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| Completed tasks |
| 5.1 "Fulfil managerial requirements of the funding agency" |
| 5.2 "Internal collaboration" |
| 5.3 "Dissemination of project results tailored to diverse audiences" |

The project set up formal and informal collaboration agreements, including preparation of consortium agreement, contract with the project partner and subcontractor, reporting and arrangement of financial flows.

Project team meetings were held biannually (Oct 17 2022, June 26 2023, Nov 22 2023, Dec 14 2023, June 3 2024, Oct 22 2024, Feb 26 2025, Nov 14 2025, and March 3 2026). The meetings served to exchange empirical findings2, collectively interpret results, decide on next steps and publications, and plan stakeholder engagement. The project website (https://boku.ac.at/focal-points) has been continuously updated, informing about news and ongoing project activities in German and English.

Two events presenting the project to scientific and general audiences were held in the reporting period: On Nov. 7, 2023, the project hosted a workshop at BOKU "sustainability day", for a detailed description, see WP 3.

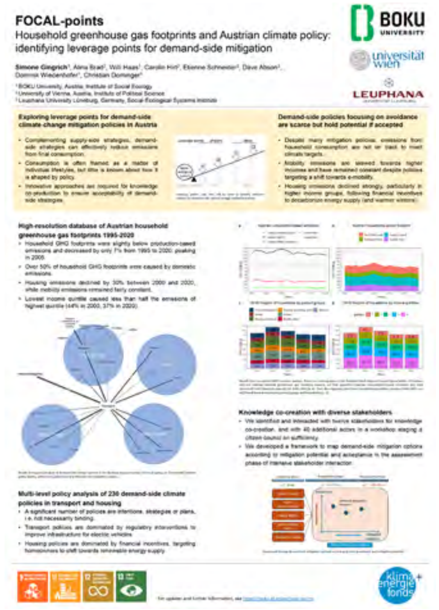



**Figure 12: *Poster presented at Klimatag. For full resolution, see [website](website).***

On April 2-4, 2024, Simone Gingrich presented intermediate project results in a poster and oral presentation (April 4) at the CCCA Klimatag at TU Vienna. The event not only made the project more visible but also resulted in important networking and feedback. Among others, exchange with colleagues from SME Research helped expand the empirical basis of the policy analysis. In addition, the ACRP steering committee provided valuable feedback to the project, e.g. to situate the Austrian case more explicitly in international context, and to reflect upon the possibilities of policies to address deeper leverage points.

Beyond these events, the project team in exchange with colleagues to feed results into the ongoing work towards the Austrian Assessment Report for Climate Change, and with NGO's interested in household GHG footprint data. Furthermore, Willi Haas attended the "Armutskonferenz" in April 2024 to exchange with (potential) stakeholders and exchange about the challenge of social justice in demand-side climate-change mitigation.

Christian Dorninger contributed to two stakeholder workshops of the two NGOs Armutskonferenz and Ökobüro. Once in St. Pölten on the 21 October 2025 and once in Vienna on the 1 December 2025 where he presented and discussed insights on carbon inequality in Austria from WP1. Dorninger also presented FOCAL-points insights at a stakeholder workshop of the Arbeiterkammer in Vienna on the 20 May 2025. He also presented WP1 results at stakeholder workshop of another ACRP-funded hosted by Prof. Riefler at BOKU University on 6 December 2024. In Oct 2025, Christian Dorninger presented FOCAL-Points insights at the International Society for Ecological Economics and Degrowth conference in Oslo. Project results have been taken up among others by WIFO in an online visualization depicting household footprint inequality in the form of isotypes: https://data-science.wifo.ac.at/emissionen-ungleichheit/.

A total of three scientific publications and two MA theses emerged from the project (see the respective WP descriptions and section 8). Of the scientific publications, two are already published (WP's 1 and 2), while one (WP4) is currently being finalized for submission.

# 5 Conclusions and Recommendations

FOCAL-points delivered four principal bodies of evidence. First, WP1 established a robust, distribution-sensitive database of consumption-based greenhouse gas (GHG) footprints of Austrian households. Between 2000 and 2020, household footprints declined only slowly. Mobility and housing/heating remain the largest contributors, with the most notable absolute reduction in direct emissions from housing and heating. By contrast, mobility-related footprints remained high. Overall carbon inequality stayed pronounced and increased within mobility and goods, meaning the richest 10 percent of households consistently caused multiple times the per-capita emissions of the poorest 10 percent, particularly through mobility. Beyond income, floor space per capita, car ownership and vacations emerged as strong explanatory variables of per-capita footprints, while population density showed no clear association in 2020. Vienna stands out with markedly stronger reductions in household GHG footprints than other federal states, yet differences across states are smaller than often assumed.

Second, WP2 shows that demand-side policies are widespread across the EU, federal and provincial levels, yet incomplete in terms of composition. Of 356 policies mapped in housing/heating and transport in Austria, including the federal level for Lower Austria and Vienna, the overwhelming majority focus on shift and improve options, while avoid options remain marginal. In transport, private cars dominate the focus. There is a long-standing trajectory of making inefficient combustion engines more expensive, recently combined with strong incentives for battery electric vehicles, and a suite of measures to shift to public transport and cycling, especially in Vienna. However, policies addressing air travel are almost absent. In housing, since the late 2000s significant subsidy volumes supported renewable heating and efficiency, flanked by progressive bans on fossil heating systems. Avoid options remain scarcely addressed, such as avoiding new construction or actively curbing growth in dwelling sizes. Across both sectors, economic instruments and subsidy regimes are prominent, often more accessible to high-income households. Countervailing subsidies and tax treatments, for example commuter allowances, diesel tax advantages and company car benefits, blunt the steering effect. Vienna stands out with a consistent package of push and pull measures and an explicit planning principle of short distances.

Third, WP3's 'Sufficiency Council' approach demonstrated that social feasibility can be built, but it hinges on careful policy design for which participatory processes can be useful. A common trade-off surfaced in deliberation: measures with high mitigation potential, such as road pricing, were viewed as socially risky, while measures with strong social acceptability, such as vacancy activation, offered more modest immediate reductions. Nevertheless, several measures emerged in a middle ground where both aims can be reconciled through design, for example speed limits, a phased ban on new internal combustion engine registrations paired with transition support, or renovation obligations that avoid passing costs to tenants. Framing matters. Narratives that emphasise a right to adequate living space rather than a narrow claim to property can open space for sufficiency. Symbolic bans, for example on fossil advertising or SUV registrations, can serve as markers that shift discourse. Distributional targeting is crucial. Measures that principally affect higher income groups are perceived as fairer. Participants repeatedly stressed that consumption change and production systems must be addressed together, including curbing the influence of fossil lobbying. They also underscored the need to weave systemic perspectives with the realities of everyday life and concrete measure design, as well as a shift in public debate from “what else could improve life” to “what is necessary for a good life”.

Fourth, work in WP4 established a workable method for coding the “depth and breadth” of policy interventions using the leverage points framework and juxtaposing policy depth and diversity with household footprint trends. Initial patterns are consistent with the hypothesis that broader and deeper combinations of leverage points, including system design and goals, align with more robust reductions. In the housing sector, combinations of efficiency, technological substitution and regulatory steps, such as fossil heating bans, correspond with clearer progress. In transport, deeper leverage points are less evident on the national scale, which tracks with stubbornly high mobility footprints. The contrast between Vienna – where emission reduction were achieved – and Lower Austria – where no mobility-related reductions were achieved – suggests that a more diverse mix of policies which also address deeper system characteristics, support stronger reductions.

# Conclusions

A policy package that relies primarily on efficiency gains and technological substitution, without systematically changing and reducing demand, is unlikely to shift consumption and emissions dynamics in transport. This helps explain persistent and unequal mobility footprints. The housing sector shows that consistent packages combining shift and improve with regulation and selected structural changes can deliver, partly because responsibilities and cost allocation can be focused more clearly on owners and providers of housing services.

Carbon inequality is not only a question of fairness; it is a mitigation problem. When mobility and goods dominate the consumption of higher income groups and inequality within these categories grows, policies that target these segments carry disproportionate leverage. Broad-brush measures that spread costs across the population without concentrating on high emitters risk political backlash with limited mitigation.

Social acceptance is malleable but cannot be taken for granted. The Sufficiency Council points to a set of design principles that make acceptance more likely: protect vulnerable groups from adverse effects, pair price signals with dividends or service guarantees, choose measures that are both effective and symbolically resonant, and frame climate policy as a strategy to deliver reliable services, security and time prosperity within planetary boundaries. Fairness by design, especially when measures concentrate burdens on affluent, high-emitting practices, is a consistent acceptance lever.

Innovative applications of the leverage points lens indicate that the breadth and depth of interventions matter more than the sheer number. Where more diverse and deeper lying system characteristics are addressed, household emissions tend to fall more and stay down.

## Recommendations

**Broaden demand-side policy mixes and anchor sufficiency**

The current tilt towards shift and improve should be corrected by systematically developing avoid options. In transport, this means reducing trip distances and the need for travel. Principles of compact urban form, mixed-use neighbourhoods and short distances should be strengthened across jurisdictions, not only in Vienna. Parking management, speed limits, traffic calming networks and active land-use policies function as system design levers. Previously neglected areas such as air travel must be addressed. Politically feasible entry points include levies on frequent flying or restrictions on niche, extremely high-emission practices such as private jets. In housing, avoid options should be developed through effective vacancy charges, social mobility and relocation support to align dwelling size with household life cycles, and a clear renovation-before-new-build hierarchy. All of this depends on fair design and reliable public services that make sufficiency practical.

**Put distributional justice at the centre of policy design**

The empirical patterns of carbon inequality argue for instruments that concentrate on high emitters while shielding low-income and structurally dependent groups. In transport, targeted pricing for high-performance vehicles, frequent fliers and luxury segments can deliver mitigation with greater fairness. Where general price signals are necessary, pair them with revenue recycling to households, mobility guarantees and service improvements. In housing, link renovation obligations to tenant protection via rent caps, fair cost-sharing rules and tailored support for non-profit and municipal housing providers. Reform eligibility rules and delivery modes so that low and middle income households can actually access support, for example through up-front grants, interest-free loans and hybrid instruments rather than tax deductions alone.

**Remove counterproductive incentives and strengthen policy coherence**

Reform major countervailing subsidies in transport, including the commuter allowance, diesel tax privileges and company car tax treatments, to avoid undermining climate objectives. Hypothecate revenues from climate instruments to fund socially fair service improvements and relief measures in the same domains, which builds policy feedbacks and public trust. In federal domains such as spatial planning, improve horizontal and vertical coordination so that climate and sufficiency goals translate consistently into zoning, building and infrastructure decisions.

### Address multiple leverage points: rules, structures and goals

Adjusting parameters remains necessary but insufficient. Reorient system structures by prioritising short-distance spatial patterns, shifting land-use and zoning rules towards climate-compatible uses, and investing in infrastructure that enables avoidance and modal shifts. At the level of rules and goals, move target systems away from volume indicators, such as numbers of cars or square metres, and towards service and wellbeing indicators, such as accessibility, housing provision, affordability and time security. Explicit goal shifts make sufficiency policies more legitimate and strengthen coherence across ministries and levels of government.

### Deploy narratives and symbolic measures strategically

The Sufficiency Council underscores that narratives and symbols expand the realm of the possible. Communication should foreground reliable public services, safety, health and quality of life rather than a rhetoric of sacrifice. Visible, fair symbolic measures can shift norms and support larger packages, such as bans on fossil advertising or new SUV registrations. Such symbols should be embedded in packages that contain substantive service improvements and fair cost-sharing. Social participation may be a viable strategy to develop practical narratives.

### Use formats and institutions that make knowledge usable

Stakeholder feedback confirms that short, visually clear syntheses and targeted briefings improve the uptake of research. Results should be prepared in one-to-two-page summaries with a single core message and two supporting points and offered in interactive short formats announced well in advance. An institutionalised Stakeholder Advisory Board can create a regular, low-threshold channel for feedback on usefulness, discourse shifts and needs, coupled with a brief written response from the research team. The Sufficiency Council has proven its value as a co-production format and can be repeated and adapted, for example with a focus on rural areas or specific population groups.

### Tighten the link between research and policy design

The integration of quantitative, political and transdisciplinary approaches proved fruitful. Future work should deepen political-science analysis of governance and actor constellations to identify sequences, coalitions and levers in finance and regulation. Behavioural and social science insights on acceptance and sufficiency should inform policy design more systematically. On the data side, household footprint estimates should be updated regularly and, where feasible, enriched with further social differentiations to improve targeting.

### Final assessment

FOCAL-points shows that Austria already has many elements of a demand-side climate policy, yet these elements do not add up to a coherent, deep and fair transformation package. Emissions and inequality patterns point to the largest gaps: avoiding transport demand, addressing luxury and high-consumption segments, and designing price signals and obligations that are socially balanced. Where deeper levers have been engaged, especially in housing and in Vienna's transport and planning portfolio, progress is visible. Combining sufficiency-oriented policies with fair design, strategic communication and structural reorientation offers realistic pathways to reduce household footprints while maintaining and even improving social support. The methods and dialogue formats developed in this project provide a solid basis for scaling and refining such efforts in the coming years.

# C) Project Details

## 6 Methods

### Overview

FOCAL-points was conceived as an integrated, mixed-methods project that links high-resolution quantitative accounting of household GHG footprints with a longitudinal, multilevel mapping of demand-side climate policies and a co-production process focused on the social feasibility of sufficiency-oriented measures. These strands come together in a systems integration that codes the “depth” and “breadth” of policies using a leverage points framework and relates policy depth and diversity to household emissions trajectories. The following sections describe the methodological approaches in each work package and explain how they fit together to generate decision-relevant insights for Austrian climate policy in the domains of housing/heating and transport.

### WP1. Modelling and analysis of Austrian household GHG footprints

WP1 provides the quantitative backbone of the project. Its objective is to quantify consumption-based greenhouse gas emissions induced by Austrian households, trace their development over time, and illuminate the distribution of these emissions across consumption categories, income groups, and regions. To achieve this, the team constructed a high-resolution database that integrates environmentally extended input–output analysis with official national inventories and detailed household expenditure microdata.

The starting point is EXIOBASE v3.8.2, a widely used multi-regional input–output model that links monetary transactions to environmental extensions in a harmonized global framework. EXIOBASE allows calculation of the greenhouse gas footprint associated with final demand in consistent time series. To enhance national credibility and consistency, the Austrian greenhouse gas satellite accounts within EXIOBASE were replaced with official production-based emissions data from the Environment Agency Austria and Statistics Austria, using the residence principle and the AR6 Global Warming Potentials for all covered greenhouse gases. This alignment ensures that territorial emissions embedded in the footprints reflect the national greenhouse gas inventory.

Household-level disaggregation relies on the Austrian Household Budget Surveys for the years 2000, 2005, 2010, 2015, and 2020. Each wave covers 6,000 to 8,000 households and reports detailed expenditures across a standardized classification. The team harmonized these waves to a common set of 108 product groups and then aggregated results to five analytically meaningful consumption categories: mobility, housing and heating, food and beverages, goods, and services. For each wave, a concordance links household expenditure to EXIOBASE product groups. Indirect supply chain emissions were calculated for the sum of Austrian household final demand and then allocated to individual households in proportion to their expenditure shares for each product category. Direct household emissions from motor fuels and heating fuels were allocated using microcensus data on energy use in private households, proportionally assigned according to reported expenditures in the relevant categories. All analyses applied official household weights to ensure representativeness.

The database supports trend analysis at multiple levels. At the national level, consumption-based footprints can be reported annually from 1995 to 2022 for total final demand and for the household component. At the household level, footprints are available for the five survey years, allowing comparison across income deciles and quintiles and across consumption categories. The distributional analysis uses Lorenz curves and Gini coefficients to quantify inequality in total footprints and by product group. To explain variation in per capita footprints, the team estimated weighted multiple regression models with robust standard errors. Predictor variables included income per capita, floor space per capita, number of cars owned, household size, number of vacations per year, heating energy carrier, residence status (ownership vs renting), and population density. The models were estimated for the full sample and separately for the top and bottom income quintiles to unpack drivers within more homogeneous income groups.

Regional comparisons complement the national picture. Where data permit, the team compared household footprints per capita across federal states and population density classes. Vienna and Lower Austria receive particular attention because they provide a useful contrast in governance styles, urban form, and policy portfolios in housing and transport. This regionalization later enables closer triangulation with the longitudinal policy mapping and the systems integration.

The approach has clear strengths and known limitations. Replacing EXIOBASE's Austrian emission accounts with official data improves consistency, and using household weights strengthens representativeness. At the same time, input–output modelling requires assumptions of product homogeneity within sectors, and the household budget surveys do not capture household-specific electricity generation mixes. Expenditure underreporting affects some categories, especially in early waves, and EXIOBASE relies on nowcasting for monetary structures after 2011. These limitations were documented, and sensitivity considerations were taken into account when interpreting results. Despite these caveats, WP1 establishes a rigorous, distribution-sensitive quantitative baseline that later work packages can relate to policy dynamics and social feasibility.

## WP2. Multilevel mapping and coding of demand-side climate policies

WP2 complements the quantitative backbone with a comprehensive, multilevel map of actual demand-side climate mitigation policies and public investment decisions in Austria from 1995 to 2024. The focus is on policies that explicitly or implicitly target household decisions and behaviours in housing and transport. The mapping covers European Union measures, federal Austrian policies, and provincial policies in Vienna and Lower Austria. This multilevel scope allows examination of how policy mixes evolved over time and varied across levels of governance.

The policy corpus was assembled through several complementary strategies. A systematic literature review identified relevant policies mentioned in peer-reviewed and grey literature on Austrian transport and housing policy. Following screening, 90 publications were selected for detailed coding. Targeted documentary research then located legal texts, policy strategies, regulations, and subsidy scheme descriptions on ministry and agency websites. Press releases and initiative pages, such as the federal klimaaktiv program, were systematically screened. References in policy documents were used to track measures backward in time, and repeated or revised subsidy schemes were followed longitudinally. To validate and refine the corpus, the team conducted semi-structured interviews with civil servants in the Federal Ministry of Climate Action and the City of Vienna's climate office. These interviews provided insight into policy relevance, implementation history, and moments of change. Two online meetings with the Austrian climate policy research community provided peer feedback on the completeness and consistency of the dataset. Preliminary findings were also presented at a stakeholder workshop with federal and provincial policy makers and NGOs, which helped identify gaps and clarify interpretations.

Policies were coded along three dimensions. First, each policy was classified according to the avoid–shift–improve framework, originally developed for transport and adapted for housing and energy demand. Avoid policies aim to reduce demand for services, for example by shortening travel distances or promoting compact urban form. Shift policies promote less emission-intensive modes of service provision, such as switching from private cars to public transport or from fossil heating to renewables. Improve policies increase the efficiency of technologies or end-use practices, such as higher building energy performance or more efficient cars. Second, the target of each policy was recorded, for example private cars, public transport, cycling, walking, building efficiency, heating systems, repair and maintenance, or spatial planning principles. Third, the core instrument type was coded as regulatory, economic, or informational, based on the primary mechanism by which household decisions were intended to change. For example, the introduction of short-term parking fees in Vienna was coded as an economic instrument because it alters financial incentives for driving, even if the legal vehicle for introducing fees was a regulation.

To avoid overcounting, multi-year subsidy schemes were treated as single measures unless scope or volume expanded substantially. Recurrent information campaigns were consolidated. Strategy documents that announced multiple measures were included and coded as plans or strategies when implementation could not be reliably traced within the scope of the study. Policies that primarily targeted supply-side changes without a direct lever on household decisions were excluded, while policies in grey areas were considered case by case, with the coding rationale documented.

Several steps were taken to ensure reliability. Multiple researchers applied the coding rules and cross-checked each other's work, discussing ambiguous cases until convergence. Interview and peer feedback rounds highlighted blind spots and helped verify choices, for example the limited coverage of air travel policies and the often indirect treatment of spatial planning competences at the provincial and municipal levels. The resulting database lists 356 policies across transport and housing, with a detailed classification for each along ASI categories, targets, instruments, levels of governance, and time periods.

The approach shines a light on what was actually done in the demand-side space, yet it does not claim to measure policy effectiveness directly. Counting policies cannot account for differences in scope, budget, or enforcement intensity. To mitigate this limitation, the mapping was complemented with expert interviews and survey feedback to differentiate higher-salience measures from marginal ones. This choice preserves the primary value of the mapping, which is to reveal the composition and evolution of the policy mix across levels and sectors, and to identify where avoid, shift, and improve options have been emphasized or neglected.

## WP3. Co-production with stakeholders: the "Sufficiency Council" format

WP3 brings a transdisciplinary perspective by engaging stakeholders in the design and assessment of demand-side mitigation measures, with a particular focus on the social feasibility and fairness of sufficiency-oriented options. The centerpiece is a structured deliberative format called the "Sufficiency Council," which simulates real-world decision contexts and provides a platform to test acceptance and redesign measures for greater social compatibility.

The format was piloted at the BOKU Sustainability Day in November 2023. In a 2.5-hour session, around 40 participants, including students and practitioners involved in sustainability and democracy issues, worked with a constrained local budget and role descriptions ("personas") to allocate funds to sufficiency-oriented measures in transport and housing. Before the deliberation, the team presented accessible results from WP1 on household carbon footprints by consumption category and income group, and explained why demand-side measures are indispensable given Austria's fair share of planetary boundaries. The persona-based small group discussions were designed to surface trade-offs and identify creative compromises, for instance a "low-heat dividend" for reduced room temperatures. The pilot confirmed high interest and revealed a strong need for quantification of greenhouse gas reduction potentials and distributional effects in concrete measures, to enable informed debate on impacts on vulnerable groups.

Building on these insights, the full-day Sufficiency Council took place at the Institute of Social Ecology in November 2024. Participants were selected to ensure a balanced set of perspectives: environmental NGOs, social NGOs, governance actors from the climate ministry, labour representation and unions, representatives of non-profit housing providers, and community workers in municipal housing. Citizen participation was planned but could not be realized due to illness. Prior to the event, participants received short summaries of household footprint distributions. At the outset, the team framed the discussion with a narrative grounded in policy reality: failure to meet 2030 EU targets implies purchasing emission certificates, whereas allocating comparable funds to make sufficiency measures socially acceptable could avoid such external payments and provide co-benefits domestically. The team presented a curated list of 20 demand-side measures in transport and housing, many with a sufficiency dimension, including indicative reductions by 2030 and brief descriptions of design features.

Participants worked in three groups that each chose three measures for in-depth assessment. One measure, vacancy activation, was selected by all groups. For each measure, groups discussed opportunities and risks, identified redesign options to enhance social compatibility, considered indicative budgets released by reduced emissions, and proposed accompanying measures. Group results were presented in plenary and then subjected to a poster walk where participants indicated agreement and flagged concerns, particularly regarding potential adverse effects on vulnerable groups. A concluding discussion synthesized cross-cutting themes.

The process yielded several insights. First, participants perceived a general trade-off between mitigation potential and social acceptability. Measures like road pricing were seen as highly effective but problematic in terms of fairness, especially for low-income, car-dependent households, while measures like vacancy activation scored high on social compatibility but offered more modest mitigation. SUV registration bans and internal combustion engine bans were assessed as more acceptable, especially when aligned with EU trajectories and accompanied by policies to address employment transitions. Second, measures that primarily affect higher-income groups were perceived as more compatible with social justice, which aligns with WP1 findings on carbon inequality in mobility and goods. Third, participants emphasized that policy narratives matter. Reframing issues, for example shifting the focus from a "right to property" to a "right to living space," can open political space for measures like vacancy activation. Symbolic measures, such as bans on fossil advertising or SUV registrations, were seen as having value for shifting norms beyond their direct emission impacts. Fourth, participants insisted on jointly considering production systems and consumption changes. They identified lobbying by incumbent interests as a barrier and argued for a reorientation of production towards sustainability and equity. Fifth, the discussion highlighted the importance of integrating a systemic view with attention to measure-specific design details and to the lived realities of different groups. Finally, the idea of a "good life" reframed as "what is necessary" rather than "what else could make life better" emerged as a promising basis for sufficiency-oriented policy debates.

Methodologically, the Sufficiency Council combines presentation of concise scientific evidence with structured deliberation anchored in realistic roles and constraints. It complements the policy mapping by testing acceptance and design features for measures that are often underrepresented in existing policy mixes, and it provides practical guidance on how to tailor avoid, shift, and improve options to protect vulnerable groups and increase fairness. It also feeds forward into the systems integration by identifying which types of interventions and narratives might correspond to deeper leverage points in socio-technical systems.

## WP4. Systems integration: leverage points and product–policy matching

WP4 serves as the integrative engine that brings together the quantitative trends from WP1, the policy mapping from WP2, and the feasibility insights from WP3. It operationalizes the leverage points concept, originally developed by Meadows (1999) and adapted by Abson et al. (2017), to code the "depth and breadth" of policy interventions and to test how the mix of leverage points addressed in policy interventions relate to household GHG trajectories in Austria, Vienna, and Lower Austria.

The leverage points framework distinguishes interventions according to the system properties they target. At the shallow end are interventions into parameters such as taxes, subsidies, and standards. Interventions at the level of feedbacks alter response dynamics, for example through adaptive revenue recycling or learning mechanisms. Changes in system design address structures such as infrastructure configurations, market rules, or institutional responsibilities. At the deepest level, interventions influence system goals and paradigms, such as shifting from maximizing flows to ensuring adequate services within planetary boundaries. Coding policies along this hierarchy provides a way to characterize not only the quantity and type of policies but also their potential to induce persistent system change.

The coding process was iterative and conservative. Two coders independently assigned leverage points to each policy in the WP2 dataset, relying on a previously developed team guide to ensure shared understanding. Ambiguities were discussed, definitions were clarified, and a second round was used to include leverage points that were initially underused due to definitional uncertainty. Policies could be linked to multiple leverage points when justified, but over-attribution was avoided by focusing on primary effects rather than secondary or unintended consequences.

To relate policy mixes to household emissions, WP4 constructs product–policy matches. Household GHG footprints in mobility and housing/heating are disaggregated into product categories where direct matches to policy targets exist. In mobility, these include motor fuels, vehicle purchases, maintenance and repair, public transport, and air travel. In housing, categories include direct and indirect emissions from gas and oil heating, electricity and district heating, and building construction, maintenance, and operation. Where policies broadly targeted a sector without a straightforward match to a specific product, sector-level effects were considered in parallel. For each product category, the policy timeline and leverage point coding can be compared to changes in household emissions over time, with attention to plausible lags between policy introduction and observable footprint effects. Vienna and Lower Austria provide a valuable contrast in both policy style and urban structure, which improves interpretability.

To move beyond counts of policies, WP4 uses simple diversity metrics to capture the breadth and balance of leverage points addressed in a given policy bundle. An inverse Simpson diversity index summarizes how evenly interventions are distributed across leverage point categories during a period. The analysis examines whether product categories and regions that experienced more diverse and deeper combinations of leverage points also recorded more substantial or persistent footprint reductions, acknowledging that attribution is limited by confounders and data constraints. The approach remains cautious about inferring causality and instead emphasizes the identification of patterns that are consistent with the leverage points hypothesis and with complementary qualitative evidence.

Several limitations are addressed explicitly. Implemented policies often manifest as parameter changes or regulatory tweaks, which are easier to document than upstream changes in system goals or rules. The coding therefore likely underdetects deep leverage points unless strategies or legal frameworks make them explicit. Not all product categories can be directly matched to policy targets, especially where structural drivers are diffuse. Time lags, external shocks, and supply-side dynamics complicate interpretation. Despite these challenges, the method allows the project to move beyond simple policy counts to a structured assessment of whether the “depth” and “mix” of interventions align with observed consumption-based emission trends.

# WP5. Knowledge integration, dissemination, and project management

WP5 ensures the overall coherence of the project, manages collaboration and reporting requirements, and tailors dissemination to audiences in science, policy, and civil society. It coordinates formal collaboration agreements, financial management, and reporting, and it convenes regular project meetings to align analytical steps and stakeholder engagement across work packages. The project website communicates in German and English and is updated continuously with news and outputs.

Dissemination has followed a dual track. For scientific audiences, the team presented intermediate results at the national Klimatag conference and prepared journal submissions on household GHG inequality (Journal of Industrial Ecology) and on the composition and evolution of demand-side policies in housing and transport (Communications Earth & Environment). An international conference session has been accepted for the joint International Society for Ecological Economics and Degrowth conference in Oslo in 2025 to present FOCAL-points results alongside related work. For policy and practitioner audiences, the team has favoured shorter, clear formats and workshops (i.e., at BOKU Nachhaltigkeitstag, stakeholder workshop at the Institute of Social Ecology), building on stakeholder feedback about effective communication. WP5 also provides the channels to feed stakeholder insights from WP3 back into the research, closing the loop between analysis and use.

## How the approaches fit together

FOCAL-points follows a coherent research logic in which each work package responds to a different aspect of the same problem and provides inputs to the others. WP1 answers who emits how much, where, and in which domains of consumption, and how this has changed over time. It shows not only aggregate footprints but also how emissions are distributed across socio-economic groups and regions. This is essential for identifying where mitigation efforts must focus and for judging fairness. WP2 answers what policies were actually implemented to influence household demand, when, and at which level of governance, and how these policies are composed in terms of avoid–shift–improve targets and instrument types. It reveals where policy mixes are dense and where gaps exist, particularly the relative neglect of avoid options. WP3 tests the social feasibility of demand-side measures and surfaces design principles for acceptance and fairness. It provides grounded guidance on how to redesign measures such as road pricing, vacancy activation, or renovation mandates to protect vulnerable groups, and it identifies narratives and symbolic measures that can shift norms. WP4 brings these strands together by examining whether policy bundles that address a broader and deeper set of leverage points align with the observed changes in household footprints in targeted domains and regions. It translates a systems concept into operational coding and juxtaposes policy depth and diversity with emissions trajectories. WP5 ensures that results are communicated in formats that stakeholders can use and that feedback is incorporated into the research process.

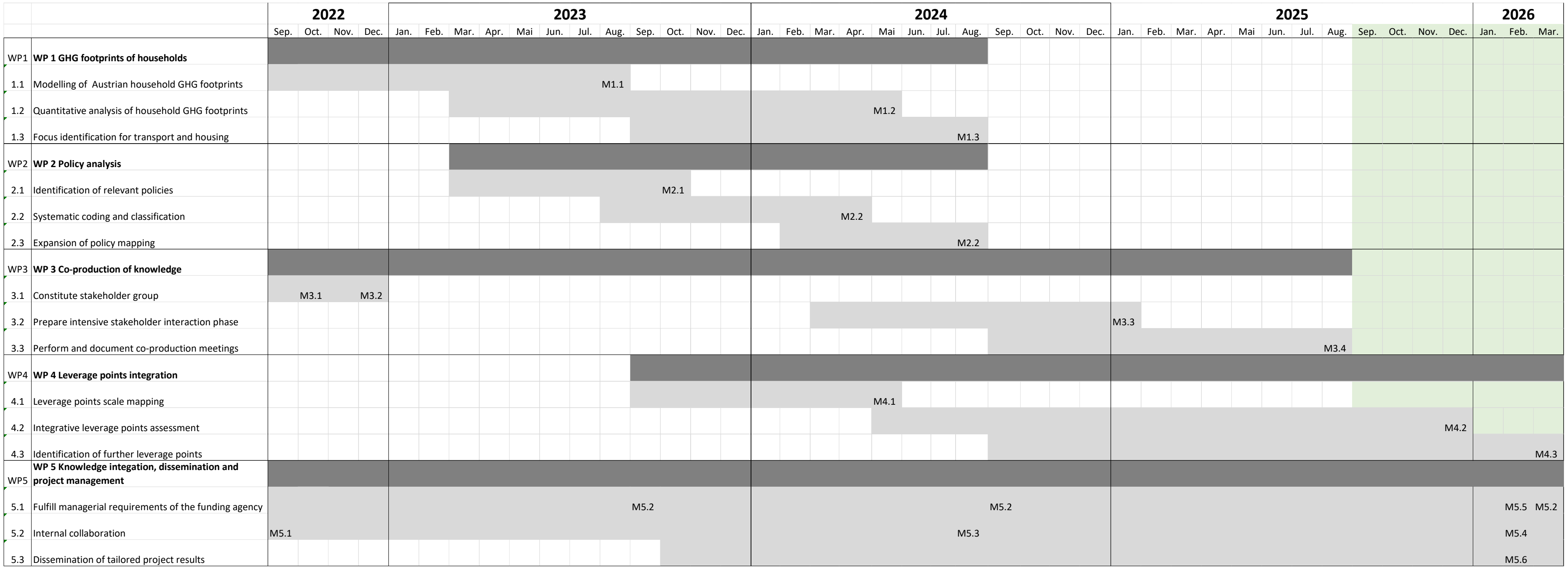
The complementarities are concrete. The household-level resolution and product-group detail in WP1 make it possible to link specific policy targets to specific consumption categories rather than relying on sectoral averages. The distributional insights from WP1 (for example, that mobility and goods are both large and increasingly unequal in their emissions, while housing shows more equal distributions and stronger declines) directly inform the selection and redesign of measures in WP3 and the priority areas in WP2. The policy mapping in WP2 provides a temporal and multilevel context for interpreting footprint trends and for looking for plausible matches and mismatches in WP4. The Sufficiency Council in WP3, grounded in data from WP1 and gaps highlighted by WP2, generates realistic design modifications and identifies acceptance issues that correspond to deeper system properties in the leverage points framework, such as the goals of housing policy or the rules governing parking and street use. The leverage points analysis in WP4 offers a structured way to examine whether moving beyond parameter changes towards feedbacks, system design, and goals correlates with more sustained footprint declines, in particular where Vienna's integrated spatial planning contrasts with the more dispersed governance context of Lower Austria.

Triangulation runs throughout. Quantitative results are cross-checked against qualitative evidence and stakeholder judgement. Policy timelines are read alongside emissions trajectories, but interpretation remains cautious about causal claims. Where attribution is not defensible, the analysis still provides useful diagnostics about policy composition and the alignment or misalignment with emission patterns. The project's design also supports a compact, maintainable approach to monitoring that reflects stakeholder needs: household footprints by consumption area and distribution, policy mix composition by ASI categories and leverage points, and acceptance signals from co-production formats.

Taken together, FOCAL-points' methodological architecture provides a coherent and credible assessment of demand-side mitigation in Austria. It establishes robust, distribution-sensitive baselines, documents actual policy efforts in detail, tests the social feasibility of measures that are often underused, and integrates these strands through a systems lens that emphasizes the depth and diversity of interventions. This integration yields insights that are scientifically rigorous and practically useful for policymakers, administrations, labor representation, NGOs, and other actors who seek to design effective and fair demand-side climate policies in housing and transport.

# 7 Work and timetable

The project largely followed the time plan sketched in the proposal. The duration of the project was extended due to parental leaves of key project participants, affecting mostly WP 4.




WP1: M 1.1: Final dataset on consumption-based household GHG footprints in Austria, from 1995-2020; M 1.2: Statistical analysis of household footprint patterns and dynamics completed; M 1.3: Identification of hotspots in housing and mobility for further analysis in WP 3 and WP 4; M 1.4: Compilation of quantitative results tailored for the analyses conducted in WP 3 and WP 4.; WP2: M 2.1: Mapping and systematic classification of climate policies relevant for demand-side mitigation completed; M 2.2: Main foci of analyzed policies in connection with pivotal consumption groups and sectors determined; M 2.3: Evidence for policy insufficiencies and ineffectiveness explored; WP3: M3.1: Stakeholders identified and invited; M3.2: Co-production meetings held; M3.3: Co-evaluation workshop held; WP4: M 4.1.: Assessment of aptness of existing demand-side mitigation policies finalized; M 4.2.: Integrative leverage points assessment completed; M 4.2.: Identification of further leverage points completed; WP5: M5.1 Project Kick-Off: Consortium agreement, kick-off meeting, implementation of project website; M5.2 periodic report; M5.3 Synthesis meeting; M5.4 Scientific articles submitted; M5.5 Final project meeting; M5.6 Final report.

# 8 Publications and Dissemination Activities

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| WP1:<br>Modelling and analysis of Austrian household GHG footprints | Dorninger, C., Gingrich, S., Haas, W., Brad, A., Schneider, E., Wiedenhofer, D., 2025. Slow and unequal reduction in Austrian household GHG footprints between 2000 and 2020. Journal of Industrial Ecology.70074. https://doi.org/10.1111/jiec.70074<br>Further publication:<br>Wieland, H., Wiedenhofer, D., Többen, J., & Dorninger, C. (under review). *A local-to-global multi-regional input-output database for Austria and its federal states consistent with official accounts*. Scientific Data. https://doi.org/10.21203/rs.3.rs-10032681/v1 |
| WP2:<br>Policy analysis of demand-side climate policies in Austria | Brad, A., Schneider, E., Dorninger, C., Haas, W., Hirt, C., Wiedenhofer, D., Gingrich, S. 2025. Existing demand-side climate change mitigation policies neglect avoid options. Re-submitted to: Comm. Earth & Env. 6, 773. https://doi.org/10.1038/s43247-025-02800-5<br>Schleißheimer, L. 2025. Hürden und Hebel für eine Mobilitätstransformation in Österreich: Strategien verschiedener Akteure im Vergleich. MA Thesis, BOKU. |
| WP3:<br>Knowledge co-production through stakeholder process | Mutschmann-Sanchez, R. 2025. Suffizienz im Kontext von Just Transition: Literaturbasierte Auswertung der Perspektiven von Governance-, Sozial- und Umweltorganisationen. MA Thesis, BOKU. |
| WP4:<br>Integrating footprints and policies from a leverage points perspective | Paper on the integration of household GHG footprint development and policy analyses via a leverage point framework is in preparation for submission to the journal Sustainability Science.<br>Further publications:<br>Haas, W., Abson, D. J., Haberl, H., Spittler, N., Wiedenhofer, D., & Dorninger, C. (2026). Reconceptualizing the role of socioeconomic material stocks in the leverage points framework to enable transformative change. *Ecological Economics*, *239*, 108759. https://10.1016/j.ecolecon.2025.108759<br>Pichler, M., Bärnthaler, R., Wiedenhofer, D., Roux, N., & Gingrich, S. (2025). Conceptualizing supply- and |

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| | demand-side climate change mitigation: A typology and new research directions. Energy Research & Social Science, 127, 104225. https://doi.org/10.1016/j.erss.2025.104225 |
| WP5: Knowledge integration, dissemination and project management | Project website.<br><br>Simone Gingrich presented FOCAL-points progress and results at Klimatag 2024.<br><br>Simone Gringrich, Christian Dorninger, and Willi Haas organized a session at the BOKU Nachhaltigkeitstag in November 2023 in which we presented first FOCAL-points insights and formed a fictious sufficiency council with session participants.<br><br>Willi Haas attended the Armutskonferenz in 2024 to further engage with social NGO's which became instrumental for conducting the Sufficiency Council workshop later that year.<br><br>Christian Dorninger and Dave Abson organized a special session called "How can the environmental pressure of consumption be countered through sufficiency and demand-side measures?" at the 18th conference of the International Society for Ecological Economics (ISEE) in Oslo, Norway, June 2025. Christian Dorninger also presented FOCAL-points results in that session.<br><br>Christian Dorninger contributed to two stakeholder workshops of the two NGOs Armutskonferenz and Ökobüro. Once in St. Pölten on the 21 October 2025 and once in Vienna on the 1 December 2025 where he presented and discussed insights on carbon inequality in Austria from WP1. Dorninger also presented FOCAL-points insights at a stakeholder workshop of the Arbeiterkammer in Vienna on the 20 May 2025. He also presented WP1 results at stakeholder workshop of another ACRP-funded hosted by Prof. Riefler at BOKU University on 6 December 2024. |

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