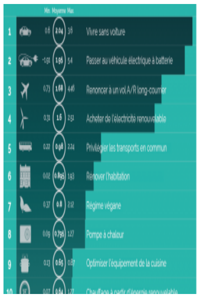
1. **Opinions**



60 consumption options to fight global warming

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Tackling the global climate crisis requires that societies drastically reduce their greenhouse gas footprints (GHG footprint). In this review, we synthesized 60 consumption options and their GHG mitigation potentials, taking into account the life cycle GHG footprints of production and consumption. We find a few options with high potentials and many options with intermediate potential. We highlight how unlocking these potentials requires overcoming infrastructural, institutional and behavioural lock-ins. Avoiding catastrophic climate change will require substantial changes in everyday life and of businesses, guided by ambitious climate policy.

Introduction: consumption and the climate crisis

Tackling the global climate crisis requires that societies drastically reduce their greenhouse gas footprints (GHG footprint) in order to avoid catastrophic climate change. Based on current policy goals and the available climate science, annual GHG emissions must decrease by 45% percent of their 2010-levels by 2030, and reach net-zero by 2050 to limit temperature changes to 1.5°C above preindustrial levels [1]. The potential impacts and risks are substantially lower for a 1.5°C global warming compared with a 2°C, including climate-related risks and threats to various ecosystems and human welfare.

“Footprints” are an increasingly popular concept to conceptualize the relations between production and consumption. GHG footprints include all direct and indirect emissions occurring along global supply chains and attribute them to the final consumption of goods and services [2]. From this perspective, household consumption induces around two-thirds of global GHG emissions, with the remainder being investments and government consumption [3]. Achieving absolute emission reductions requires transformative changes to production and consumption.

GHG footprints are very unequally distributed across the globe. This GHG inequality arises primarily from the inequality of income and consumption, with the richest being the highest GHG emitters. The global average GHG footprint amounts to 6.3 tCO2eq/cap in 2011. Regional averages vary between 13.4 and 7.5 tCO2eq/cap in North America and Europe and 1.7 tCO2eq/cap in Africa and the Middle East [345678]. GHG footprints of the super- rich have even been approximated at ~65 tCO2eq/cap 5. Yet, for a population of 8.5 billion by 2030 [9], emissions need to decrease to an average of ~2.8 tCO2eq/cap by 2030, to comply with a pathway of limiting climate change to 1.5°C of global warming [101112].

While technological solutions that decarbonize energy supply or capture GHG have to make a significant mitigation contribution, changing consumption offers much needed flexibility for reducing GHG emissions without betting on controversial negative emission technologies or geoengineering. Mitigation scenarios relying more heavily on reduction in the demand of energy services are clearly associated with the lowest mitigation and adaptation challenges [1314] and provide a range of co-benefits. Crucially, energy demand reduction should be taken seriously by policy makers worldwide, especially now that responses to economic crisis induced by the COVID pandemic are being formulated.

In a recent article published in the journal of Environmental Research Letters [15], we – a team of international scholars from the University of Leeds in the UK, the University of Natural Resources and Life Sciences, Vienna in Austria and the Mercator Research Institute on Global Commons and Climate Change in Berlin, Germany, embarked on a so-called systematic review to uncover the emission reduction potentials of climate-friendly consumption options across a rapidly growing research field. This entails comprehensively screening all the available literature and transparently and systematically selecting and synthesizing results across a wide range of studies published between 2011 and 2019.

We identify and summarize 60 consumption options from this literature and compiled and synthesize GHG reduction potentials associated with food, transport, housing and other consumption, considering the entire lifecycle and global supply chains (Figures 1 and 2). We also summarize key policy recommendations for the top options on how to overcome behavioral, institutional and infrastructural lock-ins currently inhibiting climate friendly everyday practices. This provides a rich and most-up-to-date evidence base to inform about mitigation potentials of changes in consumption practices, policies and infrastructure.

The potentials of 60 consumption options to absolutely reduce GHG emissions

We find that the top 10 climate-friendly options have substantial potential for GHG savings and adopting them could reduce an individual's GHG footprint by up to 9 tCO2eq/cap (Figure 1). Car-free living, plant-based diets without or very little animal products, renewable sources of electricity and heating at home as well as local holiday plans, all offer the possibility to drastically reduce the GHG footprints of everyday life.

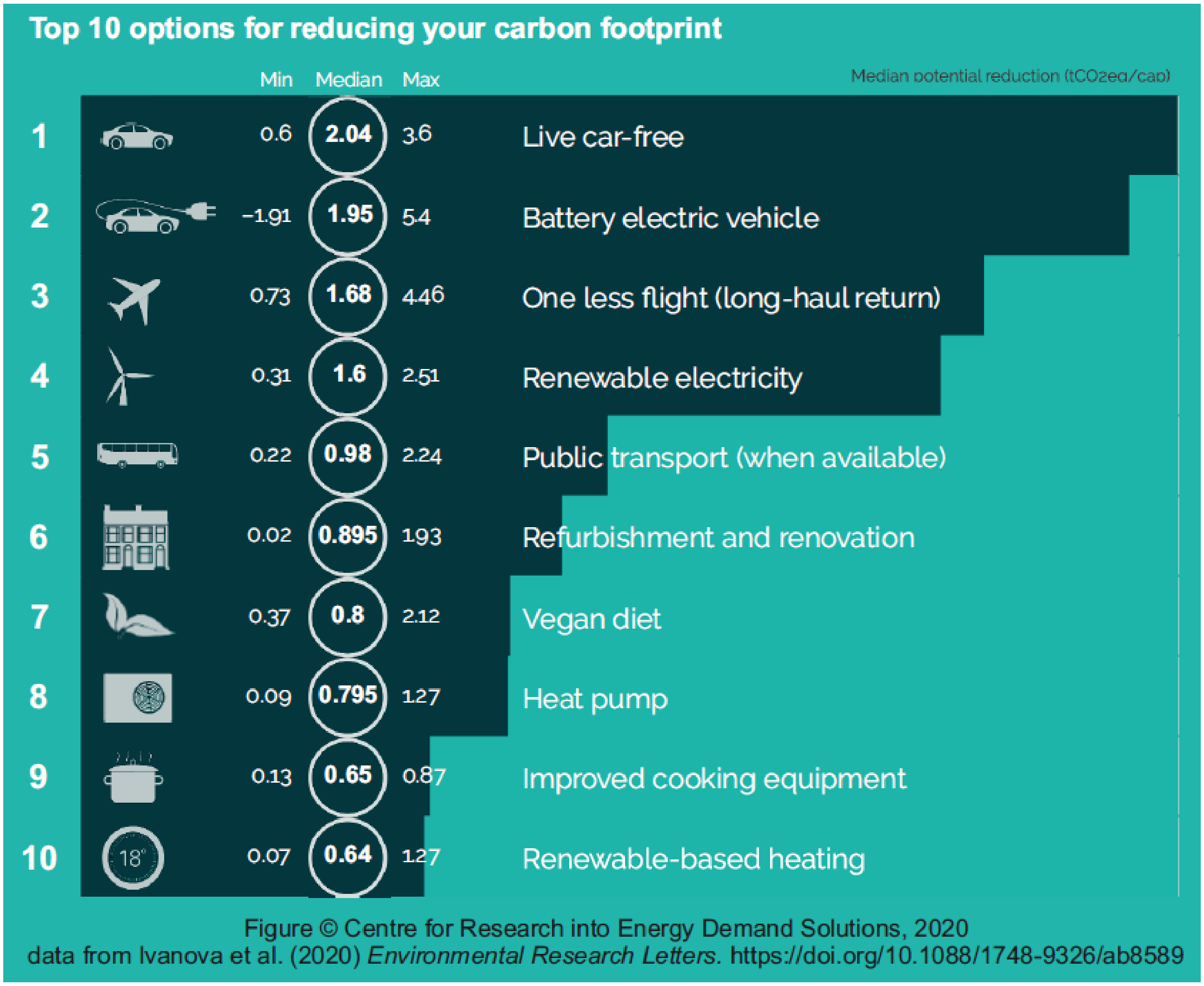

Figure 1: GHG mitigation potentials of Top 10 consumption options across the domains of food, transport and housing. Shown are median mitigation potentials and minima and maxima found in the literature. Please see figure 2 for a more comprehensive and full version across all 60 options. Source: [15]

The highest mitigation potential of all 60 reviewed options is found in the domain of transport, which is also an important driver of GHG footprint in most world regions [15]. The reduction in car and air travel have the highest mitigation potential, as well as a shift toward less GHG-intensive fuel sources, means and modes of transportation. Re-designing consumption requires 0vercoming existing social, infrastructural and institutional barriers, which "lock" us in GHG-intensive everyday practices

The potentials of 16 mobility-related options

From our review, we find that Living car-free has the highest median mitigation potential across all of the reviewed options at 2.0 tCO2eq/cap, with estimates ranging from 3.6 to 0.6 tCO2eq/cap. Assumptions around mobility practices before living car-free are key here, for example on vehicle and fuel characteristics as well as travel distance, with the maximum value being associated with giving up an SUV.

A shift to electric vehicle may reduce GHG footprints by 2.0 tCO2eq/cap, with estimates of up to 5.4 or even -1.9 tCO2eq/cap. Indicating the risk of a backfire. Strong fossil fuel dependence in electricity supply eliminates any GHG savings. Only when (relatively) green electricity is used to "fuel" electric vehicles, absolute GHG reductions occur.

Reducing air travel is another key option for those who fly, where avoiding just one long-haul return flight brings emissions down by 2 tCO2eq/cap. For partial reductions in air travel (Less transport by air) we find a median reduction potential of 0.6 tCO2eq/cap (Figure 2).

With the increase in traffic historically outpacing any efficiency improvements [16], only reduction in flights can realistically bring down emissions in the sector.

Active and public transport alternatives have much lower GHG intensities per travelled distance. Less car transport, Shift to active transport and Shift to public transport have a median mitigation potential between 0.6 and 1.0 tCO2eq/cap (Figure 2). These options are generally limited to replacing short and urban car trips with alternative transportation modes or reducing leisure trips, which constitute a relatively small portion of all travel and its embodied emissions. Telecommuting can reduce emissions by 0.4 (1.4 to 0.1) tCO2eq/cap. Car-pooling and car-sharing and Fuel efficient driving have an average GHG savings of 0.3 tCO2eq/cap (Figure 2). The practice of ride-hailing, or receiving transportation from an unlicensed taxi service, may even result in an increase in emissions as a result of “deadheading”, the travelled miles without a passenger between hired rides. The number of passenger sharing the trip makes a substantial difference in terms of mitigation potential, as well as the type of trip that is displaced (e.g. instead of private driving, public transit or walking). Thus, the shift from public transport to active transport offers only marginal mitigation potential per capita (Figure 2).

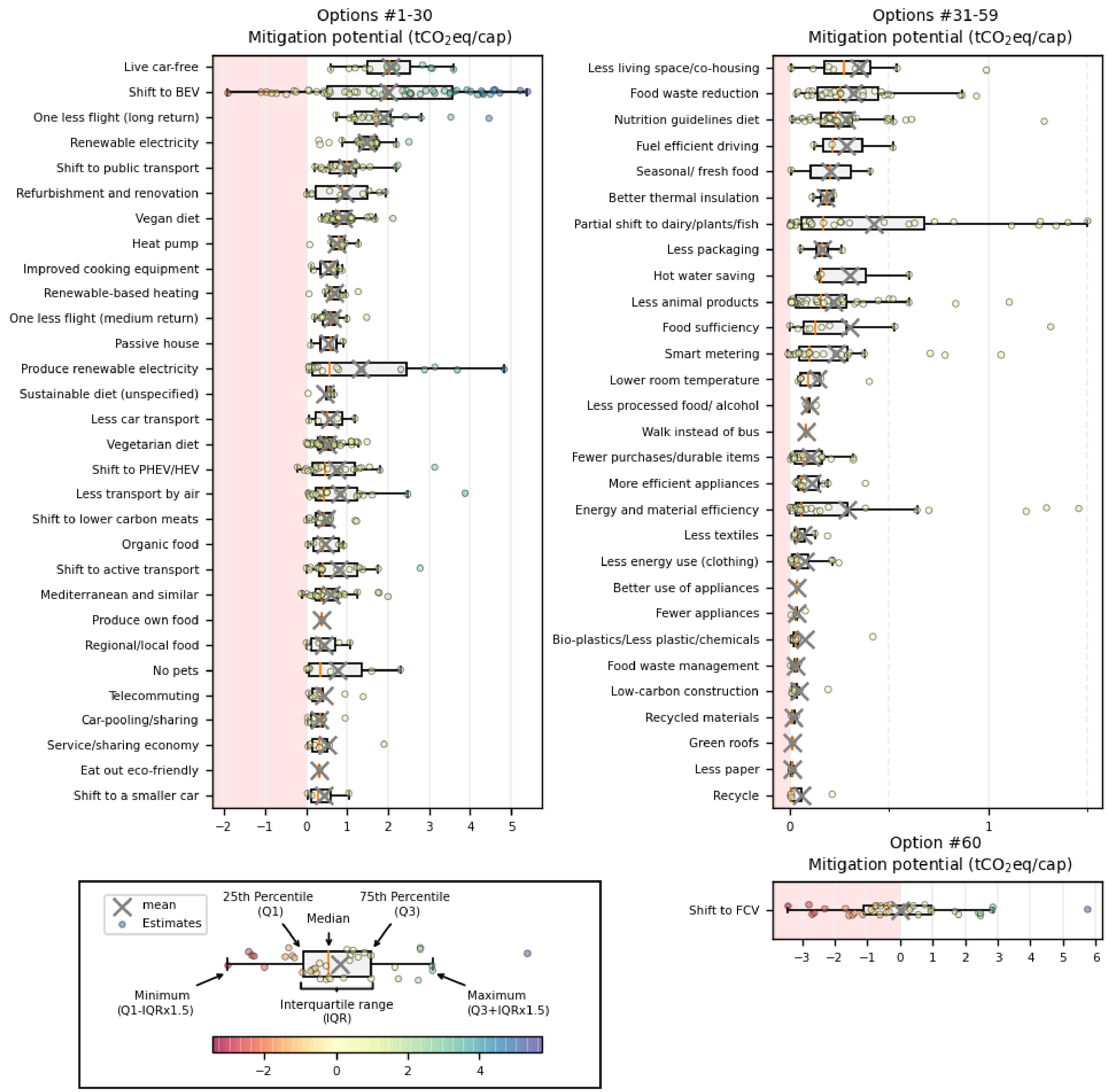

Figure 2: 60 synthesized consumption options ordered by the median GHG mitigation potential found across all estimates from the literature. The x-s are averages. The boxes represent the 25th percentile, median and 75th percentiles of study results. The whiskers or dots show the min and max mitigation potential of each option.Negative values (in the red area) represent the potential for backfire, i.e. a net-increase of GHG emissions due to adopting the option. Source: [15]

The potentials of 17 housing-related options

Purchasing Renewable electricity and Producing own renewable electricity have high potentials, with a median of 1.6 (2.5 to 0.3) and 0.6 (4.8 to 0.1) tCO2eq/cap (Figure 2). The ranges depend on the replaced primary energy source and contextual factors - e.g. energy mix and emissions required to manufacture renewable energy technologies (photovoltaik panels, wind turbines, ...), location (affecting the amount of energy that can be produced in the use phase), and the way technologies are used and maintained. Other effective housing & infrastructure-related options include Refurbishment and renovation, opting for Heat pump and Renewable-based heating, which offer a median mitigation potential of 0.9, 0.8 and 0.7 tCO2eq/cap, respectively.

Factors such as climate differences, dwelling type and share of renewables in the local grid are of crucial importance for the GHG savings potential of housing options. Furthermore, people living together tend to share space heating, cooling, lighting and the structure of the common living space, appliances, tools and equipment. These household economies of scale can also extend to other types of consumption (e.g. sharing food and cooking together).

The potentials of 19 food-related options

In terms of food-related mitigation potentials, we find that reducing or completely avoiding animal products features strongly across many options and can yield substantial GHG reductions (Figure 2). The GHG intensity per calorie is substantially lower for plant-based foods, especially compared to meat products. Deforestation (and emissions from land use change) are also most significant for meat-intensive diets due to increases in land requirements for pasture and growing feed [18].

The mitigation potentials of less or no animal products, for example through a Vegan or Vegetarian diet, a Mediterranean and similar have a median mitigation potential of 0.9, 0.5 and 0.4 tCO2eq/cap, respectively. Improved cooking equipment is associated with strong mitigation potential amounting to a mean and a median of 0.6 tCO2eq/cap. Cooking methods, fuels, choice of food and cook-ware, use and management of the cook-ware as well as storage time and space are all relevant factors.

Other options for GHG footprint reductions in the food domain focus on the production methods, transportation, seasonality and processing of food products. Organic food has lower emissions compared to conventionally produced food, with an average annual mitigation potential of 0.5 tCO2eq/cap and a median of 0.4 tCO2eq/cap. This mitigation potential is primarily attributable to the increased soil carbon storage and reductions of fertilizers and other agro-chemicals. Yet, backfires, e.g. increases in GHG emissions from organic food for the same diet can occur, due to lower crop and livestock yields in organic agriculture and the potential larger area required, inducing further land use emissions [19].

Furthermore, producing and consuming food in its natural season does not require high-energy input from artificial heating or lighting, thus reducing the embodied GHG emissions. Producing and consuming locally may reduce emissions from transportation and abate impact displacement overall, provided there are not large increases in energy requirements (e.g. in the case of heated greenhouse production or through the use of fertilizer). Regional production requiring the use of heating systems (e.g. fresh vegetables in the beginning of the growing season) may be associated with higher emissions compared to even substantial long-distance transport emissions from production sites without heating. We also note substantial mitigation potential associated with the reduction in consumed food and waste.

Policy recommendations

Finally, we selected the top ranking consumption options and synthesized respective policy recommendations from the literature towards overcoming the main infrastructural, institutional and behavioral GHG lock-ins [20]. Table 1 provides some examples of such GHG lock-ins and suggestion for overcoming them through adequate policy measures.

Top10 consumption options	Overcoming infrastructural lock-in	Overcoming institutional lock-in	Overcoming behavioral lock-in
Dietary shift (e.g. vegan, vegetarian)	Change land use practices – Remove investment infrastructure supporting unsustainable and extractive industries	Remove unsustainable subsidies in agriculture, e.g. for meat and dairy – Offer support for alternatives – Encourage just transition for animal farmers – Better availability of low-GHG options in supermarkets, restaurants, schools, etc. – Coordinated efforts of health organizations and government [21] – Ban advertising of high-carbon meats and other high-carbon items	Encourage low-carbon shared meals [22] and diets – Feedbacks for change in social norms and traditions around food consumption [22], e.g. vegan food as default – Decouple veganism/vegetarianism from a particular social identity

Top10 consumption options	Overcoming infrastructural lock-in	Overcoming institutional lock-in	Overcoming behavioral lock-in
Transport mode shift (e.g. car-free living, active and public transport)	More public transport infrastructure developments for urban and long-distance travel, e.g. cycling lanes, buses, trains – More bike spaces on public transport	Parking and zoning restrictions, e.g. car-free zones and days – Vehicle and fuel tax increases and toll charges – Make driving less convenient in urban areas – Enforce stricter air pollution standards – Ban car advertising – Tackling automobile industry power and its close ties with politics [23]	Raising awareness about co-benefits associated with active travel [24] – Social feedback with the visibility of cycling [25] – Decouple car travel from a particular social identity – Improve drivers awareness of cyclers and safety
Reduction in overall travel demand	More compact urban spaces and diverse land use [25]	Allow for flexible working schemes and telecommuting – Halt air travel expansion – Ban flight advertising	Carpooling and carsharing – Encourage telecommuting, moving into denser settlements
Upscaling of electric vehicles	Decarbonize the grid and meet potential additional capacity through renewables – Provision of charging infrastructure	Sustained policy support, e.g. free public charging, tax and fee deductions, subsidies for low-income buyers – Enforce stricter air pollution standards	Tackle charging time acceptance, range anxiety [262728]
Renewable-based heating and electricity	Infrastructure investment in renewables	Halt fossil fuel expansion/use and support upscaling of renewables Incentivize decentralized electricity generation, particularly for low-income households – Enforce stricter air pollution standards – Encourage just transitions for fossil fuel workers – Fossil fuel divestment	Raise public awareness and target NIMBY concerns
Refurbishment and renovation	Energy efficient construction and equipment	Enforce building standards – Encourage investment by dwelling owners and landlords in the fabric of the building and energy efficiency as well as broader home improvements [29] – Encourage just transitions, e.g. consideration of fuel poverty – Remove inefficiency of listed building	Public awareness around economic and environmental benefits – Reconcile investment incentives with householders‘ images of home comfort [29]

Table 1: A summary of the consumption options with the highest mitigation potential and ways to influence the infrastructural, institutional and behavioral GHG lock-ins associated with them. Source: [15]

Conclusions

Clearly, changing consumption has substantial potentials for emission reductions. We find that the large majority of household GHG footprints can be reduced with already available low-GHG consumption options (Figure 2). Systematically addressing rebounds and backfires is going to become highly relevant when implementing demand-side measures to unlock these potentials. Challenging current patterns of consumption and the societal dynamics upholding them, through a critical assessment of infrastructural, institutional and behavioral lock-ins (Table 1), therefore needs to become a priority for climate change mitigation [3031]. Making low-GHG consumption the easier and more desirable “option” requires societal changes and cannot simply be delegated to individual responsibility. Addressing the climate crisis requires mobilisation across global supply chains and becoming active change makers. This includes changing consumption but maybe even more importantly, becoming an active citizen by reflecting one’s choices and options across family life, work life, social life and political life.

Returning to the pre-COVID-19 “business (and consumption) as usual” moves societies deeper into the climate crisis. Now that many countries are lifting COVID-19 restrictions, it is a perfect time to rethink and change everyday activities locking us into emission-intensive consumption patterns [32]. To re-cast these everyday life changes into climate-friendly practices and thereby unlocking the potentials for reducing GHG footprints requires concerted efforts by policy, businesses and citizens to make them the easier and more desirable option.

Information and link to the openly available review study: Ivanova, D.; Barrett, J.; Wiedenhofer, D.; Macura, B.; Callaghan, M.; Creutzig, F. Quantifying the potential for climate change mitigation of consumption options. Environ. Res. Lett. 2020. https://iopscience.iop.org/article/10.1088/1748-9326/ab8589

Terminology:

- tCO2eq/cap = tonnes of GHG dioxide equivalents per person per year.
- GHG footprint = the amount of GHG dioxide equivalents released into the atmosphere as a result of the activities of a particular individual, organisation or community, such as a country or continent. This includes the full life-cycle emissions of production and consumption across international supply chains.

Notes

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Mobility

For the Mobile Lives Forum, mobility is understood as the process of how individuals travel across distances in order to deploy through time and space the activities that make up their lifestyles. These travel practices are embedded in socio-technical systems, produced by transport and communication industries and techniques, and by normative discourses on these practices, with considerable social, environmental and spatial impacts.

En savoir plus x

Long-distance travel

Long-distance travel is variously defined, with reference to either distance, travel time, overnighting or being outside of a person’s usual environment. When defined by distance (for example, over 100km), it typically accounts for the top 1-2% of trips.

En savoir plus x

Associated Thematics :

Lifestyles

- Alternative mobilities
- Change in practices

Policies

- Ecological transition

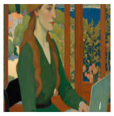
Other publications

Saudi Arabia: The transformation of mobility in the kingdom of oil

Aniss Mouad Mezoued, Mobile Lives Forum

Can universities learn to leave behind air travel?

Tamara Ben Ari, Parke Wilde



The impact of the teleworking revolution on the growth of megacities (Paris, London, New York)

BVA Xsight

Have metropolitan mobility policies been redefined by the Covid pandemic?

Jean Debrie, Juliette Maulat