WP1 Methods: Quantifying climate and health impacts of shifting lifestyles

As we have received EU 1.5° Lifestyles Work Package 1 (WP1) used environmentally extended multiregional input-output (EE-MRIO) analysis to calculate the carbon footprints of a country, region, or individual. Household carbon footprints are the greenhouse gas emissions attributed to final household consumption activities. These footprints are made up of both the indirect emissions in the upstream supply chain and the direct emissions from household fossil fuel combustion. WP1 used EXIOBASE 3 as the source data for all lifestyle change scenarios. Calculations were used to analyze baseline household carbon footprints in 2015, future carbon footprints in 2030 and 2050, carbon footprint reduction potentials of individual lifestyle options, reduction potentials of lifestyle change portfolios, and human health impacts from lifestyle change.

1. Carbon footprint projections and overshoots (Task 1) (Cap et al. 2024)

1.1. Partially decarbonized carbon footprint scenarios in 2030 and 2050

Emissions scenarios for 2030 + 2050 were created following Shared Socioeconomic Pathway 1, Representative Concentration Pathway 1.9 (SSP1-RCP1.9). This represents a 1.5°C-compatible trajectory that follows a 'sustainable development' paradigm. While the focus of our analysis was on the five case study countries selected for the EU 1.5° Lifestyles project, the background system modelling required the consideration of all of countries and regions in EXIOBASE to reflect decarbonization of imported products. We considered 11 variables to reflect the SSP1 scenario, including population, gross domestic product, total factor productivity, and economic sector shift. Additionally, household expenditures on individual final demand categories were adjusted based on income elasticities. Any activities that could be considered as lifestyle changes by the EU 1.5° Lifestyles project (e.g. reduction in household heating demand, adoption of electric cars) were omitted from the scenario to avoid double-counting with later lifestyle modelling.

1.2. Carbon footprint targets in 2030 and 2050

Household emissions for 2030 and 2050 were calculated from existing 1.5°C emissions pathways. The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR6) provides the median global emissions in all 1.5°C-compatible pathways in 2030 and 2050. We divided these global emissions in 2030 and 2050 by the corresponding SSP1 population levels to arrive at an equal global per-capita total footprint benchmark value. The emissions allocated to households were calculated with a scalar representing the household share (or 'lifestyle' share) from the total global (per-capita) emissions. This share was calculated based on the projections from this project. The average share of household emissions to total final demand emissions for all countries over the time series was calculated at 67%. The global per-capita target was then multiplied by this scalar to arrive at a household emissions budget.

2. Lifestyle change reduction potential modelling (Task 2, part 1) (Cap et al., forthc.)

The carbon footprint reduction potentials of 47 lifestyle options identified via literature review were modelled by defining scalars that represent a lifestyle change in the EE-MRIO database. These scalars were defined separately for each of the five case study countries to reflect relevant variations in baseline conditions, as well as the scenario years of 2030 and 2050. The relevant parts of the EE-MRIO database were multiplied by these scalars to reflect a discrete lifestyle change. Four types of changes are possible:

- Changes to the final demand by households, which reflect a change in consumption of the 200 product categories (e.g., reduced heating fuels for households to reflect a reduced heating demand).

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- Changes to the production recipes in the economy, which reflect a change in the composition of a product that a household buys (e.g., a change in the restaurant services sector to reflect a vegan diet).
- Changes to the direct household emissions, which reflect a change in the direct emissions from the combustion of fossil fuels. These changes are coupled with a change in the final demand. This means that eliminating a car not only reduces the emissions embodied in a car or fuel production but also emissions from fuel combustion when driving.
- Changes to the emissions intensity of products (e.g., reduced emissions of the fruit and vegetable sector from a switch to organic production).

EXIOBASE, like most EE-MRIO databases, is based on monetary units apart from the environmental extensions. Some lifestyle changes involved a reduction in physical units. With many absolute reduction options, such as giving up a car or flights, no conversion from monetary to physical units was necessary: the final demand values of the relevant categories could be set to 0. However, for modelling most other lifestyle changes, it was necessary to estimate the values in physical units to calculate the scalar representing this lifestyle change. These physical units were translated to scalar values that could be applied to the EE-MRIO database. For instance, calculating the reduction potential of solar panels required an estimation of the rooftop solar energy potential of a country, the increase in electrical materials to represent the installation of solar panels, the household financial investment needed over the lifetime of the panel, and finally a translation of these values to 200 product categories in the final demand or production recipes or the emissions coefficients in EXIOBASE.

3. Lifestyle change portfolios (Task 2, part 2)

Building on the previous modelling work to define background system decarbonization changes and consumption changes, we compiled various combinations of consumption change options into a unified portfolio representing a major lifestyle change on a population level. We then calculated the household carbon footprint resulting from various adoption levels of these lifestyle change portfolios across the five case study countries. From here, we assessed potential pathways to meeting the 1.5°C target. Portfolios were constructed so that multiple consumption change options could be taken together and so that the EE-MRIO model did not double-count the impacts from mutually exclusive options. In addition to this, we also modelled options where the relative change was important, such as switching to renewable energy and using less electricity. To accomplish this, we assessed whether each lifestyle change should be modelled relative to the baseline or after an adjustment, and then ordered the lifestyle changes in a way where relative changes took place after the other relevant changes. We created three main portfolio types. One involved the adoption of all lifestyle changes studied in this project. Another portfolio considered the preferences across the four consumption domains as expressed by individuals in citizen thinking labs (Vadovics et al., 2024). The final one assessed the theoretical maximum footprint reduction from only high-impact lifestyle changes. For all portfolios, we accounted for the effects of re-spending financial savings in a distributed manner, or on specific services with varying emissions intensities, such as education or air travel.

4. Health impacts from lifestyle changes (Task 3)

Human health impacts of mobility and nutrition-related sustainable consumption options were assessed by estimating the changes to dietary risk components and physical activity associated with each change. Changes were also assessed for portfolios of lifestyle changes. Physical layers for both mobility and nutrition were based on the values gathered for parameterizing the consumption change options. Where needed, more detail was gathered. The physical units were multiplied by corresponding

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characterization factors to express any changes to diets or physical activity levels in disability-adjusted life years (DALYs). Human health impacts from nutrition changes were assessed through dietary risk factors defined at a country level (E. Verly Jr, pers. commun.). The impacts for mobility options were based on the characterization factors established for physical activity levels associated with various transportation activities (O. Jolliet, pers. commun.). Health impacts to the general public from avoided emissions and the ensuing effects of global warming due to heat and cold stress were also considered through corresponding characterization factors (L. Rupcic, pers. commun.).

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