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Consumption Compass 2.0: a summary of methods and data used

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Contents

Summary

This document is a **method summary** for the **Consumption Compass**, a tool designed to help local municipalities in Sweden estimate and manage household consumption-based emissions. The tool is developed by the Stockholm Environment Institute and aims to promote sustainable consumption practices at the local level.

The method summary provides an overview of the methodological approaches behind the Consumption Compass, making complex data and methodologies accessible to non-experts. It outlines how different datasets are utilized, the calculations performed, and the principles guiding the estimation of consumption-based emissions. The summary is intended to inform municipal planners, policymakers and stakeholders and assist them in understanding and using the tool effectively in their strategic planning.

The Consumption Compass utilizes a variety of datasets to provide a comprehensive analysis of emissions. It focuses on estimating emissions at a high spatial resolution through a hybrid approach, breaking down consumption into **Demographic Statistical Areas (DeSO)**, thus enabling detailed insights into emissions linked to specific regions.

The tool assesses both **direct emissions**, which occur during the use of products, and **indirect emissions** that arise throughout the supply chain. It also addresses challenges such as data gaps and limitations in capturing the full impact of certain consumption behaviours.

By empowering municipalities with this information, the Consumption Compass helps local authorities plan strategies to mitigate climate impacts, supporting Sweden's broader climate goals while fostering community discussions around sustainability and resource equity.

1. Introduction

Many of the goods and services consumed in Sweden cause emissions elsewhere. Almost 65% of the total climate impact linked to Swedes' consumption occurs outside Sweden's borders (Swedish EPA, 2025). Consumption-based greenhouse gas (GHG) emissions are commonly used to account for this as they consider emissions based on the actors who consume goods and services, rather than necessarily where the emissions occur. This means that the emissions are not confined to specific geographical boundaries. This contrasts with territorial-based accounting, which is the basis of national inventory submissions to the UNFCCC, which instead considers emissions occurring within a given geographic boundary, no matter who has final responsibility for those emissions. In consumption-based emissions accounting, emissions are typically attributed to final consumers, such as individuals, households or the public sector, based on their expenditure or demand for products and services. The business sector is not considered a final consumer as all its purchases are embedded in the footprint of the products or services it produces.

The Consumption Compass is a data-driven online tool designed to estimate, monitor and mitigate household consumption-based emissions across Sweden with high spatial resolution. The tool's primary target group is Swedish municipalities, which have a central role in promoting sustainable consumption patterns among households. The tool is designed to support municipalities' strategic planning to reduce the climate impact of household consumption at the local level, and to encourage discussion and analysis about the changes needed to achieve climate goals at international, national and local levels. In addition, the tool aims to contribute to enhanced well-being and support a more equitable distribution of available resources.

The tool has been developed by the Stockholm Environment Institute (SEI) in close collaboration with Kalmar Municipality and Umeå Municipality. Funding has been provided by Formas - the Swedish Research Council for Sustainable Development.

Version 2.0 (launched in May 2025) builds on a previous Excel-based tool (version 1.0, launched in April 2022), expanding the analysis from a single year (2019) to a five-year time series (2019 – 2023).

This method summary aims to provide an overview of the methodological approaches behind the tool and the data sources used, presented in a way that is accessible to non-experts. Interested readers can refer to our scientific publication (Dawkins et al., 2024) for more detailed information about the methodology and data used in the first version of the tool. Additionally, please note that the tool's *About* page contains further information.

2. Consumption-based emissions accounting at the national level

In this section, we provide an overview of the work involved in estimating Sweden's consumption-based emissions at the national level and discuss some of the key aspects and methodologies underpinning this approach.

2.1 Classification of individual consumption according to purpose (COICOP)

In Sweden, consumption-based emission estimates are reported by Statistics Sweden (SCB) on an annual basis. To conduct these estimates, SCB uses the so-called environmentally extended input-output (EEIO) approach (Brown et al., 2022). This model takes into account Sweden's imports and exports and assigns average emission intensities to products imported from different regions or countries around the world. The model used is often referred to as the PRINCE-model (Policy Relevant Indicators for Consumption and Environment).

The consumption-based statistics follow the classification of individual consumption according to purpose (COICOP) structure (United Nations, 2018). COICOP is a UN statistical classification system used internationally for estimating households' consumption expenditures across a range of categories. In Sweden, there are 107 COICOP categories for which there are corresponding GHG at the national level.

2.2 Emission factors and carbon dioxide equivalents (CO_2-eq)

To estimate the climate impact linked to households' consumption, we need to understand the total amount of different GHG that have been generated throughout the production and consumption of the goods and services that are used. Carbon dioxide equivalents (CO_2-eq) is a measure used to illustrate the effect of various greenhouse gases that can be linked to consumption.

Different greenhouse gases have different effects on global warming. Their effects are compared with carbon dioxide (CO_2), which is the most common greenhouse gases and accounts for 75% of total emissions at the global level. It is also necessary to consider how long it takes for a given greenhouse gas to disappear from the atmosphere. All greenhouse gases have different lifespans. For example, methane is relatively short lived and is converted into CO_2 over a period of about 10 years. It is therefore common to estimate the impact of each greenhouse gas from a 100-year perspective (GWP100) (IPCC, 2023). This is also the approach used in the calculations that form the basis of the Consumption Compass.

Carbon dioxide has a global warming potential of more than 100 years (i.e. GWP100), which is set at 1. Other greenhouse gases, including methane (CH_4), nitrous oxide (N_2O) alongside various fluorinated gases (F-gases) have different values, which are typically given in units of carbon dioxide equivalents (CO_2-eq). For example, emissions of 1 tonne of methane correspond to 27 tonnes of CO_2-eq, meaning that methane impacts the climate around 27 times more than CO_2 over 100 years. Similarly, 1 tonne of nitrous oxide corresponds to 273 tonnes of CO_2-eq (IPCC, 2023).

The emissions generated during the production of goods and services can vary significantly depending on several factors, such as the country of production, the energy mix in that country, the choice of materials, production methods, and the transportation methods used to deliver goods to the point of sale. For each COICOP category (see 2.1) of consumption (e.g. car travel, clothing, furniture), SCB estimates the total climate-impacting emissions linked to the production of all goods consumed in Sweden, taking into account these factors (Statistics Sweden, 2025b). By associating these emissions with the amount Swedish households spend in each consumption category, it is possible to calculate an average emission amount (CO_2-eq) per Swedish krona (SEK) spent. This is known as the emission factor (EF). In the emission factors presented in the Consumption Compass, it is assumed that the same emission factor applies to all products within each COICOP category (e.g. clothing), regardless of whether the product is produced domestically or imported.

2.3 Indirect and direct emissions

Both indirect and direct emissions are considered when estimating consumption-based emissions. *Indirect emissions* refer to greenhouse gas emissions associated with the consumption of goods and services in any of the 107 COICOP categories. These emissions occur throughout the entire supply chain, from production to transportation, regardless of whether the products are manufactured in Sweden or abroad. For example, it reflects the emissions that arise during the production of the cars, clothes, furniture and electronics consumed in Sweden, no matter where those products were made. More than 65% of Sweden's total consumption-based emissions occur in other parts of the world and can be said to have been imported into the country for final consumption (Swedish EPA, 2025).

To get a complete picture of Swedish households' consumption-based emissions, so-called *direct emissions* are added to the indirect emissions. Direct emissions refer to greenhouse gas emissions generated within Sweden's borders during the consumption phase of a product's lifecycle. This includes emissions that occur during the use phase, such as the emissions generated when a fossil fuel car is driven, when fireworks or different types of solvents are used, or when we burn fuel to heat our homes.

3. The Consumption Compass: principles for estimating consumption-based emissions at the local level

In this section, we summarize the model behind the Consumption Compass tool and the data sources used. Before going into the details of the model, we introduce the geographical units used and describe how we have worked to align the national consumption-based emissions with consumption patterns at the local-level.

3.1 Demographic statistical areas (DeSO)

Demographic statistical areas (DeSO): The Consumption Compass estimates consumption-based impacts for Sweden's so-called **demographic statistical areas (DeSO)** (Statistics Sweden, 2025a). DeSO is a geographical classification developed and used by SCB since 2018. DeSO follows municipal boundaries and divides Sweden into 5984 geographical areas, with between several hundred and several thousand inhabitants . In comparison, Sweden has over 17 000 postal codes. DeSO is thus larger than typical postcode areas. The interested reader can read more about DeSO on SCB's website, and look at geodata on how SCB has divided Sweden into the different geographical areas (Statistics Sweden, 2025a).

3.2 Hybrid scaling approach

SCB's data on consumption-based emissions at the national level serves as the foundation for the tool's estimates. To support the downscaling of the data from the national to the local level, the model uses a hybrid approach that integrates downscaling of national-level data to local DeSO levels and upscaling of local-level data to ensure consistency with national totals. Another way to describe it is that we use a hierarchical data-scaling approach, by which we mean that the data is scaled both up and down across different levels (from DeSO to national, from local to DeSO, or national to DeSO), with different methods depending on the data source.

In doing this, the model ensures that the sum of the local emissions aligns with the national total (with one exception, for air travel emissions, as explained in section 3.3.1, point C).

More specifically, a **bottom-up approach** typically involves collecting data at the finest scale possible and scaling it up to larger geographical scales (e.g. municipality, county, country) to generate reliable estimates for a specific area. In many cases, data (typically as consumption expenditure or another consumption proxy) is obtained at the DeSO or municipal level and scaled up to match national totals. We can refer to these approaches as “bottom-up with top-down validation” within our model, where the national level emissions data is used to assign a proportion of the national emissions for the local areas.

Emissions associated with households' use of personal vehicles are the only true bottom-up calculations included in the Consumption Compass. However, even these emissions have been rescaled to align with the official national emissions statistics. This has been done by multiplying all values by the ratio between the bottom-up calculation and the official national statistics.

In the Consumption Compass model, the **top-down approach** refers to scaling down emissions data calculated by SCB at the national level to the DeSO level. This is done using different distribution principles tailored to specific consumption categories.

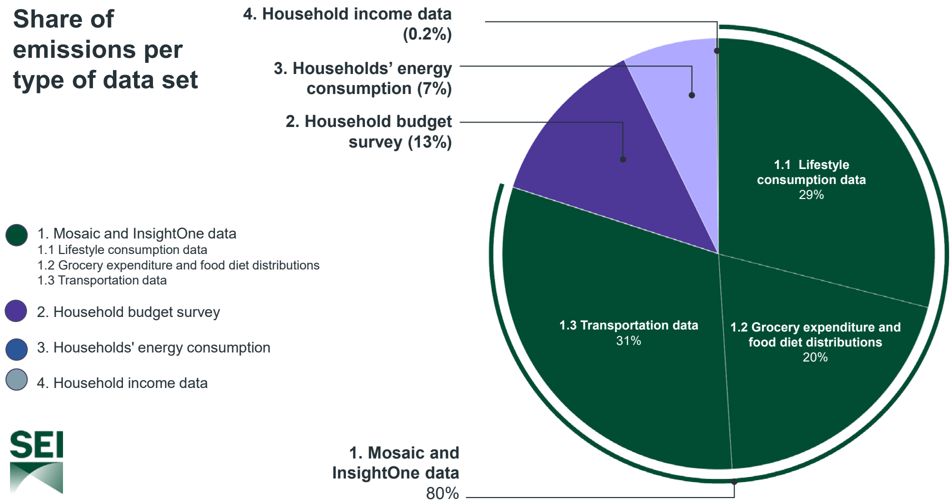
Direct downscaling: for three consumption categories (representing around 0.2% of total emissions), emissions are directly downscaled from the national level to the DeSO level, with income as the sole proxy (see 3.3.4).

Municipality-based survey data: for approximately 13% of the total emissions, we use data from SCB's household survey (Statistics Sweden, 2024), which estimates household consumption patterns across nine municipality groups in Sweden. This data is essentially collected bottom-up but further downscaled to the DeSO level. The nine municipality groups are defined based on principles such as population size, geographical density, and proximity to larger cities or urban areas (SALAR, 2022). In the first step, the total climate impact per municipal group is calculated based on consumption patterns for different municipal groups. In the second step, the distribution to the DeSO level is further refined using household income, with the assumption that higher incomes lead to higher consumption (e.g. Lévay et al., 2021; Nielsen et al., 2024). For further details, see 3.3.3 and 3.3.4.

3.3 Methodological approaches and data sources used

This section provides an overview of how the two methodological approaches (bottom-up vs top-down) are applied and outlines the data sources used in each stage. For further details, refer to Annex 1, and for the complete list of data sources used, see Annex 2. Also see Figure 1, summarizing the different datasets used.

Figure 1. Share of emissions per type of dataset



Bottom-up

3.3.1 The Mosaic dataset and InsightOne data (80% of total emissions)

The Mosaic dataset (InsightOne, 2025) is one of the key datasets in the Consumption Compass and is an integral component of the bottom-up data used in the tool. Mosaic is a dataset that SEI can access through a collaboration with InsightOne, a data and analytics company specializing in providing customer and market insights to businesses in Sweden and the Nordic countries. The Mosaic method, developed by Experian in the 1990s, segments individuals and households based on demographic, behavioural, and lifestyle characteristics, as well as consumption patterns, and provides population distributions at the DeSO level. InsightOne is responsible for applying Mosaic in Sweden and the Nordic countries.

Mosaic divides the Swedish population into 44 different household profiles, which are represented to varying degrees in each DeSO and postcode. Households in each profile are assumed to have similar consumption patterns, regardless of their geographical location. By grouping households based on lifestyles and consumption patterns, we can assess consumption at a more detailed level. This is useful for identifying targeted, effective measures to influence consumption at the local level.

To create the Mosaic segments, InsightOne combines public and private data sources. This includes demographic and geographical data from SCB as well as data from authorities such as the Swedish Transport Agency. Furthermore, InsightOne collects information about consumption behaviour and transaction history through collaborations with retail companies and e-commerce sites. To generate data on Swedes' lifestyles, values and interests, InsightOne also conducts its own surveys, often in collaboration with KantarSifo, a leading Swedish market research and public opinion institute, to generate insights into consumer behaviour, media, and societal trends.

Based on the consumption and lifestyle habits of each Mosaic profile, SEI calculates the emissions linked to how much people in each profile spend (in SEK) on different consumption categories. To ensure that the total values align with SCB's national figures, Mosaic data is used solely to understand the composition of the consumption per DeSO. What is important for the emissions calculations is the proportion of total expenditure each DeSO represents. These are then used as weights to downscale the national emissions. Almost 80% of the total national emissions have been estimated with the support of the Mosaic and InsightOne data. Points A to C below describe where Mosaic data has been applied (see Annex 1 for a detailed list of the consumption categories that have been estimated with the different data sources). The percentage value noted under points A to C refer to the share of national emissions , with the percentage range describing the minimum and maximum shares seen across all years.

A. Mosaic lifestyle consumption data

Percent of total emissions at the national level: 29%
Number of consumption categories included: 40
Percentage range of total national emissions across the time series: 27–31%

This data uses consumption patterns and socio-economic data from surveys to estimate the annual consumption of each consumer profile across 40 different consumption categories, such as clothes, furniture, toys, sports equipment, electronics and more (see Annex 1 for details). We have mapped these categories to the COICOP classification. By combining this mapping with the distribution of Mosaic profiles in each DeSO area, we estimate the total expenditure on each COICOP category associated with the Mosaic household profile. Emissions are then assigned to each DeSO based on the expenditure of the Mosaic groups represented in each DeSO.

B. Mosaic grocery expenditure and food diet distributions

Percent of total emissions at the national level: 20%
Number of consumption categories included: 14
Percentage range of total national emissions across the time series: 18–23%

A slightly different approach is used for emissions associated with food. In this case, Mosaic data on grocery expenditure in each DeSO is used (14 categories). However, in order to recognize variations in diet, this data is combined with data from the online tool Klimatkalylatorn (Stockholm Environment Institute & WWF, 2023). Since its launch in 2017, Klimatkalkylatorn has collected nearly 1 million user responses at the postcode level, covering around 95% of Sweden's postcodes.

From these responses, we estimate the share of people following different diets in each municipality. To ensure more reliable estimates, we assume that dietary patterns are similar across all DeSOs within a municipality. We also assume that diet distributions remain relatively stable over time. This allows us to combine data from multiple years. These assumptions were made to increase the robustness of the dataset since it helps to mitigate sampling issues that could arise at higher spatial or temporal resolutions. Using separate data for each year and DeSO could lead to sample sizes being too small or not representative enough of the local population and thereby having a high susceptibility to outliers.

We then estimate the proportion of food expenditure across food-related COICOP categories for each diet. By multiplying these values by the distribution of diets in each DeSO, alongside Mosaic data on grocery expenditure, we generate an estimate of total expenditure on food-related COICOP categories in each DeSO. This is adjusted for regional price differences using data collected by PRO, the Swedish pensioner's organisation (PRO, 2025), on the average cost of a basket of goods across Swedish supermarkets. Emissions are then assigned to each DeSO based on its proportion of total calculated food expenditure across all DeSOs.

C. InsightOne and Mosaic transportation data

Percent of total emissions at the national level: 31%
Number of consumption categories included: 13
Percentage range of total national emissions across the time series: 27–37%

For estimating most of the transport-based emissions (13 categories in total), we rely on data from InsightOne. For private transport (i.e. **car travel**), we use estimates of total distance driven in kilometres and emissions at the DeSO level, provided from InsightOne and based on data from the annual vehicle inspection registry. These emissions are scaled to national emissions and are used as a proxy for nearly all COICOP categories associated with private car use.

There is no public data available on the full impact of household **air travel**, so the model relies on a combination of different data sources to estimate air travel impacts. As mentioned above, the model downscales Sweden's national emissions to the local level and seeks to represent as accurately as possible national consumption-based emissions estimated by SCB, while incorporating local variation through available socioeconomic and spatial data. The sum of all emissions at the local level should match the national total estimated for Sweden. The only exemption we have made from this rule is connected to air travel.

SCB's model underestimates the true impact of Swedish household air travel emissions, because it only accounts for the emissions from the fuel used to load the aircraft in Sweden before take-off (so-called bunker fuels). As a result, for flights departing from Sweden with onward connections abroad (e.g. Stockholm to Paris and onward to Bangkok), only the first leg is accounted for, and emissions from subsequent segments are missed (e.g. Paris-Bangkok leg). Furthermore, SCB's data does not account for the increased climate impact caused by flying at high altitudes (Lee et al., 2021). The model behind the Consumption Compass tool accounts for both long-haul air travel and the high-altitude effects of flying.

To ensure the air travel data reflects the full effects of Swedish households' air travel, the model incorporates data from a study from Chalmers University (Kamb & Larsson, 2018), which covers Swedish air travel up to 2017. To account for developments since then, the model incorporates annual data gathered by InsightOne as part of their Mosaic data, covering a statistically representative sample of household air travel per DeSO. Additionally, it includes statistics on general air traffic developments from Swedish airports, provided by Trafikanalys (2024) to approximate changes in air travel and emissions seen since 2017.

From the Mosaic dataset, we have access to survey data on households' air travel for each lifestyle segment. Using this data, we estimate the total kilometres travelled and the number of journeys by lifestyle segment, which are then combined with the distribution of Mosaic profiles at the DeSO level.

To prevent extreme values from skewing the average, InsightOne applies a method known as the trimmed average. This approach removes the highest and lowest values per DeSO, making the mean more robust and less sensitive to outliers over time. This, alongside the greater population of DeSOs compared to postcodes on average, means that version 2.0 of the tool has fewer extreme outliers related to air travel than version 1.0.

In terms of impact, the model also accounts for the long-distance nature of air travel and the high-altitude effects. Emissions at high altitudes have a stronger climate impact than the same emissions at ground level because gases and particles behave differently in the upper atmosphere. For example, water vapour at high altitudes can lead to the formation of condensation trails, which affect the heat balance in the atmosphere. These high-altitude effects lead to a higher climate impact by emissions than if the same emissions were released at ground level, where the dispersion and climate impact of these substances differ (Lee et al., 2021 and Swedish Environmental Protection Agency, 2023. By considering these factors, the model provides a fairer and more accurate picture of the total climate impact of air travel.

The Mosaic dataset also includes survey data for other types of transport such as **public transport, long-distance train and sea** travel, which is used to estimate the total km travelled by lifestyle segment, which is then combined with the distribution of Mosaic profiles at the DeSO level.

3.3.2 Household energy consumption

Percent of total emissions at the national level: 7%
Number of consumption categories included: 5
Percentage range of total national emissions across the time series: 6–8%

Emissions arising from household energy use are based on a variety of different sources. We mainly use SCB data on energy consumption by energy type and consumer at the municipal level. This includes a breakdown between apartments and single-family houses. This is used to assign a proportion of total emissions to the municipal level. The SCB dataset has a value for zero for household gas consumption in all municipalities. In order to therefore account for natural gas-based heating emissions, we rely on data from the Swedish Energy Agency (Energimyndigheten). This data is scaled down to the county level, accounting for differences in gas use in apartments and single-family houses. Additionally, district heating emissions are also weighted by the average emission factor in each municipality, which has been determined separately for each year using annual data from Swedenergy (Energiföretagen) (2024).

From this point, energy-related emissions are distributed to the DeSO level using total floor area in each DeSO as a weight. Apartments and single houses are considered separately. This means that within each municipality (or county in the case of gas use), we assume that energy use per m^2 of floor area is constant. Estimates of floor area in each DeSO are made by combining data on the number of households, people and housing type in each DeSO, alongside the average apartment and family-size at the municipal level. We also rescale this data using InsightOne estimates of average house sizes by lifestyle segment, which was done to reflect differences in house sizes amongst the population. However, different energy sources are not distributed homogeneously within each municipality: urban areas, for example, are more likely to use district heating. To understand the distribution of each energy source within each municipality, we use non-public data from Boverket (the Swedish National Board of Housing, Building and Planning) for the purposes of this analysis, from the current and previous year. Since Boverket data is self-reported and only includes data on house and apartment sales, its reliability and coverage across and between DeSOs could not be verified. It is therefore only used to determine whether an energy source is present in a DeSO, not how much energy is consumed.

The COICOP classification includes categories for the purchase of solid, liquid and gaseous fuels. However, as stated above, SCB's model for consumption-based emissions does not account for household combustion of these fuels. To address this, we estimate the national share of direct household emissions associated with each fuel type by using emission factors from Sweden's national inventory report (Naturvårdsverket, 2024) and total energy use of each fuel type in private houses from the Swedish Energy Agency. After calculating the proportion of direct emissions associated with each fuel carrier, these direct emissions are assigned to the DeSO level based on its proportion of emissions across all DeSOs for the COICOP categories associated with solid, liquid and gaseous fuels. Since a detailed elaboration of the data is done at the local level before scaling it up to the national level, we consider this to be part of the model's bottom-up approach.

Top-down approach

3.3.3 Household budget survey

Percent of total emissions at the national level: 13%
Number of consumption categories included: 32
Percentage range of total national emissions across the time series: 11–15%

For the remaining 32 categories of products and services that are not covered by the previously mentioned datasets, we used SCB's 2021 household budget survey (Statistics Sweden, 2024). This is considered part of the model's top-down approach because we use these datasets to assign expenditure and therefore emissions to municipal groups, after which it is downscaled to the DeSO level. The household budget survey, a survey undertaken by SCB at irregular intervals, provides data on household expenditure at the municipal group level, for which there are nine in Sweden

(SALAR, 2022). The categories in the household budget survey are similar to, but do not fully align with, the COICOP classification. Therefore, we reclassify the data into COICOP categories and adjust from the household level down to the per capita level, using data on average household size by municipal group, provided by SCB. The proportions of total expenditure between municipal groups are used to downscale the Swedish national emissions to the municipal group level for each year in the tools. This builds on the assumption that the per capita consumption in the different groups is stable over the years and total variations in total consumption between years depend only on population change.

However, the SCB survey has some data gaps, due to uncertainties or insufficient coverage. In these cases, we interpolate or apply values from municipal groups with similar characteristics (e.g. urban, suburban, rural) to fill in the gaps, ensuring an accurate comparison between groups. We then multiply this adjusted expenditure by the population in each municipal group for each year to estimate total expenditure for these remaining COICOP categories. Finally, we downscale this total expenditure to all DeSOs within the municipal group, using net income as a proxy to estimate expenditure for each DeSO. Emissions are assigned to each DeSO based on the proportion of total expenditure across all DeSOs.

3.3.4 Income as a proxy

Percent of total emissions at the national level: 0.2%
Number of consumption categories included: 3
Percentage range of total national emissions across the time series: 0–0.2%

For three categories of consumption (stationary materials, private education and religious and ritual items), detailed data to support downscaling to the DeSO-level is currently unavailable. As a result, these values are assigned to each DeSO using only net income as a proxy and no assumptions are made about how such expenditure varies as a result of lifestyle, geography or other factors. From this point, emissions are then allocated to each DeSO using the proportion of its expenditure relative to total expenditure across all DeSOs.

3.3.5 Model limitations

The Consumption Compass is based on a model that estimates the climate impact of consumption for all of Sweden's households at fine geographical scales. The model links the climate impact to monetary flows, and as such the inherent limitations of this approach also exist in the model. EEIO-based approaches amalgamate different individual products into categories or sectors and assign emissions only at this sectoral level. This is known as the homogeneity assumption. Furthermore, such approaches assume a linearity between expenditure and emissions which may not always reflect reality. For example, it is not possible to see whether a household has bought five cheap shirts or one expensive one and the climate impact is estimated to be the same in both cases. These two limitations are well-known and reported extensively in literature (see e.g. (Kitzes, 2013). Additionally, all the datasets that the model relies on will have their own associated limitations and uncertainties. Data that were originally generated from sampling, such as the annual questionnaires used in the Mosaic data, rely on the results generated from a subset of a given population being an accurate reflection of the total population. Other data, such as those derived from national emissions inventories, will depend on the methodologies used in each case. For instance, private vehicle emissions are often estimated from national fuel sales, assuming all fuel is used that year and mostly by residents within the country. While some cross-border driving and non-resident fuel use occurs, most fuel is likely consumed domestically by residents, making territorial and consumption-based emissions roughly equal in this case.

SCB also reports on uncertainties in calculations done at the national level (Statistics Sweden, 2021). For example, the household budget survey data from SCB have several limitations, and data points for which the uncertainty was deemed too large were not shared with us. The methods used to estimate the impact connected to the consumption categories informed by the household budget surveys are described in Section 3.3.3. Indeed, since there is no access to detailed data on exactly how households consume, the model is based on estimates and generalizations, such as the assumption that many households have similar consumption patterns regardless of their location in Sweden. A key general assumption, which further reflects that inherent to EEIO, is that emissions scale linearly with the unit used to downscale emissions, such as expenditure, floor area, or distance travelled. However, this can be justified in the absence of more information on these relationships, which may also vary across geography and between different years. Overall, the tool can still be considered to offer informed estimates that can serve as the basis for comparing differences and similarities in household consumption patterns across the country, and support strategic decision-making, policy and knowledge development.

4. Forecasted emissions

Version 2.0 includes data for the period 2019–2022 and forecasted emissions for 2023. Official consumption-based emissions statistics from SCB are typically delayed by about two years. Data for 2022, for example, was only released in November 2024, and it is also the most recent year for which emission factors are available. However, much of the data for 2023 is already accessible, so emissions for this year are provided in Consumption Compass 2.0 by projecting the relevant missing datasets to 2023. Datasets available up to 2022 include:

- Emissions and emission factors for all categories of consumption by COICOP category
- Total national household consumption by COICOP category
- Direct emissions for transport and household fuels
- Emissions from public consumption and investments
- Household Budget Survey (latest available data from 2021)

No national-level consumption-based emissions or expenditure data are yet published for this year. These values thus had to be forecast based on the available data until 2022. To do this, the average expenditure per capita for each category of consumption was determined for the years 2014–2022 using constant 2020 prices. Next, a projection for 2023 was made for each category, typically using a linear regression with exponential smoothing to emphasise more recent trends. A similar calculation was performed using the emission factors for previous years. These values were then multiplied together and scaled by the population in 2023 to give an estimate of total emissions for that year. The associated expenditure data was converted into 2023 prices to derive the emission factors used in the tool. Similar forecasting was performed for any missing direct emissions.

The forecasting introduced additional limitations for the year 2023, not least because the effects of the Covid-19 pandemic often led to abrupt changes in emissions and consumption in the years 2020–2022. However, the associated values for 2023 do in general follow the trends of prior years and will further be updated with the official figures once they become available.

5. Scenario function

The scenario function in the Consumption Compass enables municipalities and other actors to explore how changes in local consumption can contribute to lowering the carbon footprint of Swedish households. Through the scenario function, users can adjust household consumption in transport, housing energy, food, clothing and goods, in relation to the tool's most recent estimates. The tool then shows how these adjustments would affect emissions over time, starting in the year in which an adjustment is initiated (2022 or later) through to 2050. These results can be useful for illustrating how adjusting consumption patterns in Sweden can support global efforts to achieve greenhouse gas emission targets.

5.1 Reference scenario

Emission reduction scenarios are constructed against a simplified reference scenario. The reference scenario holds *per capita* consumption-based emissions *constant over time*, starting with a municipality's 2022 inventory and continuing to 2050. *Total* emissions in the reference scenario increase (or decline) in proportion with projected changes in population, but underlying consumption patterns and emission intensities remain unchanged. This provides a simplified, but transparent, basis for evaluating emission reduction measures.

5.2 Emission reduction scenarios

Emission reductions scenarios are constructed by configuring inputs related to 10 possible shifts in consumption across four different sectors:[1]

Transport	Home energy	Food	Goods and clothing
Reducing car travel Reducing car ownership Shifting to electric cars Reducing air travel	Reducing home energy consumption	Reducing household food waste Reducing meat consumption Reducing dairy consumption	Reducing clothing consumption Reducing furniture & furnishings consumption

For each scenario lever, users can select the target percentage change in consumption, the year in which this change begins, and the year by which the full change is achieved. For reduced meat and dairy consumption, users must additionally specify the types of food or beverages to which consumption is shifted.

1 Note: in principle, adjustments to consumption could be positive or negative. Because the tool is focused on modeling emission abatement scenarios, it allows only adjustments that reduce emissions.

5.3 Rebound emissions

All emissions reduction options, except for shifting to electric vehicles, will result in some degree of cost savings.[2] However, money that households save on one type of consumption is typically spent on other forms of consumption, which have their own associated emissions. The scenario tool estimates these "rebound" emissions by assuming that any monetary savings made from a reduction in one type of consumption will be spent on an average mix of all other types of consumption. Total rebound emissions are therefore calculated according to the following general formula (Equation 1).

Equation 1:

$$RE = \sum_i \left(\frac{ER_i}{I_i} \times I_a \right)$$

Where:

RE	=	Rebound emissions (tCO_2-eq)
ERi	=	Consumption-based emission reductions from reduced consumption in category i (tCO_2-eq)
Ii	=	Emissions intensity for consumption category i (tCO_2-eq / 100 SEK)
Ia	=	Average emissions intensity of all household consumption (tCO_2-eq / 100 SEK)

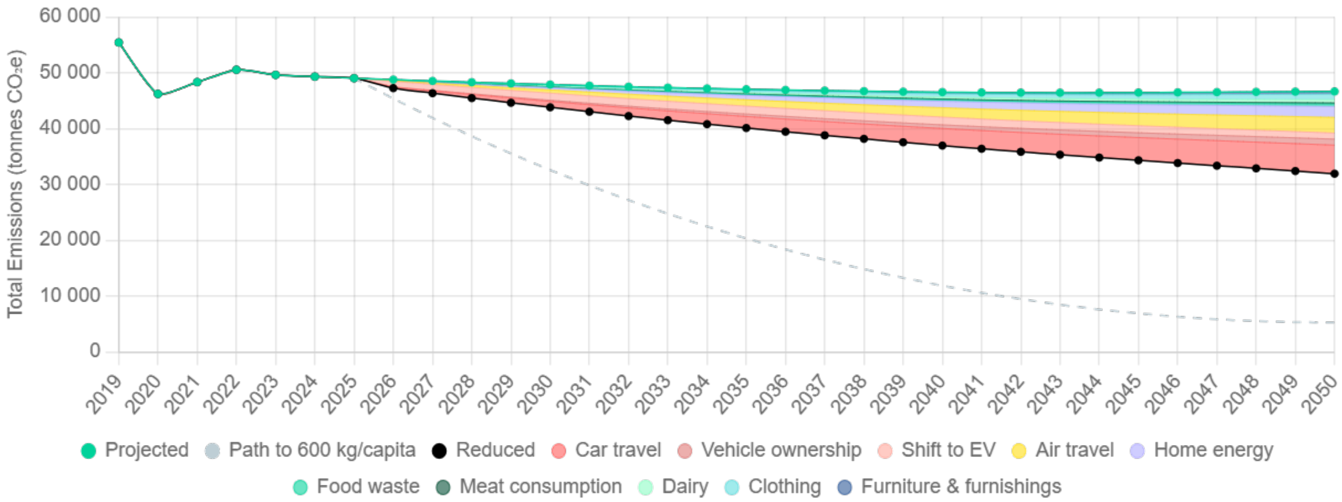
However, not all emission reductions measures will result in cost savings. Emission reductions *not* associated with cost savings are excluded from Equation 1.

5.4 Results

The results of scenario configurations are displayed in two different charts. The first is a "wedge" chart, a common visualization in climate mitigation analysis that illustrates the relative contribution of each measure to reducing consumption-based emissions over time. The values in this chart are calculated based on user inputs. See Figure 2. The top line of the wedge chart indicates reference scenario emissions (historical values are shown for years 2019–2022; all other years are projected). The shaded areas ("wedges") beneath this line indicate emission reductions, relative to the reference scenario, associated with user-configured consumption adjustments. Rebound emissions are not included in the wedge chart.

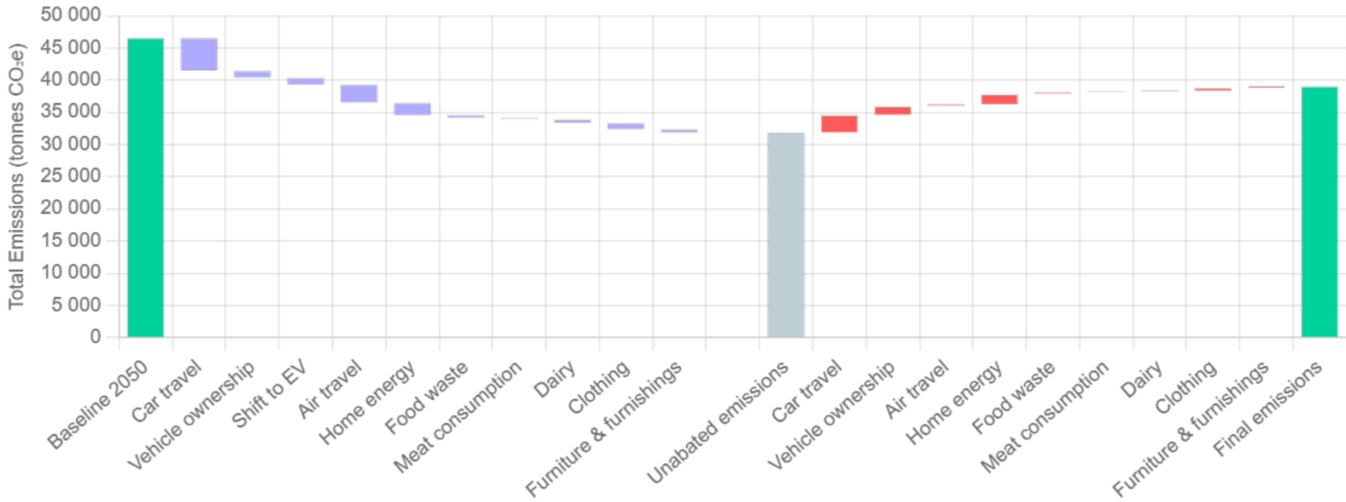
2 Multiple studies suggest the total cost of vehicle ownership is lower with electric vehicles. For simplicity, however, shifting from conventional to electric vehicles is assumed to have no cost savings.

Figure 2. Consumption scenario wedge chart



The second chart is a "waterfall" chart, which indicates the relative contribution of each measure to reducing emissions in a *single year* (i.e. 2050) – see Figure 3. Reference scenario emissions are indicated in the bar on the far left of the chart. The contributions of each consumption measure are shown in successive, staggered rectangles to the right of this bar. The central bar displays "unabated" emissions, or the remaining emissions after measures are implemented. To the right of this bar, further successive rectangles illustrate the rebound emissions that are associated with each of the implemented measures. The total net reduction in emissions from all measures, after including rebound emissions, is indicated by the bar to the far-right side of the chart.

Figure 3. Consumption scenario waterfall chart



5.4 Model limitations

The scenario tool's outputs illustrate potentially achievable consumption-based emission reductions, assuming changes in consumption relative to a reference scenario. While the results are derived from a model, they should not be interpreted as forecasts. In particular, the tool does not simulate economic interactions, such as shifts in production, supply chains, and emissions intensities that might occur in response to major shifts in household consumption. The tool should therefore be considered as a kind of "sketch tool" for exploring emission reduction potentials.

In addition, scenario measures only target a subset of total household consumption-based emissions (emissions potentially affected by available measures account for approximately 60% of *total* consumption-based emissions). Emissions from consumption of services, for example, are not affected. This means that, even if all measures are set to their maximum reduction values, emissions will not be reduced to zero by 2050. The tool is intended to illustrate the potential contribution of a set of feasible and impactful consumption changes, not to explore all possible ways in which emissions could be reduced.

Annex 1. Consumption categories according to COICOP, and by downscaling source

In this Annex and in Tables A to F, we list the data sources that have been used to inform the downscaling of the COICOP categories. For more details about the different COICOP categories, please refer to United Nations (2018). Kindly note that for some categories, we have shortened and simplified the naming of the COICOP categories in the tool. The categories in each table have been downscaled using slightly different methodologies, based on the data source or type listed in the heading, alongside other data. More information on the downscaling methods is given in the main text.

Mosaic lifestyle consumption data (29% of total emissions)

40 consumption categories, range at the municipality level: 27–31%

COICOP number and name of consumption category
01.1.9 ready-made food and other food products
02.1.1 spirits and liquors
02.1.2 wine
02.1.3.1 high-alcoholic beer
02.1.3.2 low-alcoholic beer
02.3 tobacco
03.1.1 clothing materials
03.1.2 garments
03.1.3 other articles of clothing and clothing accessories
03.1.4 cleaning, repair, tailoring and hire of clothing
03.2.1 shoes and other footwear
03.2.2 cleaning, repair and hire of footwear
04.3-04.4 maintenance, repair and security of the dwelling and other services
05.1 furniture, furnishings, and loose carpets
05.2 household textiles
05.3 household appliances
05.4 glassware, tableware and household utensils
05.5 tools and equipment for house and garden
06.1.1 medicines
07.2.1 parts and accessories for personal transport equipment
07.2.2 fuels and lubricants for personal transport equipment
08.2 software, excluding games
08.1 information and communication equipment
09.1.1 photographic and cinematographic equipment and optical instruments
09.1.2 major recreational durables
09.2.1 games, toys and hobby-related articles
09.2.2 sporting, camping and open-air recreation equipment
09.3.1 garden products, plants and flowers
09.4.6 recreational and sporting services
09.6 cultural services
09.7.1 books
09.7.2 newspapers and periodicals
09.7.3 miscellaneous printed matter
09.8 package holidays
11.1.1 restaurants, cafés and the like
13.1.3 hairdressing salons and personal grooming establishments
13.1.1 electric appliances for personal care
13.1.2 other appliances, articles and products for personal care
13.2.1 jewellery and watches
13.2.9 other personal effects (not elsewhere classified)

Mosaic grocery expenditure and food diet distributions (20% of total emissions)

14 categories, range at the municipality level 18–23%

COICOP number and name of consumption category
01.1.1 cereals and cereal products
01.1.2 live animals, and meat and other parts of slaughtered land animals
01.1.3 fish and other seafood
01.1.4 milk, other dairy products and eggs
01.1.5 oils and fats
01.1.6 fruits and nuts
01.1.7 vegetables, tubers, plantains, cooking bananas and pulses
01.1.8 sugar, confectionery and desserts
01.2.2 coffee and coffee substitutes
01.2.3 tea, maté and other plant-derived products for infusion
01.2.4 cocoa drinks
01.2.1 fruit and vegetable juices
01.2.5 water
01.2.6 soft drinks

Mosaic transportation data (31% of total emissions)

13 categories, range at the municipality level 27–37%

COICOP number and name of consumption category
07.1.1 motor cars (including direct emissions from fuel combustion)
07.1.3 bicycles
07.2.3 maintenance and repair of personal transport equipment
07.2.4.3 driving lessons, tests, licences and roadworthiness tests
07.2.4.2 toll facilities
07.2.4.1 parking services
07.2.4.5 tax benefit cars
07.3.1 passenger transport by railway
07.3.2 passenger transport by road
07.3.3 passenger transport by air
07.3.4 passenger transport by sea and inland waterway
07.3.5 combined passenger transport
07.3.6 other passenger transport services

Energy-based emissions (7% of total emissions)

5 categories, range at the municipality level 6–8%

COICOP number and name of consumption category
04.5.1 electricity
04.5.2 gas
04.5.3 liquid fuels
04.5.4 solid fuels (incl. direct fuel emissions used to heat homes)
04.5.5 district heating and other energy for heating and cooling

Household budget survey and DeSO net income (13% of total emissions)

32 categories, range at the municipality level 11–15%

COICOP number and name of consumption category
02.1.9 other alcoholic beverages
02.4 narcotics
04.1.1 actual rental payments made by tenants for main residence
04.1.2 other actual rental payments
04.2.1 imputed rental payments of owner-occupiers for their main residence
04.2.2 other imputed rentals
05.6 goods and services for routine household maintenance (incl. direct emissions from use of solvents)
06.1.2 medical products
06.1.3-06.1.4 assistive products and repair, rental and maintenance of medical and assistive products
06.2.1 preventive care services
06.2.3 other outpatient care services
06.2.2 outpatient dental services
06.3 inpatient curative and rehabilitative services
06.4 diagnostic imaging services and medical laboratory services
07.1.2 motorcycles
07.2.4.4 hire of personal transport equipment without driver
07.4.9 other transport of goods
07.4.1 postal and courier services
08.3 information and communication services
09.5.2 audiovisual media
09.5.1 musical instruments
09.4.2-09.4.4 hire, maintenance and repair of major recreational durables
09.3.2 pets and pet products
09.4.5 veterinary and other services for pets
09.4.7 games of chance
11.2 accommodation services
13.3.0.1 childcare services
13.3.0.3 home care services for elderly and disabled
13.3.0.2 retirement homes for elderly persons and residences for disabled persons, not providing medical care
12.1 insurance
12.2 financial services
13.9 other services

Income (0.2 % of emissions)

Three categories; range at the municipality level 0–0.2%

COICOP number and name of consumption category
09.7.4 stationery and drawing materials
10.1-10.5 education services (private)
13.2.2 devotional articles and articles for religious and ritual celebrations

Annex 2. List of data sources used

Table 1 summarizes the data and data sources used. Most of the data is based on data for each year 2019–2023, unless otherwise stated. For data not available on an annual basis, we scale the data to match the total consumption level for each year in the time series. All data with a spatial resolution higher than the national level is grid based unless otherwise stated.

Table 1. Datasets used in the Consumption Compass

Data name	Description	Spatial resolution	Years available in dataset	Source and year published
DeSO shape files	Areas and locations of all DeSOs in Sweden	DeSO (vector based)	2019–2023	SCB (2018)
Mosaic Lifestyle profiles	Distribution of Mosaic profiles across DeSOs	DeSO	2019–2023	Insight One (2024). Restricted Access
Mosaic consumption expenditure survey	Average expenditure by mosaic profile across a range of products	By profile	2019–2023	Insight One (2024). Restricted Access
Mosaic private vehicle data (car travel etc.) and local transport data	Data on use of personal vehicles, including average distance travelled per year	DeSO	2019–2023	InsightOne, incl. data from the Swedish Transport Registry (2024). Restricted Access
Mosaic annual travel datasets (air travel, public transport, train etc.)	Air travel data and other modes of transport (other than personal vehicles): public transport, train, bus, taxi, sea etc.	By profile	2019–2023	InsightOne (2024). Restricted Access
Household budget survey	Household expenditure on products and services	Municipal class	2021	Statistics Sweden - SCB (2024)
Income distribution	Household income in fractiles	Municipal level	2019–2023	Statistics Sweden - SCB (2025)
Household national emissions by COICOP	Emissions associated with consumption across 107 different consumption categories	National	2019–2022	Statistics Sweden - SCB (2024)
Household national expenditure by COICOP	Total expenditure across 107 different consumption categories	National	2019–2022	Statistics Sweden - SCB (2024)
Household national expenditure by COICOP	Total expenditure across 18 different consumption categories	National	2023 (per quarter)	Statistics Sweden - SCB (2024)
Inflation index data	Consumer price index for a variety of COICOP products and other products, used to correct the 2023 projection from constant to current prices	National	Annual	Statistics Sweden – SCB (2024); Statistics Sweden – SCB (2024)
Food price survey data	Grocery expenditure differences by region	County level	2019–2023	PRO (2024)
Household type by DeSO	Number of people living in different types of accommodation by DeSO	DeSO	2019–2023	Statistics Sweden – SCB (2024)
Net income by DesO	Annual net income for each DeSO per capita	DeSO	2019–2023	SCB (2024)
House size distribution by municipality	Distribution of house sizes by type of housing	Municipal level	2019–2023	SCB (2024)
Energy use in single houses and apartments	Use of residential gas in single houses and apartments (only available at national and county level)	National and county level	2019–2023	Energimyndig-heten (2024)
Energy use by carrier type and consumer	Energy use in single houses and apartments	Municipal level	2019–2023	SCB (2024)
District heating energy use and emission factors	Detailed list of heat production and emission factors by district heating network	Municipal level	2019–2023	Swedenergy - Energiföretagen (2024)

Data name	Description	Spatial resolution	Years available in dataset	Source and year published
National air travel emissions	Emissions from air travel for Swedish residents during 1990–2017, including long-range destinations and high-altitude effects	National level	1990–2017	Kamb and Larsson (2019), Kamb and Larsson (2018)
Total passenger kilometres from domestic and international travellers at Swedish airports	Used to scale data from Kamb and Larsson (2019) to later years (together with Mosaic data, see table row 2)	National level	2019 – 2023	Trafa -Transport Analysis (2024)
Food diet distributions	Data on the variation of food diets (i.e. the proportions of people with different types of diet)	Municipal level	2017–2023	The Climate calculator – Klimatkal-kylatorn. The calculator is open for use, but access to the database is restricted.)
Costs of grocery basket from supermarkets	Average regional grocery price differences	County level (with some exceptions)	2019–2023	PRO
Direct emissions	Direct emissions from households for private transport, heating and other categories	National	2019–2022	Statistics Sweden - SCB (2024)

Table 2 summarizes the data and data sources used in the tool's scenario function.

Table 2. Datasets used in the scenario function of the Consumption Compass

Data name	Description	Spatial resolution	Years available in dataset	Source and year published
Private vehicle ownership per capita	Average number of cars owned per person	National and municipal level	2019–2023	Statistics Sweden - SCB (2024) and InsightOne (2024). Restricted Access.
Swedish electricity grid emissions	Average grams of CO_2 emitted per kilowatt-hour of electricity generation	National	2000–2023	Statista (2023)
Net emission reductions from shifting transport modes	Baseline forecasts: Average per passenger reduction in emissions from switching trips to public transport instead of private automobiles	National	N/A	Swedish Transport Agency - Trafikanalys (2022)
EV energy intensity	Average number of kilowatt-hours expended per kilometre travelled in electric vehicles	Global	N/A	UK Government (n.d.) Electric Vehicle Database
Vehicle production emissions	Estimate of relative emission associated with vehicle manufacturing for conventional and electric vehicles	Global	N/A	UK Government (2021) Lifecycle analysis of UK road vehicles, Figure A11
Share of electric vehicles	Percentage of household automobiles that are electric (including plug-in hybrids)	National and municipal level	2019–2023	Statistics Sweden – SCB (2019); Transport Analysis – Trafikanalys; and Insight One (2024)
Share of new car sales that are electric	Percentage of new car sales that are electric (including plug-in hybrids)	National and municipal level	2019–2023	Statistics Sweden – SCB (2024)
Total amount of food consumed	Kilos of total food consumed in the households	National	2021 (1960–2023)	The Swedish Board of Agriculture – Jordbruksverket (2024)
Total amount of food wasted	Kilos of total food consumed that is wasted in the households	National	2021 (2012–2023)	Swedish EPA – Naturvårds-verket (2025)
Cost savings from dietary shifts	Cost savings (per calorie) associated with reducing meat and dairy consumption and replacing with vegetarian alternatives	Global	N/A	Springmann, M. et al., (2021)

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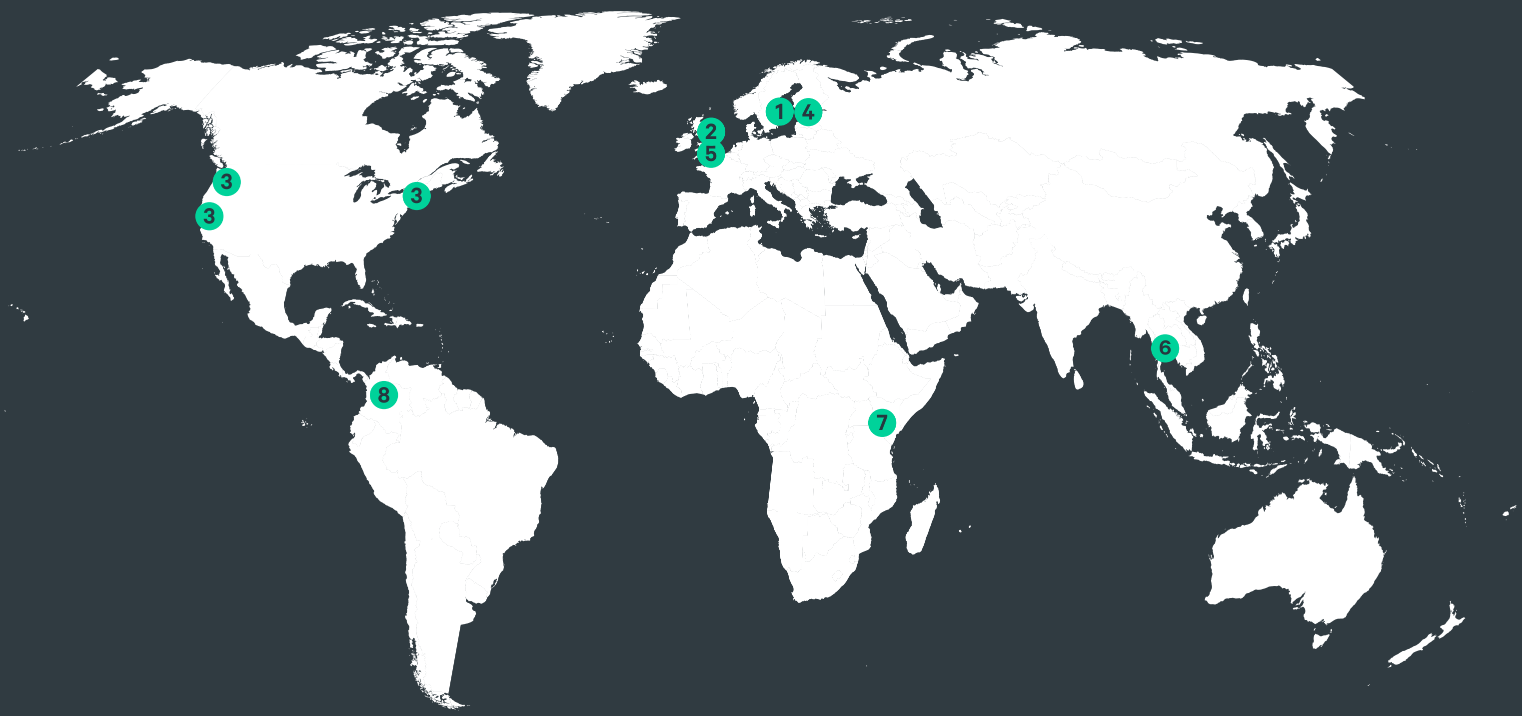

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