Annex A. Data Sources for Current Lifestyle Carbon Footprint Estimation

A.1. Specific Methodology and Data Sources

We estimated the lifestyle carbon footprint per capita in Norway by employing both bottom-up and top-down approaches. For domains nutrition, housing, personal transportation and holiday houses in leisure category we utilized the global LCI databases, primarily ecoinvent (Wernet et al., 2016), supplemented by country-specific LCI estimates and product-specific LCA studies. Data on annual consumption amounts per capita were gathered from national statistics, surveys, and publications.

Regarding goods, leisure, and services, we used monetary values derived from the national input-output table of 2022 (Statistics Norway, 2023i). Carbon intensities are from Exiobase (Stadler et al., 2018). To combine input-output data on Exiobase carbon intensities, current prices were converted to basic prices.

Table A.1. Data sources of consumption amounts

Domain	Components	Source	Remarks
Personal transportation	Walking	Grue et al. (2021)	Average distance travelled by walking multiplied by the number of travels per day. Daily total walking distance/capita multiplied by number of days in the year. Most recent data available from the travel survey 2018/2019.
Personal transportation	Bicycle: conventional, electric	Grue et al. (2021)	Average distance travelled by walking multiplied by number of travels per day. Daily total walking distance/capita multiplied by number of days in the year. Most recent data available from the travel survey 2018/2019. Share of conventional and electric bicycles estimated based on the shares of daily travels by conventional and electric bicycle.
Personal transportation	Motorcycle: conventional, electric	Annual passenger kilometers: Statistics Norway (2023e) Share of fuel type by vehicle type: Statistics Norway (2023f)	Annual total passenger kilometers for motorcycles and mopeds divided by the population (1st Jan 2022). Share of conventional and electric fuel types based on total amounts light and heavy motorcycles and mopeds by type of fuel.
Personal transportation	Car (private, rental, taxi); conventional, electric, gas, hybrid, other	Annual passenger kilometers: Grue et al. (2021)	Annual total passenger kilometers for private and rental cars, and taxis divided by the population (1st Jan 2022). Share of different fuel types based on registered amount of private cars by fuel type.

		Share of fuel type by vehicle type: Statistics Norway (2023f)	
Personal transportation	Train (local, regional, intercity, night trains, boundary crossing trains, suburban railways and urban tram): electric, diesel	Annual passenger kilometers: Statistics Norway (2023g) Share of fuel type by rail line: Norway Trains (2023) VY (2023b) Papatolios (2023)	Annual total passenger kilometers for rail transport divided by population (1st Jan 2022). Main locomotive force for different rail lines defined.
Personal transportation	Bus (intra city & city are routes): conventional, electric, gas, hybrid, other	Annual passenger kilometers: Statistics Norway (2023e) Share of fuel type by vehicle type: Statistics Norway (2023f)	Annual total passenger kilometers for intra-country and city routes are divided by the population (1st Jan 2022). Share of different fuel types based on registered amount of buses by fuel type.
Personal transportation	Ferry (domestic car- and passenger/fast ferries)	Information from the Miljødirektoratet's expert by an email.	Only estimated direct emissions for all ferry types. Emissions from electrified, biodiesel, and hydrogen ferries are estimated to be zero CO2e. Emissions of car ferries are divided between LNG (38%) and marine gas oil (62%). Emissions from passenger/fast ferries are related to the use of diesel and marine gas oil.
Personal transportation	Ferry (international)	Departures and destinations, distances, and average CO_2e emissions per nautical mile: Kystdatahuset (2024) International ferries CO2e per nautical mile: THETIS-MRV (2024)	Only estimated direct emissions for all international cruise ships. The number of departures of passenger ferries from the most important Norwegian harbors departing to an international destination multiplied by the distance between the departing port and destination and average CO2e emission per nautical mile. Only trips made by domestic passengers are included.

		Share of domestic passengers: Dybedal & Landa-Mata (2022)	
Personal transportation	Leisure boats	13931: Greenhouse gases AR5, by source (activity), energy product, contents, year and pollutant: Statistics Norway (2023h)	Only estimated direct emissions for leisure boats. No data related to emissions from different fuel types.
Personal transportation	Airplane (domestic)	Annual passenger kilometers: Statistics Norway (2023e) Share of business trips and share of foreign travelers: Avinor (2020)	Annual total passenger kilometers for domestic air transport divided by population (1st Jan 2022). Business trips and the share of foreign travelers on domestic flights excluded.
Personal transportation	Airplane (international)	Annual passenger kilometers: Buus Kristensen & Thune-Larsen (2022) Share of business trips and share of foreign travelers: Avinor (2020)	Annual total passenger kilometers for international flights based on PACER-models projected estimates of passengers in 2023 and average distance of European and intercontinental flights. Total distance is divided by population (1st Jan 2023). Business trips and share of foreign travelers on international flights excluded.
Nutrition	All other components	Food items: Helsedirektoratet (2022a) Population statistics: Statistics Norway (2023a)	Food availability/capita by commodity and year. The population statistics used for per capita calculations is the average for the year ("middelfolkemengde" in Norwegian), calculated as the population 1st January in a given year added to the population 1st January in the next year, divided by two. Food loss at household and distribution side included in total consumption amounts.
Nutrition	Meat	Helsedirektoratet (2022b)	Carcass weight

Nutrition	Fish	Helsedirektoratet (2022b)	Round weight: guts and head included
Nutrition	Honey	Bunger (2020)	
Nutrition	Wine, tax free	Kvaavik et al. (2023)	
Nutrition	Food waste	Total amount and composition of food waste produced by the households: Stensgård et al. (2021)	Total amount of food waste produced by the households divided by the population. Composition of household food waste estimated as percentage shares for different sub-components. It is assumed that items within sub-components are wasted in the same proportion as those consumed.
Goods		Expenditure data on goods: Statistics Norway (2023i) Number of households: Statistics Norway (2023j)	Expenditure data from goods is from input-output tables in 2021, category "Final consumption expenditure by households, purchaser's prices". Values are divided by population 2021 to get per capita values.
Housing	Living space	Oppøyen (2023)	The average living space (m^2) per person by housing type.
Housing	Electricity mix: hydro, thermal, wind	Energy consumption: Statistics Norway (2023b) Energy sources: Statistics Norway (2023c)	Electricity consumed in households divided by population. Electricity consumption of free-time residential buildings excluded. Share of different electricity sources based on information published by SSB. Losses from production and transmission of electricity are included in electricity consumed.
Housing	Other energy: coal and coke, light heating oil and special distillate, heating kerosene, LPG, fuelwood and pellets, natural gas, district heating.	Statistics Norway (2023b)	Energy consumed in households divided by population (1st Jan 2022). Share of different energy sources based on information published by SSB.
Housing	Water consumption	Statistics Norway (2023d)	Average household consumption per person/day (litres/person/day) multiplied by number of days in the year.

Leisure		Expenditure data on leisure: Statistics Norway (2023i) Number of households: Statistics Norway (2023j) Household Expenditure Survey: Statistics Norway (2023k) The share of food in restaurant services: Latva-Hakuni (2020) Lounasheimo et al. (2019) Helsingin kaupungin ympäristöpalvelut (2013)	Expenditure data from leisure is from input-output tables in 2021, category "Final consumption expenditure by households, purchaser's prices". Values are divided by population 2021 to get per capita values. Based on Household Expenditure Survey, approx 8% of the consumption from this category is allocated for accommodation and 92% for restaurant services. To avoid double counting (as restaurant services also include food that is already in the nutrition domain), food from the restaurant services was excluded. Food is estimated to account for 85% of restaurant services.
Leisure	Living space for holiday houses	Number of holiday homes before 1945-1964 and 1970-1982: Universitetsforlaget (1982) Number of holiday homes 1965-1969: Ericsson et al. (2011) Total utility space of holiday homes 1983-2022: Statistics Norway (2023l) Average size of a holiday house: Statistics Norway (2023l) Helgerud (2024)	Total number of existing holiday homes by decade multiplied by the average size of holiday house built in a certain decade. Estimated existing utility floor space (m2) between the period "before 1945"-1983. Before mentioned utility space before 1945-1983 is summed with built utility space (m2) for holiday homes 1984-2022. Total utility space divided by population (1st Jan 2022).

Leisure	Electricity mix for holiday houses: hydro, thermal, wind, imports	SSB 13929: Energy consumption in households, incl. holiday cottages, by contents and year: Statistics Norway (2023b) The share of different energy sources: Statistics Norway (2023c)	Electricity consumed in households divided by population. Electricity consumption of free-time residential buildings only included. Share of different electricity sources based on information published by SSB. Losses from the production and transmission of electricity are included in electricity consumed.
Leisure	Other energy for holiday houses: fuelwood	Statistics Norway (2023b)	Energy consumed in free-time residential buildings divided by population (1st Jan 2022).
Services		Expenditure data on goods: Statistics Norway (2023i) Number of households: Statistics Norway (2023j)	Expenditure data from leisure is from input-output tables in 2021, category "Final consumption expenditure by households, purchaser's prices". Values are divided by population 2021 to get per capita values.

Table A.2. Data sources of carbon intensity

Domain	Components	Source	Remarks
Personal transportation	Walking		No emissions calculated for walking.
Personal transportation	Bicycle: conventional, electric	Ecoinvent 3.9.1. (Wernet et al., 2016)	Conventional bicycle, Swiss average. Production, maintenance & use of road infrastructure included. For electric bicycle, Swiss value. Electricity from renewable electricity production. Production, maintenance, electricity use & use of road infrastructure included.
Personal transportation	Motorcycle: conventional, electric	Ecoinvent 3.9.1. (Wernet et al., 2016)	Conventional and electric motorcycle, Swiss average. Production, maintenance & use of road infrastructure included.

Personal transportation	Car: conventional (diesel and petrol), gas, paraffin, hydrogen, hybrid, other	Production, infrastructure & maintenance: Ecoinvent 3.9.1. (Wernet et al., 2016) Emissions from fuel combustion for different fuel types: Miljødirektoratet (2020) Occupancy rate: Statistics Norway (2019) Average share of biodiesel: Regjeringen (2023) Emissions from biofuel combustion: Neste (2020)	Average transport unit emissions for car transport, including emissions from production, maintenance, use of road infrastructure, and fuel combustion, are divided by the average occupancy rate. Different emission factors for production and maintenance depend on the vehicle fuel type. Production and maintenance for hydrogen vehicles is similar to gas vehicles. The average share of biodiesel (13.9 %) in diesel fuel is considered. Direct emissions from hydrogen fuel combustion are assumed to be zero.
Personal transportation	Car: electric	Production, infrastructure & maintenance: Ecoinvent 3.9.1. (Wernet et al., 2016) Occupancy rate: Statistics Norway (2019) Average electricity consumption for Tesla model in 2023: Tesla (2024)	Average transport unit emissions for car transport, including emissions from production, maintenance, use of road infrastructure, and fuel combustion, are divided by the average occupancy rate. Miljødirektoratet estimates direct emissions for electric vehicles to be zero, thus average Norwegian grid electricity intensity and average Tesla model's kWh/km-consumption are used to calculate emissions from electric vehicle fuel combustion.
Personal transportation	Train (local, regional, intercity, night trains, boundary crossing trains: electric, diesel	Energy consumption for different train routes: SJ (2022) Local, regional and intercity average energy consumption of SJ's entire fleet	Carbon intensity per passenger is calculated by multiplying the energy use of different train types multiplied by Norwegian electricity mix intensity. For diesel trains, the direct value for emissions per person-km was used.

		based on average occupancy. Night train and boundary crossing trains: average energy use for SJ EuroNight based on average occupancy. Regional and night train with diesel: Jernbanedirektoratet (n.d.)	
Personal transportation	Train: suburban and urban (tram)	Finnish Environmental Institute (2019)	Carbon intensity per passenger kilometer
Personal transportation	Bus (intra-city & city are routes): conventional, electric, gas, hybrid paraffin	For all combustion models, production, infrastructure and maintenance: Ecoinvent 3.9.1. (Wernet et al., 2016) Emissions from fuel combustion: - petrol, gas Ecoinvent 3.9.1. - Diesel, electric: VY (2023a) - Paraffin: Miljødirektoratet (2020) Average share of biodiesel: Regjeringen (2023)	Average transport unit emissions for bus transport, including emissions from production, maintenance, use of road infrastructure, and fuel combustion, are divided by the average occupancy rate. Production and maintenance for paraffin and gas vehicles is similar to diesel/petrol vehicles. The average share of biodiesel (13.9 %) in diesel fuel is considered. Direct emissions from paraffin fuel combustion are assumed to be 10% of diesel combustion related emissions
Personal transportation	Ferry (domestic and international)		Only data for direct emissions for international passenger ferries, thus no transportation demand or specific carbon intensity for international ferries available.

Personal transportta tion	Leisure boats		Only data for direct emissions for leisure boats, thus no transportation demand or specific carbon intensity for leisure boats available.
Personal transportati on	Airplane (domestic)	Ecoinvent 3.9.1. (Wernet et al., 2016) Radiative forcing: Lee et al. (2021) Share of trips by distance: Avinor (2020)	Weighted average of transport, passenger aircraft short haul and very short haul flights. In addition to direct CO2 emissions, air transport increases the coercion of radiation into the atmosphere, for example through high particulate matter and changes in cloud cover. There is considerable uncertainty associated with these estimates, but the latest study, published in 2020, estimates that 66% of all the climate impact of flying comes from sources other than the direct impact of fuel carbon dioxide (Lee et al. 2020). It is therefore justified to multiply the carbon footprint based on fuel consumption by three in order to take into account other known sources of radiation exposure in the light of current knowledge.
Personal transportati on	Airplane (international)	Ecoinvent 3.9.1. (Wernet et al., 2016) Radiative forcing: Leet et al. (2020) Share of trips by distance: Avinor (2020)	Weighted average of transport, passenger aircraft long, medium, short, and very short haul flights. In addition to direct CO2 emissions, air transport increases the coercion of radiation into the atmosphere, for example through high particulate matter and changes in cloud cover. There is considerable uncertainty associated with these estimates, but the latest study, published in 2020, estimates that 66% of all the climate impact of flying comes from sources other than the direct impact of fuel carbon dioxide (Lee et al. 2020). It is therefore justified to multiply the carbon footprint based on fuel consumption by three in order to take into account other known sources of radiation exposure in the light of current knowledge.
Nutrition	Domestically produced meat, dairy and fish products	Van Oort & Andrew (2016)	Domestically produced animal-based products are from the Norwegian LCA study.
Nutrition	Other food categories	Ecoinvent 3.9.1 (Wernet et al., 2016) and Agribalyse 3.1.	For other food categories, there is no comprehensive country-specific dataset available. For other food categories, the analysis uses ecoinvent 3.9.1. and Agribalyse 3.1. databases, using system boundary cradle-to-retail.
Goods		Carbon intensities: exiobase 3.9. (Stadler et al., 2018) Value-added tax: Norwegian Tax	Cabon intensities for goods are from exiobase 3.9., the year 2019. The prices are converted from current prices to basic prices. This conversion includes removing value-added tax. To match carbon intensities and prices, the inflation rate between 2019-2021 is also considered.

		Administration (2023) Inflation rate: Statistics Norway (2024b)	
Housing	Living space	Ecoinvent 3.9.1. (Wernet et al., 2016) Average minimun height standard: Norwegian Building Authority (2017)	Multi-store building: includes building materials, energy for construction, and disposal of the building. Also included is electricity construction, maintenance and demolition. Excludes operation. The lifecycle of the building 80 years. Average EU value. Ecoinvent value given in m3, therefore is multiplied by average minimum height standard of Norwegian rooms.
Housing	Electricity mix: hydro, thermal, wind	Ecoinvent 3.9.1. (Wernet et al., 2016) Production, imports and exports: Statistics Norway (2023b)	In the analysis, so called local electricity consumption mix, i.e. electricity that is used locally is based on domestic production, and the value is adjusted for power transfers with neighboring countries. Thus, average carbon intensity for Norwegian electricity mix is based on production, imports, exports and consumption of electric energy statistics for Norway. Norwegian carbon intensity values for high voltage electricity production. For imported electricity average intensity of grid electricity mix is used depending on the country of origin. The weighted average of electricity mix is based on electricity mix breakdown, share of imported and exported electricity.
Housing	Other energy: LPG, heavy fuel oils, and natural gas.	Statistics Finland (2024)	Caloric values & coefficients of fuel converted into CO2 emissions per kWh.
Housing	Other energy: wood	Emissions from households' fuel wood burning: Statistics Norway (2023h) Energy consumption on the basis of wood burning: Statistics Norway (2023b)	Intensity calculated based on announced emissions from household wood burning divided by the energy consumption by wood burning.

Housing	Other energy: district heating	Ecoinvent 3.9.1. (Wernet et al., 2016) Share of used fuel types: Statistics Norway (2023m)	Weighted average based on share of used fuel types.
Housing	Water consumption	Ecoinvent 3.9.1. (Wernet et al., 2016)	Tap water, EU average value.
Leisure	Living space for holiday houses	Finnish Environmental Institute (2019)	Average intensity of detached and/or terraced house.
Leisure	Electricity mix: hydro, thermal, wind	Ecoinvent 3.9.1. (Wernet et al., 2016) Production, imports and exports: Statistics Norway (2023b)	In the analysis, so called local electricity consumption mix, i.e. electricity that is used locally is based on domestic production, and the value is adjusted for power transfers with neighboring countries. Thus, average carbon intensity for Norwegian electricity mix is based on production, imports, exports and consumption of electric energy statistics for Norway. Norwegian carbon intensity values for high voltage electricity production. For imported electricity average intensity of grid electricity mix is used depending on the country of origin. The weighted average of electricity mix is based on electricity mix breakdown, share of imported and exported electricity.
Leisure	Wood for holiday houses	Emissions from households' fuel wood burning: Statistics Norway (2023h) Energy consumption on the basis of wood burning: Statistics Norway (2023b)	Intensity is calculated based on announced emissions from household wood burning divided by the energy consumption by wood burning.
Leisure		Carbon intensities: exiobase 3.9. (Stadler et al., 2018) Value-added tax: Norwegian Tax	Carbon intensities for leisure are from exiobase 3.9., the year 2019. The prices are converted from current prices to basic prices. This conversion includes removing the value-added tax. To match carbon intensities and prices, the inflation rate between 2019-2021 is also considered.

		Administration (2023) Inflation rate: Statistics Norway (2024b)	
Services		Carbon intensities: exiobase 3.9. (Stadler et al., 2018) Value-added tax: Norwegian Tax Administration (2023) Inflation rate: Statistics Norway (2024b)	Carbon intensities for services are from exiobase 3.9., the year 2019. The prices are converted from current prices to basic prices. This conversion includes removing the value-added tax. To match carbon intensities and prices, the inflation rate between 2019-2021 is also considered.

A.2. Sensitivity Analysis for Norwegian Grid Electricity Mix

In the analysis, so-called local electricity consumption mix, i.e. electricity that is used locally is based on domestic production, and the value is adjusted for power transfers with neighboring countries. Thus, the average carbon intensity for the Norwegian electricity mix is based on production, imports, exports and consumption of electric energy statistics for Norway (Table A.3, Statistics Norway, 2023b), 90% of the electric energy gross consumption is based on domestic electricity production and the remaining 10% is imported electric energy.

Table A.3. Gross consumption, and the share of domestic production and imports of the total gross consumption for electricity.

Gross consumption			133 420 GWh	
	Domestic production		145 942 GWh	
	Imports		13 270 GWh	
	Exports		25 792 GWh	
Share of domestic production and imports of the total gross consumption				
	Domestic production – export		120 150 GWh	90,05%
	Imports		25 729 GWh	9,95%
		Sweden		*47,5%**
		Denmark		*23,0%**
		United Kingdom		*13,5%**
		Germany		*12,7%**
		Netherlands		*3,3%**
		Finland		*0,1%**
	Total		**133 420 GWh**	**100,00%**

*ISE (2024).

The average intensity for electric energy consumed in Norway is calculated:

$$\frac{Emissions\ from\ domestic\ electricity\ production\ +\ from\ imports\ -\ from\ \ exp\ exp\ o\ rts}{Domestic\ production\ +\ imports\ -\ \ exp\ exp\ o\ rts}$$

Emissions for domestic and imported electricity are calculated by multiplying the amount (GWh) of electricity with the emission factors for electric production. The average domestic Norwegian electricity intensity is based on domestic electricity production (hydro-, thermal and wind power) and Norwegian specific intensities given by ecoinvent 3.9.1. (Wernet et al. 2016). For imported electricity, country-specific electricity mix intensity is used (Wernet et al 2016).

Based on the gross border physical electric energy flows of Norway with its neighbors in 2022 (ISE, 2024), and the share of domestic production, imports and exports, **the average carbon intensity for Norwegian grid electricity is on average 46 gCO2e/kWh.** The emission factor includes all GHGs and considers emissions from direct combustion and emissions from infrastructure.

Table A.4. compares the estimated, import-export adjusted average intensity for Norwegian electricity production to average domestic, Nordic and EU electricity intensity. Method for each intensity is described after the table.

Table A.4. Comparison of Norwegian domestic electricity production, import-export adjusted, average Nordic and average EU electricity intensity.

	Average intensity based on:	**Carbon intensity, gCO_2e/kWh**	**References**
1	Norway domestic production [a)]	32	Ecoinvent 3.9.1. (Wernet et al., 2016)
	Norway import-export adjusted		
2	*European Environment Agency* [b)]	40	European Environment Agency (2023)
3	*Ecoinvent* [a)]	46	Ecoinvent 3.9.1. (Wernet et al., 2016)
4	Average Nordic [b)]	60	Nordic Energy Research (2020)
5	Average EU [a)]	251	European Environment Agency (2023)

[a)] all GHGs and infrastructure included.
[b)] only direct emissions, i.e. emissions from infrastructure excluded. Renewable electricity sources with carbon intensity of 0.

1) **Norway domestic production** (32 gCO_2e/kWh) is based on domestic electricity production (hydro-, thermal and wind power) and Norwegian specific intensities given by ecoinvent 3.9.1. (Wernet et al. 2016). The emission factor includes all GHGs and considers emissions from direct combustion and emissions from infrastructure but excludes high-intensity emissions related to imported electricity.

2) **Norway import-export adjusted, EEA based intensity** (40 gCO_2e/kWh) includes only direct GHG emissions related to fuel combustion but excludes the emissions related to infrastructure, i.e. so called indirect emissions. CO_2e represents "CO_2 equivalent emissions-fuel combustion in public electricity and heat production (share heat production is excluded from the intensities). A zero CO_2e emission factor was applied to nuclear power, renewables (including the biodegradable fraction of municipal solid waste), and to solid biofuels.

3) **Norway import-export adjusted, Econivent based intensity** (46 gCO_2e/kWh) is based on domestic electricity production (hydro-, thermal and wind power) and Norwegian specific intensities given by ecoinvent 3.9.1. (Wernet et al. 2016). For imported electricity, country-specific electricity mix intensity is used (Wernet et al 2016). The emission factor includes all GHGs and considers emissions from direct combustion and emissions from infrastructure. The electricity intensity is based on a weighted average of the shares of domestic production and imported energy.

4) **Average Nordic** (60 gCO_2e/kWh) includes only direct CO2 emissions related to fuel combustion, excluding also infrastructure and other greenhouse gases but excludes emissions related to builded infrastructure. In addition, the average intensity for Nordic energy, includes electricity and energy. The report from 2020 states that the average intensity for Nordic grid electricity is under 60 gCO_2/kWh. Therefore using 60 gCO_2e/kWh as an average might be overestimated as the share of renewables in electricity production has increased in Nordic countries over the past few years (approximately 6% from 2019-2022) (Statista, 2023)

5) **Average EU, EEA based intensity** (251 gCO_2e/kWh) includes only direct GHG emissions related to fuel combustion. CO_2e represents "CO_2 equivalent emissions-fuel combustion in public electricity and heat production (share heat production is excluded from the intensities). A zero CO_2e emission factor was applied to nuclear power, renewables (including the biodegradable fraction of municipal solid waste), and to solid biofuels. Includes 27 European country's average emission factors from 2022.