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Calculation criteria used in the Sitra lifestyle test

1 Living

The environmental impacts of living taken into account in the lifestyle test include construction, the heating of dwellings and the use of electricity at home. The lifestyle test begins with a question on how many people live in the respondent's household, because the environmental impacts of housing are divided between all family members.

The environmental impacts of a building are taken into account by using a factor calculated per living area and the number of years the building has been in use (Saari et al. 2001: a block of flats equals 8.0 and a single-family house or semi-detached house equals 6.9 kg CO2e/y/htm2). The factor takes account of the land-use change, the manufacturing of materials and the construction, maintenance and demolition of the building. The assumed total lifespan is 50 years.

The default value for electricity consumption (excluding electricity used for heating) is based on a survey on households' electricity consumption conducted in 2011 (Adato Energia 2013). The default values are calculated as follows, when X= (number of people in the family - 1): Block of flats = 1400 + X*500 / Semi-detached house = 2600 + X*700 / Single-family house = 4600 + X*900.

The greenhouse gas emissions of electricity production take into account the direct emissions of electricity production, or the emissions caused by burning of fuels and the fuel production chain. The emission factor of electricity production is 281 g CO2e/kWh (Salo et al. 2017). The emission factor for green electricity is close to zero (Wernet et al. 2016). The coefficient takes account of the land-use changes related to electricity production. Green electricity has also been taken into account in rail transport (see the transport section).

The classification of the house types from different eras is based on the Ministry of the Environment's (Ympäristöministeriö 2013) updated energy efficiency classification system and the estimates on the placement of buildings in different energy classes. Houses built after 2010 are considered “new building stock”, whose typical energy class is C (energy consumption 130 kWh/m2). The energy class A requires a house to produce some or all of its own energy and class B buildings are classified as low-energy houses. House types built between 1990 and 2010 typically represent the energy class D (energy consumption 160 kWh/m2). The energy class of houses built before the 1990s may vary significantly, but by default older houses are expected to have higher energy consumption (energy class F, energy consumption 240 kWh/m2).

The question concerning the primary heating method of the respondent’s home takes into account the most commonly used heating methods. The emission factor specified for district heating (approx. 158 g CO_2e per kWh) is based on specific CO_2 emission statistics compiled by Statistics Finland (2019). To balance seasonal variation, the figure used is the 5-year moving average reported by Statistics Finland, and in addition, the benefit sharing method is applied to the factor. The benefit sharing method refers to the sharing of specific emissions between electricity and heat when estimated with alternative production methods (Motiva n.d.). Benefit sharing applies to combined heat and power plants (CHP). However, it must be noted that the emissions from district heating vary in Finland, depending on the type of the power plant and the fuels used in particular. Furthermore, the emissions from district heating have been in decline in recent years as renewable energy sources are replacing fossil fuels. The emission factor for green electricity has been estimated to be close to zero, since green district heating is often produced using byproducts generated by the forestry industry (e.g. wood pellets and felling waste). However, the

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factor takes account of the emissions related to harvesting of wood-based biofuels, which are approximately 14 gCO2e/kWh (Salo et al. 2019). The aim is to further specify the emissions calculations related to the production of green district heating as the market develops.

The emission factor for light fuel oil is 265 g CO2e/kWh (Tilastokeskus 2018). The response to the earlier question on the kind of electricity the respondent uses is taken into account in the calculations concerning the electricity consumption of electric heating, a groundsource heat pump or an air-source heat pump. The efficiency rate of ground-source heating and an air-source heat pump is based on the values specified by Motiva (2017c). An air-source heat pump is usually used as a complementary heating system, but when used us a primary heating method, there are probably more air-source heat pumps in use than one, and the efficiency of an air-source heat pump was assumed to be about the same as the efficiency of ground-source heating.

If the respondent is unable to define the primary heating method of his or her home, the CO_2 factor of district heating is used as the calculation criterion. According to Statistics Finland, approximately 90 per cent of blocks of flats use district heating and most of the remaining blocks of flats are heated with electricity, with its emission factor close to that of district heating (Tilastokeskus 2016a). This also applies generally to terraced and semi-detached houses, although the share of electricity is clearly higher and these buildings are also heated with fuel oil and ground-source heat more commonly than blocks of flats are. As district heating is the clearly most popular heating method in housing companies and as electricity used for heating is typically paid for by residents themselves, it is likely that most of the “I don’t know” respondents live in district heating households.

In addition to the house type and time of construction, the respondents are asked in which part of Finland they live. This defines how much less/more heating energy they need in comparison to the average consumption of heating energy (+/- 10%) (Motiva 2017a). The effect of room temperature was also taken into account in the need of heating energy. A two-degree drop/rise in the room temperature may reduce/increase the need for heating energy by 10% (Motiva 2017b).

The time spent in a shower affects water consumption and therefore also the amount of heating energy used for heating the water. Heating one litre of water to the temperature of 40 degrees requires 0.04 kWh of energy.

The emission factors for other sources of heating energy are based on the information on the greenhouse gas emissions of various heat production methods produced by Motiva (2010) and Statistics Finland (Tilastokeskus 2018).

2 Transport and tourism

The average estimates on the use of different means of transport are based on the National Travel Survey (Liikennevirasto 2018) statistics.

The carbon footprint of driving is calculated based on the annual number of kilometres driven and the average number of people driving a car. For driving, the climate emissions consist of the fuel consumption, the manufacturing of the car and the emissions from building the road infrastructure. The generated emissions are divided between the number of people typically driving a car. The emission factors for fuel are based on the emission factors (petrol and diesel) or consumption (natural gas-powered, electric or hybrid cars) per passenger kilometre reported by the LIPASTO database. Ten per cent of the emissions of natural gas-powered cars are assumed to derive from the use of petrol, since the gas-driven cars sold in Finland also have a petrol fuel option. The consumption ratio of biogas and natural gas is based on the shares of such gases produced as fuels reported by GASUM (2017). Biogas does not produce any calculated CO2 emissions, since the burning of gas releases the same amount of carbon dioxide as was captured in the “biogasified” material earlier in time (GASUM 2017). The emissions generated by the manufacturing of different car types are based on global average rates (Wilson 2013). Approximately 10% (20 g CO2/vehicle km) of the overall emissions from driving are allocated to road infrastructure (Hill et al. 2012).

Public transport includes travel by bus, train, tram and metro. The relative shares of the different means of public transport are based on the National Travel Survey (Liikennevirasto 2012 & 2018) statistics. The shares were used as a basis for calculating a weighted average emission factor for public transport. The emission factors of different means of transport are based on the emission factors reported by the LIPASTO database. As regards rail transport, the use of green electricity by VR and Helsinki City Transport were taken into account. With reference to buses, the different shares and emission factors for city and long-distance transport have been considered.

The emission factor per hour for air travel is based on the average greenhouse gas emissions per kilometre reported by the Ecoinvent database. (Wernet et al. 2016). It has been weighted based on the relative shares of domestic, intra-European and long-distance air traffic (Finavia 2019). The emissions of individual flights depend on such factors as the air fleet, aircraft occupancy rate, allocation of emissions between passengers and cargo, as well as taking account of the impact of clouds in the higher atmosphere. At the moment, the calculations include fuel consumption, and the CO2e-emissions from the energy and materials used for building aircraft and airports.

In addition to direct CO_2 emissions, air traffic increases atmospheric radiative forcing, as a result of fine particles released high in the atmosphere and changes in cloud cover, for example. There is considerable uncertainty associated with these estimates; however, the latest research paper, published in 2020, estimates that 66 per cent of the total climate impact of aviation comes from sources other than the direct impact of the carbon dioxide in fuel (Lee et al. 2020). Consequently, it is justified to multiply the carbon footprint based on fuel consumption by three to account for other causes of radiative forcing that are known in the light of current knowledge. The average airspeed of air traffic is based on the average cruising speeds of different types of aircraft reported by Finnair (Finnair 2019).

The average lengths of passenger shipping are based on the Statistics Finland material (Tilastokeskus 2016b; 2017a) on the travel habits of Finns. The trip-specific average emission factor for maritime passenger transport was calculated on the basis of unit emission factors of different ship types and routes reported by the LIPASTO database and the relative shares of maritime transport destinations reported by Statistics Finland.

3 Food

The carbon footprint of the person taking the lifestyle test is affected by the amount of food he or she eats and the amount of waste this generates as well as the relative amounts of different ingredients used. It is assumed that a respondent who eats less/more compared to other people at a mealtimes, eats 15% smaller/larger portions per meal.

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In the lifestyle test, the respondent's diet is further calculated on the basis of the ingredients he or she consumes at mealtimes. The consumption of various products either reduces or increases the footprint, depending on whether the respondent eats less or more of such products compared to the average consumption habits in Finland. The reducing/increasing effect of the choices is deducted from/added to the carbon footprint of an average Finn, which is approximately 1.6 tons a year (Seppälä et al.; Lettenmeier et al. 2018).

The ingredients with significant climate impact have been classified into various categories: beef and hard cheese / pork, chicken, fish, cottage cheese, fresh cheese and other soft cheeses and eggs / milk and dairy products / drinks. An average portion size was calculated for each category and a portion-specific weighted emission factor was calculated based on the percentage of the various ingredients in the portion. The portion sizes of the various ingredients are based on the reported annual consumption of food commodities per capita (Luonnonvarakeskus 2017) and the food measures defined by the National Public Health Institute (Sääksjärvi & Reinivuo 2004). The sources used for emission factors included the climate impacts of products defined in Kausiruokaa (Seasonal food) publication by Kaskinen et al. 2011 and the Ecoinvent database (Wernet et al. 2016). For example, the Climate Guide (Ilmasto-opas.fi) gives several estimates of the greenhouse gas emissions of foods.

Beef and hard cheese were classified under the same category due to having higher emission factors than other foods (the Climate Guide: beef 14–42 kg CO_2e per kg, Kaskinen et al.'s estimate for European meat: 19 kg CO_2e per kg; hard cheese, Voutilainen et al. 2003: 13 kg CO_2e per kg). For cheese, there were both international (e.g. the Ecoinvent database) and Finnish (e.g. Voutilainen et al. 2003, Aalto 2018) estimates available; the carbon footprint of Finnish cheeses was typically estimated to be lower. This is explained by the differences between the emission factors of milk produced in different countries (e.g. Pulkkinen 2018). In the lifestyle test, it was decided that more weight is placed on emission factors calculated according to the Finnish approach. When it comes to the carbon footprint, cottage cheese, fresh cheese and other soft cheeses differ clearly from hard cheeses, which require more milk and a longer maturation period. For this reason, an emission factor of 6.5 kg CO_2e per kg has been assigned to soft cheeses, placing them in the same category as pork, chicken, fish and eggs in the lifestyle test (e.g. the Climate Guide).

Cottage cheese, fresh cheese and other soft cheeses, pork, chicken, fish and eggs were classified into a single category. The emission factor of pork is slightly higher than that of other foods in the category but, on the other hand, significantly lower than the emission factor of beef. The emission factors used are the following: 5.6 kg CO_2e per kg for pork, 3.6 kg CO_2e per kg for chicken, 3.0 kg CO_2e per kg for fish and 2.7 kg CO_2e per kg for eggs (Kaskinen et al. 2011). The calculator does not make a difference regarding whether the meat consumed is game since game accounts for only approximately 2 per cent of the meat consumption of an average Finn. The estimated emission factor for domestic elk meat, for example, is 1.6 kg CO_2e per kg (Kaskinen et al. 2011), for which reason the carbon footprint of a person consuming game as the primary meat product can be assumed to be lower than that of a person consuming meat of animals bred for the production of food. Further information on the climate impact of game and other meat products in the WWF Meat Guide (in Finnish at wwf.fi/lihaopas).

Milk and dairy products were highlighted as a third category, since their high consumption has an effect on the carbon footprint. Finns consume annually approximately 125 kg of milk and approximately 40 kg of dairy products (excluding cheese) per person. In the lifestyle test, the emission factor used for milk is 1.4 kg CO2e/kg (Kaskinen et al. 2011: low-fat milk from Finland).

For drinks a portion-specific environmental impact was calculated, being approximately 0.3 kg CO2e/portion (range 150–400 g/portion). The emission factors for different drinks are based on the sources Kaskinen et al. (2011), Wernet et al. (2016) and Berners-Lee (2010).

As concerns meals eaten outside the home, the energy consumption used for providing the service, or preparing the food (2 kWh/time eating out), was taken into account.

Finnish people throw away approximately 23 kg of edible food a year (Saarinen et al. 2011), which increases the carbon footprint. The emission factor for food waste was calculated based on the biowaste of an average Finnish person eating a mixed diet (2.55 kg CO2e/kg biowaste).

4 Goods and purchases

Living, mobility and food are the most significant sub-sectors in the carbon footprint of an average consumer. It would require a number of questions to make a comprehensive estimate and analysis of the climate emissions of other sectors of personal consumption. In such a case, the effort it would require for a respondent to complete this section would no longer be in proportion to the significance of this sub-sector. However, in the lifestyle test we wanted to highlight a few important matters, acknowledging that other choices (such as services and interests) have an impact as well. In this calculator, the sub-sectors included contain pets, summer cottages and consumption of goods.

The question concerning shopping habits includes goods, household articles, clothes and footwear. The question does not cover environmental impacts related to services, only tangible products. On average, the combined climate emissions of furnishings and home care products, clothes and footwear, goods related to spare time activities and hobbies, audiovisual devices, as well as books, magazines, newspapers and paper products amount to approximately 600 kg/person/year (Seppälä et al. 2009). The estimates of minimum and maximum values of goods consumed, on the other hand, are based on a survey by Kotakorpi et al. (2008). The carbon footprint of a person buying recycled goods is estimated to be 50% smaller than that of an average consumer, because buying recycled products, does not generate the climate emissions caused by the manufacturing of new goods and clothes.

Pets bring joy to people's lives and are often treated as members of the family. However, pets also consume natural resources in the form of food and different services and products. Still, the question concerning pets is difficult, because pets can be of very different sizes. The estimate about the average monetary value of the products and services Finnish people use for their pets is based on the PetNets survey (2015). On the other hand, the estimates on the quantitative content of products and services are based on the price comparisons of various service providers and companies. The estimates produced by Hirvilammi et al. (2014) on the air consumption of different services were used as the source for the climate emissions of services. Air consumption describes the amount of air changed chemically or physically or used for combustion, or in practice the amount of oxygen, used for producing a service. The air consumption is often directly proportional to CO2 emissions, because burnt oxygen generates CO2. The climate emissions of food consumed by pets were estimated by comparing the nutritional values of dog and cat foods and using the emission factors of the Ecoinvent database.

There are almost 500,000 summer cottages in Finland. The average living area of a summer cottage is approximately 50 m2, but there is a lot of variation in how the cottages are equipped (FCG 2016). In the question about summer cottages, the assumption is that the summer cottage is modestly equipped. The average electricity consumption during summer season and/or winter season was also taken into account (Piiroinen 2009). It is assumed that basic heating is maintained in a cottage used year-round even when it is not in active use. The earlier answer given by the respondent on whether he or she uses ordinary or ecological electricity was taken into account when calculating electricity consumption. In addition to electricity consumption, the lifestyle test accounts for the climate impacts of the consumption of raw materials needed for building the cottage, land use and maintenance of the cottage. The emission factor used is based on the calculation made by Salo et al. (2008) on the day-specific air consumption caused by the use of a cottage (modest free-time residence 27 kg/day). The estimates of the average usage of cottages in summer and winter (days/year) are based on the statistics of the Free-Time Residence Barometer (FCG 2016). The climate emissions generated by the use of a cottage are divided between people using a cottage on a regular basis.

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