Calculation criteria used in the Sitra lifestyle test

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In connection with the update, following changes have been made in the background calculations of the Lifestyle Test:

In the area of living, in the question concerning the primary heating method, district heating and oil heating were separated into two distinct alternatives, since the updated emission factor for district heating is significantly lower than that for oil heating. Furthermore, green district heating was added as a primary heating method, since several towns and cities give consumers an opportunity to choose district heating produced using renewable energy sources as the heat source for their home.
In the area transport and tourism, the emission factor per unit applied to air travel takes into account the impact of upper atmosphere on the generation of CO2 emissions.
In the area of things and purchases, the estimate of the carbon footprint associated with average consumption of things and services has been updated to correspond with the estimates of the ENVIMAT study.

Closer explanations of the updated calculation criteria can be found in the text paragraphs addressing the calculations of each area separately.

Living

The environmental impacts related to 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 of 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 the 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: block of flats 8.0 and single-family house or semi-detached house 6.9 kg CO_2e/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 CO_2e/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 (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/m^2). The energy class A requires own energy production and class B buildings are low-energy houses. House types built in 1990-2010 typically represent the energy class D (energy consumption 160 kWh/m^2). The energy class of houses built before the 90s may vary significantly, but by default older houses are expected to have higher energy consumption (energy class F, energy consumption 240 kWh/m^2).

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. 150 g CO_2e/kWh) is based on the relative shares of the energy production forms

of district heating reported by Statistics Finland (Official Statistics of Finland 2017) and the average emission factors for the fuels used for cogeneration of heat and power adapted to the Finnish conditions reported by the Ecoinvent database (Wernet et al. 2016). The fuel classification of Statistics Finland (Official Statistics of Finland 2018) has been used for the emissions factor of peat used for heat production only. 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 by-products generated by the forestry industry (e.g. wood pellets and felling waste). However, the factor takes account of the emissions related to harvesting of wood-based biofuels, which are approximately 14 gCO_2e/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 CO_2e/kWh (Official Statistics of Finland 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 ground-source 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, an average heating method defined separately for each house type – based on the Statistics Finland material (Official Statistics of Finland 2015) on energy consumption of housing by source of energy – is used. For example, in blocks of flats, the primary heating method is district heating, but a small share of blocks of flats are heated with light fuel oil. In single-family houses, on the other hand, the primary heating method is wood/pellets or electricity, but the use of ground-source heating, light fuel oil and district heating is also taken into account. Based on the relative shares of various

heating methods, a weighted average was calculated as the emission factor used for the heating method of various house types.

In addition to the house type and time of construction, the respondents are asked in which part of Finland they live in. 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 of heating energy by 10% (Motiva 2017b).

The time used 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 (Official Statistics of Finland 2018).

Transport and tourism

The average estimates on the use of different means of transport are based on the National Travel Survey (2016) statistics.

The carbon footprint of motoring is calculated based on the annual number of kilometres driven and the average number of people driving a car. In motoring, the climate emissions consist of the fuel consumption, car manufacturing and the emissions from the use and maintenance of the road infrastructure. The generated emissions are divided between the number of people typically driving a car. The emission factors for fuels are based on the emission factors (gasoline and diesel) or consumption (gas-driven, electric or hybrid cars) per passenger kilometre reported by the LIPASTO database. 10% of the emissions of gas-driven cars are assumed to derive from use of gasoline, since the gas-driven cars used in Finland are usually gas-driven hybrids that can also use gasoline, if necessary. The consumption ratio of biogas and natural gas is based on the shares of such gases produced into fuels reported by GASUM (2017). Biogas does not produce any

calculated CO_2 emissions, since the burning of gas releases the same amount of carbon dioxide as was captured in the biomass used as the source of gas earlier in time (GASUM 2017). Approximately 15% of the emissions of ethanol-driven cars are assumed to derive from use of gasoline, since the ethanol-based RE85 fuel used in Finland contains 85% ethyl alcohol and 15% regular gasoline (Safety data sheet 2014). In Finland, the ethyl alcohol used in RE85 fuel is mainly produced from food or farm waste, for which reason its calculated CO_2 emissions are considered to be very small (ABC, St1). The fact that the consumption of RE85 fuel is approximately 30% higher than the consumption of regular gasoline (Mäkinen et al. 2005) has been taken into consideration in the CO_2 emission factor per kilometre used for the fuel. The emissions generated by the manufacturing of different car types are based on global average rates (Wilson 2013). Approximately 10% (20 g CO_2/vehicle km) of the overall emissions of motoring 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 (2010–2011) 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. In reference to buses, the different shares and emission factors for city and long-distance transport have been taken account of.

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 CO_2e-emissions from the energy and materials used for building aircraft and airports. Paragraph 19 of the preamble to Directive 2008/101/EC of the European Parliament and of the Council states the following regarding the climate impact of aviation: “Aviation has an impact on the global climate through releases of carbon dioxide, nitrogen oxides, water vapour and sulphate

and soot particles. The IPCC has estimated that the total climate impact of aviation is currently two to four times higher than the effect of its past carbon dioxide emissions alone. Recent Community research indicates that the total climate impact of aviation could be around two times higher than the impact of carbon dioxide alone. However, none of these estimates takes into account the highly uncertain cirrus cloud effects (high in the upper atmosphere). Research on the formation of contrails and cirrus clouds and effective mitigation measures, including operational and technical measures, should be promoted." Therefore, the emission levels caused by fuel consumption of aviation have been justifiably multiplied by two. The average airspeed of air traffic is based on the average cruising speeds of different types of aicraft reported by Finnair (Finnair 2019).

The average lengths of passenger shipping are based on the Statistics Finland material (Official Statistics of Finland 2016 and 2017) 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.

Food

The carbon footprint of the person doing 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 meal, eats 15% smaller/larger portions per meal.

In the lifestyle test, the respondent's diet is further tailored on the basis of the ingredients he or she consumes at meals. 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 environmental impact have been classified into various categories: beef and cheese / pork, chicken, fish and eggs / milk and milk products / drinks. An average portion size was calculated for each category, and a portion-specific emission factor was calculated based on what is the percentage of the various ingredients of the portion. The portion sizes of the various ingredients are based on the reported annual consumption of food commodities per capita (Natural Resources Institute Finland's Balance Sheet for Food Commodities 2017) and the food measures defined by the National Public Health Institute (Sääksjärvi & Reinivuo 2004). The sources used for emission factors included the environmental effects of products defined in the Kausiruoka (Seasonal food) 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 cheese were classified under the same category due to having higher emission factors than other foods (Kaskinen ym. 2011: beef from Europe 19 kg CO_2e/kg and cheese 13 kg CO_2e/kg). Pork, chicken, fish and eggs were classified under the same category. The emission factor of pork is slightly higher than that of ofter foods in the category but, on the other hand, significantly lower than the emission factor of beef. The emission factors used are: 5.6 kgCO_2e/kg for pork, 3.6 kg CO_2e/kg for chicken, 3.0 kg CO_2e/kg for fish and 2.7 kg CO_2e/kg for eggs (Kaskinen et al. 2011). The calculator does not take a stand on whether the meat consumed is game, since game accounts for approximately 2% of the meat consumption of an average Finn. The estimated emission factor for domestic moose meat is 1.6 kgCO_2e/kg (Kaskinen et al. 2011), for which reason the carbon footprint of a person comsuming 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 milk 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 milk products (excluding cheese) per person. In the lifestyle test, the emission factor used for milk is 1.4 kg CO_2e/kg (Kaskinen et al. 2011: low-fat milk from Finland).

For drinks a portion-specific environmental impact was calculated, being approximately 0.3 kg CO_2e/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 what the biowaste of a basic Finnish person eating a mixed diet contains (2.55 kg CO_2e/kg biowaste).

Things 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 to go through 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 concrete 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) “KotiMIPS – Kotitalouksien luonnonvarojen kulutus ja sen pienentäminen” (Household MIPS – Natural resource consumption of Finnish households and its reduction). The carbon footprint of a person buying recycled goods is estimated to be 50% smaller than that of an average consumer, because when

you buy recycled products, they do 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 on 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 m^2, but there is a lot of variation on how the cottages are equipped (Finnish Free-Time Residence Barometer 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 (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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