Minimize Carbon Footprints

Sources and Research Methods

General Information

The goal of the information graphic *Minimize Carbon Footprints* is to give an impression of how many emissions are currently caused by different Germans and to compare them to the German climate targets. We also want to show which effective measures can be taken to reduce the CO_2e consumption. The main data source is the CO_2 calculator of the *Umweltbundesamt*[1]. With the help of the calculator we have developed three consumer scenarios and determined which values need to be changed in order to save emissions.

Development of Consumer Scenarios

The data that forms the basis of the CO_2 calculator mentioned above is based on a paper from June 2007[2]. To create the consumer scenarios, we first created the profile of a Medium Emission Consumer. His consumption habits are based on different sources created between 2016 and 2019, which provide information about the current average consumption in Germany. However, the final annual consumption of the Medium Emission Consumers doesn't display the current average consumption in Germany, as the actual average values can't always be entered in the CO_2 calculator. For some categories there is also no accessible data and because the calculator is based on old calculations, often different technological and political conditions are assumed. The scenarios for the Low Emission Consumer and the High Emission Consumer are based on fictional personas and are only intended to give a picture of which emissions can be caused by which behaviour and how wide the range of personal emissions can be.

Selection of Measures

The basic conditions, such as the square meters of an apartment and the number of persons per household, doesn't change through the measures taken. The measures are chosen by effectiveness. In some cases, measures with a small effect aren't applied in order to avoid giving them unjustifiably high importance within the information graphic. The selection of measures has been editorially chosen by us as authors of the information graphic. A different selection of measures could possibly be just as effective. To delve deeper into the subject, we would like to invite you to use the CO_2 calculator of the Umweltbundesamt (https://uba.co2-rechner.de/de_DE/).

German Climate Targets:

The stated climate target of 1.11t CO_2e in 2050 is based on the *Klimaschutzszenario 95 (KS95)* from the *Klimaschutzszenario 2050 (2.Modellierungsrunde),* whereby a reduction in greenhouse gases of 95% compared to 1990 is to be achieved. The target is also stated in the publication *Klimaschutz in Zahlen* by the *Bundesministeriums für Umwelt, Naturschutz, Bau und Reaktorsicherheit*[3] and is shown as a climate protection target in the CO_2 calculator of the *Umweltbundesamt.* In general, the target is to achieve extensive climate neutrality in Germany by 2050.

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2   K. Schächtele, H. Hertle. CO2 Bilanz des Bürgers – Recherche für ein internetbasiertes Tool zur Erstellung persönlicher CO2 Bilanzen, ifeu Institut für Energie- und Umweltforschung, 2007
3   Bundesministeriums für Umwelt, Naturschutz, Bau und Reaktorsicherheit. Klimaschutz in Zahlen: Klimaschutzziele Deutschland und EU. https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/klimaschutz_in_zahlen_klimaziele_bf.pdf
    Visited: 08.07.2020

Input Data and Derivation Medium Emission Consumer

General Information

Most sources for the derivation of the Medium Emission Consumer are from the year 2018. 83.0 million people are presupposed to have lived in Germany in 2018 in order to convert the total German consumption data of various categories into per capita consumption[4].

Heating

The average German living space per capita in 2018 is 46.7sqm[5]. A household is most frequently inhabited by 2 persons[6], which is why a living space of 93 square meters is assumed. The ownership rate in 2018 was 46.5%[7]. This means that there were more tenants than owners, which is why we assume the consumer to be a tenant. Block/central heating systems are the most common type of heating[8]. The average year of construction for a house in 2018 is between 1949 and 1978[9]. The most common type of energy used for heating at this time is gas[10].

The heating consumption was calculated with the annual estimation function of the CO_2 calculator. The following consumption behaviour was assumed: Heating systems are averagely 17 years old, gas heating systems 15 years (as of 2019)[11]. The average room temperature in German living rooms is about 21°C, in bedrooms about 16°C[12]. Based on this, a value of 19°C is assumed for the apartment. With 48%, shock ventilation is the most frequent ventilation behaviour[13]. Central hot water preparation is most common[14]. The remaining values are estimated due to lack of data. Average values are assumed (no subsequent modernisation, daily showers, some economy fittings are used).

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4 Statistisches Bundesamt. Pressemitteilung Nr. 022 vom 17. Januar 2020. https://www.destatis.de/DE/Presse/Pressemitteilungen/2020/01/PD20_022_12411.html
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5 Umweltbundeamt. Wohnfläche. https://www.umweltbundesamt.de/daten/private-haushalte-konsum/wohnen/wohnflaeche#zahl-der-wohnungen-gestiegen
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6 Bundesinstitut für Bevölkerungsforschung. Zahl der Privathaushalte und durchschnittliche Haushaltsgröße in Deutschland (1871-2018) https://www.bib.bund.de/DE/Fakten/Fakt/L49-Privathaushalte-Haushaltsgroesse-ab-1871.html
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7 Statistisches Bundesamt. Von Eigentümern bewohnte Wohnungen (Eigentümerquote) 2018. https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Wohnen/_Grafik/_Interaktiv/eigentuemerquote.html
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8 Statistisches Bundesamt. Wohnungen nach Art der Heizung. https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Wohnen/Tabellen/wohnungen-heizungsart-bundeslaender.html
   Visited: 08.06.2020

9 Statistisches Bundesamt. Wohnungen nach Baujahr. https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Wohnen/Tabellen/wohneinheiten-nach-baujahr.html
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10 Statistisches Bundesamt. Wohnungen nach Energieart der Beheizung. https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Wohnen/Tabellen/wohneinheiten-energieart-beheizung.html
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11 BDEW. Wie heizt Deutschland 2019? https://www.bdew.de/media/documents/Pub_20191031_Wie-heizt-Deutschland-2019.pdf
   Visited: 08.06.2020

12 Energieverbrauch der privaten Haushalte und des Sektors Gewerbe, Handel, Dienstleistungen (GHD). https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/energieverbrauch-abschlussbericht.pdf?__blob=publicationFile&v=12

13 ebd.

14 Süddeutsche Zeitung. Welche Form der Warmwasserbereitung ist kostengünstiger? https://www.sueddeutsche.de/wirtschaft/immobilien-welche-form-der-warmwasserbereitung-ist-kostenguenstiger-dpa.urn-newsml-dpa-com-20090101-181102-99-639171
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Electricity

It is assumed that two people per household will consume electricity. The annual consumption was calculated with the estimation function of the CO_2 calculator. The following consumption behaviour was assumed: Mainly LED or energy saving lamps are used[15]. Most households have a fridge/freezer/cooler combination, a dishwasher, a washing machine, a microwave and a coffee machine[16]. Less than 50% of German households have a freezer or a tumble dryer. The classification of the appliances is assumed to range from A+ to A+++, as the calculator is based on 2007 data and the other age choices are backwards from that date. For a household from 2018, it is assumed that a 20–10 year old appliance is the exception rather than the rule. Most households own a television set[17]. The remaining values are estimated due to lack of data. Average values are assumed (one HIFI system, one computer, one laptop, no air conditioning unit, normal number of small appliances, no circulation/heating pump).

Rides and Trips

The average age of cars in Germany in 2019 was 9.5 years[18]. It is therefore assumed that the average car of 2018 was bought in 2009. The cars with the most new registrations in 2009 were the VW Golf, the VW Golf Plus and the VW Jetta V[19]. For the further calculations, the values of the VW Jetta V are used, since a middle class car is assumed to be a car with average consumption. Most of the passenger cars in the 2019 stock are petrol cars (65.9%)[20]. A VW Jetta with petrol engine consumes 5.7l/100km[21]. Per 1,000 inhabitants 568 people had a car in 2018[22]. Since more than half of the persons owned a car, it is assumed that the medium emission consumer owns a car. In 2018 the average per capita mileage was about 11,263km[23] (83.0 million Germans are assumed). Since it is assumed that the medium emission consumer has his or her own car, he or she does not use CarSharing. Public transport per capita was approx. 1059km in 2018[24] (83.0 million Germans are assumed). The additional kilometres travelled by bicycle have no effect on the CO_2 balance, which is why they are

15 statista. Welche der folgenden Leuchtmittelarten werden aktuell in Ihrem Haushalt verwendet? https://de.statista.com/statistik/daten/studie/253727/umfrage/bevorzugte-lampen-technik-als-nachfolger-der-gluehlampe-in-deutschen-haushalten/
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16 Statistisches Bundesamt. Ausstattung privater Haushalte mit elektrischen Haushalts- und sonstigen Geräten - Deutschland. https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Einkommen-Konsum-Lebensbedingungen/Ausstattung-Gebrauchsgueter/Tabellen/liste-haushaltsgeraete-d.html
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17 Statistisches Bundesamt. Ausstattung privater Haushalte mit Unterhaltungselektronik - Deutschland. https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Einkommen-Konsum-Lebensbedingungen/Ausstattung-Gebrauchsgueter/Tabellen/liste-unterhaltungselektronik-d.html
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18 statista. Durchschnittliches Alter von Pkw in Deutschland in den Jahren 1960 bis 2020. https://de.statista.com/statistik/daten/studie/154506/umfrage/durchschnittliches-alter-von-pkw-in-deutschland/
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19 Autobild. Die Party ist vorbei. https://www.autobild.de/artikel/hitliste-der-meistverkauften-autos-2009-1036259.html
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20 Kraftfahrtbundesamt. Jahresbilanz des Fahrzeugbestandes am 1. Januar 2019. https://www.kba.de/DE/Statistik/Fahrzeuge/Bestand/b_jahresbilanz.html
   Visited: 08.06.2020

21 auto motor sport. VW Jetta V (Typ 1K5, 1KM) Technische Daten. https://www.auto-motor-und-sport.de/marken-modelle/vw/jetta/v-typ-1k5-1km/technische-daten/
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22 Umweltbundesamt. Mobilität privater Haushalte. https://www.umweltbundesamt.de/daten/private-haushalte-konsum/mobilitaet-privater-haushalte#verkehrsaufwand-im-personentransport
   Visited: 08.06.2020

23 ebd.

24 Umweltbundesamt. Mobilität privater Haushalte. https://www.umweltbundesamt.de/daten/pri-

neglected here.

Flights

In 2018, 70.5 billion kilometres were covered for passenger air transport[25]. This results in approximately 848 km per capita. This corresponds to a flight from Berlin to Paris, which has a flight time of 1.40 hours[26]. Since a clear number of hours is required for the CO_2 calculator of the Umweltbundesamt, this value is rounded up to 2 hours, which corresponds to a flight from Porto to London, which is about 1324.71 km[27]. Economy is assumed to be the most used flight class. In Germany, less than 1% of flights were compensated in 2018[28], so it is assumed that the Medium Emission Consumer does not compensate his or her flight.

Food

The distribution of men and women in Germany is roughly equal. For the calculation of emissions from nutrition, a woman is assumed. The average age of a German woman in 2018 was 46.8 years[29]. An age of 47 years is therefore assumed. The average weight of German women between 45 and 50 years was about 69.4 kg in 2017[30]. A weight of 69 kg is assumed. In 2018 6% of the German population were vegetarians, 1% vegans and 28% consumed meat and sausages daily[31]. Based on these data, we aussme mixed diet as average diet for the calculation with the CO_2 calculator. For the other required data, average values are assumed (partly regional, mixed seasonal, occasionally frozen products, partly organic products, low activity, little sport).

Other Consumption

Other consumption mainly includes emissions that occur in industry, trade, commerce and services as well as freight transport. Here it is difficult to find precise data, as even the calculation of this category is not as detailed as that of the others. It is based on the average consumption values calculated by the CO_2 calculator of the Federal Environment Agency (average purchasing behaviour, functionality as the main purchasing criterion, sometimes used items, monthly consumption expenditure of 450€ per capita, less than 2 weeks of hotel overnight stays per year, no climate-friendly financial investments, no compensation from CO_2).

vate-haushalte-konsum/mobilitaet-privater-haushalte#verkehrsaufwand-im-personentransport
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25 Bundesministerium für Verkehr und digitale Infrastruktur. Verkehr in Zahlen 2019/2020. https://www.bmvi.de/SharedDocs/DE/Publikationen/G/verkehr-in-zahlen-2019-pdf.pdf?__blob=publicationFile
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26 Flugzeitrechner. https://flugzeit-rechner.de
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27 ebd.

28 GEO. Massentrend CO2-Kompensation? So ernüchternd sind die Zahlen wirklich. https://www.geo.de/natur/nachhaltigkeit/21475-rtkl-flugverkehr-massentrend-co2-kompensation-so-ernuechternd-sind-die
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29 Statistisches Bundesamt. Durchschnittsalter. https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Bevoelkerungsstand/Tabellen/durchschnittsalter-zensus.html
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30 Gesundheitsberichterstattung des Bundes. http://www.gbe-bund.de/oowa921-install/servlet/oowa/aw92/WS0100/_XWD_FORMPROC?TARGET=&PAGE=_XWD_2&OPINDEX=2&HANDLER=_XWD_CUBE.SETPGS&DATACUBE=_XWD_30&D.000=3739&D.003=43
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31 Bundesministerium für Ernährung und Landwirtschaft. Deutschland, wie es isst - der BMEL-Ernährungsreport 2019. https://www.bmel.de/DE/themen/ernaehrung/ernaehrungsreport2019.html
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Input Data and Derivation Low Emission Consumer

General Information

The data on the Low Emission Consumers are much more speculative than those of the Medium Emission Consumers. They are based on the assumption of a person who lives with low emissions through his or her basic conditions (socio-demographic data, workplace, geographical data) and through his or her behaviour, whether consciously or unconsciously. The aim is to show that different lifestyles have different environmental impacts. The technological measures are not yet defined as a basic prerequisite, so a better comparability between the individual consumers can be created.

Heating

The low emission consumer lives with three other people in a 100 square meter apartment. The common use of the living space has a positive effect on heating and electricity consumption and at the same time reduces other consumptions. The house was built after 2001. As with the Medium Emission Consumer, natural gas is used for heating, as it is the most common type of heating in Germany. Personal consumption is low: there is a central heating system, which was installed after 2005. The average room temperature is 18°C, and the house is ventilated intermittently. Showers are taken (but not on a daily basis) and there are mainly economy taps. Hot water is produced centrally.

Electricity

The electricity is purchased from the German electricity mix. Consumption is low: all lamps are LEDs or energy-saving lamps. A refrigerator, a freezer, a dishwasher and a washing machine are in use. All appliances are classified with A+ to A+++. An induction cooker is in use, as well as a HIFI system and a laptop. The number of small appliances is small and there is no electronic heating pump.

Rides and Trips

The person lives in the city centre of Leipzig and has short distances to work, friends, etc. The distance to work of 6km (distance there and back) is covered by public transport. The assumption is 230 working days per year, which corresponds to the standard value at the tax office for a 5-day week. Once a year the person goes on holiday to Stralsund by carpool (distance there and back: 926km). Four people sit in the car. On three days a week trips are made to sports, shopping, etc. An average distance of 5km (there and back) is assumed. All other distances are covered by bicycle.

Flights

Flights are completely avoided.

Food

The basic requirements of the person were taken from the Medium Emission Consumer (female, 30-59 years old, 69kg, sedentary activity, little sport). The diet is vegetarian, mainly regional, mainly seasonal and mainly organic. Frozen products are completely avoided.

Other Consumption

As with the Medium Emission Consumer, consumer spending amounts to 450€ per month. However, the consumer consumes sparingly, pays attention to longevity and often buys used items. Less than 2 weeks per year are spent in the hotel. The person has no climate-friendly investments and does not compensate for CO_2.

Input Data and Derivation High Emission Consumer

General Information

The data on the High Emission Consumer is much more speculative than that of the Medium Emission Consumer. The data is based on the assumption that the person causes high emission figures both through his basic conditions (socio-demographic data, workplace, geographical data) and through his behaviour, whether consciously or unconsciously. The aim is to show that different lifestyles have different degrees of environmental damage.

Heating

The high emission consumer lives alone in a 100 square meter apartment. The house was built before 1978 and has not been renovated since. For heating, heating oil is used, which results in high emission values. Heating oil heating systems were frequently installed between 1949 and 1978[32]. The personal consumption is also high: there is a central heating system that was installed before 1980. The average room temperature is 24°C, with many windows in a permanently tilted position. The consumer often takes a bath and there are no economy taps. Hot water is produced centrally.

Electricity

The electricity is purchased from the German electricity mix. The consumption is high: no lamps are LEDs or energy-saving lamps. There is a refrigerator, a freezer, a dishwasher, a washing machine and a dryer, all appliances are newer than 1996 (In the CO_2 calculator of the Umweltbundesamt this corresponds to the category "younger than 10 years", as the calculator uses data from before 2007). An electric cooker is available, as well as televisions, HIFI systems, laptops and air conditioners in numbers of three or more each. The number of small appliances is high and there is no electronic heating pump.

Rides and Trips

It is assumed that the person lives in Potsdam and works in Berlin Friedrichshain. He travels 84km to work (distance there and back) in an upper class car. The upper class car is assumed to be a 7 series BMW G11, 750Ld xDrive with 532 HP and a petrol engine. The consumption is 9,5l/100km[33]. The distance to work is covered on 150 days per year. 80 days a year the person is on business trip, of which he drives 40 times a year with the same BMW to Hamburg (distance there and back: 568km). The High Emission Consumer also owns a sports motorcycle. We assume a BMW S 1000 R with 160 HP. The consumption is 5.52l/100km[34]. With the motorcycle, a distance of 146km

32 Statistisches Bundesamt. Wohnungen nach Energieart der Beheizung. https://www.destatis.de/DE/Themen/ Gesellschaft-Umwelt/Wohnen/Tabellen/wohneinheiten-energieart-beheizung.html
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33 mobile.de. Technische Daten BMW 7er (G11/G12). https://www.mobile.de/auto/bmw/7er/2015/limousine/ modell/daten-fakten
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34 Spritmonitor.de. https://www.spritmonitor.de/de/detailansicht/756464.html
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(distance Potsdam-Wittenberg there and back) is covered 12 times a year. The choice of the vehicle brand is not important. Real existing vehicle models are only used to create realistic scenarios. The consumption values are similar across brands within a vehicle class.

Flights
A total of six flights per year is assumed. Twice the person flies in Business Class from Berlin to Sydney and back for business purposes. Three times a year he flys from Berlin to Rome and back for business purpose in Business Class and once a year he flys in the First Class from Berlin to the Maldives and back for holidays. Especially the transcontinental flights cause very high greenhouse gas emissions. The flight class affects how many people are seated in an aircraft, which in turn has an impact on per capita emissions.

Food
The basic requirements of the person differs from the Low and Medium Emission Consumer: male, 30-59 years old, 85kg, sedentary activity, a lot of sports. These requirements alone lead to increased emissions compared to the other two types of consumers. The diet is meat-based and often based on imported goods. No consideration is given to the seasonality of products. Two to three times a week frozen products are used and no organic products are bought.

Other Consumption
The consumer spents 900€ per month on other consumptions (e.g. electronic products, clothing, books). The consumption is generous, functionality is the most important reason for purchase . No used items are bought. More than 4 weeks per year are spent in the hotel. The person has no climate-friendly investments and does not compensate CO_2.

Input Data and Derivation of the measures

Heating
Instead of the gas heating, a heat pump is used, which is operated with green electricity. Even with the same behaviour a large part of the emissions can be saved. The behaviour remains the same for the Low and Medium Emission Consumer to show that political/technological measures would be most effective.

Electricity
Instead of the German electricity mix, only green electricity from renewable energies is used. A large proportion of emissions can be saved while maintaining the same behaviour. The behaviour remains the same for the Low and Medium Emission Consumer to show that political/technological measures would be most effective.

Rides and Trips
Low Emission Consumer
Emissions can hardly be reduced, when the travelled distance stays the same.

Medium Emission Consumer
The number of kilometres travelled annually remains the same (11,733km by car + 1,059km by public transport + 1,324.7km by plane = 14,116.7km in total). As a measure the total number of kilometres is only redistributed to other means of

transport. 90% of the distance is now covered by public transport, 10% by bicycle. So 12,705km are covered by public transport and 1,412km by bicycle.

High Emission Consumer

The car and motorcycle are waived. The distance to work is covered by public transport. The previous motorbike trips to Wittenberg are waived. The number of trips to Hamburg are reduced to 20 trips per year and made by Deutsche Bahn. The holiday on the Maldives will be cancelled and replaced by a holiday in Stralsund. The distance from Potsdam to Stralsund will be covered by car with four persons in the car (distance there and back: 616km).

Flights

Low Emission Consumer

There is already a complete ban on air travel.

Medium Emission Consumer

Flying is avoided completely. It is assumed that the previous distance (1,324.7 km) will be covered by public transport (see *Rides and Trips*).

High Emission Consumer

Flying is avoided completely. Business trips will be replaced by video conferences. Holidays in the Maldives will be replaced by a more ecological holiday (see Mobility Travel and Travel).

Food

The diet is completely changed to vegan, seasonal, regional and organic. Frozen products will be avoided. Data on age, weight and sporting activity remain the same, as it is not intended to convey, that the renunciation of sporting activity or other damage to one's own body should be used to save the climate.

Other Consumption

Consumer spending is limited to 150€ per month. In addition, consumption is based on thrift, longevity and used items. Hotel accommodation is completely renounced. The strong reduction of consumption is the most effective.