Calculate the Emissions for Your Own Cards

Calculation Exercise (30-120 minutes)

Task description / Instructions for Teachers

In this exercise, the students get to practice calculating the emissions for selected activities, providing them with an opportunity to enhance their computational skills and creativity.

The exercise can be carried out in three different steps, with each step representing a higher level of difficulty.

Step 1: Students calculate the emission value for an existing card.

Step 2: Students update a calculation of an existing card by changing one or more assumptions or parameter values. In this step, you as a teacher can either let the students search for the parameter values they need, or give them the data they need.

Step 3: Students make their own calculation from scratch for an existing card or their own card. This exercise may be difficult for many students to do on their own. One suggestion is that you as a teacher choose some suitable alternatives, for example among the cards for which there are calculation descriptions on our website (https://www.climatecallgame.com/calculations).

If the students manage to calculate the emissions for some new cards, you can print out the template at the end of this pdf to design the front and back and then laminate them - voilà! Now you have new cards that you can use when you play the game!

You might want to print out the following pages and distribute them to students to work on the exercise. Let them work on their own or in groups of 2-3 students in each group.

Expected Learning Outcomes

Upon completing this exercise, students are expected to have enhanced their computational and problem-solving skills through practice in calculating emissions for various activities and be able to reflect on when to use assumptions and when to rely on known values in calculations.

Calculate the Emissions for Your Own Cards

Step 1: Calculate the emissions of an existing card

In this exercise we use the card "Shower for 10 minutes every day for a year". Start by finding the card in the deck and keep it in front of you.

1. Gather the data needed for the calculation

Use the same assumptions and data that have been used to calculate the emission value on the card.

Given assumptions:

- Water consumption for shower head: 12 liters per minute
- Water temperature of incoming water (before heating): 13 °C
- Water temperature for shower water: 39 °C

Parameter values:

- Energy requirement for heating water: _____ MJ per liter and degree
- Emissions from heating water using electricity: _____ g CO2e per MJ

Tip: Check the calculation explanation on the website (https://www.climatecallgame.com/calculations/housing/front_housing1/) to find the missing parameter values.

2. Carry out the calculations

Water consumption

The first step is to calculate how much water is consumed in a year:

_____ [liters per minute] × _____ [minutes per day] × _____ [days per year] = _____ [liters per year]
Water consumption × Shower time × Repetitions = Total amount of water

The calculation shows that showering requires _____ liters of water per year.

Energy consumption for the heating of water

The next step is to calculate how much energy is needed to heat _____ liters of water from _____ °C, to _____ °C.

_____ [MJ per liter and °C] × _____ °C × _____ [liter per year] = _____ [MJ per year]
Energy demand for water heating × Number of degrees × Total water volume = Total energy demand

The calculation shows that it takes _____ MJ per year to heat the water.

Emissions from the heating of water

Finally, the greenhouse gas emissions are calculated by multiplying the total energy requirement by the emissions of greenhouse gases from heating the water using an electric boiler.

_____ [MJ per year] × _____ [g CO2e per MJ] =_____ [g CO2e per year]
Total energy demand × Emissions from heating = Total emissions

The calculation shows that the emissions amount to _____ kg of CO2e per year (NOTE: unit conversion from g to kg).

3. Check the calculation

Ask your peers or teachers to check your assumptions and calculations, or check your calculation against the calculation explanation on our website (https://www.climatecallgame.com/calculations/housing/front_housing1/). There you can see exactly how we have calculated the emissions from showering.

Step 2: Make a new calculation for an existing card

This exercise consists of recalculating an existing card by changing one or more assumptions or parameter values.

Based on the calculation in Step 1, think about which values could be changed and what this would mean. For example, make your own assumptions about the duration of the shower, the temperature of the water, or the type of heating used. Note that the "energy required to heat water" is a physical quantity that never changes.

Calculate the emissions with your new input data / new assumptions. Present your calculations clearly. Ask your peers or teachers to check your calculations and assumptions.

Below are some values that may be useful. You'll need to search for any additional values on your own.

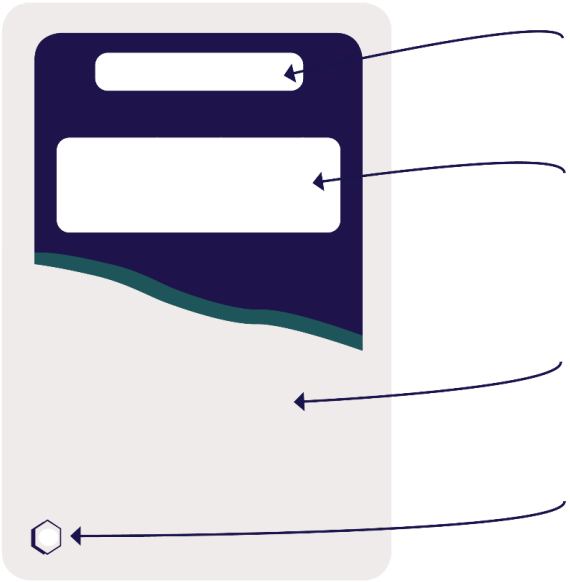
Parameter values	Value	Unit
Energy requirement for the heating of water	0.004184	MJ per liter and degree
Emissions from electricity generation (European average)	73	g CO_2e per MJ
Emissions from electricity generation (global average)	121	g CO_2e per MJ
Emissions from combustion of gasoline	85	g CO_2e per MJ
Emissions from combustion of diesel	89	g CO_2e per MJ
Emissions from combustion of aviation fuel (kerosene)	88	g CO_2e per MJ
Heating requirements for houses	360	MJ per square meter and year
Energy use for shorts flights (for example within Europe)	2.0	MJ per seat and km
Energy use for long-distance flights	0.9	MJ per seat and km
Energy use for train travel by high-speed train	0.16	MJ per seat and km
Fuel consumption for car	0.05	liters per km
Fuel consumption for bus	0.3	liters per km

Step 3: Calculate your own card

In this exercise, you will calculate the emissions for your own card. Think about what activity you would like to calculate the emissions for. Be creative!

Tip: Start with a card for which there is already a calculation explanation on our website (https://www.climatecallgame.com/calculations) so you can check the results later.

1. Fill in the front of the card



TITLE
For example: *shower*

DESCRIPTION
How long and how often the activity is performed and any other relevant assumptions you have made.

ILLUSTRATION
Feel free to include an illustration of your activity!

FREQUENCY
How many times the activity is performed

2. Make the necessary assumptions and search for parameter values

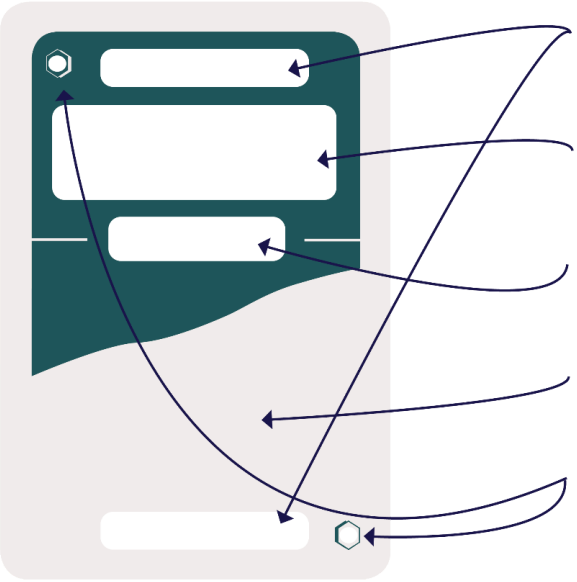
Identify the information you need to calculate the emissions and write down the assumptions you need to make. Find the data you need and make the necessary assumptions. Justify your assumptions.

Tip: Limit the task to counting only the most important emissions, and use unit analysis to figure out what information is needed.

3. Calculate the emissions

Break down the calculations into logical calculation steps and present each step separately, as in Step 1. Present your calculations clearly. Be sure to print the correct units everywhere, and convert to kg CO2e at the end.

4. Fill the back of the card



TITLE
Same as on the front page

DESCRIPTION
Same as on the front page

EMISSION VALUE
Fill in the calculated emission value in kg CO2e

ILLUSTRATION
Feel free to include an illustration of your activity!

FREQUENCY
Same as on the front page

5. Check your calculations with the help of peers and teachers.

Does your answer seem reasonable? Compare with some other cards and try to assess how well you have managed to calculate the emissions. Are there any assumptions or parameter values that you are unsure about? Please note that there is no "right answer", only reasonable estimates and correct calculations.

Bonus Task

In this exercise we will distinguish between assumptions and parameter values. Reflect (in groups) on the difference between assumptions and parameter values. When can you make assumptions, and when do you need to use known values, in these types of calculations? How should you think when making assumptions? Are the following things that you can make your own assumptions about, or do you need to use known values?

1) Emissions from the european electricity mix
2) How much food a particular meal consists of
3) How much a particular gadget weighs
4) The distance between two cities
5) The fuel consumption of a car