Card #1: Human Activities

This is where it all begins…



This card can be considered:

* either as the **cause** of all the economic sector cards ([Industry](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_2_industry), [Building Usage](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_3_building), [Transportation](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_4_transportation), [Agriculture](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_8_agriculture)),
* or as a **heading** for these cards (in which case they can be grouped together and circled).

### Consequences

* [Industry](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_2_industry) accounts for 40% of greenhouse gas (GHG) emissions
* [Building usage](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_3_building) accounts for 20% of GHG emissions
* [Transportation](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_4_transportation) accounts for 15% of GHG emissions
* [Agriculture](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_8_agriculture) accounts for 25% of GHGs if we include induced deforestation.

## Other possible links

### Other causes

* [Fossil Fuels](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_5_fossil_fuels) One can wonder whether human activities use fossil fuels or fossil fuels enable human activities. Do not waste time on this debate and put these two cards together if necessary. When I sing in my garden, I carry out a human activity without fossil fuels. When windmills or water mills produced flour, they did not use fossil fuels. Luckily, there are still many human activities that do not use fossil fuels.
* [Armed Conflicts](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_40_armed_conflicts) This is the Club of Rome feedback loop! The system will eventually regulate itself, but not necessarily gently. Players often make this connection and sometimes even suggest rolling up the Fresk to connect the beginning and the end. Moreover it is interesting notice that humankind appears in the first and last cards, but not in the middle.

### Other consequences

* [Deforestation](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_6_deforestation) Deforestation can be considered either as a human activity, or as a consequence of agriculture, or both.
* [Terrestrial Biodiversity](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_25_terrestrial_biodiversity) Humans occupy almost all available space on Earth, leaving no room for animals and plants. This entails the disappearance of natural habitats and it is the main cause of biodiversity loss today, well ahead of climate change.
* [Marine Biodiversity](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_27_marine_biodiversity) With this link, we highlight all the degradations that humans are inflicting on marine life such as plastic pollution and overfishing. It's irrelevant to climate change, but it's interesting to make the connection anyway.

## Card #2: Industry

Industry uses fossil fuels and electricity. It accounts for 40% of greenhouse gas (GHG) emissions.



## Explanation

This is the manufacturing of all consumer goods. Industry is comprised of many different sectors, the most prominent in terms of GHG emissions being the paper, cement, steel, aluminium and chemicals industries. In order to reduce emissions from industry, the solution lies in extending the lifespan of products and reducing consumption.

## Correction

### Causes

* [Human activities](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_1_human_activities)

### Consequences

* [Fossil fuels](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_5_fossil_fuels)

## Other possible links

### Other causes

### Other consequences

* [Deforestation](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_6_deforestation) This link is possible for wood-consuming industries. However, wood used by a factory in a sustainably managed forest would not be considered as deforestation.
* [Other GHGs](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_9_other_ghgs) In fact, methane emissions from industry are as strong as emissions from agriculture because of fugitive emissions (natural gas leaks from pipelines). This is a point that is little known, so this relationship is not considered strongly relevant. Industry also emits HFCs (refrigerants).

## To go further

### Buildings

The construction of buildings belongs to the Industry card, but not their usage.

### Cement

Cement production accounts for 10% of the world's GHG emissions. Between 2011 and 2013, China used more cement than the United States did throughout the entire 20th century. To make cement, limestone (CaCO3) has to be burnt, resulting in lime (CaO) and releasing CO2 into the atmosphere.

## Card #3: Building usage



The building sector (housing and commercial use) uses fossil fuels and electricity. It accounts for 20% of greenhouse gas (GHG) emissions.

## Explanation

We consider here buildings' usage, not their construction (which is included in the card on [Industry](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_2_industry)). This includes heating, air-conditioning, lighting, electronics, etc. The big topic in Europe and the US is the thermal insulation of buildings. As far as new construction is concerned, it is vital to build well-insulated buildings. However, the stakes are limited as the standards for new buildings are much higher than in the past and only a small proportion (1%) of buildings are constructed each year. The challenge is therefore much more in the thermal renovation of buildings.

## Correction

### Causes

* [Human activities](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_1_human_activities)

### Consequences

* [Fossil fuels](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_5_fossil_fuels)

## Other possible links

### Other consequences

* [River flooding](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_26_river_flooding) Soil artificialisation is also responsible for flooding because the soil is no longer able to absorb rain water.
* [Aerosols](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_10_aerosols) Buildings emit few aerosols directly. The only significant emissions are chimney fires. In Chamonix, 85% of the fine particles present in the atmosphere come from wood heating [[1]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_3_building#cite_note-1).
* [Deforestation](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_6_deforestation) It can be said that heating buildings with wood is in part responsible for deforestation, but it is not significant. Neither is building a major cause of deforestation. Agriculture is the main cause of deforestation, way in front of buildings and their usage.

## Card #4: Transportation



## Explanations

15% is not much, but it varies a lot depending on the country and lifestyle. In Western countries, the share of transportation, especially air travel, can account for a significant part of people's carbon footprint. If you take one or more long haul flights a year, that's the bulk of your carbon footprint.

## Correction

### Causes

* [Human activities](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_1_human_activities)

### Consequences

* [Fossil fuels](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_5_fossil_fuels)

## Other possible links

### Other consequences

* [Deforestation](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_6_deforestation) Road construction sometimes requires deforestation, but the one-dimensional aspect of the road makes it almost negligible compared to deforestation linked to agriculture.
* [Aerosols](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_10_aerosols)

## To go further

### French energy mix

In France, transport is the leading GHG emitting sector with 28% of emissions[[1]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_4_transportation#cite_note-1).

The individual car represents 67% of the carbon footprint of transport, which is huge![[2]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_4_transportation#cite_note-2)

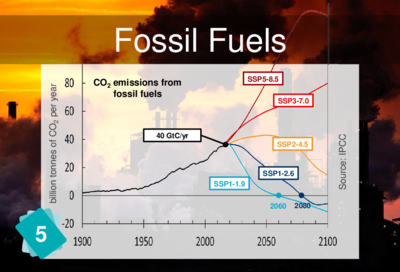
France's energy mix is 70% dominated by nuclear power, which is a low carbon energy (hydraulic 11%, fossil fuels 8%...)[[3]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_4_transportation#cite_note-3) (Electricity represents only 24% of the energy consumed in France. [[4]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_4_transportation#cite_note-4)). Therefore, an electric car in France will emit less CO2 than a fossil fuel car, but in the calculation of emissions per kilometre, the emissions linked to the manufacture of the car must be included. So it's better, but it's not zero emissions, as some advertisements would suggest.

### Some figures

* A single economy class roundtrip from New York (JFK) to Paris (CDG) emits the equivalent of 1.9 tonnes[[5]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_4_transportation" \l "cite_note-5) of CO2, which is almost the annual amount of carbon that the average person in the EU should reach in 2050.

## Card #5: Fossil fuels

Fossil fuels are coal, oil and natural gas. They are used mainly in buildings, transportation and industry. They emit CO2 when burned.



## Explanation

There is often a debate between placing the fossil fuels cards before or after [human activities](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_1_human_activities). Like the chicken and the egg, there is no definitive answer. One should not waste time on this. The graph represents the emissions of fossil fuels. In a +2°C scenario, they should reach zero by 2070.

## Correction

### Causes

* [Industry](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_2_industry)
* [Building usage](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_3_building)
* [Transportation](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_4_transportation)

### Consequences

* [CO2 emissions](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_7_co2_emissions)
* [Aerosols](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_10_aerosols)

## Other possible links

### Other consequences

* [Human activities](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_1_human_activities) What comes first? Do human activities cause the use of fossil fuels or do fossil fuels ensable human activities? Don't waste time on this and group the two cards together if necessary. Plenty of activities, happily, do not require burning fossil fuels, like windmills and watermills grinding grains for flour.
* [Marine biodiversity](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_27_marine_biodiversity) Oils slicks in the ocean are an example of a link between fossil fuels and marine biodiversity.
* [Armed conflicts](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_40_armed_conflicts) Although conflicts may occur because of resources, they are not directly caused by climate change, rather by resource depletion or scarcity. The relationship can be made, but it is due more to politics than to the climate crisis.

## Card #6: Deforestation

Deforestation is defined as cutting down or burning trees beyond the ability of the forest to restore itself. 80% of deforestation is driven by agricultural expansion.



## Definition

Deforestation, clearance, clearcutting or clearing is the removal of a forest or stand of trees from land which is then converted to a non-forest use. Deforestation can involve conversion of forest land to farms, ranches, or urban use.[[1]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_6_deforestation#cite_note-1)

## Explanation

Deforestation can be seen as a human activity, as a consequence of agriculture, or both. However, the main issue with deforestation is not so much that it destroys carbon sinks, but that it emits CO2 that took decades or centuries to capture. It's a question of flow vs. stock.

## Facilitation advice

The consequences of this card and of the [Other GHGs](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_9_other_ghgs) card are often forgotten, because participants often focus on the consequences of [Fossil Fuels](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_5_fossil_fuels). It is important to make sure that participants also consider the consequences of this card.

## Correction

### Causes

* [Agriculture](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_8_agriculture)

### Consequences

* [CO2 emissions](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_7_co2_emissions)

## Other possible links

### Other causes

* [Industry](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_2_industry) This link is possible for wood-consuming industries. However, wood used by a factory from a sustainably managed forest is not considered deforestation.
* [Transportation](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_4_transportation) Road construction sometimes requires deforestation, but the one-dimensional aspect of the road makes it almost negligible compared to wide-scale agriculture-related deforestation.

### Other consequences

* [Carbon Sinks](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_12_carbon_sinks) Participants often think that deforestation reduces carbon sinks. In reality, the impact is minimal because deforested areas represent a very small part of the total forest area. Moreover, a mature forest has reached its equilibrium and no longer absorbs carbon. Therefore, as mainly mature forests are deforested, this does not impact carbon sinks. On the other hand, the amount CO2 released is very high.
* [Radiative forcing](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_15_radiative_forcing) When forests are cut down, a dark green surface is replaced by a light green one, which has a higher [albedo](https://en.wikipedia.org/wiki/Albedo) and therefore absorbs less energy.
* [Disruption of the Water Cycle](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_20_disruption_water_cycle) Deforestation can perturb local precipitation.
* [Terrestrial Biodiversity](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_25_terrestrial_biodiversity) Deforestation causes huge losses of biodiversity. To animal biodiversity because forests are hosts to many species. The forest biodiversity index fell by 53% between 1970 and 2014 [[2]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_6_deforestation#cite_note-FAO_2020-2). And also to plant biodiversity, as 8,000 of the 60,000 known tree species are considered endangered.[[2]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_6_deforestation#cite_note-FAO_2020-2).
* [River Flooding](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_26_river_flooding) Vegetation retains water. Cutting it down can lead to flooding.
* [Droughts](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_30_droughts) Deforestation can be the direct cause of droughts because trees stock a lot of water. If they are cut down, they no longer play their part as humidity regulators.
* [Forest Fires](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_35_forest_fires) One way of clearing forests is to burn them down, with the risk of losing control of the fire. This is what happened in the summer of 2019 in the Amazon forest and [in Australia](https://en.wikipedia.org/wiki/2019%E2%80%9320_Australian_bushfire_season).

## Additional content

### Wood usage

93% of the wood from deforestation is burned (paper, agriculture, disposable furniture, etc.) and only 7% is used in a sustainable way (long-lasting furniture, construction, etc.).

### Distribution of causes of deforestation

The drivers of deforestation[[3]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_6_deforestation#cite_note-3) are:

* 40% for commercial agriculture, to breed livestock or to grow soy or oil palm
* 33% for local subsistence farming
* 10% for urban expansion
* 10% for infrastructure expansion
* 7% for mining.

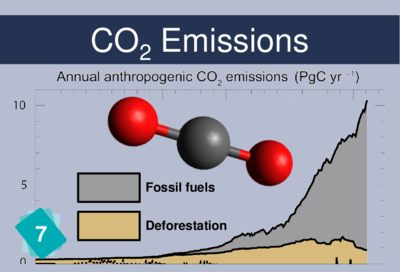
These numbers are global averages, and vary greatly from country to country.

### Speed of forest loss

The area of forest lost each year is gradually shrinking. It has decreased from 7.8 million hectares lost per year in the 1990s to 4.7 million hectares in 2010. This is mainly due to the fact that forests are growing elsewhere, either naturally or artificially.[[2]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_6_deforestation#cite_note-FAO_2020-2).

## Card #7: CO2 emissions

CO2, or carbon dioxide, is the main anthropogenic (produced by human activities) greenhouse gas in terms of emissions. These emissions come from our use of fossil fuels and from deforestation.



## Correction

### Causes

* [Fossil fuels](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_5_fossil_fuels) Coal, oil and natural gas emit CO2 during combustion.
* [Deforestation](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_6_deforestation) emits CO2 because a large proportion of deforestation caused by man is achieved by burning the forests.

### Consequences

* [Carbon sinks](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_12_carbon_sinks)

## Wrong links

### Wrong consequences

* [Concentration of CO2](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_11_concentration_of_co2) The correct link is via the carbon sinks card.
* [Ocean acidification](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_24_ocean_acidification) The correct link is via the carbon sinks card.

## Current energy mix

### Global

The global energy mix is 85% dependent on fossil fuels[[1]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_7_co2_emissions#cite_note-1) and today renewable energy sources tend to add capacity rather than replace fossil fuels.

### France

In France in 2018, the final energy consumption (at consumer level) split by primary energy source was as follows[[2]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_7_co2_emissions#cite_note-2):

* Fossil fuels: 67.4% (coal 1.9%, oil 44.0%, natural gas 21.5%)
* nuclear: 17.7%
* renewables: 14.9% (biomass-waste 9.8%, hydropower 3.0%, wind 1.2%, solar 0.5% (mainly photovoltaic), other 0.3%).

## Card #8: Agriculture

Agriculture does not emit much CO2 but does emit large quantities of methane (from cattle and rice paddies) and nitrous oxide (from fertilizers). In all, agriculture accounts for 25% of GHGs if we include the induced deforestation.



## Explanation

Agriculture uses very little fossil fuel compared to the emissions of other GHGs for which it is responsible. It is responsible for 80% of deforestation because of the large areas needed to grow crops, especially to feed farm animals. Agriculture is a human activity that began as soon as the climate stabilised, at the beginning of the Neolithic period 10,000 years ago, after the last deglaciation, which itself lasted 10,000 years.

Since then, the impact of human activity on its environment has been growing. Plant species have been domesticated (today, domesticated rice is no longer able to reproduce without human intervention), forests have been cleared to expand cultivated areas, depriving animal species of their natural habitat, and since the Green Revolution (green for agricultural, not for ecological), we have been using [pesticides](https://simple.wikipedia.org/wiki/Pesticide) and inputs that are harmful to the environment and to our health.

## Correction

### Causes

* [Human activities](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_1_human_activities)

### Consequences

* [Deforestation](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_6_deforestation)
* [Other GHGs](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_9_other_ghgs)

## Other possible links

### Other consequences

* [Fossil fuels](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_5_fossil_fuels) Agriculture does not use much fossil fuel, just enough to keep tractors running. Its carbon emissions are high, bu mainly because of methane and nitrous oxide.
* [CO2 emissions](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_7_co2_emissions) Agriculture does not emit much CO2 except from deforestation. Its carbon emissions mainly come from othe GHGs.
* [Aerosols](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_10_aerosols) Spraying crops does result in aerosols and air pollution, but not to the same extent as incomplete combustion from power plants.
* [Carbon Sinks](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_12_carbon_sinks) It doesn't matter if this link is not made, but it is true that agriculture can improve storage capacity through photosynthesis. This is the 0.4% principle (if we increased the soil's capacity to sequester carbon by even 0,4%, we would have a significant impact on CO2).
* [Terrestrial Biodiversity](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_25_terrestrial_biodiversity) Here, we are thinking mainly of pesticides (especially Roundup or neonicotinoids). No link with the climate, but an interesting relation to make.

## To go further

### Footprint of animal husbandry

Much of the impact of agriculture is due to animal husbandry. However, it is very difficult to agree on a percentage of greenhouse gases due to livestock.

* Which Global warming potential (GWP) to choose: methane is the main warming gas due to livestock farming. If we look at a 20-year horizon, it has a GWP of 84, but of 28 only over a 100-year horizon: difference of a factor three.[[1]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_8_agriculture#cite_note-1)
* Partnerships with various private institutions [[2]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_8_agriculture#cite_note-2) who have a vested interest in this number, such as:
  + The European Feed Manufacturers' Federation (FEFAC)
  + the European Vegetable Oil and Proteinmeal Industry (FEDIOL)
  + the International Dairy Federation, (IDF)
  + the International Meat Secretariat (IMS)
  + the International Egg Commission (IEC)
  + the International Poultry Council (IPC)
  + the International Federation for Animal Health (IFAH)
  + the World Wildlife Fund (WWF).

However, the two figures most often found are:

* 18% of total emissions according to the 2007 report [[3]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_8_agriculture#cite_note-3)
* 14.5% of total emissions according to the 2012 report [[4]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_8_agriculture#cite_note-4)

### Key concepts

* The IPCC distribution key logically assigns to industry the agro-industry (fertilisers, crop treatment products, herbicides, agricultural machinery) and the agro-food industry. But this does not help to estimate the positive effects that a system based on agroforestry, shorter distribution channels and a sharp drop in the consumption of industrially processed food products could have.
* The massive use of chemical fertilisers and pesticides gradually destroys the micro-flora and micro-fauna of the soil.
* Earthworms are disappearing, whereas they act as small ploughmen working for root penetration and improving the permeability of the soil and the renewal of water tables. They also feed on the residues of previous crops and transform them into humus, a stable form of organic matter capable of storing a large quantity of water and releasing it in times of drought. Moreover, humus stores the mineral elements that can be used by the plant.
* Fungi are also disappearing under the effect of fertilisers and chemical treatment products, although they are intermediaries living in symbiosis with the plants. They act as an extension of the roots, fetching water and mineral salts and exchanging them for organic molecules produced by the plant.

### Storing carbon through agroforestry

The disappearance of earthworms and fungi, as well as deep and frequent ploughing and leaving land naked for many months between two crops, accelerate the decomposition of organic matter. Agricultural soils in chemical-input agriculture are net producers of carbon and deplete organic matter, while agroforestry provides an annual increase of 4‰[[5]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_8_agriculture#cite_note-5) in the level of organic matter in the soil. The soil thus becomes a [**carbon sink**](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_12_carbon_sinks).

Widespread use of these techniques would make agriculture **the safest and cheapest carbon sink** at very low or no cost. It would provide a much healthier diet and would maintain and even develop a population that could live decently from agriculture, the basis of food autonomy in many countries. Biodiversity would be greatly enhanced as a result. The shortening of circuits would reduce energy consumption. The same applies to a decline in the agri-food industry, which would also improve the health of our fellow citizens[[6]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_8_agriculture#cite_note-6). A major source of pollution would disappear.

The jobs lost in agribusiness and agro-industry would be largely offset by those generated by agroforestry, which is much more labour-intensive than chemical-input agriculture.

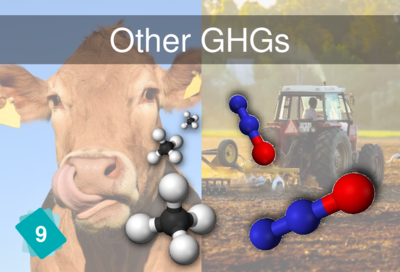
At the same time, a significant reduction in meat consumption would sharply reduce the areas devoted to the production of cereals for animal feed (mainly cattle, pigs and poultry). This would compensate for the lower crop yields in the absence of chemical inputs.

In total, we would have :

* much **healthier food** produced by farmers who are proud of their work
* a **healthier** population (reduction in particular of cardiovascular diseases and cancers) as a result of eating less meat and food that does not contain chemical residues,
* soils becoming an important **carbon sink** by increasing the level of organic matter in the soil (4‰/year)
* a shift from industrial jobs (agrochemicals, agricultural machinery, agri-foodstuffs) to **agricultural jobs**
* a reduction in food packaging
* a strong **decrease in energy consumption** by the whole sector
* a **decrease** in [**methane**](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_9_other_ghgs) production by reducing the number of ruminants
* the **disappearance** of **nitrous oxide** production linked to nitrogen fertilizers
* a boost to [**Terrestrial**](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_25_terrestrial_biodiversity)**and**[**Marine Biodiversity**](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_27_marine_biodiversity) (disappearance of green algae and the ecological imbalance of which they are a symptom).

## Card #9: Other GHGs

CO2 is not the only greenhouse gas (GHG). Among others are methane (CH4) and nitrous oxide (N2O), both of which mainly come from agricultural activities.



## Explanation

The other GHGs described here are methane and nitrous oxide. In fact, there are a few others such as HFCs (refrigerants).

Methane is released as soon as there is anaerobic decomposition (i.e. in the absence of oxygen):

* in a cow’s belly, also known as the rumen, which gives its name to ruminants (in the rumen, bacteria digest the cellulose that the cow cannot metabolise, then the cow regurgitates this grass to chew it again and swallow it for good)
* in rice fields because they are covered with water, and the organic matter underwater does not receive oxygen when it decomposes
* in waste dumps, when the piles are too deep for oxygen to reach the bottom of the pile.

Methane is also the main component of natural gas. Leaks on gas pipelines therefore also release methane into the atmosphere.

Emissions of nitrous oxide (N2O) are mainly due to the use of agricultural nitrogen fertilizers, the production of animal feed and certain chemical processes, such as the production of nitric acid.

There are also fluorinated gases which are used as refrigerants (air conditioning and cold chains), fire extinguishers and in certain industrial processes and consumer goods (such as certain solvents). They are not naturally present in the atmosphere.

## Correction

### Causes

* [Agriculture](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_8_agriculture)
* [Permafrost](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_41_permafrost)

### Consequences

* [Additional Greenhouse Effect](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_13_additional_greenhouse_effect)

## To go further

### Global warming potential

When we talk about emissions of other GHGs, we measure them in CO2eq (CO2 equivalent). This allows us to equate the emissions of other GHGs to CO2 emissions on a comparable basis. We then define the Global Warming Potential (GWP) of a gas over a certain period of time.

|  |  |  |  |
| --- | --- | --- | --- |
| **Global warming potential of some GHGs**[[1]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_9_other_ghgs#cite_note-1) | | | |
| **GHG** | **Life span (years)** | **GWP20** | **GWP100** |
| CH4 | 12.4 | 84 | 28 |
| N2O | 121 | 264 | 265 |

## Card #10: Aerosols

Nothing to do with aerosol spray cans. Aerosols are a type of local pollution that comes from the incomplete combustion of fossil fuels. They are bad for human health and they negatively contribute to radiative forcing, meaning that they have a cooling effect on the climate.



## Definitions

Aerosols are solid or liquid particles suspended in the air, generally ranging in size from a few nanometres to 10 micrometres and which remain in the atmosphere for at least several hours. Aerosols can be of natural or human origin (through [transportation](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_4_transportation) or [industry](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_2_industry)). They can affect the climate in a variety of ways: [directly](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_15_radiative_forcing#Cooling_effects), by scattering or absorbing radiation, and [indirectly](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_15_radiative_forcing#Cooling_effects) by acting as condensation nuclei of clouds or glaciogenic cores, by modifying the optical properties and lifetime of clouds.

## Correction

### Causes

* [Industry](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_2_industry)
* [Transportation](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_4_transportation)
* [Fossil fuels](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_5_fossil_fuels)

### Consequences

* [Radiative forcing](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_15_radiative_forcing) Aerosols cool down the climate.
* [Human health](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_38_human_health) Although aerosols are not alone in the "fine particle" category, every year 391,000 people in EU countries die from air pollution[[1]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_10_aerosols#cite_note-1), and it causes 1.1 million premature deaths in India and China[[2]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_10_aerosols#cite_note-2). Air pollution such as soot caused by the burning of fossil fuels such as coal and oil was responsible for 8.7m deaths globally in 2018. [[3]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_10_aerosols#cite_note-3)[[4]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_10_aerosols#cite_note-4)

## Other possible links

### Other causes

[Building usage](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_3_building) Buildings emit few aerosols directly. The only significant emissions are chimney fires. In Chamonix, 85% of the fine particles present in the atmosphere come from wood heating[[5]](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_10_aerosols#cite_note-5).

## Facilitation advice

This card can be removed most of the time, unless the players are likely to understand it, have the time and the facilitator has a good grasp of the subject.

[Card 13](https://wiki.climatefresk.org/en/index.php?title=En-en_adult_card_13_additional_greenhouse_effect) can be used to explain this: Aerosols mainly play on the orange arrows (they increase the size of the "Reflection" arrow, while the additional greenhouse effect plays on the red arrows (it increases the size of the "Greenhouse Effect" arrow which returns to the earth).

## To go further

### Origins of anthropogenic aerosols

Aerosols are a form of local pollution caused by the incomplete combustion of hydrocarbons. When we burn fossil fuels, a perfect and complete combustion produces only CO2 and water vapour. However, the hydrocarbons we burn are not pure and the combustion is not complete. Therefore, polluting gases such as NOx or carbon monoxide and aerosols such as black carbon (soot) or hydrogen sulphide are also emitted.

### Natural Aerosols

If clouds already existed before the industrial era, it is because aerosols exist in their natural state. They are for example microscopic grains of sand, salt crystals, volatile organic compounds (VOCs) such as microorganisms blown by the wind from the leaves of trees. The micro-droplets of water that make up clouds can only form on a condensation core such as an aerosol.

### Uncertainty related to the calculation of the influence of aerosols

Although aerosols are thought to cool the climate on average, their total contribution is the result of warming and cooling effects with great uncertainty. The sum of the two is therefore highly subject to uncertainty. The Futura Science article [Why so many uncertainties in climate predictions?](https://www.futura-sciences.com/planete/dossiers/climatologie-tant-incertitudes-previsions-climatiques-638/) (in French) provides a good understanding of the origin of these uncertainties.