INTRODUCTION

Print

The terms 'climate change' and 'global warming' were first used by scientist Stephen Schneider in 1976. His findings were acknowledged and accepted by the United Nations in 1988. Environmental organisations, among other efforts, made climate change caused by humans *a hot topic*, although there are still sceptics who turn a deaf ear.

In this set of lessons, we will try to provide a clear picture of the situation, while also giving you the opportunity to think about possible solutions.

Students: the assignments:

1. Weather and climate
2. The greenhouse effect
3. Climate change throughout history
4. Controversy
5. The effects of climate change on nature
6. The effects of climate change on plants, animals and people
7. Climate agreements
8. Fossil-free energy
9. Geoengineering
10. What can your school do?
11. What can you do?

Finally, there will be a final assignment: this is tied to a fun campaign set up by the students (with a personal budget from the EU!)

Teachers

To get access to the teacher's guide, we ask teachers to register and sign in first. Every lesson comes with a teacher's guide with teaching tips, answers to the questions, and key objectives and attainment targets. The 11 teacher's guides are collected also by us in an all-inclusive teacher's guide.

We ask you to help us improve the lesson series 'Climate change'. We have developed a self assesment evaluation tool (SAT) that we will gladly send you by email. We also have a self assesment tool for students available.

Ideally, the lesson series looks like this

* Registration
* SAT for teachers prior to the lesson series
* SAT for students prior to the lesson series
* Your or the students choice from the 11 assignments of the teaching and learning unit
* SAT for students after the lesson series
* Finishing the SAT for teachers
* Students action

Send an email to h.deridder@fm.ru.nl for the SATs or phone with +31 24 3615902.

Teacher's Guide Teaching and Learning Unit Climate Change

Print

The lesson series 'Climate change' is in line with the UN's Sustainable Development Goals.

The lesson series introduce the students to the following concepts:

* weather
* extreme weather
* weather alert
* climate
* greenhouse gasses
* natural greenhouse effect
* enhanced greenhouse effect
* climate change
* Pangaea
* perihelion
* aphelion
* axial tilt
* natural disasters
* climate research
* climate discussion
* climate change denial
* think tank
* glacier
* permafrost
* rising sea levels
* absolute sea level change
* relative sea level change
* migration
* climate refugee
* reduction target
* Climate Agreement
* Agenda 21
* Forest Principles
* Kyoto Protocol
* Paris Agreement
* bunker fuel
* energy sources
* wind energy
* wind turbine
* wind park
* solar energy
* hydropower
* hydropower station
* tidal power station
* blue energy
* biomass
* electric car
* geoengineering and climate engineering
* SRM – Solar Radiation Management
* CRD – Carbon Dioxide Reduction
* aerosol
* Bike to Work Day
* Warm Sweater Day
* Energy Challenges
* waste separation
* environmentally friendly school
* climate friendly
* CO2 equivalent
* climate law

We would also like to refer you to the Glossary with didactic backgrounds of the project 'Get Up And Goals!'.

The didactic goals of the TLUs are:

a) **Ability to grasp the interconnection between local, national and global levels**
TLUs should address global issues from a planetary perspective and connect the latter to the local dimensions. The learning objectives should not be eurocentric or nationalistic in tone. This can be called also "capacity to grasp the transcalarity of the themes, "ie the study of phenomena, through the use of different geographical scales and related analyses that proceed from local to national, continental, global and vice versa and tend to highlight the interconnections that, although arising from a single phenomenon, linking different spaces.
(Understanding local immigration in transcalar terms, for example, means having to connect local events to continental and / or global scale, vice versa the great global phenomena such as climate change have continental, national, local effects, each attributable to the overall phenomenon and each one at the same time with its own specificity).

b) **Skills to grasp present realities in relation to the present**
Even when dealing with a theme related to the historical past, the TLUs will highlight the connection between the past and present realities.

c) **Capacity to grasp interdisciplinarity of the themes**
It is not always easy to grasp interdisciplinarity in school systems that are organized through division into disciplines (or "subjects"),.
Nevertheless is important that students are aware of each theme as a whole. This whole is divided into different subject to facilitate the analysis, but must also be reconnected to a final synthesis grasping all the interdependences.

d) **The ability to Think Critically and capacity for self-reflection**
TLUs encourage learners to examine resources, images and messages from various critical positions, including paradoxical ones and strive to extend student's critique to self-reflection on our thoughts, feelings and responses to a certain resource or issue at hand.
(Connected with the critical thinking):

e) **Capacity of decentralization- (or capacity to take into consideration a plurality of points of view)**
It means to take an integrated, complex look, knowing that there are so many ways to relate to the existing and that your approach is only one of the many possible visions. In this way it becomes possible to simultaneously evoke the different positions and situations in play.
Example: to study climate change from the point of view of people from the South.
Purpose: deepen the look to account for multiple situations so as to empathize with each other to overcome sterile dichotomies and promote a sharing of meanings.

f) **Capacity of reflection on the role of individuals and groups in building peaceful, fair and sustainable futures**
While personal commitment to engage with global issues is the first necessary step, TLUs also aim to explore possibilities on how individuals and groups can combine their strength to better influence capability of change and to discuss the role of institutions and their positions of power.
Example: pose a problematic situation in which knowledge is put into play to resolve critical issues such as when new laws need to be designed to overcome gender inequality or to grant citizenship rights to immigrants.
Purpose: to promote a knowledge of responsibility for which those who know can not but act to overcome inequalities or situations of violation of human rights.

Answers to student assignments

Weather and climate

Step 1: Answers
1) *A fair-weather friend*: A friend who is only there for you when things are going well.
Being under the weather: Feeling bad or ill.
Hitting rough weather: Going through a difficult time
Every cloud has a silver lining: You can still find something positive in a bad situation.
Come rain or shine: No matter what.
Being in a fog: Being confused or unaware of things.
Chasing rainbows: Trying to reach an impractical or impossible goal.
Knowing which way the wind blows: Knowing how a situation is developing and being prepared for the future.
The calm before the storm: An unusually stable and quiet time before a bad or difficult period.
Stealing someone's thunder: Taking credit for something someone else did.

Breaking the ice: Doing something to relieve a tense or uncomfortable situation.
Putting something on ice: Postponing something, usually a task or plan.
Being snowed under: Having more work than you can handle.

The expressions that do not make sense literally are: A fair-weather friend, being under the weather, chasing rainbows, stealing someone's thunder

Step 2: Answers
2) The pupils' own opinions
An atlas can be used to find more examples, like maps 38F and 38G in the Grote Bosatlas (55th edition).
- The number of very cold days is decreasing
- The number of very warm days is increasing
You could wonder if ice skating will remain possible in the future.

Step 3: Answers
3) These definitions of the climate are missing an element: "in a certain area". A complete definition could be "The climate is the average weather in a certain area over a period of at least 30 years".
4) 'Extreme weather' refers to deviations from the norm in peak moments (extreme amounts of rain or extreme cold and frost). Climates do not have peak moments. When we say 'extreme climate', we mean situations that make places less habitable for humans. One example is the climate on the North and South Poles, with temperatures below -20°C/-4°F. Only scientists live and work there. Another example is deserts, where the average human does not want and is not able to live.

The greenhouse effect

Step 1: Answers to the questions
1) The sun creates ozone, so the extremely low temperatures above the South Pole in winter mean that less ozone can be created. Combined with the ozone decay caused by propellant gasses, this creates a hole in the ozone layer.
2) One: HCFC breaks down very slowly, which means its effects continue long after it stops being used.
Two: Not everyone complies with the ban on propellant gasses.

Step 2: Answers to the questions
3) One: archaeological and geographical research. For example, tree rings show how much CO_2 was in the air in those specific years.
Two: Computer models. These models are shown to be accurate when compared to measurements we do have.

Step 3: Answers to the questions
4) The Netherlands is a highly industrial country that uses a lot more (polluting forms of) energy than, for example, developing countries. Societies where industry is less developed contribute less to the rise in the global temperature.
5) When more people are fed, we require more resources to produce cattle and farmed produce (especially in rice farming). This increases the amount of methane in the atmosphere. Methane is a powerful greenhouse gas that contributes to the enhanced greenhouse effect. If we all stop eating meat and become vegetarians, the amount of methane in the air will increase less rapidly.

Climate change throughout history

Step 1: Answers
1) Thanks to GPS and satellite images, we can calculate the exact distance between continents. For example, the gap between North America and Africa is getting 3.3cm bigger every year.

Stap 2: Answers
2) In favour: Both a meteor strike and an atom bomb release massive amounts of energy, with disastrous consequences.
Against: The meteorite occurred naturally, was larger in size, and had bigger consequences for all life on Earth. The atom bomb was a human creation, is much smaller, and its consequences are horrible but not as wide-spread.

Step 3: Answers
3) The Tropic of Cancer and the Tropic of Capricorn are imaginary lines around the Earth, which mark the borders of the areas above the Northern and Southern hemispheres where the sun is perpendicular to the Earth. The two Tropics are at about 23.45° and indicate the Earth's axial tilt.
4) Above the polar regions, the sunlight has to travel further through the atmosphere and warm up a larger surface area, which means it is always cold. A change in the angle of the sun also changes the amount of surface area that can be heated. The smaller the angle, the warmer it gets.

Step 4: Answers
5) One: 70% of the Earth is covered with water. Most fossils and other remains can be found here.
Two: The sea cannot erode, while erosion washes land into the water. More researchable materials can be found in the water.
6) There are a lot of factors that do not just influence the climate, but also influence each other. This makes it difficult to understand and weigh the importance of every factor.

Controversy

Step 1
1) Cherry-picking: Being selective. Only looking at information that supports your story and ignoring other evidence.

Step 2
2) Climate change can only be stopped if the whole world works together, which costs a lot of money. A characteristic of populism is belief in one's own national pride and one's own policies, combined with a lack of interest in solving problems on a global scale (which would mean giving up some autonomy). Additionally, many populists deeply distrust what the government says, including statements about what to do about climate change.

Step 3
The article in The Guardian: https://www.theguardian.com/environment/2013/feb/14/funding-climate-change-denial-thinktanks-network.

3) This rule also applies to science: He who pays the piper, calls the tune. If you do not share who your sponsors are and people find out later, your publication will no longer be seen as objective or reliable.
4) Shell introduced the term greenhouse refugees. Nowadays we sometimes talk about climate refugees or environmental refugees, but these are not common phrases.

The effects of climate change on nature

Step 1
1) Map 275F (Sea Ice Surface) of the Grote Bosatlas edition 55* clearly shows that the thickness of the ice in winter fell from just above 16 meters to below 15 meters between 1980 and 2013 (measured in March. It also dropped from just under 8 meters to 5 meters in summer between 1980 and 2013 (measured in September), If the line continues, the North Pole will be free of ice in 55 years (2013 + 55 = 2068).
2) They will have more trouble finding water. They collect melted ice from the glaciers in a reservoir. When these glaciers get smaller, less water will be able to reach the water supply. The amount of water will no longer be enough for everyone, but getting water somewhere else is too expensive.
3) Building infrastructure in frozen ground is difficult. Building and using machines generates heat, which can cause further defrosting and may lead to land subsidence.

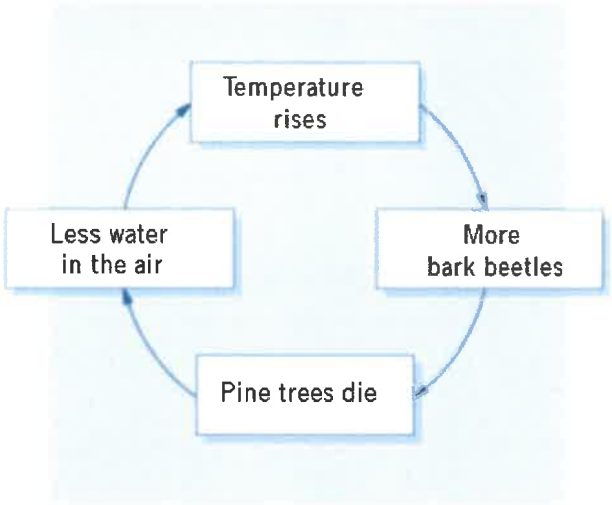
* An atlas that is used by every student in the Netherlands

Step 2
4) Absolute sea level rise: the difference between the higher sea level and the current ground level.
Relative sea level rise: the difference between the higher sea level and ground that is subsiding.
5) The Netherlands is protected by dunes, dykes, and deltas. Bangladesh does not have any natural protection and therefore floods more easily.
Bangladesh has a lot more river mouths than the Netherlands.
The Netherlands is a rich country that can afford expensive technological solutions, while the less rich Bangladesh cannot afford the same.

Step 3
6) Hefty: It cannot be ignored.
Key phrases refer to the necessity of taking action immediately. The time for waiting is over. Examples of these keywords are: "Not tomorrow or the day after, but today." "Not a distant problem of the future, but right now."

The effects of climate change on plants, animals and people

Step 1
1)



2) Consequence: When sea water gets warmer, it also becomes more sour. Sour sea water dissolves the calcium skeleton of the coral.

Step 2
3) Moving to a different environment that fits their needs better.
4) The animals that are dependent on the sea cannot just move to any new area.
Oystercatchers: the acidity of the sea cannot decrease somewhere else.
Puffins: the little fish they eat move to sea areas far away from the puffins.
Green sea turtle: the beaches where they lay their eggs get smaller when sea levels rise and sea turtles cannot just find another beach to lay their eggs.

Step 3
Source for the EJF's claim: https://ejfoundation.org/what-we-do/climate/protecting-climate-refugees.

5) An example is the harvest of grapes for wine, which becomes possible in more places because the Earth is getting warmer.

Climate agreements

Step 1
1) Examples: lowering the thermostat, taking shorter showers. But also: insulating your house and putting solar panels on the roof.

Step 2
2) In favour: They do not have enough money to deal with these climate issues. On top of that, dealing with climate problems slows down the economic growth these countries need to prevent poverty.
Against: To make sure everyone signs the agreement, you cannot make demands that you know will prevent certain countries from signing.

Step 3
See the original text of the Agreement: https://unfccc.int/resource/docs/2015/cop21/eng/l09.pdf.
3) There are also many companies that can create jobs which benefit from the new climate agreements, like the manufacturing and placement of wind turbines and solar panels.

Step 4
4) Because that would mean the emissions are counted twice.
5) No one wants to be the first to take this step, because it costs jobs. If Schiphol Airport becomes more expensive, people will go to airports in Belgium or Germany. The same goes for Rotterdam. If their harbour becomes more expensive, container ships will go to other harbours.

Step 5
One way to handle the import and export of CO_2 emissions caused by kerosene and fuel oil would be to tax one of them after all. It would make sense to apply this tax to the import, since that is how taxes are arranged for all types of fuel in the Agreement.

Fossil-free energy

Introduction

Steps 1 through 4 explained how the total production of sustainable energy is divided in the Netherlands. The Grote Bosatlas 55 (map 63L) shows the division as follows:

53% wind
8% sun
39% biomass
1% water

This is 90% of the total. The remaining 10% is generated by burning trash. The question here is how sustainable burning trash really is, but this lesson will not go into this subject further.

Step 1
1) Advantages and disadvantages taken from 'Wat is Duurzaam?' (What is Sustainable?) http://www.wattisduurzaam.nl/2136/energie-opwekken/wind/overzicht-windenergie-de-voord-en-nadelen-van-energie-uit-wind/ (Dutch)

Advantages of offshore wind energy	Disadvantages of offshore wind energy
▪ **The wind is more powerful at sea** At sea, nothing can block the wind. That means it blows harder, more often, and more constantly. Wind turbines at sea generate about 40% more energy per megawatt of installed power than wind turbines on land.	▪ **Construction and maintenance at sea is expensive** High wind speeds at sea make it a good place to generate wind energy, but it also makes it difficult to construct wind turbines there. Work at sea requires specialised materials and very well-trained personnel and they have to wait for safe working conditions. They can only work on calm waters.
▪ **No sound pollution from wind turbines at sea** At sea, far away from civilisation, no one can be bothered by the noise of wind turbines. There are still sound limits to prevent harming sea life. These limits are especially relevant when pile driving to construct the foundation for the offshore wind turbines. A wind turbine that is allowed to be more noisy, regardless of wind direction, generates more energy. The turbine's shadow also will not bother anyone at sea.	▪ **Power plugs at sea necessary** Wind parks at sea are at least 20 kilometres from the coast, but the power they produce needs to get to land. Seaworthy power cables are expensive and require complex offshore equipment to prevent loss of energy in transport from the turbine to the coast.
▪ **Less visual pollution from wind turbines at sea** Criticisms like "not in my backyard" are less relevant at sea. The closest backyard is 20 kilometres away. Business-owners who work on the beach do worry that tourists will stay away because of the view. However, in practice, the wind turbines can only be seen by someone with good eyesight, in sunny weather, and when you know where to look.	▪ **A lot of materials are needed to stay afloat** At sea, foundation piles need to be dozens of metres high to reach above the surface. The cost of these materials is added to the standard expenses for wind turbines, and it all needs to be resistant to the salty sea water. Instead of using a regular foundation, several parties are doing research into floating foundations.

Step 2
2) Advantages and disadvantages taken from 'Wat is Duurzaam?' (What is Sustainable?) http://www.wattisduurzaam.nl/5675/energie-opwekken/zonne-energie/overzicht-zonne-energie-de-voor-en-nadelen-van-zonnepanelen-en-collectoren/ (Dutch)

Advantages of solar panels

- **Your own sustainable energy, at every scale**
  Solar panels provide renewable energy in personal portions. Whether you put solar panels on half a roof or a big field, the investment and returns per panel remain about equal. If your need for energy changes, expanding or decreasing your amount of solar panels is often easy to do.
- **No inconvenience and barely any maintenance**
  Solar panels do not contain moving parts and generate power without making a sound. After its instalment, a solar panel will barely require any maintenance. A spot of rain is usually enough to keep the smooth solar panels clean. They will continue functioning adequately as long as you occasionally brush off bird droppings and leaves, and periodically check if everything is still in working order.
- **Still generates energy when it is overcast**
  Photovoltaic solar panels work best under bright blue skies, but still work fine when it is cloudy. Solar cells can also turn diffuse light into electricity.
- **Cheaper than power from the electricity grid**
  Dutch households (and companies that are small consumers) can deduct the power generated by their solar panels from their yearly energy consumption. People with solar panels save on taxes and transport for non-sustainable energy, even if they cannot fully live off solar power. These tax exemptions mean that people will recoup their investment within 5 to 10 years. The solar panels will then last for about 25 more years, during which the energy they generate is technically 'free'.

Disadvantages of solar panels

- **Use and generation of energy do not happen simultaneously**
  Most solar panels are on the roofs of private homes. They mostly generate energy in the middle of the day, while people mostly use electricity in the mornings and evenings. Additionally, use of electricity is higher in winter, while solar panels generate most in summer.
- **Uncertainty about tax exemption rules**
  Tax exemptions make solar panels more attractive for consumers, but they still rely on the electricity grid. One can only wonder how long consumers can keep using the grid like a 'free battery' (with limited capacity). The Ministry of Economic Affairs and Climate has been thinking about doing away with the tax exemptions.
- **Lower yield on hot days**
  Solar panels are electronic machines, which get less efficient when the temperature rises. On hot summer days, solar panels generate less electricity than they do on a mild spring day.
- **Solar panels are ugly**
  Beauty is subjective, but the way solar panels look can be a deal-breaker when thinking about investing in sustainable energy for your home. On top of that, cities often do not allow the look of their cityscape and monuments to be changed by the addition of solar panels.

Step 3
3) Plenty of water and (any kind of) height difference.

Step 4
4) The answer can be found in the SchoolTV video: to get the biomass they need, trees are cut down in Canadian forests. Next to this deforestation, transporting the wood over long distances is also not environmentally friendly.

Step 5
5) Technology: batteries keep getting better = new batteries will last longer. Building and charging batteries requires electricity. The benefit to the environment would be bigger if the power plants ran on sustainable energy as well (like biomass).
Politics: Subsidising the purchase of electric cars and/or making cars that run on gasoline more expensive.

Step 6
-

Geoengineering

Step 1
1) People live in the Sahara and other deserts. Where would they go? No country wants to chase its own inhabitants away.

Step 2
2) The sulphur would eventually end up in the sea, which would have disastrous consequences for the plants and animals there. The sea would turn sour and coral would die even faster.

Step 3
3) Climates might have to deal with unexpected consequences: flooding in some places and drought in others.

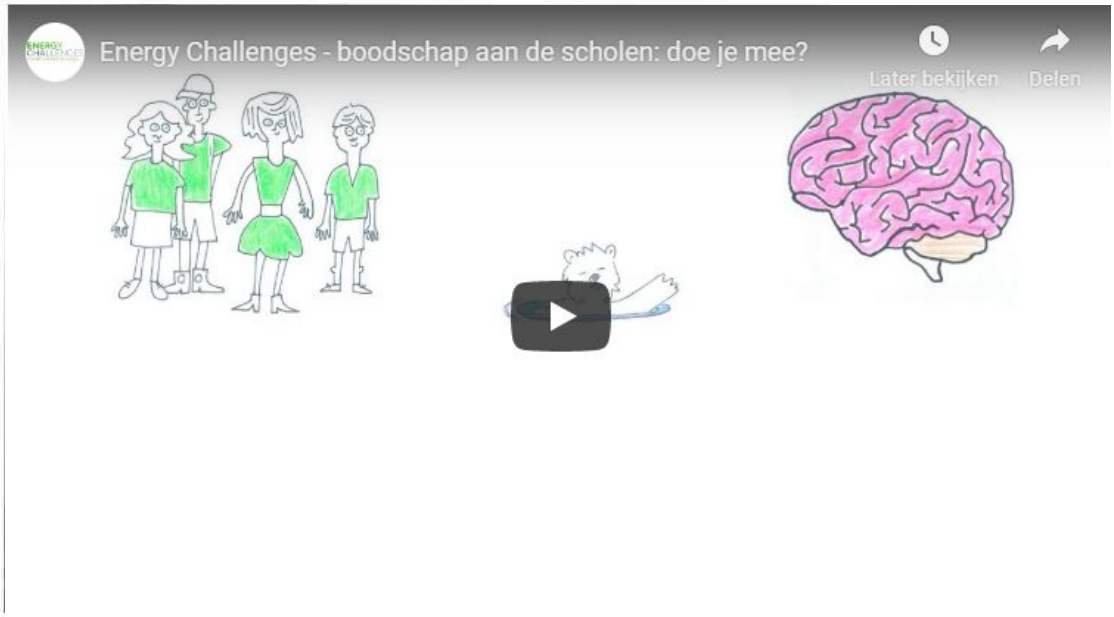
Step 4
4) The large amount of extra algae would eventually die and the bacteria that feed on them would consume all the oxygen. The food chain in the ocean would be broken and all sea life would die.

Step 5
A tree absorbs about 11 tons of CO_2 every year. One of professor Lackner's artificial trees could absorb 1 ton of CO_2 every day (as the video shows). That is 11 tons per year.
Artificial tree 365 tons : natural tree 11 tons = 33 times as effective.
5) The CO_2 that was absorb is liquefied and stored underground. This requires the construction of massive underground reservoirs. We would eventually reach maximum capacity.

Step 6
Some information on the plan to cover glaciers with blankets:
To prevent the glaciers from melting, they could be covered with a protective blanket. The blanket would reflect or absorb the heat, so the ice below does not melt. This would be inconvenient and a risk for the animals in the area. Covering a glacier with a blanket is already troublesome in the first place. Still, it is applied in a few places.

What can your school do?

Step 1
To introduce the Energy Challenges, there is an introduction video for teachers.



Translation of the title: Energy Challenges - message to the schools: will you participate?
Please note: the film is in Dutch; click here for a transcription in English.

1) -

Step 2
2) Paving an area with tiles means the rain water cannot properly sink into the soil, which can cause floods, problems with the sewer, pollution of surface water, and ground subsidence. Tiles also get a lot warmer in the summer. Additionally, a tile surface is not very attractive to birds and butterflies. Adding green and blue will cool things down, create shade, and have a positive effect on CO2 emissions.

Step 3
3) Examples are paper, cardboard, and kitchen and garden waste. Other possibilities are listed below.

Separating trash	
Cans and other metals	Clothing, textiles, and shoes
Building materials and debris	Small chemical waste
Through the sink or toilet	Empty batteries
Drink cartons	Paper and cardboard
Electrical equipment	Plastic packaging
Glass: jars, bottles, etc.	Bioplastic
Kitchen and garden waste	Residual waste
Bulky waste	

Step 4)
4) –

What can you do?

Step 1
1 a) 1990-2017 = 27 years. In that period, emissions lowered by 13%, which is 0.481% per year. We will round this up to 0.5% to make things easier to calculate.
b) By 2017, emissions had gone down by 13%, while the goal is 49%. The remaining percentage is 49-13 = 36%. At a tempo of 0.5% a year, it would take 72 years to reach the target, which means we would reach this goal by 2062 (or 2065 if we use the original 0.481%).
c) We had 40 years to reach the 49% decrease (1990-2030), which means 1.225% a year, which is twice as much as the yearly average right now. We have 13 years left to do this: 2017-2030. This is impossible. A 36% decrease in 13 years is 2.77% a year, which is more than five times as much as the current rate of decrease.

Step 2
The quiz contains a few multiple choice questions and correct or incorrect statements:
1) Which food product is worst for the climate?
2) Which means of transportation is best for the climate?
3) What is the best way to reduce CO2 emissions?
4) Correct or incorrect: When insulating your home, you can save the most energy by insulating the floor.
5) Correct or incorrect: Not using a dryer saves more energy than washing your laundry on lower temperatures.
6) Which of these alternatives would reduce your CO2 emissions the most?
7) Correct or incorrect: Trams are a more climate friendly form of transportation than buses.
8) Which of these choices would save the most CO2 on a yearly basis?
9) Correct or incorrect: Tofu harms the climate more than cheese.

Answer to the question:
2) According to the pupils' opinions.

Step 3
Take care! Make sure to ask your pupils to collect data from home (questions about transportation, electricity usage, gas usage). Also do the test yourself before giving it to the class, to make sure you know what kinds of questions will be asked and to see what the advice will look like!

Core objectives and attainment targets
Core objectives: 29, 41

Attainment targets: geography

Havo domain C2: The Earth, connected systems and differences on Earth.
No. 7: Describing, recognising and explaining natural phenomena on the Earth's surface and in the atmosphere, taking into account different scales of time and space.

No. 7a4: The external system of the Earth (lithosphere, atmosphere, hydrosphere, and what it means for climate systems, including air circulation and ocean currents).
* Important methods: Describing and analysing climates and climate phenomena on different scales of time and space.
Key term: Climate change (specifically effects on the climate systems)

No. 7a: Describing, recognising and explaining natural phenomena on the Earth's surface and in the atmosphere, taking into account different scales of time and space.
* The actuality principle: The present is the key to the past. (The assumption that physiological processes work the same way now as they did in the past.)
Key term: geological time scale

No. 7b: Describing the characteristics of Earth's different landscape zones, analysing the differences between them, and relating them to each other.
* Earth's landscapes are dynamic systems: if one geofactor changes, this will cause changes in the other factors.

Sub-domain E1: National and regional issues.
No. 11a: The candidate can form a well-argued opinion about the influence of the changing climate and human intervention on water levels in the Rhine and Maas rivers.
No. 11a1: Important methods:
* Making connections between climate change, human intervention, and the risk of flooding.

VWO domain C1: The Earth as a natural system: connected systems and diversity.
No. 5: Describing the Earth as a unique natural system and applying this knowledge to the analysis of changes to the Earth's surface on different scales of time and space.

No 5a: Describing the Earth as a unique natural system and applying this knowledge to the analysis of changes to the Earth's surface on different scales of time and space.
* Important methods: Relating geomorphological phenomena to their paleogeographic positions.
Key term: Geological time scale

No. 5b1: Characteristics of the landscape zones on Earth.
Earth's landscapes are a dynamic system: if one geofactor changes, this will cause changes in the other factors.

No. 5b2: Characteristics of landscape zones and changes in these zones
* Important methods: Making connections between climate change and shifts in climate zones and vegetation zones.

No. 9a: The candidate can form a well-argued opinion about topical issues related to flooding.

No. 9a1: Important methods:
* Making connections between climate change, human intervention, and the risk of flooding.
* Making connections between rising sea levels and the effects on the Dutch coast, the rivers, the Ijsselmeer, and the Dutch Southwest delta.
* Analysing the risk of flooding from different perspectives (natural, economic, political, and sociocultural) and on different scales of space.

No. 9a3: Important methods:
* Making connections between global climate change and risk of flooding on a regional level.
* Possible measures to prevent flooding and drought on a regional level and to analyse it from different perspectives (natural, economic, political, and sociocultural).

WEATHER AND CLIMATE

Print

Donald J. Trump
@realDonaldTrump

This very expensive GLOBAL WARMING bullshit has got to stop. Our planet is freezing, record low temps,and our GW scientists are stuck in ice

Vertalen uit het Engels

01:39 - 2 jan. 2014

January 2014 was an extremely cold month in New York. Donald Trump, who was not the president of the United States yet, wrote this tweet back then.

Did he ridicule the scientists or himself with this tweet? Did little Donald pay attention in class when he was a child?

In these lessons, we will teach little Donald the difference between weather and climate. It might also be useful for the rest of you to refresh your memory on the difference between the two.

LEARNING OBJECTIVES

Print

This project is connected to the Sustainable Development Goals

By the end of this lesson, you will:
- Know that the weather plays an important role in society
- Be able to name some elements that come together to decide the weather
- Know what is meant by 'extreme weather'
- Be able to give a definition of 'climate'
- Be able to name some climate phenomena

By the end of this assignment, you will know the meaning of the following terms:
* weather
* extreme weather
* weather alert
* climate

Final product
The final assignment for this lesson is to **write a tweet** in response to Donald Trump's tweet about climate change from January 2014. With this final assignment, you will show you have reached the learning goals.

Assessment
The final product will be graded by your teacher.

Your teacher will grade the assignment based on the following:
- **Content**: Does your tweet show that you understand the difference between weather and climate?
- **Form**: Did you take care to give your text the right form?
- **Language mistakes**: Does your tweet contain the knowledge you gained from steps 1 – 4 and are there not too many language mistakes?

Group size
You will work by yourself for this lesson.

Time
This lesson will take two hours.

Step 1: Weather

Print

A fair-weather friend
Being under the weather
Hitting rough weather

These are three well-known idioms or expressions.

If we look at different forms of weather more closely, we find more expressions, like:

Every cloud has a silver lining
Come rain or shine
Being in a fog
Chasing rainbows
Knowing which way the wind blows
The calm before the storm
Stealing someone's thunder
Breaking the ice
Putting something on ice
Being snowed under

The weather plays an important role in society. Not a day goes by when we do not talk about the weather.

Still, it is not easy to understand what exactly the 'weather' is. A simple definition is one from the Cambridge learner's dictionary: "The temperature or conditions outside, for example if it is hot, cold, sunny, etc."

Another definition of the weather from the Cambridge dictionary is "the conditions of the air above the earth such as wind, rain, or temperature, especially at a particular time in a particular area."
The Merriam-Webster dictionary defines it as "the state of the atmosphere with respect to heat or cold, wetness or dryness, calm or storm, clearness or cloudiness."

These definitions include different elements that decide the weather together:
- Air pressure
- Air temperature
- Humidity
- Cloud cover
- Cloud types
- Precipitation
- Wind
- Visibility

There are also specific weather phenomena, such as:
- Storms
- Whirlwinds
- Frost
- Sand or dust in the air

Question
1) Choose three of the idioms listed above. Describe their literal and figurative meanings. Which of these expressions are not literally possible?

STEP 2: EXTREME WEATHER AND WEATHER ALARM

Print

Weather is always around. Even without rain, snow, storms, or any other remarkable things happening in the sky, that is still weather.

When things do happen, there is a chance of extreme weather. 'Extreme' means 'a lot' (as in "I was extremely tired,") or 'different and unusual' (as in "his ideas were so extreme it was scary."). Weather is officially called extreme when the circumstances are very different from what they normally are. Temperatures over 35°C/95°F in the shade are typical for Burkina Faso, but it would be extremely warm for the Netherlands. Temperatures around -20°C/-4°F are normal at the North Pole, but would be extremely cold for a lot of other countries.

The same can be said for the extreme rain in Asten (the Netherlands) in June of 2016, as shown in this SchoolTV fragment:

Translation of the title: Why does it rain more often? / Downpours, hail and flooding
Please note: the film is in Dutch; click here for a transcription in English.

Heavy rain or snow, frost, a heat wave or icy cold, heavy thunder, big storms, thick fog. We can often see it coming, but extreme weather can also be unexpected and local.

When heavy weather occurs, the control room receives hundreds of calls from citizens reporting problems and damage. Life-threatening situations are resolved before other requests for help. Employees in the control room who take calls quickly assess the risk and therefore cannot spend a lot of time on every call.

The consequences are not always predictable, but you can prepare. A general tip: Keep an eye on the weather report. The weather institute usually announces extreme weather ahead of time and uses a colour-coded warning system. These can also be found on NOS teletext pages 710 and 713.

Question
2) In the SchoolTV fragment, Rob Sluijter from the Royal Netherlands Meteorological Institute says it rains more and more often, with an increase in heavy showers, hail, and flooding. Heavy showers occurred about six times a year for the past 50 years, but the recent average is ten. The question is: When is weather no longer 'extreme' (different and unusual)? Give another example of extreme weather becoming more normal.

Step 3: Climate

Print

Weather and climate are bound together.

The weather changes every day. It is the wind in your hair, the rain from the sky, and of course the temperature around you. Wind, precipitation, and temperature are the elements that create the weather.

The climate does not change overnight, because it is the average weather over a longer period of time.

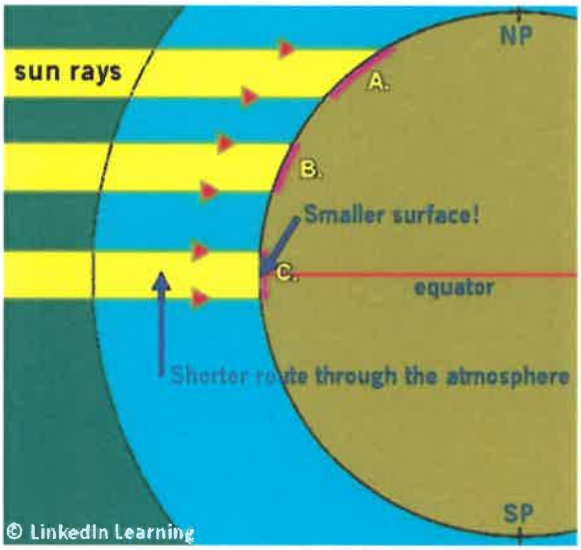
The definition of climate as formulated by the Royal Netherlands Meteorological Institute is: "The climate is the average weather over a certain period."

We usually calculate the average weather over a period of 30 years, as the definition on Wikipedia shows: "The climate is an average of the weather conditions (temperature, wind, cloud cover, precipitation) over a period of at least 30 years."

The Royal Netherlands Meteorological Institute has calculated the average climate of the Netherlands: 80 centimetres of precipitation and 10°C/50°F. Of course, the winters are colder and the summers are warmer. This means the average temperature is neither very high nor very low. The Netherlands has a temperate climate.

The climate is not just decided by the average weather, but also by these climate factors:

Latitude
Around the equator, the sun is closest to the Earth and it is always warm. Above the polar regions, the sunbeams have to travel further through the atmosphere and warm a larger surface area, so it is always cold. Latitude has a big influence on average temperatures.



Longitude
You would think that mountaintops being closer to the sun than ocean surfaces means that they are warmer. Not true! The higher you climb, the lower the temperature. The distance between the Earth and the sun is 150 million kilometres, so a few kilometres more or less do not make a difference. The warmth you feel outside comes from the sun heating the Earth's surface, which then transfers heat to the air. The air gets thinner as you get higher. At greater heights, there are fewer air particles that can retain heat.

The temperature on a mountain also depends on whether the sunlight hits it directly. The Italian village Viganella is surrounded by mountains and always in the shade. To prevent everyone from wanting the leave the village, they built a big mirror of 8 by 5 metres. The mirror was placed on the sun side of the mountain and reflects sunlight towards the village. This has raised the average temperature by a few degrees since 2006.

The intervention of the 200 inhabitants of Viganella has contributed to a climate change, albeit on a very small scale.

(Interested? Watch this 5 minute YouTube video: https://www.youtube.com/watch?v=4NRR2HpALhM)

Land or sea
Land conducts heat and cold better than water. You will notice this when you go to the beach for the first time in spring. The air is warmer than the sea. It often takes weeks for the sea to warm up.

Still, Dutch people are lucky that their country is by the sea. The seawater there is rather warm thanks to the warm Gulf Stream. The water heats up off the coast of Mexico and flows all the way to the tip of Scandinavia. The warm summers and cold winters are made more temperate by the warm water.

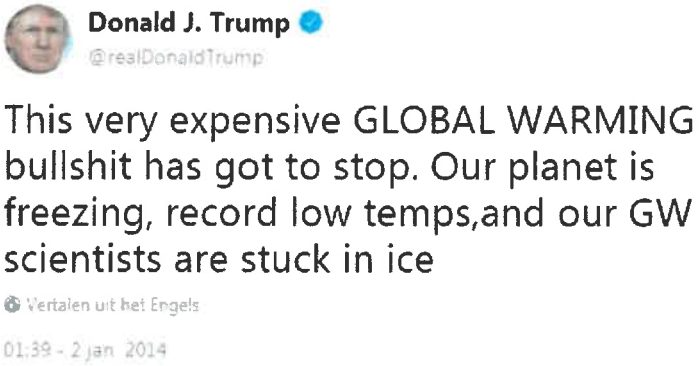
Questions
3) The definitions of 'weather' from the Royal Netherlands Meteorological Institute and Wikipedia are incomplete. What aspects are they

missing?
4) 'Extreme weather' is not the same as 'extreme climate'. Explain the difference.

STEP 4: A TWEET IN RESPONSE TO TRUMP

Print

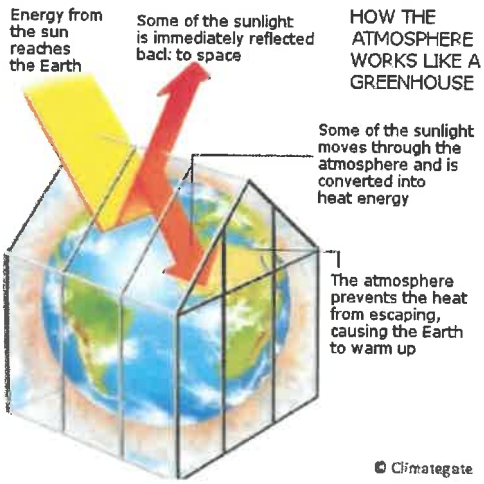
You have read Trump's tweet. We will show you the tweet again:



If you have paid attention, you can now explain the difference between weather and climate.
Reply to Trump with your own tweet. Good luck!

GREENHOUSE EFFECT

Print



A greenhouse is a building with glass windows that is used to cultivate plants. In a greenhouse, the sunlight falls through the angled windows and the heat is trapped inside, so the temperature is much higher inside than outside the greenhouse. The Earth's atmosphere works just like a greenhouse. Greenhouse gasses in the atmosphere form a kind of "blanket" that stops the heat from getting out. We call this the greenhouse effect.
Without this blanket, life on Earth would not exist.

In this lesson, we will take a look at the greenhouse effect, making a distinction between the natural and the enhanced greenhouse effect. Humans are responsible for the latter.

LEARNING OBJECTIVES

Print

This project is connected to the Sustainable Development Goals, especially goal 13.

By the end of this lesson, you will:
- Know the composition of the atmosphere
- Know what greenhouse gasses are and why they are essential for life on Earth
- Know that the average world temperature is rising and why
- Know why scientists worry about a 2°C/3.6°F increase in temperature and why it is referred to as a 'tipping point'

By the end of this assignment, you will know the meaning of the following terms:
* greenhouse gasses
* natural greenhouse effect
* enhanced greenhouse effect
* climate change

Final product
The final product for this lesson is to develop an **informative campaign about the dangers of laughing gas to the climate** as part of a campaign team. With this final assignment, you will show you have reached the learning goals.

Assessment
The final product will be graded by your teacher.

Your teacher will grade the assignment based on the following:
- **Content**: Does your campaign show the dangers of using laughing gas?
- **Form**: Did you take care to give your text the right layout?
- **Language mistakes**: Does your text contain the knowledge you gained from steps 1 – 4 and are there not too many language mistakes?

Group size
You will work by yourself for this lesson. You will do the final assignment in a group of four.

Time
This lesson will take two hours.

Print

STEP 1: LONG LIVE THE GREENHOUSE GASSES

The Earth's atmosphere contains 78% nitrogen, 21% oxygen, and 1% other gasses. Sunlight passes through some of these gasses, but these gasses also trap a portion of the heat under the atmosphere. This means that the lowest layer of the atmosphere (the troposphere) gets warmer.

The gasses that let sunlight through and partially reflect its heat back into the atmosphere are called greenhouse gasses and they cause the greenhouse effect. The atmosphere contains about 30 greenhouse gasses. Four out of five of the most important gasses occur naturally in the atmosphere:

1) Carbon dioxide or CO_2
This gas is responsible for 50% of the greenhouse effect. The gas is absorbed by plants and exhaled by animals and people.

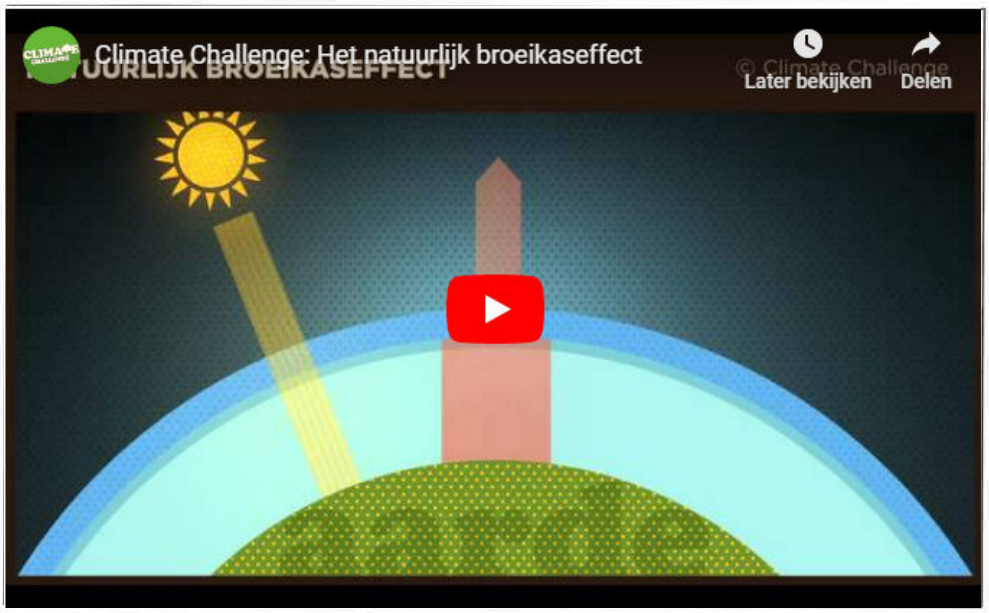
2) Methane or CH_4
This gas is responsible for 20% of the greenhouse effect. Methane is in farts and faeces of animals and people. Rice farming also releases a lot of methane.

3) Laughing gas or N_2O
This gas makes up less than 1% of the atmosphere. Laughing gas is sometimes used as an anaesthetic and is also part of the spraying mechanism in whipped cream cans. Laughing gas stays in the atmosphere for over a century.

4) Ozone or O_3
This gas is mostly in the ozone layer, between 15 and 40 kilometres up in the atmosphere. Ozone is created under the influence of sunlight and stops some of the harmful UV rays of the sun. Without ozone, everyone who walks or lays in the sun would quickly get cancer due to the ultraviolet radiation.

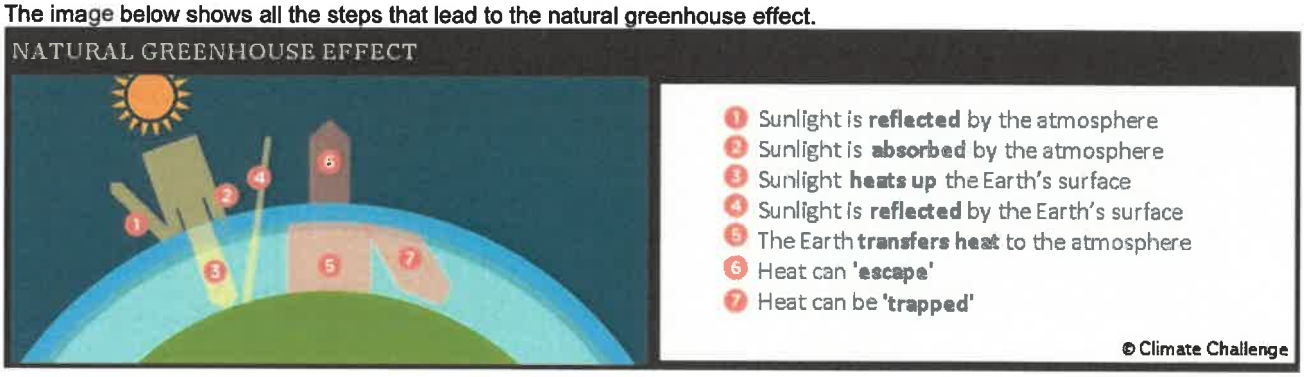
5) Hydroclorofluorocarbon or HCFC
This gas does not naturally occur in the atmosphere. It is used as a propellant gas in spray cans, refrigerators, and freezers. HCFC breaks down ozone in the ozone layer, but the gas itself breaks down very slowly. A thinner ozone layer is very harmful to animals and people. Use of HCFC is no longer allowed.

Life on Earth would not be possible without greenhouse gasses and the natural greenhouse effect. The YouTube video *Climate Challenge: The Natural Greenhouse Effect* explains how this works:



Translation of the title: Climate Challenge: The natural greenhouse effect
Please note: the film is in Dutch; click here for a transcription in English.

The image below shows all the steps that lead to the natural greenhouse effect.



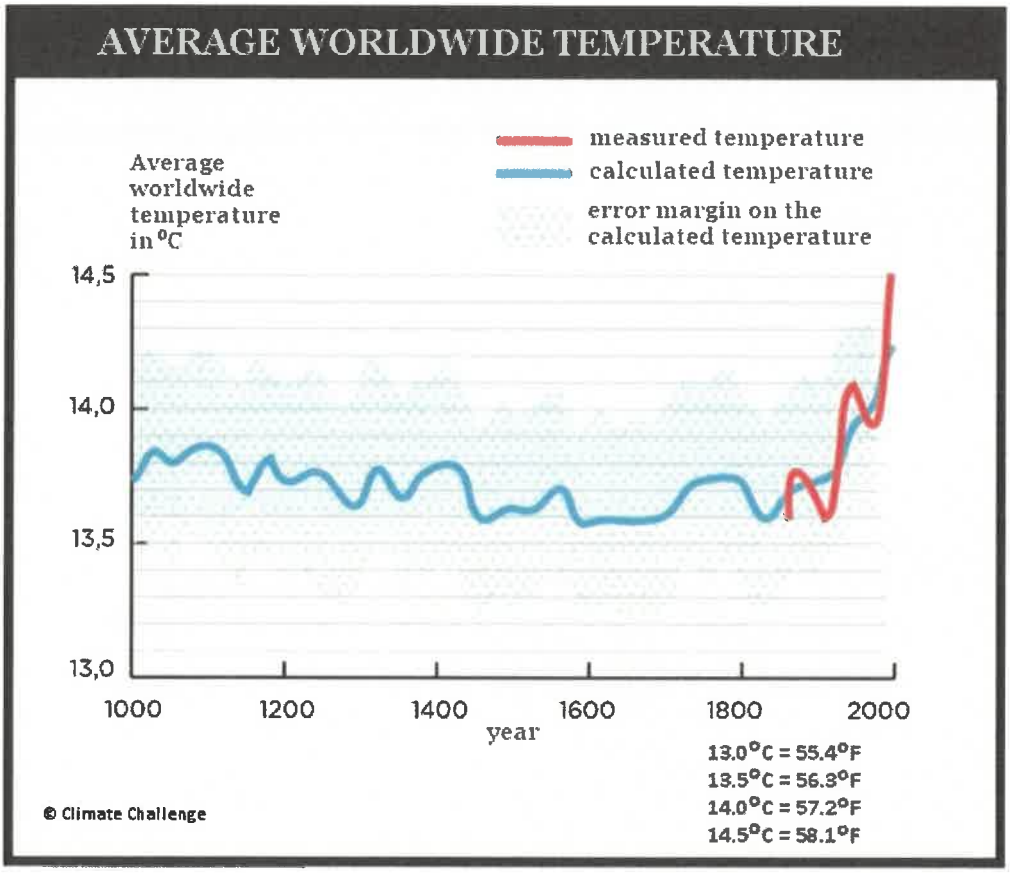
Questions
1) Scientists have discovered a hole in the ozone layer, that is especially big above the South Pole. This hole was caused by our use of HCFC. What characteristic unique to the South Pole (that has not been mentioned yet) increases the decay of ozone and causes a bigger hole in the ozone layer?
2) Give two reasons why the ozone layer still has a hole in it, even though propellant gasses are no longer allowed.

STEP 2: AVERAGE WORLD TEMPERATURE

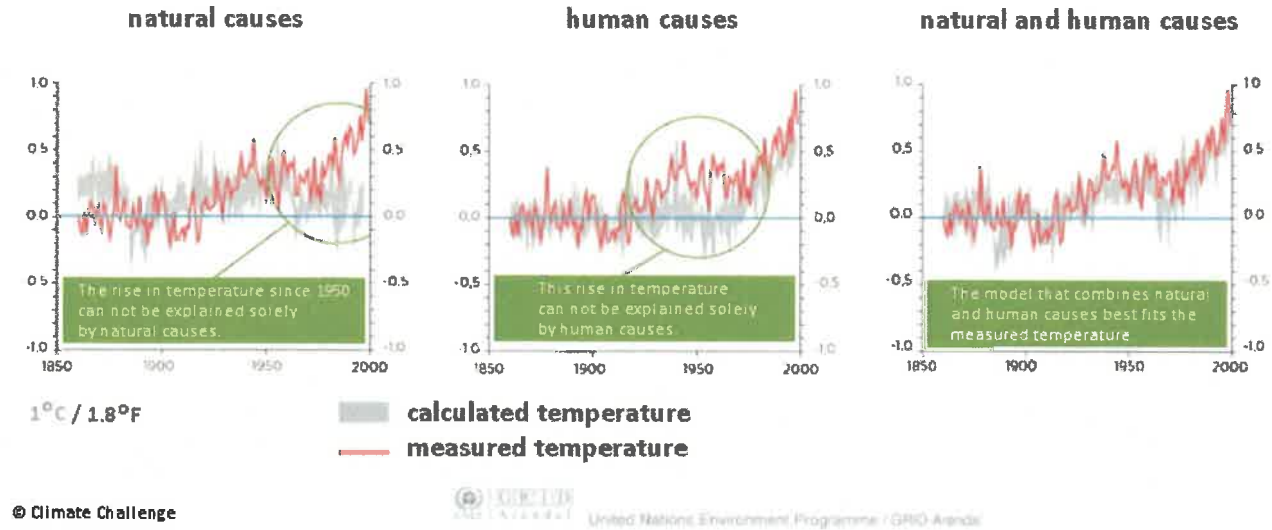
Print

Most of the greenhouse effect is caused by nature, which have made the average world temperature 33°C/59.4°F warmer than it would have been without the greenhouse effect (+15°C/59°F instead -18°C/-0.4°F). The global temperature has risen by almost 1°C/1.5°F since the Industrial Revolution, with most of this increase occurring since the end of World War II (around 1950).

The global temperature is the average temperature of the Earth's surface. Calculating this average is not easy. There is no such thing like one specific thermometer that measures the world's temperature. The data comes from weather balloons, satellites, and thousands of thermometers spread out over weather stations on all the land masses of the Earth, combined with thousands of measurements of sea surface temperatures. These measurements show that the average temperature has risen by almost 0.85°C/1.5°F since 1880.



Before we started calculating the global temperature, many countries, including the Netherlands, already had reliable data available, but this was not enough to calculate a global temperature. Temperature measurements were not done systematically before 1860. Thankfully, there are other ways to find out if it used to be warmer or colder.



A rise in temperature of 0.85°C/1.5°F does not sound like much at first. You cannot feel the difference yourself. However, if we look at it from the perspective of the whole planet, this is a fast and important change.

This can be illustrated by an example: During the coldest period of the last ice age – about 18,000 years ago – the temperature was only 4°C lower than it is now, but a thick layer of ice covered large parts of Europe and North America. When seen from the perspective of the whole planet, a rise of 0.85°C/1.5°F makes a big difference.

Question

3) How can we still find out the average temperature before 1860? Name two different methods.

Step 3: The enhanced greenhouse effect

Print

The 0.85°C/1.4°F rise of the global temperature since the Industrial Revolution is caused by an increase in greenhouse gasses, especially the amount of CO_2 in the atmosphere. For these calculations, we use a number that shows how many parts of CO_2 there are in a million parts of air (parts per million = ppm).

In Greenland and at the South Pole, scientists take samples of ice from great depths. The deeper the ice, the older it is. The samples show how much CO_2 was in the atmosphere at the time when the ice froze. Ice samples of different ages show that CO_2 levels were not nearly as high hundreds of thousands of years ago as they are now. Not even in between the two ice ages, when the Earth was just as warm as it is now, if not warmer.

The concentration of CO_2 in the atmosphere is now over 400ppm*. This is 120ppm more than the 'natural' pre-industrial level (280 ppm). This means that the concentration of CO2 in the atmosphere has risen by 40% since the start of the Industrial Revolution.

* You can check here to see how high CO_2-levels are right now.

The increased amount of greenhouse gasses in the atmosphere heighten the natural greenhouse effect and lead to an increase in the global temperature. This phenomenon is called the enhanced greenhouse effect.

This *Climate Challenge* YouTube video clearly explains the causes of the enhanced greenhouse effect one more time:

Translation of the title: Climate Challenge: The enhanced greenhouse effect
Please note: the film is in Dutch; click here for a transcription in English

In this video, a 'tipping point' is mentioned, which occurs at an increase of 2°C/3.6°F. This tipping point is mainly based on CO_2 emissions, even though other greenhouse gasses also contribute to climate change.

If climate change reaches this tipping point, scientists fear it will escalate. For example, the permafrost in Siberia will melt, releasing more methane into the atmosphere.

Scientists fear that, once we cross the threshold of 2°C/3.6°F, climate change will become irreversible. This is why it is referred to as the tipping point. Most experts put this point at 450 ppm, but others put it at 400 ppm – a line we have already crossed.

The odds are not in our favour. The global temperature has risen every year of the 21st century, with only a few exceptions.
Almost every year in the top 10 hottest years in the Netherlands occurred in the last two decades. Nine out of ten of the hottest years, with an average temperature between 10.7°C/51.3°F and 11.7°C/53.1°F, occurred since 1999.

The Netherlands is warming up more quickly than the rest of the world. The rise in temperature in the Netherlands since 1950 is more than twice as high as the global average.

Question
4) Give a potential explanation for the fact that the temperature is rising more quickly in the Netherlands than the rest of the world.
5) As the global population grows, we have more mouths to feed. Why does this have a negative impact on our efforts to slow down climate change? What can we do to limit this growth?

Step 4: Laughing gas campaign

Print

The use of laughing gas as a drug is popular among young people. Take a look at this YouTube video:

Translation of the title: Children aged 12 on laughing gas: 'Something has to be done'
Please note: the film is in Dutch; click here for a transcription in English.

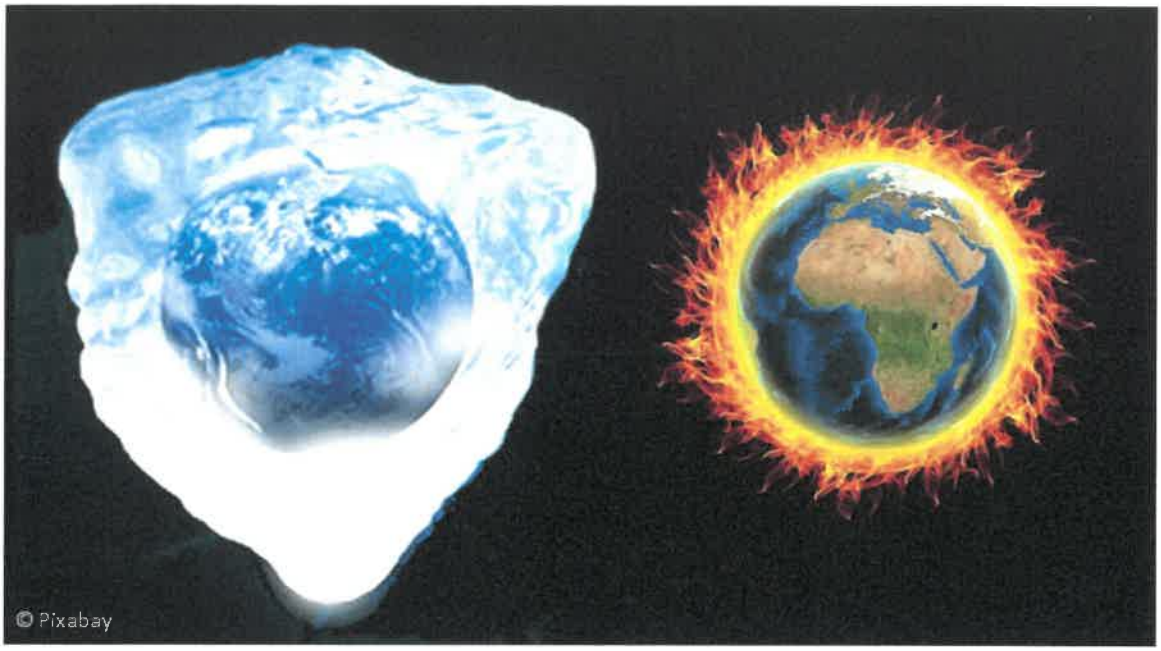
The Independent warns about the dangers of using laughing gas as a drug: (https://www.independent.co.uk/news/uk/home-news/how-dangerous-is-laughing-gas-legal-highs-hippy-crack-nitrous-oxide-safety-facts-explained-a7088226.html)

Discussions about laughing gas in the news usually leave out another danger. Laughing gas is a powerful greenhouse gas that destroys the ozone layer. It is about thirty times as powerful as CO_2 and it is the gas we expel the most. Frequent use of laughing gas contributes to the greenhouse effect and climate change.

You are a member of a campaign team. Design a poster, Facebook page, or another form of communication to show young people how laughing gas damages the environment.

CLIMATE CHANGE THROUGHOUT HISTORY

Print



The South Pole used to be covered in palm trees, the Sahara used to contain the world's largest lake, and Hawaii used to be home to polar bears. Climate change has always been happening. Research shows that the Earth has gone through different phases: warm and humid, hot and dry, or incredibly cold. How do we know? Why do scientists research climates and climate change that occurred millions of years ago? How relevant is that knowledge now? These are the questions you will be answering.

LEARNING OBJECTIVES

Print

This project is connected to the Sustainable Development Goals, especially goal 13.

By the end of this lesson, you will:
- Know how the continents were shaped over the course of history
- Know how oceans and land masses influence the climate
- Know the effect of big natural disasters on climate change
- Be able to explain the effect of Earth's orbit around the sun on the weather and the climate
- Be able to explain what the Earth's axial tilt is and how it influences climate change
- Be able to explain the relevance of climate change research that looks back millions of years
- Know why climate change research that looks back millions of years is done mainly at sea

By the end of this assignment, you will know the meaning of the following terms:
* climate change
* Pangaea
* perihelion
* aphelion
* axial tilt
* natural disasters
* climate research

Final product
The final product for this lesson is to create **a slogan or a jingle about the work done by the Royal Netherlands Institute for Sea Research**. With this final assignment, you will show you have reached the learning goals.

Assessment
The final product will be graded by your teacher.

Your teacher will grade the assignment based on the following:
- **Content**: Does your slogan show the goal of climate research?
- **Form**: Did you take care to give your text the right layout?
- **Language mistakes**: Does your slogan contain the knowledge you gained from steps 1 – 4 and are there not too many language mistakes?

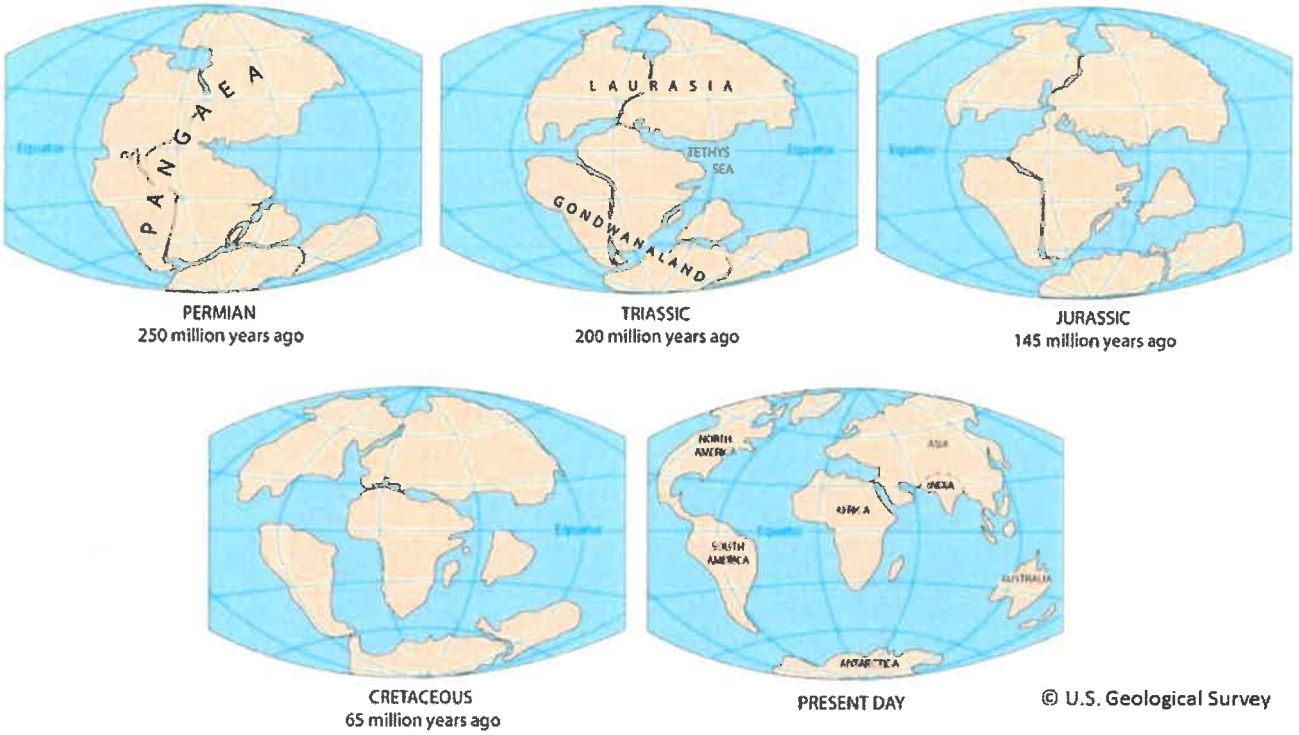
Group size
You will work by yourself for this lesson. You will do the final assignment with one other person.

Time
This lesson will take two hours.

Step 1: Supercontinent Pangaea

Print

The Earth was formed about 4.5 billion years ago. A supercontinent developed approximately 250 million years ago. The Earth only had one land mass, called Pangaea, and one ocean, called the Panthalassa Ocean. Pangaea has fallen apart over the course of millions of years to form the continents we know now.



What does this have to do with climate change? Oceans are enormous reservoirs where heat is stored. This heat spreads through ocean currents.
The position of the continent influences the currents. When the continents were close together or still in one piece (like Pangaea millions of years ago), the water flowed differently than it does now, when the continents are further apart.

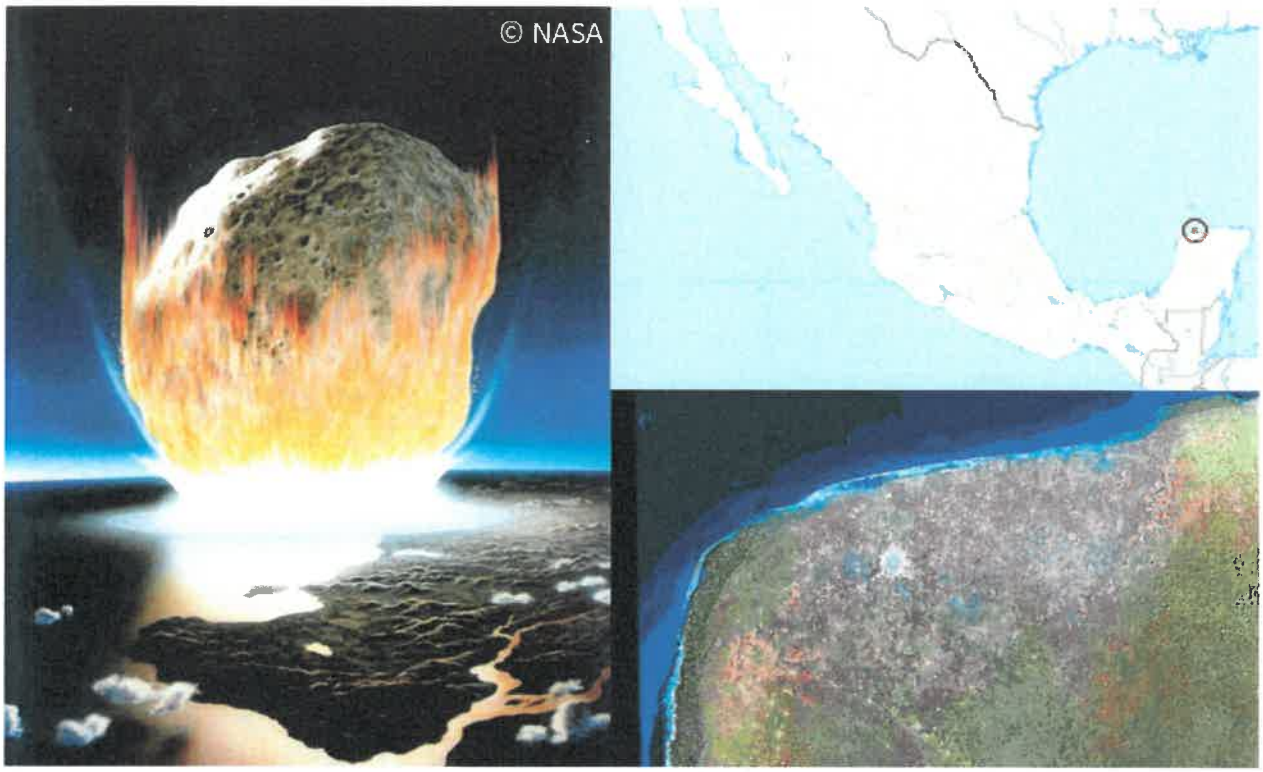
When the continents are close together, warm water can reach different places more easily. In contrast, heat is distributed less efficiently when the continents are further apart, which means it gets colder.

Question
1) The continents continue to move. Can you think of a way to measure this movement?

Step 2: Natural disasters

Print

A natural disaster is an event that creates catastrophic consequences for living creatures. One of the biggest natural disasters occurred 65 million years ago near a place we now know as Chicxulub, Mexico. An enormous meteor that was 300 kilometres wide hit the Earth.



The picture shows an image of the meteor strike near Chicxulub (left). The Chicxulub crater in Mexico (top right) is not visible on the surface, but can only be detected in gravity anomalies (bottom right).

The meteor strike probably caused a big change in the climate. The consequences must have been considerable. The impact created a release of energy big enough to fling boulders into the air up to a height of 100 kilometres. Large meteor showers, which caused forest fires, occurred all over the world. The impact caused earthquakes and tsunamis worldwide. This meteor probably released large amounts of dust into the atmosphere, which meant that sunlight could no longer reach the surface. This also meant that plants, which depend on sunlight to generate carbohydrates, died. Animals would have been unable to find food.

Scientists assume that this meteor caused (most) dinosaurs to go extinct 65 million years ago, not because of the initial impact, but because of a lack of food afterwards.

Volcanic eruptions can also lead to climate change. When dust and sulphur get into the stratosphere – a layer of the atmosphere – they will block sunlight. This means it will get colder, just like with meteor strikes. The effects of an eruption can remain noticeable for up to two years. Here is an example from 'recent' history:

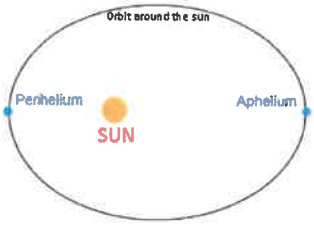
In 1783-1784, the Laki mountain range in Iceland was hit by a series of ten volcanic eruptions in eight months, followed by three years of extreme weather and very harsh winters. Crop failures and famines occurred everywhere on the Northern Hemisphere.

Question
2) Some scientists compared the meteor strike that happened 65 million years ago to an atomic bomb. Give an argument in favour and an argument against this comparison.

Step 3: Rotations and axial tilt

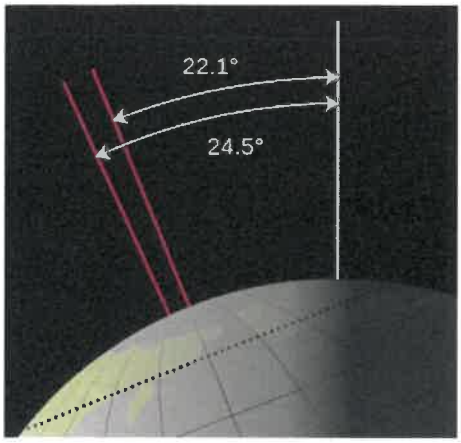
Print

Among other factors, the weather and climate are decided by the Earth's distance to the sun. The Earth's orbit around the sun is not a circle, but an ellipsis. As you can see, the sun is not neatly in the middle of the ellipsis:



The point of the ellipsis that comes closest to the sun is called the perihelion. The point that is furthest away is called the aphelion. The Earth gets warmer during the perihelion and colder during the aphelion.

The Earth does not just move around the sun. Our planet is a bit tilted on its axis and it does not always move the same way. The Earth wiggles a little. You could compare the Earth to a spinning top that is not fully upright.



The axial tilt is not constant. It varies within a period of about 41,000 years. The tilt has been between 24.5° and 22.0° for the past five million years.

Right now, the axial tilt is 23.45°, but it changes throughout the year, because of the Earth's orbit around the sun. Every year, the angle shifts from 23,45° in one direction to 23.45° in the opposite direction: a change of 46.90°. The changing angle explains our seasons. The sun is at a straight angle to the Tropic of Cancer around noon on June 21st and at a straight angle to the Tropic of Capricorn around noon on December 21st. These are the two extremes – the sun is constantly moving towards and away from the equator throughout the year.

The difference in axial tilt also changes how cold it is at the North and South Pole. At a 22° angle, the Poles are less cold than they are at an angle of 24.5°.

Questions

3) Explain how the Tropic of Cancer and the Tropic of Capricorn relate to the Earth's orbit around the sun and how they relate to climate change.

4) Explain why the temperature is higher at the Poles when the axial tilt is smaller.

Step 4: Climate research

Print

Why should we look back at climate change from millions of years ago? We can say that the climate has always been changing, but we do not have records on the climate that go back more than 150 years. So how can we look back at the climate in the past? The best answers can be found at sea!

Translation of the title: Climate research: how do you investigate that? - Reconstructions of the climate from the past
Please note: the film is in Dutch; click here for a transcription in English.

Now you know that palm trees grew on the North Pole once, 55 million years ago. This knowledge might be interesting, but is it useful?

Appy Sluijs from the Royal Netherlands Institute for Sea Research says the following: "To make better predictions about the climate in the future, we first need to know how the climate changed in the past."

When we look at the past, we hope it will inform our predictions for the future. Our most recent climate models still show too much deviation from the average. Will the global temperature increase by 1 degree or 6 degrees this century? Will sea levels rise by 2 centimetres or 2 metres in the next thirty years?

Climate data from the past can also be used to test if our computer models are accurate. Computer are not just used to calculate probable changes to the climate in the future, but also to explain the changes that occurred in the past. As we do more climate research and our computers become more powerful, climate models become increasingly accurate. The current models are capable of making credible predictions about the climate in the future.

Question
5) In the SchoolTV video shown above, climate research starts at sea. Give two reasons why this research is done mostly on sea and less so on land.
6) Why is it so difficult to design reliable computer models for climate change?

Step 5: Slogan for NIOZ

Print

The Royal Netherlands Institute for Sea Research (NIOZ) was founded in 1876 and will soon have existed for 150 years.

This sea research institute is a renowned institution that is famous for its paleoceanographic and paleo-climate research (paleo = the history of the oceans and climates in the geological past), but most people have never heard of it.

To advertise the work done by the Royal Netherlands Institute for Sea Research, you are going to write a slogan or jingle as part of a radio ad for the institute. Incorporate the paleo-climate research into your ad.

Good luck!

CONTROVERSY

Print

Ever since scientist Stephen Schneider introduced the terms 'climate change' and 'global warming' in 1976, and put the blame on humans, there has always been resistance among climate change sceptics and deniers.

Some people simply deny that the Earth is getting warmer. Others say that global warming has already stopped.

There are also critics who think the problem of climate change is exaggerated, or they do acknowledge the issue but say it is purely caused by nature.

Many different businesses do know the Earth is warming up, but they make so much money off fossil fuels that they do not want to listen, so they subsidise climate sceptics in an attempt to negatively influence public opinion.

We will give you an overview on all the arguments used by sceptics, critics, and deniers.

LEARNING OBJECTIVES

Print

This project is connected to the Sustainable Development Goals, especially goal 13, but also goal 17.

By the end of this lesson, you will:
- Know that scientists, politicians, and companies are involved in a controversy about the extent to which humans are responsible for climate change
- Be able to give an example of an alternate explanation for climate change
- Be able to name a politician who does not believe in climate change
- Know that businesses play a controversial role in the denial of climate change
- Be able to name some companies that were sponsored to create doubt about human-caused climate change

By the end of this assignment, you will know the meaning of the following terms:
* climate change
* climate discussion
* climate change denial
* think tank

Final product
The final assignment for this lesson is to **design a slogan, picture, or short article**. With this final assignment, you will show you have reached the learning goals.

Assessment
The final product will be graded by your teacher.

Your teacher will grade the assignment based on the following:
- **Content**: Does your slogan, picture, or short story succeed at creating doubt about human-caused climate change?
- **Form**: Did you take care to give your text or image the right form?
- **Language mistakes**: Were your answers to the questions in steps 1 – 4 and the final product written without too many language mistakes?

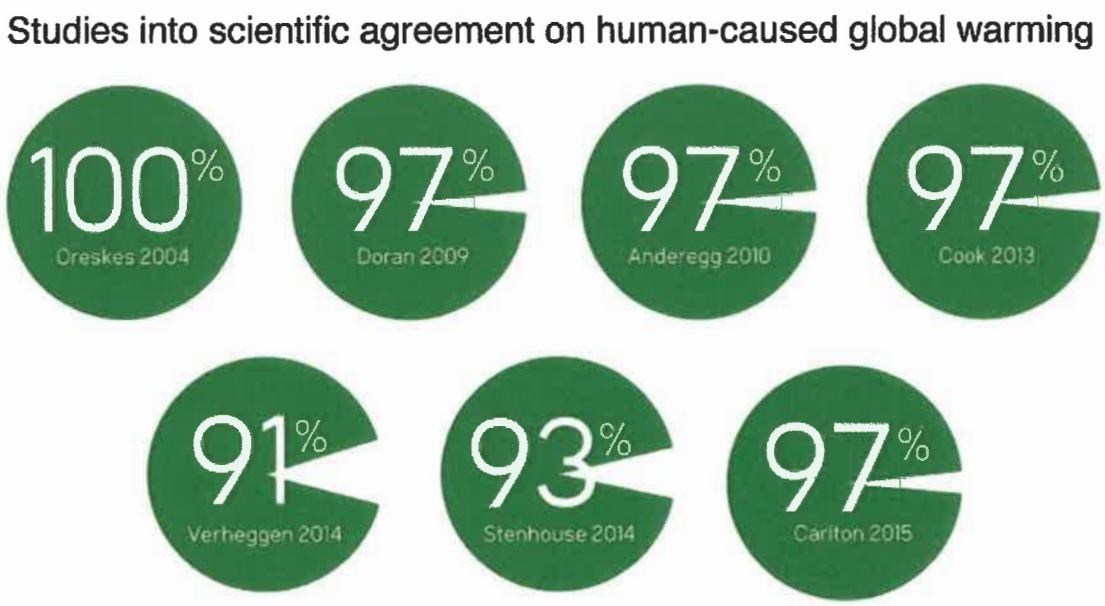
Group size
You will work by yourself for this lesson. The final product will be made in a group.

Time
This lesson will take two hours.

Step 1: Scientists

Print

In 2016, renowned American scientists Naomi Oreskes, Peter Doran, William Anderegg, Ed Maibach, Stuart Carlton, and John Cook cooperated with Dutch scientist Bart Verhegge to research how much climate scientists agree with each other. John Cook compiled the results of seven studies in the diagrams below.



You can see that about 97% of climate scientists agree that the global warming we are seeing now is caused by human action.

This 97% also means that 3% of climate scientists do not support this view on the causes of climate change.

They support alternative views. British scientist Bob Carter takes this the furthest. He claimed that global warming had ended, with a graph that showed the period between 1998 and 2012. The British Association for Skeptical Enquiry could easily disprove this claim by showing the whole graph (instead of just the piece Carter showed). This clearly showed that the planet continued getting warmer.

Other scientists, like Danish physicist Henrik Svensmark, explain global warming by pointing at solar flares as a cause. They say that fluctuations in cosmic rays and solar flares cause differences in the global temperatures.

Dutch scientist Salomon Kroonenberg is a geologist who researches ice ages. He says we are currently in an interglacial period (between two ice ages) which means it makes sense that the Earth is warming up, and it will cool down again when we get closer to the next ice age. He says there is no connection between CO2 emissions and global warming.

Question
1) The Association for Skeptical Inquiry accuses Carter of cherry picking.
Use your own words to explain what cherry-picking means in the context of these alternative explanations for climate change.

Step 2: Politicians

Print

There are many politicians and political parties all over the world, including in the Netherlands, that do not believe climate change is caused by people. Geert Wilders, leader of the Party for Freedom, calls environmental policy a waste of money. He thinks there is nothing wrong with the environment, the climate, or the CO_2 levels in the air.

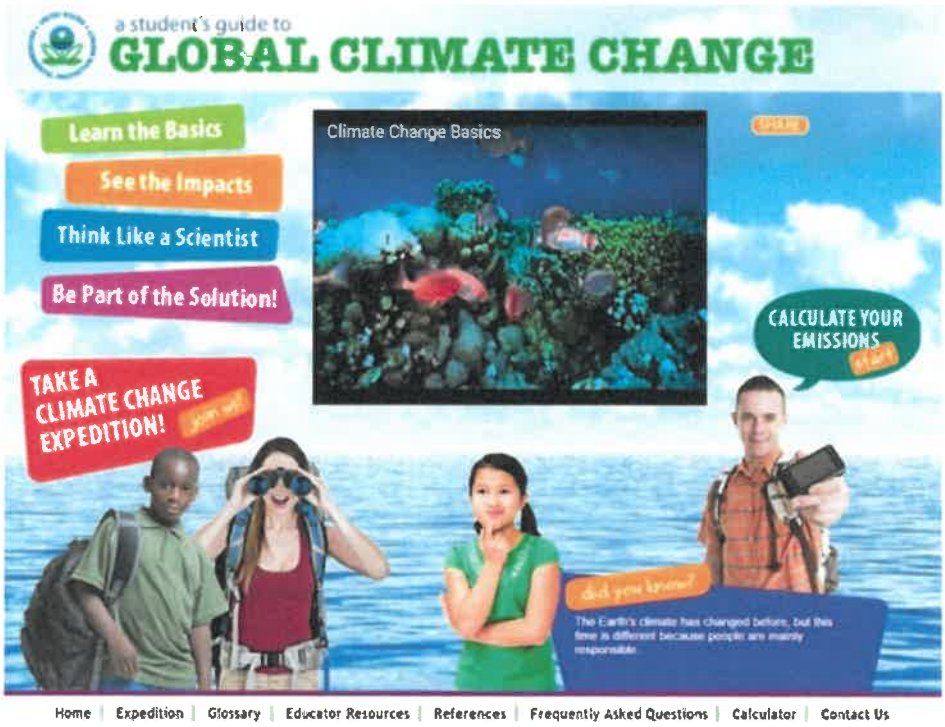
Donald Trump, the president of the United States of America, has even stronger opinions. Many of his tweets are about climate change, though he prefers to refer to it as a hoax, a canard, or a con. "Global warming has been proven to be a canard repeatedly over and over again." (29/03/2012)

He is a fervent climate denier. "Whether Global warming or Climate Change. The fact is We didn't cause it. We cannot change it." (18-02-2014)
In four years, he has tweeted about a cold day over 50 times: "Where the hell is global warming when you need it?" (27-01-2015)

He thinks that climate change is an idea invented by the Chinese, because they want to weaken the American economy by making the government waste lots of money to combat global warming, which means the economy cannot flourish. "The concept of global warming was invented by and for the Chinese in order to make U.S. manufacturing non-competitive." (06/11/2012).

He tweeted this before he became president, but he has continued tweeting and acting on these beliefs as president. He wanted big budget cuts for the Environmental Protection Agency, but Congress prevented this. The EPA did remove a lot of information about climate change from its website. These pages now say "This page is being updated".

One of the things that were removed was the Student's Guide to Global Climate Change, seen in the screenshot below:



Question
2) Give a reason why many populist politicians like Trump, with his motto "America First", do not want to hear about climate change.

Step 3: Industry

Print

In 2013, British newspaper The Guardian revealed that some millionaires, billionaires, and corporations that benefit from the use of fossil fuels are paying scientists to publish results that claim the sun is the main cause of climate change, rather than human action.

For example, Koch Industries (involved in oil and chemicals), ExxonMobil (one of the biggest oil companies in the world), and American Petroleum Institute (involved in oil, gas, and the petrochemical industry) all sponsored Willie Soon, a scientist with the Harvard-Smithsonian Center for Astrophysics who is also a climate change denier.

© Wikimedia

Controversy arose when it became clear that he had not mentioned these sponsorships from the fossil fuel industry in his scientific publications.

Shell
The oil company Shell also created controversy, but for a completely different reason. De Correspondent, a Dutch newspaper, got access to confidential documents from Shell that showed Shell had already raised the alarm about climate change internally in 1986. Researchers from Shell warned against a relatively quick and dramatic change in the climate, with consequences for the liveability of the planet, our future standard of life, and our food supply, which would potentially have big social, economical, and political consequences."

© De Correspondent

In 1991, Shell released a 28 minute video titled "Climate of Concern" in English, Dutch, Arabic, and Turkish. The video warns about the consequences of climate change and encourages its audience to think about possible solutions.

Below you can see a 2 minute summary on Youtube:

Shell quickly retracted its video. Back then, Shell was involved in a campaign to create doubt about climate science and prevent "draconian" government measures. American members of congress later made an unsuccessful attempt to start a criminal investigation on the involvement of Shell in deceiving the public.

Question
3) Why is it seen as non-scientific when researchers do not mention who sponsored them?
4) What new term for victims of climate change did Shell introduce in its video?

Step 4: ThinkTank

Print

A think tank is an organisation made up of advisors, scientists, and commentators that delve into a certain subject and release publications about it. Think tanks focus on social and political issues and try to formulate advice about how to solve the problem. American politics often relies on think tanks to decide its political course.

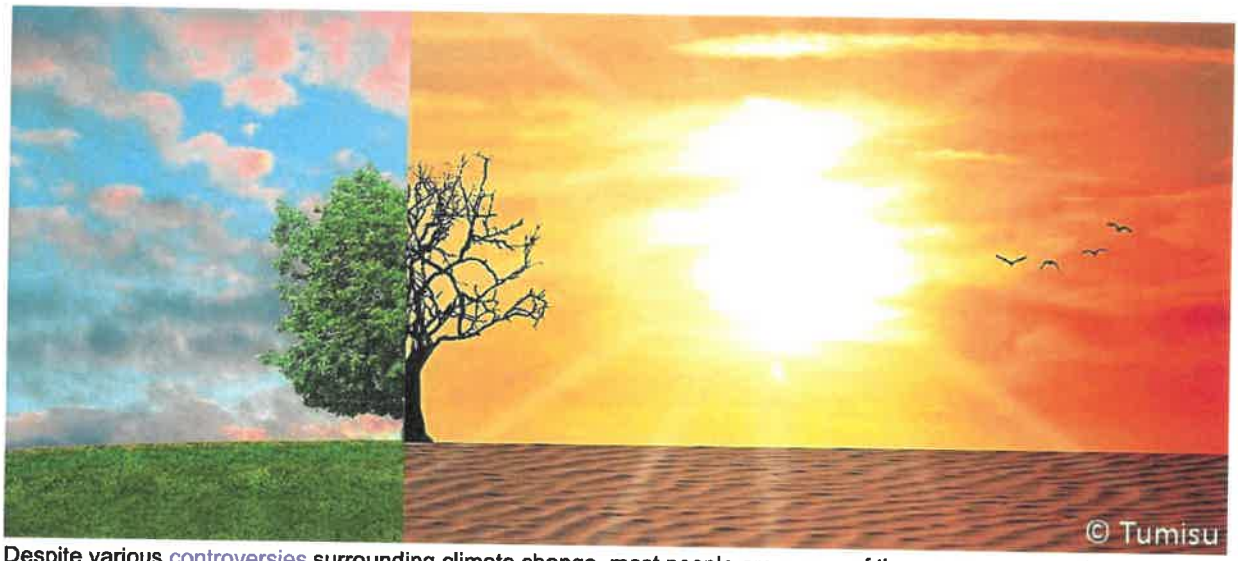
The Guardian discovered that conservative American think tanks have spread 120 million dollars among over 100 different campaign groups that worked to create doubt about human-caused climate change.

You are part of a conservative campaign group that received funds from a rich think tank. You will think of a tweet, slogan, picture, or short article that aims to create doubt about human influence on climate change among the people of your town or city.

Good luck!

THE EFFECTS OF CLIMATE CHANGE ON NATURE

Print



Despite various controversies surrounding climate change, most people are aware of the consequences of global warming. Those consequences are so far-reaching that they cannot be explained in one lesson.

We have somewhat arbitrarily divided the effects of climate change into two lessons: the effects of climate change on natura (like rising sea levels and more extreme weather) and the effects of climate change on plants, animals, and people (like damage to crops, an increase in the tick population, and a decrease in the number of pine trees).

We will give you an overview of these effects.

Print

LEARNING OBJECTIVES

This project is connected to the Sustainable Development Goals, especially goal 13, but also goals 15 and 17.

By the end of this lesson, you will:

- Know the difference between sea ice and land ice
- Know that climate change in the North Pole region has bigger consequences than climate change in the South Pole region
- Know the consequences of melting glaciers for millions of people
- Know the consequences of melting permafrost
- Be able to name three causes of rising sea levels
- Know which places on Earth are most sensitive to rising sea levels
- Know that climate change is causing an increase in the number and intensity of climate extremes

By the end of this assignment, you will know the meaning of the following terms:
* climate change
* glacier
* permafrost
* rising sea levels
* absolute sea level change
* relative sea level change
* extreme weather

Final product
The final assignment for this lesson is to write a **report about the consequences of climate change**. With this final assignment, you will show you have reached the learning goals.

Assessment
The final product will be graded by your teacher.

Your teacher will grade the assignment based on the following:
- **Content**: Does your report manage to convince the Dutch population of the need to take action?
- **Form**: Did you take care to give your text the right form?
- **Language mistakes**: Were your answers to the questions in steps 1 – 4 and the final product written without too many language mistakes?

Group size
You will work by yourself for this lesson. The final product will be made in a group.

Time
This lesson will take two hours.

STEP 1: MELTING ICE

Print

North and South Poles
The Earth is composed of land (30%) and sea (70%). Part of the Earth is permanently frozen. We differentiate between sea ice and land ice.

The North Pole region mostly consists of sea ice, also called pack ice. The thickness of the ice varies depending on the season, but is never less than three metres. The ice melts in summer (mainly in September) and grows again in winter (mainly in March). Scientists have not reached a consensus about when the North Pole will have melted completely, but they agree it will happen before the end of the century.

North Pole © Christopher Michel

South Pole © Girlart39

Unlike the North Pole, the South Pole is on top of a land mass. This means the ice on the South Pole is mainly land ice. The thickness of the ice varies between 300 metres to 3 kilometres! The South Pole is so cold (-89.2°C/-128.56°F) that climate change does not affect the ice much, except for the sea ice around the edges.

Scientists worry a lot more about the land ice in Greenland in the North Pole region. The temperature is a lot higher there than it is around the South Pole. Part of Greenland is always frozen, at temperatures between -6°C/21.2°F to -30°C/-22°F, but other areas of the country see summer temperatures above the freezing point and up to 12°C/53.6°F. The thickness of the ice around the edges is decreasing by over half a metre a year in some places.

Questions
1) Use an atlas (Grote Bosatlas 55th edition, map 275). How can you tell the North Pole is at risk of becoming completely free of ice? Can you use the maps in the atlas to predict when all the ice will have melted?

Glaciers
A glacier is a body of ice that is formed in mountain ranges when a thick mass of snow accumulates on land and slowly turns to ice over a long period of time. A defining characteristic of glaciers is that they move under their own weight, like slowly flowing rivers. Glaciers are melting worldwide, like this glacier in Austria:

Translation of the title: The knowledge of today in the classroom / Melting glaciers
Please note: the film is in Dutch; click here for a transcription in English.

Question
2) When glaciers melt, millions of people see their water supplies decreasing. Use your own words to explain how this happens.

Permafrost
Permafrost is permanently frozen ground. About a fifth of the Earth's land mass is permanently frozen. Permafrost can be found near the Polar regions and in high mountains. An increasing number of these areas (Siberia, Alaska, the north of Canada) are melting. There are a lot

of roads, houses, and oil pipelines in these areas. These areas are badly affected by the fact that the permafrost there is now defrosting.

Permafrost contains a lot of methane. When it defrosts, the methane escapes from the soil. This increases the strength of the greenhouse effect, which influences global warming.

Question
3) Infrastructure is a big challenge when permafrost is involved, for two reasons. Which two reasons?

Step 2: Sea level rise

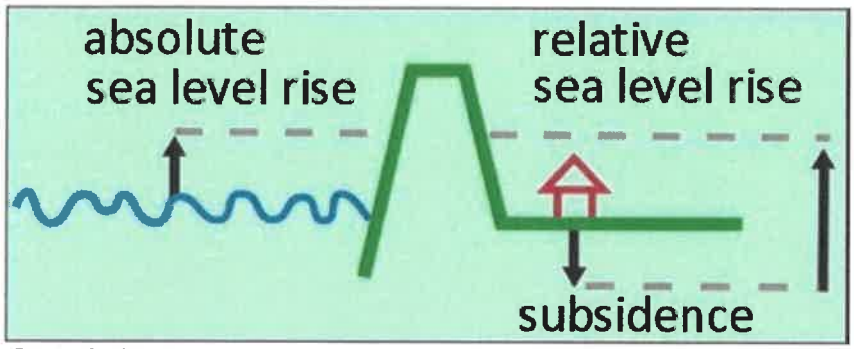
Print

During the last ice age, about 20,000 years ago, sea levels were about 120 metres lower than they are now. We are currently in an interglacial period (between two ice ages). It makes sense that sea levels have risen since then, but global warming means sea levels are rising faster than expected. There are three reasons why sea levels are rising more quickly:

1) Global warming has caused sea ice and land ice to melt. Most of this melted ice ends up in the sea. We already see a lot of the land ice in Greenland melting and flowing into the ocean. If all the land ice in Greenland melted, there would be an absolute sea level rise of 7 metres worldwide.

2) Water expands when it gets warmer, which leads to an absolute sea level rise. The average depth of the ocean is 3790 metres. With every increase of 1°C/1.8°F in the global temperature, sea levels rise by a little less than a metre.

3) Land subsidence increases the distance between the seabed and the land. Among other things, this is caused by groundwater pumping. When the Earth's surface sinks, it causes a relative sea level rise.



© Binnenlands Bestuur

When it comes to predicting the increase in sea levels by the year 2100, there is no consensus. Some models predict a few decimetres, while others predict an increase of two metres. The Intergovernmental Panel on Climate Change of the United Nations (a panel of 2500 experts) has concluded there will be an increase of about 18 to 59 centimetres by 2100. Due to land subsidence, the Royal Netherlands Weather Institute predicts a relative sea level increase of 35 to 85 centimetres.


© StockByte / World Bank

Coastal areas
A large percentage of the Earth's population lives at or near the coast. Coastal cities are economically attractive (harbour, fishing, transportation, industry), which is also true for the Netherlands and Bangladesh.

A significant area of the Netherlands is already below sea level, protected by dunes, dykes, and deltas. Bangladesh is also by a river delta, exposed to the laws of nature. Something like a storm will already cause the coastal region to flood. If sea levels rise by a metre, 40% of Bangladesh will be permanently flooded.

Small islands
Various small islands in the Pacific Ocean and the Indian Ocean are at risk of being flooded by a rise in sea levels. The area that is most at risk is Tuvalu, an archipelago of 113 islands, only eight of which are inhabited (Tuvalu means 'eight islands'). The highest point of Tuvalu is 4.6 metres above sea level and the whole area is only 1 metre above sea level on average. Tuvalu is doomed and the exodus has already started: thousands of people have emigrated, mostly to New Zealand.


© Ryan:G

Questions
4) Use your own words to explain the difference between absolute and relative sea level rises.
5) The Netherlands and Bangladesh are both on a river delta, but they are very different countries. Name a few differences.

Step 3: More extreme weather

Print

The weather is always changing. It could be different every day. Extreme weather has also been around forever (as was already mentioned before), but there has been an increase in climate extremes, which climate scientists have linked to human-caused climate change.

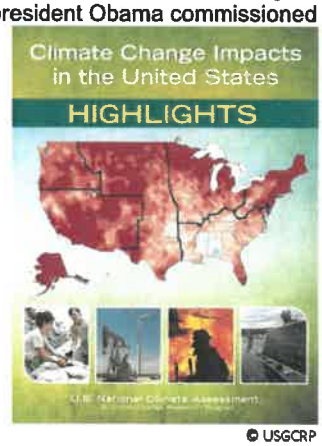
According to meteorologist Robert Henson, the United States of America has the most extreme weather in the world. Hurricanes, tornadoes, drought, flooding, forest fires, storms, heat waves, and cold fronts: America has them all.

Every year, America has to deal with over ten thousand heavy storms and over a thousand tornadoes. Compare that to China, which is a country of similar size (America: 9,629,091 km2; China: 9,596,961 km2), but sees less than ten tornadoes a year. Every year, America is hit by 80% to 90% of all the tornadoes in the world.

What makes the weather in the United States so special? This is partly related to geographical circumstances. America is right in the middle between the equator and the North Pole. Sometimes the wind blows to the United States from icy Canada and Siberia, other times the wind brings tropical heat over from South-America.

America is also between two oceans and there are no mountains on the east coast to block the sea winds (like there are on the west coast). A lot of tornadoes and hurricanes reach land around the Gulf of Mexico and the south east coast by Florida. Everyone remembers hurricane Katrina, the natural disaster in New Orleans, which caused the death of 1,836 people as well as 80 to 90 billion dollars in damage.

Extreme weather and natural disasters seem to be part of daily life for Americans, but the number of natural disasters has been increasing for years and can no longer be explained by normal climatological circumstances. During his presidency, former president Obama commissioned scientists to investigate these natural disasters. They wrote this in their report:



© USGCRP

"Climate change, once considered an issue for a distant future, has moved firmly into the present. Summers are longer and hotter, and extended periods of unusual heat last longer than any living American has ever experienced. Winters are generally shorter and warmer. Rain comes in heavier downpours.

This is not some distant problem of the future. This is a problem that is affecting Americans right now. Whether it means increased flooding, greater vulnerability to drought, more severe wildfires — all these things are having an impact on Americans as we speak."

An American newspaper had the following response:
"The wave of natural disasters in the United States is an effect of global warming. The consequences of global warming are not waiting to face us tomorrow or the day after. We are feeling them right now."

Question
6) American media see this as a hefty report. Why hefty? Which key phrases from the report would you use to convince American citizens to take action?

Step 4: Our own extreme weather

Print

The United States of America may have the most extreme weather in the world, but the Netherlands deals with extreme weather as well.

Commissioned by the Dutch government, you will write a report about the effects of climate change on the Netherlands.
You and your team will write down some highlights for the Dutch people. You will end your summary with the same sentence as the American report, but adapted for the Netherlands.

"All these things are having an impact on Dutch people as we speak."

Good luck!

THE EFFECTS OF CLIMATE CHANGE ON PLANTS, ANIMALS, AND PEOPLE

Print

As we said before, the consequences of climate change are so widespread that we cannot discuss them in a single lesson.

We have somewhat arbitrarily divided the effects of climate change into two lessons: the effects of climate change on nature (like rising sea levels and more extreme weather) and the effects of climate change on plants, animals, and people (like damage to crops, an increase in the tick population, and a decrease in the number of climate refugees).

We will give you an overview of these effects.

LEARNING OBJECTIVES

Print

This project is connected to the Sustainable Development Goals, especially goal 13, but also goals 15 and 17.

By the end of this lesson, you will:
- Know some examples of the consequences of climate change for plants, animals, and people
- Know two examples of the consequences of climate change for plants
- Know three examples of the consequences of climate change for animals
- Be able to explain the consequences of climate change for agriculture
- Know that there are climate refugees and which group was first seen as climate refugees
- Know that climate change can also lead to more diseases

By the end of this assignment, you will know the meaning of the following terms:
* Climate change
* Migration
* Climate refugee

Final product
The final assignment for this lesson is to **write a letter** to the 'causers' of climate change. With this final assignment, you will show you have reached the learning goals.

Assessment
The final product will be graded by your teacher.

Your teacher will grade the assignment based on the following:
- **Content**: Did you write a polite but firm letter that highlights all the key points?
- **Form**: Did you take care to give your text the right form?
- **Language mistakes**: Were your answers to the questions in steps 1 – 4 and the final product written without too many language mistakes?

Group size
You will work by yourself for this lesson. The final product will be done with one other person.

Time
This lesson will take two hours.

STEP 1: CONSEQUENCES FOR PLANTS

Print

Trees: evergreens
George Sperber was a forester in Germany for 50 years. He is worried about the effects of climate change on the forest.

Translation of the title: Climate witness / George Sperber - Germany
Please note: the film is in Dutch; click here for a transcription in English.

According to Gerber, climate change mostly affects fir trees in Europe. Increasing temperatures create ideal circumstances for oak processionary caterpillars. The caterpillars eat so much they strip the trees, which means the trees could die.

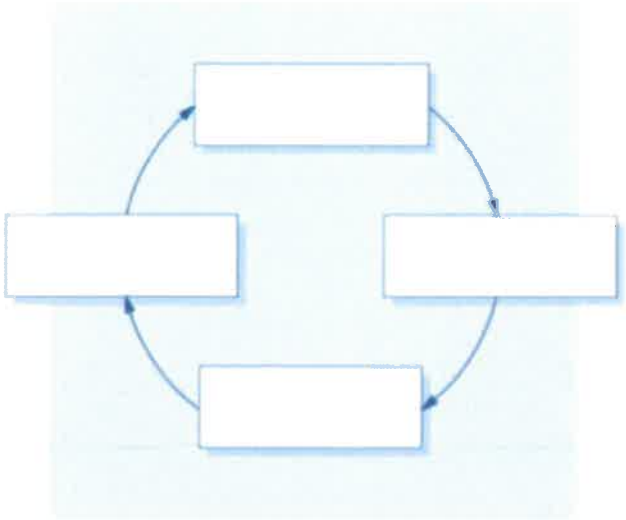
Another small creature in America and Canada that is very happy about global warming is the bark beetle and one of its subspecies, the mountain pine beetle. This insect survives more easily in the warmer winters and longer summers, which gives it more opportunities to infect the trees it eats with a fungus. Within a few weeks after the infection, the tree has died completely. Due to the death of so many trees, the temperature has gone up by 1°C/1.8°F in these affected areas. With fewer trees, the forest cannot circulate as much water through the air, which causes temperatures to rise.

Left: © Forest Service of the United States Department of Agriculture
Right: © Don Becker, U.S. Geological Survey

The brown evergreens are dead

That increased temperature makes it easier for the bark beetle to increase its numbers again. This means the little insect is responsible for a radical change in the entire climate system of America and Canada.

Question
1) The appetite of the bark beetle affects the environment in a vicious cycle. Explain how this cycle works.



Coral: symbiosis of plant and animal
Coral is technically not a plant. It is part of the animal kingdom. The animal in question is very small. Coral is actually a collection of little animals stuck together that form big colonies together. These bits of coral live with algae that make their home in the skin of the animal. You cannot see them, but when enough algae are together, they create a colour. They make the coral green, purple, or brown. You are not seeing the colour of the coral, but of the algae.

The relationship between algae and animal is very fragile. This is explained in this SchoolTV video:

Translation of the title: Climate hunters in the classroom / The disappearance of coral in Oceania
Please note: the film is in Dutch; click here for a transcription in English.

Question
2) The coral in the Great Barrier Reef strongly depends on a balanced environment. Rising temperatures in the sea water are causing the coral to become unbalanced. At the same time, the increased temperature of the sea water has another effect. What is it?

Step 2: Consequences for animals

Print

The habitat of animals strongly depends on the plants and trees that grow there and the food supply. The things that can live and grow in a place depend on the climate. This animation from WWF The Netherlands/Naturalis explains it:

Translation of the title: Climate change in a nutshell!
Please note: the film is in Dutch; click here for a transcription in English.

Climate Challenge has made three videos (all in 1.07 minutes) from the perspective of animals who explain what climate change has done to their habitat.

The oystercatcher in the Netherlands:

Translation of the title: An Oystercatcher testifies - The Netherlands
Please note: the film is in Dutch; click here for a transcription in English.

The puffin in Great Britain:

Translation of the title: A Puffin testifies - United Kingdom
Please note: the film is in Dutch; click here for a transcription in English.

The green sea turtle in Malaysia:

Translation of the title: A Green sea turtle testifies - Malaysia
Please note: the film is in Dutch; click here for a transcription in English.

Question
3) The video from WWF/Naturalis discusses animal 'migration'. What does that mean?
4) Why is migration more difficult for animals that depend on the sea, compared to animals that live on land?

Step 3: Consequences for people

Print

People in the industrialised West are the prime contributors to climate change, but the consequences are biggest for people in developing countries. The video "The Seasons are Confused", made by the Belgian organisation Climate Challenge, makes this painfully clear:

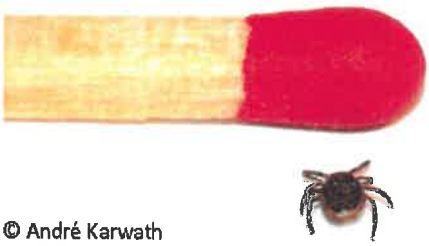
Translation of the title: Consequences for people in the South - The Seasons are confused
Please note: the film is in Dutch; click here for a transcription in English.

In (sub)tropical regions, climate change can have catastrophic consequences for agriculture. Less rain and more drought – or alternatively, more rain and soil erosion – heavily damage crops. Unlike in the West, most of the population of developing countries works in agriculture. For comparison: In Senegal, 77% of the active population works in agriculture. In the Netherlands, this is only 2%. On top of that, we know that most of the 1 billion underfed people in the world are farmers. The people who produce the food are the ones who are going hungry!

People that have to flee their homes or countries because of the consequences of climate change are called climate refugees. The first group of people who were given this status were the citizens of the island Tuvalu. They were given residence permits in New Zealand in 2014, for climatological reasons. (See also "small islands".) Researchers from the Environmental Justice Foundation (EJF) estimate that the number of climate refugees could increase up to 150 million by 2050.

People who flee from floods and drought are not the only ones in danger! Global warming also causes animals and diseases to spread to places they did not appear before. For example, the habitat of mosquitoes is getting bigger and bigger.

People in America, Europe, and parts of Asia are seeing increasing numbers of ticks. This tiny animal (see image to the right) becomes active at temperatures above 8°C/46.4°F. Ticks feed on the blood of animals, reptiles, mammals, and humans. Their bite does not hurt and is usually not dangerous. However, this bite can have very negative consequences. 20% of all ticks are infected with the Borrelia bacteria, which can cause Lyme disease. People with Lyme disease can get very sick and may have to deal with chronic pain.



© André Karwath

Question
5) Climate change could also be an advantage for agriculture in mild climates. Could you give an example?

Step 4: A letter to the 'causers'

Print

You have seen that climate change affects people in developing countries the most. You will write a letter from the perspective of someone in a developing country. Write half a page to the 'causers' of climate change; people in the industrialised West.

Think carefully about what you want to say. Will you ask them to apologise? Will you ask for tips on how to deal with the consequences of climate change?

CLIMATE AGREEMENTS

Print

On December 12th, 2015, 195 countries signed the **Paris Agreement** and promised to take concrete measures to stop global warming. The Dutch secretary of state of the ministry of infrastructure and the environment at the time, Dijksma, said the following:

"Signing this climate accord confirms once more that the world wants to do the work needed to limit global warming and the disastrous consequences of climate change. Now these agreements must be turned to actions. We are working hard to do this, because we have a big challenge ahead of us. The clock is ticking."

Where have 30 years of climate agreements led us? Did we manage to turn these agreements into concrete actions? Has the world succeeded in stopping climate change?

We hope you will have found some answers by the end of this lesson.

LEARNING OBJECTIVES

Print

This project is connected to the Sustainable Development Goals, especially goals 13 and 17.

By the end of this lesson, you will:
- Know which countries have signed various climate agreements
- Know that these agreements have not had a big effect on the environment yet
- Be able to give one or more reasons why these climate agreements have not been successful
- Know how the Paris Climate Agreement is different from previous climate agreements
- Know the conditions under which the Paris Climate Accord could be successful
- Know what bunker fuel is and why this was excluded from the Paris Climate Accord

By the end of this assignment, you will know the meaning of the following terms:
* reduction target
* Climate Agreement
* Agenda 21
* Forest Principles
* Kyoto Protocol
* Paris Agreement
* Bunker fuel

Final product
The final product for this lesson is to **add an article to the Paris Climate Agreement**. With this final assignment, you will show you have reached the learning goals.

Assessment
The final product will be graded by your teacher.

Your teacher will grade the assignment based on the following:
- **Content**: Does your article make a relevant contribution to the accord?
- **Form**: Did you take care to give your text the right layout?
- **Language mistakes**: Does your text contain the knowledge you gained from steps 1 – 4 and are there not too many language mistakes?

Group size
You will work by yourself for this lesson. You will do the final assignment with one other person.

Time
This lesson will take two hours.

Step 1: United Nations Framework Convention on Climate Change

Print

In 1988, the United Nations held an international convention on climate change. They founded the Intergovernmental Panel on Climate Change (IPCC). The goal of this organisation is to investigate what is happening to the climate and how it will affect people and nature. They quickly agreed that climate change is caused by increased amounts of greenhouse gasses in the atmosphere, particularly carbon dioxide (CO_2).

To stop climate change, we need to reduce greenhouse gas emissions. Therefore, every agreement about the climate starts with plans to reduce emissions. These plans are called reduction targets.

In 1992, *The United Nations Conference on Environment and Development* was held in Rio de Janeiro (Brazil). The countries who were represented there made some important agreements:

* The member states created the *United Nations Framework Convention on Climate Change (UNFCCC)*, which was signed by almost all the countries in the world. The declaration stated that greenhouse gas emissions needed to be limited to stop climate change, but did not say how to do this.

* The member states also made *Agenda 21*. This is a worldwide action plan to improve the environment in the 21st century. This action plan also describes how to deal with the enhanced greenhouse effect.

* Finally, they produced the *Forest Principles*. This was a promise to stop deforestation.

Question
1) Which 'reduction target' could you work towards at home?

STEP 2: COP

Print

The goal of the UNFCCC was to reduce greenhouse gas emissions and thereby prevent unwanted consequences of climate change.

In 1995, the member states that signed the declaration met again. The United Nations referred to this as the Conference of Parties (COP). They agreed to meet every year to evaluate the process on their plans. The COPs are numbered.

COP 1 was in Berlin (Germany) in 1995. COP 2 was in 1996, etc.

By COP 3, held in Kyoto (Japan) in 1997, it had already become clear that the declaration had not led to much progress. Greenhouse gas emissions had gone up instead of down in most countries. The 160 member states create the Kyoto Protocol. It stated that greenhouse gas emissions had to be 5.8% lower in 2012 compared to 1990. All member states also agreed how much they would limit emissions in their country. For example, the Netherlands promised to reduce emissions by 6%, Belgium by 7.5%, and the United States by 8%.

Some members signed this protocol, but a few countries that emit a lot of greenhouse gasses, like the United States, did not. Most countries held off on signing until they knew other countries would do it too. They want to do something about their greenhouse gas emissions, but only if it does not hamper the growth of their economy.

Developing countries hesitate about signing the protocol. They say that the richest countries emit most of the greenhouse gasses, so they should lead the way. They also say they have more right to economic growth (and increasing wealth) than richer countries.

The United States do not want factories in developing nations to be able to compete with them because they do not need to adhere to the strict and therefore expensive environmental demands. The United States think this is unfair. After he became president in 2001, George W. Bush stated he had no intention of signing the protocol.

Question
2) What is your opinion on the request made by these developing countries? Give an argument in favour and an argument against their request.

Step 3: Paris Agreement

Print

In spite of all these agreements and concrete goals, the world has not managed to stop climate change. The British secretary of state at the time, David Miliband, said this during COP 12 in Nairobi in 2006: "There is a large gap between the emissions cuts which science suggests are necessary, and the level of political commitment to making those cuts."

It took a long time for politicians to realise it could not go on this way. After two years of preparation, the countries signed the *Paris Agreement* during COP 21.

On 12 December 2015, a day earlier than planned, the Paris Agreement was presented. The accord says we need to limit global warming to an increase of 2°C/3.8°F compared to the Industrial Revolution; the first time such a limit was set. It also set the goal of limiting global warming to 1.5°C/2.7°F. Additionally, the agreement included putting an end to the use of fossil fuels, since this is an important cause of CO2 emissions.

The agreement requires member states to make new national climate plans, which need to become increasingly ambitious as time goes on. The agreement also included that richer countries were expected to financially support other countries in the process of reducing their emissions.

The Paris Agreement was signed by 174 countries in New York on Earth Day, 22 April 2016.

Will this agreement mean we can limit climate change to 1.5°C/2.7°F or 2°C/3.8°F? Time will tell, but it does not look promising. For example, take a look at this video about three reasons why Donald Trump is against the Paris Agreement.

Translation of the title: Three reasons why Trump is against the Paris Agreement
Please note: the film is in Dutch; click here for a transcription in English.

Question
3) Trump says he wants to protect the coal industry and create more jobs in this sector. Which economic argument would you use to

convince the president that signing the Paris Agreement would actually help decrease unemployment?

Step 4: Not in the climate agreements

Print

The Paris Agreement is a set of agreements made to limit the emission of greenhouse gasses. Every country has made its own plans to reduce emissions from factories, transport, and houses. However, one sector is left out: the use of fuel oil for ships and kerosene for planes. Fuel oil and kerosene are both types of a kind of fuel called bunker fuel or bunker oil.

Planes and seagoing ships can get their fuel very cheaply, because they do not need to pay tax over bunker fuel. Thanks to this cheap bunker fuel, we can ship cheap products from China and book cheap flights for holidays.

In the Netherlands, more bunker fuel is used for international transport by water (75%) and air (25%) than for every car, truck, bus, and train in the Netherlands put together.

Every climate accord, including the Paris Agreement, includes measurements of every country's CO_2 emissions, based on import and the oil, gas, and coal that is mined.

The CO_2 production of a plane full of kerosene is seen as export. On the way to a destination, all the kerosene is burnt up, and the country where the plane lands does not need to add these CO_2 emissions to their own supply. That way, no one is held responsible for the CO_2 emitted through the use of bunker fuel.

Questions

4) Why do we not simply calculate how much CO_2 is imported and exported?

5) Why do countries not want to pay taxes over bunker fuel?

STEP 5: WRITE YOUR OWN CLIMATE AGREEMENT

Print

The Paris Agreement is an accord that consists of 29 different articles. For example, Article 12 is about the following:

Parties shall cooperate in taking measures, as appropriate, to enhance climate change education, training, public awareness, public participation and public access to information, recognizing the importance of these steps with respect to enhancing actions under this Agreement.

As you read in Step 4, CO_2 emissions from the use of kerosene and fuel oil was excluded from the agreement.

It's about time we change this!

You will write an additional article for the Paris Agreement, which includes kerosene and fuel oil. You will include a solution for how to calculate the import and export of CO_2 emissions from the use of bunker fuel.

Good luck!

FOSSIL-FREE ENERGY

Print

The banner shows the text: fossil-free (fossielvrij.nl)

About 60% of greenhouse gas emissions consist of CO_2 that is released when fossil fuels are burned (oil, gas, coal, and brown coal). These fuels are used for the production of electricity, transport, heating, plus petrochemical and other industrial processes.

To limit the negative consequences of climate change, scientists say that global warming must be limited to a maximum increase of 2°C/3.8°F compared to pre-industrial levels. To reach this goal, greenhouse gas emissions must decrease by 80% to 90% by 2050, compared to emission levels in 1990.

This is tough, but not impossible. To drastically reduce CO_2 emissions, we do not just need to save energy, but we also need to replace the fossil fuels we use with sustainable or green alternatives (which cannot run out and do not harm the environment). According to Statistics Netherlands, 5.9% of all energy sources used in the Netherlands are sustainable, and this number is increasing by 0.1% every year. According to the Paris Agreement, it should be 14% by 2020 and 49% by 2030, but the Netherlands is far from reaching that goal.

In this lesson, we will discuss several 'fossil-free' sources of energy.

LEARNING OBJECTIVES

Print

This project is connected to the Sustainable Development Goals, especially goal 17, but also 7, 9, and 14.

By the end of this lesson, you will:
- Know about several sustainable energy sources
- Be able to rank the four most important sustainable energy sources
- Know the biggest wind turbines can be found at sea
- Know that only a fraction of the sunlight that reaches the Earth is converted to solar energy
- Know about three different forms of hydropower
- Know that water power projects are sustainable, but also have a negative impact on people, fauna, and flora
- Know that biomass, used to generate bio energy, is a controversial subject
- Know that electric cars are much better for the environment than cars that need gasoline or diesel

By the end of this assignment, you will know the meaning of the following terms:
* Energy sources
* Wind energy
* Wind turbine
* Wind park
* Solar energy
* Hydropower
* Hydropower station
* Tidal power station
* Blue energy
* Biomass
* Electric car

Final product
The final assignment for this lesson is to **design a leaflet for a solar scooter**. With this final assignment, you will show you have reached the learning goals.

Assessment
The final product will be graded by your teacher.

Your teacher will grade the assignment based on the following:
- **Content**: Does your leaflet show that you understand the idea behind solar energy?
- **Form**: Did you take care to give your text the right form?
- **Language mistakes**: Does your leaflet contain the knowledge you gained from steps 1 – 5 and are there not too many language mistakes?

Group size
You will work by yourself for this lesson. The final assignment will be done in a group of three or four.

Time
This lesson will take two hours.

STEP 1: WIND ENERGY

Print

For as long as we can remember, humans have been using wind as a source of energy, generated by machines like windmills. First, windmills were used to grind grain or saw wood into timber. These days, we use wind turbines to generate electricity.

Wind energy is clean and endlessly renewable. The wind is always blowing, though it does not blow equally hard in all places. Some areas get higher wind speeds than others. The wind blows harder over sea and near the coast than it does over land. This is because the wind rarely runs into obstacles over sea, while the wind on the mainland is mostly slowed down by forests, buildings, hills, and mountains.

The video below shows the importance of wind energy.

Translation of the title: Research into wind energy is going well!
Please note: the film is in Dutch; click here for a transcription in English.

If you look in an atlas like the Dutch Grote Bosatlas, you can find the total production of sustainable energy (see GB55, map 63L). 52% of our energy sources are wind-based. Of this 52%, 44% is generated on land and 8% on sea.

Wind energy is the biggest and most important sustainable source of energy and we will continue to rely on it more and more, because there are plans to set up big wind parks in the North Sea that will supply millions of people with green energy. In 2017, they finished the Gemini wind park with 150 wind turbines, about 55 kilometres off the coast of Ameland and Schiermonnikoog.

Question

1) List two advantages of wind parks at sea and two disadvantages.

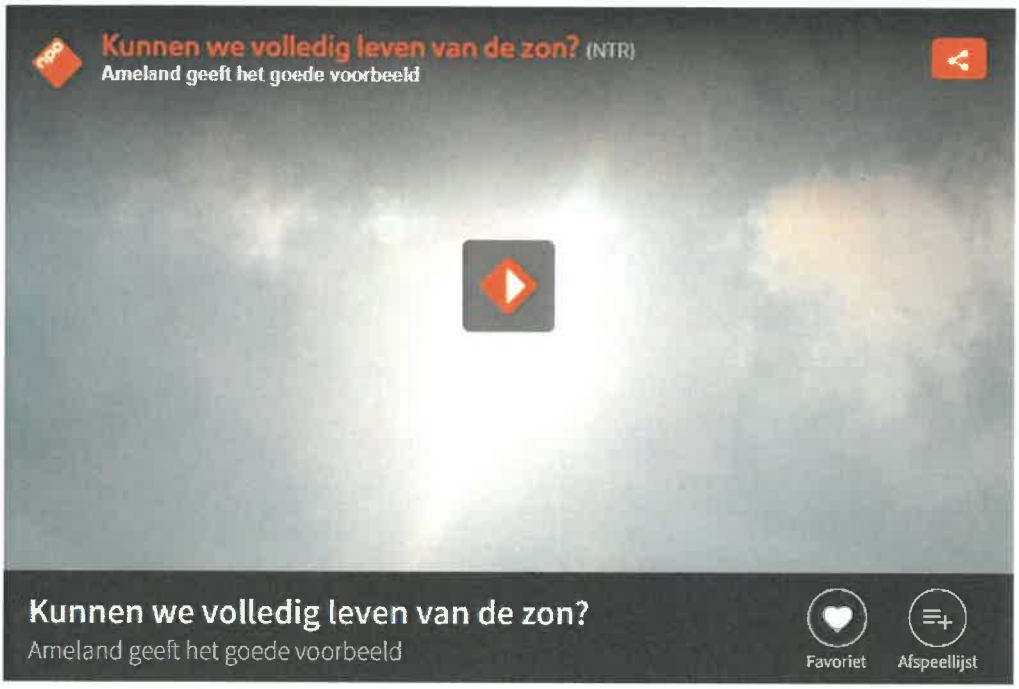
STEP 2: SOLAR ENERGY

Print

The amount of energy that the Earth gets from the sun every year is over ten thousand times as big as the amount of energy that the entire population of the planet uses in a year. And solar power is entirely free!

No wonder that we use solar power to generate electricity. We do this with solar panels. A solar panel is a panel that transforms solar energy into electricity. A large number of solar cells are mounted on the panels. These solar cells are usually made of silicon. This silicon is made up of two layers. When the light hits it, an electrical current starts flowing between the layers. The power this generates can be transferred to the electrical grid, stored in batteries, or used directly to power something like a pump.

The Dutch island Ameland wants to use solar power to become completely self-sufficient in its energy supply. They have not reached this point yet, but they are working towards it.



Translation of the title: Can we live off the sun completely? Ameland gives the right example
Please note: the film is in Dutch; click here for a transcription in English.

No matter how solar energy is used, it does not create waste or pollution. Apart from electricity for homes and industrial applications, the use of solar power is expanding. Most of these uses are still in experimental stages, like new designs for solar powered cars. You may be familiar with the famous student competition for solar powered cars in Australia, which has already been won by Dutch students from technical universities on Eindhoven and Delft several times, but now they have made something even more special: the first solar powered family car.

Translation of the title: Store solar energy in your car. A moving battery is the future.
Please note: the film is in Dutch; click here for a transcription in English.

Question
2) Solar power seems to be the energy source of the future. Still, only 8% of all renewable energy is generated from the sun. Name two

advantages of solar panels and two downsides.

Step 3: Hydropower

Print

Hydropower is a clean energy source, which only accounts for 1% of all sustainable energy produced in the Netherlands. There are various ways to use water to generate energy.

1) Hydropower plant

Brazil wants to get most of its energy from water and has planned to place dozens of water power plants in the Amazon. The first few have already been built. Out of the top 5 hydropower plants in the world, three are in Brazil. The biggest one is in China, but numbers 2, 3, and 5 are in Brazil. Number three is the Belo Monte Dam in the river Xingu, one of the most important offshoots of the Amazon river. Construction started in 1975, but was put on hold by judges several times. It was not until 2010 that the project was officially green-lit for the energy company Eletrobas. They put aside the objections of 140 national and international organisations and signatures from half a million Brazilians.

The dam comes with far-reaching consequences. It blocks the river, which disrupts the natural flow of water and separates branches from the river. Large parts of the area are now flooded, which has consequences for flora and fauna. On top of that, 20,000 indigenous people were forced to move away.

The dam lowers the water level in the river, which means the people who live here can no longer catch enough fish. The lower water level also means that the river is no longer deep enough for boats seven months of every year.

The goal of the dam was to generate 11,223 megawatts of electricity, but it turned out to be the least efficient water power plant in the history of Brazil. It only functions at 40% capacity.

2) Tidal power stations

Tidal power stations use the difference in water levels between ebb and flow. The difference between high and low can get up to a few metres. During high tide, a dam stops the rising water. When the tide then gets low again, the turbines are opened and the water flows back to the sea. This way, electricity is generated.

3) Blue energy

Blue energy is generated by mixing salt water and fresh water. Professor René van Roij explains how this works.

Translation of the title: René van Roij - Blue energy
Please note: the film is in Dutch; click here for a transcription in English.
You can also click on 'Ondertiteling / Subtitles' of the video (right below): it is subtitled in English then

The seas and oceans contain enormous amounts of salt. On top of that, almost every river also supplies the seas with fresh water throughout the year. Blue energy cannot run out. The bigger the difference in salt content between the two types of water, the more electricity is generated. In the video from 2013, professor Van Roij was still talking about an experiment. Meanwhile, the first blue energy plant of the Netherlands has already been built, by the Afsluitdijk.

Question
3) Which two things do you need for hydropower?

STEP 4: BIOMASS

Print

Biomass is organic material like wood, straw, wheat, corn, rapeseed, as well as vegetable, fruit, and garden waste. Manure also counts as biomass, as well as meat and bone meal. By burning, gassing, or fermenting this material, bioenergy is generated.

See also this SchoolTV video:

Translation of the title: A sustainable form of energy production. Make energy with wood and cow manure.
Please note: the film is in Dutch; click here for a transcription in English.

Growing crops specifically for bioenergy is a controversial topic, because it requires valuable land. This could cause shortages on the food market, which increases further by the high demand for biomass to use in the production of bioenergy.

In Brazil, corn and soy is used increasingly to produce oil that is turned into biofuel, instead of being farmed to be eaten. The same goes for cane sugar, which can either be eaten or turned into ethanol. Most cars in Brazil run on ethanol.

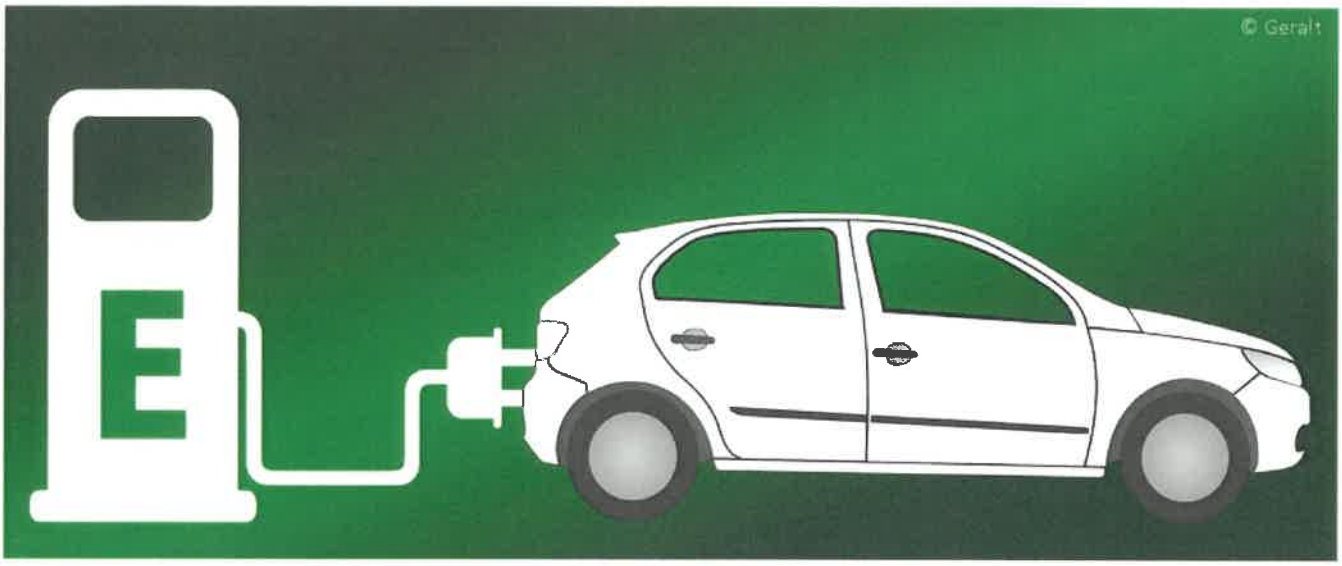
Bioenergy accounts for 40% of all sustainable energy generated in the Netherlands. This percentage is about 50% in Belgium.

Question
4) Different groups of people think burning materials is not that sustainable after all. They point out, for example, that growing crops for biomass harms our ability to produce food. Can you think of another reason why the use of biomass in Dutch power plants is not sustainable?

Step 5: Electric car

Print

You probably mostly know cars that run on gasoline and diesel. But did you know that the first motor invented by Rudolf Diesel ran on peanut oil? And that Henry Ford's first cars also ran on biofuel? Most cars in Brazil run on ethanol, which is also a biofuel. Even our cars that run on gasoline only do so for 95%, while the other 5% is bioethanol. Germany also sells more and more Super E10 at gas stations, which is a mix of gasoline with 10% rather than 5% bioethanol. Still, the car of the future does not run on increasing amounts of ethanol, but on electricity.



A car that runs on gasoline emits various harmful substances: CO_2, NO, and particulate matter, despite the catalyser and particulate filter. A completely electric car does not produce CO_2 while driving. Still, a car is not entirely climate friendly. An electric car still needs a battery, and building and charging a battery requires electricity that usually comes from a plug that is connected to a power plant. Fossil fuels are used to generate this electricity. It would take 2.5 years of use to compensate for this pollution, before driving an electric car becomes more environmentally friendly than a car that runs on gasoline.

Still, since a modern car can last 15 or 20 years, driving electrically ends up being much better for the environment than driving on gasoline.

Question
5) The environmental benefits of electric cars could become much bigger than they are now. How?

Step 6: Your own solar scooter

Print

You already know about electric cars and cars that run on solar power. You may even have heard of electric scooters. However, something that does not exist yet is solar powered scooters.

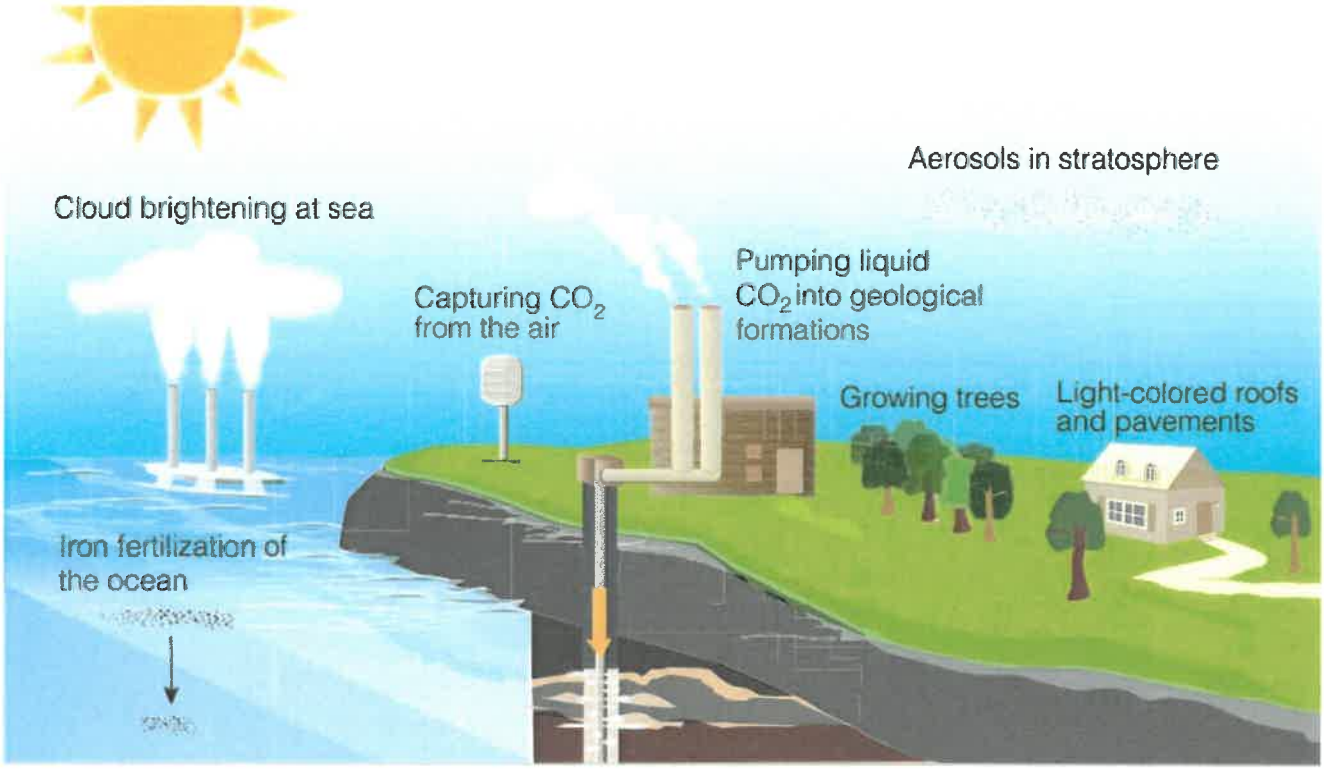
You will start a recruitment campaign aimed at people aged 16-18 (the age when you are allowed to drive a scooter in the Netherlands*, but not a car). Get rid of the gasoline-guzzling scooters of the past, because the solar scooter is here! Use every argument you have to convince people.

Good luck!

** In the Netherlands: 18 years, in the UK: 17 years*

GEOENGINEERING

Print



Examples of climate engineering technologies. Source: GAO. © Jim Lee

Some climate scientists fear that the consequences of climate change have already reached so far that they can no longer be reversed or even slowed down. They say that extreme measures and new technology are absolutely necessary. Purposeful intervention in the Earth's natural systems with the goal of stopping climate change is called geoengineering or climate engineering.

Geoengineering, deliberately tinkering with the climate, is a controversial topic, because it involves large-scale, risky changes to the Earth's ecosystems, using technology that is largely untested, with unknown effects. Large-scale geoengineering is not allowed, though small scientific experiments are being done, in case we need the knowledge in the future.

Geoengineering technologies can be divided into two categories: Solar Radiation Management (SRM) and Carbon Dioxide Removal (CDR). We will list the most unconventional solutions from both groups in this lesson (SRM in steps 1-3 and CDR in steps 4-5). You will be able to form your own opinion on geoengineering.

LEARNING OBJECTIVES

Print

This project is connected to the Sustainable Development Goals, especially goal 13.

By the end of this lesson, you will:
- Know what geoengineering is
- Be able to name different technological solutions for geoengineering
- Have formed your own opinion on geoengineering
- Be able to say which geoengineering techniques seem best (or least harmful) to you

By the end of this assignment, you will know the meaning of the following terms:
* Geoengineering and climate engineering
* SRM – Solar Radiation Management
* CRD – Carbon Dioxide Reduction
* Aerosol

Final product
The final product for this lesson is to write a **pitch to present and explain a new technological solution**. With this final assignment, you will show you have reached the learning goals.

Assessment
The final product will be graded by your teacher.

Your teacher will grade the assignment based on the following:
- **Content**: Is your pitch clear and convincing?
- **Form**: Did you take care to give your text the right layout?
- **Language mistakes**: Does your text contain the knowledge you gained from steps 1 – 5 and are there not too many language mistakes?

Group size
You will work by yourself for this lesson. You will do the final assignment in a group of three or four.

Time
This lesson will take two hours.

STEP 1: REFLECT SUNLIGHT

Print

There are different ways to reflect sunlight back into space. No matter how odd they may sound, they have all been seriously considered by geoengineers.

You could paint every roof and pavement white to increase the Earth's reflective ability. But even if you painted every roof in the world white, the effect would be minimal.

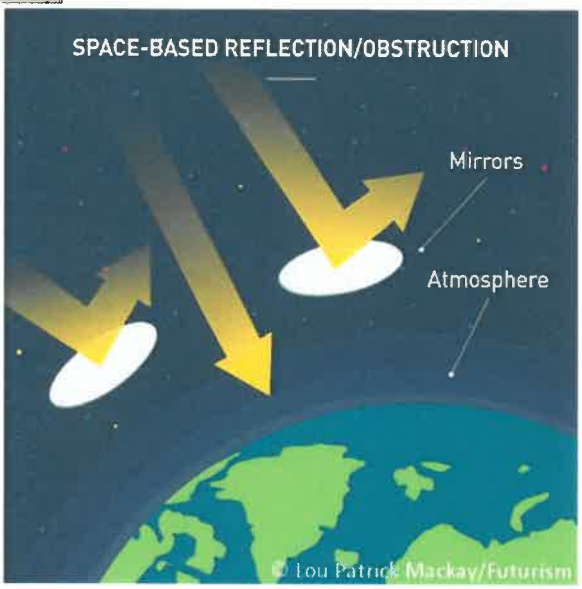
Test with white-painted roofs

Placing mirrors would have a bigger effect. This can be done in two different ways:

1) Sending sunshades into space and placing them between the sun and the Earth, to limit how much sunlight reaches the planet. To do this properly, you would need millions of well-placed screens. This is not only incredibly expensive, but also difficult to control. There is a high chance of a screen crashing into some space debris.

2) Placing mirrors in the desert. To compensate for the current amount of global warming, you would need 340,000 square kilometres of desert, which is a space eight times the size of the Netherlands. This would also be extremely expensive and it is uncertain whether we would have enough space to carry out this plan.

The idea of using mirrors is still in the planning stages.



Question
1) Name a geopolitical factor that would complicate the placement of mirrors.

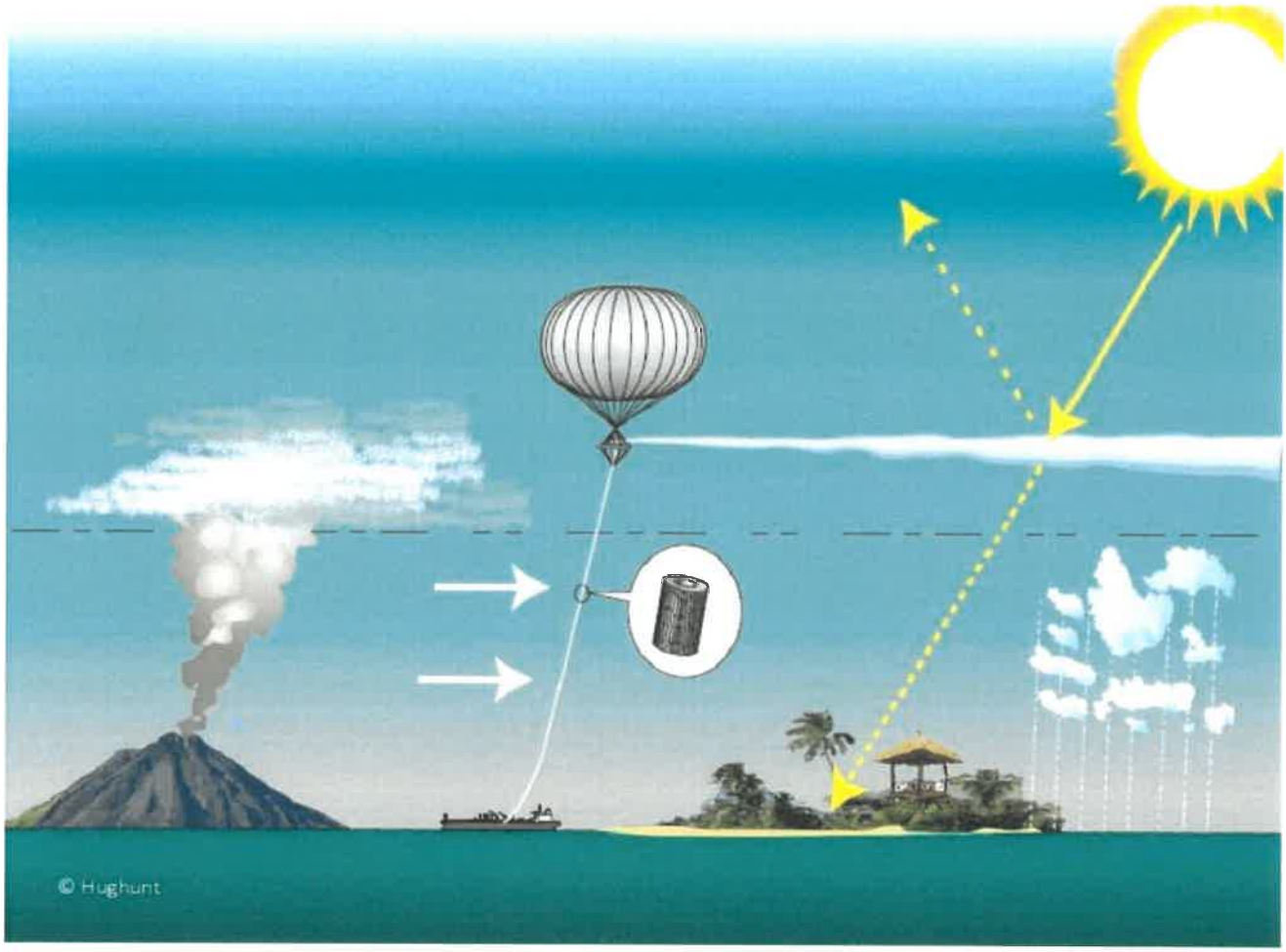
Step 2: Spray reflective particles into the air

Print

On April 2nd, 1991, the Mount Pinatubo volcano erupted and put so much sulphur into the air that the Earth saw a 10% decrease in sunlight, which caused the global temperature to get 0.7 °C/1.26°F lower. This gave scientists the idea to spray sulphur or other aerosols* into the air to mimic a volcanic eruption.

*Aerosol: an umbrella term for floating particles that can be found in the air. Aerosols can be natural (released after sandstorms, forest fires, or volcanic eruptions) as well as fabricated (emitted by factories or car exhausts).

The British SPICE project (Stratospheric Particle Injection for Climate Engineering) expanded on this idea. Scientists working on SPICE looked for the 'ideal particle' that would reflect the most sunlight.



SPICE wanted to test this by using balloons, rockets, or planes to inject sulphur into the atmosphere at a height of one kilometre, but environmental organisations protested. The tests were eventually cancelled.

The risk was judged to be too high. The consequences would have been very unpredictable and difficult to control. The eruption of the Mount Pinatubo volcano also showed the risks of blocking the sun. In the following years, the Sahel faced serious drought and hundreds of thousands of people died, while the Mississippi river saw more water than it could handle.

Question
2) Another reason not to go through with the test was related to the sea. What negative consequences could the test have had for the oceans?

STEP 3: MAKING THE CLOUDS WHITER

Print

"If you watch satellite footage of a boat sailing beneath the clouds, you can see the clouds are a little brighter there. This is because boats emit soot and other particles into the air, which attach themselves to water vapour. More soot means clouds get denser, which means they reflect more light," according to Herman Russchenberg (climate researcher at the Technical University of Delft).

People can reinforce clouds. One way to do this is to spray sea salt into the air. There is permanent cloud cover off the coast of Namibia and California, which would be a good place for this. NASA and billionaire Bill Gates have been working on this idea for ten years. The plan would require about 1,000 special boats.

Professor Russchenberg still issues a warning: "These experiments influence the weather all over the world and we don't know if the solution causes more problems than it solves."

Question
3) Which consequences could these experiments have on the weather?

Step 4: Iron fertilization of the oceans

Print

"Every year, 180 million tons of desert dust blows from the Sahara into the Atlantic Ocean. This has a big influence on sea life. Desert dust is not just sand, but also contains all kinds of nutrients and minerals that serve as a kind of fertiliser for life in the sea," says researcher Berend Jan Stuut from the Royal Netherlands Institute for Sea Research. "A good amount of dust will help plankton grow, which also benefits the fish."

But the organism that benefits most is the algae, which feeds on CO_2 and turns it into oxygen, just like plants do on land. All the iron in this sand, which blows into the ocean and stimulates the growth of algae, gave some scientists the following idea: throw a few tons of iron into the water and let the algae save the world.

In theory, algae would absorb CO_2 and then sink down to the bottom of the sea when they die. A company called Planktos had already started this iron fertilisation off the coast of Ecuador when Greenpeace stopped them.

Stuut explains the objections. "Algae only permanently capture CO_2 when they sink to the bottom after they die, but nature usually does not allow this to happen. Fish and other ocean life eat the algae, which puts the CO_2 back into the food chain, and eventually back into the air."

Question
4) Iron fertilisation could have an unintended negative side effect: dead zones in coastal waters. Explain how this would happen.

Step 5: Plant artificial trees

Print

You already know that plants and trees absorb CO_2 and turn it into oxygen. Deforestation means the Earth can no longer absorb as much CO_2. Extensive reforestation projects could be a solution. The BECCS project (Bio Energy With Carbon Capture Storage) can help. With BECCS, the CO_2 that is released when trees are felled and burned is captured before it can enter the atmosphere. Instead, it is turned into a liquid that gets stored somewhere deep in the earth. The felled trees can then be used as biomass for power plants.

There is just one problem: To compensate for the amount of CO_2 emitted in the Netherlands every year, we would need to plant 15 million hectares of trees, an area four times the size of the Netherlands.

Using BECCS worldwide would require a third of the total amount of fertile soil on the planet. There are not enough trees to do this and we cannot cut down all the trees we do have to store CO_2.

But what if we could make our own trees that can absorb a lot more CO_2 than real trees? This sounds like a wild idea, but that is exactly why professor Klaus Lackner from Arizona State University is developing artificial trees.

The professor has calculated that an artificial tree could absorb 33 times more CO_2 than a real tree and that 60 million artificial trees would be needed to absorb all the surplus. The CO_2 would be stored just like in the BECCS project. There are no big risks, but where would you put that many trees?

Question
5) Which disadvantages come with planting artificial trees, apart from the lack of space?

STEP 6: COVER GLACIERS WITH A BLANKET

Print

You have now been introduced to seven technological geoengineering projects.

1) Painting all the roofs and pavements white
2) Placing sunshields in space
3) Placing mirrors in the desert
4) Spraying aerosols into the air
5) Spraying salt water into the clouds
6) Fertilising the oceans with iron
7) Planting artificial trees

These seven solutions were explained in steps 1 through 5. Which solution do you think is best (or least harmful)?

There is one possible solution that has not been discussed yet:

8) Covering glaciers with a blanket

Work together in a small team to create a pitch* for this eighth solution. Imagine you are trying to find investors for your project. Use at least one key term from the core objectives.

*A pitch is a short but powerful presentation, in which you present your message in a few sentences

Good luck!

WHAT CAN YOUR SCHOOL DO?

Print

Everyone can contribute to stopping climate change, including your school. This lesson will discuss what teachers and pupils can do and will also take a look at the school building: How much energy does it use and what could be done to become more sustainable? To wrap up this lesson, you will investigate how environmentally friendly your school is. This will be done with a checklist.

LEARNING OBJECTIVES

Print

This project is connected to the Sustainable Development Goals, especially goals 13 and 4.

By the end of this lesson, you will:
- Be able to name some ways teachers and students can improve sustainability
- Be able to list examples of measures that schools have taken to be more environmentally friendly
- Know that measures to increase sustainability are more effective if pupils, teachers, and support staff all contribute
- Be able to judge how environmentally sustainable your own school is

By the end of this assignment, you will know the meaning of the following terms:
* Bike to Work Day
* Warm Sweater Day
* Energy Challenges
* Waste separation
* Environmentally friendly school

Final product
The final product for this lesson is to **investigate your own school with a checklist.** With this final assignment, you will show you have reached the learning goals.

Assessment
The final product will be graded by your teacher.

Your teacher will grade the assignment based on the following:
- **Content**: Was your research thorough?
- **Form**: Did you take care to give your text the right layout?
- **Language mistakes**: Does your text contain the knowledge you gained from steps 1 – 5 and are there not too many language mistakes?

Group size
You will work by yourself for this lesson. You will do the final assignment in a group of three or four.

Time
This lesson will take two to three hours.

STEP 1: PUPILS AND TEACHERS WILL GET TO WORK

Print

Every May, FiscFree organises the yearly Bike to Work Day. FiscFree asks people not to go to work by car, but to take their bike instead and support the environment. You could ask your teachers to come to work on their bike, or ask pupils who have a moped. Of course, it would be even better to use your bike every day!

Warm Sweater Day - join us!

Another easily accomplished initiative is Warm Sweater Day. Every year, people in the Netherlands reduce their energy consumption by turning down the thermostat and exchanging tips to save energy. Joining is easy: just turn down the heating, wear a warm sweater, and comfortably save 6% of your energy consumption and CO2 emissions for each degree. Ask your school to join!

Saint Joseph Technical College in Comines, Belgium combines theory and practice in the Soléole project. The pupils learn about climate change and alternative energy sources, while also building their own solar panels and wind turbine with their teachers. This also profits the school. Perhaps this might work for your school?

Translation of the title: The Technical College Saint Joseph in Comines is doing well!
Please note: the film is in Dutch; click here for a transcription in English.

Finally, we present the Energy Challenges: Smart With Energy at School. The Energy Challenges encourage secondary school pupils to set up their own sustainability campaign. Every school forms a team (pupils and teachers) of 'Energizers'. This team leads the school and their neighbourhood in becoming more sustainable. During the campaign, the teams will go out into the world of energy, technology, and sustainability.

Translation of the title: Energy Challenges - message to the young: will you participate?
Please note: the film is in Dutch; click here for a transcription in English.

Question
1) Design your own national day that helps to prevent climate change.

Step 2: Adjustments to and in the school building

Print

Just like any other building, your school requires resources and energy. This is preferably done in an environmentally friendly and climate friendly way. Being environmentally friendly is easier when the building is new, but old school buildings can also be adapted.

We will take a look at a few secondary schools that have taken measures to prevent climate change: the RSG N.O. Veluwe school in Epe, the Etty Hilversum Het Vlier school in Deventer, and Clusius College in Castricum and Alkmaar.

Top left: RSG N.O. Veluwe / Top right: Etty Hilversum Het Vlier
Bottom left: Clusius College Castricum / Clusius College Alkmaar

RSG N.O. Veluwe uses solar panels and a solar boiler.

Etty Hilversum Het Vlier has isolated the roof and walls and uses gas water pumps for cooling as well as heating the building. The school has automatic sunscreens that keep the school cool in summer.

Clusius College Castricum uses solar panels, heat-cold storage, and green roofing. A roof with succulents growing on it isolates and improves heat regulation. A green roof also stores water, which slows down the speed at which rain water is drained by 50%.

Both Etty Hilversum Het Vlier and Clusius College Alkmaar use energy-efficient lighting: movement sensors make sure that the lights are only on when a room is occupied.

Finally, there are the timed taps at Etty Hilversum Het Vlier. The water stops automatically after a few seconds, which means less water is wasted.

Question
2) Another measure to save energy is turning a tiled area into a green and blue schoolyard. Hoogheemraadschap in Delftland has set up a subsidy programme to help schools turn their schoolyards into an area with green (plants) and blue (water). How will this help the environment?

Step 3: Smart management of energy at school

Print

Making adaptations to the building is not the only way to increase the sustainability of your school. There are also things that pupils, teachers, and support staff can do themselves.

RSG N.O. Veluwe uses solar panels and a solar boiler to reduce their energy consumption, but they also saved a lot by being smarter about the way they used their central heating.

Just like most schools, RSG N.O. Veluwe used to turn off the heating in the afternoon and then turn it on again in the morning. Heating the building took a long time and a massive amount of energy. Head of technical services Jeroen Paas says: "It wasn't working. It was cold in the morning and then some rooms were too hot in the afternoon. That's why I started experimenting by keeping the heating turned on from Monday through Friday."

The effect was surprisingly positive. The temperature stayed constant and complaints about the heat or cold disappeared. On top of that, the boiler did not have to work as hard. At the end of the year, it turned out that the boiler had used 12.5% less gas than previous years.

The idea of constantly having the heating on low can be compared to 'the new style of driving'. A car that keeps braking and accelerating uses a lot more fuel than a car that drives calmly and constantly. The same is true for heating."

Most schools separate their waste, but Clusius College Castricum links their waste separation to recycling by composting their kitchen waste.

This is a regional school. Many pupils come to school by car or scooter. The school has set up a transportation system for pupils from the Zaan district. From December to the end of March, two buses drive back and forth between the train stations in the area and the school. Teacher Koen Glorie from the eco team at this school says: "Pupils can get on the bus here. They arrive at school more quickly, it saves fuel, and CO_2 emissions go down."

Question
3) The picture next to this question shows a waste separation system with three different bins: plastic cups (yellow), other plastic (orange), and other waste (grey). What other kinds of trash could you collect separately at your school?

STEP 4: CHECK YOUR OWN SCHOOL

Print

Using the checklist below, you will investigate how environmentally friendly and climate friendly your school is. You will form groups and go around the school to do this. You might not be allowed to go into every room. In that case, you can ask someone in charge of the school to answer these questions for your research.

CHECKLIST
Name of the school:
Address of the school:
Person responsible for maintenance:
Names of the pupils who completed the checklist:

The school uses:

- ○ Composting plant
- ○ Gas water pump
- ○ Insulation of roofs and facades
- ○ Cold-heat storage
- ○ Sedum roof
- ○ Cavity wall insulation
- ○ Water pump
- ○ Windmill
- ○ Solar water heater
- ○ Solar panels
- ○ (Automatic) blinds

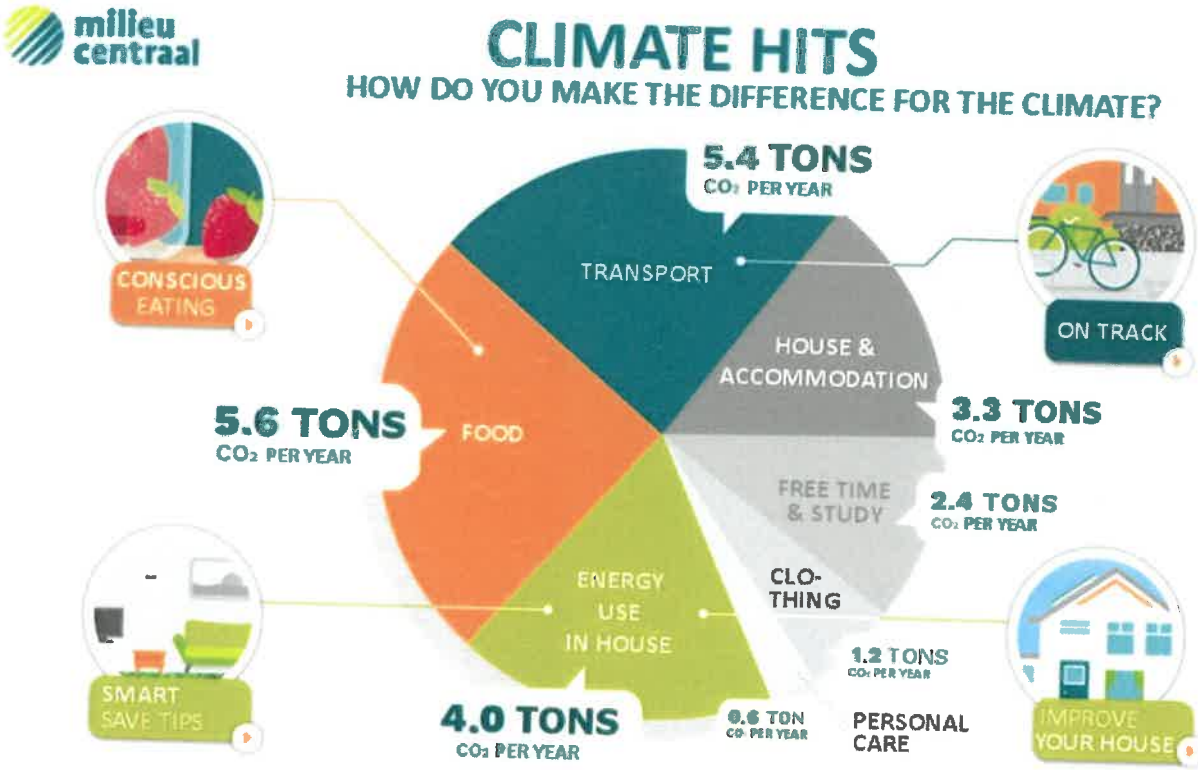
- ○ Other, mainly:

Existing	Missing	N.a.		
○	○	○	Heating	Are the radiators equipped with thermostatic valves?
○	○	○	Heating	Are the deviating days (special days like King's Day and Easter) tuned?
○	○	○	Boiler	Is the boiler a high-efficiency boiler?
○	○	○	Lighting	Is daylight being used via the roof?
○	○	○	Lighting	Are the light bulbs replaced with energy saving or LED lamps?
○	○	○	Lighting	Is energy-efficient lighting with motion sensors used?
○	○	○	Equipment	Is equipment like computers and candy machines switched off outside school hours?
○	○	○	Water	Are the valves equipped with a timer?
○	○	○	Waste	Is the waste separated?
○	○	○	Waste	Is plastic collected separately?
○	○	○	Waste	Are vegetable, fruit and garden waste collected separately?
○	○	○	Waste	Is the glass collected separately?
○	○	○	Waste	Are paper and cardboard collected separately?

What is the final result for your school? Are you working to protect the environment? Is there room for improvement?

Print

WHAT CAN YOU DO?



Everyone can contribute to the prevention of climate change, so you can help too. This lesson will help you see how climate friendly you are. How can you test your climate friendliness? This can be done with the **Environmental** or **Carbon Dioxide Footprint** test by WWF.

First, before you take the test, you will update your knowledge about CO_2 emissions in the Netherlands and look at the measures we can take to make the biggest climate impact.

LEARNING OBJECTIVES

Print

This project is connected to the Sustainable Development Goals, especially goal 13, but also goals 6, 7, and 12.

By the end of this lesson, you will:
- Know how much CO_2 is emitted in the Netherlands every year
- Know that Dutch people emit much more CO_2 than the average person on Earth
- Know which sector contributes most to climate change
- Be able to calculate whether the Netherlands will reach the climate goals or not
- Be able to list some climate tips and know the four main terrains on which the most CO_2 can be saved
- Know how climate friendly you are

By the end of this assignment, you will know the meaning of the following terms:
* Climate friendly
* CO_2 equivalent
* Climate law

Final product
The final product for this lesson is to **test how climate friendly you are**. With this final assignment, you will show you have reached the learning goals.

Assessment
The final product will be graded by your teacher.

Your teacher will grade the assignment based on the following:
- **Content**: Did you find out how environmentally friendly you are and how you can improve?
- **Form**: Did you take care to give your text the right layout?
- **Language mistakes**: Does your text contain the knowledge you gained from steps 1 – 4 and are there not too many language mistakes?

Group size
You will work by yourself for this lesson. You will do the final assignment alone too.

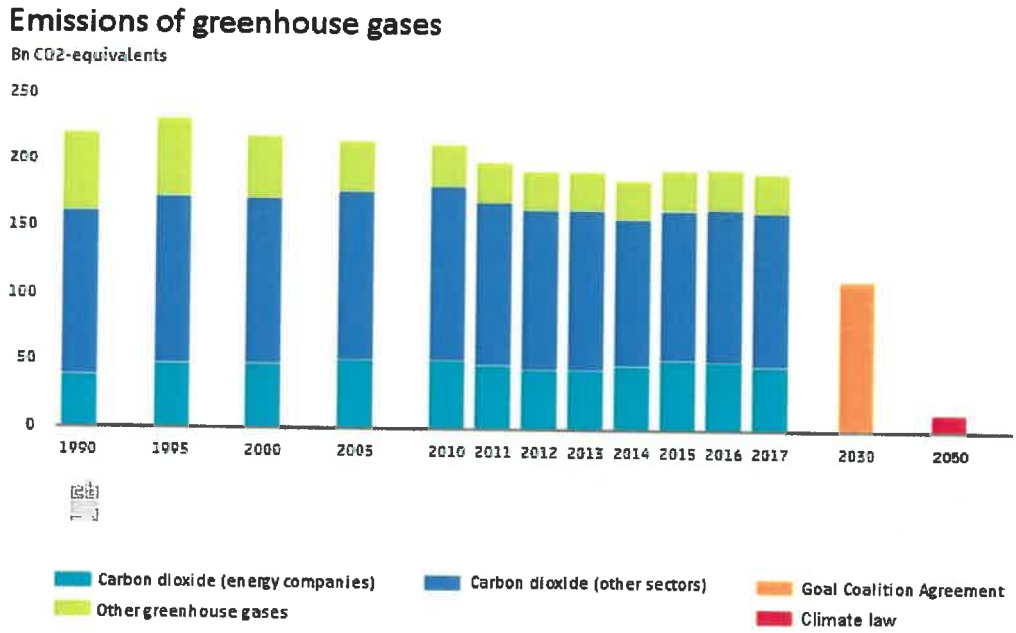
Time
This lesson will take two hours.

STEP 1: CO2 EMISSIONS FROM THE DUTCH

Print

The people of the Netherlands emit a little less than 200 billion tons of CO_2* every year. Dutch people are responsible for three times as much CO_2 as the average person on the planet. The average Dutch person emits 10,110 kg or 10.11 tons of CO_2 every year, while the world average is 3.4 tons of CO_2.

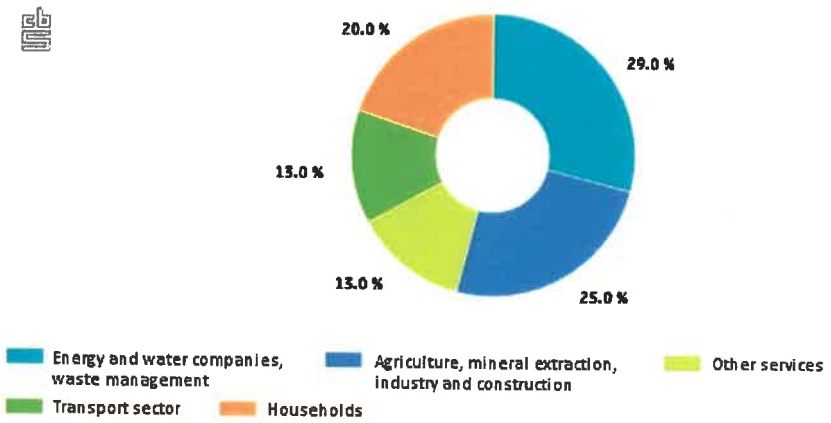
*CO_2 emissions are usually calculated in tons. (1 ton = 1,000 kg)



In 2017, 193 million tons of greenhouse gasses were emitted in the Netherlands. This is 13% lower than in 1990. According to the Government Agreement of October 10th 2017 (in line with the Paris Agreement), emissions in the Netherlands need to be 49% lower than they were in 1990 by 2030. The goal for 2030 is 113 million CO_2 equivalents (= all greenhouse gas emissions converted to CO_2).

In 2018, the Netherlands was the first country in the world that turned their climate agreements into a law: the Climate Law. According to this law, emissions need to be 95% lower by 2050, which is a little less than 10 million tons of CO_2 equivalents.

There is one sector that is responsible for most of this pollution: the energy companies, water companies, and waste management put together are responsible for 29% of all CO_2 emissions. Households are responsible for 20% of CO_2 emissions.



Since power plants started replacing coal with gas as their source of fuel, their greenhouse gas emissions have been decreasing. The household sector uses less gas to heat their homes, but people still use a lot of gasoline and diesel for transportation.

Question
1) According to the government agreement, CO2 emissions need to be decreased by 49% compared to 1990.
a) The reference point we have is 2017. At that point, emissions had decreased by 13% compared to 1990. How much did they decrease per year, on average, in this period?
b) When will we reach the goal of 49% if we continue at this pace?
c) How big should the yearly decrease be from now on if we want to reach this goal by 2030?

STEP 2: CLIMATE HITS

Print

CO_2 emissions in the Netherlands are much higher than the global average. Milieu Centraal is an environmental organisation that informs Dutch people on how to reduce their emissions.

Step 1 is becoming aware of the choices you can make to be more climate friendly. To do this, do the Climate Quiz by Milieu Centraal (a quiz in English with docx-files).

Go through the nine questions and discover how much you really know about the impact of your everyday choices on the climate. Are you a climate expert or do you still have a lot to learn?

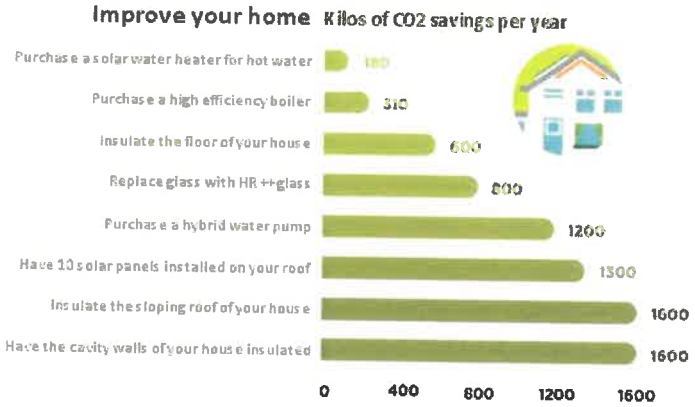
Step 2 lets you take a look at the climate friendly measures (which Milieu Centraal calls Climate Hits) you can take to reduce your carbon footprint.

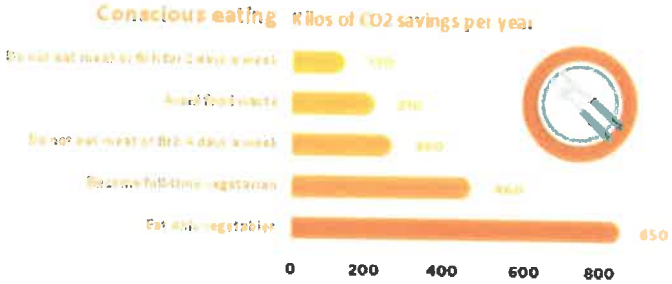
Translation of the title: Easy tips to save CO_2
Please note: the film is in Dutch; click here for a transcription in English.

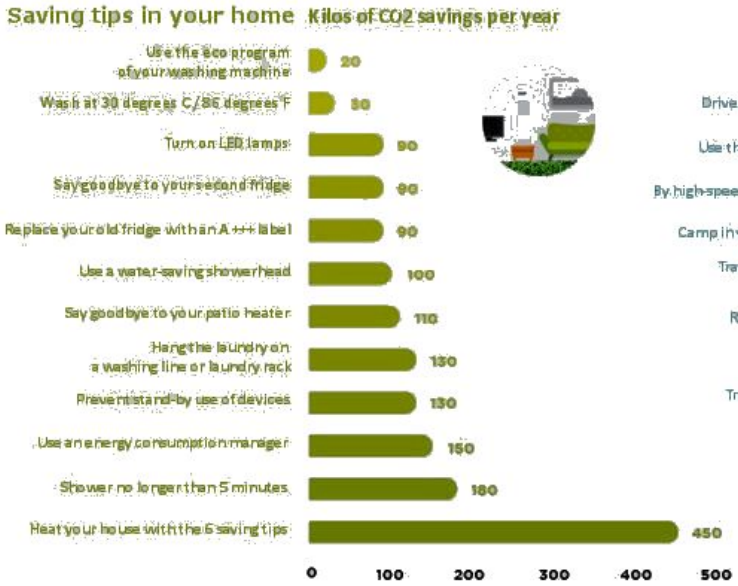
Taking the train to work or going on vacation closer to home? Eating less meat or putting solar panels on your roof? Milieu Centraal will calculate the effect of these measures on the size of your yearly CO_2 emissions. That way, you can see what has the biggest impact in your home, on your plate, and on the road. Milieu Centraal will give you tips to save CO_2 in four different areas:

* Improve your home
* Conscious eating
* Saving tips in your home
* On track

milieu centraal | CLIMATE HITS







Question

2) Which tips could you easily apply in your own life? Make a top 3.

STEP 3: DO YOU MAKE A DIFFERENCE FOR THE CLIMATE?

Print

Improve your home

Your home energy: efficient and comfortable

Conscious eating

Now you know what to buy and cook

Saving tips in your home

Make a big difference with small adjustments

On track

Save CO2 on the way from A to B

You know how many tons of CO_2 the average European emits. You also know which measures can be taken to limit CO_2 emissions. Now it's time to show how climate-friendly you really are in a WWF test.

Which (daily) choices do you make and how much CO_2 does this release per year?

Answer the questions about your energy usage, transport, clothing and food consumption and you will find out what you are doing right and how you can improve.

Some questions may not apply to you, like the question: "How many hours a week do you spend on the train or bus for personal use including commuting?". In that case, you fill in how the situation is at home.

It would be helpful to ask the following questions at home before you start the test:.

* In a typical month, how much do you spend on phone, internet and TV contracts?

* Is your electricity on a green tariff?

* Which of these home energy efficiency improvements are installed in your home?

P.S.: Some questions are about your budget for purchases; these questions are asked in pounds.
£ 10 ≈ € 11,40 / € 10 = £ 8,77

How well do you score?

GET STARTED NOW

Final assignment: a fun campaign? We can sponsor you!

Print

Are you a secondary school pupil in the Netherlands? Were you taught about climate change at school?

Do you have brilliant ideas for a fun campaign at school or in your town/city? Can you convince your classmates to join you?

Put your idea on paper (one page maximum) and ask your teacher to send your idea for a fun campaign to the Centrum voor Mondiaal Onderwijs. The European Union has a budget for their project *Get Up and Goals!* for campaigns to raise awareness of climate change set up by pupils (10 × €2,000) in the academic year 2018-2019 and 2019-2020.

Do not start your campaign immediately! Wait for our confirmation. Your school can earn a maximum of €2,000 for a report of your campaign that includes clear videos and/or photos.

Email: cmo@fm.ru.nl or call: 024-3615902.