



EDUCATIONAL ACTIVITIES



Understanding the greenhouse effect and its impact

- > 5th year Primary
- > 2nd year High school
- > Separable duration
- > Learning skill, introduction to science
- > English

The greenhouse effect is both a common and complex concept. Every day, the media reminds us of the need to change our behaviour... And yet, too few people change their habits! Perhaps it is a question firstly of understanding the basic concepts to facilitate this change. This section will help students to understand the greenhouse effect in order to understand its impact on our planet.

Learning and mobilisation activity

Activity menu

Stage 1: What is the greenhouse effect? Demonstrations (length+ -30')

Stage 2: What is the greenhouse effect? Experiments (length +1 period)

Stage 3: What is the mechanism of the greenhouse effect? (length + -30')

Stage 4: Documentary verification. 'C'est pas sorcier' [It's not rocket science!] (length +- 1 period)

A helping hand with methodology

If the adult's intention is to enable the pupils to understand the greenhouse effect (what, how...) before the exhibition: completion of Stages 1 to 4

If the adult's intention is to raise questions and motivate the pupils and to give the visit a purpose: Stages 3 and 4 can be carried out after the visit.

They can also be supplemented by the activity "The impact of climate change on my city."

LINKS WITH BELEXPO



Educational objectives

- Understanding the greenhouse effect
- To understand the impact of the increase in greenhouse gases
- Understand how the Earth's atmosphere works (greenhouse effect mechanism)
- To ask questions and start a project (if the intention is to mobilise the students)

LINKS WITH THE REFERENCE SYSTEM

- **Learning skill - introduction to science**
- Discover and grasp a complex reality: identify clues and explore research options that are appropriate for the situation
- Investigate research options:
- Collect information via experimental research and observation

Available Material

- Teacher's sheets 1 and 2
- Pupils' sheet

Requirements

For Stages 2 and 3

- 1 suspended heating lamp (e.g. 150W halogen spotlight); it is also possible to use direct sunlight (very good radiance is required on the day of the experiment)
- 2 polystyrene boxes of identical dimensions without lids (+- 20 x 15 cm) de +- 10 cm high
- 1 transparent Plexiglas plate, which can completely cover on of the two boxes
- 11 large glass bowl or other transparent object that can completely cover one of the boxes and the cover provided



- Collect information using documentary research
- Structure results, communicate them, validate and summarize them
- Energy: distinction between heat and temperature
- Air: air, the gaseous substance that surrounds us and whose movement we perceive
- People and the environment

DID YOU KNOW?

Greenhouse effect: a natural phenomenon that traps heat on the Earth's surface. This is made possible by the greenhouse gases in the atmosphere that retain heat. They act as an «insulating layer» around the Earth. The classroom windows and the gardener's greenhouse, like the greenhouse gases, prevent the heat from the sun's rays from escaping.

DID YOU KNOW?

The emissions of the 4 main greenhouse gases are:

- 76 % carbon dioxide
- 16 % methane
- 6 % NO_x
- 2 % fluorinated gases (CFCs)

Source : IPCC 5th report

- 2 identical thermometers

For Stage 4

- DVD of the programme C'est pas sorcier - the greenhouse effect or the official YouTube channel C'est pas sorcier: www.youtube.com/watch?v=KZbcAylQzkl
- Depending on the way the class is run, the support used to structure the knowledge discovered during a learning sequence (mind map, summary booklet, etc.)

Procedure

Introduction

- Context: « An upcoming visit to Missions BELEXPO, an exhibition designed to raise questions and understand climate and environmental issues to improve the city of tomorrow and the lives of its inhabitants. »
- Announcement of the objectives of the session:
- To jointly answer 2 priority questions:
 - «What is the greenhouse effect? «
 - « What does the greenhouse effect look like? «

Identify all the other questions the group has about the greenhouse effect?

- Announce the Activity Menu (see Activity Menu).

Stage 1: What is the greenhouse effect? Demonstrations

The teacher asks the pupils about the meaning of this term which is often mentioned: «the greenhouse effect» All the answers are written on the board so that they can be returned to at the end of Stage 2.

A helping hand with methodology

- If some answers are related to the temperature on earth or the sun...
- To stimulate reflection: ask the pupils about:
 - when it is hottest in the classroom,
 - What do we do when the sun shines through the windows and it is too hot in the room?
 - => We open the window to ventilate.
- If the pupils do not make a link with the temperature or the sun, if the «greenhouse effect» does not mean anything to them...
- To stimulate reflection: ask the pupils what the word «greenhouse» might make them think of, what is a greenhouse in a garden, what links might there be with the greenhouse effect...

Stage 2: What is the greenhouse effect? Experiments

2.1. Observation of the phenomenon

The teacher conducts an initial experiment in front of the pupils. The pupils observe what happens in order to help them answer the first question «What is the greenhouse effect? «

Experiment:

2 identical boxes are placed side by side under a halogen lamp, or directly in the sun

(if there is enough sunlight). A thermometer is placed in each box. Then a plexiglass is placed on just one of the boxes.

Result 1:

The temperature of the covered box is higher than that of the other box. The heat remains well trapped inside the box by a layer of Plexiglas. This is called the greenhouse effect. The Plexiglas represents the layer of greenhouse gases in the atmosphere.

2.2. Initial response

- The class pools its observations and compares them with the initial group presentations: additions, modifications. The contributions are added to the board.
- In sub-groups, the pupils formulate a definition of the greenhouse effect: «For us, the greenhouse effect is...».
- The sub-groups share their definitions. These will be revisited in Stage 4. The teacher keeps a record of the groups' proposals.

A helping hand with methodology

For younger students whose knowledge of the atmosphere is not yet very well developed, skip Stage 3. The knowledge associated with this stage will be covered by the resource in Stage 4 anyway.

Instead, take time to record any questions students have about the greenhouse effect and what they observed in the experiment.

Stage 3: How does the greenhouse effect materialise?

3.1. What is the consequence of the increase in greenhouse gases?

Hypotheses and observation of the phenomenon

- The teacher asks the students:
 - what would happen if the amount of greenhouse gases increased,
 - what would need to be changed in the original experiment to be able to test their assumptions.

The students' ideas are noted on the board.

- The teacher carries out the proposals put forward by the pupils to check their assumptions.

Minor experiment: Add a 2nd transparent container (large glass or Plexiglas bowl) on top of the box that has already been covered. Read the temperature at different intervals..

Result 2:

As the greenhouse effect increases, the temperature increases.

3.2. Pooling of observations and comparison with the initial assumptions.

The teacher completes, adds to and modifies the pupils' hypotheses according to their responses.

3.3. How does the greenhouse effect occur? Assumptions

- The teacher informs the students that without the greenhouse effect, the average temperature on Earth would be -18°C... which is not the case!
- The teacher asks the students:
 - But why should our planet experience this greenhouse effect when it has no glass/Plexiglas around it?
 - What could be playing the rôle of this glass/Plexiglas?
- The teacher writes the responses on the board. All these responses will be reviewed in Stage 4.

3.4. Initial response

- In sub-groups, based on the previous ideas and observations the students formulate a reply to the question “How can the greenhouse effect be seen?”
- The groups pool their answers. These will be reviewed at Stage 4. The teacher keeps a record of the group proposals.

Stage 4: Documentary audit

4.1.: Contextualisation

- Reminder of the sub-group responses to the two key questions “What is the greenhouse effect? How can it be seen?”
- Statement of the main aim: to obtain information thanks to the discovery of a report by C’est pas sorcier in order to validate the responses of the sub-groups.

A helping hand with methodology

If the students have participated in BELEXPO in the meantime: review the 2 central questions and the ones formulated by the students in the introduction to identify what the students know more about today.

4.2. Documentary *C’est pas Sorcier - The Greenhouse effect, heatwaves on the planet*

The documentary can be viewed, amongst other possibilities, on the official YouTube channel of C’est pas sorcier www.youtube.com/watch?v=KZbcAyIQzkl or can be borrowed as a DVD at the Point Culture.

..... DID YOU KNOW ?

Very often, students confuse the notion of «greenhouse gases» with that of «ozone». It is interesting to differentiate them (see Teacher’s Sheet 1).

- The pupils discover the questionnaire to be completed during the broadcast of the report. The teacher ensures that the pupils understand the text. The questionnaire allows the pupils to follow and understand the narrative of the report. Each question targets information essential to understanding the phenomenon.
- First broadcast of the whole sequence. At the end of the broadcast, each student reviews the questionnaire and assesses the number of answers they can already give.
- Second broadcast with pauses. Students who wish to may take notes.
- Completing the questionnaire in sub-groups.
- Pooling of answers and corrections with the whole class.

A helping hand with methodology

The programme is divided into several sequences grouped into three parts. If you

are doing this Stage 4 before visiting the exhibition, we advise you to use only the first part, up to 11'18:

1. The greenhouse effect: a natural phenomenon that man disturbs!

- The greenhouse effect a natural phenomenon
- Climate history: it changes!
- Carbon dioxide
- The other greenhouse gases

2. The climate is warming! What are the consequences for the planet?

3. How can the damage be limited? Reducing pollution is not rocket science!

The second part deals with global warming and the recent COP21 in Paris (Nov. 2015) has defined a new approach. It seems more relevant to ask the pupils about the consequences of a rise in temperature and to look for answers and possible actions in the exhibition (or to use the content discovered during the visit). The activity "The impact of climate change" will also allow us to continue thinking about the consequences of a rise in temperature.

4.3. Organisation

According to current practice in their class, the teacher takes time to allow their pupils to organise the new knowledge individually and collectively and to take a step back in relation to this knowledge and the way in which they have learned it.

"What have we learned? Why? How?"

The teacher also takes the opportunity to:

- look back at the original perceptions and assumptions and identify how they have changed,
- take stock of the additional questions students had and check that they were all answered.



TEACHERS' SHEET 1



Learning all about the greenhouse effect Theoretical benchmarks

The greenhouse gas layer is a kind of blanket around the Earth. If we didn't have one, we would be very cold. If the blanket is too thick, we become too hot!

The understanding of the greenhouse effect mechanism takes place in 3 stages. Each of these 3 stages can be summarised as follows.

1. The Earth without any atmosphere

If the Earth were a planet with no atmosphere (no gas around it), the temperature would be about -18°C . The sun's rays would heat the Earth and it, like any warm body, would emit heat radiation (infrared). All this heat would be lost to space, so life as we know it could not develop on Earth.

To go further: The greenhouse gas layer is located only in the first layer of our atmosphere, the troposphere, up to +10 km in altitude. It is at the limit of this layer (the tropopause) that aircraft fly, because the winds are more stable there.

2. The atmospheric layer around the Earth

Fortunately, there are naturally occurring gases that form the atmosphere. These gases have an extraordinary function. They have the capacity to store the heat rays emitted by the Earth. Thanks to them, the Earth's average temperature is about 15°C , which allows us to have the climate we know today.

Further information: How does it work? Depending on their composition, these gases will retain more or less heat (this is their radiative power), for a longer or shorter period of time (life span). We can use the following metaphor with the students: each gas molecule has a backpack of varying size in which it stores this heat. But it will only be able to carry this backpack for a certain period of time. For example, CO_2 will store a little heat, but for almost 125 years! Whereas nitrogen oxides (NO_2 for example) will store 310 times more heat, but only for 12 years! The greenhouse effect of a gas therefore depends on 3 parameters: its concentration (the number of molecules), its radiative power (its capacity to retain heat) and its life span.

3. The thickness of the greenhouse gas layer

For more than 100 years, we have been discovering that there are many sources of energy under the Earth that can be used very easily. Which ones? Coal, gas, oil. We don't have to wait for wind to turn our turbines. But what we did not foresee is that when this energy is used (burnt), it emits many greenhouse gases... And we use a lot of it, sometimes without even knowing it (electricity, travel, heating the house or water, etc.). We have thus enormously increased the concentration (the number of molecules) of greenhouse gases in the atmosphere. And if the concentration of



greenhouse gases increases, so does its impact. So it is already warmer on average on Earth. Scientists agree that the temperature will increase by 1 to 6°C.

For more information: Fossil fuels (also called hydrocarbons: hydrogen and carbon) are the result of a very slow process of fossilisation of organic matter.

They are a reservoir of chemical energy. But to use the energy of hydrocarbons, they must be burned.

The energy is then used in the form of heat, while the hydrocarbon is transformed into CO₂... which is then released into the atmosphere (+ H₂O in the form of water vapour).

AND WHAT ABOUT OZONE IN ALL OF THIS?

The ozone layer is a completely different layer. It is located in the upper layer (the stratosphere) above the layer of greenhouse gases (the troposphere). The stratosphere covers an area between 10 km and 50 km in altitude..

This layer of gas, made up of 3 oxygen atoms (O₃), has an essential function for life on Earth: it filters out the most harmful solar rays (ultraviolet C and B rays capable of altering or destroying DNA). Without this ozone layer, life on Earth as we know it would simply not be possible.

The ozone layer is like the Earth's sunglasses. If there are small holes... it becomes very dangerous!

Beware, the presence of ozone at low altitude (peak ozone) is absolutely not natural. It is the result of pollution (mainly from cars) which has allowed the production of ozone (under the effect of sunlight). Ozone is a gas that is a health hazard and irritates the respiratory tract.

Ozone is a pale blue gas. It is the gas that gives the sky its beautiful colour.

A helping hand with methodology

The content of this document could also be used to structure the students' knowledge at the end of the sequence. In this case, the teacher could associate a schematic representation with each stage.

The teacher draws a large Earth on the board and sketches the continents very roughly. The teacher then uses yellow to symbolise the sun's rays reaching the Earth and red to symbolise the heat rays emitted by the Earth. The atmosphere will be represented by a circle of white chalk.



TEACHERS' SHEET 2



The greenhouse effect, it's not rocket science!

Video segmentation and corrections

The greenhouse effect, it's not rocket science!

- [1'10"] What temperature would it be on the earth if there were no greenhouse effect? A: 18 °C
- [2'25"] The sun sends rays to the Earth. These are ultraviolet (the famous UV), infrared and visible rays. Once these rays have warmed up the Earth, it in turn sends rays back into space. It is these rays that warm the atmosphere. What kind of rays are we talking about? B: *infrared rays*
- [3'25"] The climate has always varied over time, from ice ages to interglacial ones. For the past 13,000 years or so, what type of era are we in? B: *an interglacial era that is warmer*
- [4'20"] Scientists have studied the glaciers of Antarctica (South Pole) and have taken ice core samples. This makes it possible to study the different layers of ice, from the oldest to the most recent. How old are the oldest layers? B: *400,000 years old*
- Analysis of air bubbles trapped in the ice has shown that the concentration of CO₂ trapped in the ice is related to the temperature of the atmosphere. However, the temperature of the atmosphere A: *has drastically increased over the last century*
- [4'45"] Carbonic gas (CO₂ or carbon dioxide) is partially absorbed by the oceans and by... C: *the photosynthesis of living organisms*
- [5'18"] The production and absorption of CO₂ by nature are normally equal. In this state of equilibrium, the atmosphere contains 585 billion tons (gigatons) of CO₂. However, for several decades this amount has been steadily increasing by... B: *3.5 billion tons per year*
- [7'43"] Since 1850, the earth's temperature has risen by... C: *0.6 °C*
- [8'22"] Rich countries are responsible for the largest share of greenhouse gas emissions. These emissions are mainly due to energy production. Together, rich countries are responsible for... C: *60% of all global emissions*
- [9'02"] There are several greenhouse gases. Link each greenhouse gas with its «lifetime» (left-hand column), i.e. the time it remains active in the atmosphere and acts as a greenhouse gas.
120 years -> nitrous oxide
12 years -> methane
50,000 years -> CFC
100 years -> carbon dioxide

Then link it with the sources that produce it.

Carbon dioxide -> forest, car, plane, factory

CFC -> fridge, aerosols

Methane -> forest, cow

nitrous oxide -> forest, sea, countryside



STUDENTS' SHEET



The greenhouse effect, it's not rocket science!

Questionnaire

I. The greenhouse effect, a natural phenomenon

- 1 What temperature would it be on the Earth if there were no greenhouse effect?
 - A -18 °C
 - B 0 °C
 - C 15 °C
- 2 The sun sends rays to the Earth. These are ultraviolet (the famous UV), infrared and visible rays. Once these rays have warmed up the Earth, it in turn sends rays back into space. It is these rays that warm the atmosphere. What kind of rays are we talking about?
 - A x-rays
 - B infrared rays
 - C cosmic rays
- 3 The climate has always varied over time, from ice ages to interglacial ones. For the past 13,000 years or so, what type of era are we in?
 - A a glacial era
 - B an interglacial era, which is warmer
 - C a period of mini-glaciation, as regularly occurs during interglacial eras

II. Climate history: it changes

- 4 Scientists have studied the glaciers of Antarctica (South Pole) and have taken ice core samples. This makes it possible to study the different layers of ice, from the oldest to the most recent. How old are the oldest layers?
 - A 40,000,000 years old
 - B 400,000 years old
 - C 40 years old
- 5 Analysis of air bubbles trapped in the ice has shown that the concentration of CO₂ trapped in the ice is related to the temperature of the atmosphere. However, the temperature of the atmosphere ...
 - A has drastically increased over the last century
 - B has strongly diminished over the last century
 - C has virtually not changed



III. Carbonic gas

- 6 Carbonic gas (CO₂ or carbon dioxide) is partially absorbed by the oceans and by ...
- A the transpiration of living organisms
 - B factories
 - C the photosynthesis of living organisms
- 7 The production and absorption of CO₂ by nature are normally equal. In this state of equilibrium, the atmosphere contains 585 billion tons (gigatons) of CO₂. However, for several decades this amount has been steadily increasing by...
- A 7 billion tons per year
 - B 3.5 billion tons per year
 - C 100 tons per year
- 8 Since 1850, the earth's temperature has risen by...
- A 3 °C
 - B 1 °C
 - C 0,6 °C
- 9 Rich countries are responsible for the largest share of greenhouse gas emissions. These emissions are mainly due to energy production. Together, rich countries are responsible for ...
- A 20 % of all global emissions
 - B 90 % of all global emissions
 - C 60 % of all global emissions

IV. Greenhouse gases

- 10 There are several greenhouse gases. Link each greenhouse gas with its «lifetime» (left-hand column), i.e. the time it remains active in the atmosphere and acts as a greenhouse gas.

<u>Lifetime</u>		<u>Greenhouse gases</u>
120 years	<input type="checkbox"/>	<input type="checkbox"/> carbonic gas
12 years	<input type="checkbox"/>	<input type="checkbox"/> CFCs
50 000 years	<input type="checkbox"/>	<input type="checkbox"/> nitrous oxide
100 years	<input type="checkbox"/>	<input type="checkbox"/> methane

Next, link them with the sources that produce them:

Carbonic gas

CFCs

Methane

Nitrous oxide

