Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

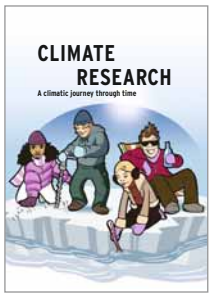
CLIMATE PROTECTION AND CLIMATE POLICY

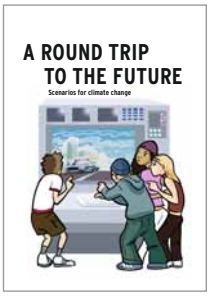
EDUCATIONAL AND INFORMATION MATERIALS

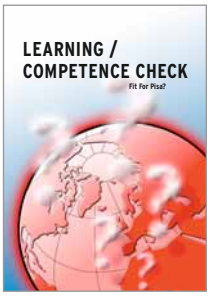
Note: This material was originally published in German and was designed for lessons for 12-16 year old pupils in Germany. It may therefore be necessary in some cases to adapt the worksheets to the situation in the countries where the material is to be used. To this end, the material is available for download free-of-charge on the Federal Environment Ministry's website at www.bmu.de/bildungsservice.

IMPRINT

Published by:	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) Public Relations Division · 11055 Berlin · Germany E-mail: service@bmu.bund.de · Website: www.bmu.de/english
Text:	Peter Wiedemann, Sabine Preußer, Ulrich Böhme
Editors:	Dr. Korinna Schack, Achim Schreier Division ZG II 1 (BMU) Frank J. Richter, Zeitbild Verlag und Agentur für Kommunikation GmbH
Academic Advisers:	Prof. Dr. Gerhard de Haan, Free University of Berlin, Department of Educational Science and Psychology, Educational Future Science Section Dr. Gerhard Petschel-Held, Potsdam Institute for Climate Impact Research (PIK) Georg Eckert Institute for International Textbook Research
Design:	Zeitbild Verlag und Agentur für Kommunikation GmbH, Berlin
Printing:	Bonifatius GmbH, Paderborn
Illustrations:	Zeitbild / Oedekoven
Date:	July 2008
First Print:	2.000 copies



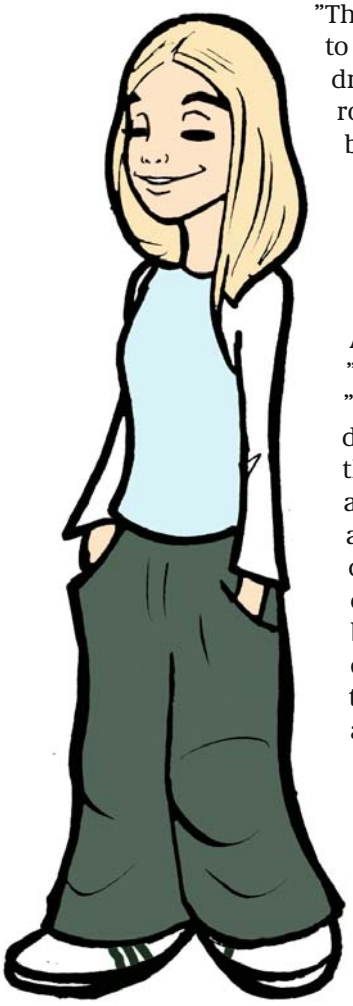




CLIMATE RESEARCH

A climatic journey through time

WEATHER OR CLIMATE?



”That’s pretty long, Viona!“ grins Manuel. ”What on earth are you planning to do with it?“ Viona refuses to be goaded. ”It’s an ice core.“ She continues drawing coloured rings on the ”thing“, which is about as long as the classroom itself. ”Rubbish,“ interrupts Aysche, having felt it. ”It’s only cardboard!“ ”Well it is only a model,“ retorts Viona.

Patiently she draws ring after ring. Manuel finds it boring. He looks across at Felix, but he’s busy too. He’s cutting up sheets of cardboard to make little cards. ”Did I miss something on Blue Peter?“ Manuel asks. Felix just nods and hands him a pair of scissors. But Manual can’t be bothered.

A short while later, Manuel is standing at the window next to Aysche. ”What a climate!“ he moans. The rain is pelting against the window. ”Weather, dear,“ corrects Aysche, ”Weather“. ”But it’s been like this for days,“ he counters. ”It’s over a week now!“ ”A longer period means more than a few days - at least thirty years to be precise.“ ”Well what’s weather as compared to climate, you walking encyclopaedia?“ asks Manuel. Aysche answers as though she’s been rehearsing it, ”Weather is the current status quo. We can measure it. The temperature, for example, wind speed and direction, rainfall and number of hours of sunshine.“ She draws a deep breath, which gives Manuel the chance to slip in another question. ”And climate? Can’t we measure it?“ Aysche gives the matter some consideration. But Viona has been listening to the pair of them and knows the answer. ”Climate is calculated. On the basis of weather data. Some people say that climate is the weather statistics.“

”Is climate always the same?“ asks Manuel, and looks at Aysche. ”Normally it changes over a period of hundreds or thousands of years,“ she explains. ”Exactly,“ adds Viona, ”during ice ages it gets very very cold.“ ”I am impressed,“ says Manuel, grinning, ”But how can we know what the climate used to be like? A really long time ago, I mean, before there were any written records?“ ”But maybe records were still kept,“ says Viona mysteriously, and draws the last ring on the cardboard pipe.

EXERCISES:

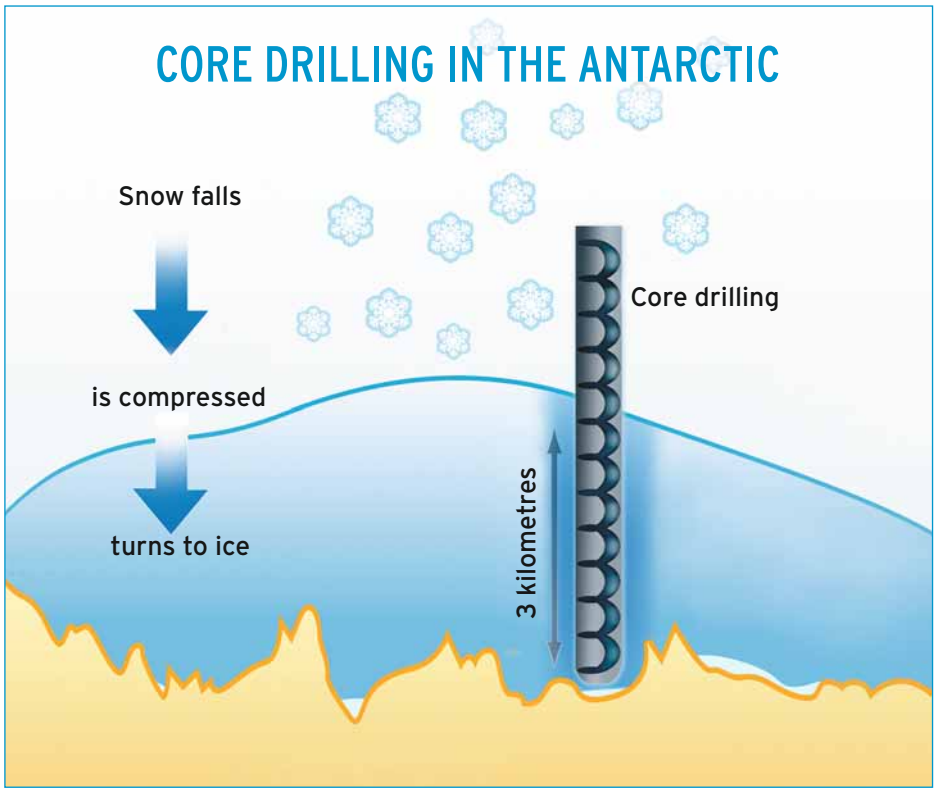
1. *What is the ice core? Use the following information sheet and gather additional information from books, journals and the Internet. Record what you find, and put all your information into your folders.*
2. *Put together everything you know about ice ages and interglacial periods. What were the consequences of the ice ages for life on Earth?*
3. *Present your results to the class and compare results.*

HOW DO WE KNOW WHAT THE CLIMATE USED TO BE LIKE?

You can find clues from the past on practically every larger building site. If a new basement garage is being built in your town, for instance, archaeologists will be accompanying the excavators. They will be looking to see if they can find any artefacts from the past 500 to 1,000 years. These could be earthenware jugs, items of jewellery or bones. If you want to take a look at the past, you have to dig deep. The annual growth rings of coral and trees also provide us with information.

When we talk about the climate, we need to look at entirely different time-scale. The principle remains the same though. In 2004, for instance, a 340 metre deep hole was drilled in the bed of the Arctic Ocean. The core revealed a wealth of information about the climate over the last 55 million years.

Core drilling directly into the "permanent ice" taps straight into a reliable database. The ice cap at the South Pole is more than 400,000 years old. That's not a million years, but every layer consists of the same material – snow.



You can read off important information almost like reading a scale. Was it warmer or cooler than today when the snow fell? How much carbon dioxide (CO_2) was in the air? Were there volcanic eruptions? Temperature differences can even be measured directly. Small air bubbles tell us about the concentration of CO_2 in the air. The thickness of the individual annual layers allows us to work out whether it snowed a little or a lot. Volcanic eruptions leave behind thin layers of dust in the ice.

Scientists have to calculate most other figures using complicated formulae. If you want to ascertain the age of the ice at a certain depth, you must, for instance, take into account the fact that the layers at the bottom are compressed by the huge weight above them. At a depth of 30 metres, one metre corresponds to a period of thirty years. At a depth of 3,000 metres the same thickness corresponds to a period of 270 years.

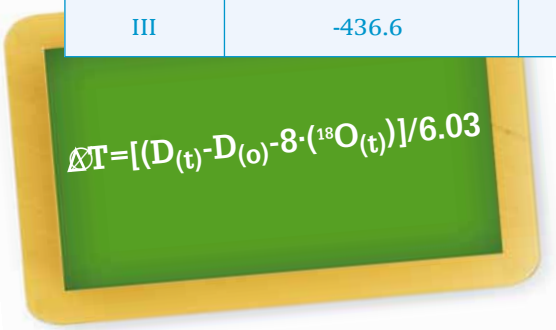
The question as to whether the air was warmer or cooler than today is very important. This information is provided by the concentrations of a special form of oxygen, the oxygen isotope oxygen-18 (18O), and of what we call heavy hydrogen, also known as deuterium. A lower concentration of 18O, indicates that temperatures were higher.

ANALYSING AN ICE CORE

Viona, Aysche, Manuel and Felix contemplate the cardboard pipe, adorned with a series of rings. Felix made the model of an ice core. "Now you all know what the core is about," he noted. "Let's look at a concrete example. This is the ice core "Vostok" drilled in the Antarctic. At the bottom of the core, the ice was about 420,000 years old." All four look reverently at the lower end of the core.

On the blackboard Felix has drawn a table and entered some figures. "And, what's that?" Aysche wants to know. "These are some of the figures from the core," explains Felix, "The percentage of heavy hydrogen or deuterium as it is also known and of the oxygen-18 isotope." Viona realises that one column is empty. Felix explains that that is the column for temperatures. "What it warmer or cooler than today at the altitude at which snow clouds formed?"

Timescale (t)	Concentration of deuterium (D)	Concentration of oxygen-18 isotope (18O)	Temperature (Kelvin)
0	-438.0	0	0
I	-488.3	0.790212	
II	-416.6	0.240387	
III	-436.6	0.001637	



"And how can you calculate that?" asks Manuel. "Arithmetic!" they all answer in unison. Felix has already put the formula on the board. He didn't work it out himself, of course. He found it in a science book.

EXERCISES:

1. *Get together in your group and consider how to use the formula. Calculate the temperature differences as compared to today (timescale 0)! Enter your results in the "Temperature" column of the table.*
2. *Devise an appropriate graph and plot the four figures.*
3. *Look at the curve and try to interpret the trends in temperature change. What could have caused these changes? Discuss your ideas.*

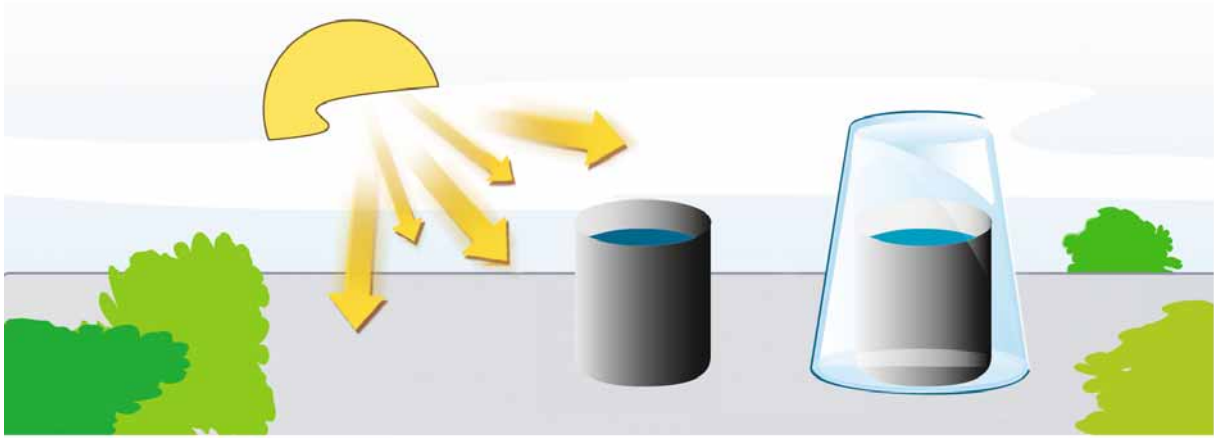
THE GREENHOUSE EFFECT

”Why do you keep going on about these greenhouse gases?“ Viona asks Felix. ”Do greenhouses have special gases?“ ”Yes, when you let your tomatoes rot,“ Manuel teases her. ”Well, you’re not that far wrong actually,“ says Felix. ”When plants rot, they release CO_2. But that’s not ..“ Aysche interrupts him, ”But the question is, why do tomatoes or lettuce ripen faster in a greenhouse? Although it’s still cold outside.“ ”What a stupid question,“ giggles Viona. ”Because it’s warmer in the greenhouse of course.“

But why? Investigate the issue. Collect:

- Two black 35 mm film containers filled with water, without a lid
- One thermometer;
- One water glass which you should place over one of the two film containers.

Use the thermometer to measure the temperature in both film containers every three to five minutes, and enter the temperature in the table. Caution: The water can get really hot.



Time	Temperature in container 1 (°C)	Temperature in container 2 (°C)

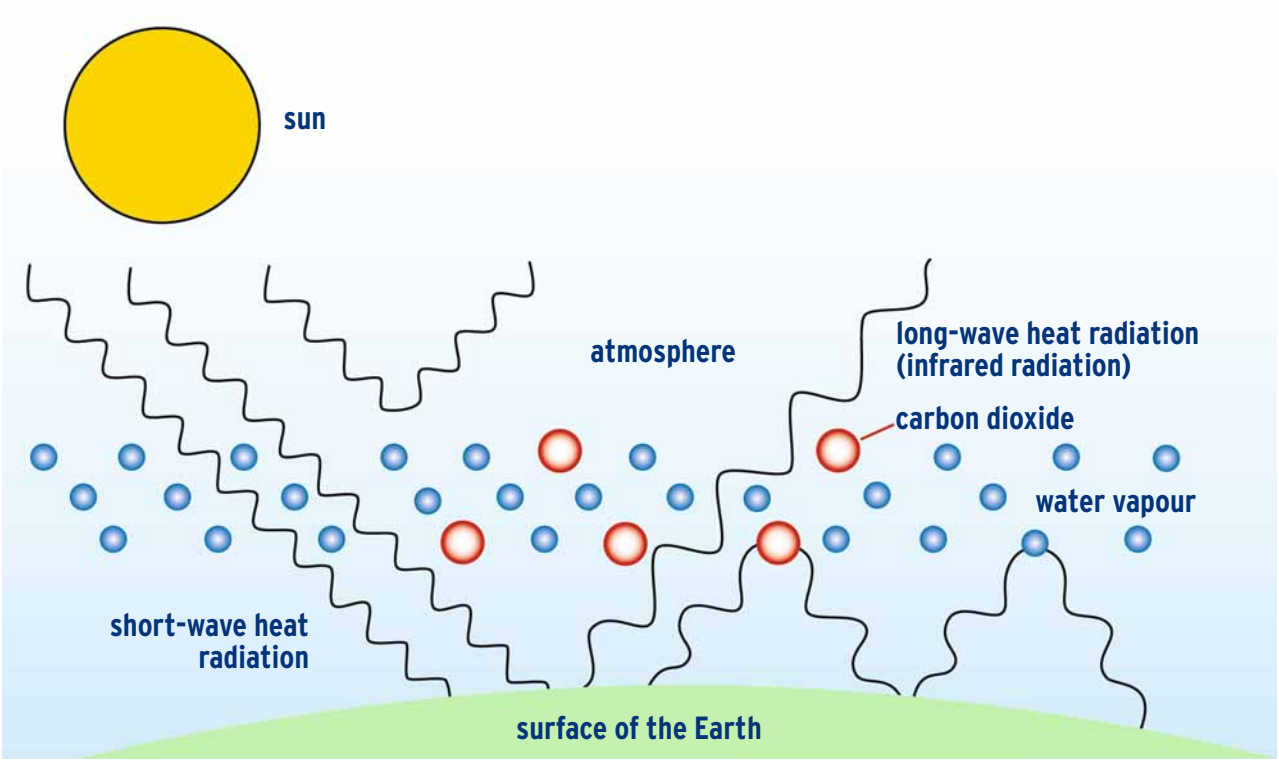
EXERCISES:

1. *Consider why the water is warmer in one film container than in the other. Write down your ideas.*
2. *There is a greenhouse effect in the atmosphere of the Earth too. What causes it? After all the Earth is not a crystal ball. Gather information, consult books and look on the Internet.*
3. *Why is the natural greenhouse effect important for life on Earth? What would happen if it didn’t exist? Find at least three answers.*

THE GREENHOUSE EFFECT

Of course the Earth is not a greenhouse, but there must be something that keeps temperature on Earth within a range which makes life possible. Just like a greenhouse. After all, in space the temperature is -273°C, whereas the lowest natural temperature ever recorded on Earth was about -90°C. What protects us from the cold? Mainly it is the atmosphere. The Earth's atmosphere consists of gases, which surround the Earth like a protective blanket, keeping in the heat. We call these gases greenhouse gases because they have the same sort of effect as the glass roof of a greenhouse. They allow the heat radiation from the sun to pass through towards Earth but they prevent the surface of the Earth from reflecting the heat back out into space.

The most abundant greenhouse gas is water vapour. Carbon dioxide (CO_2) released into the atmosphere by human beings comes nowhere near it in terms of quantity, but the impact of CO_2 is much greater. It is a much more efficient greenhouse gas. Look at the diagram below. Water vapour traps a large percentage of the heat, which the surface of the Earth would otherwise reflect back out into space, but there are gaps in the spectrum of heat radiation of the Earth, where long-wave radiation can pass through the atmosphere. And it is precisely these gaps which are closed partially or completely by the other greenhouse gases such as CO_2.



EXERCISE:

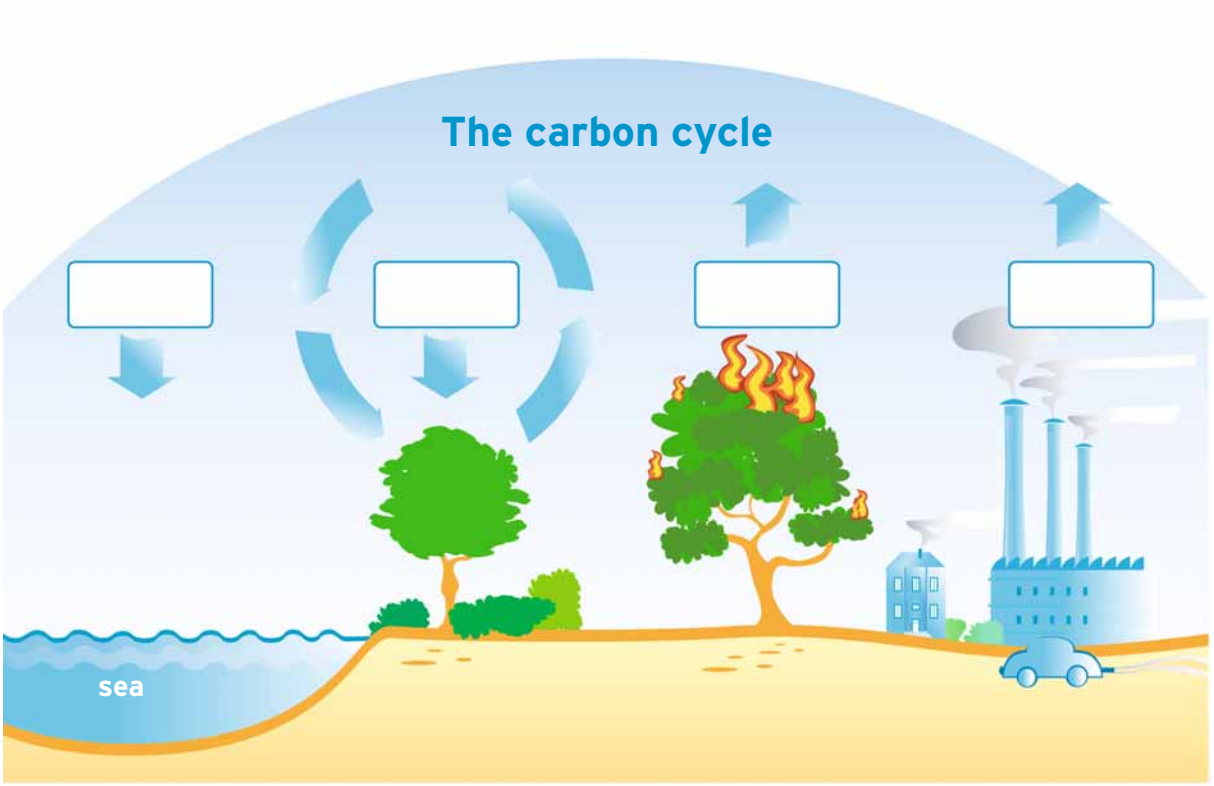
1. What happens to the average temperatures on Earth if the concentration of carbon dioxide in the atmosphere rises?

- ☐ *Temperatures remain unchanged.*
- ☐ *Temperatures rise.*
- ☐ *Temperatures drop.*

Give reasons for your answer!

CARBON DIOXIDE AND GLOBAL WARMING

All life on Earth is based on carbon compounds. If these compounds break down as a result of combustion or rotting, the main product is carbon dioxide, which is released into the atmosphere. Thus, for millions of years there has been a natural carbon cycle on Earth. Since industrialisation first started more than 150 years ago, human beings have, however, influenced this cycle to a great extent. We use fossil fuels (coal, oil and gas) to generate power and when we burn them we release additional carbon dioxide. Since carbon dioxide, or CO_2, plays such a major part in the greenhouse effect, we must look at how it actually gets into the atmosphere.



Source: PIK

Carbon sources and carbon sinks (in billions tonnes per annum)

- Released into the atmosphere through the use of fossil fuels (6.3 billion tonnes p.a.)
- Absorbed by the oceans (2.3 billion tonnes p.a.)
- Released into the atmosphere by burning biomass (1.7 billion tonnes p.a.)
- Stored in living biomass (2.4 billion tonnes p.a.)

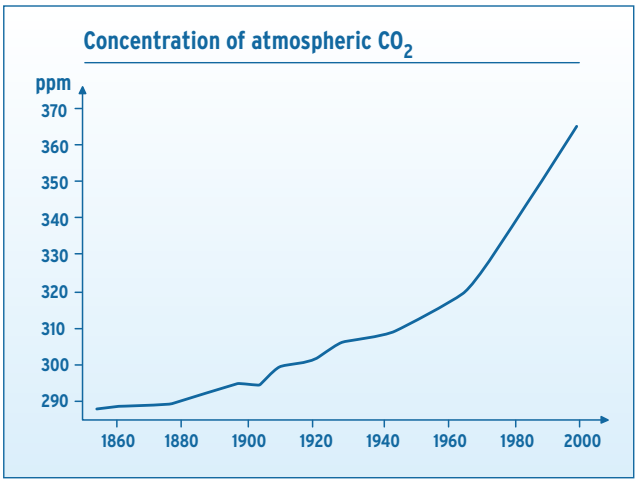
EXERCISES:

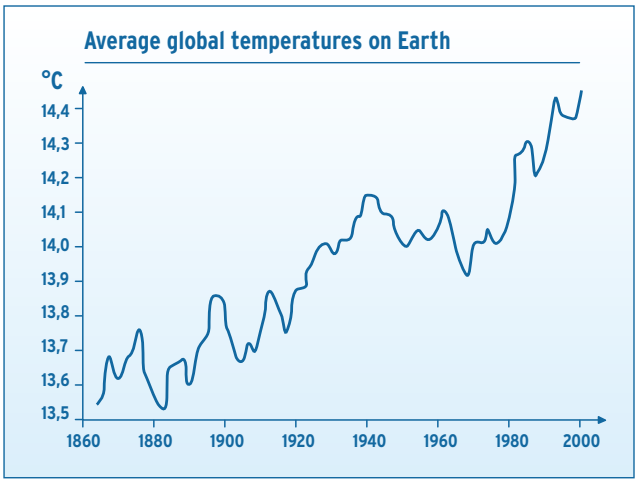
1. *Match up the carbon sources and carbon sinks listed above with the diagram. Enter the appropriate figure in each box.*
2. *Calculate how many billion tonnes carbon dioxide are "left over" every year in this cycle, i.e. how much carbon dioxide is released into the atmosphere.*

CO_2 released (tonnes p.a.) _____

CARBON DIOXIDE AND THE GLOBAL TEMPERATURE ON EARTH

The "Vostok" ice core gave us the evidence. Temperatures on Earth, and thus the climate, have fluctuated wildly in the past. Between the top temperature of the interglacial periods and the lowest temperatures of the ice ages, temperatures varied by up to ten degrees Celsius. But normally, changes of this magnitude happen over thousands of years. Animals and plants have time to adjust. Since 1860, however, things have been moving much more rapidly. In the last century alone, the average surface temperature on Earth (i.e. the average of the air temperature over land and the temperature of the surface of the oceans) rose by about 0.6 °C. This was equivalent to the change recorded in the previous 1,000 years.





Source: IPCC

There is no rock-solid evidence as to what has caused this acceleration. Some people say that it is just a natural fluctuation. Temperatures have never been static. The vast majority of experts, however, along with almost every government in the world, believe that the comparatively rapid rise in average temperatures over the last 150 years has been caused primarily by human intervention. A look at the rising concentration of carbon dioxide in the atmosphere over the last 1,000 years makes this the obvious conclusion to draw.

EXERCISES:

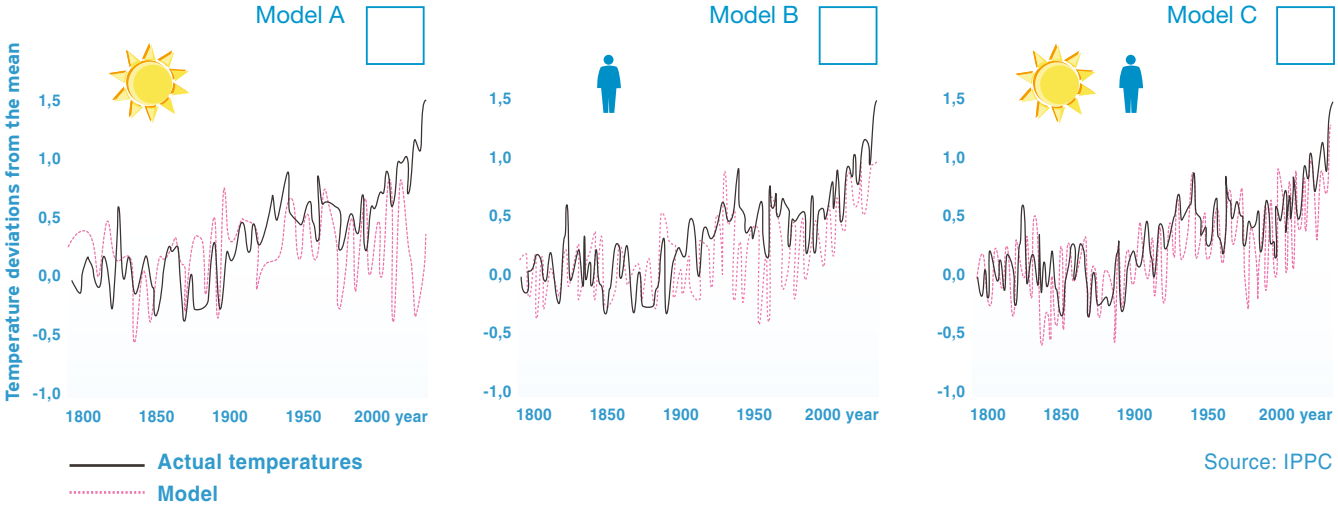
1. *Why do experts believe that the rising concentration of CO_2 in the atmosphere is responsible for the rise in global average temperatures on Earth?*
2. *What rise do experts expect to see this century?*
   You will find information on the Internet, for instance, at:
   www.ipcc.ch/graphics/gr-ar4-wg1.htm > Global Climate Projections

ANTHROPOGENIC (MAN-MADE) OR NATURAL?

Scientists from the Intergovernmental Panel on Climate Change (IPCC) have calculated how the climate would have changed between 1858 and 2000 if we take into account only certain factors. To produce their models, they fed all sorts of data into a computer. One model is based only on natural causes of climate change (the sun, volcanic eruptions, etc.), while another takes into account only the anthropogenic (man-made) influence on the climate. The third model combines natural and anthropogenic influences.

IPCC

Within the framework of the United Nations, a new IPCC report on the current knowledge on the causes and possible consequences of global climate change was published in 2007. This report is the fourth of this kind (Assessment Report 4 = AR4) and assesses the risks and consequences of climate change as even more serious than earlier reports. The IPCC was established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) in 1988. In 2007 the IPCC was honoured with the Nobel Peace Price.



EXERCISES:

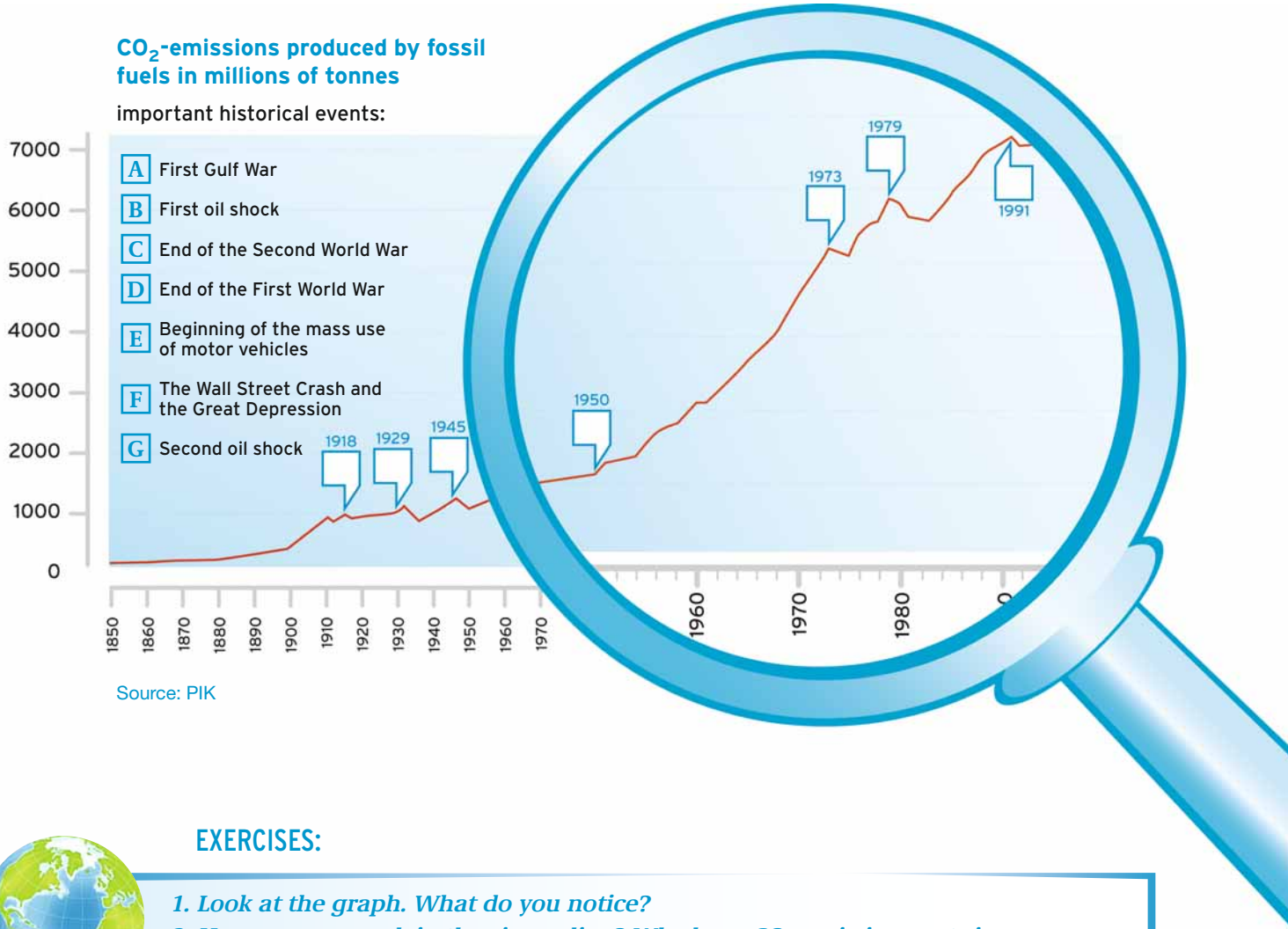
1. *Tick one of the boxes above to show which graph which you think best corresponds to actual observations of the world's climate.*
2. *Why has the concentration of CO_2 in the atmosphere risen since the middle of the 19th century. Discuss as a class what the human race has had to do with it.*
3. *In 1991 the volcano Pinatubo erupted on the Philippines. Think about which model (A or B) has been affected by the eruption, and how. What was the impact of the eruption on the temperatures actually measured? Discuss this as a group. What does the rest of the class think of your ideas?*

WHAT IS THE IMPACT OF WORLD POLITICS ON CO_2 EMISSIONS?

Viona is not going to give up, "Felix, you said that there is more and more carbon dioxide flying about in the atmosphere. How did it get there?" "That's obvious," interrupts Aysche. "Factory chimneys and car exhausts." "That's right," adds Manuel. "Every time you burn something you produce CO_2." So much information all at once. Viona is irritated. After all she knew that last bit too. "Just for your information, the most important fuel is oil," she adds her tuppence worth. But what's wrong with Felix. Why isn't he saying anything? He's back at the blackboard where he has written one word in big fat letters – EMISSIONS.

What does that mean? Viona, Aysche and Manuel look it up in a dictionary and an encyclopaedia. You could follow their example.

CO_2-emissions produced by fossil fuels in millions of tonnes



Source: PIK

EXERCISES:

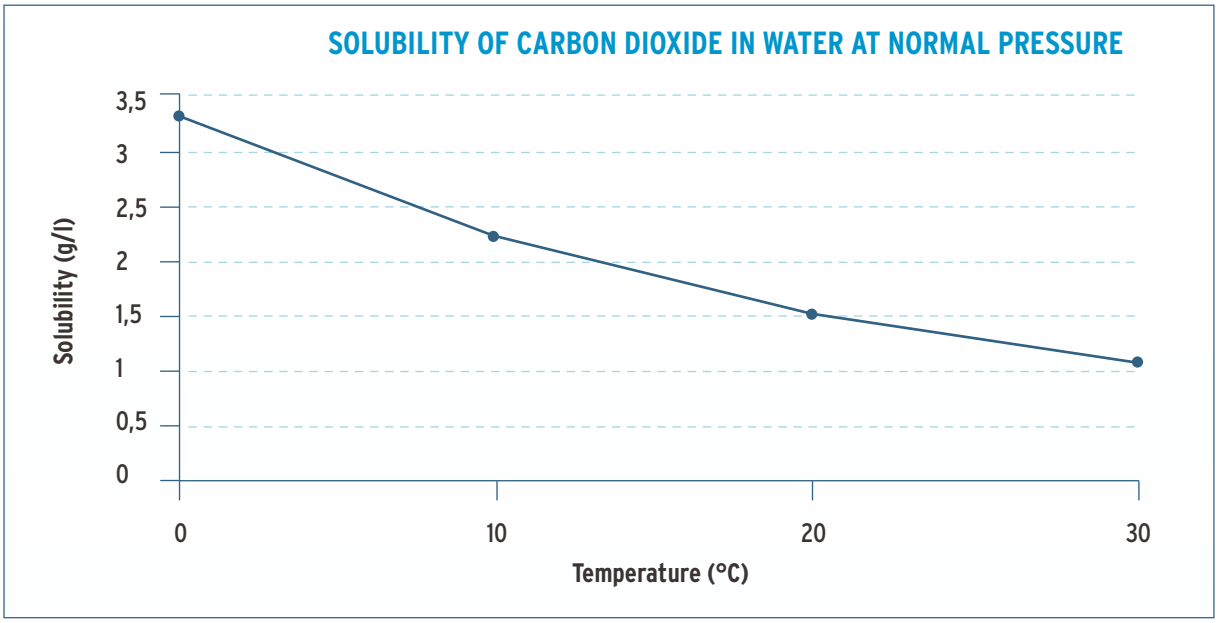
1. *Look at the graph. What do you notice?*
2. *How can you explain the zigzag line? Why have CO_2 emissions not risen consistently? Why have they always fallen again a little in between times?*
3. *The boxes list important historical events of the last one hundred years or so. What impact have they had on CO_2 emissions?*
   Match the events with the years in which they happened and check the graph to see if emissions were affected in the way you predicted.
   N.B. Not every event has an immediate impact on emissions. Sometimes the changes can only be seen one or two years later.

CLIMATE AND CHEMISTRY – THE CARBONIC ACID EQUILIBRIUM

Fizzz! Manuel opens his bottle of mineral water, and the contents excitedly fizz up and over the side of the bottle. Aysche only just manages to save her folder from the puddle on their desk. "Oh really Manuel," she scolds him crossly, "Why do you always have to drink sparkling water? Can't you just drink still water?" "And what's more," Viona interjects, "You're just polluting the air with more CO_2. They put carbonic acid in the water to make it bubbly, you know. When you open the bottle, most of it breaks down into CO_2 and water." Manuel looks guiltily at his bottle. "It was only a joke," Viona comforts him. "Mineral water is definitely not responsible for climate change." Nevertheless, Manuel is pensive. Then he seems to have a flash of inspiration. "Do you think it would work in reverse?"

What do you think?

Quite right!
CO_2 reacts with water to produce carbonic acid: $H_2O + CO_2 \rightleftharpoons H_2CO_3$

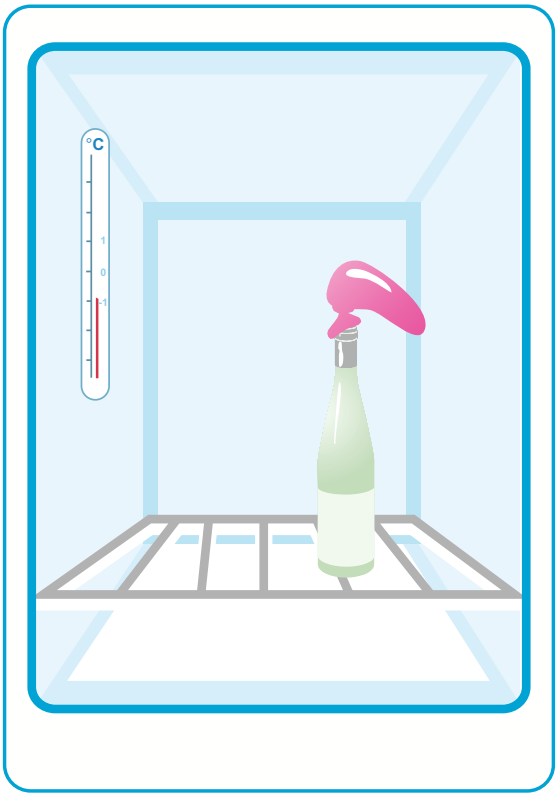


Carbon dioxide is one of the gases that dissolves best in water. Because it also reacts in salt water with calcium, the oceans can in fact absorb even more CO_2 than freshwater could. But have we solved the greenhouse gas problem? Only partly, and only if the carbon dioxide then sinks to the lower layers of the ocean. If it remains in the upper layers of the ocean, the currents take it on a round the world trip.

EXERCISES:

1. *Look at the graph. What happens when the water becomes warmer?*
2. *Think about the impacts global warming could have on the ability of the oceans to absorb CO_2.*

Experiment:
Open two well cooled bottles of sparkling mineral water and immediately fit a balloon over the neck of each bottle. Put one bottle with the balloon over the neck back in the fridge and place the other one in a warm place.



EXERCISES:

1. *Compare the two balloons. Describe any differences you observe. If you observe any differences, try to explain why they differ. Make a note of your observations and results in your exercise book.*
2. *Now it's time to do some calculations: The North Sea has a water volume (V) of about 93,830 km³.*
   How much CO_2 could it absorb, theoretically,
   a) at a water temperature T of 0°C?
   b) at a water temperature T of 25°C?
   (N.B. To make things easier we will not take into account currents, local temperature deviations and the time factor.)

STATION PASS

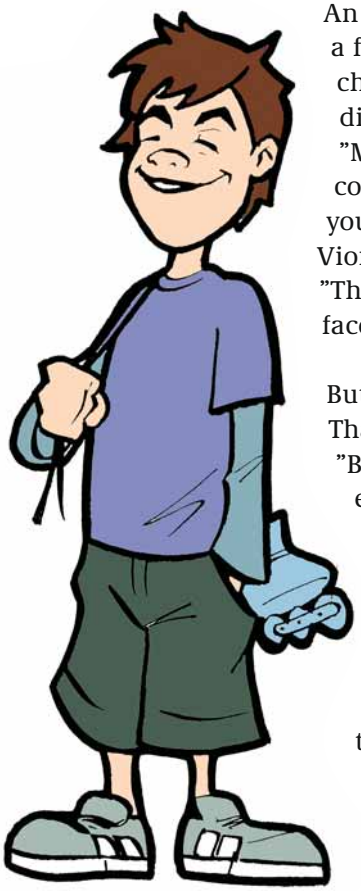
Family name First name Grade

Station no.	Station name	Total points

THE GLOBAL CLIMATE ON ITS SICKBED

What are the consequences of climate change?

INTRODUCTION



An evening at the cinema. Aysche, Viona, Manuel and Felix have been watching a film entitled "An Inconvenient Truth" all about the consequences of climate change. The credits have just started to roll, and they are already deep in a lively discussion. "That was way over the top," says Viona. "Things can't be that bad." "Maybe they can," Felix contradicts her, "If we pull the wrong card." Viona is completely lost, and Aysche stares at him uncomprehendingly. "What card do you mean," asks Felix. "The climate collapse card!" "The climate what card?" asks Viona. And Felix replies, as though it were the most natural thing in the world, "The climate collapse card." For a moment he enjoys the confusion on the others' faces, and then he explains. "There's a game ..."

But Manuel doesn't take things so seriously. "The Earth is warming up, isn't it? That's brilliant! I've never liked winter. What's the problem?" Aysche answers him, "Because it doesn't mean that the weather is getting better. It is only getting more extreme." "And what does than mean? More extreme?" Manuel wants to know "Will they have snow in the desert? That would be cool." The other three laugh, but Manuel finds his own joke better than anyone else. Aysche quickly becomes serious again. "Unfortunately not. You saw the storms and flooding in the film." Viona decides to act as the devil's advocate. "So it's a question of living in the right place, is that right?" "Well that's all right then," Aysche retorts angrily. "Actually, Viona is not far wrong," says Felix. "In spite of all the terrible consequences of climate change there are a few good things." Aysche and Viona stare disbelievingly at Felix. How can he say that after the film they've just seen? "And what were you saying about the climate collapse card?" Manuel wants to know. Felix replies like a shot, "If we pull it, it's all over."

EXERCISES:

1. *Do you believe that films or books like this can get people interested in climate change, and get them to change the way they live?*
2. *Use the arguments laid out on the information sheet "An Inconvenient Truth" for the discussion.*
3. *Read what climate experts and the former US Vice-President Al Gore say on Infosheet 1. What do the experts criticise about the film "An Inconvenient Truth"? Why did Al Gore make the film this way?*
   Note key ideas, and then discuss these as a class.

What do climate experts think of the film:
The news agency AP asked leading international climate experts what they thought of the film. Those who had actually seen the film were astonishingly unanimous - Al Gore had given a true reflection of scientific opinion. William Schlesinger, for instance, Dean at the Nicholas School of the Environment and Earth Sciences at Duke University, said, "He uses the most important material, and he uses it correctly". There were minor errors here and there, he continued. At one point, for instance, the wrong ice core is shown. These are tiny details and not serious errors, though. Tom Wigley, a former scientist at the National Center for Atmospheric Research, criticises Al Gore. Gore's claim that we can still do something to halt climate change is unrealistically optimistic in his view.

(based on: The Washington Post, 27 June 2006)

Al Gore explains:
Al Gore: My goal with my slide shows, this film and a new book, which will be coming out soon, is first and foremost to convince people that we urgently need to tackle the climate crisis. There is a planetary state of emergency, which we can only resolve by pulling together. But we can resolve it. We have the means – what we perhaps do not have is the political will.

(Source: Welt am Sonntag, 11 June 2006)

THE WEATHER REPORT

Can we already see genuine signs of climate change? Have there been any extreme weather events caused by climate change recently? Aysche, Viona, Manuel and Felix think so. They remember the violent rainfall that caused terrible flooding along the River Elbe in 2002, the remarkably dry summer of the following year and the huge number of hurricanes in America in 2004. Are they right?

	Headlines about:	
	Weather	Climate change
"Storms set to worsen"	☐	☐
"Today the cold, wet weather is set to continue"	☐	☐
"Flooding – only a taste of things to come"	☐	☐
"The heatwave is here to stay"	☐	☐
"Desert wind pushes out the forest breeze"	☐	☐
"Dry today with top temperatures of up to 30°C"	☐	☐
"54 die as storms hit Japan"	☐	☐
"A dream summer with nightmarish consequences"	☐	☐
"The day Europe's heating packed in: 8,200 years ago the Gulf Stream stopped"	☐	☐
"The global climate becomes more and more extreme and less and less stable"	☐	☐
"Some like it hot in Saxony"	☐	☐
"Tsunami lays waste to Southeast Asia"	☐	☐
"Ten tonnes of carbon dioxide a head is too much"	☐	☐

EXERCISES:

1. *The page above shows thirteen headlines taken from newspapers over the last few years. Which ones point to climate change and which refer only to weather? Make a table and enter the headlines under climate change or weather, and give reasons for your answers. In some cases more than one answer is possible.*
2. *Look at recent newspapers, in newspaper archives and on the Internet for other appropriate headlines. Enter them in your table under weather or climate change.*

RISING SEA LEVELS

Top temperatures of up to 30 degrees Celsius ... Viona looks out of the window. Doesn't look like it today. It's raining and the thermometer on the window frame is showing no more than 17 degrees Celsius. She opens the window and breathes hard on the thermometer – the mercury crawls sluggishly another three degrees upwards. "What's wrong with you?" comes Aysche's voice suddenly. Viona feels that she has been caught in the act. "How does a thermometer actually work," she asks, as though she had just been conducting an important experiment. "Why does the liquid inside rise as it gets warmer?" "Well, because it expands," explains Aysche, "Like every liquid." Viona rubs a few raindrops off her nose. "Water too?" she asks. "Of course," says Aysche. "Have you never heard about rising sea levels?" "Yes, of course, But the sea can really expand in all directions. There's water there already," says Viona. "Or land," adds Felix, who has apparently been listening to the two of them for some time. Aysche has the facts at her fingertips. "Experts expect sea levels to rise by an average of between 9 and 88 centimetres over the next hundred years." "So what?" interjects Manuel, "What's nine centimetres between friends? Even at 88 centimetres, my swimming trunks won't get wet." "But if a storm tide is pushing half a metre more sea in front of it, things can get pretty wet on land," Aysche points out. "It can be a regular problem for more than 100 million people on Earth." "Exactly," says Felix. "Fifty million people are suffering already."

Possible causes of the rising sea levels:
As the climate warms up, sea levels rise because

Ⓐ it rains more. The rivers carry more water down to the sea.
Ⓑ water expands as it warms up, and so the oceans take up more space.
Ⓒ the crust of the Earth rises, meaning that the seabed too rises.
Ⓓ the Greenland ice shield and the Antarctic ice cap melt.
Ⓔ the air and water get warmer and warmer, so more and more people go swimming.
Ⓕ the glaciers in the mountains melt.

EXERCISES:

1. *What is really causing the rising sea levels? Some possible reasons are listed above. Three are correct and three are wrong. Tick the correct reasons and discuss your decisions as a class.*
2. *Take a world map, a globe or an atlas and find out which regions of the Earth would be particularly vulnerable to rising sea levels.*

MELTING ICE AND RISING SEA LEVELS

Greenland and Antarctica are covered by ice shields several thousand metres thick. If the global climate warms up, this ice could melt, with dramatic consequences for the sea level.

The experiment

You can try a small experiment to illustrate what would happen. You will need a glass, a shallow bowl, water and ice cubes. Place the glass in the bowl. Fill the glass almost to the rim with water. Mark the water level on the outside of the glass. Add a few ice cubes and watch what happens.

1. What happens to the water level when you add the ice cubes?

☐ Water level rises ☐ Water level drops ☐ Water level remains unchanged

2. What happens to the water level once the ice cubes melt?

☐ Water level rises ☐ Water level drops ☐ Water level remains unchanged

What does this mean for the world's oceans?

This experiment illustrates the principle.
How do things look if we take a look at the ice masses on Earth?

Region	Volume (in millions of cubic kilometres)
Greenland (land-based ice)	2.85
Antarctica	26.03

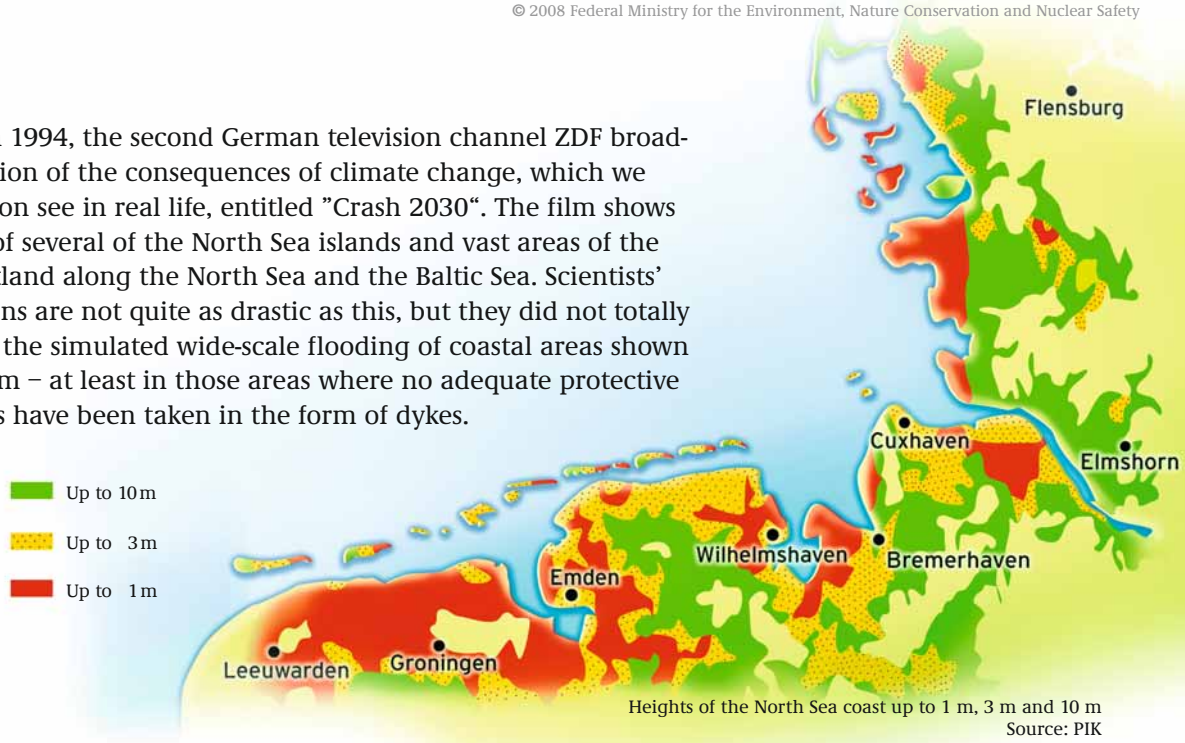
Formula (for rising sea levels)	$\frac{\text{Volume of melted ice x thickness of ice}}{\text{surface of the sea}}$
Conversion factor	0.9 l water is equivalent to 1 l ice
Surface area (of the ocean)	361 million square kilometres

EXERCISES:

1. *What consequences can you draw from your experiment in terms of rising sea levels?*
2. *Calculate how much the sea level would rise if all of the Greenland ice shield and the Antarctic ice cap were to melt.*

WILL THE NORTH SEA OVERFLOW?

In March 1994, the second German television channel ZDF broadcast a vision of the consequences of climate change, which we might soon see in real life, entitled "Crash 2030". The film shows the loss of several of the North Sea islands and vast areas of the flat coastland along the North Sea and the Baltic Sea. Scientists' predictions are not quite as drastic as this, but they did not totally discount the simulated wide-scale flooding of coastal areas shown in the film – at least in those areas where no adequate protective measures have been taken in the form of dykes.



Heights of the North Sea coast up to 1 m, 3 m and 10 m
Source: PIK

Potential consequences of the rising level of the North Sea		
For industry	For the population	For the environment

EXERCISES:

According to the predictions of scientists, Germany's coasts too are threatened by a rise in the sea level, especially the North Sea coast.

1. *Do some research and establish how much scientists expect sea levels to rise in the North Sea. Discuss the results of your research. Which results seem to be the most probable?*
2. *Look at the map and draw up an overview: What could this mean for the German North Sea coast? Make a distinction between the consequences for industry, the environment and the population.*
   Draw your own conclusions first and then check these.
   You will find information on the Internet at:
   www.krim.uni-bremen.de/englisch/indexenglisch.html /
   http://en.wikipedia.org/wiki/Sea_level_rise /
   www.bbc.co.uk/climate/impact/sea_level.shtml

THE CONSEQUENCES OF CLIMATE CHANGE

”Where’s Viona gone?“ Aysche asks in surprise, and looks around. Manuel and Felix too start looking for her. ”Shh!“ whispers Aysche. When they are all quite again, they hear the soft clicking of a computer mouse. Yes, Viona has taken herself off into the furthest corner of the computer area of the classroom. Aysche creeps up to her and looks over her shoulder. She can just make out, ”Last minute“, before Viona starts, and closes the page with a click. ”Well,“ says Aysche ironically, ”I don’t know if we’ve got to the last minute quite yet. But it’s definitely the eleventh hour in terms of the climate“. ”And that just happens not to be what I’m worrying about,“ retorts Viona. ”For a change it’s only the weather that’s getting me down. I’ve had enough of this never-ending rain. I thought I’d just pop over to Egypt for the weekend and get in some diving.“

”Are you crazy?“ shouts Aysche, so loudly that Manuel and Felix sit up and start to take notice. ”To Egypt to scuba dive? For the weekend????“ ”Calm down Aysche,“ says Viona quietly. ”The LeisureAir flights are really cheap.“ Manuel and Felix have made it to the computer corner too now. And that is the last straw for Aysche and Viona. ”The climate just can’t change fast enough for you,“ hisses Aysche at her friend. ”Maybe you could fly somewhere every weekend.“ ”No, every second weekend would be enough.“ ”And if the sea rises? No more beautiful white beaches with palm trees and gorgeous guys.“ ”I don’t care. If the sea rises, I can dive deeper!“

Silence. Aysche, Manuel and Felix just stare at Viona. She tries to change the subject. ”What have you two been up to all the time?“ she asks the two boys.

Manuel and Felix have drawn up a list of 14 hypotheses, laying out the probable consequences of climate change. Seven affect Europe, and seven affect Africa. Unfortunately in the argument they have dropped their papers, which are now totally jumbled up.

14 hypotheses regarding the consequences of climate change in Europe and in Africa.

A Anthropogenic systems (e.g. water supply, food sector, power and industry, residential areas, health) on the continent are for the most part very adaptable.

B The anthropogenic systems on the continent are not easily able to adapt because the economy is still little developed. Rain-fed farming, frequent droughts and flooding further weaken the system, along with widespread poverty.

C Vectors of infectious diseases spread and affect human health on the continent for a long time to come.

D Half of the glaciers and areas with extensive permafrost could vanish by the end of the 21st century.

E Higher temperatures and heatwaves could change traditional summer holiday destinations. Less reliable snow will have a negative impact on winter tourism.

F Because it rains less and the soil becomes drier, desertification will worsen.

G In the south of the continent water will become scarcer, and the soils drier. This will widen the gap between the water-rich north and the drought-threatened south of the continent.

H Cereal harvests are expected to drop further, undermining food security.

I In the north of the continent the impact on agriculture can be expected to be positive, while harvests will drop in the south and in the east.

J Rising sea levels and worsening coastal erosion will lead to settled land being flooded and destroyed.

K Biotic zones will shift northwards and into higher altitudes. Habitat loss will threaten some species.

L Plant and animal species will become extinct on a large scale. This will have a negative impact on agriculture, tourism and biodiversity.

M A large percentage of the continent will be threatened by river flooding. In coastal areas the risk of flooding and erosion will rise. This will have an impact on residential areas, industry, tourism, agriculture and the natural habitats in coastal areas.

N Major rivers on the continent are very sensitive to climatic fluctuations; water availability will be reduced in Mediterranean countries and in the southern countries.

EXERCISES:

1. Help them put their things back in order. Write the appropriate letter in the boxes.
2. Mark the hypotheses you could not match up, or which could apply to both continents.
3. Give reasons for your decisions in a discussion within your group or as a class.

WHERE DO THE EMISSIONS COME FROM?

CO_2 emissions and the polluters

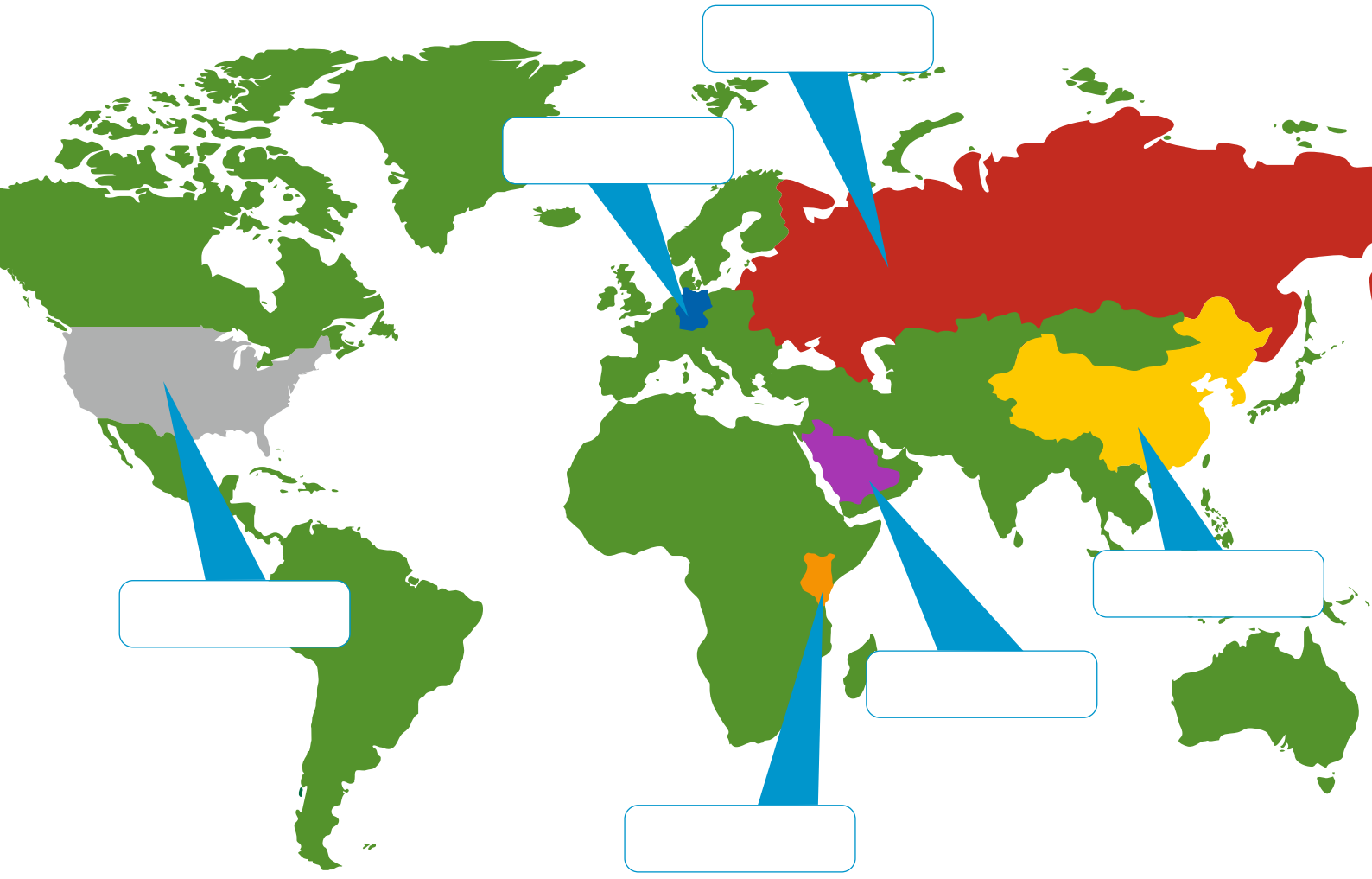
INTRODUCTION

Where do the emissions come from? page 1/2

Felix has hung up a strange world map. Aysche, Viona and Manuel have never seen one quite like it. ”Country energy types,“ Aysche reads slowly, ”what does that mean?“ ”I know,“ shouts Manuel, ”They’re countries that live from energy like agricultural countries live from agriculture.“

”You’re barking up the wrong tree there,“ says Aysche dryly and carries on with her explanation. ”The colours show the energy sources used – green for eco-power, blue for hydropower, yellow for solar power.“ Viona’s suggestion goes off on yet another tack. ”It’s probably a question of the type of energy that guys use to try and attract the attention of the girls.“ However imaginative her proposal, she too is way off the mark. Felix provides the answer. ”Every country in the world has its own way of using energy, and consuming oil, gas and coal. There are, however, a lot of similarities, which have allowed experts to break them down into these six groups.“

”But only six countries are marked,“ notices Manuel. ”That’s to make it a bit easier,“ explains Felix. ”There is one example given for every group: One country that uses a lot of energy and produces CO_2, one country that uses very little because it is very poor, and one country that does not use much itself, but is interested in ensuring that other countries use a lot.“ ”Hold on,“ exclaims Aysche and takes a board game off the shelf. ”I knew I had seen a map like that before ...“



State	CO_2-emissions per annum	Percentage of total global emissions accounted for (%)	Population	CO_2 emissions per capita per annum
	5,799.97 Mio. t		293.95 Mio.	
	4,732.26 Mio. t		1,296.16 Mio.	
	1,528.78 Mio. t		143.85 Mio.	
	897.00 Mio. t		82.5 Mio.	
	324.88 Mio. t		23.95 Mio.	
	9.00 Mio. t		33.47 Mio.	

*Source: IEA 2004, Federal Environmental Agency 2006

EXERCISES:

1. Which states are given as examples? Enter their names on the map. You can use an atlas to help you.

2. Felix has already described the way individual countries use energy. Match up Felix's definition with the names of the states.

a) Uses a lot of energy and emits a lot of CO_2:

b) Uses very little because it is very poor:

c) Is very interested in ensuring that other countries use a lot:

Give reasons for your decisions.

3. The table shows the ranking list of countries by CO_2 emissions. Add the country names. What percentage of the total emissions of CO_2 in the world is produced by these states (total emissions = 24,101.8 million tonnes)? Calculate the percentages and enter the results in the table.

4. Calculate the per capita emissions of CO_2 in the six countries. Enter the results in the table. What do you notice? Discuss with your partner why there are such vast differences, and what they tell us about the standard of living of the people in these countries. Note the ideas in your exercise books.

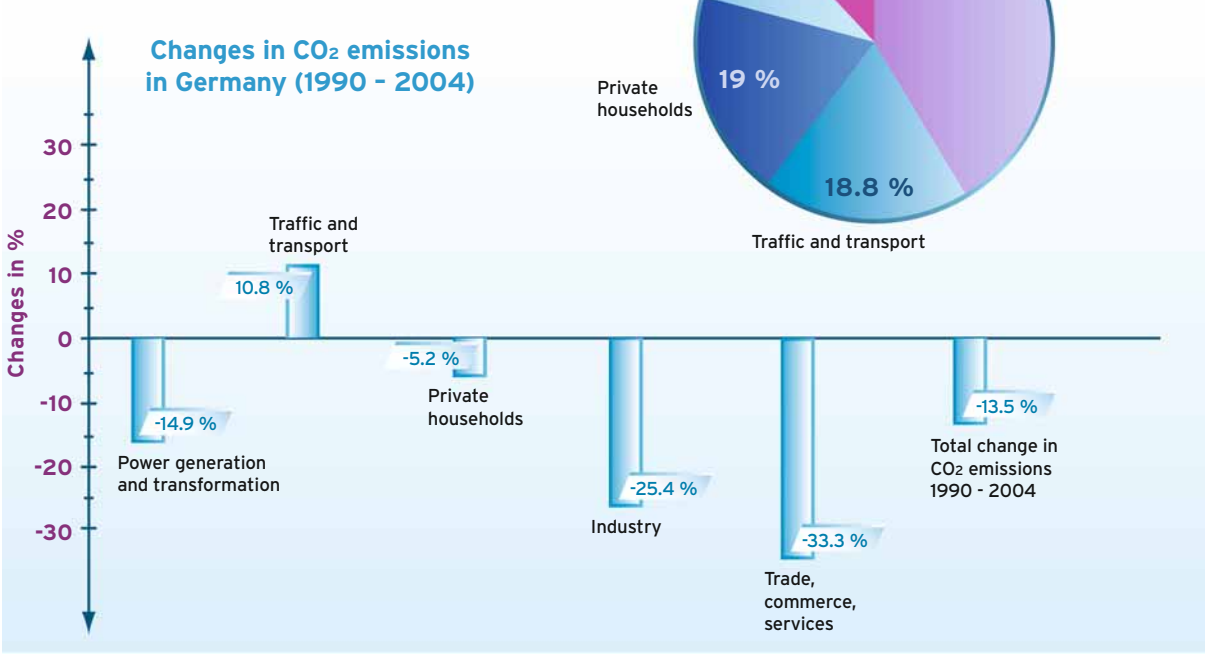
Note: Further information is available on the Internet (interactive) at: www.climate-policy-map.econsense.de/index.html

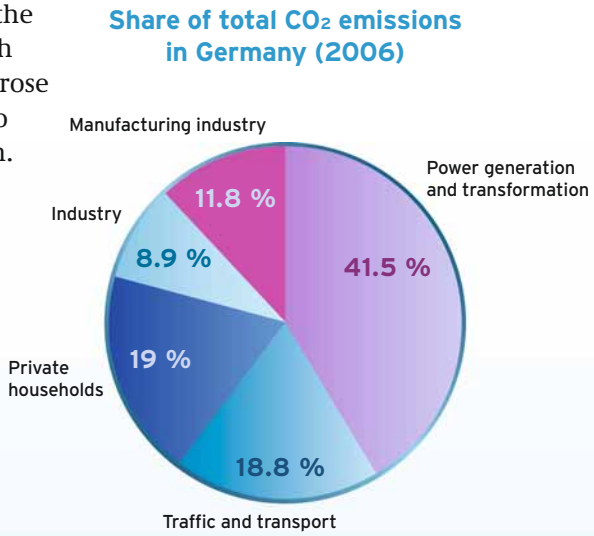
CO_2 EMISSIONS IN GERMANY

Where do the emissions come from? worksheet 1 page 1/3

If you think that only industry, with all its factories and power stations, is the worst polluter, you're a bit behind the times. With lots of new technology and a bit of pressure from politicians, industry has taken a giant step forward. Since 1990 the levels of CO_2 emissions have dropped dramatically, although industry as a whole has expanded. Industry, we might say, has already tied a knot in its chimneys.

The position in private households is somewhat different. Although technology is improving all the time here too, CO_2 emissions have dropped much more slowly. And road traffic emissions actually rose between 1990 and 2000! At least they do seem to have peaked now and be on the way down again. For the first time in the history of the Federal Republic of Germany, CO_2 emissions caused by road traffic too have dropped since 2000.





Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU): National Allocation Plan 2008-2012 for Germany (NAP II), Berlin, 28.06.2006, Source: Klimaschutz: Plan B, Greenpeace and EUtech, Source: Federal Environmental Agency

Exercise:
Why are the CO_2 emissions of households falling so little, and why are they actually rising in the traffic and transport sector? Please try to find at least five reasons.

It is not only huge factories and power stations which belch out greenhouse gases. Every household, every family does its bit. But how much is their bit? We will calculate it, taking the examples of cars, electricity consumption and heating.

1. How much CO_2 does our car produce?

Ask your parents and your older brothers and sisters how many kilometres they drove last year (k), and how many litres of petrol or diesel your car uses on average for 100 km (FC). Enter the figures in the table below. Then add the emission values (se) for the appropriate engine type:

Diesel engine: se_{Diesel} = 2.63 kg CO_2/l
Petrol engine: se_{Otto} = 2.32 kg CO_2/l
By way of comparison:
Natural gas engine se_{CH_4} = 2.23 kg CO_2/kg natural gas

	Car	Kilometres per year (km p.a.)	Fuel consumption (litres/100 km) (FC)	Petrol or diesel engine?	CO_2 emissions per litre (se)	CO_2 emissions per annum in kg
Example	VW Lupo	12,500	3.0	Petrol car	2.32 kg/l	870.0
Example	Opel Astra 1.4 Liter, 90 PS	12,500	6.3	Petrol car		
Example	Ford Fiesta 1.4 Liter, 68 PS	12,500	4.4	Diesel car		
Example	Opel Zafira 1.6 Liter, 97 PS	12,500	4.98 kg/100 km	Horsepower	2.23 kg/kg	
					Total for car	

You can calculate the CO_2 emissions per year using the following formula:

S_{Model} = km p.a. · FC · $se_{engine\ type}$/100

Enter the results in the table. If your household has more than one car add the results for all the cars (not counting the four examples of course). If your household has no car, your CO_2 balance of course looks a lot healthier.

Exercises:
What are the CO_2 emissions of the railways and airlines? You will find information about the railways at: **www.db.de/site/bahn/en/start.html** > DB Group > Commitment > Environment > Environmental comparison. Look at the sections "EcoTransit" and "UmweltMobilCheck". You'll be surprised. You can find information on air travel at: **www.atmosfair.com** > Emissions calculator

2. How much CO_2 is produced by the electricity we use at home?

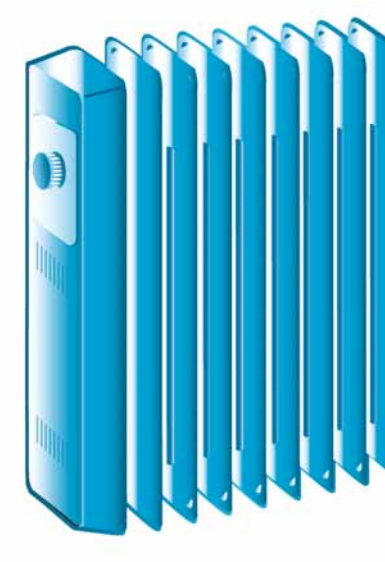
Consult your electricity bills for the last year to calculate total electricity consumption in kWh (EC) and enter the figure here:

EC = kWh

You can calculate CO_2 emissions using the following formula:
Total CO_2 emissions caused by electricity consumption =

EC · $se_{electricity}$ ($se_{electricity}$ = 600 g CO_2/kWh)

Total$_{for\ electricity}$ =



3. How much CO_2 does our central heating produce?

Consult your heating bills from last year to establish how much oil, gas, etc. you used, or ask your parents. Enter the total here stating which unit of measurement you are using (litres for oil, cubic metres for gas, kilowatt-hours (kWh) for heating from combined heat and power stations):

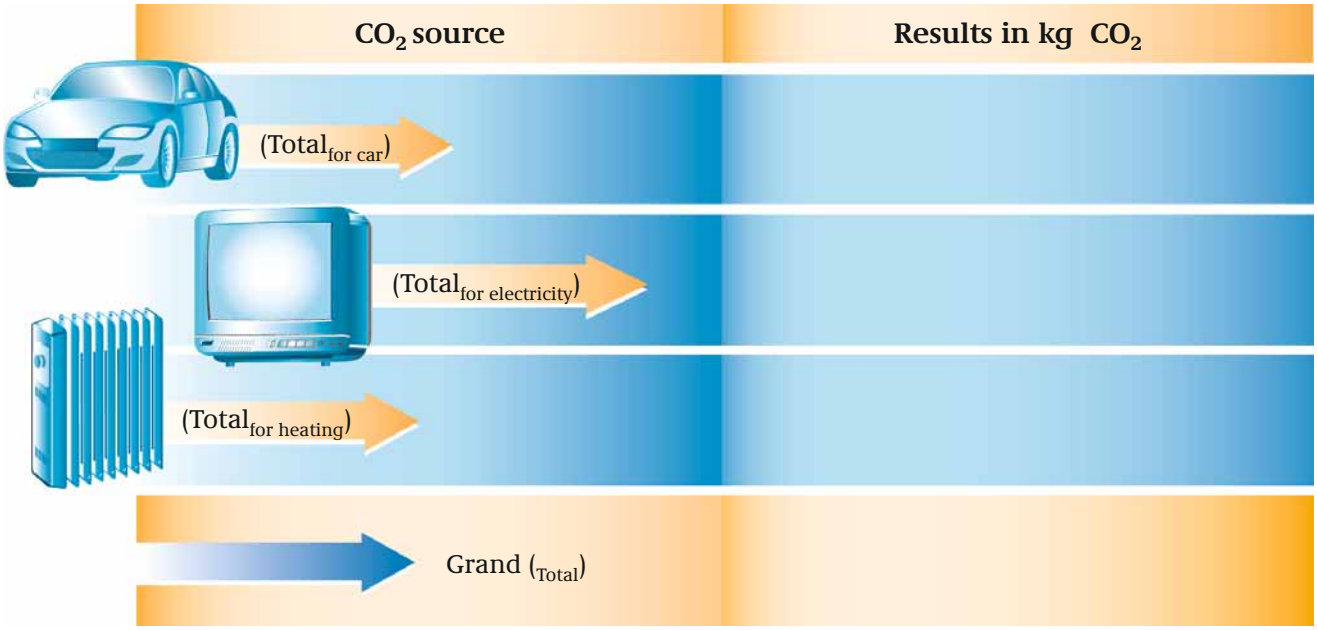
Heating consumption (HC) =

The formula is similar to that used for electricity consumption.
Work it out yourselves.

$Total_{for\ heating}$ = ·	$Total_{for\ heating}$ =

Oil heating: se_{Oil} = 2.7 kg CO_2/l
Gas heating: se_{Gas} = 2.0 kg CO_2/m^3
Combined heat and power: $se_{Combined\text{-}heat\text{-}and\text{-}power}$ = 0.225 kg CO_2/kWh

If you add up the results in the grey boxes, you will have a figure for the total CO_2 emissions your household generates.

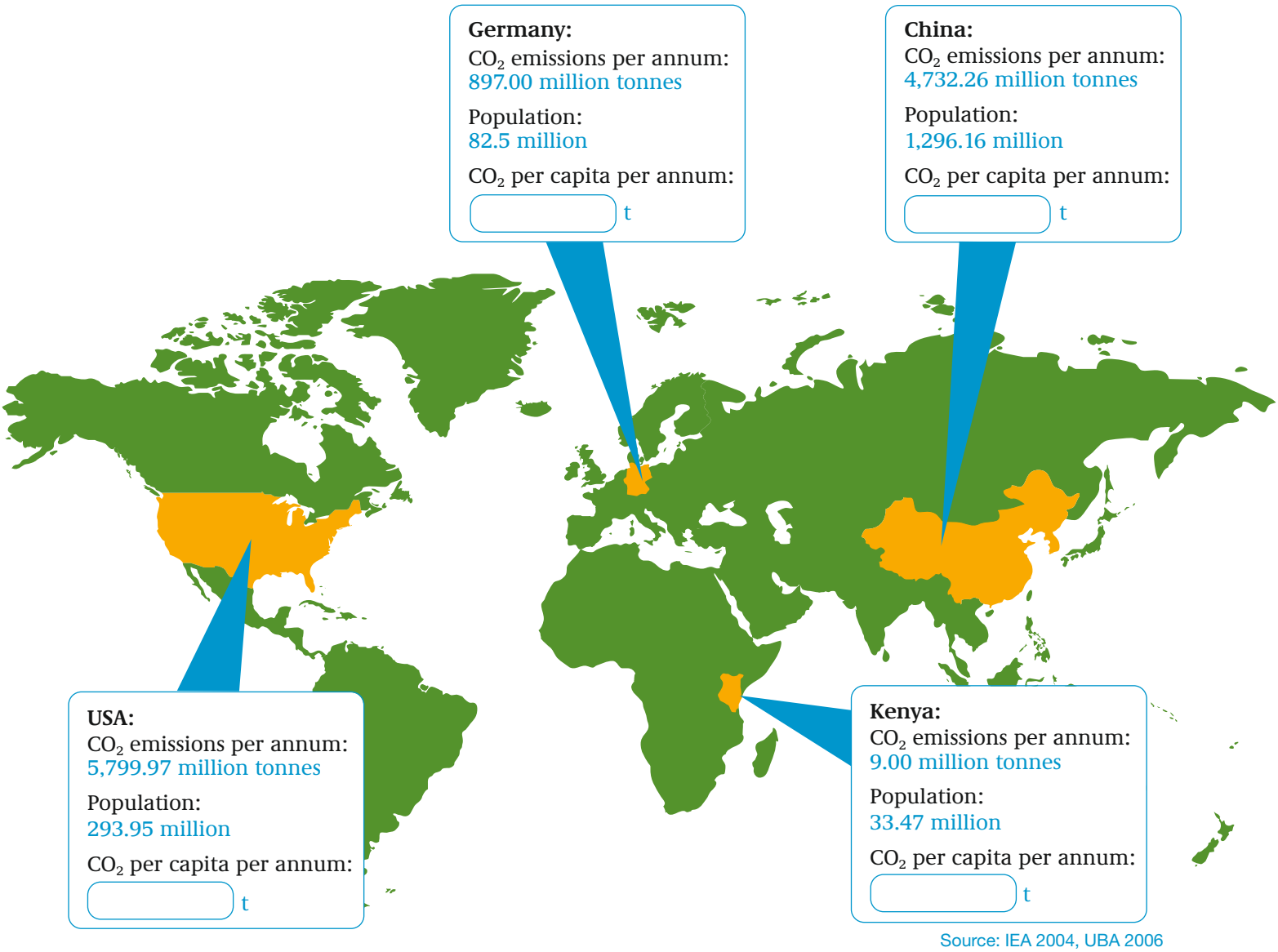


Now divide the grand total by the number of people living in the household.

$Grand_{total}$	Grand total : no. of people in household	= kg CO_2 per capita per annum

COMPARING COUNTRIES

Now you know how much CO_2 your family produces. But is that a lot or a little compared to the average consumption in Germany? Or in China, or the USA or Kenya? Can we compare consumption? The level of development varies so much from one country to another.
Firstly, the per capita emissions can be compared on a general basis:



Source: IEA 2004, UBA 2006

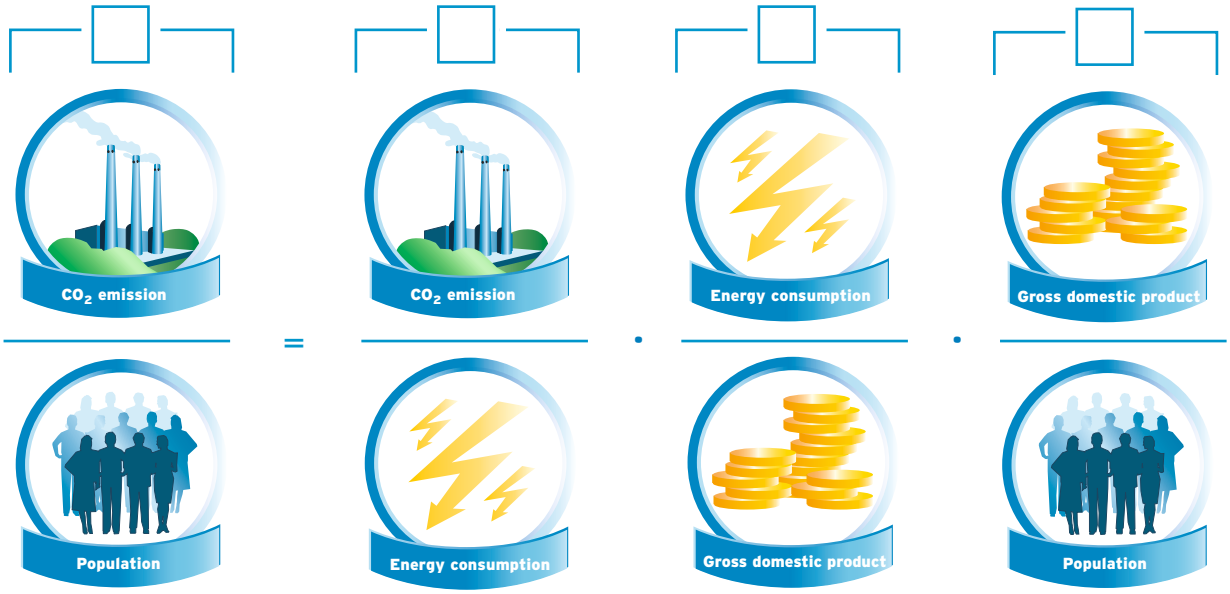
EXERCISES:

1. Calculate the per capita CO_2 emissions in each of the four states. Enter the results in the table. What do you notice? Discuss why there are such dramatic differences, and what they tell us about the standard of living of the populations of the four countries.

Note: Further information is available on the Internet (interactive) at: www.climate-policy-map.econsense.de/index.html

COMPARING COUNTRIES

So that we can compare different countries better, scientists look at the per capita emissions in terms of energy consumption and gross domestic product (GDP). To do this they use the "Kaya formula":



A	Per capita emissions	C	Energy intensity
B	Carbon intensity	D	Economic output

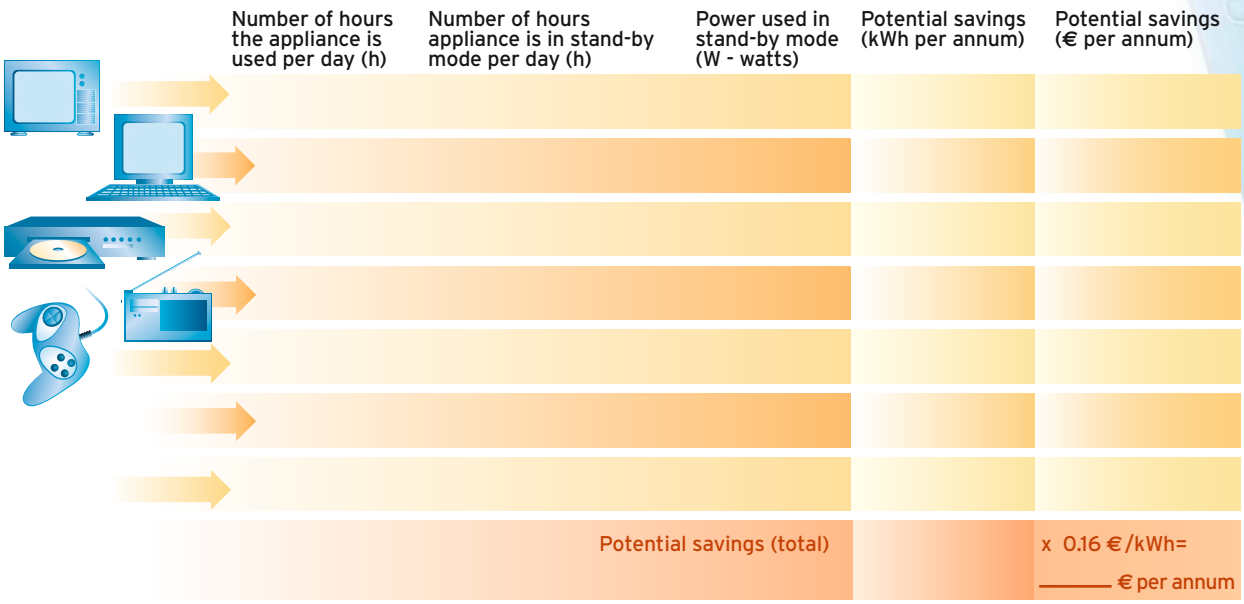
EXERCISES:

1. *Match the letters A to D with the respective illustrations.*
2. *If we assume that the population numbers and the gross domestic product (GDP) remain constant, what must change in order to reduce the per capita CO_2 emissions? Underline the correct answer.*
   The carbon intensity must: rise / fall
   The energy intensity must: rise / fall
3. *How can we reduce the carbon intensity? Tick the correct solution(s).*
   a) Energy consumption rises, CO_2 emissions rise proportionately or more sharply.
   b) Energy consumption drops, CO_2 emissions remain constant or drop.
   c) Energy consumption drops, CO_2 emissions drop more sharply.
4. *How can the energy intensity be reduced? Tick the correct solution(s).*
   a) GDP rises, and energy consumption remains constant.
   b) GDP drops, energy consumption remains constant.
   c) GDP remains constant or rises, energy consumption drops.

Bonus question:
What must happen in the USA in terms of carbon intensity and energy intensity if it is to shake off the doubtful honour of being top of the CO_2 emissions table?

SAVING ENERGY IN OUR SLEEP

So what now? Aysche, Viona, Felix and Manuel stand and stare helplessly at the formulae. Where should they even start? With the best will in the world there is not a lot the four of them can do to boost the gross domestic product. And they can do a limited amount to change the population. Suddenly, loud music erupts from the television, as though controlled by a ghostly hand. They only jump, however. Manuel has the remote in his hand. "Hey," complains Aysche, "Will you stop playing around with that thing!" "Put it off," demands Viona, grabbing the remote from Manuel and pressing the button herself. Felix looks at her searchingly. "Put it off properly." "What do you mean properly?" asks Manuel astonished. Felix gets up, walks across to the television and presses the big button under a small red light. The light goes off. Manuel is surprised. "Oh, can you put it off like that too?" "And what do you do if there's no button there?" Aysche asks. Quick as a flash Viona answers, "Pull out the plug." "Or turn it off at the wall," says Felix, and once again he has the last word on the matter.



EXERCISES:

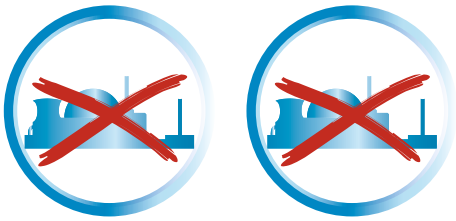
1. *Use the table to list ten appliances with stand-by mode in your household. Make a note of how many hours per day they are used and how many hours they are in stand-by mode.*
2. *Obtain a device for measuring the power used, which you connect up between the appliance and the socket. You can get devices like this from your local power utility, and share them. Measure the power your appliances use in stand-by mode and enter the figures in the table.*
3. *Work out a formula that you can use to calculate the potential annual savings using the number of hours stand-by time (sbT) and the power used in stand-by mode (sbP).*

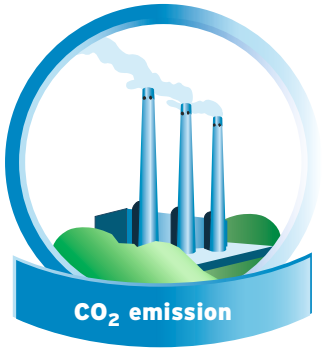
Potential savings = ...

4. *Calculate the potential savings for each appliance and add up the results.*
5. *Multiply the sums by the electricity price given and calculate the potential saving in euros. You could also ask your parents what price they pay for electricity, or take the results of Worksheet 1.*

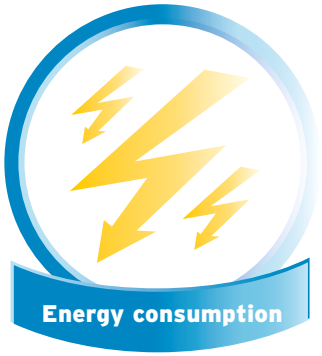
JUMP ON THE CO_2 BRAKE

While Viona, Felix and Manuel are searching for unnecessary power guzzlers, Aysche stares at the formulae (Worksheet 2). If all the appliances in Germany were turned off properly instead of being left in stand-by mode, two nuclear power stations could be decommissioned tomorrow.





Energy can really be saved. The energy intensity drops, the energy efficiency (or energy productivity) rises. But what about the carbon intensity??? If the energy consumption drops, but not the CO_2 emissions, the carbon intensity rises significantly. There can only be one solution, thinks Aysche after giving the matter some thought. She must tell the others immediately:
”I don’t like to bother you lot, but .....“

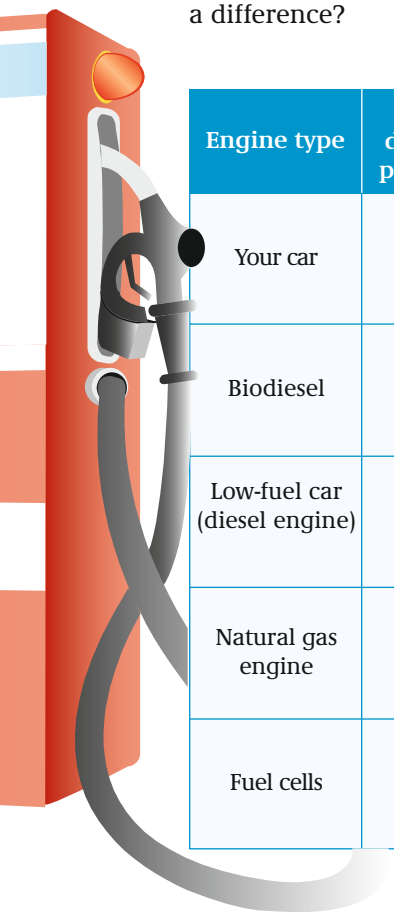


EXERCISES:

1. *What does Aysche mean when she says there can only be one solution? Look carefully at the ratio represented by the carbon intensity. Discuss what you notice and write down in one sentence what you think Aysche said to Viona, Felix and Manuel.*

JUMP ON THE CO_2 BRAKE

On Worksheet 1 you saw that the CO_2 emissions are very high for cars alone. Yet a lot of people don't want to give up their car. Engines and technologies which reduce emissions could help. At present we can choose between engines that run on biodiesel, engines with low fuel consumption, natural gas engines and cars with an electric engine powered by fuel cells. But does it really make a difference?



Engine type	Distance driven (km per annum)	CO_2 emissions (kg) per 100 km	CO_2 emission (kg) per annum	Drop in CO_2 emissions	Pros	Cons
Your car						
Biodiesel		CO_2-neutral (zero emission)	CO_2-neutral (zero emission)	100 %		
Low-fuel car (diesel engine)						
Natural gas engine						
Fuel cells		0	0	100 %		

EXERCISES:

1. *Take the figures for your family from Worksheet 1 (Exercise 1) for distance driven (km per annum), CO_2 emissions per 100 km, CO_2 emissions per annum and enter them in the table. If you have no car use the example.*
2. *Take the kilometres per annum for the alternative engine types and calculate the CO_2 emissions per 100 km and the CO_2 emission per annum for a 3-litre car and a natural gas car.*

   (Emission values: se_{Diesel} = 2.63 kg CO_2/l, se_{Petrol} = 2.32 kg CO_2/l, se_{Gas} = 150 g CO_2/km)

   The calculations only take into account CO_2 emissions while driving and not the emissions caused by manufacturing the vehicle or producing the fuel.
3. *By what percentage is the CO_2 emission level reduced in each case. Calculate the result, and enter the results in the table.*
4. *Discuss the pros and cons of the five options listed. The CO_2 generated to produce the fuel must be taken into account here.*

SAVING ENERGY – PROTECTING THE CLIMATE

”It will take years,“ Manuel moans, ”And we can’t even change anything directly.“ ”Why not?“ Aysche asks. ”Well can you design me a low-fuel car?“ ”Not directly ...“ ”See!“ Viona intervenes. ”There are other ways of doing something immediately.“ ”What can we do?“ Manuel repeats. ”Somebody who ought to know once said that each one of us can do a little to bring some portion of misery to an end,“ states Viona ponderously. Aysche wrinkles up her nose and says, ”That’s not exactly new. It’s been used a bit too often.“ ”But does that mean it’s wrong?“

(* Viona is quoting Albert Schweitzer)

Where?	What?	To date	In future	Potential savings
Way to school	Petrol/ diesel	Mum brings me by car	I go on my bike	100%

EXERCISES:

1. *Give one another ideas as to how you can reduce your energy consumption. Each group should identify examples taken from home, school and leisure time for the fields of*
   - *Saving energy*
   - *Saving motor fuel*
   - *Saving heating energy*

   Write your tips in the table.
   You can publish your results in the form of a wall newspaper, the school newspaper, the school’s homepage, or in other media.

WHO CAN SAVE THE WORLD?

Climate protection and climate policy in Germany and worldwide

BACK TO THE PRESENT

Boooom! The time machine comes to a standstill. Viona rubs her bottom ruefully, "Felix, you should brush up your landing skills," she complains. She had never really been wild about the level of comfort available in the time machine, and they had been through a lot on their journey through the millennia. But enough is enough. "We're back in 2006," announces Felix. "Reality is usually a bit harder than fiction, sweetie." Aysche and Manuel too still look a bit bemused after the landing. Or are they sad to be back? "Is the wonderful journey really over?" asks Aysche. Felix gives a superior smile. Once again he knows more than the others. "Oh no," he says, "The journey is only beginning."

Aysche doesn't understand. "I thought the futurometer is at zero." Now Manuel too comes to. He looks at the display. Zero! Zero, zero, zero! No more power for trips into the future. Now it will take as long as it takes. More than twenty years until the year 2030. He won't see Saranchimeg for another 24 years. The he will be 40, and Saranchimeg will be 15.

"What's twenty-four years, man?" says Felix. Is he a mind-reader? Manuel wipes his eyes hastily, as he sees his friend. He's still wearing that stupid superior grin of his. It seems to be getting on Viona's nerves too. "Compared to the time dinosaur skeletons were buried, it might not seem long," she snaps. Felix becomes serious again. "Do you remember our stop-over in 1979? That was 27 years ago. Scientists pointed out for the first time that there was a real threat of climate change. And what has happened since?"

Viona undoes her safety belt, and opens the door. She's had enough of these hard seats and her rear end is still very tender. She can't help grimacing from the pain as she tries to swing abruptly out of the machine. The others look at her half questioningly and half pityingly. "Don't stare," Viona exclaims. "I'm just off to save the world."

"She's right you know," pointed out Felix. "In future we'll have to keep a stiff upper lip. Do you think Saranchimeg, Sergio and the others in 2030 would have come so far if we hadn't got things moving?" "Smart alec!" thinks Aysche. "Saranchimeg," whispers Manuel.

As they throw a tarpaulin over the time machine, Aysche asks, "What do we do now? The world is a big place. Where do we start?" They all stare inconclusively at the corner of the tarpaulin in their hands. "We need a plan," states Felix. "A map or something." "Oh yeah. Or something," Viona mimics him. "What do you think Manuel?" He starts. "What? Where? How?" "Dreamer!" "Don't mind me," says Manuel defensively, and gives Felix the cue. "That's it, we need a mind map". But what is a mind map?

EXERCISES:

1. Do you know? What does Felix mean by a "mind map"?

THE CLIMATE AND WHO CAN DO SOMETHING FOR IT

Felix and Viona are now embroiled in a full-scale argument. They are squabbling about who can do something to halt climate change. Really do something to make a difference. Felix maintains that it is **UP TO EVERY INDIVIDUAL**. "You can't change anything except your own life," he says. "You never run out of brilliant ideas, do you," Viona retorts. "Should every single one of 80 million people in Germany draw up their own climate protection plan? Ideally in the form of a mind map?" "Why not?" "But lots of them can't even read and write" "Or don't want to," Manuel adds. "Exactly. And that is why **THE STATE** must take responsibility," declaims Viona, triumphantly. But that wasn't what Manuel meant. "The experts must think of something," he says, "**SCIENTISTS**". That makes Aysche laugh. "What are they going to do, then?" she asks. "**INDUSTRY** must make the difference. Big businesses. They're the ones that belch out most of the filth into the air."

Felix is smiling his superior smile again. But he says nothing. Yet. First of all Viona explodes at Aysche, "And my dear, who do you think is going to force big businesses to belch a little less? The state of course," she sums up, and stares round jubilantly. Felix waits until her gaze settles on him, and says, "Businesses operate in lots of different states nowadays. Worldwide. Globally. And the filth doesn't stop at national borders. What can any one state do?" "Hold on," interjects Manuel. "A minute ago you wanted to make every individual responsible and now you're saying that not even individual states can do anything." "Is that a problem?" Felix defends himself. "Individuals can get together, say as NGOs" "As whats?" "**NGOs** Viona – non-governmental organisations." Silence reigns. After a little while Aysche says, "But don't all these people have some sort of influence over climate change? Each group is responsible for a bit." But Viona is not going to compromise on this one. "And if somebody doesn't know what to do, they can always set up a working group?" "Or they can organise an **international climate conference**," says Felix, and yet again has the last word.

EXERCISES:

1. *Who are the most important actors in climate protection? Who can exert an influence on the climate? Write your answers in the spaces on the mind map.*
2. *Explain the terms and write a short definition of what you understand by the individual actors.*

CLMATE CONFERENCE: GETTING THE WORLD AROUND A TABLE

Viona, Aysche, Manuel and Felix want to see how a climate conference would work. They have agreed that for simplicity's sake only representatives of the different states should take part, and not any other actors. But what is simple? There are more than 200 states in the world. They'll have to be put into groups. But how, and what criteria should they use? Geographically? By region? North, south, east, west? By climatic zones? By religion? By economic system? After much discussion, the four friends settle on six country groups? What do you think they are? Aysche drew them on the world map like this.

EXERCISES:

1. Give the six country groups a name. Which countries belong to each of the groups? What do the countries have in common?
Write the group names in the boxes and enter them in the table overleaf.

CLIMATE CONFERENCE: GETTING THE WORLD AROUND A TABLE

USA, Canada, Japan ...	Germany, France, Poland, Italy ...	Russia, Ukraine, Kazakhstan ...	Saudi Arabia, Iraq, Qatar, Nigeria ...	India, China, Brazil, Mexico ...	Ethiopia, Congo, Peru, Cambodia ...	
						Name of the country group
						Percentage of total surface area of the Earth
						Percentage of world population
						Economic strength (per capita GDP)
						CO_2-emissions (total)
						CO_2-emissions (per capita)
						Number of votes at climate conference

EXERCISES:

1. *Calculate the percentage of the surface area of the Earth and the percentage of the world population accounted for by each country group. Find out about GDP and CO_2 emissions. Use reference books, atlases and the Internet, e.g. http://earthtrends.wri.org > climate and atmosphere.*
   Enter the results in the table.
2. *Discuss in pairs or in groups how voting rights are distributed at a conference. Should they be distributed by size, population, GDP or CO_2 emissions?*
   Enter your results in the table.
3. *Agree on a code of conduct for participants at the international conference.*
4. *Assess the results as a class.*

SOS CLIMATE: THE KYOTO PROTOCOL

Kyoto Protocol to the Framework Convention on Climate Change:

ARTICLE 2

(1) Each Party ... in order to promote sustainable development, shall: - 2 -
a) Implement and/or further elaborate policies and measures in accordance with its national circumstances, such as:
i) Enhancement of energy efficiency in relevant sectors of the national economy;
iv) Research on, and promotion, development and increased use of, new and renewable forms of energy, of carbon dioxide sequestration technologies and of advanced and innovative environmentally sound technologies;
v) Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies ... that run counter to the objective of the Convention ...;
vi) Encouragement of appropriate reforms ... aimed at promoting policies and measures which limit or reduce emissions of greenhouse gases ...;
vii) Measures to limit and/or reduce emissions of greenhouse gases ... in the transport sector;

ARTICLE 3

(1) The Parties ... shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amounts, ... with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012.

This is an extract from Articles 2 and 3 of the Kyoto Protocol. It was drawn up at the 1997 climate conference held in Kyoto, Japan, and aims to reduce the concentration of greenhouse gases in the atmosphere. The main focus is on carbon dioxide (CO_2). The Protocol is probably the best-known climate protection document. One reason for its fame is that it took almost eight years before it came into force (1997 to 2005). Against this background the "Kyoto Protocol" was often in the news. But as is so often the case, everyone has heard of it, but nobody knows what it says, although the entire text is only twenty pages long.

EXERCISES:

1. *What is the aim of the Kyoto Protocol?*
2. *What is the current status quo? Which countries have ratified the Protocol? Which countries have not ratified it?*
3. *Why did it take almost eight years before the Protocol could come into force? Which rules were agreed in the Protocol for this?*

In the Kyoto Protocol, the industrialised states of the world undertake to reduce their aggregate (total) greenhouse gas emissions by 5 percent of the 1990 level by 2012. Developing countries and emerging economies were not obliged to make any changes. But, just a minute! If total emissions are to be cut by 5 percent, does that mean that every individual industrialised state has to cut its emissions by 5 percent, or are there differences? The fact is that some countries are to make greater cuts than others. Some are actually entitled to increase their 1990 levels. The European Union, for instance, was to cut emissions by 8 percent of the 1990 levels. That does not mean, however, that each of the then 15 EU member states has to make reductions of 8 percent. Here are the reduction targets for some EU member states, by way of example:

Denmark	**-21.0 %**	**France**	**0 %**	**Greece**	**25.0 %**
Germany	**-21.0 %**	**Finland**	**0 %**	**Portugal**	**27.0 %**
United Kingdom	**-12.5 %**	**Sweden**	**4 %**	**Ireland**	**13.0 %**

Source: UBA (Federal Environment Agency)

In 1990 Germany was responsible for emissions of a fantastic 1,251,723 million tonnes of greenhouse gases, most of them CO_2. By 2002 this figure had been reduced to 991,421 million tonnes. Germany had thus made good progress towards achieving its reduction goals. But progress is not even across the board. The following graph shows how the percentage of total energy consumption accounted for by certain sectors, and thus their greenhouse gas emissions, have changed in Germany since 1990:

Climate protection after 2012:

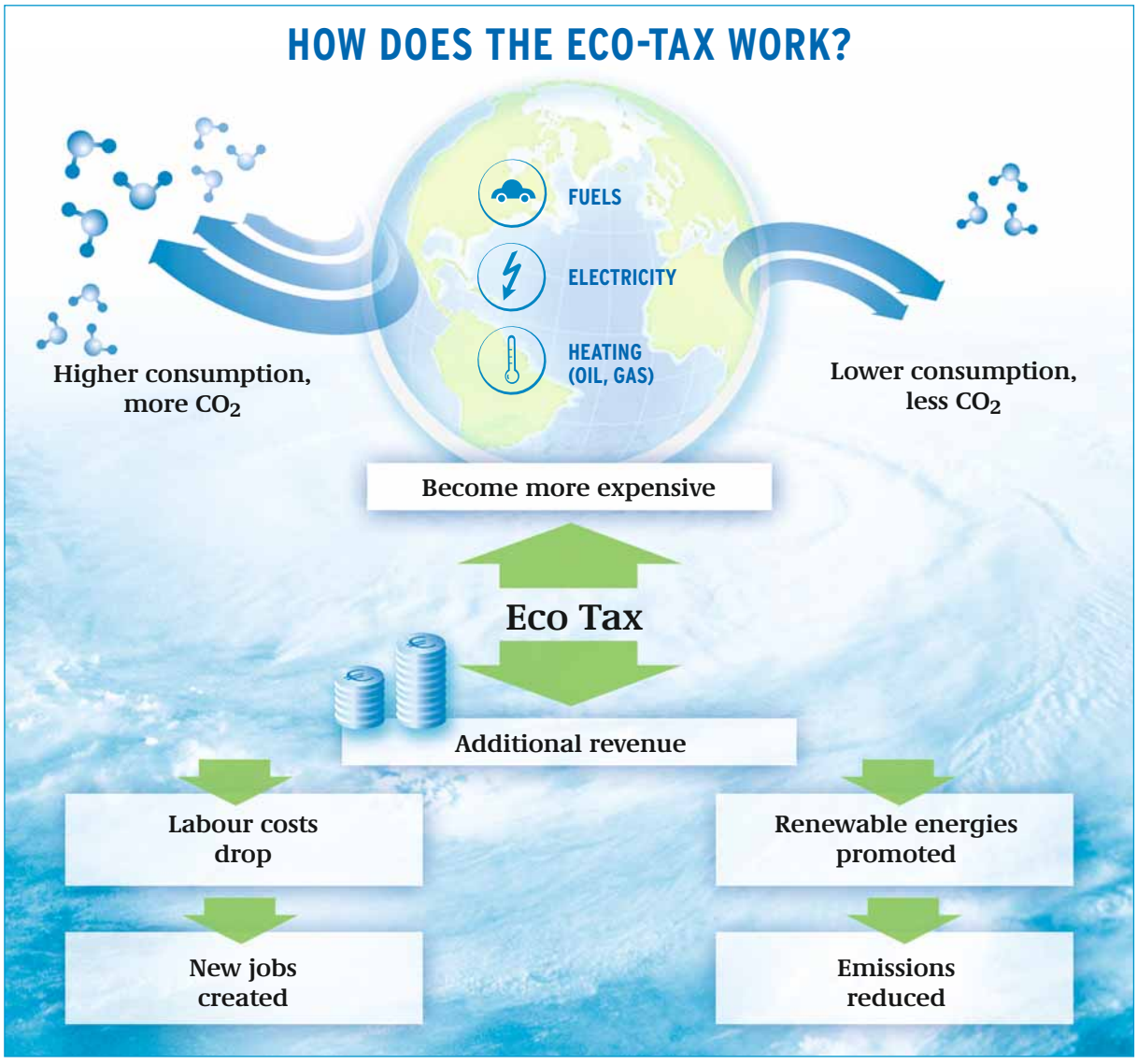
At the UN climate change conference in Bali in late 2007, the industrialised states, including the US, promised to combat climate change in a verifiable manner and to limit and reduce greenhouse gas emissions. The developing countries, too, committed to a step-by-step introduction of climate protection measures after 2012. Germany committed to reducing greenhouse gas emissions by 40% by 2020 compared to 1990!

EXERCISES:

1. *Why did only the industrialised states undertake to reduce emissions under the terms of the Kyoto Protocol?*
2. *What are the reasons for the differences in reduction targets among EU states?*
3. *What progress has Germany made towards its reduction goals?*
4. *Where could more progress be made in future in reducing greenhouse gas emissions? Suggest how this could be achieved.*

ENVIRONMENTAL AND CLIMATE POLICY TOOLS

Viona beams. She believes that reality has proved her right. The Kyoto Protocol places the brunt of responsibility on nation states. National governments are to ensure that the emissions of greenhouse gases are reduced. But Felix is not going to give up so easily. "The state itself is not the main polluter, and therefore not to blame," he points out. "How can it force citizens and businesses to emit less carbon dioxide and so on?" "Weeeeeell," says Viona slowly, "They could just ban it." Manuel bursts out laughing. "Ban it? Ban carbon dioxide?" He gasps for breath. "You'd better shut up so you don't breathe out as much." "But they banned CFCs," Viona protests. "Yes, but only your old fridge exhales those when you throw it out." "It's still working," she says, and really shuts up this time. "OK. Bans are difficult," Felix sums up. "What about strict regulations?" "Or incentives?" suggests Aysche. Three faces stare at her questioningly. "For example, the state will give subsidies to companies developing engines that produce fewer toxic gases." "And where will the money come from?" demands Manuel. "That's obvious," grins Felix, "From those that produce the most greenhouse gases."



CARROT OR STICK?

The tools used by states in the field of environmental policy

Bans	Strict regulations (e.g. limits)	Financial incentives	
			Eco-tax
			Deposit on cans
			Ban on CFCs
			Ordinance on energy saving
			Limits on soot particle emissions

EXERCISES:

1. *Germany has introduced an eco-tax to help reduce greenhouse gas emissions. What type of environment-policy tool is this (ban, strict regulation, financial incentive)?*
2. *Class the other tools listed. Find other examples of tools and put them in the appropriate categories.*
3. *Discuss in pairs the pros and cons of bans, strict regulations and economic incentives. Take into account the economic, social and ecological contexts.*

PRESS AND PUBLIC RELATIONS WORK

At a climate conference, participants consult and discuss for hours and hours, often into the small hours. Even if the conference were broadcast live, practically nobody would watch it. So it is up to the press to report on the conference. Journalists collect information, sift the facts and then write an article or produce a report for television or radio.
The politicians prefer it if the press publishes only what is contained in official press releases or what is said at a press conference. But journalists ask questions, and that is not always pleasant for politicians. They are forced to explain their decisions. Sometimes they have to admit that something has gone wrong, and explain why, even when they would much rather just sweep their setback under the carpet.
Naturally journalists have their own opinions, but they do not conceal these in their newspaper articles, nor do they stick them in the headline. If they want to force readers to think about something they write a special editorial, which is published as such.

Surprising breakthrough at the Bonn Climate Summit

Last minute compromise

Marathon negotiations end in major success

Climate protection - as many holes as a Swiss cheese

”

“

The UN climate conference in Bonn has approved a compromise brokered by Japan, which removes the obstacles to implementing the Kyoto Protocol on the reduction of greenhouse gases. The breakthrough came after an all-night marathon at the negotiating table. The German government spoke of a ”major success“. The alternative to a compromise would have been, ”to postpone the matter ad infinitum“, according to deputy government spokesman, Béla Anda. In Bonn, the rules for reducing greenhouse gas emissions have now been laid down for industrialised countries. Some countries, Japan in particular, are to be allowed to use their forests to offset a generous portion of their reduction commitments. Greenpeace spoke of a ”historical step forward“ but demanded at the same time that ”effective measures be taken swiftly to protect the world's climate“. Greenpeace criticised Canada, Japan and Australia, who ”attempted to the bitter end to block any agreement on the ratification of the Kyoto Protocol“. As a result, the organisation claimed, ”the Kyoto Protocol now has as many holes as a Swiss cheese.“

(Taken from ”Die Welt“ 24 July 2001)

EXERCISES:

1. *How does the general public find out what is discussed at a climate conference and what results have been agreed?*
2. *How do journalists get their information?*
3. *Which of the four headlines fits the article best? Discuss them as a class, and vote on the headlines. Maybe you will find an even better headline of your own.*

WHO KNOWS ABOUT CLIMATE PROTECTION?
THE QUIZ

Question 1

Who are the most important actors in climate-related affairs?

A Manufacturers of air conditioning equipment

B Non-governmental organisations (NGOs)

Question 2

China, India and Brazil are

A Emerging economies

B Developing countries

Question 3

In which year was the Kyoto Protocol signed?

A 1985

B 1992

C 1997

Question 4

What minimum conditions had to be met before the Kyoto Protocol could come into force?

A 55 percent of all states on Earth had to have signed it.

B It had to be ratified by 55 states, which were together responsible for at least 55 percent of the greenhouse gas emissions of industrialised countries in 1990.

C The countries which ratified the Protocol had to account for at least 55 percent of the world's total land mass.

Question 5

What sort of a climate-policy tool is the eco-tax?

A A ban

B A strict regulation (limit)

C An economic incentive

Question 6

One regulation in the field of climate protection in Germany is

A The eco-tax

B The solidarity levy

C Tobacco tax

D The 1516 Purity Law

CAN WE GAMBLE WITH THE CLIMATE?

”All correct,“ shouts Felix, and grins provocatively again at Viona. ”We expect no less of our resident smart alec,“ she says, grinning back. ”But I’ve got them all right too.“ ”And me too,“ call Aysche and Manuel in unison. But Felix doesn’t let down his guard, and just admonishes them to ”Keep cool!“ That’s what is says in big letters on the box that Felix brings out from under the table with a flourish.

The three others are surprised. Viona lists up the lid curiously to have a look, and then asks shocked, ”A game? Don’t we have anything better to do?“ ”We can practice a bit first,“ says Felix. ”That’s what the game’s about.“ Aysche is already reading the rules. ”Cool, we get to build factories. I like that.“ ”Let me see,“ demands Viona and tries to pull the rule book out of Aysche’s hand. Felix gives her her own rule book. And he has another one for Manuel. While the three other begin to read, Felix gets started on preparing the game. In the silence, Manuel suddenly says, ”Sergio and Saranchimeg should be here now. Then we’d have ...“ ”... six players!“, Viona interrupts him crossly. ”Can’t you think of anything else? We can play the game with four players!“ ”I was only thinking,“ says Manuel defensively. Felix is busy thinking about another option. ”It’s really fun when a whole class plays. You get a real conference atmosphere.“ ”How are we going to manage that?“ Aysche wants to know.

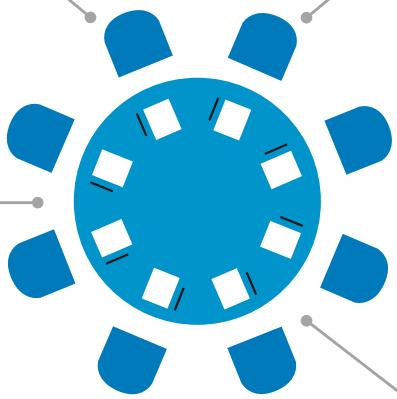
Felix explains:
”The class is divided up: We need leaders of the delegations, members of the delegations, members of the press corps and – if the class is big enough – an audience, i.e. the interested general public.“

Leaders of the delegations

They make the moves once they have discussed the options available with their delegations. They may also negotiate with the delegations from other country groups. And they have to provide the members of the press corps with information.

Delegations

The delegations consult and discuss the moves. Each group decides for itself how the group will make decisions (unanimously, by a two-thirdsmajority, by an absolute majority).



The press

Each country group nominates press representatives. They too should have done well on the quiz. Two or three journalists can also be appointed who will be reporting on the conference independently of the country groups. The ladies and gentlemen of the press document the course of the conference in a wall newspaper. This is updated after every three moves of the country in question. After every five moves, or if a special situation arises, the leader of the respective delegation is interviewed (see the worksheet on press and PR work).

Audience/General public

The audience responds to each report issued by the press with approval or protest.

CLIMATE PROTECTION AGREEMENT REMAINS INEFFECTIVE

Environmentalists are frustrated: the UN has published new figures which bury all hope that greenhouse gas emissions will be reduced rapidly. Instead of reducing their emissions, industrialised countries are emitting more and more climate damaging gases.

(...)"These trends are alarming," said Yvo de Boer, Executive Secretary of the Climate Change Secretariat in Bonn. Between 2004 and 2005 emissions increased by 2.6%, almost reaching a new record high. However, de Boer tries to stay optimistic: the 40 countries which have ratified the Kyoto Protocol can still reach its target of reducing greenhouse gas emissions by 5% by 2012 compared to 1990. (...)

by Volker Mrasek,
Spiegel Online, 20 November 2007

BILLIONS FOR THE POOR

The consequences of global warming could be mitigated by introducing a new global CO_2 tax. The United Nations commissioned the authors to calculate whether this could be done.

(...) Desertification, depletion of water resources and increased flooding can no longer be avoided. However, adaptation measures can considerably reduce the damage. Measures responding to the rise of sea levels, for example, could include the adaptation of settlements and structural defences. The World Bank estimates the necessary annual investments for adaptation measures until 2030 at 10 to 40 billion US dollars. The major share of this amount would have to be invested in poorer developing countries.

As the need for financing exceeds existing funds by far, we have to find new solutions. One proposition is to impose a worldwide CO_2 tax in the form of a financing levy. (...)

by Othmar Schwank and Helen Lückge,
Rheinischer Merkur, 10 January 2008

AFTER BALI: HIGH ENERGY PRICES SAVE THE CLIMATE

(...)It will not be long before the oil price rises over the 100 dollars-per-barrel mark (159 litres). What is sad news for tenants and house owners, in particular during a cold winter, will give a major boost to climate protection in the medium term. The higher the prices for oil, the faster energy-saving investments pay off. Some will buy new windows or a more energy-efficient refrigerator; others will insulate their apartment buildings.

High prices provide incentives in particular for developing countries to shape their economic growth in an environmentally friendly way. In China there are projects to make entire cities CO_2 neutral. Of course it would be better if governments agreed soon on binding agreements on climate protection. However, there is much more hope in trusting the market.

by Margaret Heckel,
Welt Online, 15 December 2007

GERMANY PLANS TO PARTICIPATE IN US CLIMATE TALKS

Bonn – Germany will continue participating in the climate talks of the Major Economies which were initiated by the US and are not part of UN negotiations. In Bonn, Matthias Machnig, State Secretary at the Federal Environment Ministry announced that he would represent the German government during the second series of the meetings in late January in Honolulu, Hawaii.

Machnig said there were positive signals from the US at the climate change conference in Bali in December. The meeting initiated by the US might make sense if those countries with the highest greenhouse gas emissions discussed their own contributions. He underlined that it was clear that these talks were not an alternative and could not replace negotiations of the global community within the framework of the United Nations. "The US is also committed to continuing UN negotiations." (...)

www.welt.de,
12 January 2008

A DECENT PROPOSAL

DONATIONS FROM AIR TRAVELLERS FOR CLIMATE PROTECTION ARE A VERY PROFITABLE BUSINESS. HOWEVER, NOT EVERY OFFER IS TRUSTWORTHY

(...) The idea: as compensation for taking climate-damaging flights, people pay money to a project which reduces CO_2 emissions on earth. It helps the climate, eases the conscience and is tax-deductible. Even though some sneer at it as a modern form of "indulgence trade", it has turned into a booming business in the past year and is ever present in the entire travel sector with its online offers. Among those who collect the money and distribute it are genuine environmentalists as well as clever profiteers. (...)

by Burkhard Strassmann,
DIE ZEIT, 03 January 2008 No. 02

THE WORLD IN 2008: CHINA

The economic boom of the last decade has led to a situation in which this country, with its 1.3 billion population, has become part of either the solution or the problem of many global issues today. The heads of China's ruling party have never before had the international influence they have today. As they have the greatest currency reserves worldwide at their disposal, they have an influence on the exchange rate of the euro and the dollar and thus on the state of national economies. Since their factories will soon be emitting more greenhouse gases than those of other countries, they hold the key to the success or failure of global climate policy. China is the biggest investor and donor in Africa and has an influence on regimes from Teheran to Pyongyang.

by Harald Maass, Beijing:
Tagesspiegel of 02 January 2008

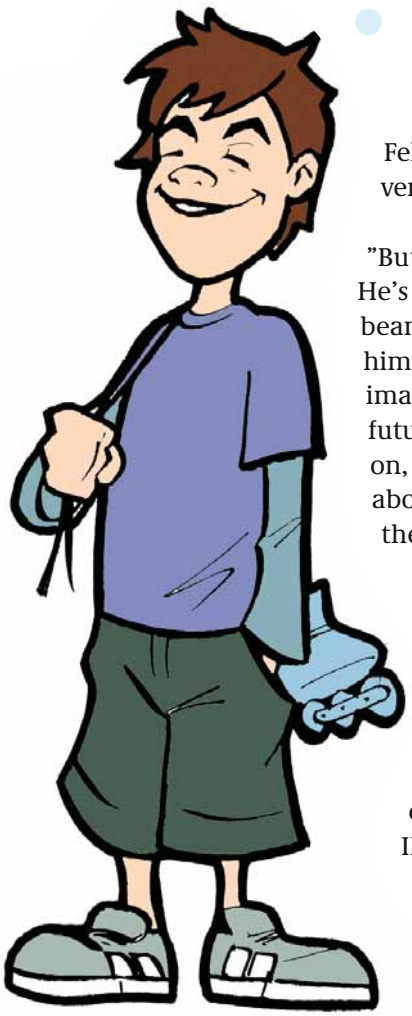
A ROUND TRIP TO THE FUTURE

Scenarios for climate change

Thank goodness it was only a game! Aysche, Viona, Manuel and Felix breathe a sigh of relief. The climate collapse won't be happening quite as quickly as it did in the game. But neither can we escape it. Viona is first to regain her composure, as usual. "It's not too late, yet," she says.

"But," says Aysche, "I just can't see how the Earth can still be saved. Industry has to keep growing somehow, and one day everybody in China is going to want their own car." "What have you got against the Chinese?" asks Viona sharply. "That was only an example," backtracks Aysche. "But there are almost 1.3 billion of them."

"And I just can't imagine that things can really be that serious." That was Manuel of course. "You're just naive," the two girls accuse him "No," says Manuel, laughing. "I'm an incurable optimist."



Felix keeps out of things and writes something on the board, "Prediction is very difficult, especially about the future." (Niels Bohr)

"But we can find out quite easily what will happen," says Manuel, eyes shining. He's hoping to get to see Saranchimeg again, the girl from the future. "We can beam ourselves over by mobile." He stares at Felix, daring him to contradict him. Felix shakes his head. "No, that really won't work," he said. "We only imagined it." "Oh yes it will work," calls Viona. "We can imagine what the future will be." Aysche agrees, "Exactly, there's that ... that ... technique. Hold on, it's on the tip of my tongue. I know. Scenario technique!" She rummages about in the card file and brandishes a card triumphantly. She glances over the text and thrusts it under Viona and Manuel's noses.

Viona reads aloud slowly, "With the help of the scenario technique you can bring together ideas about the individual positive and negative trends in the future, to produce holistic images and models, which are readily comprehensible and tangible.

At the word "tangible" Manuel's eyes light up. Saranchimeg ... While he dreams of the future, Viona, Aysche and Felix are discussing scenarios and IPCC, A1 and B2, swelling populations and shrinking economies, or vice versa. All of a sudden Viona prods him with her elbow and thrusts a piece of paper into his hand, with the command, "Now read that out loud."

SCENARIO TECHNIQUE

When trying to identify climate trends we typically have to work with very long periods of time over which today's developments will have an impact. Political decisions are thus based on figures and graphs, produced by scientists and research institutes like the IPCC.

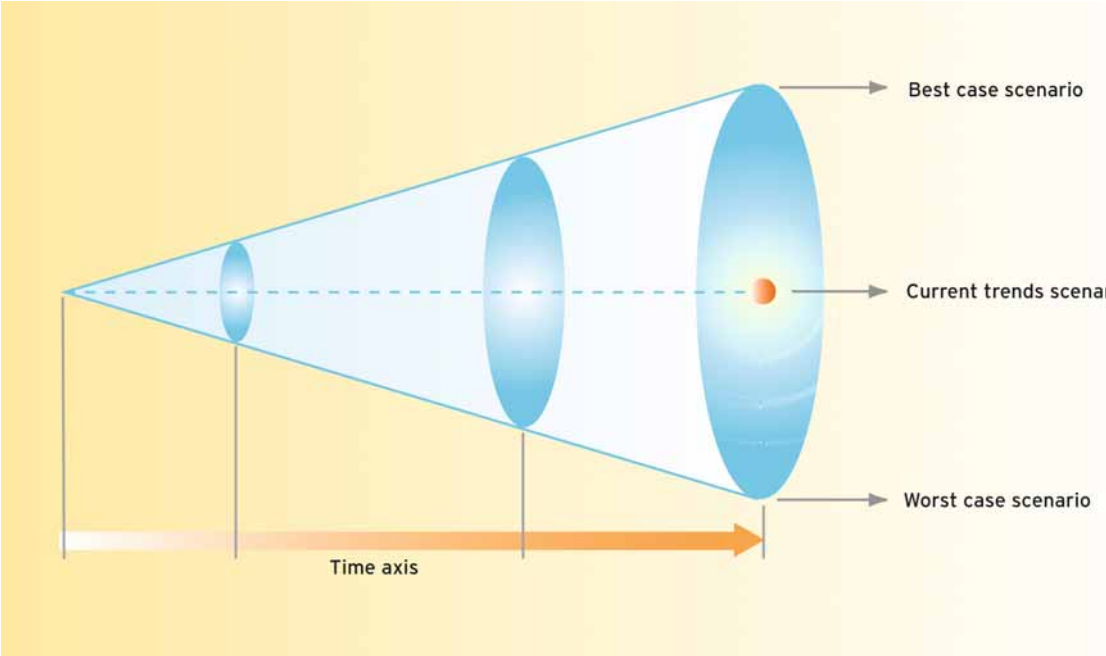
The figures and graphs naturally cannot tell us what Germany will look like in 2050 or 2100 when we open our front doors. Nobody can really imagine that. Or can they? You can give it a go, at least.

This is the major advantage of the scenario technique. It is based on a few genuine facts and figures, but leaves scope for your lively imagination.

The scenarios to emerge are not a forecast based on complex algorithms. But neither are they wild conjecture or some sort of utopia, far removed from reality.

Generally, three basic types of scenario are produced:
- The positive extreme scenario, in which future trends are as good as possible (best case scenario)
- The negative extreme scenario in which future trends are as bad as possible (worst case scenario)
- A current trends scenario which projects today's situation into the future.

The short-term scenario covers a timescale of five to ten years, the medium-term scenario covers the next eleven to twenty years and the long-term scenario look at what will happen in over twenty years.



The scenarios are made tangible with the help of a scenario filter funnel. The present is taken to be the narrowest part of the filter funnel (at the left hand side of the diagram). The further into the future we look through the funnel, the more complex and divergent the options and the more uncertain the future.

CAN WE CALCULATE THE FUTURE?

The experts at the Intergovernmental Panel on Climate Change (IPCC) have given a great deal of thought to the climate of the future. First of all, they thought about the basic paths developments on Earth could take. For example, they asked:
How will emissions of CO_2 and other greenhouse gases change

- if the population of the Earth grows or drops
- if the global economy expands rapidly or not so rapidly
- if the development status of the various parts of the Earth converge, or if they do not converge
- if power is generated primarily from oil and coal or more from renewable energies
- if modern technologies allow us to use less and less materials?

Because there are a wide range of possible answers, they produced a total of four scenarios, known as A1, A2, B1 and B2. For us, the first of these scenarios is particularly interesting. Scenario A1 is based on the assumption that the economy grows robustly and uses increasingly efficient technologies. There are three variations – determined by the energy used, the best case and worst case scenarios and the current trend scenario: In $A1_{fossil}$ (A1FI*) the main sources of energy are fossil fuels, i.e. oil and coal. $A1_{renew}$ (A1T*) presumes the use of renewable energy sources, $A1_{both}$ (A1B*) assumes that fossil fuels and renewables are used in equal parts.

* A1FI, A1T and A1B: The IPCC Special Report on Emissions Scenarios (SRES; Nakicenovic et al., 2000)

Scenarios

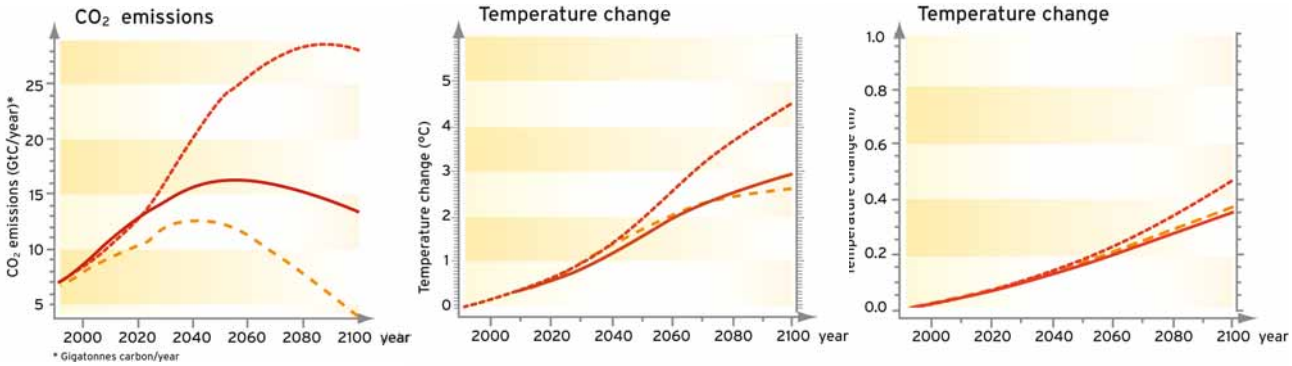
$A1_{fossil}$ (A1FI)

$A1_{renew}$ (A1T)

$A1_{both}$ (A1B)

Which curve goes with which scenario?

Scientists fed an enormous number of facts, figures and formulae into a huge computer. It then calculated, for instance, how the concentrations of CO_2 in the air will change and what impacts this will have on the temperature on Earth or on sea levels. Plotted on graphs, the results are shown below.



EXERCISES:

1. Which curve represents which scenario? Label the curves $A1_{fossil}$, (A1FI), $A1_{renew}$ (A1T) and $A1_{both}$ (A1B) and give reasons for your choice.

Tip: If you want to find our more about these scenarios you can read the IPCC reports or extracts from these reports on the Internet: www.cics.uvic.ca/scenarios/index.cgi?More_Info-Emissions and www.grida.no/climate/ipcc/emission/index.htm.

HOW WE COULD BE LIVING IN 2020

Manuel is still standing there, the piece of paper in his hand. Viona has to prod him again. "Your turn!" When Manuel stares at her uncomprehendingly, she commands, "Read!"

"We have it hellishly good!"

It is 2020. The world's climate has changed drastically. Temperatures worldwide have risen by about seven degrees Celsius. Sea levels have risen by two metres. The amount of available land has dropped markedly. Many forests have been completely cleared or destroyed by slash and burn farmers. They were blocking access to the very last oil and coal reserves. Deserts continue their onward march. But, who cares? The classic oil-producing countries were always deserts anyway. Respiratory diseases are widespread. Vehicle exhaust fumes have turned the air into a cocktail of toxic chemicals. The only fun we can still have outside is racing down the motorway at 250 km/h.

Although water covers more of the surface of the Earth than ever before, drinking water reserves are in very short supply. Some water has to be flown into Europe from North America – the second air lift. Now there are plans to build a pipeline. People are becoming more and more inventive. New technologies are being invented all the time to help us cope with the consequences of pollution. Because this is so costly, the Europeans and Americans have stopped development aid. They need the cash to import raw materials.

The high costs of providing energy and food have opened up a gulf between the haves and the have-nots in the formerly prosperous states of the northern hemisphere too. There is no middle class any more. The better-off have retreated to heavily guarded biospheres, some of them roofed-over, where the last animals can also be found.

The poor, by contrast, live in extreme destitution. They cannot afford waste disposal services, so rats have become a genuine plague. Water can only be used for food, and personal hygiene has to go by the board. Solar energy plants that had been installed have been destroyed by natural disasters such as tornados and hailstorms.

(based on: Albers, Olaf/Broux, Arno: Zukunftswerkstatt und Szenariotechnik – Ein Methodenbuch für Schule und Hochschule*. Beltz Praxis. Weinheim and Basel 1999)

EXERCISES:

1. *This scenario was produced using the scenario technique. Do you think this is a best or worst case scenario? Or is it a current trends scenario? List the reasons for your decision using key words. Vote as a class on which scenario you think this represents and discuss your opinions.*
2. *Could this really happen? Is it a realistic scenario for the year 2020? Or is it wild conjecture? Gather the facts that speak for or against this scenario. Discuss them as a class and decide what you need to bear in mind when you produce your own scenario.*

THE CLIMATE IS AT STAKE – HOW DO PEOPLE LIVE IN GERMANY IN 2050?

”Do you know what?“ says Viona, enthusiastically, ”Let’s try it.“ ”What?“ asks Manuel, who is apparently still a bit at sea. But Aysche and Felix know what she means, and how it works. ”First, we have to write down precisely which problem we want to look at,“ says Felix. And Aysche follows up with a good suggestion. ”The climate is at stake – How do people live in Germany in 2050?“ Manuel comes to again, ”That’s genuine science fiction.“

EXERCISES:

1. *Produce your own future scenarios. The table gives you the most important factors which will influence tomorrow’s climate. Think about how these could change and enter the results in the last column of the table, e.g. as an arrow showing the trend (up, down constant).*

   Work together to produce a story about the general situation and everyday life in 2050. Take the facts listed in the table as your basis and otherwise give your imagination free rein.

   Think about how you can present your scenario to the class. Can you already see examples in Europe or in the world which point which way trends will go? Use these examples to justify your choice of scenario and explain why you think your scenario is the most probable.

BEST CASE SCENARIO – GERMANY IN 2050

Factor	Status quo	Probable in 2050
Number of cars used regularly	ca. 0.5/ inhabitant	
Air traffic in flights per inhabitant per year	ca. 1.8	
Fossil and nuclear energy (% of total power generated)	88.2 %	
Renewable energies (% of total power generated)	11.8 %	
Energy productivity (taking 1990 as the base year, 1990=100)	130	

Factor	Status quo	Probable in 2050
International agreements	Kyoto Protocol in force	
CO_2 emissions (2005)	897 Mio. t CO_2	
CO_2 emissions (2005)	ca. 380 ppm	
Average temperature compared with today	0	
Sea level compared with today	0	

Source: UBA 2007, BMU, NOAA, ESRL, Uni Bremen

EXERCISES:

1. Draw up a best case scenario.
Take your lead from the following bullet points and the information in the table.

- *The human race manages a radical turn-around. Thanks to international agreements and the efforts of every individual, emissions of CO_2 and other reenhouse gases are reduced drastically.*
- *At least as many billion dollars are invested worldwide in renewable energies and resource-saving technologies as used to be invested in developing and operating nuclear power stations.*
- *The average temperature of the Earth's atmosphere remains as high as in 2005.*

WORST CASE SCENARIO – GERMANY IN 2050

Factor	Status quo	Probable in 2050
Number of cars used regularly	ca. 0.5/ inhabitant	
Air traffic in flights per inhabitant per year	ca. 1.8	
Fossil and nuclear energy (% of total power generated)	88.2 %	
Renewable energies (% of total power generated)	11.8 %	
Energy productivity (taking 1990 as the base year, 1990=100)	130	

Factor	Status quo	Probable in 2050
International agreements	Kyoto Protocol in force	
CO_2 emissions (2005)	897 Mio. t CO_2	
CO_2 emissions (2005)	ca. 380 ppm	
Average temperature compared with today	0	
Sea level compared with today	0	

Source: UBA 2007, BMU, NOAA, ESRL, Uni Bremen

EXERCISES:

1. Draw up a worst case scenario.
Take your lead from the following bullet points and the information in the table.

- *The Kyoto Protocol fails, and there is no follow-on agreement.*
- *Instead of renewables, the major states put their money on nuclear power. Billions are poured into developing, operating and securing these plants. At the same time oil and coal reserves are ruthlessly exploited to the last drop and the last nugget.*
- *New technologies are used primarily to protect the rich from environmental toxins and natural disasters.*
- *The Earth heats up by more than four degrees.*

CURRENT TREND SCENARIO – GERMANY IN 2050

Factor	Status quo	Probable in 2050
Number of cars used regularly	ca. 0.5/ inhabitant	
Air traffic in flights per inhabitant per year	ca. 1.8	
Fossil and nuclear energy (% of total power generated)	88.2 %	
Renewable energies (% of total power generated)	11.8 %	
Energy productivity (taking 1990 as the base year, 1990=100)	130	

Factor	Status quo	Probable in 2050
International agreements	Kyoto Protocol in force	
CO_2 emissions (2005)	897 Mio. t CO_2	
CO_2 emissions (2005)	ca. 380 ppm	
Average temperature compared with today	0	
Sea level compared with today	0	

Source: UBA 2007, BMU, NOAA, ESRL, Uni Bremen

EXERCISES:

1. Draw up a current trend scenario.
Take your lead from the following bullet points and the information in the table.

- *The Kyoto Protocol is successfully implemented. A follow-on agreement limits emissions of CO_2 and other greenhouse gases.*
- *Renewable energy sources are used increasingly.*
- *The Earth heats up by a maximum of two degrees Celsius.*

THE FUTURE OF THE CLIMATE HAS ALREADY BEGUN

What prospects! Aysche, Viona, Felix and Manuel are impressed. Although a lot seems pretty extreme, the truth is probably somewhere in the middle. Now they all ask:

What can we do? Who can do what?

Actors	Objectives	Timescale short-term medium-term long-term	Activities
Me (the individual)			
Us (parties, associations)			
Industry			
The state (local, regional, national government)			
European Union			
The internatio-nal community (UN, World Bank)			

EXERCISES:

1. *Consider what the individual, associations, the state etc. can and must do to save the Earth.*

THE FUTURE OF THE CLIMATE HAS ALREADY BEGUN

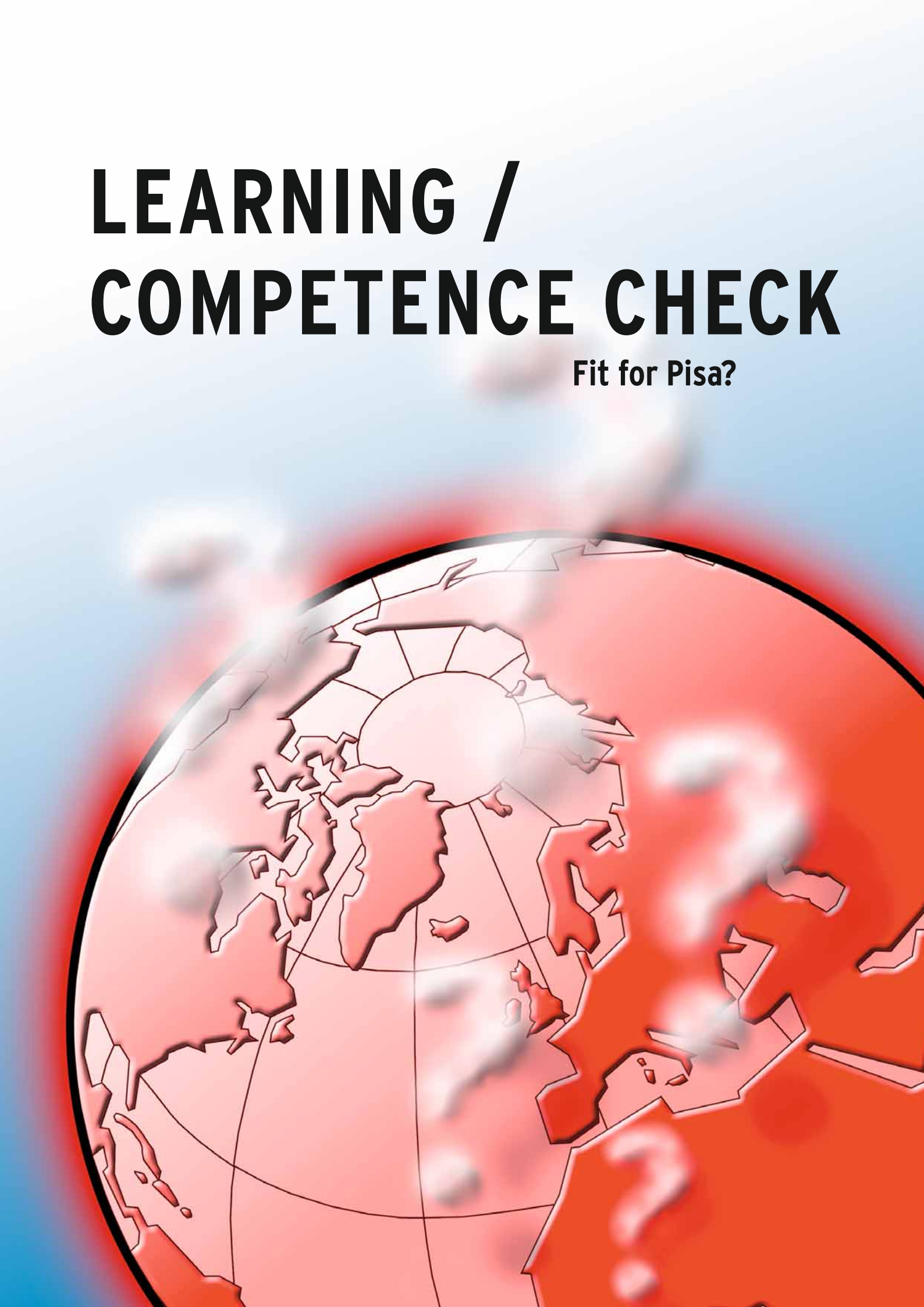
Objective: Reduce CO_2 emissions in the long term	Activities: Promote renewable energies	A
Objective: Reduce petrol consumption	Activities: Build low-fuel cars	B
Objective: Halt desertification	Activities: Support poor states	C
Objective: Make people enthusiastic custodians of the environment	Activities: Grab their imagination with special activities	D
Objective: Save electricity	Activities: Turn off appliances properly (do not leave them on stand-by)	E
Objective: Protect consumers from environmental toxins	Activities: Produce and enforce EU guidelines	F

EXERCISES:

1. *Match up the examples with actors and enter them in the table on page 1 of 2. Remember some of the objectives and activities can be matched up with more than one actor.*
2. *List more objectives, and consider who should be responsible for achieving them.*
3. *Consider when these objectives should be achieved (in the short term, medium term, long term)*
   N.B.: The Kyoto Protocol which obliges the industrial states to reduce emissions of major greenhouse gases came into force on 16 February 2005 when it was ratified by Russia. The Framework Convention on Climate Change was adopted in 1992 in Rio de Janeiro.
4. *Lay down what, specifically, the individual actors can do in order to achieve these objectives.*

LEARNING / COMPETENCE CHECK

Fit for Pisa?



NEWS FROM THE FUTURE

Everybody is speaking about the climate change that could drastically change our planet in future. Viona and Felix have seen an exciting video. The whole of New York had vanished under a sheet of ice. "We could travel to the New York of the future," suggests Viona. Manuel rolls his eyes. "Don't be daft. That's impossible," he objects. Felix ignores Manuel completely. "We can do some research and establish what was found in the ice in and around New York when the ice melts again in 2750". "How are we supposed to know anything about that?" Aysche wants to know. "It's an imaginary research trip," counters Viona. "Something different at last," says Felix, "A round trip to the future – New York under ice."

HERE IS THE RESULT OF THE IMAGINARY RESEARCH TRIP

Figure 1 shows how the ice sheet that covered New York and the surrounding area from 2050 to 2750 changed over the centuries. In 2050 New York was not yet covered by ice. The ice sheet was formed later. By 2750 the ice sheet had vanished again.

FLUCTUATIONS IN THE DEPTH OF THE ICE SHEET OVER NEW YORK AND THE SURROUNDING AREA

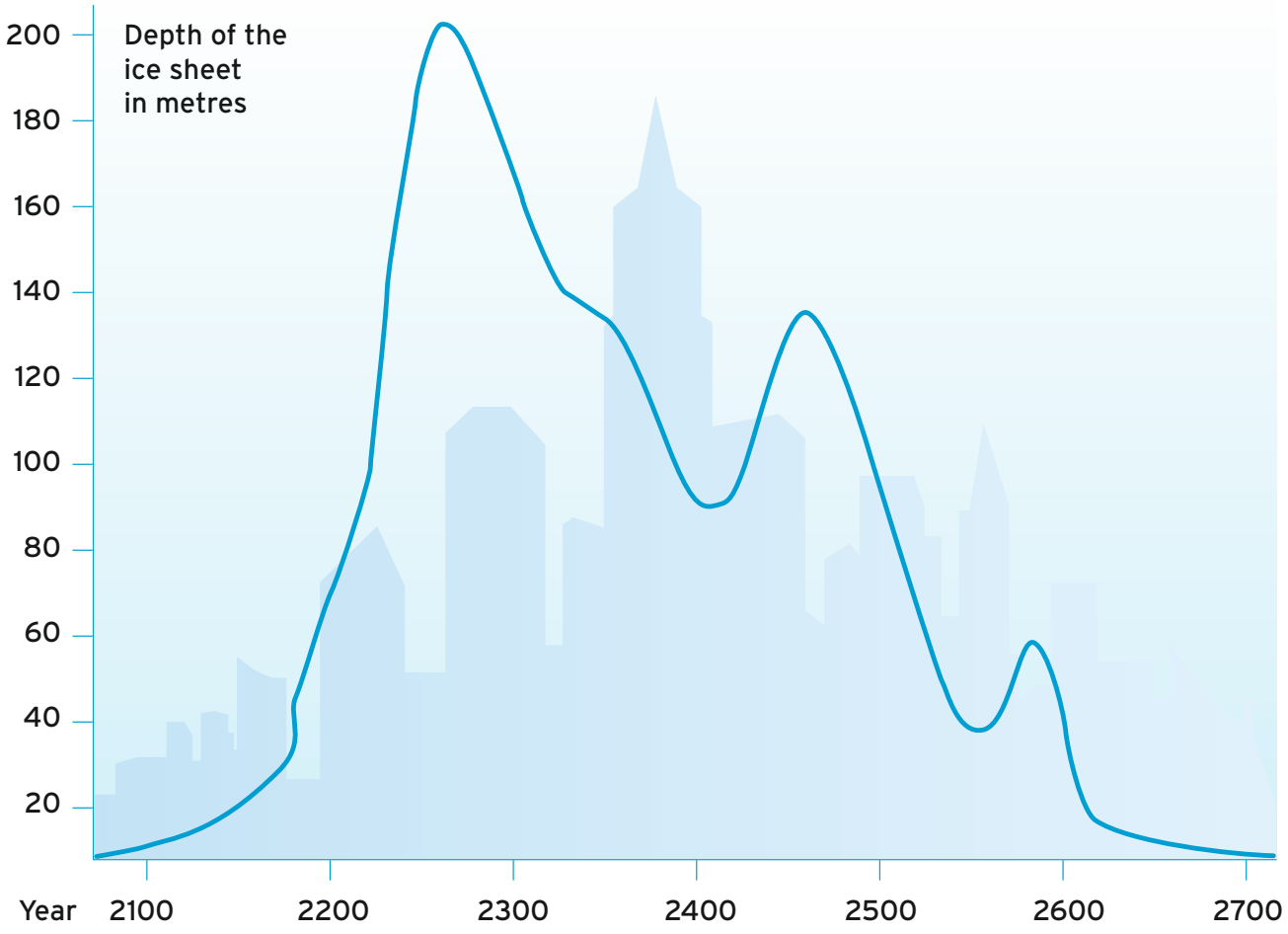
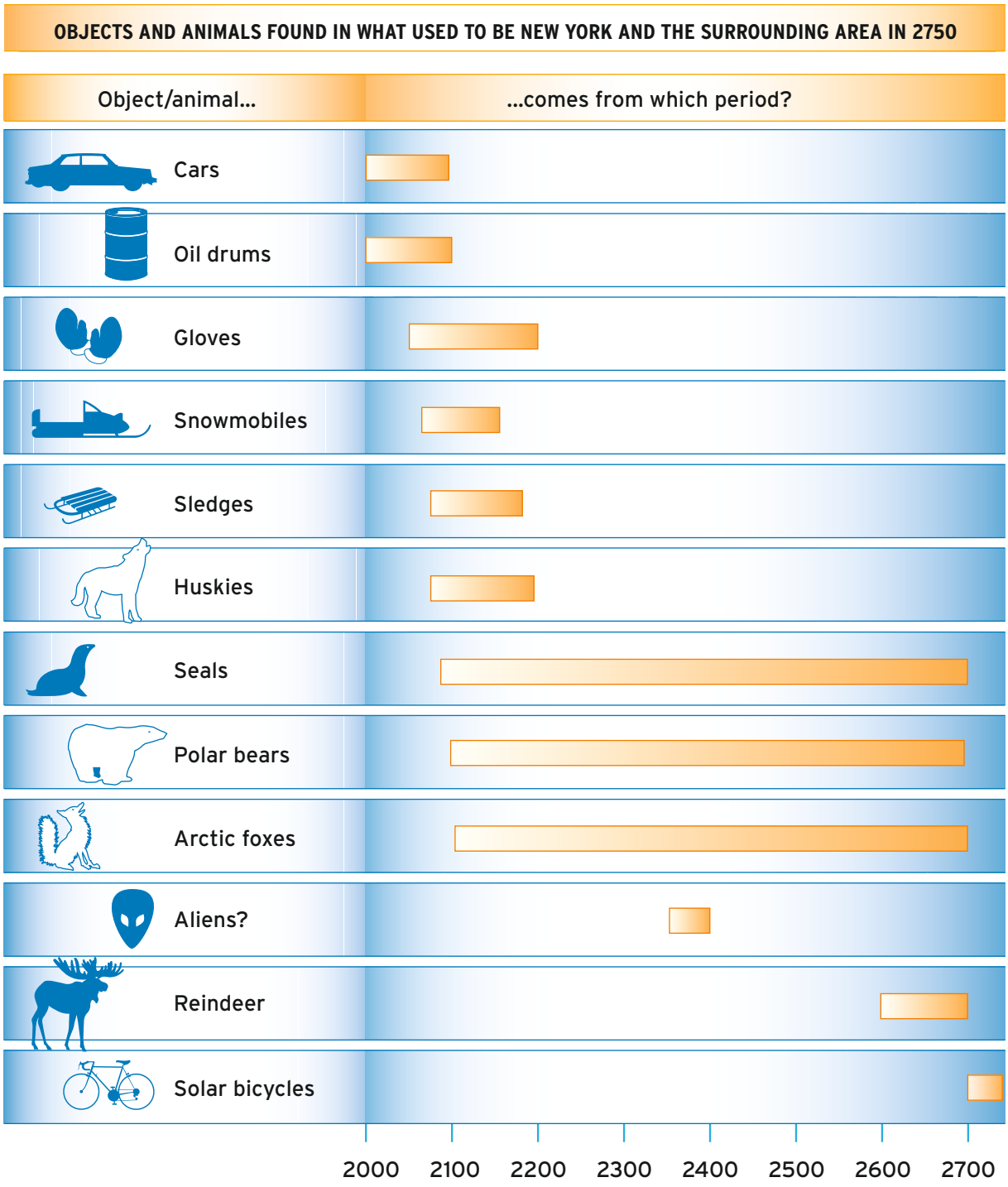


Figure 2 shows objects and animals found by scientists in 2750 in the area of what used to be New York. The left-hand column shows the objects and animals found, with their names. The length of the bar in the right hand column shows how long the animals lived in New York and the surrounding area, or the period of time over which the objects were used.



1. How thick was the ice sheet in 2450?

- ☐ between 120 and 140 metres
- ☐ between 80 and 100 metres
- ☐ between 60 and 80 metres
- ☐ At this point the ice sheet is at its thickest.
- ☐ We were given no information about this.

2. In roughly what year does the diagram in Figure 1 begin?

_____

3. Why did scientists start the diagram at this point?

_____

4. When they produced Figure 2, scientists assumed that ...

- ☐ the objects were used here and not anywhere else.
- ☐ the objects and animals were used or lived at that time in or around New York.
- ☐ the oil barrels were only used until 2100.
- ☐ people no longer entered New York after 2250 since it was under ice.

5. By what criteria are the objects and animals in Figure 2 listed?

- ☐ first the objects then the animals
- ☐ alphabetically
- ☐ without any system
- ☐ by which occurred or was used first
- ☐ by duration used/lived in the area and time of disappearance

6. Seals, polar bears and arctic foxes vanished ...

- ☐ once the ice had disappeared completely.
- ☐ at the start of the ice age.
- ☐ when the ice sheet was at its thickest.
- ☐ once the ice sheet had grown for more than 500 years.
- ☐ when the ice sheet was about 60 metres thick.

7. Which of the following statements is correct?

- ☐ When the ice sheet was at its thickest, there were more animals than objects.
- ☐ Polar bears live in very cold regions. When there were no polar bears any more, the ice must have melted.
- ☐ Changes in the objects found generally correspond to changes in the ice sheet (growing or melting).
- ☐ When the reindeer appeared, the seals had vanished again.

ARE YOU AND YOUR PUPILS FIT FOR PISA?

The Education Service expressly offers information primarily on scientific, geographic and social studies topics. The aim is to give pupils modern scientific skills, with a view to enabling them to play a responsible, understanding and active part in today's and tomorrow's society. This corresponds to the competencies tested at international level within the framework of the PISA test. In line with this, test questions have been developed for the Education Service and are designed to allow teachers to assess the competence level attained by their pupils.
The competencies to be acquired are very varied and demanding. The materials on this topic aim to develop the proactive skills of pupils. (See also: **www.blk.de/Inforundgang/Gestaltungskompetenz.php**).
Our ideas today as to what constitutes a high-quality, practice-oriented, situation- and problem-appropriate basic scientific education (i.e. giving pupils scientific literacy), generally makes a distinction between the following fields, in which competencies can be categorised (PISA 2000, p. 195):

- Scientific concepts and principles (...)
- Methods of scientific investigation and scientific ways of thinking (...)
- Ideas as to what is special about sciences (...)
- Ideas as to the relations between science, technology and society (understanding of the "Science Business" in a social, economic and ecological context)
- Attitudes to and value-based decisions on the application of science and on nature as part of our living world.

The central facets of scientific literacy are:

Scientific processes – These are ways of thinking and working used by science (e.g. recognising that a problem can be tackled on a scientific basis, drawing appropriate conclusions on the basis of data and findings, the ability to explain something to others on the basis of scientific arguments, the ability to make predictions on the basis of data, interrelations and events).

Scientific concepts and subject matter – The topic fields and fields of application in which science offers facts and findings (e.g. forces and motion, evolution, the immune system).

In our modern understanding of science, the fields of application are considered to be very important. After all, the knowledge acquired is to be used in situations outside the classroom or laboratory. A distinction is made between individual, local or municipal and global importance.

A distinction is made between five competence levels:

Competence level I:
Nominal scientific literacy.
Pupils are able to draw conclusions on the basis of everyday scientific knowledge and can reproduce simple factual knowledge.

Competence level II:
Functional scientific literacy on the basis of everyday knowledge
Pupils are able to apply everyday scientific knowledge in order to make predictions or offer explanations. They can refer to scientific information in order to draw conclusions and assess these.

Competence level III:
Functional scientific literacy with application of scientific knowledge
At this level pupils are able to use scientific concepts in order to explain phenomena and make predictions. They are able to decide which questions can be scientifically explored.

Competence level IV:
Conceptual and procedural scientific literacy
Pupils can identify and articulate additional information which they need in order to make valid conclusions. They can use relevant data in their chain of arguments and can communicate these. They can make use of elaborated scientific concepts to word predictions and offer explanations.

Competence level V:
High-level conceptual and procedural scientific literacy
Pupils can work with conceptual models and can systematically analyse experiments. They can take into account several different perspectives and argue in terms of one specific target group.

Competence levels IV and V differ in terms of the complexity, precision and systematic approach needed to resolve the problems set. In the 2000 PISA Test of scientific literacy 60% of questions were multiple choice and 40% open format tasks. We have not chosen the same breakdown here, since multiple choice questions are very easy to produce and this is common practice. We have thus chosen to concentrate more on open format questions. For every topic area covered by the Education Service, questions are drawn up and classified in line with the above competence levels.

This categorisation is based on assumptions of plausibility and is not intended to be taken as a gold standard. It should be seen as a suggestion, which teachers can and should adapt on the basis of their own experience. This also applies to the degree of difficulty involved in the exercises and the number of possible answers to some questions. In future, the Education Service plans to take into account concrete feedback from teachers with respect to the questions and exercises set.

We would also like to point out the following:
1. In the PISA Test in 2000, German fifteen-year-olds (across all forms of secondary school) were clustered at the upper end of competence level II. Only 3.4% achieved competence level V, while 26% attained only competence level I (another 26% attained competence level II, 20% reached competence level III and 24% managed competence level IV).

2. It is not possible to cover every aspect of basic scientific literacy in one block of exercises. Several exercises would be needed for each aspect.

3. The individual questions contained in the exercises also require pupils to find and use information and skills that are not covered by these materials on water. This is customary and necessary when classifying competences in order to avoid too restrictive a link to the curriculum.

Notes for teachers:
The depth of the ice sheet during the various periods of the ice age varied from a few hundred metres to up to 3,000 m.
The length of the ice ages was very different, from a few thousand years to several hundred thousand years.

QUESTION 1

Purpose of the question:
To identify information, to reproduce simple factual knowledge contained in the graphic. This corresponds to competence level I.

Correct answer:
- between 120 and 140 metres

QUESTION 2

Purpose of the question:
It is to be ascertained whether pupils can glean information from the graph which is not explicitly presented. This corresponds to a competence level between I and II.

Correct answer:
- Answers between 2040 and 2080 are correct.

Wrong answers:
- Today (2005) or 2100 (first figure on the x-axis)

QUESTION 3

Purpose of the question:
Information contained in tables and graphs relating to events and the course of events is organised systematically. Generally they start with the first evidence of the event in question. The answer given by pupils must be plausible, and based on conclusions drawn from the entire theme complex ”glaciation“. The reading text must also be consulted for assistance. This corresponds to competence level II.

Correct answer:
- After 2050, because this was the point where the ice sheet started to form.

QUESTION 4

Purpose of the question:
It is to be ascertained whether the hypothesis on which Figure 2 is based has been correctly recognised. The task aims to distinguish between what can be said on the basis of research results and what cannot be verified or what is incorrect. This corresponds to competence level III.

Correct answer:
- 2. ... the objects and animals were used or lived at that time in or around New York.

QUESTION 5

Purpose of the question:
Information that can be gleaned from the figure should be used to identify the underlying system used. This is a practice-oriented exercise in which individual identifiable facts must be related to one another and compiled in general statements. This corresponds to competence level III.

Correct answer:
- 4. by which occurred or was used first

QUESTION 6

Purpose of the question:
It should be ascertained whether it is possible to identify a systematic correlation between the two figures and use the pieces of information to make a general statement. Pupils must compare the two figures very exactly. Since this task involves comparing a statement with the information contained in two different figures it requires a higher level of competence than that needed to identify concepts and facts and glean information from only one figure. This corresponds to competence level V.

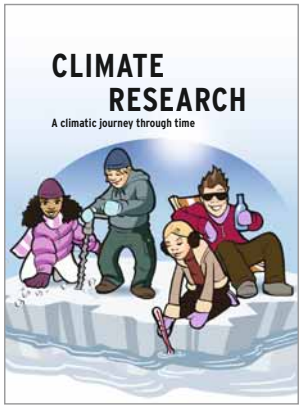
Correct answer:
- 1. ... once the ice had disappeared completely.

QUESTION 7

Purpose of the question:
It should be ascertained whether pupils can systematically assess statements contained in the answers on the basis of the diagram. Several different perspectives must be explored. They must not only recognise the correlation between individual bar charts but also combine the information contained in several apparently independent entries (objects are found at the start and at the end of the ”ice age“. This corresponds to competence level IV.

Correct answer:
- 1. When the ice sheet was at its deepest, there were more animals than objects.
- 3. Changes in the objects found generally correspond to changes in the ice sheet (growing or melting).

BACKGROUND INFORMATION FOR TEACHERS



The air in the greenhouse is getting worse – the pearls of sweat can be seen glistening on the countenance of the Earth. Since the human race has been trying to make life easier for itself with oil central heating, machinery and cars, the Earth has been having an increasingly difficult time. Things are heating up in the atmosphere. Over the last century alone, the average temperature on Earth has risen by 0.6°Kelvin and the trend is not only continuing; it is set to gain momentum in the decades to come.

Naturally everybody knows that there have always been ice ages and interglacial periods on Earth. This becomes particularly clear if we draw a graph of the data provided by ice cores, for instance. This also makes it very obvious that the sudden and marked temperature rise since about 1850 is out of the ordinary.

What is the greenhouse effect? What role does CO_2 play in it? How does CO_2 get into the atmosphere in the first place? These are the questions we will be looking at in this lesson unit. It has been specially devised for multi-disciplinary lessons in science, but it can also be used in social science lessons. It is suitable for use with "learning stations" through which the pupils must pass. The materials can also be used independently of one another.

POINTS OF CONTACT WITH THE SYLLABUS

- Climate history: Cycles of climate change and the causes thereof
- Correlation between climate, vegetation and utilisation: Vegetation zones, signs of adaptation, limitations of use
- Natural preconditions: Climate, soil, relief
- Our atmosphere – a greenhouse: The atmosphere shapes our living conditions; the greenhouse effect – a shift in the radiation balance of the Earth
- The influence of the human race on the climate and on weather: The Earth as a greenhouse, the greenhouse effect
- Anthropogenic impact on the climate, greenhouse effect, the depletion of the ozone layer
- The radiation balance of the Earth/atmosphere system
- The Earth's energy balance; disturbing the energy balance
- Properties and impacts of the world's oceans; the impact of the Gulf Stream and the Humboldt Current on the climate and on flora and fauna
- Fuels: Environmental problems; type and scope of pollution (local to global impact of human interventions in the air, water, soil, climate, etc, individual impacts, correlations)
- Selected ecosystems: Vegetation and climate zones
- Climatic peculiarities of temperate zones
- Tropics and subtropics – an overview: Climate, ecosystem

SUGGESTED APPROACH

1. As an introduction to the lesson unit, discuss with the class unusual weather phenomena that have been reported recently. Encourage the pupils to air their opinions about whether a trend can be seen towards more of these extreme weather events, and whether the weather used to be different.

2. The genuine work on the topic starts with the exercise on the introductory sheet. Pupils learn about the method of ice core analysis and become familiar with some of the basic terminology and concepts used in this context.

3. The problems to be tackled in station work are introduced. Why does the climate change? What is this greenhouse effect we hear so much about? What is the impact of carbon dioxide on the climate?

4. The class should then be split up into working groups.

5. Pupils should work independently in their groups at the different stations. We recommend that you use five stations, one for each worksheet. Pupils can also check their own results. You can provide support as required. Pupils should organise a loose-leaf folder in which they gather all the completed worksheets, outline solutions, etc. The folders should also contain a "station pass". Once all stations have been completed, the pupils are "climate experts". This phase can be spread over several lessons.

6. The stations should be evaluated in a class discussion. Pupils can reflect on their work and focus again on what they have learned.

MATERIALS:

- **Introductory sheet and information sheet on "How do we know what the climate used to be like?"**
- **Worksheets, recommended for five stations**
- **Control sheets with answers (copy from the teacher guidelines)**
- **Station pass**

TIP:

Other teaching materials can be downloaded free of charge from the online Education Service of the Federal Environment Ministry at www.bmu.de/bildungsservice. To link up with the topic of climate protection we particularly recommend the field of renewable energies.

NOTES AND ANSWERS ON THE WORKSHEETS

Station 1: Analysing an ice core (Worksheet 1)
Exercise 1: The results (as shown in the table from the top down): -9.39; 3.23; 0.23.
Exercise 3: The main causes of the extreme fluctuations in temperatures over the last 420,000 years were the ice ages and the interglacial periods.

Station 2: The greenhouse effect (Worksheet 2
Page 1, Exercise 1: The water is warmer in the film container covered by the glass. The glass prevents the heat (infrared radiation) from being reflected back into the environment.
Exercise 2: The effect caused by the glass in the experiment is replicated by the gases in the Earth's atmosphere, including water vapour and carbon dioxide.
Exercise 3: If there were no greenhouse effect, the temperature everywhere on Earth would be below freezing point, average temperatures would be about −18°C rather than 15°C. The Earth would not be habitable and there would be no animals or plants.

Page 2: Temperatures rise because less infrared radiation (heat) is reflected back into space.

Station 3: Carbon dioxide and global warming (Worksheet 3)
Exercise 1: 2.3 billion tonnes per annum, 2.4 billion tonnes per annum, 1.7 billion tonnes per annum, 6.3 billion tonnes per annum (from left to right)
Exercise 2: 6.3 − 2.3 + 1.7 − 2.4 = 3.3 (billion tonnes per annum)

Station 4: Carbon dioxide and the global temperature on Earth (Worksheet 4)
Page 1, Exercise 1: CO_2 is one of the so-called greenhouse gases and prevents the heat being reflected back from the surface of the Earth into space.
Exercise 2: Because of the additional anthropogenic greenhouse effect, average temperatures on Earth can be expected to rise by up to 6°C by 2100.

Page 2: Anthropogenic (man-made) or natural?
Exercise 1: Graph 3 (on the far right)
Exercise 2: The industrial revolution took place in the mid-nineteenth century. Since then, people have been using more and more fossil fuels (coal, oil and gas).
Exercise 3: The eruption of Pinatubo affected Model A, since it is a natural impact. The eruption also has an impact on the actual temperatures measured, with a temporary drop in average temperatures on Earth.

Page 3: What is the impact of world politics on CO_2 emissions?
A − 1991; B − 1973; C − 1945; D − 1918; E − 1950; F − 1929; G − 1979

Station 5: Climate and chemistry (Worksheet 5)
Page 1, Exercise 1: As the water becomes warmer, less CO_2 dissolves in the water.
Exercise 2: As temperatures on Earth rise, the surface temperature of the oceans also increases. The water absorbs less atmospheric CO_2. At the same time the oceans release more CO_2 into the atmosphere again, and the concentration of CO_2 rises.

Page 2, Exercise 1: The balloon inflates more at room temperature because more CO_2 is released than at the lower temperatures in the fridge.
Exercise 2:
a) 3.42 g/l = 3.42 kg/m^3 = 3,420,000 t/km3 x 93,830 km3 = 320,898,600,000 t
b) 1.45 g/l = 1,450,000 t/km3 x 93,830 km3 = 136,053,500,000

STATION PASS

Family name First name Year

Station no.	Station name	Total points

Climate change is no longer a topic that interests only experts and politicians. Everyone knows the term, thanks in no small way to a number of natural disasters such as the "flood of the century" in 2002, when the Rivers Elbe and Mulde burst their banks causing widespread damage, as well as series of articles in major newspapers and of course the film "An Inconvenient Truth". Most people have only a vague or distorted idea of what climate change really means, however. We cannot say that accurate knowledge on the topic is widespread. How many people are really familiar with the reports of the Intergovernmental Panel on Climate Change (IPCC) or the results of research conducted by the Potsdam Institute for Climate Impact Research (PIK), although much of this is readily accessible on the Internet?

This lesson unit is intended to help pupils gain a scientific understanding of climate change and focus their existing knowledge rather than the distorted or fragmented knowledge otherwise found. It offers links to physics, chemistry and biology. Pupils should discuss the film and identify signs of climate change in newspaper headlines. They perform experiments, for instance to identify the impacts of the warming of the Earth's atmosphere on sea levels, and then consider what the consequences will be for the North Sea coast, for instance. Finally a global impression is given of the different impacts of climate change in the North and in the South. Pupils work on an interdisciplinary basis, recognise risks for the future and become competent in planning and implementation.

POINTS OF CONTACT WITH THE SYLLABUS

- Properties and impacts of the world's oceans; impact of the Gulf Stream and the Humboldt Current on climate, flora and fauna
- Correlation between climate, vegetation and utilisation
- Importance of climate change for the landscape and human beings
- Will the climate change? Interests of the individuals in affected regions and interests of industry and private consumption
- Importance of climate and climate change
- Consequences on a personal and societal level
- Strengthening the greenhouse effect: Increase in concentrations of greenhouse gases, global and regional consequences
- Soil and climate - the basis for agriculture
- Peace building, conflicts and conflict resolution mechanisms: Climate change/ scarce resources/ world food
- The theory of heat; temperatures and how to measure them; impacts of temperature change; expanding liquids, the volume of liquids depends on the ambient temperature; the anomaly of water and the importance of this scientific phenomenon in nature

- Spreading heat
- Statistics
- Chemical reactions: Substances and their properties
- Environment and technology; weather and climate: Impacts of weather events on vegetation, economic structures and people's way of life
- Causes and correlations of weather events
- Insights into processes in nature and technology: Weather, climate
- Ecosystem: Disturbing the biological balance and the consequences; analysis of causes, anthropogenic influence, natural disasters, climate change ...
- Ecological research into the global inter-relations of pollution

SUGGESTED APPROACH

1. The film "An Inconvenient Truth" offers several entry points to the topic. It is not essential for all pupils to have seen the film. The materials available online at www.bmu.de/bildungsservice provide enough of a basis for discussion. Pupils should consider how realistic the scenario shown in the film actually is.

2. Pupils should then look at the signs of climate change already visible, by classifying the newspahave access to a suitable library, you can use the newspapers found there in your research. Other-wise you can use archives on CD-ROM or online. The online archives of the national weekly newspaper Die Zeit and the daily Die Welt, for instance, are freely accessible online (see box).

   This part of the project could also be set as homework. Pupils can conduct research individually or in small groups focussing on weather reports, climate change at home, and climate change elsewhere in the world. The results can be compiled in the following lesson in a class discussion, sorted, and entered in a table like the one shown on Worksheet 2.

3. In the next stage, the rising sea levels can be taken as one example of a consequence of climate change and examined in more detail. Pupils work through the various worksheets and perform the experiments to identify the ecological, social and economic impacts of rising sea levels.

4. Notes on the worksheets:

Worksheet 1

- **Tip:** Regional newspapers often offer subscribers free access to their archives. Almost all websites offer free access to headlines and the first few lines of an article.

Worksheet 2

- Firstly pupils should state what or who they think is responsible for the rising sea levels, before going on to establish which areas would be worst affected worldwide.

Worksheet 3

- The melting ice cube experiment should illustrate in a simple way in physics or chemistry lessons what the impact on sea levels would be, were huge bodies of ice to melt.

Worksheet 4

- Pupils should now apply their knowledge to the question as to what the consequences would be of a rise in the level of the North Sea. The map should help illustrate the impact on a rise in the level of the North Sea on coastal areas. Pupils should distinguish between various categories of consequences (economic, ecological, social). At this point, the consequences of temporary or permanent flooding on human settlements can be discussed. This would be a good time to organise a field trip.

Worksheet 5

- The hypotheses on Worksheet 5 come from the report of the Intergovernmental Panel on Climate Change (IPCC). The pupils should match them up with the two continents.

MATERIALS:

- **Introductory sheet and information sheet on the film "An Inconvenient Truth"**
- **Possibly the film on video or DVD**
- **Worksheets 1 to 5**
- **Equipment in the physics or chemistry labs**
- **Computer with Internet access**

TIP:

Other teaching materials can be downloaded free of charge from the online Education Service of the Federal Environment Ministry at www.bmu.de/bildungsservice. To link up with the topic of climate protection we recommend in particular the field of renewable energies.

CLIMATE CHANGE AND POSSIBLE IMPACTS ON THE GERMAN NORTH SEA COAST

Forecasts indicate that over the next few decades the average temperature on Earth will rise by 2 to 3°C. As a result, coastal regions will be faced by an average rise in sea levels of about 50 cm per century (as compared to 20 cm per century hitherto). Storm tides too and other extreme sea levels can be expected to be higher.

Coastal areas attract particular attention in connection with climate change, firstly because they are directly affected by changes in the sea (danger of flooding, loss of land through storm tides, etc.), and secondly because the variety of functions of these areas makes them extremely important.

Because of the greenhouse effect, current rises in sea levels can be expected to accelerate markedly. According to the most recent calculations of the IPCC, the average global rises in sea levels will be of the order of 20 – 95 cm by 2100, whereby the actual figure is expected to be around 50 cm (IPCC 1995). In some regions, however, such as shallow coastal seas like the North Sea, the rise in sea level could well be significantly higher than the average, because the effect of the thermal expansion of the surface water will have a disproportionate effect here; a tripling of the current rate is considered realistic. It seems safe to assume that tides will become stronger and extreme tides higher at the coast.

The most important processes which represent a threat to coastal areas are thus:

- Rising average and extreme water levels
- Increasing wave height
- Dyke breaches and the danger that low-lying areas will be flooded
- Erosion of coasts and the seabed
- Salinization of soil and groundwater

Teacher's Guide "world climate"

Greenland's ice sheet is the great unknown variable in all climate models used to calculate the rise in sea levels. The average thickness of the sheet covering almost the entire island is 2 kilometres. How fast and to what extent the ice will melt will determine the speed and extent to which sea levels will rise. The calculations of American scientists reveal that if Greenland's ice sheet continues to melt at the present rate, sea levels will rise by 36 to 118 centimetres by the end of the century. This is twice as much as forecasted by the IPCC. If the ice in Greenland were to melt away completely, it would cause a rise in sea levels of around 7 metres.

Source: based on Spiegel-Online "Schmelzendes Grönlandeis lässt Meeresspiegel schneller steigen", 19 February 2008

NOTES AND ANSWERS ON THE WORKSHEETS

Introduction

Climate experts say:
Scientific facts correct, errors in a few details, perhaps overly optimistic regarding what can still be done.
Al Gore:
He aims to point out the facts to people, make them aware of the problem, we do still have tools we can use to take effective action.

Worksheet 1

Headline	Weather	Climate change
Storms set to worsen		x
The global climate becomes more and more extreme and less and less stable		x
Ten tonnes of carbon dioxide per head is too much		x
Today the cold, wet weather is set to continue	x	
Flooding – only a taste of things to come		x
The heatwave is here to stay		x
Desert wind pushes out the forest breeze		x
Dry today with top temperatures of up to 30°C	x	
54 die as storms hit Japan	x	(x)
A dream summer with nightmarish consequences	x	(x)
The day Europe's heating packed in: 8,200 years ago the Gulf Stream stopped		x
Some like it hot in Saxony	(x)	x
Tsunami lays waste to Southeast Asia	Headline has nothing to do with the weather or the climate.	

Worksheet 2

Exercise 1: Which statement is correct?
Answer: Statements B, D and F

Exercise 2: Which countries are worst affected?
Answer (a small selection):
Netherlands, Gambia, India and Bangladesh, the Maldives, Pacific island states.

Worksheet 3

What happens to the water level in the glass?
Answer: Experiment 1: The water level rises. Experiment 2: The water level stays constant. The Archimedes Principle holds true.

Exercise 1: The consequences that can be drawn from the experiment
Answer: If the icebergs and bodies of ice floating on the sea melt, there will be no impact on the sea level. For the sea level it does not matter whether the water is liquid or whether it is floating on the sea in the form of ice. However if bodies of ice currently on a land mass enter the ocean, there will be a rise in sea levels.

Exercise 2: By how much would the sea level rise if all of the Greenland ice shield and the Antarctic ice cap were to melt?
Answer: If the Antarctic ice cap were to melt, the sea level would rise by about 65.5 m while the melting of Greenland's ice shield would raise sea levels by about 7.2 m.

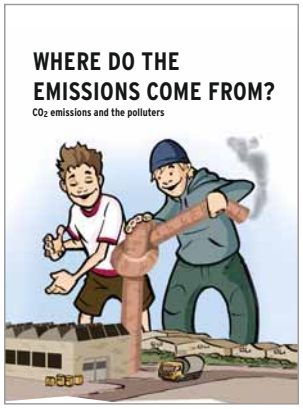
Worksheet 4

Exercise 1: The impacts of rising sea levels in the North Sea on coastal areas
Answer (a small selection):
Coastal protection (dyke construction and flood protection barriers), the Wattenmeer, agriculture, tourism, power generation (off-shore wind turbines), erosion of islands, flooding in major cities (Hamburg), shipping and ferry lines, fishing, land loss, etc.

Worksheet 5

Exercise 1: Match up the letters with the boxes.
Answer: Europe A, D, E, G, I, K, M and Africa B, C, F, H, J, L, N
Some hypotheses could apply to both continents. Pupils should explain why they have matched up the statements in this way.

BACKGROUND INFORMATION FOR TEACHERS



Anthropogenic carbon dioxide emissions are one of the main reasons for climate change. The industrialised countries in particular are responsible for disproportionately high emission levels. Even if Germany is consistently reducing its CO_2 emissions, there is still lots of scope for reductions. Our materials on polluters therefore focus on ourselves before pointing fingers at the rest of the world.

Pupils should calculate the (direct) CO_2 emissions caused by their own households and identify ways of improving their CO_2 balance in the short and medium term. The project is most closely related to physics and mathematics.

POINTS OF CONTACT WITH THE SYLLABUS

- Energy saving potential in everyday life: Ways of saving energy in the immediate environment of pupils; regional and global potentials for saving energy
- Utilisation of different energy sources: Consequences for the environment, the concept of sustainability
- Energy and technology in transition: Electricity in everyday life; energy supplies past, present and future
- Will the climate change? Interests of the individuals in affected regions and interests of industry and private consumption
- Global environmental issues and problems, problem-solving approaches: Measures to reduce emissions, reduction of CO_2 emissions
- Will the climate change? Problem-solving approaches and avenues for action; consequences for individuals and society (e.g. energy-saving measures)
- Possible ways to use energy more economically: Ways to save energy in the home, appliance codes

SUGGESTED APPROACH

1. Pupils get together with a partner and work through the introductory sheet, doing the exercises. The class should then discuss the results. You can present the game "Keep Cool!" at this stage, since it is part of the lesson materials "Save the world".

2. The class should be divided up into two, four or six groups. One half should tackle Worksheet 1 and other half Worksheet 2. Afterwards they swap or each group can present their results to the other(s). The subsequent discussion should be steered in the direction of energy savings.

3. The teacher finds a cue in the discussion to move on to the topic of stand-by mode. The relevant worksheet can be set as homework, whereby the class can also be told to work in groups, if the social structure of the class permits. About one week later the results of measurements and calculations can be evaluated in class.

4. Worksheet 4 is based on the figures on Worksheet 1. It must be ascertained that pupils still have these or can find them again. After they have solved the introductory question during the class discussion, pupils should work in pairs on the calculations. The results are compared with the whole class, and the discussion focused on the reduction figures. Then the groups from the earlier phases or five newly established groups should look at the pros and cons of the five engine types.

5. The groups should collect their lists of pros and cons and present them to the other groups in class. This too should be followed by a discussion of what is the most environmentally friendly engine type, in spite of all the disadvantages.

6. Ideas for further-reaching activities
   Get your pupils to talk to their parents, brothers, sisters, and other relations, friends and acquaintances about what they can do. Maybe you could agree on joint goals and measures and assess progress after three months. Get your pupils to report on their experience of talking to others in the next lesson.

MATERIALS:

- **Introductory sheet and Worksheets 1 to 5**
- **An appliance to measure electrical current**
- **Computer with Internet access for research purposes**

TIP:

Other teaching materials can be downloaded free of charge from the online Education Service of the Federal Environment Ministry at www.bmu.de/bildungsservice. To link up with the topic of climate protection we recommend in particular the field of renewable energy sources.

NOTES AND ANSWERS ON THE WORKSHEETS

Introduction:
1. USA (grey), China (yellow), Russia (red), Germany (blue), Saudi Arabia (purple), Kenya (orange); in line with the ranking in the table
2. a) USA, Germany, (China)
   b) Kenya
   c) Russia, Saudi Arabia

Worksheet 1, Page 1/3
Possible reasons (a small selection):
Private households: Number of electric household appliances rising, number of individual households rising, number of appliances with stand-by mode increasing
Traffic and transport: Percentage of gas-guzzlers rising (e.g. SUVs, 4x4s , etc.), truck transport rising (EU enlargement and transit), total number of cars licensed in Germany rising, rise in air travel (because of low-cost airlines))

Worksheet 1, Page 2/3
The calculations depend on the information provided by pupils. If individual pupils cannot or do not want to provide figures, you can provide your own figures by way of example. The examples given in the table show typical consumption figures.

Worksheet 2, Page 1
1. Germany 10.87 t CO_2 per capita per annum, USA 19.73 t CO_2 per capita per annum, China 3.65 t CO_2 per capita per annum, Kenya 0.27 t CO_2 per capita per annum

Worksheet 2, Page 2
1. A, B, C, D
2. Carbon intensity and energy intensity both need to decrease
3. b and c
4. a and c

Bonus question: Both drop

Worksheet 3
4. Potential savings (PS) = sbT · sbP · 365

Worksheet 4
1. CO_2 emissions must drop relative to energy consumption, e.g., thanks to the use of renewable energies.

Worksheet 5
Information on the topic available in the internet, e.g.:
www.energyquest.ca.gov/saving_energy/index.html

1992 was an important year for the Earth. Participants at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro not only adopted Agenda 21, but also the Framework Convention on Climate Change. About 190 states have now signed the convention, thus undertaking to do something to halt the dangerous impacts of climate change. The agreement was translated into more concrete terms in the form of Protocols adopted at follow-up conferences. In the Kyoto Protocol, for instance, which takes its name from the Japanese city where the conference was held in 1997, the industrialised states undertake to reduce their emissions of greenhouse gases, in particular carbon dioxide, by five percent of the 1990 level over the commitment period 2008 – 2012.

In this lesson unit, pupils will become familiar with the actors involved in climate protection. They should realise that climate change can only be combated on a global, international level, but that at the same time local-level efforts are essential and that every individual can do his or her bit. They will look at how international climate change conferences work and at the results achieved to date in the field of climate protection. They will find out what the Kyoto Protocol really says, and what Germany is doing to achieve climate-protection goals. Finally, they themselves take part in an international climate conference – as part of the game "Keep Cool. Gambling with the Climate". They will discover how the various actors have to work together to allow the global climate to recover and avert a climate collapse.

POINTS OF CONTACT WITH THE SYLLABUS

- The greenhouse effect – depletion of the ozone layer – summer smog: Including Agenda 21, sustainable development
- The future of humanity: The greenhouse effect, global warming
- Correlation between human activities and climate change
- Will the climate change? Interests of the individuals in affected regions and interests of industry and private consumption
- Will the climate change? Problem-solving approaches and avenues for action; consequences for individuals and society
- Search to replace substances that pollute the environment
- Measures to reduce emissions
- The increasing greenhouse effect: Measures to limit the greenhouse effect and its consequences
- Peace building, conflicts and conflict resolution mechanisms: Environmental destruction, climate change, scarcity of resources, world food, population growth: Ethnic conflicts, power-related conflicts, values-based conflicts
- What can be done at a political level?
- What every individual can do
- Developing the ability to form judgements
- Approaches to resolving environmental problems
- Pros and cons of the eco-tax

SUGGESTED APPROACH

1. Pupils should be introduced to mind-mapping, if they are not already familiar with it.
2. Under the banner "Climate protection – how can it work?" they devise a mindmap of the actors involved in climate protection and their respective roles. One important realisation that should emerge at the end is that climate protection is only possible at international level. National actors must come together at international climate conferences and agree on common goals. Pupils should also bring with them relevant materials (articles, essays, books, etc.), which you could use to set up an information corner in the classroom.
3. With a view to the game, "Keep Cool", the class should discuss which interest groups meet at a world climate conference and which criteria should be used to weight voting rights. A code of conduct should also be agreed.
4. They should then take a look at actual climate protection, under the banner, "What has actually happened to date". The focus should be on the Kyoto Protocol and the reduction commitments based on this agreement.
5. The pupils should look at the options open to a state to achieve its climate protection goals, taking Germany as an example. The focus should be on the eco-tax within the scope of the national climate protection programme.
6. Press and PR work play a very important part in this scenario. The "press" should cover the progress of the "delegations", taking a critical external stance, while the "delegations" try to make use of the public attention in order to explain their goals.
7. A quiz should be used to identify the climate experts who will be leading their national delegations in the climate game.
8. Finally the class can play the game. "Keep Cool. Gambling with the Climate".

"Keep Cool. Gambling with the Climate" was developed on the basis of the board game with the same name for the educational service of the Federal Environment Ministry for use with groups. All the materials you need have been devised so that they can be produced using the free templates. The board game, "Keep Cool. Gambling with the Climate" was invented by Klaus Eisenack and Gerhard Petschel-Held from the Potsdam Institute for Climate Impact Research (PIK). You can order it from Verlag Spieltrieb (www.spieltriebgbr.de) for € 22.95.

Additional service: All materials along with the relevant worksheets and guidelines can also be downloaded in English free of charge and can thus be used for example in English classes (www.bmu.de/bildungsservice).

9. At the end of the game, the experience should be assessed within the framework of a class discussion. The delegations should present their results and compare their strategy, using the reports to help them. Feedback, risks, over-steering and alternatives can be examined. In conclusion the pupils should present which interests were pursued and in what way.

N.B.:
During the game, the press corps should force the leaders of the delegations to think about what they are doing by asking leading questions. (Why are you doing that? What will the consequences of your actions be? Who will be affected?) You could hold a special briefing session in advance with all the members of the press corps. Good basic information can be found, for instance, in Dietrich Dörner's book, "The Logic of Failure" which deals with the concept of acting within complex systems.

MATERIALS:

- Worksheets
- Press round-up
- Information sheet "The logic of failure"
- Materials for the game "Keep Cool"

HOW TO ACT IN COMPLEX SITUATIONS

Today, political action is marked, more than ever before, by uncertainty as to the medium- and long-term consequences of decisions made. Even the way a city works is affected by a large number of variables, which are mutually defining. A city can then be seen as a complex system in that the inter-relations of cause and effect cannot be clearly and satisfactorily defined and understood.

Developments in the field of environmental and energy policy, in particular, however indicate that coming to terms with the complex systems we have put in place might well now be a question of survival for humanity (we need only think of Chernobyl).

In his bestseller "The Logic of Failure", psychology professor Dietrich Dörner demonstrates how easily people can fall into logical traps, particularly when they act with the best of intentions. Realising this is an important learning goal of this lesson unit.

Some tips for strategic thinking can also be deduced:

- It is essential to be clear about your own goals. This might sound obvious, but it is a point which is often ignored.
- It is only possible in very rare cases to achieve all your goals simultaneously. You must learn to compromise.
- It is important to set priorities. Priorities, however, are not set for eternity and must also be able to change.
- You must know where to find information. Sometimes rough information is enough, but sometimes we have to look in great detail and very precisely at something, and gather a huge amount of very detailed information.
- It is very helpful to have an idea of the inter-relations within a system. What are the causes, and what effects can they have? But a word of caution is called for. Many people leap to conclusions precipitately and then them stick to them through thick and thin, although their original hypothesis proves to have been incorrect.
- You should bear in mind the fact that small causes can have major effects, and sometimes undreamed of side-effects. You should anticipate as far as possible.
- Some causes do not have an immediate effect, but impact with a time lag.
- It is crucial to reflect on one's own actions with the help of feedback.

Dietrich Dörner specifically recommends simulation games as a risk-free way of developing your own set of rules as to how to act within complex systems. This set of rules should then also be constantly revisited and refined.

NOTES AND ANSWERS ON THE WORKSHEETS

Worksheet 2 – Actors in climate protection

On the basis of the text, pupils should identify the individuals, groups and institutions which can influence climate protection. On the two branches to the left of the key term they should place the individuals and NGO on their mindmap. On the right hand side, they should enter state, academic community and industry. Short definitions and examples should help to clarify who is meant, e.g. "the state" stands for government, parliament, the civil service. The class should then be split up into five working groups, each of which should look at one of the actors, and make a list of what this actor can do for climate protection. The ideas should then be matched up with the entries on the mindmap. Finally, the groups should compile their results as a class and put them together in the form of an overall mindmap which can then be presented as a wall newspaper. The overview should be used for the ongoing work on the topic and as a reminder during the game "Keep Cool".

Worksheet 3 – Climate conference

The six groups should be based on the game "Keep Cool", which we will be turning to later: USA and its partners, Europe, former Soviet Union, OPEC, emerging economies, developing countries.

Worksheet 4 – Kyoto Protocol

The Kyoto Protocol was adopted at the United Nations Climate Conference in the Japanese city of Kyoto in December 1997. The agreement lays out binding goals to reduce emissions of greenhouse gases. The industrial countries undertake to cut their emissions of greenhouse gases by 5.2 percent of the 1990 levels during the commitment period 2008 – 2012. The Protocol could not come into force until it was ratified by a minimum of 55 countries, which together accounted for at least 55 percent of the carbon dioxide emissions of industrialised countries in 1990. Thanks to the ratification of the Protocol by Russia, this is now the case. To date 126 countries, including Germany, have ratified the Kyoto Protocol. The USA and Australia have not yet done so.

Worksheet 5 – Climate protection tools

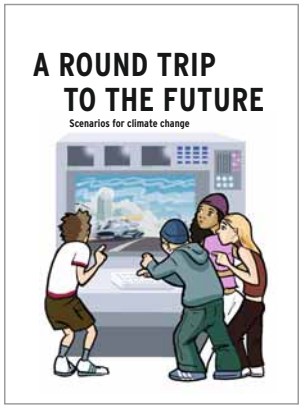
Bans: Ban on CFCs, obligation to return empty batteries
Strict regulations: Limit levels for emissions of pollutants
Incentives: Eco-tax, deposit on drink cans, vehicle tax levels depending on emissions of pollutants in exhaust fumes

Worksheet 6 – Press and public relations work

The original caption was, "Surprising breakthrough at the Bonn Climate Summit". Basically all suggestions are appropriate but the other three imply a clear evaluation or opinion.

Worksheet 7 – Quiz

Answers: 1B, 2A, 3C, 4B, 5C, 6A



When looking at climate trends we typically have to deal with longer time-periods over which today's developments will have an impact. Political decisions are thus based on scenarios forecast by research institutes or bodies like the IPCC.
These scenarios, in the usual form of graphs or tables, are often not vivid enough for school lessons.

We must therefore find a way of presenting these various possible future scenarios in a tangible way, without losing sight of the scientific basis. It is not a question of wild conjecture or fuelling fears about the future. We are interested in well-founded scenarios of what the future could bring, or as the worksheets put it, science fiction in a literal sense. The scenario technique is a good way of doing this, partly because it is likely to be familiar in the school context. It is also relatively easy to understand and use the method in the simplified form suggested here.

Pupils can learn in this way that their decisions and actions today have medium- and long-term consequences. They should realise how slowly processes unfold, and that this makes it all the more difficult to reverse them. Finally, pupils draw their own conclusions as to how to avoid the worst case scenario.

POINTS OF CONTACT WITH THE SYLLABUS

- Will the climate change? Problem-solving approaches and avenues for action; consequences for individuals and society
- Global environmental issues and problems, problem-solving approaches, topical examples: Acid rain/ ozone depletion
- The increasing greenhouse effect: Rising concentrations of greenhouse gases, global and regional consequences, measures to limit the greenhouse effect and its consequences
- Peace building – conflicts and conflict resolution mechanisms: Environmental destruction, climate change, scarcity of resources, world food, population growth; ethnic conflicts, power-related conflicts, values-based conflicts ...
- The future of humanity: The greenhouse effect, global warming ...
- Anthropogenic influence on the climate
- Energy sources: environmental problems, type and scope of pollution (local to worldwide impacts of human interventions on air, water, soil, climate, etc., individual impacts, the wider picture)

SUGGESTED APPROACH

1. On the basis of the introductory sheet and the information sheet, you should introduce the scenario technique. Use a search engine such as **www.google.com** to access a number of excellent internet websites.

2. You can then look at the climate scenarios of the IPCC. Pupils work through Worksheet 1 together. The results can then be discussed with the whole class. The main aim is for pupils to gain an idea of what several hundred scientists around the world have compiled and calculated. It might also give them ideas for the scenarios they will be working on at a later date.

   N.B.: For the worksheet, we have chosen the IPCC's so-called A1 scenario, because it focuses in particular on trends in power generation.

3. The example of a scenario given on Worksheet 2 should be read by one or more pupils. Then the pupils should work through the two exercises in small groups or in pairs, before the results are discussed by the whole class.

4. As preparation for the scenario work per se, any comprehension problems should be cleared up at this stage. Then, the pupils should work in a minimum of three groups on Worksheets 3.1 to 3.3. Depending on the time and space available, several groups can tackle the same exercise, so that the class generates a number of different extreme scenarios or current trend scenarios.

   Important: The idea of producing scenarios is not to generate a work of imagination. Future trends are to be elaborated on the basis of the facts we have at our disposal today. The global aspect is particularly important. Point out to your pupils that they should look at global equity in their scenarios, e.g. how the relations between poor and rich countries will develop, how different the impacts of climate change will be, etc.

5. Each group should then present its scenario to the other groups, and give reasons for why they think this scenario is the most likely. To do this they can make use of:
   - The knowledge gained during lesson units on climate change and renewable energies (see **www.bmu.de/bildungsservice**)
   - The knowledge gained from their science classes
   - Topical information from newspapers or other media

6. Finally, problem-solving strategies and measures can be developed. This involves the development of short-, medium- and long-term measures and considering what the individual, associations/political parties, the state, etc., can do, in order to realise the measures and achieve the goals. The results of the sets undertaken so far should be used, and thus repeated, supplemented and reinforced.

7. To present their measures and strategies, pupils should produce wall newspapers, which can then be presented and discussed by the class as a whole.

MATERIALS:

- Introductory sheet and information sheet on scenario technique
- Worksheets 1 to 4
- Computer with Internet access for research work

TIP:

Other teaching materials can be downloaded free of charge from the online Education Service of the Federal Environment Ministry at www.bmu.de/bildungsservice.
To link up with the topic of climate protection we recommend in particular the field of renewable energies.

NOTES AND ANSWERS ON THE WORKSHEETS

Worksheet 1

The top curve refers to A1FI, the bottom one to A1T and the middle one to A1B.
It is interesting to point out that even in the best case scenario, i.e. the use of non-fossil fuels, both the temperature and the sea levels will continue to rise, although carbon dioxide emissions have been falling for some time.

Worksheet 2

1. B
2. This is a worst case scenario.

Worksheet 4

1. A – State
   B – Industry
   C – International community
   D – Political parties/associations
   E – Individuals
   F – EU

The goal of modern learning is to shape society and one's own life in a well considered, soundly reasoned and self-determined manner, working alongside others. This being so, schools must do more than teach pupils to merely react to the school's demands and to changes in later life. Teaching must enable them to acquire competencies, not only for coping with the future, but also for actively shaping the future. One fundamental aspect is therefore the acquisition of competencies that are not confined to managing and structuring everyday life in a self-determined fashion, but are also suitable for shaping life in the world of tomorrow.

So it is hardly surprising that topics like Renewable Energy Sources, Biological Diversity, Environment and Health, Water, Use of Natural Areas, or Waste and Recyclable Materials are commonly found as subjects in a modern syllabus or curriculum. These are important issues in everyday life today, and are of central importance for shaping a life worth living the world over.

But is it sufficient merely to put these topics on the timetable? What kind of results do we expect as the outcome of such learning? To arrive at a clearer and more detailed picture, it makes sense to take a closer look at the competencies for shaping this future. According to a definition by F. E. Weinert, competencies are "the cognitive abilities and skills that individuals possess or can learn for solving specific problems, and the associated motivational, volitional and social readiness and abilities that enable them to use these solutions responsibly and successfully in a variety of situations". Thus competencies are primarily a matter of the ability to take action, not of abstract school knowledge. The ability to solve problems is seen here in close connection with standards, values, readiness to act and – of course – available knowledge. As the ability to take action, competencies are tied to specific objects, contents, knowledge and skills.

Competence-oriented education strategies are output-oriented, whereas conventional curricula and didactic approaches are input-oriented: the latter ask what topics the pupils should be studying. The output approach, by contrast, asks what problem-solving strategies, action concepts and abilities they should possess. Only on this basis is it possible to determine what needs to be learned. This can to some extent be made dependent on pupils' prior knowledge, motivation, local and individual everyday associations – and can thus enhance both the learner's interest in the subject and an acquisition of competence that is not confined to the mere accumulation of "dull knowledge" (Weinert).

What abilities and skills, social and cultural reference points should children and adolescents possess to enable them to manage and shape their future? What knowledge should they share and have in common? These questions guide the search for teaching content when approaching the problem from the competence point of view. Looking at things from this angle, the list of possibilities is extremely long. It is nevertheless possibly to identify a few over-arching educational objectives that help with the selection of what is to be learned. A study commissioned by the OECD mentions human rights, the goal of being able to practise living democracy, and the criteria for sustainable social, economic and environmental development. The pursuit of human rights, within a framework of democratic structures and in the interests of sustainable development, represents three over-arching educational objectives which form guidelines for defining competencies. These statements are of no small importance. After all, the OECD is also responsible for the PISA studies; and in 2006 these surveyed pupils' competencies in the natural sciences.

The competencies that children and adolescents should possess if they are to be able to act in the interests of sustainable development are subsumed in Germany under the term Gestaltungskompetenz. Gestaltungskompetenz denotes the ability to identify problems of non-sustainable development and apply knowledge about sustainable development – in other words, being able to draw conclusions about environmental, economic and social developments and their interdependence from analyses of the present and studies of the future, and to use them as a basis for taking, understanding and implementing decisions that permit the realisation of sustainable development processes.

This general description of Gestaltungskompetenz displays close relations to the definition of "scientific literacy" which underlies the PISA studies – including the 2006 study which investigated young peoples' competencies in the field of natural sciences. It reads as follows: "Scientific literacy is the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity." Both competence definitions are concerned with findings, knowledge, understanding phenomena and actions, and taking decisions that affect the environment. Above and beyond this, Gestaltungskompetenz focuses specifically on problem-solving skills and the ability to take proactive and future-oriented action.

In all, Gestaltungskompetenz comprises eight individual competencies. Placing them in the context of scientific and technical findings and problems, as presented in this large package of materials, results in the following picture:

1. **The competence to think in a forward-looking way,** to cope with uncertainty and with forecasts, expectations and designs for the future – for example, with regard to the future use of renewable energy sources – is the individual competence to look beyond the present. The crucial factor is being able to grasp the future as something that is open and capable of being shaped with the aid of innovative technologies, and to develop various action options from current situations on the basis of this attitude. Forward-looking thinking and acting makes it possible to consider potential future developments – such as climate change – and to discuss the opportunities and risks associated with present and future developments, even if these are unexpected. At the level of learning goals, this means:

- The pupils are familiar with various methods of future research into (non-) sustainable development (e.g. energy scenarios; species reduction forecasts). They are able to use the methods in group work. They can assess and describe the strengths and weaknesses of the methods.

- The pupils are able to select the various methods of future research appropriately for problem areas of environmental change and applications of environmental technology that have not yet been dealt with in lessons.

- The pupils can reproduce the main statements of various future scenarios and forecasts, for example on climate change, especially with regard to environmental risks, poverty and non-sustainable global economic developments. They are sufficiently familiar with associated action recommendations and strategies to be able to reproduce them in their threads of argument.

- On the basis of material and information sources provided on non-sustainable or problematical developments – e.g. with regard to landscape depletion due to settlement-related measures – the pupils can work together in projects to design and visualise positive scenarios of technical, social, environmental and economic change, and can present them in verbal and pictorial form both logically and on the basis of value judgements and imaginative components.

2. **The competence to work on an interdisciplinary basis.** Problem areas of non-sustainable development and perspectives of viable future changes can no longer be coped with by a single technical discipline or using simple action strategies. They can only be handled by cooperation between multiple technical disciplines, different cultural traditions and aesthetic, cognitive and other approaches. The development of suitable abilities is indispensable for identifying and understanding system contexts and dealing appropriately with their complexity. Such abilities are fostered by problem-oriented interlinking of natural and social sciences, innovative technical knowledge and planning strategies, and imaginative thinking and innovative access facilities. This presupposes interdisciplinary, i.e. cross-subject, learning. This leads to the following learning goals:

- The pupils can describe complex situations with the aid of integrated analytical methods from the natural and social sciences.

- With the aid of creative methods, normative criteria, personal value judgments and research-oriented learning, the pupils can work on problematical non-sustainable development situations – e.g. biodiversity reduction – in a way that permits their transformation into models of sustainable development – e.g. as illustrated by biosphere reserves.

- When presented with problem situations – e.g. the threat to fresh water from inputs of environmental toxins – the pupils can analyse them to see which technical disciplines, information sources and actors need to be consulted to permit appropriate analysis and countermeasures.

3. **The competence of cosmopolitan perception, transcultural communication and cooperation.** Gestaltungskompetenz implies the ability to grasp and localise phenomena in their worldwide context of links and interactions. This competence focuses on perceptions that broaden contexts and horizons. Because a regional or national point of view is too narrow to permit orientation in a complex global society, perception and assessment horizons need to be expanded in the direction of a global approach. For example, a Central European view of freshwater reserves and use is totally different from the viewpoint of nations and peoples in arid or semi-arid regions. In terms of learning goals, this means:

- The pupils can describe relations between global climate change, resource consumption, pollutant inputs, economic ramifications and the social situation in developing countries on the one hand, and national pollutant inputs and resource consumption on the other.

- The pupils are able to familiarise themselves independently with other cultures' views and arguments regarding individual aspects of sustainability, and to assess and use these views and arguments in their own arguments, descriptions and assessments of situations. For example, what is the significance of exporting old cars and old clothes to Africa?

- They are also able to describe, with the aid of examples, the impacts that their own actions and those of their surroundings (school; region) have on resource consumption, pollutant inputs and equitable distribution at a supra-regional level and over long periods. To this they can apply a concept for calculating flows of materials.

- The pupils are familiar with methods of presentation and treatment that reflect different interests and problems from the viewpoint of various cultures and philosophies. What arguments do developing countries put forward when they are called upon to invest in environmental technology or to reduce pollutant emissions? In this connection the pupils can make a conscious change of perspective, identifying and assessing important points in the perspectives of different cultures, and using them in the interests of communication and understanding.

4. **Participation competence.** The ability to take part in shaping sustainable development processes is of fundamental importance for future-oriented education. There is a growing need to take part in decisions and a growing interest in helping to shape the world in which we live – at least in our culture: Involvement in decisions and self-determination at work, in civil society (and not just when it comes to planning leisure time) – are acquiring increasing importance for an empathetic, independent way of life. This interest in "having a say" is evident in the field of "Environment and Health", for instance. More and more people are objecting to harmful substances in rooms, products and food. This implies the following abilities:

- The pupils have the ability to draw up, together with their fellow pupils, teachers and nonschool partners, joint sustainability objectives – for example, with regard to species protection or the use of renewable energy. They are able to stand up publicly with others in support of their joint objectives.

- The pupils can appreciate divergent positions of individuals, groups and nations on individual aspects of sustainability – e.g. regarding the designation of nature conservation areas and the protection of certain species. Together with their fellow pupils and other actors, they are able to turn conflicts and controversies into constructive suggestions for solutions.

- On the basis of practical activities, the pupils display the ability to engage regularly with others in environmental, economic or social fields of sustainability. This may relate to reducing energy and water consumption, advocating waste avoidance, or propagating gentle tourism or ideas for sustainable homes in the future.

5. **Having planning and implementation competence means** being able to assess action workflows with regard to the necessary resources and their availability from a sustainability point of view, to design cooperation networks, to allow for side-effects and possible surprise results, and to cater at the planning stage for their potential occurrence. Relevant learning options discuss feedback, delayed consequences and time lags of the kind familiar from the damage to the ozone layer or inputs of environmental toxins into water, and offer a corresponding repertoire of methods. Implementation competence comprises the actual interest in pushing action beyond the intention and planning stage – for example commitment to the installation of a photovoltaic system on the roof of the school. The pupils should therefore be able to do the following:

- The pupils can use sustainability criteria to estimate the resources (e.g. heat energy, water, office materials, cleaning and polishing agents) necessary for services, production or the ongoing operation of a facility (e.g. the school) and make optimisation proposals on this basis.

- Within planning processes, the pupils are able to cope with surprise effects, uncertainties and necessary modifications by reacting appropriately to such effects and situations and readjusting the planning processes – e.g. rising consumption as a result of dwindling commitment on the part of pupils, shortfall on savings targets due to cold winters.

- In this context the pupils are familiar with the phenomena of feedback, late consequences, and delayed occurrence of problem situations. For instance, they can name examples and can describe and critically assess forms of reaction and anticipation that are practised by the economic and political world in this context. The different reactions by various nations to climate change analyses provide a number of good examples.

- The pupils are in a position to implement a project successfully on the basis of their acquired planning competence. In this respect they undertake activities by developing planning processes into action concepts and taking them to the action stage either independently or in concert with others. Saving resources, propagating new heating technologies and using environmentally friendly materials provide numerous opportunities for action here.

- They are able to present the results of their sustainable planning processes to different external groups (parents, teachers, citizens in a pedestrian zone, younger pupils) in a manner appropriate to the individual groups.

6. **Capacity for empathy, sympathy and solidarity.** All sustainability concepts set out to achieve greater equity, which always involves a balancing transfer between rich and poor, advantaged and disadvantaged, and seeks to minimise or abolish oppression. This is not just a matter of morals. It also involves the will to exploit scientific and technological potential. This in particular has frequently not been the case in the past. Many new ideas for environmentally friendly technologies are not used because of short-term economic considerations or long-established habits. The ability to stand up for greater equity and the use of innovative Potentials makes it necessary to develop a certain empathy, a kind of global "togetherness". Education for sustainable development therefore aims to develop individual and collective action and communication competence in a spirit of worldwide solidarity. It provides the motivation and empowerment to find viable joint solutions to joint problems and to make a considered stand for greater equity. This starts with collecting for a solar cooker that can be used by families in semi-arid areas with little fuel wood, and continues with support for whaling rules that conserve whale populations while

acknowledging the traditional whale catching rights of indigenous peoples. This includes the following examples:

- The pupils are able to express their empathy for animal protection, species-appropriate livestock farming, conservation of endangered species and ecosystems, and biological diversity.

- They can argue in favour of local and regional measures designed to combat non-sustainable developments – for example reduction of land take for settlement purposes – and for sustainable changes in socio-economic and natural living conditions, for instance by advocating greater use of wind energy, biosphere reserves and equitable water resources management in arid and semi-arid areas of the Earth. They express their emotional attitudes to the relevant circumstances.

- The pupils can describe, both with rational arguments and with emotive approaches, the situation of people who live in poverty, who lack adequate medical or other care, who are oppressed, or who have little or no access to education. Thanks to their knowledge of innovative technologies and sustainable management of resources, they are able to discuss action options for improving the situation.

- They are able to argue in favour of the interests of such people with the aid of international treaties and conventions, such as the Framework Convention on Climate Change or conventions on species protection, by reference to religious or ethical standards and values, and by making use of existing scientific and artistic works.

7. **The competence to motivate themselves and others.** Getting to grips with the concept of sustainability, breathing life into it and developing viable and satisfactory everyday lifestyles requires a high degree of motivation to change oneself and encourage others to do the same. Education for sustainable development sets out to develop the motivational drive we need if we want to lead a fulfilled and responsible life even under the complex conditions of an increasingly interdependent world. Being able to motivate oneself and others means knowing about action options – in other words knowing innovative environmental technologies, resource-conserving lifestyles, nature-friendly forms of mobility and economic activity, and being able to argue in favour of their use. What does this mean when translated into learning goals?

- The pupils can cite activities and learning progress from their work on sustainability issues, such as ”Renewable Energy Sources“, ”Biological Diversity“, ”Regional Utilisation and Threats“, which motivate them to put into practice and supplement the knowledge, problem-solving strategies and action concepts they have acquired.

- The pupils can demonstrate to others their commitment, problem-solving abilities and factual knowledge in relation to sustainable development processes and the identification of non-sustainable developments by informing them, say at exhibitions and other presentations about the use of fuel cells, wind energy, solar technology and the implications of the growing consumption of oil for energy production.

- In the course of their learning, the pupils display increasing expectations about their own effectiveness with regard to the possibility of implementing strategies for sustainable development processes. This means, for example, that after working on Renewable Energy Sources for some time they should be more convinced than before that it is possible for them to make a contribution to the ”energy revolution“.

8. The competence to engage in detached reflection about individual and cultural models.
Identifying and critically appraising one's own interests and wishes, localising oneself in one's own cultural context, or actually adopting a well considered stance in the debate on global equity calls for the competence to engage in detached reflection about individual and cultural models. This is partly a question of perceiving one's own behaviour as culturally conditioned, and partly of getting to grips with social and societal models. For example, there are socially favoured lifestyles (the ideal of a detached house out in the country; air travel to one's annual holiday destination; a car of one's own; solarium-tanned skin) which are problematical from the point of view of health and sustainability. What kind of abilities and skills should pupils possess in connection with this individual competence?

- The pupils are able to give a structured description and assessment of their lifestyles and their local and family environment in the light of the perspective of people and living conditions in developing countries. This can for example be done by comparing land take for housing, differences in interest in repairable equipment, or misgivings about the use of environmentally harmful chemicals. Against this background, the pupils show their ability to describe the limits of their own lifestyles and the extent to which they can be generalised.

- The pupils are able to identify and describe the intentions associated with their lifestyles in terms of their consequences for the environment and for social equity. Suitable issues for this include topics from the complex "Use of Energy", and also reflections about leisure interests, clothing fashions, interest in the protection of animals and in mobile phones free from "electromagnetic smog".

- They are able to analyse their designs for the future – for example the kind of homes they want, their ideas about mobility, use of leisure time, travel destinations – from the point of view of social equity, consideration for the freedom of action of future generations and their potential environmental impacts, and can cite action options for reducing the resulting friction between sustainability and designs for the future.

It goes without saying that it cannot be the objective of every project or every lesson to teach all these individual competencies. They define the background against which the content should be chosen and discussed and the teaching methods selected. It will of course be necessary to specify the individual competencies in more detail, particularly in relation to the material taught. This is done in the following material under the heading of "Learning Goals".

Bibliography

- OECD (Ed.): DeSeCo Strategy Paper. An Overarching Frame of References for a Coherent Assessment and Research Program on Key Competencies.
www.statistik.admin.ch/stat_ch/ber15/deseco/deseco_strategy_paper_final.pdf

WHAT DO SYLLABUSES AND FRAMEWORK PLANS ON CLIMATE PROTECTION AND CLIMATE POLICY HAVE TO SAY?

”Economic growth, technological progress, and population growth go hand in hand with incalculable risks for the natural resource base on which human life on our planet is based. Pupils should examine and assess the scope of this threat and the various inter-related factors involved so as to develop understanding and responsibility for sustainability in their own lifestyles, in political decisions and on global issues,“ according to the Framework Plan for Social Studies for junior secondary level of integrated comprehensive schools in Hamburg (2003).

The topic ”Climate Protection and Climate Policy“ is not only found in syllabuses and framework plans for political studies or social studies. The focus of climate policy is of course, as is obvious from the name alone, not on the sciences. The main thrust probably tallies best with geography and with interdisciplinary lessons, although political studies, history, science and religion/ethics offer points of contact for this very topical issue. It does, however, still account for only a very small part of the overall spectrum of topics relating to sustainable development when compared with topics such as energy, ecosystems or general pollution.

A look though the syllabuses and framework plans for social studies/political studies, geography, physics, biology, chemistry and religion/ethics provides few opportunities to broach climate protection and climate policy in grades 6 and 7. The situation changes however at the level of grades 8 and 9, where geography in particular looks at climate policy as do interdisciplinary topic groups. In geography textbooks for this level, for instance in North-Rhine/Westphalia we find that pupils are expected to get to grips with the Kyoto Protocol, the eco-tax, the ecological rucksack, etc.

Interdisciplinary lessons

Above, we pointed out the importance of interdisciplinary lessons for the topic area dealt with here. This sort of instruction is becoming increasingly important in new syllabuses and framework plans. In this instruction, different subject teachers work together on a subject directly related to the real world. If, for example, Grade 8 is to measure the carbon dioxide concentration in the air, look at air pollution in chemistry, explore designs for the future in German and French environmental policy in French, while investigating the stability and instability of nature, taking climate as an example in geography according to the syllabus, and global problems are to be tackled in political education (as is the case in the state of Brandenburg (Germany) for example), these aspects can all be well integrated into the overarching theme complex of climate change and climate policy.

Topic-specific priorities for the subject lessons

The correlation between climate change and the use of fossil fuels (oil, gas, coal) and global economic growth in contrast to the extreme poverty in the world – this is the backdrop against which geography and political studies syllabuses in particular look at climate policy. If we concentrate on the topics contained in syllabuses and framework plans at the interface between scientific and social, economic and ethical views of climate change and climate policy, we can identify three priorities:

1. Climate and climate change
2. General climate protection and climate policy
3. Individual inputs to climate protection

1: Climate and climate change

Most syllabuses and framework plans take the topic ”fossil fuels“ to introduce climate change. There is a clear focus on lignite, coal and oil, linked with the expectation that pupils get to grips with the problems of using fossil fuels. Oil, for instance, is identified as a fossil fuel which is extremely important for the economy, but which, when burned, contributes significantly to climate change, and which is also a recurrent cause of conflicts because of the way the reserves are distributed around the globe. Few school textbooks look at the significance of the loss of the Amazon rainforest for climate change, or at traffic and transport as a factor in climate change. The greenhouse effect is explained in physical and chemical terms and the individual components of the greenhouse gas mix analysed to determine where they come from. In this context, issues of resources distribution with respect to fossil fuels, resource consumption per country, the expanding world population and the probable consequent increase in natural resources use are raised. Generally, dealing with the causes of climate change also includes an indication as to who are the worst polluters. It is, however, extremely rare to find references to historical data and factual or potential extreme weather events related to climate change such as storms, droughts, flooding, etc.

2: General climate protection and climate policy

In geography and interdisciplinary classes in particular, statements are then made on (international) climate-protection efforts. The climate policy of the EU, climate conferences since Rio, and the climate policy of the United Nations are dealt with. In social studies, lessons also look at actual and potential international conflicts related to climate change, the availability of fossil fuels, etc. More modern textbooks provide a more concrete reflection of the syllabuses and framework plans, look at the Kyoto Protocol and eco-tax. This usually takes the form of a presentation of controversies and divergent opinions. The presentations are generally rudimentary. With this material you have the chance to take a more differentiated and thus more appropriate approach to climate policy. This is often called for by the syllabus, say in the form of realising a planning game or interviewing experts, or that pupils undertake detailed research on their own.

3: What the individual can do to protect the climate

While technical literature focuses fairly and squarely on technical progress as a way of reducing emissions of greenhouse gases, textbooks suggest ways that pupils can make their own contribution to climate protection. Climate experts do not place too much hope on the impact of changed consumer behaviour patterns. Syllabuses and framework plans do give a little information on renewable energies (solar, wind and hydro-power, biogas). The syllabuses and framework plans often provide detailed presentations of the physical, chemical and biological processes involved in the use of renewables and in procedures used to transform energy (combined heat and power stations, for instance). They also look at the pros and cons of individual fuels and the areas in which electricity is used. They offer ideas as to how energy can be saved in the home, at school and in offices. These materials provide an entry point to the complex field of climate change and climate protection. As a basic activity, the simulation of a climate conference with reference to the Kyoto Protocol has been selected, which pupils can try out within the scope of a planning game.

Before this stage, pupils should be familiar with climate change and also with the topic of renewable energies. Pertinent materials can be downloaded from the online Education Service of the Environment Ministry at www.bildungsservice.de. Since the syllabuses and framework plans, in particular for interdisciplinary lessons, also suggest using methods such as mindmaps, planning games and discussions, the materials take into account the directives laid down by the syllabuses and framework plans for the junior secondary level on the topic of climate protection and climate policy.

EXAMPLES OF CLIMATE AS A TOPIC IN FRAMEWORK PLANS FOR SCHOOLS

Influence of the climate on ecosystems

1. Breakdown of the tropics; use of climate diagrams, tropical climate
2. Tropics and subtropics – an overview of the natural area: Climate, ecosystems
3. Properties and impacts of the world's oceans; the impact of the Gulf Stream and the Humboldt Current on the climate and on flora and fauna
4 Natural preconditions: Climate, soil, relief, perhaps mineral resources
5. Germany – natural preconditions: Climate relief, vegetation, soils, mineral resources
6. Russia: Living and working in an unfavourable climatic environment – the ecological consequences
7. Correlation between climate, vegetation and utilisation: Vegetation zones, signs of adaptation, limitations of use; anthropogenic impact on natural vegetation

Ozone layer, greenhouse effect, climate change

8. Greenhouse effect – depletion of the ozone layer – summer smog: Including Agenda 21, sustainable development
9. The influence of the human race on the climate and on weather: The Earth as a greenhouse, the greenhouse effect
10. The future of humanity: The greenhouse effect, global warming, living with the sun ...
11. Our atmosphere – a greenhouse: The atmosphere shapes our living conditions; the greenhouse effect – a shift in the radiation balance of the Earth
12. Anthropogenic impact on the climate, greenhouse effect
13. Climate change through anthropogenic interventions: Worsening greenhouse effect, depletion of the ozone layer, smog formation as an ecological problem
14. The radiation balance of the Earth/atmosphere system: ... the greenhouse effect
15. Significance of climate change for landscape and people
16. Correlation between human activities and climate change
17. Will the climate change? Interests of the individuals in affected regions and interests of industry and private consumption
18. Will the climate change? Significance of climate and climate change, causes of possible climate changes
19. Will the climate change? Impacts of atmospheric pollution
20. Will the climate change? Problem-solving approaches and avenues for action; consequences for individuals and society
21. The Earth's energy balance; disturbing the energy balance (greenhouse effect)
22. Global environmental issues and problems, problem-solving approaches, topical examples

Measures to counter the worsening greenhouse effect

23. The increasing greenhouse effect: Rising concentrations of greenhouse gases, global and regional consequences, measures to limit the greenhouse effect and its consequences

Climate in various contexts

24. Fuels: Environmental problems; type and scope of pollution (local to global impact of human interventions in the air, water, soil, climate, etc. individual impacts, correlations)
25. Peace building, conflicts and conflict resolution mechanisms: Environmental destruction, climate change, scarcity of resources, population growth, power-related conflicts, values-based conflicts ...

LEARNING GOALS

There is scarcely another environmental topic that has captured public awareness to the same extent as climate change. The omnipresence of the topic in the media, its importance for future development opportunities on Earth, and the numerous risks entailed by climate change alone make it indispensable to deal with the topic in schools.

In the final analysis, the aim must be to enable pupils to play an active part in shaping a future that we want to live in, and to allow them to assess climate policy from this point of view. To this end they must not only become familiar with the relevant international agreements and national strategies to halt climate change. They must also read the scenarios that have been forecast for the future and be able to examine these for plausibility. They must be able to intervene personally. For this, they will need proactive democratic skills, which will allow them to develop knowledge, propose arguments, act in heterogeneous groups within which a variety of opinions prevail, and act independently or in political parties or NGOs to protect the climate.

WHAT COMPETENCIES SHOULD PUPILS ACQUIRE AS THEY TACKLE THE PROBLEMS OF CLIMATE CHANGE AND CLIMATE POLICY?

- Pupils can assess and evaluate presentations of past and present climate change.
- Pupils are able to identify political actors and activities (international agreements, national legislation, fiscal measures, etc.) intended to reduce emissions of greenhouse gases, to describe how they work and to assess their impacts.
- Pupils can then analyse problems of climate change presented to them, and identify which expertise and specialist knowledge, which information channels and actors must be consulted if the problem is to be analysed appropriately.
- Pupils can reproduce the salient points of various future scenarios and forecasts regarding climate change, in particular with respect to the risks entailed for individual countries and regions. They are familiar with pertinent recommendations and strategies for action to the extent that they can use these in their chains of argument.
- Pupils are familiar with the phenomenon of feedback, long-term impacts and delayed consequences of the combustion of fossil fuels, the reduction in forest cover and expansive economic growth. They can recount the problems involved and describe and assess the way scientists and politicians react and anticipate impacts in his context.
- Pupils can present the relations between economic prosperity, energy consumption and reduction in natural CO_2 sinks, pollution and the social situation in developing countries on the one hand and the national pollution and energy consumption as well as the concomitant social situation on the other.

LEARNING GOALS

- Pupils can work on problems related to climate change with the help of creative methods, normative directives and individual values-based decisions, as well as research-based learning, such that they can present these problems within the framework of planning games.
- Pupils are able to become familiar with the views and arguments of other cultures in terms of the causes of climate change, and can respect and use these views and arguments in their chain of argumentation, their presentations and their assessments of climate change.
- Pupils can present the results of their research on climate change in groups which bring together different opinions and different levels of information, and in external groups (e.g. parents, teachers, or members of the general public in a pedestrian precinct).
- Pupils are able to express their empathy for the need to mitigate climate damage, and for countries and people who are severely affected by climate change.
- Pupils are enabled to explain the reasons for international and national climate protection measures. They can take their own position on the issues involved in climate protection, with the help of scientific knowledge, international agreements and conventions, national legal regulations and a knowledge of political and fiscal steering instruments, and can form their own opinions.
- Pupils can identify activities and learning achievements in the field of climate protection and climate policy which motivate them to extend and apply the knowledge, problem-solving strategies and concepts for action they have acquired.
- Pupils can identify the contributions they make to climate change with their own lifestyle and can describe measures they could take to help reduce emissions of greenhouse gases.

WHAT DO SCIENTIFIC EDUCATION STANDARDS FOR INTERMEDIATE-LEVEL SCHOOL CERTIFICATES SAY ABOUT "CLIMATE CHANGE MITIGATION AND CLIMATE POLICY"?

The intermediate-level standards of the KMK (standing conference of the ministers of education of the federal German states) for Chemistry, Biology and Physics recently came into force. Since they are binding on all federal states and serve as the rules for future measurement of your pupils' performance, the following remarks are provided to clarify how the material on "Climate Change" is related to the educational standards.

With regard to the intermediate-level KMK education standards for Biology, the material on climate change clearly touches on the following key areas of the **competence area "technical knowledge"**:

The pupils
- describe interactions between the biosphere and other spheres of the Earth;
- know and understand the fundamental criteria of sustainable development;
- are familiar with and discuss human encroachments on nature and criteria for such decisions.

In the **competence area "knowledge discovery"**, the material on climate change pays special attention to the field of explaining dynamic processes in ecosystems with the aid of model concepts and assessing the information value of models. In the competence area "communication", the material on climate change permits a more detailed approach to the competence of applying "idealised representations, schematic drawings, diagrams and symbolic language to complex situations".

With regard to assessment competence, the pupils are to learn to describe and assess the impacts of human encroachments on an ecosystem (in this case: climate change). They should also be able to analyse and assess ecosystems from the point of view of nature conservation and human use, and to assess the environmental and health consequences of material flows (in this case: emission of greenhouse gases). They also discuss action options for environmentally sound and nature-friendly participation in the interests of sustainability (reducing greenhouse gas emissions; using alternative energy sources).

The topic of climate change also has several points of contact with intermediate-level education standards in Physics. For example, energy production from fossil raw materials is covered in the **competence area "technical knowledge"**. The standards in the **competence area "knowledge discovery"** are concerned among other things with selecting and evaluating information from various sources, developing model concepts, exploring simple mathematical relationships, and also taking an appropriate approach to a task or problem and checking the validity of empirical results. This is taken up several times in the material provided.

There are also strong links with the **competence areas "communication" and "assessment"**. The competencies to be acquired include not only research, exchange and discussion of findings, but also assessing the possibilities and limitations of physical viewpoints in purely physical and in interdisciplinary contexts, comparing alternative technological solutions having regard to physical, economic, social and environmental aspects, and assessing the risks of everyday activities.

The material on climate change also has several points of contact with the education standards for Chemistry. For example, in the **competence area "technical knowledge"** the problem of greenhouse gases touches on the field of chemical reactions, the energy aspects of substance conversion, and the field of "substance cycles in nature and technology".

With regard to the **competence area "knowledge discovery"**, the entire spectrum of competencies is addressed. This ranges from asking questions that can be answered with the aid of chemical knowledge and investigations, to searching for relevant data and linking social developments with chemical findings.

In the **competence area "communication"** the pupils are to acquire the ability to obtain information, present it in appropriate ways for specific audiences, and use it in their own arguments (this applies particularly to positioning in relation to climate change and the necessary action). They are also to learn how to work in a team – the climate change material expressly requires this for carrying out the studies and dealing with the questions.

The **competence area "assessment"** is especially relevant with regard to the fact that pupils are to discuss and assess "socially relevant statements from different perspectives" (you will find a number of relevant worksheets and exercises in the material). Furthermore, they are to identify whether issues are related to other subjects, and if so, how. Since climate change is subject to anthropogenic influences, the material deliberately focuses on the interconnections between the natural sciences, geography and social science subjects.

EDUCATIONAL MATERIALS OF THE FEDERAL ENVIRONMENT MINISTRY

Under the banner "Building technical and scientific problem-solving capacities through environmental and conservation-related topics", the Federal Environment Ministry publishes educational materials on priority topics such as renewable energies, the environment and human health, water in the 21st century, biological diversity, land use, phasing out the nuclear power programme, etc. in conjunction with the publishing house Zeitbild Verlag and the Department of Educational Science and Psychology, Educational Future Science Section at the Free University of Berlin. The materials build on the most recent findings in the field of educational research and on the model programme, Education for Sustainable Development.

E-mail: bildungsservice@bmu.bund.de
Materials can be downloaded free of charge from
www.bmu.de/bildungsservice

PUBLICATION ORDER:

Federal Ministry for the Environment, Nature Conversation and Nuclear Safety (BMU)
Postfach 30 03 61
53183 Bonn
Germany
Tel.: +49 228 99 305-33 55
Fax: +49 228 99 305-33 56
Email: bmu@broschuerenversand.de
Website: www.bmu.de/english

This publication is part of the public relations work of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. It is distributed free of charge and is not intended for sale.
Printed on 100% recycled paper.