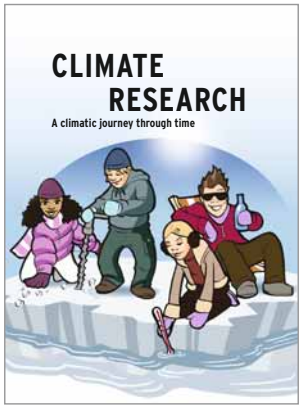
BACKGROUND INFORMATION FOR TEACHERS



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.

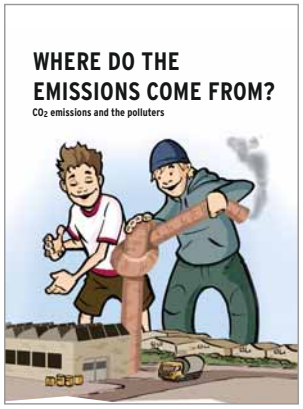
Worksheet 4

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

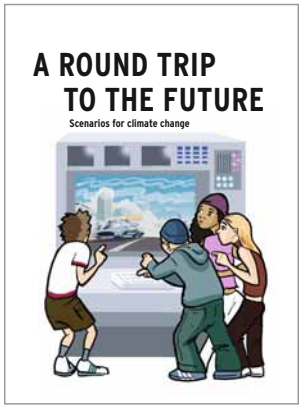
Bans: Ban on CFCs, obligation to return empty batteries
Strict regulations: Limit levels for emissions of pollutants
Incentives: Eco-tax, deposit on drink cans, vehicle tax levels depending on emissions of pollutants in exhaust fumes

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.