ENERGY & ENVIRONMENT

TEXTBOOK FOR SECONDARY SCHOOL PROGRAM

SPARE

SCHOOL PROJECT FOR APPLICATION OF RESOURCES AND ENERGY

SPARE

SPARE is an international school project that has been run by the Norwegian Society for the Conservation of Nature since 1996. Through SPARE pupils learn how to use energy and resources efficiently. Active SPARE schools conduct education on sustainable use of energy and resources, implement practical measures on energy efficiency or renewable energy, and finally inform the neighbourhood about their achievements. The educational activities in each country are coordinated by national NGOs, who also promote education on energy and environment into the national educational plans as well as simple technologies for energy efficiency and use of renewable energy sources. Several thousand schools in so far 16 countries work with the SPARE educational programme.

SPARE educational material is aimed at pupils aged 10-14, and is developed by environmental NGOs and teachers through more than 10 years of active use in schools. The main implementation strategy is adaptation of teacher guides and methodologies for each country, as well as training of teachers. Teacher training is often made in cooperation with institutions for retraining of teachers. School activities have proven to be an efficient channel for energy information and promoting energy efficiency in households. On the basis of SPARE, national NGO coordinators, schools and other partners cooperate for development and implementation of simple low cost energy efficiency and renewable energy measures at schools and in private homes. SPARE has many partners in different countries, from ministries of education and environment, institutes for retraining of teachers, local administrations, UNDP and other local donors and organisations.

You are welcome to join in as partners in promoting sustainable energy!

Visit our website: **www.spareworld.org**

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OSLO

2008

CONTENTS

Dear Readers!

This workbook is part of the international educational program for school children SPARE (School Program for Application of Resources and Energy).

A large number of serious ecological problems of world scale are connected with the production and use of energy. The idea of the SPARE program is to go from a discussion of global problems to practical actions of schoolchildren, to receive an answer to the question: how can we satisfy our need for energy (heating, light, transport) without dangerous and devastating consequences for nature.

SPARE is much more than a usual school program, as it not only gives knowledge, but invites schoolchildren to conduct independent investigations, and stimulate interest for applying various scientific achievements. SPARE assists in practical matters to increase the effective use of energy in the school and at home. The results of the investigations and practical findings of school children in the sphere of energy efficiency can be useful for all - parents, friends and neighbors.

The SPARE program was created in 1996, by the Norwegian Society for the Conservation of Nature (Norges Naturvernforbund). From that time on the program has been realized and developed by school and environmental non-government organizations in many countries of Europe, with more than 50,000 school children participating. The first SPARE workbook was designed for Scandinavia, Western and Central Europe. Now the SPARE workbook exists in many languages in printed edition, electronic (CDs) and online edition as well. In 2003/2004 adapted versions were published in Russia, Ukraine, Poland, Moldova, Romania, Azerbaijan, Armenia, Georgia, Kazakhstan, Kyrgyzstan, Tadzhikistan, Turkmenistan, and Uzbekistan. Non-profit organizations and school of Northwest Russia participate in SPARE from the first year of the work of the program.

From 2002 the Ministry of Education of the Russian Federation has conducted the project "Inclusion of Low-Cost Measures of Energy-Efficiency in the Educational Sector of the Russian Federation". One of the goals of the projects of the Ministry of Education has been the creation of a state educational program and school workbook "Energy Savings" for the elective course for the 8th grade of middle school on the basis of use of the experience of SPARE. In the 2003/2004 school year the book "Energy Savings" and the course program was presented to all schools of the pilot regions of the Ministry of Education project (Murmansk Oblast, Arkhangelsk Oblast, Karelia and Tver') and the distribution of these materials throughout Russia has started.

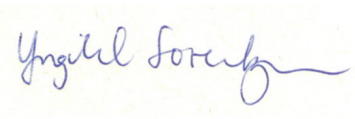
The current version of the SPARE school textbook is intended for use in Russia and in the Russia-language regions of the Baltic countries, Ukraine, Belarus, Moldova, Caucasus region and Central Asia. This version is prepared on the basis of the previous issue of the book "Energy Savings," which was again, based on the first SPARE textbook. Specialists from Tver' State Technical University, the NGOs Children of the Baltic and Geia, and also teachers of Northwest Russia contributed to its creation. A new section, concerning solar energy, is published by the NGO "BIOM" of Kyrgyzstan. We hope that this material will be helpful for the introduction of the simplest solar heaters for the local communities.

In addition to this textbook, various materials have been developed: study plans, methodological guidance for teachers, leadership instructions for NGOs for distributing SPARE, suggestions for including practical low-cost measures of energy-savings, methodological and informational video films, and multimedia CDs and DVDs.

You may contact the national SPARE coordinators for all additional information.

We are grateful to all the school children, teachers, activists of NGOs and specialists of various organizations who assisted in the development of the SPARE program.

We also express our gratitude to the Ministry of Foreign Affairs and Ministry of the Environment of Norway, which have provided financial support for the program.



WHAT WILL WE STUDY

Why conserve energy?

In 1992, the United Nations conference on environment and development took place in Rio-de-Janeiro, Brazil. Representatives of 197 countries of the world participated.

The conference, orientated towards sustainable development solutions, was first to establish on a global level, ideology of sustainable use of resources and conserving the environment for the generations to come. Energy saving and use of renewable sources plays the key role in development and environmental protection, since common sources of energy have so far been the greatest polluters on the planet.

All energy processes use energy sources. Some sources are clean, like solar and wind energy, with zero gas emission, and therefore no negative effect on environment, while others can lead to catastrophic consequences, with great greenhouse gases emission and polluting waste. Non renewable energy sources, with no exception, affect the environment, and so severely that they have global negative impact, changing both climate and nature.

Most of the energy used in Europe comes from burning processes of oil, coal and gas. By using these non-renewable energy sources, humans create pollution, such as carbon dioxide (CO2) and other greenhouse gases release into the atmosphere. Carbon dioxide is the main cause of global warming, which already has dramatic consequences.

Although we are still uncertain as to when and to which proportions these changes will occur, according to the UN's climate committee there is no doubt that global climate change has begun.

The simplest solution

Without the sun, life on earth would cease. Sun rays reach surface of the Earth in eight minutes and fifteen seconds and over this time/space relation sends as much energy as humans use in an entire year. If the energy is used wisely, many energy problems of the future may be solved. .

Perhaps the simplest way of reducing pollution is by energy conservation, or what is more simply called - the energy saving. This means using energy more efficiently. Huge amounts can be saved by public and private efforts. By using less non-renewable energy, the amount of greenhouse gases released would be greatly reduced.

Is there enough energy for everyone?

Human energy use has a severe effect on the planet, and moreover, since 1960 we have doubled our energy use.

Distribution between North and South, rich and poor, is extremely unequal. At one end of the scale there are countries with cold climates, a few inhabitants and a great wealth, such as Scandinavian countries and Canada, and at the other densely-populated but overwhelmingly poor countries such as India, Indonesia and Bangladesh. The drop in energy use seen in some poor countries cannot be attributed to energy conservation measures and fear of global warming. It stems from economy decline, debt crisis and lack of technology. Once these countries have sorted out economical issues, they will follow suit. since they stream to improve their standard of living – to the standard people of Europe enjoy.

Young people are the future

The UN has stressed that the world's children and youth must take action in taking care of the environment.
The aim of this project is to provide future generations with more knowledge about energy and to motivate them to develop a society based on environmentally-friendly energy use. This project will enable pupils themselves to use energy properly and to influence those people in their local community to do the same. In addition, we hope to establish contact between schools beyond national borders, so that pupils can exchange experiences and information.

Many small streams make a big lake

Together with teachers and pupils in many countries, you have now said "Yes!" to the challenge of playing an active role in your own, your family's and your school's energy use.

Through practical tasks and good examples, we shall acquire skills for productive use of energy and begin to save energy on a small scale.

Our aim is that all of us become a little better at using energy more sensibly than we do now. We think you should first begin from yourselves and start right away!

Task 1.
Test of energy conservation

In your home	Yes	No
You write down your electric use		
You turn off the light when you leave it		
The washing machine is always completely full when we use it		
The refrigerator stands in a cool room		
We do not leave furniture in front of the heater		
We have started to use compact fluorescent light bulbs		
We use local lighting (for example, table lamp)		
We ventilate the room quickly and effectively and only for a few minutes each time		
We tape windows in the winter		
We close windows at night		
We put the lid on the kitchen pot		
We often defrost the refrigerator		
We use the sink for washing dishes		
We take a shower rather than bath		
We go by foot or by bike to school and work		
We lower the temperature at home when we go out		
We lower the temperature at home at night		
We recycle glass, paper and metal		
We do not buy goods that can only be used once		
We do not buy goods in big volumes		
We repair things rather than replace them		

Add up all the **Yes** responses. If you have:

- from 1 to 5 responses Yes:
You need to learn a lot more, so begin right now.
- from 6 to 10 responses Yes:
You have many good habits, which can serve as the foundation for further work.
- from 11 to 15 responses Yes:
You are a very good example for others.
- from 16 to 20 responses Yes:
Someone from your family should become minister of the environment.

PART ONE

ENERGY

PART ONE – ENERGY

1. ETERNAL ENERGY

Most astrophysicists now believe that when The Universe was created all the energy and mass was pressed together in a "cosmic egg." But, this energy could not be contained for any length of time – and the result was The Big Bang, explosion that occurred some 20 billion years ago. It is not critical to study in detail this theory, but it is important that energy has been around since the beginning of time and will continue into eternity.

But just what is energy? An easy question to ask, but rather difficult to answer, at least in a concise, comprehensive way, which everyone understands.

Let us begin by stating that energy is an abstract concept which was developed by physicists to try and explain in unified terms various phenomena related to work. This concept became so useful that energy is now the most fundamental of all dimensions in the natural sciences –and not only there, but in all areas of society and all cultures. We cannot think of any activity which does not involve energy – even the process of thinking involves energy.

Therefore the simplest definition of energy is capacity to do work, and capacity for different types of work are measured by different measurement categories, such as temperature, mass, distance, radiation, electric current etc.

Of course, we can get a lot of enjoyment out of a television without knowing more than how to use the on/off button. We can also be actively involved in debates concerning how to ensure enough energy for the future without knowing anything about its various properties. But, if you do have a certain insight, this can provide you with good key for understanding many environmental questions and why it is necessary to find new energy paths into the future. Working with energy will develop attitudes and skills, better enabling us to contribute to a sustainable development.

2. ENERGY – FORMS, PROPERTIES AND DIMENSIONS

"The house I live in is yellow and 14 m long. Outside, it is raining and windy and the temperature is only 7 degrees Celsius." We describe objects and surroundings using physical characteristics and dimensions such as color, length, temperature…but not all of them are equally important nor we need to mention all the same time, or every time. However, one characteristic, or better to say – a dimension, is present everywhere and in everything.

Energy occurs in many different forms:

•Everything that is in motion has, due to this movement, kinetic energy

•An object which has a position relative to another object has a potential energy to this

These are commonly known as the mechanical energy.

When we burn wood in a fireplace, the chemical energy stored in the logs is released and produces thermal energy (heat). Our electricity pylons carry electrical energy. The sun sends enormous quantities of radiation energy down to the Earth. Nuclear energy is transformed to electrical energy in nuclear power stations. Radiation energy from radioactive sources is used in hospitals in different medical treatments. There are many other forms of energy such as: thermal, chemical, electrical, nuclear, magnetic, to mention those most known.

difficult to do so. Nevertheless, we will talk about these energy forms as we do in a common daily conversation.

Task 2.

How I use energy

Analyze your actions during the course of the day that use energy.

What type of energy did you use completing one or another action. Discuss this with your fellow students.

Energy
– a measure of something that can happen
The various forms of energy can be very interesting themselves, but what is even more interesting is what happens when energy transforms from one form to another.

All objects which move have kinetic energy. When the object stops (a change takes place), this kinetic energy changes to other forms of energy – just think of the saying "It isn't the speed you travel at, but the sudden stop, which kills."

When an object is in one position relative to an underlying surface, that object has potential energy in relation to the surface. The man (which is an object here) in the illustration has potential energy in relation to the ground. He will suddenly notice changes when his energy goes over to other forms.

These are two simple illustrations of the general rule: every time energy changes form, something happens and the vice versa, every time something happens, energy changes form.

If we were to summarize all these experiences in a short sentence which describes simply what energy is, we could say - energy is that which can make something happen.

In practice, electrical energy is measured in kilowatt-hours (kWh).

1kWh: Is approximately the quantity of energy which is needed to accelerate a 10-ton truck to a speed of 100 kilometers/hour. An equal amount of energy is spent each day when a 40-watt light bulb is left lit in an empty room.

In physics, energy is measured in joules. The relationships between the different energy measurement units can be viewed in the table.

The Power
– a measure of the energy transformation rate
When you describe how you move from one place to another, a certain distance or way, it is useful to explain it using a new category – speed. If you use a long time to cover a certain distance, your speed is low. If you use a short time, your speed is high.

Speed is therefore a measure of the rate at which you move for a certain distance.

Speed = distance/time

Effect = energy used/time

It has been shown in many cases that it is useful to have a category which tells us something about how fast energy is transformed (or used). We call this dimension power. High power means that a certain quantity of energy is transformed (used) in a short time – and low power means that we use a long time to transform the same quantity of energy.

1 watt-second (Ws) = 1 joule
1 watt-hour (Wh) = 3600 Ws
1 kilowatt-hour (kWh) = 1000 Wh = 10^3 Wh = 1000 Wh
1 megawatt-hour (MWh) = 1000 kWh = 10^6 Wh = 1000000 Wh
1 gigawatt-hour (Gwh) = 1000 MWh = 10^9 Wh = 1000000000 Wh
1 terawatt-hour (TWh) = 1000 Gwh = 10^{12} Wh = 1000000000000 Wh

Task 3.
Measuring energy use at home

Each evening during the course of a week you should write down the readings of your electric meter. Fill in these readings in the table. In this way you will see how much energy you are using at home. At the bottom, indicate what energy you use for heating – central heating, coal, gas, oil or wood.

Begin to record the electric readings Monday evening. On Tuesday you must do the same. In order to clarify how much energy you have used in the last 24 hours, subtract the meter readings from Monday from those readings from Tuesday. Note the results in the corresponding space in the table. Do this every evening, including the last Monday. At the end draw a line through the crosses. You will have a graph of energy use for each day of the week. Sum the results to receive the overall energy that was used in your house in a week. Remember that it is necessary to indicate which energy you used.

After this you can stop measuring energy use for a week.

At the same time study your own energy use and try to decrease it. Then repeat the recording of energy use for one week. Write the results in the spaces, but using other colors than the first time. At the end compare the results. Did you achieve an energy savings?

20 kW/hr							
19							
18							
17							
16							
15							
14							
13							
12							
11							
10							
9							
8							
7							
6							
5							
4							
3							
2							
1							
0	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Indicate what you use:

Coal Gas Oil Central heating Wood

Think and Reply

1) Look around you and name those objects that possess potential energy.
2) Cite the examples of those objects that possess kinetic energy.
3) What type of energy does the follow possess:
   - candle flame
   - airplane
   - battery in a calculator
   - bread taken out of the oven
4) Why is it harder to climb up to the fifth floor than the second floor?
5) When do you expend more energy:
6) Preparing for class at your desk with a desk lamp of 60Wt power for three hours, or turning an electric kettle of 600 Wt for 10 minutes in order to drink tea?

3. THE FIRST LAW OF THERMODYNAMICS

The energy is conserved

Physicists who worked with energy established two laws of energy. These two energy laws have since been considered so fundamental that they have been given the status of the "Principle Laws of Thermodynamics". These energy laws have many names and are expressed in many different ways.
The first law of thermodynamics is often described as the Law of Energy while the second is called the Law of Entropy. It can also be useful to explain the first as the Law of Quantity and the second as the Law of Quality. Soon, you will see why.

The quantity of energy remains constant

When we twist an elastic band in a wind-up motor, we are working on the elastic band. The work is the transfer of energy from our body to the potential energy in the elastic band. When we release the wind-up motor, the potential energy is transformed and transferred to kinetic energy in the drive band, and from there to the axle in the dynamo. Magnets are attached to the axle which rotates between the coils in the in the dynamo. The kinetic energy here is transformed and transferred as electrical energy in the coils, which is then transferred through leads to the light bulb. In the light-bulb filaments, the electrical energy is transformed to light and thermal energy.

This is one concrete example of an infinite number, demonstrating the fundamental properties of energy, i.e.: energy passes from one form to another in a long, long chain – an energy chain.

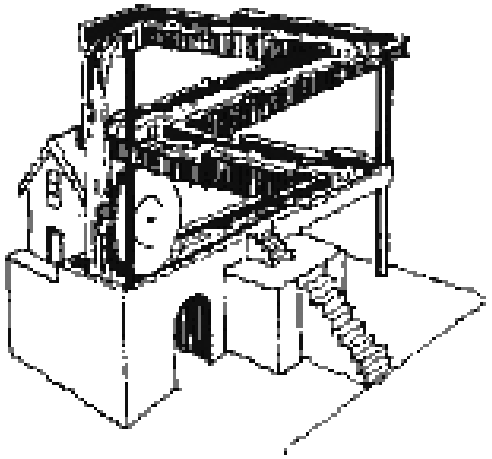
The first law of thermodynamics covers this property, and the law is usually expressed as:

Energy cannot be destroyed or create itself.

Or as:

Energy can only change form or space.

The first law tells us something about the quantity of energy, how much energy there is and which quantities of energy exist. It is the experiences and consequences of this law which enable us to work with dimensions such as heat capacity and different energy units, in short, relationships which mean we can calculate how much energy there is, how much energy we have available in the form of coal, electricity and solar energy, etc. We are able to numerate or quantify how much energy we are working with, hence the name – the law of quantity.

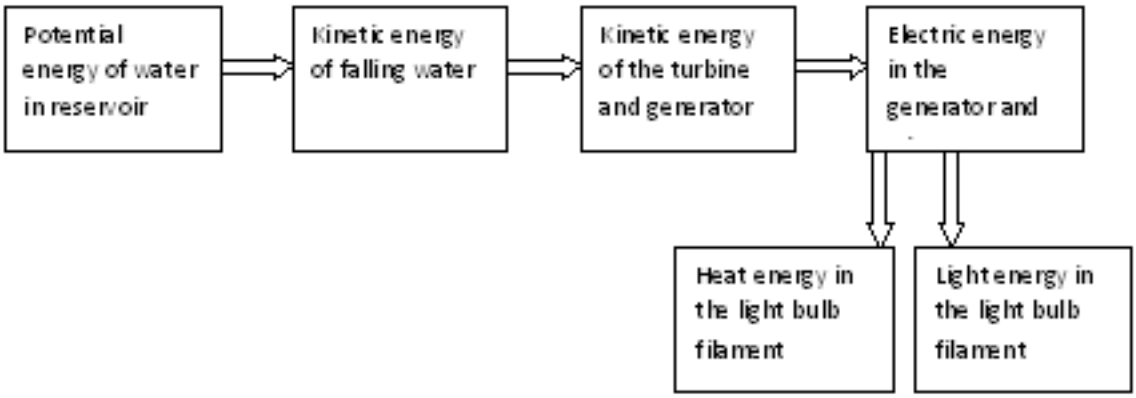


It is this energy law which is used when we set up different types of energy accounts, energy balances or energy flow charts. One example of an energy flow chart is shown below, illustrating the energy flow during the production of aluminum:

Since, according to this law, energy cannot be used up, it is incorrect to talk about "consumption of energy." One energy form, however, can be used up when the energy is transformed to another energy form, sometimes into the form we can not use. It is therefore, correct to talk about, for instance consumption of electrical energy – but energy itself we can only use, and not consume.

The law of quantity tells us that energy does not disappear – it just transforms to another form. If this energy law covered all properties of energy, it would give us a simple solution to the problem of insufficient energy in the future: energy recycling – ensuring that the energy is always transformed to a form we need!

The second law of energy explains why things are not so simple.



Task 4.

Create your energy cycle

You will need 2 kilos of peas (yellow, dried) and a gutter, which can be made from anything. It is best to get hold of an old piece of guttering. It is very important that there are no holes in the guttering. You will also need a basin or bowl into which the peas can run.

Place the guttering at any angle so that the peas can run down along it. The peas will gather in the basin/bowl at the bottom. Remove them with a cup and quickly fill them into the top end of the guttering again and again. Now you have made a stream of peas, which forms a circuit, which we call a closed circuit. You are the battery, ensuring that the peas continue to flow from the bottom of the guttering to the top, from where they pour down to the bottom again.

In an electric circuit with a battery and a conductor (the guttering in our experiment), it is the battery which keeps the electrons charged up (at the top of the guttering) so that they can "drop" down through the conductor (guttering).

4. THE SECOND LAW OF THERMODYNAMICS

Why does the automobile run? Some of the chemical energy in the petrol which goes into a petrol engine is converted to kinetic energy and can be used. We call this useable energy or work i.e. exergy. The rest of the energy (remember the law of quantity) is eventually transferred to the surroundings, and transformed to the thermal energy. We call this energy source non-useable energy or anergy.

This simplified example using the petrol engine also demonstrates another characteristic of energy, i.e. each time energy passes from one form to another, only a certain percentage of the energy can be used. How high this percentage is varies greatly, depending on the sort of energy and the technology used.

Thermal power machines work on the principle of transforming thermal energy to a useable energy (mechanical work), of which the petrol engine is an example. In order for a thermal power machine to function, it must comprise a warm and a cold component. The temperature difference between the warm and the cold components determine in part how much useable energy we can get out of the machine. The greater the temperature difference, the greater the useable energy.

Not all energy forms are equally useable for us, or equally valuable; they have different energy quality High energy quality means that most of the given form of the energy can be used i.e. transformed to exergy. One can therefore say that energy quality is a measure of the accessible quantity of the energy.

We classify energy forms in qualities as follows:

Excellent quality:
Example: potential energy, kinetic energy, electrical energy

High quality:
Example: nuclear energy, chemical energy, high-thermal energy (temperature above 100 degrees Celsius)

Low quality:
Example: low-thermal energy (temperature below 100 degrees Celsius)

Take for example two forms of energy in an equal quantity - 1kWh, the one in the form of electrical energy and the other in the form of thermal energy, with a temperature a little above the room temperature. Nevertheless, they are very different because they have different energy quality. The electrical energy can be used to carry out many tasks, from moving a car a short distance to heating up a small room. But the same quantity of thermal energy can only be used to heat up the room.

This property of energy, which we are talking about here, can be expressed by saying that energy of high quality can be transformed to a lower quality with a slight waste – while the reverse transformation in the same manner is impossible. Of course, one can transform energy of high quality to energy of excellent quality, such as converting chemical energy to electrical energy in a thermal power station. But this always results in transformation of a large part of the original quantity of energy to energy of lower quality (waste heat). Overall, the original quantity of energy will have a lower energy quality after conversion.

This fundamental property of energy can be expressed in the second law of thermodynamics:

It is not possible to build a machine which can completely transform a certain quantity of thermal energy to useful work.

Or:

When one quantity of energy is transformed, the energy quality is reduced.

The second law of thermodynamics deals with how the energy quality is reduced when a quantity of energy changes form – we call this, therefore, the law of quality.

Think and Reply

1. The purpose of the steam engine locomotive and the electric locomotive is identical. Why has the electric locomotive replaced the steam engine locomotive?
2. Try to list all conduits of loss of energy during the motion of an automobile.

PART TWO

ENERGY USE

PART TWO – ENERGY USE

1. HUMANKIND NEEDS MORE AND MORE ENERGY

When first men mastered the energy use it was a groundbreaking point in our history. Control and use of energy was the prerequisite for the very first health revolution. People learned to boil and fry their food, thus reducing the effects of harmful bacteria and parasites contained in it. By controlling fire they could keep the dangerous animals away, keep warm and scorch the dead grass, making it easier for new plants to grow.

Let us emphasize that, for us as consumers, it is not the energy in itself which is the great advantage, but all the goods and services which we can access and benefit from, by applying this energy.

One of the gifts that humans have is the ability to think – and to convert these thoughts into actions. Throughout history, this has resulted in various methods and techniques for exploiting other energy sources, and by using those, to implement different activities.

Vast sources of energy and the technology to exploit these, have enabled us to use energy and machines to take over the work of humans (the first is most probably the introduction of the "spinning jenny," a multi-spool spinning weal, which replaced many workers in the yarn industry; tractors which replaced working-animals in farming and robots replacing manpower in hazardous and heavy work).

Many of the goods and services which most of us in the industrialized world associate with an increased standard of living demand substantial energy subsidies or extra input of energy.

2. THE HISTORY OF ENERGY USING

This section covers some of the main developments which show how people have been able to achieve so much activity, in other words milestones, in the history of energy. All of history of energy use shows that an increase in living standard has been accompanied by an increase in energy use.

Using local energy sources

One main development which we find many examples of is: All societies use the energy sources available to them. Let us start by looking at grinding wheat grains. Using their muscular energy, people ground the grains with the help of stones and wooden clubs.

The development of millstones meant that much larger quantities of wheat could be ground. This technique was based on an upper stone which was turned while a lower stone remained stationary. Corn was fed in through a hole in the top stone so that the outer husk was removed and the grain was then crushed between the stones.

Human body (i.e. the muscle energy) was first used to turn the upper stone of the milling mechanism, but later the muscle energy of working animals was used. In areas with hills and enough water, techniques which used the energy contained in running water were developed, first using small stream mills and later, water wheels and large millstones.

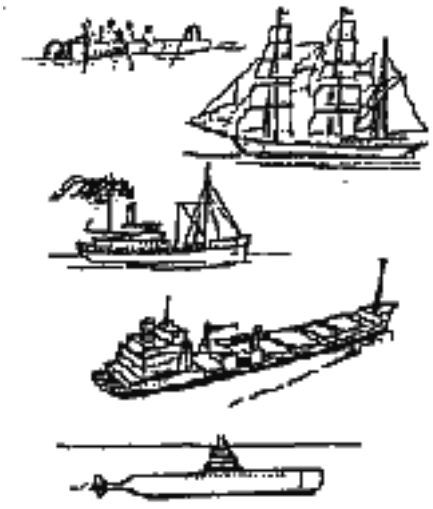
In flat and windy areas, similar techniques were developed to utilize the energy in the wind, as well as the energy in tidal waters.

Today, we mill cereal grains with the help of electrical energy. But in transforming energy we are still using the local energy sources. It is not just by chance that in Norway most of the electricity is obtained by transforming the kinetic energy of running water into electrical energy, since the country is rich in hydropotential, while in Eastern Europe the chemical energy bound in coal is transformed into electrical energy.

From Renewable to Non-Renewable Energy
Perhaps the most significant milestone in the history of energy can be briefly stated as: People first start to use renewable energy sources carefully but have since slowly gone over to a thoughtless use of non-renewable energy sources.

We can illustrate this by a few examples. For the transport of people and goods across the oceans, in the beginning, human muscle energy was used for rowing, then people utilized wind and current and in 19th century managed to even more efficiently use energy of the wind. Humans then progressed to using more and more quantities of energy from coal, oil and uranium.

The production of food provides us with a slightly different example. The purpose of agriculture is basically to utilize photosynthesis for collecting and transforming solar energy to products like food and clothes. The farmer helps in this process with a certain quantity of input energy (energy subsidizing). This input energy takes the form of own work, working animals, tractors, tools, manure, irrigation systems, insecticides, that is all forms of yield increase stimulation.



It is many years since Europe stopped using the hoe agriculture, but this is still used by almost 460 million people throughout the world.
Not much more than a generation has passed sine most of Europe also progressed from the working-animal agriculture, but this is still used by almost 260 million people around the world who work with 335 million horses, oxen, camels and donkeys. Only 50 million people are using tractors in agriculture.

The energy account for these forms of operation is interesting. In the hoe agriculture and working-animal agriculture, the energy content of the product is often many times higher than the added energy input. In the tractor agriculture, it is quite the opposite. The input energy is often many times greater than the energy content of the product and this energy input (energy subsidizing) can nearly always be traced back to oil sources.

One milestone in the history of energy is: On the road to a more technological society, we have become more and more dependent on non-renewable energy sources and electrical energy.

We do not seem to realize how dependent we have become on electricity and oil products before those disappear. How on earth are we then going to be able to transport goods? If electricity disappears for a few days all the PC screens would shut down – think of the chaos this would cause!

Control over energy gives power
The last milestone in the history of energy which we shall mention is: Those who control the energy sources and the technology to exploit these sources, have the power.

History of energy use leads us to the conclusion: those who control energy resources are those who rule. This may be one of the main reasons for poor utilization of solar energy. The sun emits enormous quantities of energy, but this energy form is diffuse and it is not possible for anyone to have exclusive control over it. Due to its diffusion, perhaps the most interesting method for utilizing it would be small and simple plants. This will not lead to centralization and accumulation of power, unlike when it comes to non renewable energy sources.

Think and Reply

1. Where is the muscular energy of man now used?
2. Why is such a form of power such as "horse power' still sometimes used?
3. Is the fluctuation in the price of oil products reflected in the price of food products? Why?
4. How do you explain the expression "Control of energy gives power"?

Imagine that you live in England at the end of the 19th century on Baker Street in the same apartment as Sherlock Holmes and that your name is Watson. It is late in the evening and you are sitting at the fireplace and discussing the events of the day. Today you have again accompanied Mr. Holmes during the course of solving a crime. Explain what sources of energy and for what purpose you used during the course of the day, beginning from the early morning. What energy sources did you use for your tasks today?

Task 5.

Food and Energy

What is in your stomach? Write down a list of the contents (ingredients) of the dinner you ate last night.

Complete the table below – on your own – before you discuss with a fellow pupil.

Try to guess where the food you have eaten comes from. If it comes from a place nearby - place a cross in the first column. If it is produced a short distance away, still in your country – place a cross in the second column. If the food is imported to your country, place a cross in the third column.

Try to figure out which food requires the most energy in its production. Consider cultivation, transport and processing. Write the letter E beside that food which requires the most energy. A carrot which has been grown in your garden and eaten immediately is cheap in terms of energy. However, if the carrot is in a tin, it is more expensive energy-wise.

Find out if what you have eaten is really necessary to help you grow and keep you healthy.

Compare your results with one or two of your classmates. Help one another with the answers and cross off under E (energy) and U (useful).

In small groups, discuss rules for how our foodstuffs can be improved in terms of energy and nourishment. Discuss the most important questions with the whole class.

Ingredients	Near	Own Country	Abroad	Energy	Useful
Example: Potatoes	X	X			N
Carrots					
Milk					
Bananas					
Bread					
Meat					
Etc.					

3. GLOBAL ENERGY USE

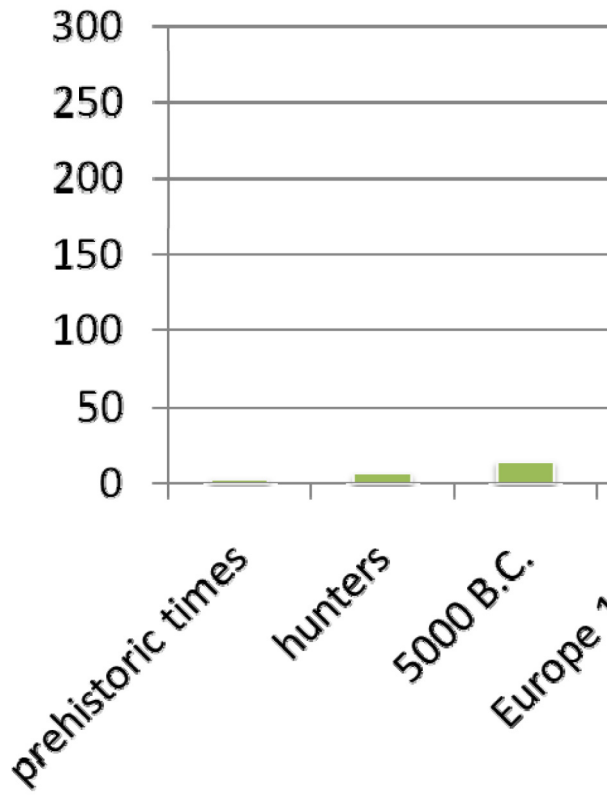
Energy use in different societies
The first hunter and harvester societies needed a little of administration. There was perhaps a leader or a council of elders who led the camp. Most of the leaders had to hunt and harvest just the same as the others. Food and other resources were seldom so bountiful that they could provide for a full-time leader.

In the first agricultural societies, three to ten kilos of wheat could be harvested for every kilo sown. Some of this surplus food/energy could be transferred to society so that after a while it could be provided for leaders, medicine men, priests and warriors. These non-farmers improved conditions for agricultural production by ensuring stability and safety for the farmers, who in turn could devote their time and work to increasing this surplus of feed/energy.

Where the conditions for agriculture were exceptionally good and agricultural technology improved, the surplus was high enough to provide for larger groups. Concentrations of larger groups in villages allowed the development of even more specialists such as masons, woodcutters, blacksmiths, tradesmen and sailors. The goods and services from the specialists increased the standard of living. It was not until the middle ages that the water wheel came to Europe, and with it, machines that could utilize the energy contained in larger and stronger energy sources than those represented by man and animals.

In 1784. Scotsmen James Watt has invented the first mobile steam machine. From that time on, man could transport and utilize both bioenergy such as wood, and not least, non-renewable energy such as coal. This invention had a major role in transition from manual to machine force.

In the modern technological society, the technologies for utilizing non-renewable energy and electricity are highly developed and still growing.



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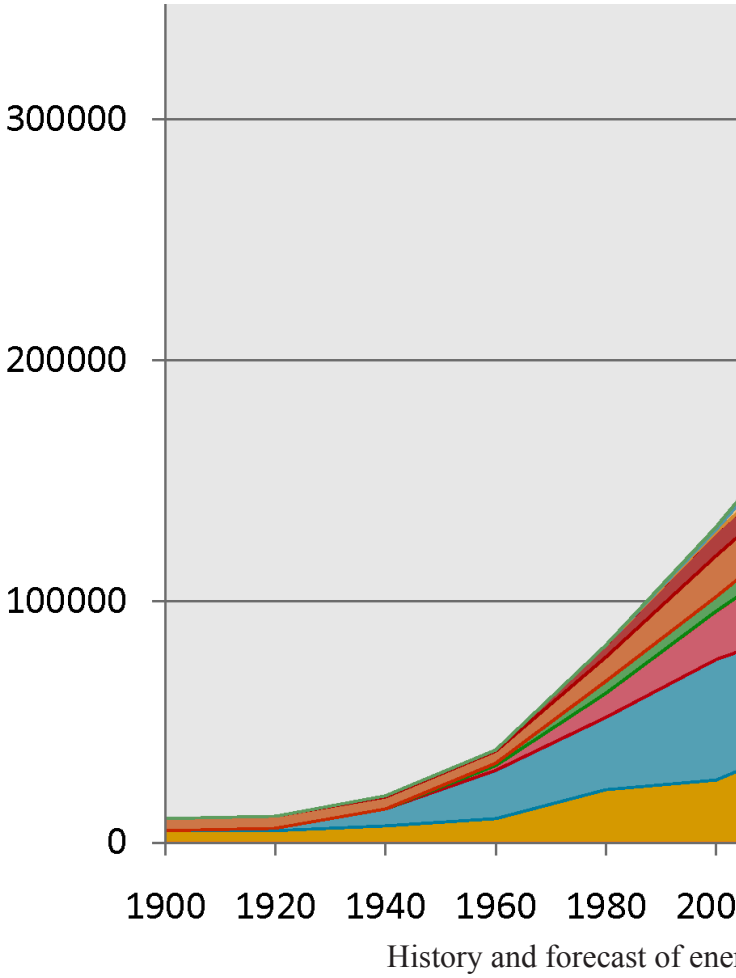

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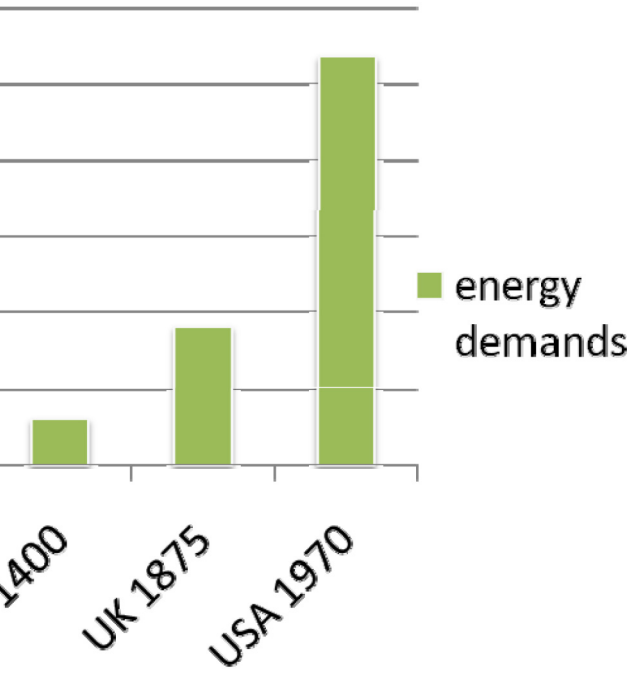

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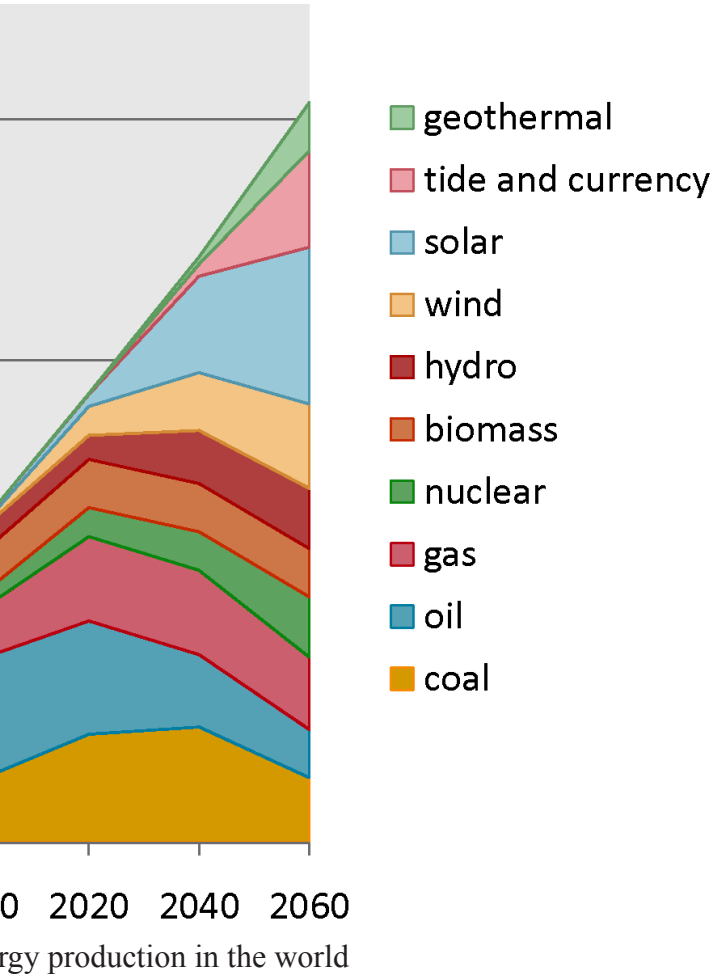


rgy production in the world

Energy from different sources

Up until the end of the 1800s, coal and wood were the dominant energy sources. At the end of the 1890s oil accounted for only 2% of energy use. The use of non-renewable energy sources, has increased enormously after the Second World War– and keeps on with the growing trend. Electricity produced in hydroelectric power stations or nuclear power stations accounts for only a small fraction of the global energy use.

An unequal global distribution

Access to cheap energy has been one of the causes for the increased standard of living in our part of the world. Up to a certain level, there is a definite correlation between materialist standard of living and the energy use. But once this level is reached, the situation is much more complicated. The political regime, level of technological development and distribution of goods play a vital role.

Each year, the UN publishes statistics which show how much energy, on average, each inhabitant in the various countries uses. For several reasons, one cannot accept these figures at face value. Two reasons are worth mentioning here, the first that there are very often considerable differences in energy use between the poor and the rich in the same country, and the second that it is only commercial energy use which is included. In many poor countries, wood is the prime energy source and it is most often not included.

Task 6.
Discuss

One American uses as much energy as two Europeans, 35 Indians, 210 Tanzanians and 600 Bhutanese. What will happen to energy use when Indians, Tanzanians and Bhutanese want to use as much energy as we use in the developed world? Can we manage to increase energy production that much?

Is it right that we increase our use when others are not allowed to?

Think and Reply

Place in chronological order those energy sources as they have become available to humankind, beginning with the earliest:

- Nuclear energy
- Muscular energy of work animals
- Oil
- Wind energy
- Muscular energy of people
- Coal
- Hydropower energy

4. CONSEQUENCES OF ENERGY USE

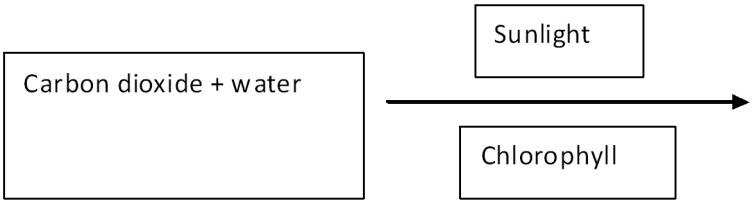
There are two sides to every coin, and energy is no exception. Put very simply, one can say that all transformation and use of energy has unfortunate consequences. This section is divided into two parts, looking first at environmental consequences and at energy crises.

The environmental consequences
Great amounts of energy are today in use, in fact more than ever. This means that we can live in a great comfort too, but on the other hand this is where a great deal of problems is originating from.

Let us start by looking at a table which schematically presents the environmental consequences of using our most common energy sources. We can see here that there are large differences between those which are most and the least environmentally friendly energy sources.

As there is no single energy source or combined energy sources that are not, in one way or another, harmful to the environment, the one most important thing that people can do is to save energy. We must save energy to ease the pressure on nature, and use those energy sources that are least harmful to the nature. Only then will we achieve a sustainable development.

Because it is the use of non-renewable energy which leads to the greatest environmental impact, both globally and locally, we will look a little more closely at the synthesis and organic material decomposing.
Plant cells contain chlorophyll, which uses sun rays to convert inorganic compounds such as carbon dioxide and water into high-energy organic compounds, such as carbohydrates, with the release of oxygen – in a process of photosynthesis. These high-energy organic compounds are the most important building blocks in all organic materials. Other elements such as nitrogen and sulfur are also built into small building blocks, eventually producing cells and finally entire living organisms of the plant and animal kingdom. Cells, organs and organisms all contain everyone of these elements, only in different quantities.



These organic compounds are combustible, i.e. if oxygen and the suitable physical conditions are present, the organic compounds decay, eventually reaching the form of their origination - carbon dioxide and water, followed by the energy release. Other elements, such as nitrogen and sulfur may also be released in small quantities.

As previously noted, when organic compounds are decomposed carbon dioxide is released. This carbon dioxide is initially released into the atmosphere causing an increase in the concentration of this gas. Decomposition of organic materials can take place slowly – when grass withers away in the autumn for example, or quickly, when we burn oil or wood. The concentration of carbon dioxide is increasing all the time and the main cause is release during burning of non-renewable fuels.

Whether we use non-renewable fuel – fossil fuel or renewable - biofuel, carbon dioxide is released into the atmosphere. Nevertheless, the burning of the bio fuel still significantly differs from fossil fuels burning.

The non-renewable sources of energy which are stored in the earth contain large quantities of car-

bon. When we burn the non-renewable energy sources, this carbon is released into the atmosphere as carbon dioxide. This causes an overall increase in the concentration of carbon dioxide in the atmosphere. The carbon released from biofules burned will be used for new plant growth (that again, can be used as biofuel), which closes the cycle of carbon dioxide in atmosphere and basically has zero carbon emission. We can therefore say that burning biofuel is CO2 neutral.

When the concentration of carbon dioxide in the atmosphere increases, it aggravates the greenhouse effect, on a global scale, which appears to be one of the greatest environmental challenges the world is facing today.

Organic matter + oxygen

5. THE GREENHOUSE EFFECT

The greenhouse effect has been the centre of attention in recent decades. But first, we must distinguish between the natural greenhouse effect and one caused by people. The greenhouse effect is essential for all life on Earth – without life, the average temperature would be around -18 degrees Celsius. The average temperature today with the natural greenhouse effect is around +14 C degrees.

The greenhouse effect on the earth and the atmosphere is process very similar as the one in the greenhouses used for gardening. Here, the sun rays pass through the walls and roof made of glass. The rays reach the ground and heat it up. The walls and roof absorb the heat from the air, heated by the ground. If the greenhouse is to maintain the heat balance, the temperature inside the greenhouse must be higher than the temperature outside when the sun is shining. Sun rays reach the ground inside the greenhouse, but they can not escape through the roof back to the atmosphere, due to change of wave length. Therefore, sun rays keep entering and stay captured inside the walls of the greenhouse, significantly increasing the temperature. Very simply, the walls and roof of the greenhouse are equivalent to the layer of air around the Earth that we call the atmosphere.

Here on Earth we are balancing on an edge of a knife. It is easier to understand this if we look at our nearest plants, Mars and Venus. Venus, which is closer to the sun than the Earth, has an atmosphere mainly composed out of carbon dioxide, and much thicker than Earth atmosphere. The temperature on Venus is around 500 degrees Celsius near the ground and zero degrees Celsius in the clouds. It is due to the greenhouse effect. Obviously, it is impossible for complex life to exist at those temperatures.

Mars has no greenhouse effect and a very variable atmosphere. In some places the atmosphere is very dense, while in others it is frozen such as at the poles of the planet. Average temperature on this planet varies from -50 to -100 degrees Celsius, in different locations. Recent discoveries indicate that perhaps simple life forms have existed on Mars. Nevertheless, the atmosphere here is so unstable and the water necessary for life to develop is frozen, hence it was impossible for complex forms of organisms such as animals, plants and people to appear, in such harsh conditions.

On earth however, the balance between the atmosphere and the greenhouse effect means that it is neither too hot nor too cold to live, with average temperature of 14 degrees Celsius above zero. Unfortunately, human activity causes climate-changing gases release, which makes the atmosphere denser, increasing the greenhouse effect and thus, the temperature rise. This will have unforeseen consequences.

The biggest concern is that the greenhouse effect would cause temperature swings on Earth. If this happens, the sea-level will rise and precipitation patterns will change. Large areas of land will be submerged and hundreds of millions of people will have to move. Large migrations of people, due to change and destroy of their habitats, could also have very serious consequences.
The world scientists believe that the average world temperature will increase by 3 degrees Celsius by the end of the 21 century, if the greenhouse gases

emissions are not reduced drastically. Three degrees in a hundred years does not sound too dramatic, perhaps, however this is the biggest temperature increase over the last 10,000 years, and will give the highest average temperature for 150,000 years. In this light, it is apparent that the changes can be indeed dramatic.

Other consequences of energy use

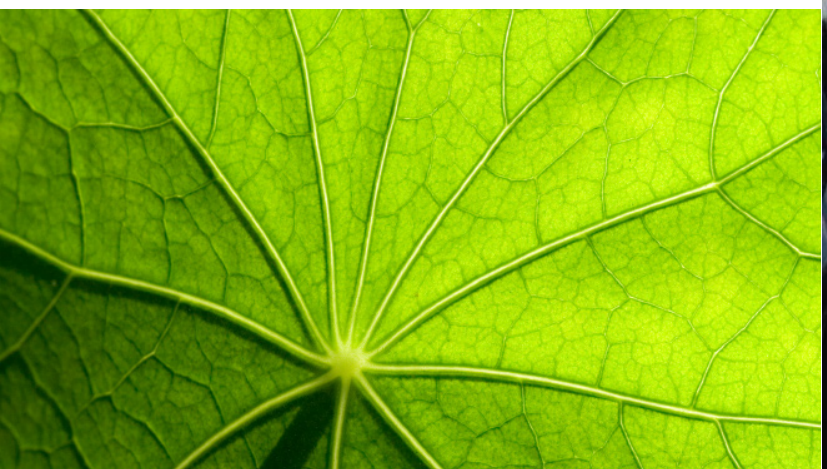
When organic materials are burnt, gases like nitrogen and sulfur are also released into the atmosphere. The fossil fuels contain significant amounts of these compounds than, for example, wood. Over time, those compounds react with oxygen and water resulting in acid rain, smog and ground ozone. These pollutants are found locally and regionally.

Big power plants occupy a great surfaces meaning that this land could have been, but it is not, used for agriculture or green areas. Depending on what these land areas could otherwise be used for, this can result in conflicts of interested sides.

Use of radioactive materials in nuclear power plants also leads to additional, new and enormous environmental challenges.

Think and Reply

1. What is photosynthesis?
2. Can photosynthesis take place in the dark?
3. Why does the use of biofuel for the production of energy not increase the concentration of CO_2 in the atmosphere?
4. How does acid rain form?
5. What is the “greenhouse effect”?



Task 7.

The Greenhouse Effect

For this task, you will need two thermometers with the same scale, so small that they each can stand in a jam jar with screw top. In the first jar you place a piece of black, non-shiny card which covers roughly half of the glass inside. The thermometer in this glass should be placed on the shady side of the card.

In the other jar place a piece of aluminum foil in the same way as the black card in the first jar. The thermometer in this jar should stand on the shady side of the foil, i.e. the non-shiny side. Position the jars beside each other in direct sunlight. Place them on something which can act as insulation, e.g. a book. Make sure that the thermometers are standing on the shady side of the glass. Soon you will see that the temperature rises fastest in the glass with the black card.

This is what happens: The sun's rays which reach down to us have both short and long waves. The short waves go through the glass. In the jar with the aluminum foil the rays are reflected by the metal. The length of the waves remains unchanged and they leave the jar as easily as they entered. In the jar with the black card the rays are taken up (absorbed) by the card. This heats up the card, which in turn increases the temperature of the surrounding air. The black card also sends out rays, but the wavelength of these rays is longer than the sun's rays and they cannot pass back through the glass. The energy in the rays remains in the jar, thereby increasing the temperature. This is how the atmosphere works. Without atmosphere the temperature on earth would be -18 degrees Celsius.

6. THE ENERGY CRISES

Electricity and fuel crises
In the developed part of the world, when one speaks about energy crises, we generally mean emergency situations which would arise if we cannot secure enough access to cheap electrical energy and energy from oil. There is no doubt that sooner or later the oil reserves will be depleted – and what will we use as fuel then?

In order to avoid such a situation, enormous resources are being invested in finding new oil sources, developing new types of nuclear power plants and other large energy plants. Oil reserves have been estimated to last for another 70 years, while natural gas reserves will be on disposal only half of the century. Until now, it has not been as interesting to invest in more efficient energy use or in small-scale power stations which use renewable energy sources, but this trend is perhaps finally beginning to change. And it only depends on us.

The fuel crisis
While the developed part of the world will be threatened by an energy crisis at some point in the future, a large number of people are already today experiencing a brutal energy crisis – a catastrophic lack of wood to burn for cooking and heating water and homes.

Compared to industrial countries, the energy use in the third world countries is very low. Forests are most important energy source in these regions. In the villages, almost everybody is entirely or partly dependent on wood, to prepare food and for the heating. In many towns, charcoal and wood are the most important energy sources for the low and middle class. Until now these energy sources have been free or at least very cheap.

According to the UN statistics, at present, many millions of people live in areas where more wood is taken from the planted forests. Devastating forest land can not last to infinity. In addition, fuel is getting increasingly expensive and until now there have been no alternatives. For many people it costs more to heat their bowl of soup than to fill it. Besides, parasites in the non-boiled water can be a direct health hazard. Lack of wood in cold areas, such as the Himalayas, the Andes and other mountainous regions, makes it impossible for people to make a fire to keep warm. Also, when people are cold they are more susceptible to diseases.

Wood, coal, dried animal-droppings and household waste are still the most important sources of energy in many countries. Every day two billion people eat food which has been prepared over charcoal or wood. Half of all the bushes and trees which are chopped down are used for food preparation and heating.

One and a half billion people cannot get a hold of enough wood. They use a lot of time searching for it over large areas, hence lack of wood is for them - energy crisis itself.

When agricultural waste and animal droppings are used as fuel, large quantities of vital fertilizer are not returned to the soil. This gives poor growth, and lowers the quality of grazing areas, which are the very core of existence for many people in the developing countries.

It is primarily the poorest and the developing countries, which are experiencing the crisis. Those who can afford it, switch to more available energy source or buy from another place.

In areas where there are still enough forests, the poor people very often do not have the right to collect wood. As wood and charcoal become trade products and prices rise, the workers and hired farmers lose the rights they once had to collect wood or plant waste from the large estates. In Nepal, India and Bangladesh, the poorest must often steal wood from the state-owned forests or private estates – at the risk of fines or imprisonment.

The fuel crisis in the developing world is a frightening example of how the poorest people are destroying the basis for their future existence in their fight to survive today. They do not do this because they do not understand the consequences, but because they have no other choice.

7. FUTURE PROSPECTS

Today, there is a significant international growth of interest in use of a number of renewable energy sources. This particularly refers to energy sources such as sun, wind and bioenergy.

Over the last 15 years, these renewable energy sources have significantly increased their competitiveness related to oil, gas, coal and nuclear power. If this trend continues, the renewable energy sources will conquer an increasingly large share of the energy market. Today we already see how renewable energy sources can out-compete the establishment of new nuclear power stations.

The development is very exciting, because the renewable energy sources are today following the same development trends as oil, almost a hundred years ago.

In the report presented by the UN World Commission for the Environment and Development, the present energy situation is defined as follows:

"We cannot live without energy in some form or the other. Future development is completely dependent on continuously available energy, in increasing quantities and from sources which are reliable, non-hazardous and which do not harm the environment. At present, we have no source or combination of sources which will enable us to meet our future needs."

The challenges to be met are, in other words, immeasurable, and everybody has to, in their own way, do what they can to meet these challenges. We can start with the simplest challenge, which is also very interesting to most of us from an economic point of view – to learn to use the energy at our disposition as effectively and in the most environmentally friendly way possible.

Think and Reply

Why is the transition from non-renewable energy sources to renewable energy sources so important for humankind?

PART THREE

CLIMATE CHANGE

PART THREE - CLIMATE CHANGE

Carbon dioxide along with other greenhouse gases other gases warm the surface of the planet naturally by trapping solar heat in the atmosphere. This is a good thing because it keeps our planet habitable. However, by burning fossil fuels such as coal, gas and oil and clearing forests we have dramatically increased the amount of carbon dioxide in the Earth's atmosphere and temperatures are rising.

1. THE CLIMATE

The definition of climate is: The climate is an average stage of weather conditions over a long period of time. What this really means? It means that even though the weather can be rainy, or sunny, windy or calm, we would add up the weather conditions over a longer period of time, and see if days are mainly rainy, calm or sunny. Then we also need to know average temperatures, to see what type of temperature regime is prevailing, that is if days are mostly mild, very warm or cold. That is how we will get the main climatic characteristic. Hence, the weather is a current stage of atmospheric conditions, over a rather short period of time. Climate is a stable parameter and characterizes particular regions, while weather is unstable and changeable, and same weather can appear in different regions of the world, and different climate zones. The weather can also change from day to day, but the climate changes very slowly, over decades or centuries.

The climate has continuously changed ever since the origin of our planet. It has been depending on the different geological and astronomical changes such as volcanic activity and Earth's orbit variations. Also, the development of life on earth has been depending on the climate as well. These changes in climate regime have taken place over millions of years.

The natural climate change

The climate on earth has colder and warmer periods. The scientists use different methods to determine how the climate has been changing in the past geological eras, and it is known today that it has been varying significantly over the time. Different average temperatures create the main distinction between different climate periods, which has a consequence in change of life forms (both plants and animals). Colder and warmer periods had been succeeding one another, and scientists have named these periods – glacial and interglacial, respectively. Today, the planet is in the interglacial period, which started some 10 000 years ago. Accordingly, the next glacial period will have its coldest period in circa 80000 years, but it is uncertain when exactly will it start.

In terms of geology this is a rather short period of time, however in terms of human history, this period is indeed long.

Human influence on climate

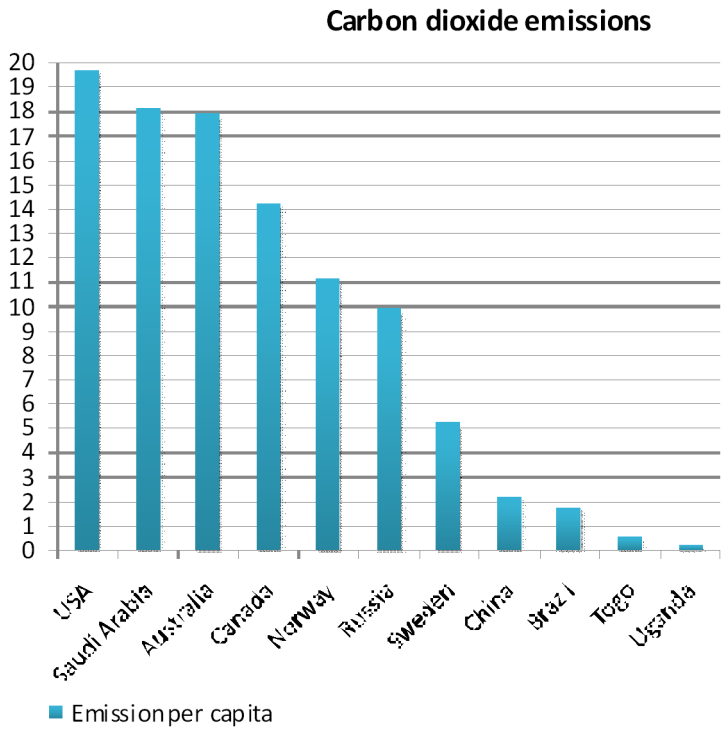
The climate changes that are debated today are different. They have taken place within the period of a human life or even shorter and they are mainly caused by human activity. Our modern life style has contributed to the increase of the amount of the greenhouse gases in the atmosphere. Use of fossil fuels releases CO2 that has been trapped in the ground for million of years, and increases its concentrations in the atmosphere. Modern agriculture - crops growth and animal breeding, also results in greenhouse gases release.

Even though the greenhouse effect is naturally occurring phenomenon, it is however aggravated by human activities during the 20th century, and today we see devastating consequences of human induced greenhouse effect. Today, the greenhouse effect is no longer as protective and beneficial for life on earth. As we mentioned that carbon dioxide is a part of processes in nature, we must realize that the amount of this gas in the atmosphere exceeds by far the necessary amounts for natural cycles. Moreover, CO2 is not the only gas that creates the greenhouse effect. Other gases released into the air due to human activities are part of the greenhouse effect, like nitrous oxide N2O, which is also toxic and methane CH4 which is flammable. However they only make a small share of gas mixture in the atmosphere. Not to forget ozone O3, a gas which is necessary in the higher layers of atmosphere since it protects life on earth from UV rays, but in the lower parts, it contributes to the greenhouse effect.

This effect created by overwhelming amounts of greenhouse gases which prevent extra heat to return

back into the space resulting with overheating the earth's surface, air and water. Therefore, this layer of greenhouse gases keeps more heat on earth than before, and more than life on earth really needs. The phenomenon, which appeared due to the greenhouse effect caused by human activity, is called global warming, since one of the major consequences of this effect is the global temperature rise. It took a long time for effects of GHG accumulation to have a strong influence on the climate on the earth; it will probably take even longer to diminish the effects of the amounts of these gases in the atmosphere today.

The increased greenhouse gases emission is a consequence of rapid development of the world after the industrial revolution, in the 19th century. Our industrialization has been developing on the massive use of fossil fuels such as coal, oil and gas. When burnt, these fuels release CO2 into the atmosphere. This has been the main contribution to the man-made greenhouse effect. Over the decades, these changes gradually became more apparent and more harmful. Today, the world average annual emission of CO2 is 4 tons per capita. However, in countries such as USA, Canada and Russia the emission of carbon dioxide per capita is substantially higher than the average, due to their large industrial potential. Other countries, particularly in undeveloped regions of the world, have CO2 emissions way below average.



Did you know...
…that there is about 50 times more carbon dioxide dissolved in the ocean, than in the atmosphere?
…that ten hottest years (ever since recording started) have occurred since 1990, due to the growing rates of CO2 emission?

2. MAJOR ANTHROPOGENIC SOURCES OF GREENHOUSE GASES

Today, we have every reason to believe that the human activities have started a chain of reactions resulting in changes in the atmosphere, water, soil and life on the planet, due to first and foremost extensive emission of the greenhouse gases...

Power stations
Power stations generate electric power, from different energy sources, traditionally from fossil fuels. These plants convert different forms of energy (such as chemical, or heat) into the usable form. Power plants that use fossil fuels such as coal, oil or natural gas are the biggest greenhouse gas source on earth, and carbon dioxide in particular. In a mixture of greenhouse gases, carbon dioxide comprises 72% of the greenhouse gases and it is therefore the contributor to the global warming.

Industry
Production and material processing is also one of the greatest carbon dioxide emitters. Combustion of woods and fossil fuels, chemical industry, cement and lime production as well as iron and steel industry substantially contribute to the GHG emission, particularly to the carbon dioxide amounts in the atmosphere. The energy used by industry sector grown for 61% from 1971 to 2004.

Transport
Traffic is the second biggest source of CO2 emission, and it is constantly growing. In Europe one fifth of the CO2 emission comes from traffic, while in the US the transportation emits one third of the amount of carbon dioxide in the atmosphere. It is important to note that cars exhaust do not only contains carbon dioxide but also induce forming of ozone, due to the chemical reaction with the sun-

light. Ozone in the lower layers of the atmosphere also acts like a greenhouse gas, capturing infrared sunrays reflected from the earth's surface.

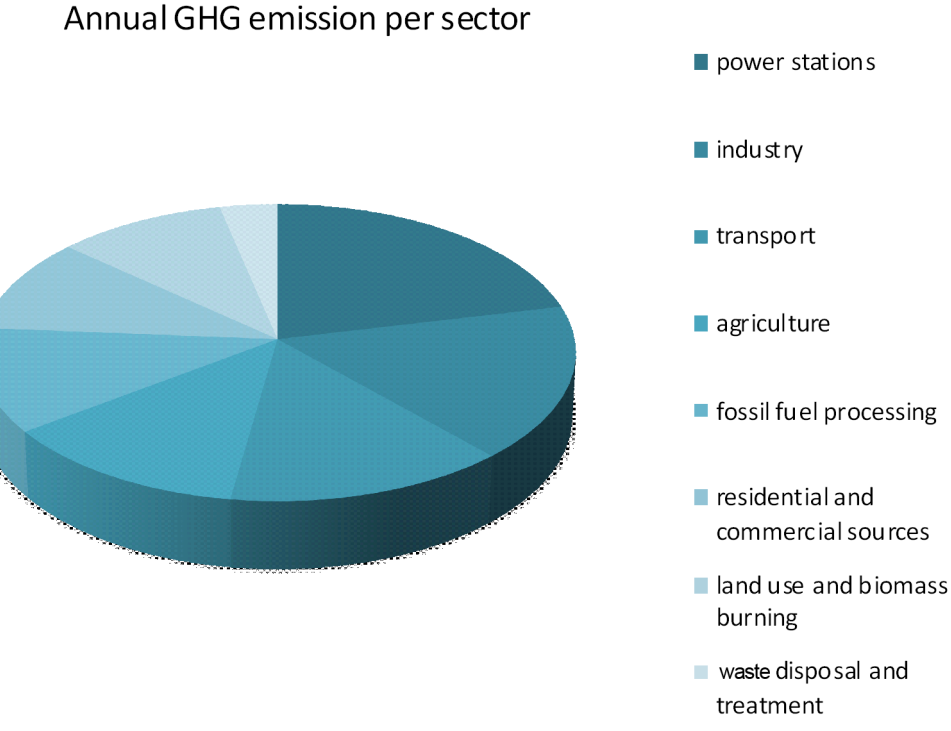
Farming

Animal farming today is one of the main sources of another greenhouse gas – the methane. Cattle, chicken and pigs make up to 37% of man induced methane emission. They emit methane created from their digestive process. The major amounts of methane are formed on gas fields due to the extraction of natural gas.

Field crops are the biggest source of nitrogen in the atmosphere (but also in the waters), particularly due to the overuse of artificial fertilizers.

Deforestation

There has never been as much of a forest cutting as today, with most rapid disappearance of the rain forests, which covers the tropical region. Every year 17 million hectares of rain forests cut and burned in forest fires, which is a approximately 4 times a size of a Denmark. On the forest cut areas, frequent rains wash away the soil, and there is a danger of a desert forming. Since plants use carbon in their physiological processes, with less and less trees less carbon can be removed from the air. Excessive forest cut prevents one of the biggest natural air purifier – the forest, to help slowing down the changes in climate. Therefore, though the forest cut is not emitting carbon dioxide, this human activity has enormous impact on the increasing rate of these gases in the atmosphere.



3. EFFECTS OF CLIMATE CHANGES

Effects on nature

Several decades ago, the climate of different regions in the world started to became less typical, i.e. it showed signs unusual for the season. Typhoons, floods, snowstorms and draughts started to appear in areas where they were not common and not expected. The average annual temperatures, particularly in boreal regions showed signs of slow gradual rising. The glaciers at high mountain ranges such as European Alps or American cordilleras were melting more rapidly during warm seasons than earlier recorded, and were rebuilding their winter ice masses slower than before. The ice and snow of northern Europe and Greenland, as well as at north of Canada and Siberia were showing signs of disappearance. Birds started to change their migration patterns, and are slowly shifting their migration, mating and nesting seasons. Other animals are also showing changes in their annual schedule and plants are blossoming prior to their time.

Either of these events may not be alarming on their own, but added up these create a clearer image. We have every reason to believe that the climate on our planet is changing.

On more global scale, it is highly likely that the ocean currents will change their directions at least slightly, as the temperature of the currents may change, sine there is a great inflow of fresh cold water from ice and snow melting. The level of the sea is likely to rise significantly in the next decades. All of these events will have a strong influence on both ocean life and coastal ecosystems.

With temperature regime change, many terrestrial and aquatic habitats are already disappearing. Plants and animals, used to certain conditions are often not able to adapt to new environment in such a short notice, which leads to a great biodiversity loss.

Effects on humans

Water

In general terms, even thou some have enough water to waste, the world is already facing a "water crises". Up to 25% of the world population lacks in water, and 40% do not have basic sanitary conditions. In 1997 the UN established the World Water Day, on 22nd of March, with a goal to raise public awareness on probably the world's biggest health issue. Most threatened are areas of central Africa and Middle East, being unable to access the clean water, while most countries of Africa, along with Indomalayan region and west part of South America have alarmingly high percentage of diseases caused by unsafe water use.

Food

The global temperature rise may cause climate belts shift, with warmer areas expanding further to north. This may have numerous consequences. Regions with fertile soil and mild climate may experience frequent draughts and floods, which will affect the agriculture. However, northern regions, with soil unsuitable for most crops will enter the mild zone, with temperature regime suitable for food production. In most northern regions, permanently frozen ground would release great amounts of methane, as it starts to melt. The climate belt shift creates excellent conditions for many parasite species to expand, that agricultural plants are not adapted to.

Changes in global climate pattern lead to the food production decline. Temperature regimes, droughts and floods have a strong influence on yield, and with the yield drop, the prices of food will start rapid growth.

Diseases and migrations

With lack of water and food, humans are more susceptible to diseases. With the temperature rise, tropical diseases may expand via insects into area where those previously did not exist. Other disease carriers, such as mice also expand their ranges where temperatures are becoming more suitable for rodents, hence bacteria and viruses arrive to new areas, with people unprepared for the diseases. Malaria, cholera and Lyme disease are reaching higher altitudes as well as higher latitudes. Changes in climate already cause great evacuations and migrations of people due to destructive weather conditions, and destroyed crops, and it is expected that the rate of human migrations, in order to escape floods, droughts and famines will increase in the future.

Sea level rise

From 3 000 years ago until the 19th century the sea level has been more or less constant, with minor rise of max 0.2 mm per year. However, over 20th

century the average annual rise rate has been 1-2 mm, and since 90s this rate reached over 3 mm, annually. The rise of the sea level has been linked to global warming, and it is likely the consequence of melting snow and ice from boreal regions and high mountain ranges. Sea level rise poses a great threat to coastal areas of the continents.

Note that due to the increase of temperature, warmer weather is not the only consequence of the climate change, even though the global warming is occurring. In same places of the world due to the global disturbance of the climate, the temperature may drop as well as other unusual weather conditions may occur, such as blizzards, tornadoes, excessive precipitations or draughts, all as consequences of changing climate patterns.

These and many other consequences of the global warming are yet ahead of us. Perhaps we can not even foresee a lot, and only guess for many. Moreover, it is rather difficult to predict exactly how and to which degree many of the consequences will occur and how exactly these would affect different areas of the world.

Did you know...
…that 96% of world ice and snow is stored at Antarctica and Greenland?
…that in next 50 years more food will have to be produced, than it has been for the past 10.000 years, due to the growing world population?
… that there has been over 30 diseases transferred to the regions of the world, where their carriers previously haven't been surviving, due to the unsuitable climate conditions?
…that one billion people will be displaced by 2050, due to the climate conditions changing?
…that in the next 100 years, the sea level might rise about 90 cm?

GLOBAL WARMING ALERTS

We're already seeing changes. Glaciers are melting, plants and animals are being forced from their natural habitat, and the number of severe storms and droughts is increasing.

Today we can see that..
- the number of Category 4 and 5 hurricanes has almost doubled in the last 30 years.

- malaria has spread to higher altitudes in places like the Colombian Andes, 7,000 feet above sea level

- the flow of ice from glaciers in Greenland has more than doubled over the past decade

-At least 279 species of plants and animals are already responding to global warming, moving closer to the poles

If the global warming continues with the present rate, we can expect catastrophic consequences.

-deaths from global warming will double in just 25 years to 300,000 people a year

-global sea levels could rise by more than 20 feet with the loss of shelf ice in Greenland and Antarctica, devastating coastal areas worldwide

-heat waves will be more frequent and more intense

-droughts and wildfires will occur more often

-the Arctic Ocean could be ice free in summer by 2050

-more than a million species worldwide could be driven to extinction by 2050

4. INTERNATIONAL AGREMENTS

Changes in the climate became very apparent in the past 15 - 20 years, even though the emission of greenhouse gases from fossil fuels burning processes started over 100 years ago.
In 1988, The Intergovernmental Panel for Climate Changes (IPCC) was established by the World Meteorological Organization and UN Environmental Program. The task of IPCC is to asses the risks of human induced climate changes and to publish reports important for the implementations of the United Nations Framework Convention on Climate Changes (UNFCCC).

UNFCCC is the treaty, established at the Earth Summit, in 1992. in Rio de Janeiro, Brazil. The conference, under its official title The United Nations Conference on Environment and Development (UNCED), set to combat the global warming, managed to achieve establishing of several protocols, from which the most famous one is the protocol established in Kyoto, in December 1997. The objective of this protocol is "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

As of 2007, 175 states have ratified the Kyoto protocol. Out of these, 36 developed countries are required to reduce their greenhouse emission, while developing countries have obliged to monitor and report their emissions.

The United Nations climate change conference in Bali in December 2007 was attended by 189 countries' representatives. The aim of the conference was to find further pathways in combating climate changes, and to reach a new agreement, which will succeed Kyoto protocol, expiring in 2012. In the future agreement, parties should set key areas that the new agreement would cover as well as upon the timeline for ratification of a new protocol, before the end of 2012.

United States is the country with the highest rate of GHG emission in the world. The second place belongs to China, third to the EU and forth position to Russia. Out of European Union countries, Germany has highest GHG gases emission. The United States has declined to ratify the Kyoto protocol, while China has signed but is not obligated to reduce emissions, being a developing country which progress strongly depends on industrial expansion. Germany and Russia have ratified the protocol in May 2002 and November 2004.

From January 2007 several states of the USA have started their initiative, following California state ground breaking decision in 2006 to reduce GHG emissions, putting the pressure to the federal authorities, regarding the emissions rates. These northeast US states that participate in the common initiative have a total population of 46 million people. From December 4th 2007, 750 cities in 50 states of America have initiate nationwide effort to meet the Kyoto protocol demands.

Many other countries, through their governments but also via civil society initiatives, have started to take measures to slow down the changes in climate regime. Through educational programs in schools as well as through media, people are today able to learn about global situation, more than they have ever been before. Information we get through schooling, but also through radio and TV programs, as well as internet can provide us with enormous amounts of information on these issues.

What is very important for you to remember is that if we work together, we can fight the climate change and every, even very small environmentally friendly acts you make, is a step forward to save our planet.

For discussion
Why do you think it took so long for effects of the GHG emission to appear?
What is the main purpose of the Kyoto protocol?
Why is it important to reach next agreement, to succeed the one from Kyoto?
What could be the reason for the world's biggest GHG emission rates in USA, China, Russia and EU?

Think and Reply
In winter, some days in northern Europe may be sunny and mild, but what climate tells us is that winter days in these regions will mainly be cold and cloudy, with high expectancy of snow (even though some days differ). Hence, weather can vary within the same season, and can change in a very short period of time, even within several minutes or hours, while the climate is more stable parameter which represents weather in average, during a long time period.

Tasks 8.
Describe what is the weather like today in your town? Does weather today differ from usual weather in this time of the year?
Picture: sunny day and rainy/snowy day
For example, it could be sunny, windy or rainy and it can change very soon.

Example:
The climate in northern Europe is colder than the climate at Mediterranean area, which is more dry and warm, while the climate at tropical regions is warm but it can also be very humid. Do not forget that those regions can all have rainy, sunny or windy weather. Not all of them however, would have snow in winter or very high summer temperatures, which depends on average annual temperatures of the region.

Task 9.
Describe what is the climate like where you live? Do the present weather conditions correspond to the climate in your region, or are present conditions untypical for the region climate? Contact your local metrological station and ask about the records of changes in the weather for the last 10 years. Do you notice any differences in weather schemes?
1) Create a table with average sunny and rainy days per year, over the last decade. Compare the data you got. Notice if there are changes in precipitation.
2) Create a table with average annual monthly temperatures for the last ten years, and notice if there is a change in average temperatures over this period of time.

All of these phenomena have indicated the same frightening fact – this time humans have gone too far. Global changes in yearly cycles of nature and temperatures have all pointed in the same direction – something has to be done before our planets hits the point of no return. There is reason to believe and increasing amount of evidence that , the climate changes are indeed caused mainly by human activities, and in more specific – greenhouse gas releases.


PART FOUR
ENERGY
SAVING

PART FOUR – ENERGY SAVING

Most of the energy we use is taken from sources that contribute to the degradation of the environment. The environmental consequences give us a good reason to look for the possibilities to reduce the energy consumption. A more efficient use of energy will benefit the environment, but at the same time it will also bring about other positive results. The measures necessary in order to improve the energy efficiency will also give us a better comfort and quality on the useful work done by the energy. Finally using less energy and resources is a way to cut expenses.

Energy services
Energy in the form of electricity, oil or gas it not useful for us as such. In fact electricity and gas is not only invisible but even dangerous. On the other hand, the work and services that can be provided by these energy sources are core elements in our daily life. The invisible and dangerous energy sources can be transformed into the light, heat, movements and other useful work. The useful work we get from the energy sources is what we call the energy services.

There are four main forms of energy services that can be provided by different sources of energy:

- Heating
- Cooling
- Lightning
- Mechanical work

Think and Reply:

Which energy services do you use most frequently?

1. APPLYING THE SCIENCE

Our energy services can be provided to us in many different ways. It is possible to use different energy sources and the transformation into useful service could happen in different ways. The losses of useful energy in the transformation and environmental impacts will depend of the energy source and the technology in use. To improve the efficiency and reduce the environmental impact of our energy consumption we have to apply our best knowledge bout from the natural science and the social science.

The chapter “Energy” introduced two laws of energy. These laws give us some of the basic knowledge and background for the work with the energy conservation. The first law of thermodynamics states that the quantity of energy remains constant but the second law tell us that the energy quality will be reduced as we put the energy sources it to use.

Driving at increased living conditions and reduced environmental impact it is necessary to find methods and techniques for how to:

Use the energy efficiently
We have to direct the flow of energy to useful work and nothing else! Our needs for energy services should be efficient without waste. Stopping leakages of hot air from the room, use of energy efficient light bulbs and reducing the time of hot water tapping is three examples.

Apply the low quality energy sources when possible
We should not waste the energy quality. For those services where it is possible to use low quality energy (such as heat) we should avoid using high quality energy (such as electricity).

But even if we follow these principles according to the laws of physics, additional efforts are needed to organise the society and our living in a sustainable way. This should involve all kind of social science, politics and public participation:

Organise the society and our living in a sustainable way
Our way of living in the modern society has to develop according to the energy laws. The organisation of the society including laws and economical regulations should benefit from energy efficiency, recycling materials, public transportation and other measures contributing to a sustainable lifestyle.

2. GETTING MORE WITH LESS

Looking at the different possibilities for the conservation of energy, we will find that there are tremendous possibilities. It is possible to conserve energy anywhere and by using many different measures. Some energy conservation measures could be dealt with here and now by anyone. These measures depend on the individual awareness and participation. Many of them are without any investment, solely depending on our behaviour. Others measures will involve small investments in order to adjust and improve the technologies in use. Let's say your family is looking for a new refrigerator. The energy consumption of two models that look the same and provide the same service could be very different. By choosing the most efficient you will save energy every year as long the refrigerator are in operation.

Energy conservation in practice
In the work with energy conservation we take different energy services we use and investigate how these can be provided with less energy, without wasting the energy quality and by optimal use of renewable sources of energy. The lists of actions are not as nearly as complete and these are simply practical examples after all. Energy conservation measures must always be considered carefully for the individual case.

And remember one unit of energy saved is much better than new unit produced. If you are you saving energy at home then you are also saving energy loses in the production and distribution system. Finally you will also reduce the impact of the energy production on the environment.

Good luck with you important work!

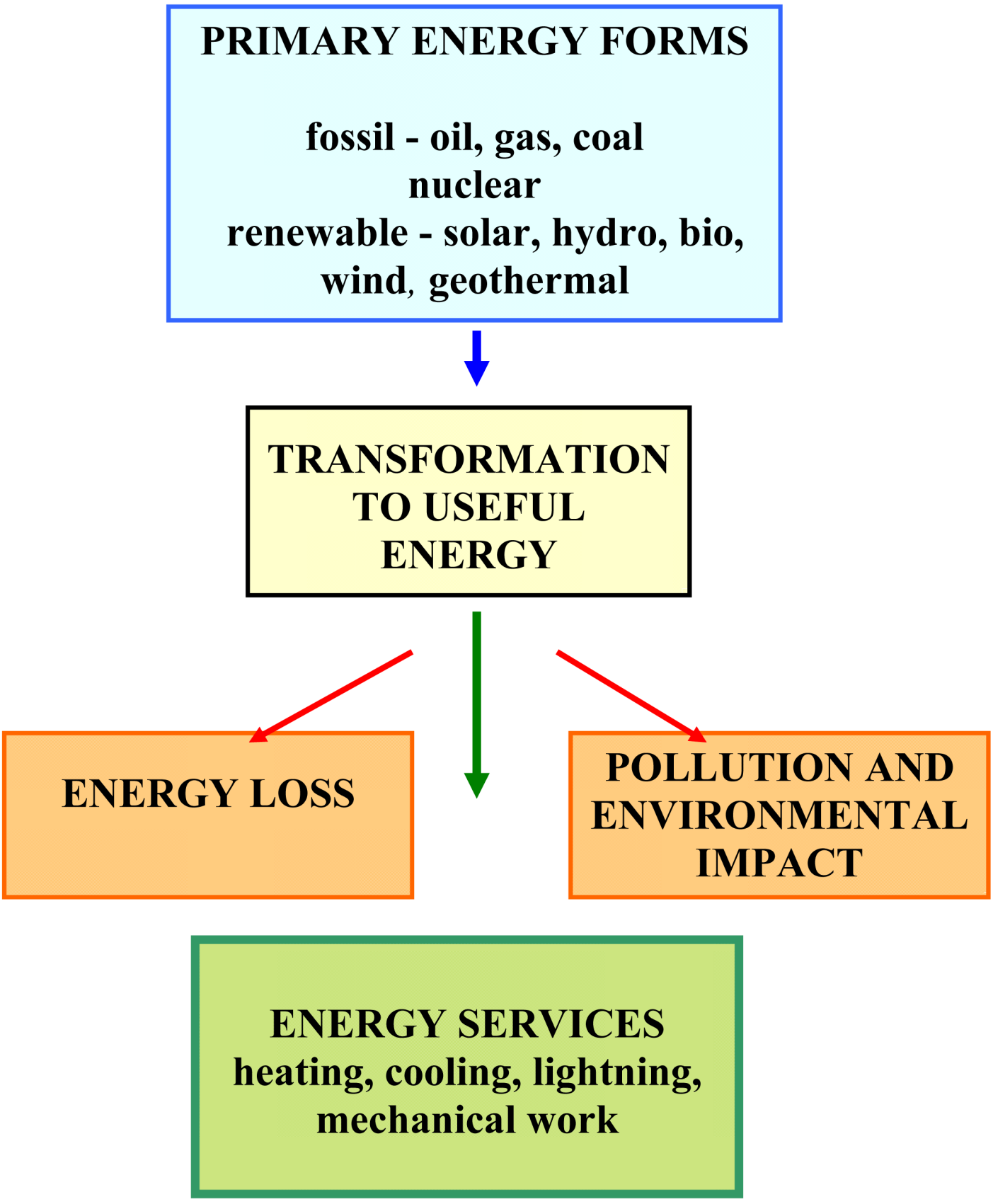
Think and Reply

Look at the figure on energy transformation and try to find examples of energy losses and energy saving measures according to the three different principles for energy conservation.

Task 10.
Visit a shop selling refrigerators and ask the shopkeeper about the energy consumption of different models. Calculate the annual savings and the total savings trough out the lifetime of the refrigerator.

In many situations the energy conservation is not only a matter of the personal decision. Many systems and technical solutions are already set and it is necessary to make a collective decision to change it. Heat for a flat is delivered from a district heating system. Improvements are often needed but in order to make them, it is necessary to involve whole families, the energy utility, the municipality technical experts, manufactures of equipment and so on.
The modern energy systems are complex structures and in many situation results in energy conservation depend of the participation from experts and big organisations. Even though, all of us deal with energy everyday and trough education and practical action you could be a part of the improvement.

All together it is a huge potential for energy conservation and reduced environmental impact from our activities. By comparing the common energy consumption with the most energy efficient examples, some energy scientist has proposed the concept "factor 4". The aim in the long run should be to get four times more useful energy service out of each primary energy unit. This will enable - reduced energy consumption and environmental impact as well as increased standard of living.


PRIMARY ENERGY FORMS
fossil - oil, gas, coal
nuclear
renewable - solar, hydro, bio,
wind, geothermal
TRANSFORMATION
TO USEFUL
ENERGY
ENERGY LOSS
POLLUTION AND
ENVIRONMENTAL
IMPACT
ENERGY SERVICES
heating, cooling, lightning,
mechanical work

3. SPACE HEATING

For those living in the tropical rainforest and other warm regions of the world, space heating is probably not a problem. For those living in a colder climate it is necessary to invent artificial methods to preserve the heat. We need to be well dressed. Good clothes make it possible to survive even the Siberian winter. But it is practical and comfortable to have the possibility to take of the fur hat when we are inside the school or at home. Standards inside comfort temperature are 18 C. To deliver the energy service need for space heating has become both highly energy consuming and expensive. The heating systems were constructed at a period time when energy prices were low and efficiency did not have a high priority yet. The inefficiency of the heating system often results in fuel shortages, economical or technical problems make difficult to reach comfortable temperatures.

Working with energy conservation the main problem is not how to deliver enough heat. Our problem is how to keep the heat. Once, the room was warm. Now it is cold. Where has the heat gone?

Theoretically, it is possible to build a completely tight – what tight means here? room as a box of conserves. If the room is well insulated, or situated in an empty space, the energy or temperature would stay there forever, but it would not be very useful for living. In a building for living there are windows and doors. We constantly need fresh air, for breathing. All this makes possible for the warm air to escape and heat to transmit trough the surfaces of the room. To compensate for the heat lost regular supply of additional heat is necessary.

In our classroom and in homes the heat escapes in two ways:

- Air leakage or ventilation where the warm air leak out and cold air getting in
- Transmission of heat trough the warm inner surfaces of the room to a the cold outside

There are many ways and methods to avoid the heat for escaping the house. In new houses it is possible, and many practical examples exist, to significantly reduce the need for supply of external heat. The main principles are to use insulation that makes difficult for the heat to transmit trough the surfaces. In addition it is necessary to avoid air leakages. The fresh air needed for ventilation should be under control and pre-heated with the old air going out of the house. The heat losses do not have to be much higher then the "waste" heat supplied from the activities in the house. The source of this "waste" heat are people, the lights and different equipments.

What to do:

Our buildings today are constructed without thinking too much about how much energy would be necessary to supply in order to keep a suitable indoor temperature. The insulation in the walls, floors and roofs are not good enough. It is either made out of materials that transport the heat away too easily or the insulation materials added are not thick enough. Often the construction or the way it is build has "bridges for cooling" in the form of spots of non-insulted material leading the heat away.

To add insulation to house already built takes a lot of work and is often very expensive. But in cases of a capital renovation of the walls or the roofs, then it would be a very good idea to add new insulation. If your room is very cold it is possible to make additional inside insulation in a more simple way. Even carpets help when covering the coldest walls or floors and thick curtains at the windows.

The most efficient and easy self-made energy efficiency measures are normally to reduce the drafts from cracks, windows and doors. In old houses, the cold air inflow is much higher than needed to breathe in fresh air. If you can feel the draft by your hand, then it is definitely too much! The cold drafts come from cracks, un-sealed windows and doors. It is a good habit to prepare the house before the winter and try to find and seal the cracks.
The windows are the most obvious place to start. Broken glasses have to be replaced, and the inner window given special strips or sealed by tape. Between the window frame and the wall is also a common week point together with corners or other places where different elements are joined.

In a refrigerator the situation is the same as in a room, to keep the temperature at the level we would

want it to be. The refrigerator has machinery, which are "pumping" the heat out. To keep the process running efficiently we have to make sure there is not too much ice inside and the best option is to place the refrigerator in order to get the lowest temperature difference between inside and outside.

Simple measures:

- Seal the windows in order to reduce cold draft
- Control and reduce cold drafts from doors, cracks or other places
- Cover the coldest surfaces in the room by carpets or other insulating materials
- Make ventilation by opening all windows for a short period of time, rather than open it slightly over a long period. In this case, you will exchange the air in the room without cooling the room surface.

Measures for professionals:

- Automatic and individual regulations on the radiators in each room
- Recovering of the heat in case of mechanical ventilation
- Changing windows and additional insulation

For discussion:

- From the energy law you know that energy cannot be used or disappear. The warm air in room contains heat energy. Where has this energy gone when the room gets cold?

Task 11.

- Show how different materials have different ability to transport heat. Take a cup of hot tea. Put a metal spoon in the cup and it will get hot. Try the same with piece of wood and notice how the wood does not transport heat good.
- Air does not transport much heat and could be used for insulation between windows and in walls. In the sauna you cold stay in 90 C air but water of the same temperature would burn your skin. You feel it when you put water on the stove and the air gets more humid… - what is this sentence example for?

Did you know…

… that you feel cold even at a high air temperature if the room's surface is cold

… a wool sweater and good slippers will make you feel warm without increasing the room temperature

… that due to the low ability to transmit heat, people are able to walk on burning coal without getting burned

… that even the low winter sun could heat the room trough the windows, take away the curtains if you need additional heat.

… that Russia has one of the word most widespread districts heating systems with combined Heat and Power Plants (TEZ in Russian). With improved efficiency this could be the best and most flexible energy system in Europe.

Exercise:

Make a drawing of your house of wishes together with your classmates. Afterwards you should "sell" the houses to each other. Empathise - DO WHAT? the low maintenance and operation costs (energy consumption) in order to get a good price for the house.

Examples

Eco-house in Novo Sibirsk

In Novo Sibirsk an ecological family house has been in use for some years already. The heating season with need for additional heat supply has been reduced from 230 days to 90 days. The house has also a number of other environmental elements like composting of the household waste a local treatment of the wastewater.

Kirovsk Kindergarten

The Kirovsk kindergarten in Murmansk Oblast is been used to demonstrate energy efficiency in existing buildings. Besides sealing of windows and heat recovery of the ventilation air form the kitchen the heating system is rebuilt. A new heating central in the basement has allowed for automatic heat regulation. This has improved the comfort and reduced the consumption. These measures cut the energy consumption by half. The new system required a more conscious use of hot water, which was followed by an additional drop in the energy consumption.

House without heating system
In Gothenburg, Sweden, 20 new flats have been constructed without any heating system at all. The well insulated house combine pleasant indoor climate with low energy consumption. The waste heat from the inhabitants, the lights and the equipment is enough to heat the house during the winter. The house has no air leakage but a ventilation system enables the old hot air to heat the new fresh air before it comes in to the house. A solar collector on the roof contributes with half of the hot water needed. The building cost for the house is not more than usual and the extra equipment needed is easily paid for, compensating for few low energy bill.

4. USE OF HOT WATER

It takes a lot of energy to heat water. In most apartment houses where the hot water is "free" (constant price, counted in rest of the expenses) has been a privilege and the consumption has become high compared to other European countries. Measurements from Apatity, Murmansk Oblast show than one person use more energy on hot water than a hole family in Norway (3600 kWh/year). In Norway the energy used on hot water are measured and paid for at each flat, which is a good motivation to pay attention how much hot water we use.

To reduce the consumption is not as much a question of technology as of our awareness and motivation to reduce wasting.

What to do:
Hot water is mostly used for washing, showering, dish-washing, washing laundry and floors. Be careful and make sure you do not use more hot water than needed for this purposes.
Often are old habits difficult to get rid of, but you should evaluate the consumption and see if it possible to find new ways which give good result with less water. You could save hot water by reducing the flow or the temperature. Be careful not to have the water running useless of and repair leaking taps. Doing a big dish washing under running hot water is a highly energy consuming.

Do not have the water running all the time when brushing your teeth. Taking a quick shower uses significantly less water than filling up the bath tub. But even showers can be improved. Special energy saving showers use less than 10 litres/min to give a comfortable shower. Perhaps you could measure the water consumption of your shower?

When cooking, it is important to used casseroles that fit to the heating source and have a right pot size for the amount of food. Further on, it is important not to use more water than needed when cooking and reduce the energy loses by using a lid.

Simple measures:
- Do not wash dishes under running water, use a peg in the kitchen tub
- If you feel that the tap/shower water is to cold you my turn down the cold water crane
- A not-too-long shower use less water than a tub-bath
- A shower should not use more than 10 l/min and still give a good comfort. Do a measuring and look for new showerhead if the consumption is high.
- Repair leaking taps leaking
- User a lid and not more water then necessary when cooking
- Fill up before starting the washing machine; check the machine programs and clothes labels to avoid using too high temperature.

Measures for professionals:

- Reduce the heat losses in the distribution network
- Make sure the pressure and temperature is not too high

Did you know…

… That electric lights and equipment get a big load in the moment it is switch on? To have the equipment last long you should not turn it off if you know that you will use it again soon.

… That TVs and other equipment with a stand-by function use electricity even when it is turned off with the remote control? Use the off-button at night to save energy and reduce the hazard of fire.

… That a light wall reflects 70 -80 % of the light, while the dark one reflects only 10-15 % of it?

Example

Oleg Bodrov in Sosnovy Bor, Russia has become much more aware of his water consumption after he installed a meter. By the end of every month he calls the Municipal Utility and inform about the consumption. The bill he gets is reduced a lot after he started to save and pay for the real consumption instead of some general standard. To buy and install the meter cost him 2000 rubbles /54,3€. He expects to have this money returned by savings over one year.

Did you know…

- If a tap leaks 10 drops a minute it makes 2000 litre during one year
- If everyone in a family have the hot water running useless for 5 min a day you will waste energy worth 1000 rubbles/27€ a year
- the food gets ready regardless if it boils slow or fast, the temperature should not exceed 100 C

Task 12.

Measure the hot water consumption in your home and calculate the amount of energy it represents. You measure the water consumption per minute in an easy way by taking the time it takes to fill a bucket (ex 1 or 10 litres). To calculate the energy consumption you also have to measure the water temperature. You my use form on the last page in this chapter.

In addition to the hot tap water we heat water in the flat when we are cooking. Washing machines (both for dishes and cloths) normally produce it own hot water with an internal electrical heater. This process could also often be improved regarding energy the consumption.

5. LIGHTING

Humans need light in order to work. From the beginning we are adapted to be active during the daylight and sleep during the night. In the modern society it is 24 hours activity and we spend a lot of time inside buildings where the daylight does not reach. The need for additional artificial light is particularly big during the short winter days in the northern areas.

Over the time, everything that can burn has been used to provide lights. After the invention of the electric lamp and more common – should this perhaps mean – more wide distribution or smth. like that?? - distribution of electricity, the electric lighting has proven to be the best option for producing artificial light. Lightning is one of the areas where it really pays off to use the high quality energy electricity, but still there are a potential for increased utilisation of daylight in combination with artificial light.

Simple measures:

- Turn the light off when not needed
- Use energy efficient fluorescent lamps. The energy you have been using for one standard lamp will be enough for 5 new lamps.
- Sometimes it is better to change the shading than installing more light.
- Let the daylight in, take away the curtains….

6. TRANSPORTATION

Imagine you are going to visit a friend who is living 50 km away. To get there takes energy, but how much energy depends on how you travel. If you are athletic and in a good shape it may be suitable to go by bike. Your body will need energy in the form of food. Converted to energy you need to feed your self with 1 kWh to be able to bike all the way. On the way back you perhaps prefer to take the bus. Your share of the bus fuel consumption could be something like 1 litre of fuel, equal to 10 kWh. If you instead drive alone in a care the fuel consumption is 5 litres or about 50 kWh.

The transportation methods in this example are different and are using different amounts of energy in order to produce the same transportation service (moving your body for 50 km). The high consumption in the example with the car is a result of the energy waste in the motor (heat) ad the additional work by moving 1000 kg of car in addition to your body. It is because, divided by number of people on the bus, the amount of fuel per person is still smaller, even though bus weights more than a car.

It is also possible to find big differences in the energy consumption for one and the same transportation method. While a standard car use 10 litre of fuel per 100 km, a small modern car uses down to 3 litres for the same distance.

What to do:
Car and plane are the most energy consuming transportation.
Public transport as bus, train, tram and metro are energy efficient ways of transport.
For the society to save energy it is important to develop the public transport and make it an attractive alternative.

It is not only people who are transported. Also, goods are transported over big distances from the first raw material that is coming to the production site and until it finally ends up in your shop.

Simple measures:
- plan your activities to include using public transport
- use bike or walk when it is possible and safe
- look for local product to buy when available (less energy is used for their transport)

Measures for professionals:
- plan the city infrastructure suitable for an efficient public transport
- improve the energy efficiency of motor vehicles

7. CONSUMING AND RECYCLING PRODUCTS

The biggest amount of the total Russian energy consumption goes on the industry.
Most of the industrial products are directly or indirectly consumed by the population or exported abroad I think we need example here. The consumption of produces form a big share of our total energy consumption

What to do:
There are several ways to reduce the energy consumption in the industry. One is to choose the products that are produced in the less energy consuming way. Window frames could be produced out of

aluminium or out of trees. Which alternative is most energy consuming?

Sometimes, a new products purchase could be avoided by repairing the old product. The most energy efficient solution is to use the existing products and pacing once more.

If the product is worn out, the materials that the product is made of could perhaps still be used. Recycling is for many materials an excellent way of reducing the waste hips and saving energy. All kinds of metals are very energy consuming when it comes to production but re-cycling could be done with much less energy. You could re-cycle 20 kg of aluminium with the amount of the energy used to produce 1 kg of new aluminium.

If the best alternatives, from an environmental point of view (re-use and re-cycling) are impossible, a burning for heat production could be an alternative. But burning of waste is too often a very dirty process. Mixed waste should never be burned. A proper sorting of the waste in order to avoid poisoning is necessary and the burning must be done only in special facilities.

Simple measures:

- repair and re-use instead of buying new products
- deliver for re-cycling whatever is possible in a place you live
- look for paper and other products made from re-cycled materials

Measures for professionals:

- develop system for re-cycling and collection of different waste materials
- develop products from re-cycled materials

Did you know…

… that the waste are actually resources, only put in the wrong place

… recycling of aluminium saves up to 95 % of the energy (used for its production)

… to buy high quality product is often more economical and gives less waste

Did you know…

… that you could travel 6 time longer by a electric train than plain using the same amount of energy

… that in a combustion engine more than 60 % of the energy from the fuel ends up as heat and exhaust

Exercise:

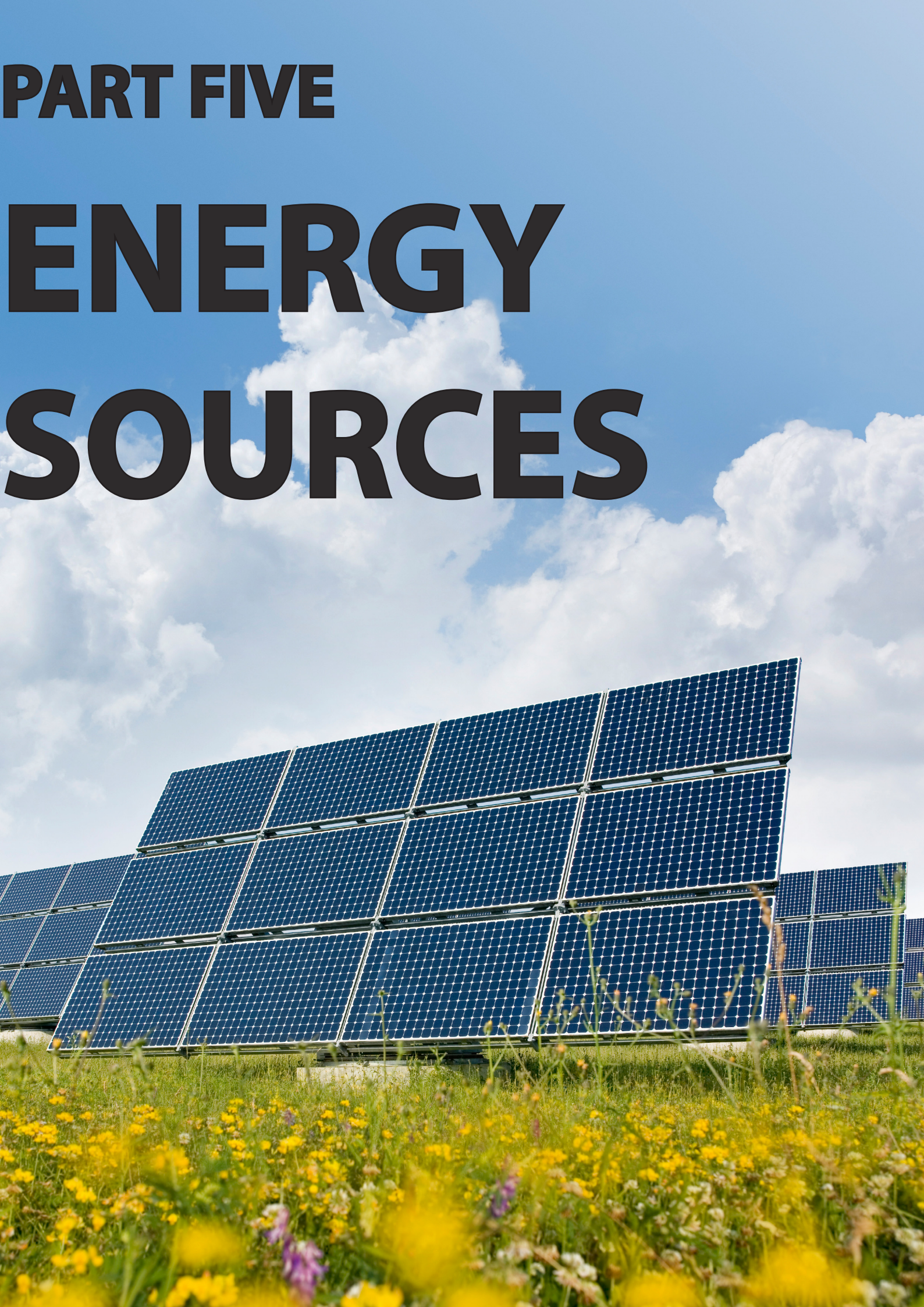
Take a usual Russian product that is made of several materials. Try to find out where it is made and where the different materials come from. Take a map and draw a line showing where all the different parts have been transported.

Task 13.

Look at the figure showing some of the most energy consuming Russian industries. Try to find examples of ordinary products in your surroundings that originating fully or partly from each of the industries.

PART FIVE

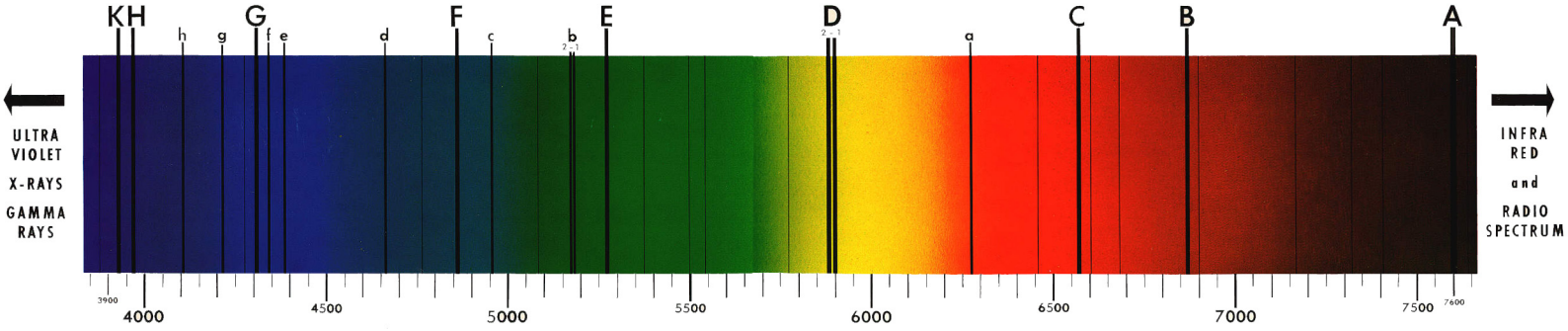
ENERGY SOURCES



PART FIVE - ENERGY SOURCES

RENEWABLE ENERGY SOURCES

Renewable energy sources can be put into five categories; sun, wind, water, geothermal and biomass energy. The category "water" includes energy obtained from rivers and oceans. All of these energy sources, with the exception of geothermal, exist due to the energy of the sun. Biomass is any organic matter, and it has stored sun energy from the sun by the process of photosynthesis. The rivers are fed by rains, which result from the evaporation of oceans and lakes under the effect of solar heat. The wind blows on the surface of the earth as a result of an uneven heating of the ground, and therefore of the air, by the sun. Geothermal energy is the energy from underground heat. We will examine only the more developed and promising sources.



1. THE SUN

The sun sends an enormous range of wave energy into an open space. About one third of that wave energy which reaches the Earth is infrared light (heat waves). A human eye cannot detect most of the waves of the sun spectrum. The visible rays, which we see as a light, present one percent of the overall radiation of the sun.

The power of sun radiation is truly colossal - 385 ZJ/s (385 x 10^{21} J/s or 385 000 000 000 000 000 000 000 watts). Just for comparison, total world's annual energy consumption was estimated to 0.5 ZJ. The annual radiation that reaches the Earth's surface varies with the geographical position of a particular location on the globe. This amount of sun energy is called insulation. At equatorial region, the insulation is evenly distributed throughout the year. Places at these latitudes receive up to 2,500 kWh/m2 per year on a horizontal surface.

Sunrays consist of small elementary particles - photons, each one carrying extremely small amounts of energy of 1-3 electronvolts. Photons wavelength and frequency of oscillating determine the type of rays they create (electromagnetic, infrared, ultraviolet, visible light…)

The sun is the world's biggest energy source. The greatest challenge for a mankind has been to capture the sunrays and use their energy for providing with power supply wherever it is needed. Out of all renewable energy sources, sun is, along with the wind, the cleanest and most accessible source of energy today.

Experts have so far managed to use the sunlight in numerous ways, building different installations that utilize energy of the sun radiation. As the price of these installations will decrease over time, these would get more and more of public attention and will be further developed. In some countries, people are paid by the government to use renewable energy sources in their homes. This is one of the means to promote and support alternative and clean energy sources.

Most common devices for solar power use are those that do not require significant investment, and yet they give enough amount of energy that cover all of the basic needs of a household.

Heating water and homes will be further explained in details in this book. The purpose is for you to apply your knowledge in your own home.

Passive use of solar energy

When the energy from the sun is used to heat a building without using any particular technical installations, i.e. there are no machines to transform the heat from the sun into energy, which could heat houses, it means that the solar heating is passive.

Often, houses had to be built with the windows facing the south. In this way, the windows act as the sun traps. The heat from the sun can also be utilized by installing special glass in the windows, or by building houses so that the sun heats them as much as possible. Then there is less need for lighting inside, and also less electricity will be used for the heating.

Water desalinization
Fresh water is essential for the activities of human. For people in arid and desert areas it is essential to have a supply of fresh water. Many desert places have substantial supplies of salt water and it is significantly less expensive to desalinate it than to bring it from other places.

The simplest equipment for desalinization is a solar distiller. It is composed of a shallow basin with black walls and bottom and a clear sealed lid. The distiller is filled with salt water. The solar energy, which goes through the lid heats the water and part of it evaporates. The water vapor, as a result of the heat convection, rises to the top and condenses on the colder lid. The drops of water then flow over the surface of the lid to drains, from which the water is then used.

Heating the water
Open reservoirs have been used in the past for heating water and heating homes. Today, there is a better solution - insulated reservoirs, where the temperature of the water reaches temperatures several times higher than open reservoir water; and vacuum reservoirs, where the heat loss is minimal.

There are several different ways this can be done at home. The simplest way is a black tank or a barrel that stands in the sun. In this way water for a shower can be heated on a sunny summer day.

However, if you place that tank or barrel in an enclosure with a glass lid and insulate it well, and then place it with southern exposure, you can take a shower or wash dishes even on a colder and even cloudy day.
Improved solution is to run a pipe of water within an insulated box. The effectiveness increases because of a more efficient use of insulation.

Today, we can also use solar systems and exterior water heaters for heating our homes. In order to receive the optimal result, it is possible to build large complexes and use expensive materials (copper, aluminum).

The advantage of such systems is that they can keep a house warm on winter days if they are integrated into the house heating.

Solar energy home heating
The idea of heating a home with solar energy has been known since ancient times, when people have been building homes with windows placed towards the south (at the northern hemisphere). Today however, there are modern designs of commercial buildings and residential homes based on passive heating as well. With simple architectural solutions of placement of windows, walls and the roof, it is possible to conserve the heat, and therefore money. In practice, those houses with passive systems of heating would heat up faster if they have fans that circulate warm air among the rooms.

When we utilize sun heat we make a solar-heating system, which we will also for example, store larger amounts of energy in. We can use it to supply heat to the industry, swimming pools or buildings. The system can in some cases, be an integrated part of a building. In this case, the system will usually have several other functions in addition to supplying the building with heat. A solar-heating system comprises a sun trap, a heat store and a heat-distribution system.

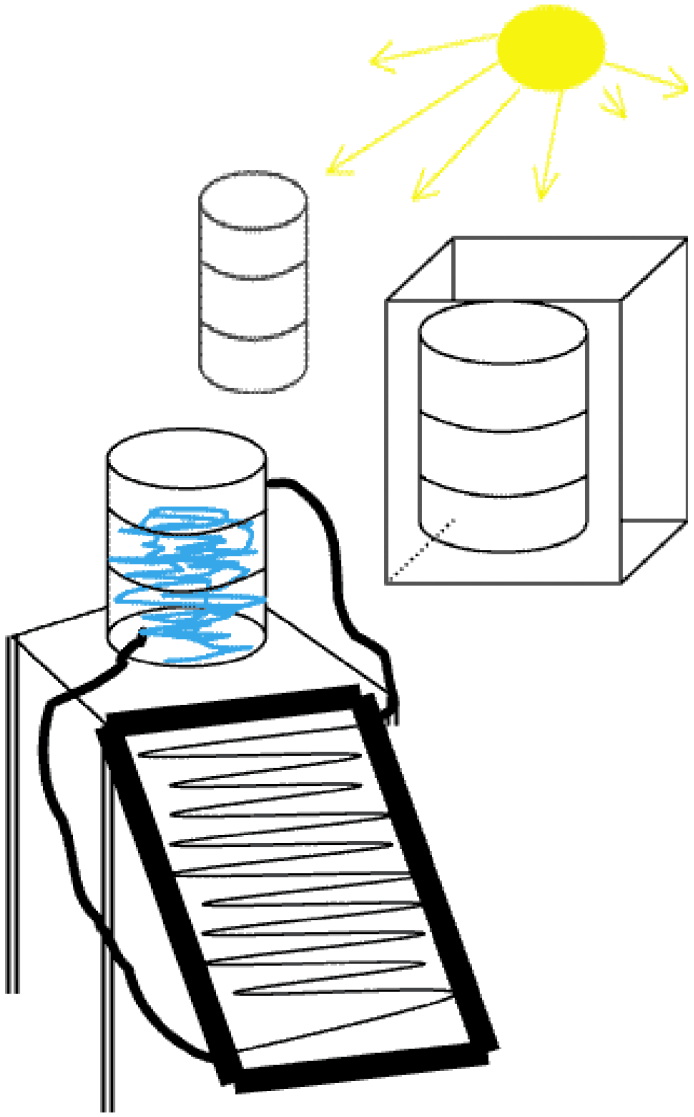
But how does the room heat up in the first place? The sun trap (glass window or a shield, for instance) captures sun rays, allowing them to enter the room, heat up objects, but disabling rays to leave the room, due to the transformation of rays from short to long, which can not pass through some materials, such as glass. It is the same process that occurs in greenhouses, and in our atmosphere, known as the greenhouse effect.

Solar systems for electricity generating
Solar cells for sun energy utilization have already been produced in the 20th century, although at their

beginnings the efficiency was considerably limited, just 1-2%. Research in the 1920s and 30s, the development of new methods in the 1940s and the space programs of the 1950s are all important elements in the development of the solar-cell systems we have today. Today the efficiency of a standard solar-cell system is 10-15%.

As previously noted, light is composed of photons. As they fall onto light-absorbing object, they eject electrons. This process is called a photovoltaic effect and occurs on metallic surfaces, liquids, and in gases. Electrons flow through the material, while rest of the photon (positively charged) flows in the opposite. Traveling electrons produce a stream of electric currency. The simplest and most convenient surface is metal. But not all metals give the same photovoltaic effect. The material most suitable is silicon. Silicon is the second most common element in the Earth's crust, after oxygen. It can be extracted from quartz sand.

You have likely seen the solar-powered pocket calculators or watches? Fortunately, the price of these photovoltaic systems is continuously falling, and we see their use in home, transportation, and elsewhere.



Tasks 14.
THE SOLAR OVEN

You will need:

1. A cardboard or wooden box (approximately 30 x 30 x 20 cm)
2. Aluminum foil (approx. .5 square meters)
3. Glass or clear plastic (size of the box)
4. Rope (approx. 1 meter)
5. Adhesive tape
6. Thermometer

Next, you should:

1. Cover the inside of the box with foil
2. Cover the lid of the box with foil
3. Attach the rope to the lid of the box (for changing the position of the box's lid)

4. Close the box with glass, place the box in the box and place the lid in an optimal position to reflect the sun's rays into the inside of the box.

5. Place a thermometer in the box and check for a rise in temperature

6. Measure what the maximum temperature within the box has been achieved

7. Try to prepare something in the oven: egg, cup of tea, sausage or something else (place the pot or frying pan in the middle of the box

Additional questions:

1. How much does construction of a solar heater cost? How much does the preparation of an omelet cooked on wood cost? How much wood is required for an average family for the preparation of food during the course of one year?
2. Make additional "wings" out of foil for the box. Does this increase the temperature in the box?

The solar collector
Here is one of the ways for making oneself a solar collector for heating water.

Take a shallow metal box (the depth should be sufficient for placing a stiff cardboard with insulation in the box), a dark stiff cardboard similar in area to the area of the box, and plastic pipe.
Holes for the entry and exit of the plastic pipe should be positioned within the box's sides in opposite corners.

Next the metal box is filled. First insulation, the stiff cardboard, which can be painted black (this will catch more sun rays), and then the pipe is placed on the cardboard and fastened in place so that it does not move. Each end is placed in the holes. All of this is covered with glass of 3-4 mm thickness which seals the box's contents from water and the air.

Connect the free ends of the pipe to a tank full of water (one of the ends at the top of the tank, the other at the bottom) and you will have a simple construction for heating water.

Think and Reply

1. In what color clothing is it better to dress on a hot sunny day – light or dark? Why?

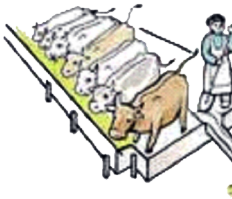
2. In the countryside, many design showers with water tanks that heat in the sun. What color should the water tank be painted? What type of use of solar energy is this: Passive or active?

3. Is it effective to use solar panels for creating electric energy in St. Petersburg? Why?

4. Why did work on the cosmic programs significantly advance the use of photovoltaic cells for generating energy?

2. BIOENERGY

More than heating with wood
Until humans began to exploit water power and non-renewable sources of energy, bioenergy was the energy form most used. Emissions of CO_2 from combustion of bioenergy do not affect the total amount of CO_2 in the atmosphere, as long as the amount burnt does not exceed the annual vegetation growth. This is because plants and trees use CO_2 as long as they are alive and carbon dioxide used for growth would even with the amount released from burnt biofuels.



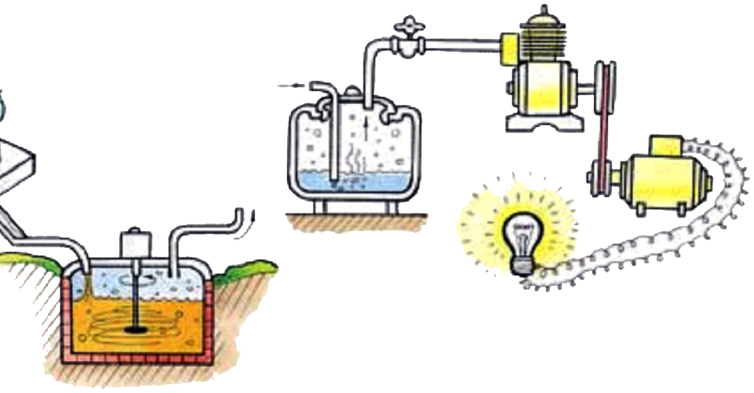
What is bioenergy
Energy contained in various types of biological mass (biomass),that is - in any organic matter, is called bioenergy. It is produced by photosynthesis, when plants, using carbon dioxide assimilated from the air together with water, synthesize organic matter. For this process they are using the energy of the sunlight, and are releasing oxygen at the same time. Even though it seems rather simple, there is no other process on earth that synthesizes biomass with such efficiency. When biomass decomposes in the nature, a certain amount of energy is released (bioenergy).Produced biomass can now be used as an alternative source of energy, through burning process. The final product of burning is usually thermal energy (heat), but it is also possible to produce electric power, liquid fuel or hydrogen from biomass.

The following are some examples of important biomass sources:

- Waste from the forestry industry
- Fertilizer, biological waste from the farming industry
- Energy plants from the farming industry
- Biogas from animal excrements
- Organic household and industrial waste
- Sewage

The total biomass growth on land is estimated at around 130 billion tones of dry material (when water content vapors) each year. This is the equivalent

of 660,000 TWh per year. Global consumption is around 15,000 TWh per year, which is approximately 15% of global energy's use. About half of the world's population uses bioenergy as their primary energy source. The potential is considerable, particularly through increased production and utilization of biomass resources, and in part rationalization of energy production. A conflict can however arise between needs for biomass as fuel and biomass for food production for the growing world population.



From Biomass to Bioenergy

Knowing the nature of photosynthesis, it is obvious which is the greatest advantage of using biomass as the source of energy, which is the fact that the amount of carbon dioxide on the Earth is not changing, due to the process of burning. Plant growth requires this gas for converting inorganic matter into an organic (such as sugar), and hence while burning biomass, there cannot be more carbon dioxide released, than it already has been assimilated by this plants (biomass) in the first place.
It is obvious why biomass is so precious. But how can it ever be converted into an energy that we need?

Burning

The oldest and most common way of converting biomass into energy is by burning wood. This energy-obtaining trend has in average a toll of 700kg loss per person per year. More than half of it is used for heating homes. And in many cases, people use old ovens and stoves, which have a terrible effect on the environment, due to the absence of purifying filters. With new stoves with catalysts in use, these emissions are notably reduced.

Pyrolysis

Pyrolysis is the process of burning on high-temperatures (450-500C) in order to obtain the heat and without any contact with the air. By products of pyrolysis are gases (methane, carbon oxides) and charcoal, which can be further burnt, for more thermal energy. The charcoal obtained from pyrolysis can be used as fuel for heating or as crude material in certain industrial areas.

BIOENERGY

Advantages

- bioenergy is a renewable form of energy
- it is CO2 neutral
- it can solve waste problems

it is a concurrent technology with a remarkably broad range opportunities

Disadvantages

- extensive areas are needed for producing biomass for energy
- severe environmental damages may rise if trees are cut down by a higher rate to the growth rate
- increased forest planting and forest care must therefore be introduced rapid population growth ask for more intensive food production, hence the need for food farming areas is constantly increasing, therefore not much land can be used for biofuel production
- irresponsible use can lead to quite considerable NOx and particle emissions, but by using modern plants these disadvantages can be reduced.

Think and Reply

1. What is bioenergy?

2. Why is bioenergy a renewable energy source?

3. How can green leaves transform and conserve the energy of the sun?

4. What process of production of bioenergy is more rational – pyrolysis or simple burning of biomass? Why?

5. Why is it necessary to plant new forest to replace those that are cut down?

Task 15.
Bioenergy in your region

Think and write down what sources of bioenergy exist in your region. Biomass can be:

- Wood wastes
- Manure and biological wastes from agriculture
- Organic wastes from households and industry
- Waste waters
- Turf

Something from the list above should be identifiable in your region. Wood wastes can be used for making briquettes. Manure and biological wastes of agriculture can be used for heating. By burning the organic wastes of household and industry, it is possible to receive heat energy. Waste waters can be used for the production of biogas, which then can be used for the production of electricity.

3. WIND

The air movement is caused by only around 1% of solar radiation. This occurs by air being set in motion by the temperature variations caused by heat from the sun. Globally, the wind energy potential is equivalent to about 100 times the world's energy consumption. But in practice only a small fraction of this can be utilized.

Humankind learned how to use wind energy early in its development. Man could sail long distances using wind energy 3,000 yearsago. Wind power-stations are now undergoing a revival and are increasingly in use.

Wind powered stations electric power production is ran by strong wind blowing. Wind power is especially used in windy and flat landscape countries such as Denmark wchis is one of the world leaders in wind wnergy utilization, along with Germany, Spain and USA. During the 90s Germany started to terminate nuclear plants power building, turning to alternative solution, such as windmills, which electricity production exceeds the nuclear plants production, by 3000MW.
Wind power plants have became an important export product for Germany and Denmark, and for the past ten years, this industry has employed over 50 000 people, developing faster than telecommunication industry.

In the last five years, several wind power installations have been built in Russia. Other former Soviet countries have also start to exploit their wind potential. Particularly, countries of Central Asia with their vast deserts areas and long seacoasts have a significant potential for this form of energy production.

On of the major difficulties, when it comes to windmills, is conflict of different interests for land use. Another factor, that seem to be important is visual effect of these mills, on landscape. Recently, and for these reason in particular, windmills have been placed offshore, along shallow seacoast areas.
Just as any other newly developed activity, wind power utility shows its downside. Wind aggregates noise, failing of the radio connections, negative effects to avian life – all those are arguments oppugning wind power use industry.

WIND ENERGY

Advantages
Wind power stations have no associated waste problems and are the least expensive of all renewable energy sources.

Wind power, like bioenergy and solar power, is competitively interesting in comparison with non-renewable energy sources.

Therefore, in the next decade, it is likely that wind will produce the cheapest power available.

Disadvantages
Wind is very unstable and unpredictable, with its sudden gusts and lulls. The wind direction and variations in strength make the technique for utilizing wind power complicated.

Windmills make a lot of noise and can look unpretty in the countryside. However, in Europe windmills are located in considerable distance from settlement, so their noise would not exceed 40-50 dB, and they would be far ways from the sight.

Disturbance of radio waves appears as an important negative effect.

Windmills are sometimes located on main routes of bird migrations, and therefore harm the bird life. Occupying land that may be used in agriculture is another counterargument, however statistics show that not more than one percent of land in Europe is actually occupied by the windmills.

Think and Reply

1. Why is wind a renewable energy source?

2. Give examples of the use of wind energy today and in history.

3. In your view, what is the major disadvantage of wind as an energy source?

Task 16.
Watermill/Windmill

You can make a watermill from a milk or juice carton and paper clips. Cut off the bottom and top of the carton, and cut the rest down to a height of 5cm. Fold the sides in, as shown in the figure. Hold the mill under the tap while the water turns it. You can also get the millwheel to turn by blowing on it.

4. HYDROELECTRIC POWER

Hydropower stations in Russia produce some 20% of electric power. Hydroelectric power is basically a renewable energy source because water, the "fuel" is continuously replenished and the production process releases no emissions into the atmosphere. However, developing of watercourses and waterfalls power-use stations has a considerable impact on the countryside and can change the local ecology – plants and animals lose their natural habitats.

The power from a hydroelectric power station is a production of water volume and fall heights. This means that even rivers with quite limited water volume can produce a lot of energy providing the fall height is very great. Very high waterfalls were therefore channeled into pipes and harnessed for energy.

On coasts a related source of energy can be tidal. Beginning in 1966, two French towns have entirely satisfied their needs for electric energy from tidal force. The huge tidal waves are created by the gravity of the moon. The tidal forces turn turbines connected to electrical generators.

To summarize we will note that although hydroelectric power production itself does not pollute, the effects on the ecological systems and landscape can be substantial.

Think and Reply

The most famous (but not the largest) Niagara Waterfalls has a height of approximately 50 meters and water flow of 5900 cubic meters/second. If all the energy of Niagara Falls would be turned into electrical energy, how many apartments, such as yours, could be provided with electricity during the course of one month? In order to calculate, ask your parents how many kilowatt/hours of electricity is spent by your family each month.

Task 17.
Compare renewable energy sources

Fill out the table and compare solar, wind, water and biomass as sources of energy.
Which source fits best for your location?

NON-RENEWABLE ENERGY SOURCES

We shall now consider the most important non-renewable energy sources. A non-renewable energy source is one that takes millions of years for nature to form.. What they have in common is that they will be used up within a relatively short time, compared to time of their formatting, that is within some 100-200 years. In comparison, the new, renewable energy sources will last as long as the sun produces energy.

Several factors decide how applicable an energy source is:

- Both short and long-term access
- Net energy content
- Harmful effects on the environment

Europe's industrial society is based on non-renewable energy sources in the form of gas, oil and coal. These energy-carriers are limited and pollute both locally and globally.

The high-developed countries get about 80% of energy from non-renewable energy sources such as natural gas, oil and coal.

5. COAL

Coal was the first non-renewable energy source to be used. England especially had a central role in the development of the use of coal. It was there too, that the Industrial Revolution started. As we shall see, coal was crucial to the development of our civilization.

The first functioning steam engine was made in 1712 in England by a Thomas Newcomen. The steam engine, for pumping water transformed coal's thermal energy to mechanical energy or work. In

years 1774-1787 James Watt built universal mobile steam machine, and coal could therefore be utilized as a universal energy-bearer. Steam boats and railways made communication easier and coal could be transported throughout the whole of England and eventually throughout the world. New cities grew up around the steam-driven, world-market oriented factories.

Pollution from burning coal rapidly increased, although it had stopped the worst devastation of forest resources ever. In the 1700-1800s pollution was an enormouns problem in the city. Smog pollution (a mixture of smoke and fog) in post-industrial revolution England represent the infamous and unprecedented consequences of environmental pollution coming from fossil fuel. .

In year 1965. coal was still the world's most important energy source. In 1985 coal accounted for 31% of energy production. Beside being suitable for obtaining electricity, it is also cheap energy source, at least for countries with easy access to it.

Natural coal is the product of the decomposition of swamp and mud vegetation When layers of rutting plants are covered by thick layers of sediment, under the pressure, temperature and microorganisms, slowly over millions of years, they transform first to peat, and then to coal.

Coal is environmentally harmful, in fact, burning coal gives off a number of gases, both toxic, as carbon monoxide (CO) and sulphur dioxide (SO_2), and also green-house gases, such as carbon dioxide (CO_2). Emission of these gases has increased significantly since the Industrial Revolution. No other non-renewable energy sources releases as much CO_2 as coal. Important problems are also dust and soot dispersal due to coal burning .

Think and Reply

1. How is coal formed in nature?

2. Why was coal a decisive factor in the industrial revolution in England and throughout the world?

3. Why did coal for a long time remain the main energy source in industry and for transport?

4. What are the advantages of coal as an energy source?
5. What is the major disadvantage of coal as an energy source?

6. OIL

Oil is not only a source of energy, but also it is used for production of plastic masses and medications. Some constituents of crude oil have been used for hundreds of years. Approximately 90% of oil is used as fuel, rest of it is used in chemical industry. The modern oil industry started to develop in Pennsylvania in 1859. and ever since, it has been steadily growing. Crude oil is unevenly distributed just as well as it is unevenly used, throughout the world. It is primarily the industrial countries which have increased their living standards by using oil beside reserves in Russia, oil is dominantly concentrated in Middle East, Latin America and Africa. On the other hand, great oil consumers are Europe and USA, where oil reserves are quite scarce.

Oil is used a great deal in the transport sector, where it has previously been difficult to replace oil. Recently however, there has been increased interest and investments in the development of electric cards, and in the use of methane and propane gases in busses, etc. In the long-term these measures can replace a lot of the oil used in this sector. For us in schools, it is easier to find ways to reduce car use. We can walk or cycle instead. If we need to travel any distance, we can use public transport (bus, tram, train).

Oil is easy to transport. It is usually transported in pipelines and by sea traffic.
Crude oil is created of small marine animals (zooplankton) which have been stored under pressure

in the earth for millions of years. In other words, nature takes millions of years to produce oil. Oil is a therefore, non renewable and a rather limited resource. It is difficult to say how long oil reserves will last. They could be used up within 50-100 years, although new reserves may be discovered. Whatever happens, we urgently need to find alternatives, and those which are environmentally friendly and which can be used renewed in a short period of time.

Extraction, transport and use of oil all cause a great environmental damage to the seas, atmosphere and life.
Since all stages in petroleum production and use, such as drilling, platform construction, production, transport and burning, lead to emissions of carbon dioxide. The extent of these activities has increased at the same rate as production development. Hence, the extent of emissions has increased as well.

We have repeatedly seen that oil-tanker accidents are detrimental to nature. Oil spills close to land especially affect sea birds, and although fish keep to deep water, where the oil does not reach, fish eggs and fry are normally found near the surface and coastal lines. On coastal stretches which are exposed to strong winds, current and waves, it takes 4-5 years until the ecosystem recovers. In waters with less wind and water currencies, the process can take 10-15 years.

Spilled oil forms an oil stain at the surface of the water, and birdsthat accidentally get into the oil stain, get covered in oil, which damages their system for thermoregulation. If the oil gets in their eyes, it leaves them blind and disorientated. Therefore, oil use enormously harms the entire environment – the oceans, the air and the biodiversity. In this respect, oil should be used only in processes where it is irreplaceable.

Think and Reply

1. How is oil formed in nature?
2. What are the advantages of oil as an energy source in comparison with coal?
3. Is oil used anywhere else in addition to the production of energy?
4. Are the harmful consequences of the use of oil only the emissions of polluting gases during its burning?

7. NATURAL GAS

Natural gas is most often found together with oil, although there are also pure gas sources. Natural gas, like oil and coal, has been created by conversion from plants and small animals.

The boiling point of "dry" natural gas (gas which contains light compounds such as methane, etc.) is less than 0 percent C. The energy content of natural gas is almost as high as that of oil. Natural gas is used as a fuel, for heating, in industry and power stations, etc.

Natural gas is the cleanest form of non-renewable energy: the toxic content is very low and it can be burned up almost entirely so it is easy to handle. However, we still have the problem of the release of CO2 when natural gas is used, because it too is formed from plants and small animals.

Natural gas can be transported to its destination in pipelines, or the temperature can be lowered so that the gas liquefies and can be transported in oil tankers. Liquid gas is called Liquefied Natural Gas or LNG.

Think and Reply

1. Why is natural gas considered one of the ecologically cleanest of the renewable energy sources?

2. In your view, what are the advantages and disadvantages of natural gas as an energy source?

8. NUCLEAR ENERGY

Nuclear energy is used almost entirely for obtaining electricity, although in some cases this energy is used for fuel. The first nuclear power plabnt has been built and opened in USSR, in 1954.
Today, nuclear energy provides us with some 17% of electricity production in the world. In nuclear power stations uranium, thorium or plutonium is used as fuel. Heat is produced by splitting (fission) the atoms of these elements. The heat is absorbed by a coolant. Sometimes the turbine is actually driven by the coolant, but otherwise a heat exchanger is used to lead the heat to a separate steam/water system.

Nuclear power plants use easily breakable (fissile) elements, i.e. elements with nucleuses which easily break apart into lighter elements, over the process of nuclear fission. Breaking releases an enormous amount of energy, and this process takes place in nuclear reactors.

At the power station, the element is placed in a reactor, and after burning, it is removed and replaced with a new one. The used elements, which consist of radioactive material, are cooled down over a period of time in a water bath. The fuel is then transported in a purpose-built container to a storage system, where the uranium and plutonium are separated. The uranium is transported back to make new fuel, while the plutonium is stored.

What remains is highly active waste which is stored in stainless steel tanks. This waste is highly dangerous and needs thousands of years to break down.

Advantages

Nuclear power plants can produce enormous amounts of energy. One kilogram of uranium has the equivalent production of energy as two and a half thousand tons of the best coal!

The waste from nuclear power stations does not include CO2, soot, sulfur or nitrogen compounds, but it is nevertheless extremely harmful to the environment.

Disadvantages

Nuclear power plants are expensive to built.
Even though there is no emission of greenhouse gases, nuclear plants are extremely harmful to the environment, duet o its radioactive contains.

So far no foolproof way to store the waste has been found. Along with the failing economies of nuclear power stations owners, this currently represents greatest danger of nuclear energy production.

The construction of a nuclear power plant is approximately five times more expensive than the construction of a thermalpower plant, that burns coal. The high cost of nuclear reactors and nuclear power plants is in large part due to the necessity to take strict measures of safety in order to avoid accidents. In addition, it must be remembered that the cost of transport, storage and processing of radioactive waste produced in nuclear plants is very high. Therefore, despite the appearance of the inexpensive and environmentally friendly nature of nuclear energy, it is one of the most expensive energy sources, if one takes into account the extraction and transport of radioactive raw material, the construction of the nuclear power plant, and the problem of waste.

The decommissioning of nuclear power plants at the end of its normal life cycle (after its planned service life) is an extraordinarily complex and dangerous process.

A serious danger related to the use of nuclear energy is the possible proliferation of radioactive materials for the preparation or use of a nuclear weapon.

Another danger of the nuclear power station is the possibility of an accident with catastrophic consequences. The accident at the Chernobyl Nuclear Power Plant in 1986 was the accident with the greatest proportions ever. The scope of this accident was global. The population of several countries suffered from its impact. The economic loss from the Chernobyl accident surpassed by three times the economic benefit of its energy production for the whole period of its existence until the accident. The problem of safe nuclear energy production remains unresolved.

CONCLUSIONS

Energy production and use is that realm of human activity that has the most destructive impact on nature. In part this impact depends on the nature's own rules, for example, in the transformation of energy of poor quality to energy of higher quality. But in many cases environmental pollution is not inevitable and is associated with an ineffective spending of energy, with the use of non-renewable energy sources, and with a reluctance to process the wastes of that production. These negative consequences of energy use are entirely surmountable, although sometimes they require significant resources and usually are carried out with much work. But humankind has no choice. Millions of years were needed so that humans could achieve their current level of civilization. And if we want for humankind and all life on Earth to continue to live and appreciate life for a countless number of future generations, then the use of safe and non-renewable energy – is the only way to achieve that goal.

A great responsibility lies on us to preserve a world in which humans, animals, plants and all living organisms can live. Let this be our common goal and the goal of each of us.

Good luck to you!