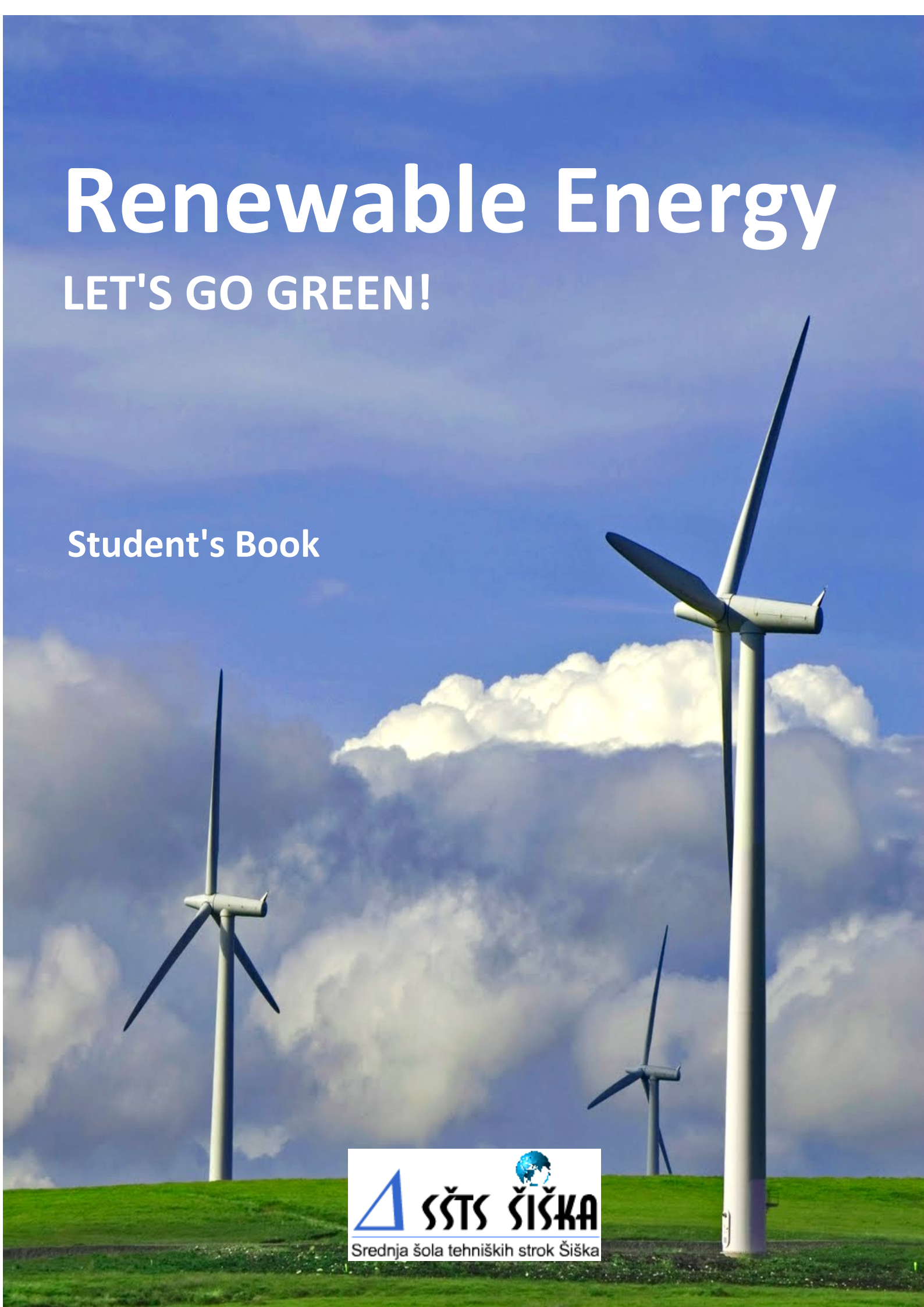
Renewable Energy

LET'S GO GREEN!

Student's Book



SŠTS ŠIŠKA
Srednja šola tehniških strok Šiška

Unless someone like you cares a whole awful lot, nothing is going to get better. It's not.

Dr. Seuss, The Lorax

Renewable Energy

LET'S GO GREEN!

Student's Book

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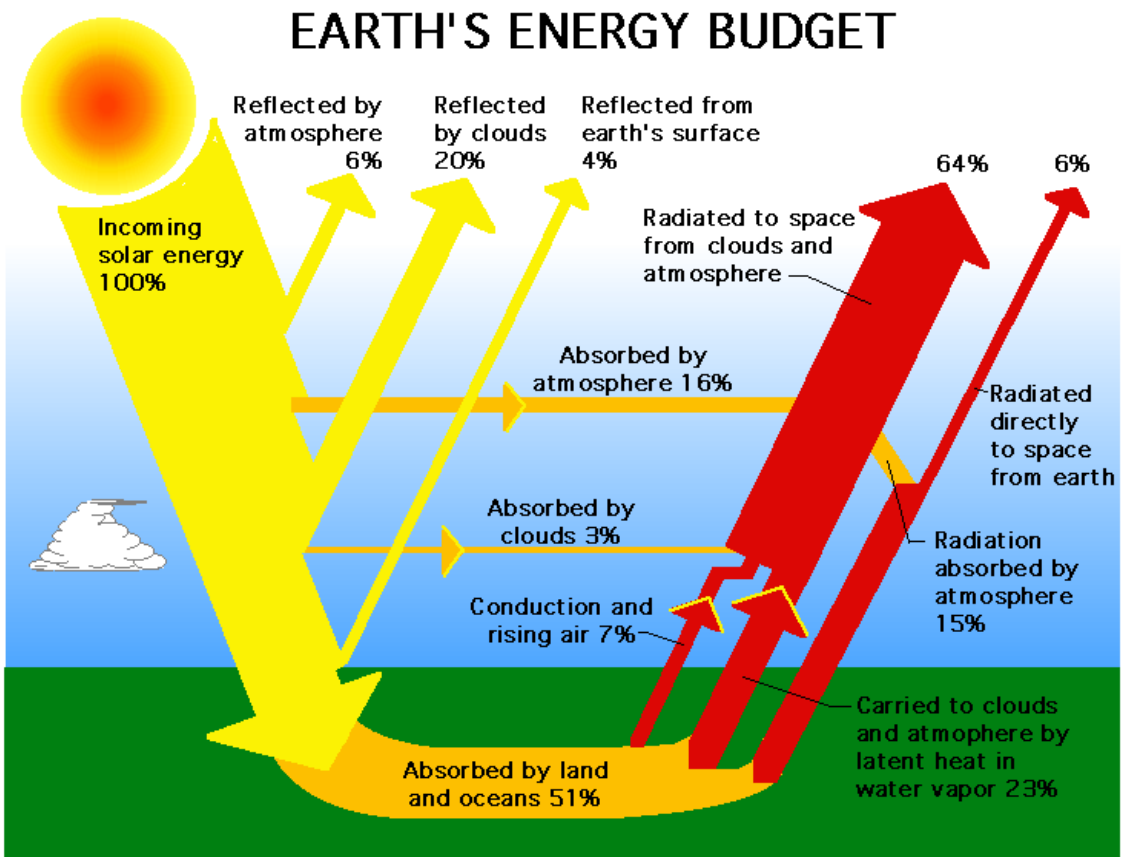
Zavod
Republike
Slovenije
za šolstvo

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA IZOBRAŽEVANJE,
ZNANOST, KULTURO IN ŠPORT

Contents

Unit 1

ENERGY



Look at the scheme and discuss the earth's energy budget.

Notes

1. WHAT IS ENERGY?

Energy helps us do things. It gives us light. It warms our bodies and homes. It bakes cakes and keeps milk cold. It runs our TVs and our cars. It makes us grow and move and think. **Energy** is the power to change things. It is the ability to do work.

Energy is Light - Light is a type of energy we use all the time. We use it so we can see. We get most of our light from the sun. Staying awake during the day saves money because sunlight is free. At night, we must make our own light. Usually, we use electricity to make light. Flashlights use electricity, too. This electricity comes from batteries.	
Energy is Heat - We use energy to make heat. The food we eat keeps our bodies warm. Sometimes, when we run or work hard, we get really hot. In the winter, our jackets and blankets hold in our body heat. We use the energy stored in plants and other things to make heat. We burn wood and natural gas to cook food and warm our houses. Factories burn fuel to make the products they sell. Power plants burn coal and natural gas to make electricity.	
Energy Makes Things Grow - All living things need energy to grow. Plants use light from the sun to grow. Plants change the energy from the sun into sugar and store it in their roots and leaves. Animals can't change light energy into sugars. Animals, including people, eat plants and use the energy stored in them to grow. Animals can store the energy from plants in their bodies.	
Energy Makes Things Move - It takes energy to make things move. Cars run on the energy stored in gasoline. Many toys run on the energy stored in batteries. Sail boats are pushed by the energy in the wind. After a long day, do you ever feel too tired to move? You've run out of energy. You need to eat some food to refuel.	
Energy Runs Machines - It takes energy to run our TVs, computers and video games— energy in the form of **electricity**. We use electricity many times every day. It gives us light, and heat, it makes things move, and it runs our toys and microwaves. Imagine what your life would be like without electricity. We make electricity by burning coal, oil, gas, and even trash. We make it from the energy that holds atoms together. We make it with energy from the sun, the wind, and falling water. Sometimes, we use heat from inside the Earth to make electricity.	
ENERGY DOESN'T DISAPPEAR - There is the same amount of energy today as there was when the world began. When we use energy, we don't use it up; we change it into other forms of energy. When we burn wood, we change its energy into heat and light. When we drive a car, we change the energy in gasoline into heat and motion. There will always be the same amount of energy in the world, but more and more of it will be changed into heat. Most of that heat will go into the air. It will still be there, but it will be hard to use.	

Adapted from: *http://www.need.org/needpdf/infobook_activities/ElemInfo/IntroE.pdf, June 2012*

Task 1A Fill in the gaps. Choose among the following words:

renewable ● forms ● work ● is stored ● non-renewable (fossil fuels)

Before getting into knowing what are energy sources we must know what energy is. Energy is the ability to do_____. Energy helps in powering business, manufacturing and transportation of goods and services. There are many different ways in which the abundance of energy around us can be stored, converted, and amplified for our use.

Energy comes in different _____: heat, light, thermal, mechanical, electrical, chemical and nuclear energy. We all use energy for our daily work like when we walk, jump, eat food, drive car, play etc. Energy _____ in different ways and can be transformed from one type to another.

So, the energy sources from which we gain energy are classified broadly into 2 groups namely: _____and _____.

Adapted from: *http://www.conserve-energy-future.com/EnergySources.php, June 2012*

Task 1B Think and write.

What would you do if there was no electricity or gas or petrol? How would you:

1. have light in your house?
2. communicate with a friend?
3. take a hot bath or shower?
4. store food in summer
5. wash your clothes?
6. keep warm or keep cool?
7. travel to school or the next town or overseas?

Task 1C Discuss the following questions in pairs.

1. Where does electricity in your house/flat come from?
2. Does your family use more electricity than an average family?
3. List five ways your family could use less electricity.
4. Using the average family electricity consumption, find out how many families make up your school. How much electricity do the families of the whole school use in a day? In a year?

Task 1D In about 90 words write about how much "energy" we consume these days as compared to when your parents and grandparents were children.

It would do well for you to think about the following:

1. *How many motor vehicles (cars, motorbikes etc) does your family own?*
2. *How many did your parents/grandparents family own when they were children?*
3. *How do most people travel around their town, Slovenia and the world?*
4. *How does this differ from 50 and 100 years ago?*
5. *Think about all the electrical/gas appliances (entertainment, cooling, heating, lighting, cooking, cleaning) you have in your home - when did they become available? Were they around 10, 20 or 50 years ago?*
6. *Before these appliances were available what did people use instead?*

2. ELECTRICITY GENERATION IN SLOVENIA AND AROUND THE WORLD

Task 2 **Read the different information below carefully and then answer the questions**.

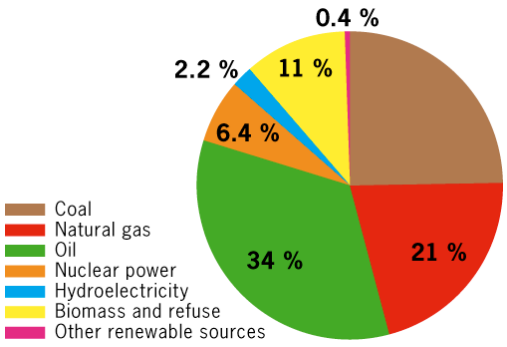
According to the Organization of American States' Office for Sustainable Development, the average American household uses about 10,000 kWh yearly.

An average school uses 1500 KWh a day.

Imports by Energy Product

Slovenia's dependency on energy imports is very close to the EU-25 average. Oil accounts for over two thirds of total imported energy, while the corresponding share for natural gas is 24%. The Russian federation and Algeria are Slovenia's suppliers for natural gas. Imported energy has increased by 44% since 1990. Slovenia occasionally exports electricity to other countries (e.g.Italy).
Solid fuels (9%), oil (67%) and gas (24%)

World dependence on different energy sources



In Slovenia, gross electricity generation has been increasing gradually since 1990. Generation is based mainly on nuclear energy, coal and renewable energy sources (mainly hydro). The shares of these sources in 2004 were 36%, 34% and 28% respectively.

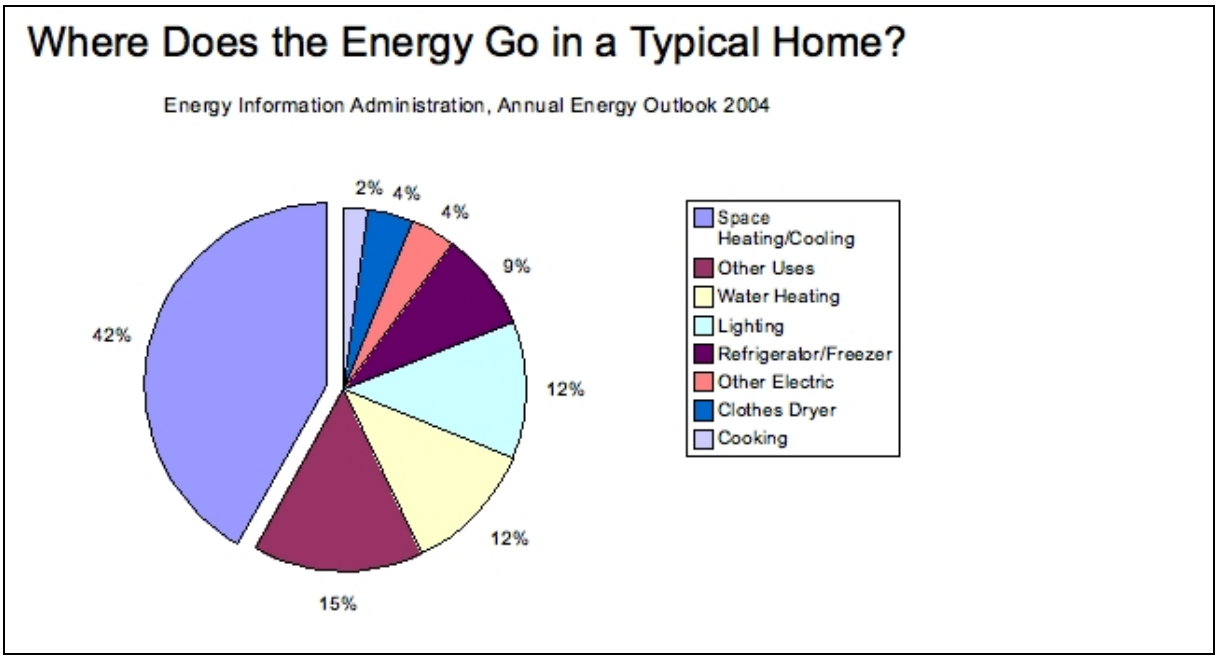
An Example of a Typical Coal-Fired PowerStation

A typical coal-fired power station(TE Šoštanj) generates electricity by burning coal in a boiler that heats up water, which is converted into superheated steam. This steam drives a steam turbine that in turn drives a generator that produces electricity.
A single coal-fired power station unit can power many thousands of houses as well as large industry.

How do you make electricity from coal - animated video
Source: http://www.youtube.com/watch?v=e_CcrqKLyzc, February 2013, 9:28

The structure of energy consumption in Slovenia:

- *buildings (heating, ventilation/air-conditioning): 43%,*
- *transport: 31%,*
- *buildings other 6%,*
- *other 20%.*

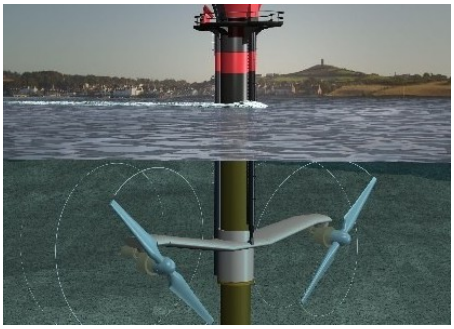


1. What is Slovenia's biggest energy source?
2. What is the Slovenia's biggest renewable energy source?
3. How much energy does Slovenia import?
4. Has imported energy in Slovenia dropped since 1990?
5. How does a coal-fired power station generate electricity?
6. In a typical home energy is used for different purposes. How many percents of the whole energy consumption is spent for space heating and cooling, water heating and lighting?
7. Energy consumed around the world is generated from different sources. Make a list of energy sources from the biggest one down.
8. Make up your own two questions related to the above information.

1
2
3
4
5
6
7
8

Unit 2

RENEWABLE ENERGY



WHAT IS RENEWABLE ENERGY

Task 1A Watch the video: 20% renewable energy by 2020

Source: http://www.youtube.com/watch?v=1cysaOnlv_E , June 2012, 4 min

1. _____ and energy dependence make it necessary to adapt our modes of energy production.
2. In 2005, renewable energy made up _____ % of the total energy consumption of the EU.
3. _____uses heat from the depth of the Earth.
4. An estimated surface area of _____ million square metres of solar heat panels were installed throughout Europe in 2006.
5. _____ is called the sleeping giant of renewable energy sources.
6. _____ is the world leader in the development of renewable energy.

Task 1B Make your own list of key words from the definitions below. Translate them into Slovene.

Natural resources come in all shapes and sizes. Water, air, trees, metal ores, land, oil, wildlife, etc. are all natural resources. Water and trees are renewable resources, meaning that we can always **replenish** our water supply and we can always grow more trees.

While oil is a natural resource, it is not a renewable resource. There are limited amounts of oil in the world and they will run out eventually.

Renewable energy is energy which comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable (naturally replenished).

Renewable energy sources are **Carbon neutral**, that is, they do not destroy the environment by increasing the **Carbon-dioxide content** in the atmosphere. They help control the **effects of Global Warming and Climate Change.**

According to the latest United Nations report, nearly 80% of the global energy supply could be met by renewable energy by 2050 if backed by the correct public policies.

Adapted from various sources (June 2012)

Key words in English	Key words in Slovene

2. TOP 10 RENEWABLE SOURCES OF ENERGY

Task 2A **Read and fill in the gaps in the right column with the words listed below.**

bioenergy ● solar energy ● geothermal energy ● wind energy ● ocean energy tidal energy ● hydroelectric power ● hydrogen ● the energy of the ocean's waves

 *PSA, south of Spain* ***Photo: SŠTS (LDV European Project)***	Most renewable energy comes either directly or indirectly from the sun. Sunlight, or _____, can be used directly for heating and lighting homes and other buildings, for generating electricity, and for hot water heating, solar cooling, and a variety of commercial and industrial uses.
 *One of the Europe's oldest'modern' windturbines in Tarifa, south of Spain* ***Photo: SŠTS (LDV European Project)***	The sun's heat also drives the winds. _____is captured with wind turbines. Then, the winds and the sun's heat cause water to evaporate.
 *Hydroelectric power Credit: US Army Corps of Engineers*	When this water vapour turns into rain or snow and flows downhill into rivers or streams, its energy can be captured using _____.
 *Switchgrass crops can be harvested to make biofuels. Credit: Warren Gretz*	Along with the rain and snow, sunlight causes plants to grow. The organic matter that makes up those plants is known as biomass. Biomass can be used to produce electricity, transportation fuels, or chemicals. The use of biomass for any of these purposes is called _____.

 *NASA uses hydrogen fuel to launch the space shuttles. Credit: NASA*	_____ also can be found in many organic compounds, as well as water. It's the most abundant element on the Earth. But it doesn't occur naturally as a gas. It's always combined with other elements, such as with oxygen to make water. Once separated from another element, hydrogen can be burned as a fuel or converted into electricity.
 *The Earth's heat-called geothermal energy-escapes as steam at a hot springs in Nevada. Credit: Sierra Pacific*	Not all renewable energy resources come from the sun. _____ taps the Earth's internal heat for a variety of uses, including electric power production, and the heating and cooling of buildings. And the energy of the ocean's tides come from the gravitational pull of the moon and the sun upon the Earth.
 *Workers install equipment for an ocean thermal energy conversion experiment in 1994 at Hawaii's Natural Energy Laboratory. Credit: A. Resnick, Makai Ocean Engineering, Inc.*	In fact, _____ comes from a number of sources. In addition to _____, there's_____, which are driven by both the tides and the winds. The sun also warms the surface of the ocean more than the ocean depths, creating a temperature difference that can be used as an energy source. All these forms of ocean energy can be used to produce electricity.

Task 2B Make sentences using the words on the left.

to generate electricity	
to capture	
to vaporize	
transportation fuels	
tides	
steam, n.	
hydrogen fuel	
heating and cooling	

Task 2C Write an abstract. In about 100 words, explain what renewable energy is.

Use at least 3 linking words	Phrases that might come in handy
although, on the other hand, it is also..., not only...but, ...too, another point is that... on the plus (minus) side... , moreover one (dis)advantage is that...	Renewable energy is energy which comes from … It is used… , … comes from… Its (dis)advantages are .../that it can... In addition, it...

Task 2D **Why do we need renewable energy ? Make a list of 5 reasons.**

3. THE FUTURE OF ALTERNATIVE ENERGY

Task 3 **What do you think will happen in the field of renewable energy sources in the future?**

Reading the text below will help you realize what the plans of the European Commission for the future are. Use "will future tense" to express predictions.

I think…

I don't think…

64% of new power to be renewable over next decade

Renewable energy is set to make up nearly two-thirds of new electricity generation capacity installed in the EU over the next decade, according to new estimates by the European Commission.

The EU executive's update on its energy trends to 2030 report, published without any public announcement, projects that renewable electricity will account for 64% of new electricity generation capacity installed over the next decade up to 2020. Gas will make up 7%, coal 12%, nuclear 4% and oil 3%.

The new figures take into account the dramatic change in the economic context since the last 2007 scenario, as energy-intensive industries have had to deal with production drops while new legislation has been passed to encourage the deployment of renewable energies and energy-efficient technologies, it said.

As a result, the EU's more ambitious scenario, which also reflects the agreed legally-binding targets on greenhouse gas emissions reduction and renewables, predicts that renewables will make up 36.1% of total electricity generation in 2030.

The Commission expects wind, including both onshore and offshore, to dominate the renewables market both in 2020 and 2030, followed by hydro power and biomass.

As renewables conquer ground, fossil fuel generation contracts significantly. The market share for gas decreases to 17.8%, while coal and other solid fuels decrease to 21.1% of total electricity generation in 2030, the Commission says.

While the share of nuclear power falls considerably, its production volumes are set to remain at current levels as some member states build new plants while others decommission them, either due to ageing or a phase-out, the report states.

The wind industry dismissed the estimates for new wind power in 2030 as unrealistic. Despite nearly doubling its expectations to 280 GW compared to its 2008 scenario, they were still far below the 400 GW that the industry itself expects to reach.

The European Wind Energy Association (EWEA) took issue with the Commission's assumption that new wind power investments would slow from an annual average of 13.6 GW in the decade up to 2020 to 5.8 GW in the following decade.

"I find it unrealistic that after 20 years there would suddenly be a dramatic decline in wind power investments, especially given the new scenario's high expectations for offshore wind energy up to 2020," said Christian Kjaer, EWEA's chief executive officer.

Adapted from: http://www.euractiv.com/energy/64-new-power-renewable-decade-news-497859, June 2012

Unit 3

CARBON DIOXIDE FOOTPRINT

1. WHAT IS A CARBON FOOTPRINT

A **CARBON FOOTPRINT** is a measurement of all greenhouse gases we individually produce and has units of tonnes (or kg) of carbon dioxide equivalent.

A carbon footprint is defined as:

The total amount of greenhouse gases produced to directly and indirectly support human activities, usually expressed in equivalent tons of carbon dioxide (CO2).

In other words: When you drive a car, the engine burns fuel which creates a certain amount of CO2, depending on its fuel consumption and the driving distance. (CO2 is the chemical symbol for carbon dioxide). When you heat your house with oil, gas or coal, then you also generate CO2. Even if you heat your house with electricity, the generation of the electrical power may also have emitted a certain amount of CO2. When you buy food and goods, the production of the food and goods also emitted some quantities of CO2.

Your carbon footprint is the sum of all emissions of CO2 (carbon dioxide), which were induced by your activities in a given time frame. Usually a carbon footprint is calculated for the time period of a year. The best way is to calculate the carbon dioxide emissions based on the fuel consumption. In the next step you can add the CO2 emission to your carbon footprint. Below is a table for the most common used fuels. Examples:

Fuel type	**Unit**	**CO_2 emitted per unit**
Petrol	1 litre	2.3 kg
Diesel	1 litre	2.7 kg
Oil (heating)	1 litre	3 kg

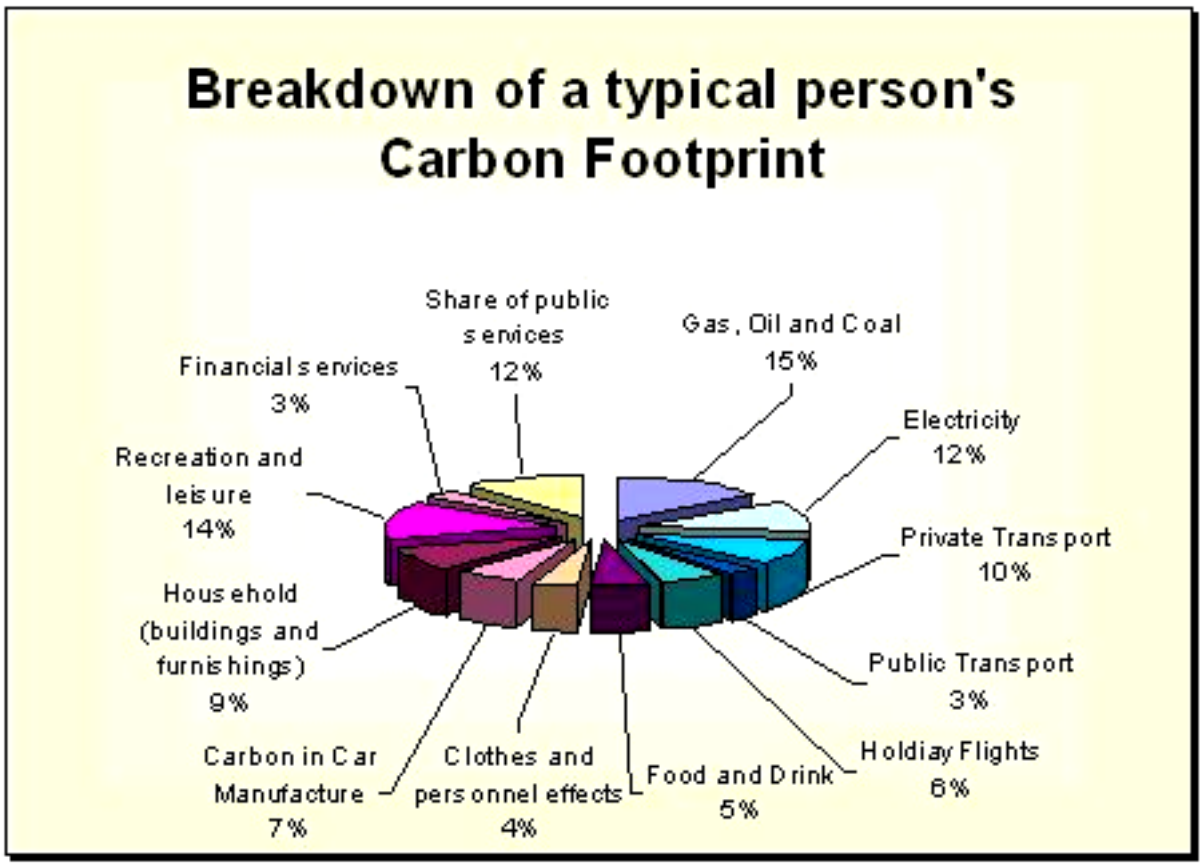
Each of the following activities add **1 kg of CO_2** to your personal carbon footprint:

- Travel by public transportation (train or bus) a distance of 10 to 12 km (6.5 to 7 miles)
- Drive with your car a distance of 6 km or 3.75 miles (assuming 7.3 litres petrol per 100 km or 39 mpg)
- Fly with a plane a distance of 2.2 km or 1.375 miles.
- Operate your computer for 32 hours (60 Watt consumption assumed)
- Production of 5 plastic bags
- Production of 2 plastic bottles
- Production of 1/3 of an American cheeseburger (yes, the production of each cheeseburger emits 3.1 kg of CO2!

The world-wide average is **4 tonnes** ofcarbon dioxide (CO2) per person per year. The average of all industrialised nations is about **11 tonnes** of carbon dioxide (CO2) per person per year. In the medium and long term, the carbon footprint must be reduced to **less than 2 tonnes** of **CO2** per year and per person. This is the maximum allowance for a sustainable living.

Adapted from:

FuturEnergia: http://www.futurenergia.org/ww/en/pub/futurenergia2007/about.htm, June 2012
Greencitizens: http://www.greencitizens.net/ecopedia/article.php?ec_id=35519712008, June 2012

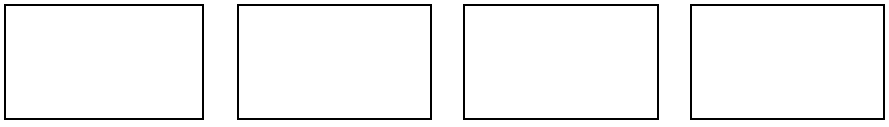


Source: *Encyclopedia of Earth, June 2012*

Task 1 Have a look at the list of countries by carbon dioxide per capita and compare the footprints of the following countries.

List of countries by carbon dioxide emissions per capita:
Hyperlink: *http://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions_per_capita*

Carbon dioxide emissions (CO_2), metric tons ofCO_2 per capita - in 2008:



2. WHAT IS CARBON DIOXIDE AND WHAT IS GLOBAL WARMING?

CARBON DIOXIDE, CO_2, is a colourless, odourless gas that is present in the atmosphere and is formed when any fuel containing carbon is burned. It is breathed out of an animal's lungs during respiration, is produced by the decay of organic matter, and is used by plants in photosynthesis.

GLOBAL WARMING is the current temperature rise in Earth's atmosphere and oceans. The evidence for this temperature rise is unequivocal and, with greater than 90% certainty, scientists have determined that most of it is caused by human activities that increase concentrations of greenhouse gases in the atmosphere, such as deforestation and burning of fossil fuels.

Task 2A Watch the video about a carbon footprint campaign and answer the following question.

Are OUR carbon footprints as easily visible as those in the video? Explain the reasons.

Video CarbonFootprintCampaign :http://www.youtube.com/watch?v=8Wf_ZVOf83E,1:02, June 2012

_____

_____

_____

Task 2B Watch the video about global warming and complete the story.

Video: None Like it Hot:
http://www.youtube.com/watch?v=2taViFH_6_Y&feature=results_video&playnext=1&list=PL0C97104524AB0CC8 , 1:42, June 2012

GLOBAL WARMING OR: NONE LIKE IT HOT!

This video talks about the problem of global warming, and shows how politicians solved the problem by _____.

The little girl's ice cream went away because of _____. We meet mister _____ who comes all the way from the sun to brighten our days. On his way back _____ stop him. Pretty soon Earth is chalkfull of Sun Beams, their rotting corpses _____ our atmosphere.

It is a fine example of treating symptoms while _____ the problem.

Task 2C **Check the SŠTŠ Šiška homepage and find out the amount of its reduction of CO2 since the instalment of the solar power plant.**

SECONDARY SCHOOL OF TECHNICAL PROFESSIONS ŠIŠKA

There is a solar power plant on the roof of SŠTS Šiška. Find out how much has it reduced its production of CO2 so far.
The school website address: http://ssts.si/

The reduced production of CO2 till this moment is _____ tonnes of CO2.

Task 2D **According to what you have learnt about carbon footprint so far answer the following questions.**

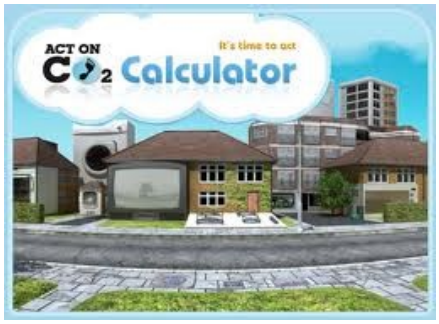
		T	F
1	My contribution to the environmental pollution is too small to be worth mentioning.		
2	I wash my feet with a good soap. There are absolutely no ecological footprints left.		
3	The production of food and goods also emits some quantities of CO2.		
4	One litre of petrol emits one kilogram of CO2.		
5	Operating my computer for 32 hours emits less than one kilogram of CO2.		
6	Production of five plastic bags adds 10 decagrams of CO2 to my personal carbon footprint.		
7	The world-wide average is 1 ton of carbon dioxide (CO2) per person per year.		
8	The average of all industrialised nations is about 11 tons of carbon dioxide (CO2) per person per year.		
9	According to Wikipedia Slovenia produced 8.5 tons of CO2 per person in 2010.		
10	According to Wikipedia Mauritius produced 15 tons of CO2 per person in 2010.		

3. CALCULATE YOUR CARBON FOOTPRINT

Task 3A **Ready to act? Use the CO_2 calculator to find out your carbon footprint.**

Calculator:
http://carboncalculator.direct.gov.uk/launch_fullscreen.aspx?url=http://carboncalculator.direct.gov.uk/index.html

Start the CO2 calculator



My yearly carbon footprint is

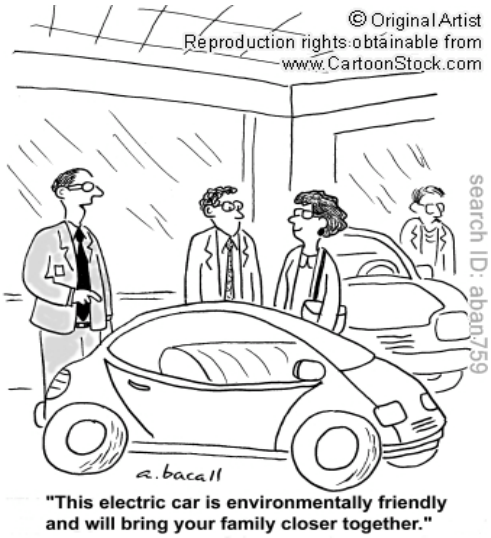
_____

tonnes of CO_2

Task 3B **While calculating your carbon footprint online, you came across the following words. Match them with the correct definitions.**

1. household	a) an open space under a roof; an attic or garret.
2. maisonette	b) a current of air
3. detached house	c) a window with two panes of glass and a space between them
4. insulation	d) the state of being lighted; illumination
5. loft	e) a house that stands alone
6. draught	f) warming
7. double glazing	g) a small house
8. lighting	h) the act of protecting something by surrounding it with material that reduces or prevents the transmission of sound or heat or electricity
9. heating	i) a house that is one of a row of identical houses situated side by side and sharing common walls
10. terraced house	j) the people living together in one house collectively

1	2	3	4	5	6	7	8	9	10



4. CARBON FOOTPRINT REDUCTION

Task 4 Read the list of simple things you can do immediately and express your thoughts by completing the sentences below.

- Turn it off when not in use (lights, television, DVD player, Hi Fi, computer etc. etc. ...)
  Click here to find out which electrical items in your household contribute the most to your Carbon Footprint
- Turn down the central heating slightly (try just 1 to 2 degrees C). Just 1 degree will help reduce your heating bill by about 8%.
- Turn down the water heating setting (just 2 degrees will make a significant saving)
- Check the central heating timer setting - remember there is no point heating the house after you have left for work
- Fill your dish washer and washing machine with a full load - this will save you water, electricity, and washing powder
- Do your weekly shopping in a single trip

The following is a list of items that may take an initial investment, but should pay for themselves over the course of 1-4 years through savings on your energy bills.

- Fit energy saving light bulbs
- Install thermostatic valves on your radiators
- Insulate your hot water tank, your loft and your walls
- By installing 180mm thick loft insulation
- Recycle your grey water
- Replace your old fridge / freezer (if it is over 15 years old), with a new one with energy efficiency rating of "A"
- Replace your old boiler with a new energy efficient condensing boiler

Travel less and travel more carbon footprint friendly.

- Car share to work, or for the kids school run
- Use the bus or a train rather than your car
- For short journeys either walk or cycle
- Try to reduce the number of flights you take
- See if your employer will allow you to work from home one day a week
- Next time you replace your car - check out diesel engines.
- When staying in a hotel - turn the lights and air-conditioning off when you leave your hotel room, and ask for your room towels to be washed every other day, rather than every day

As well as your primary carbon footprint, there is also a secondary footprint that you cause through your buying habits.

- Don't buy bottled water if your tap water is safe to drink
- Buy local, organic fruit and vegetables, or even try growing your own
- Reduce your consumption of meat
- Don't buy over packaged products
- Recycle as much as possible
- Think carefully about the type of activities you do in your spare time. Do any of these cause an increase in carbon emissions? E.g., saunas, health clubs, go-karting etc. etc...

Adapted from: http://www.carbonfootprint.com/minimisecfp.html

The steps I am ready to take immediately to reduce my carbon footprint:	
1.	
2.	
3.	
4.	
5.	

I think the most difficult thing to be carried out would be:

The arguments for my decision are:

My own ideas for the reduction of carbon dioxide emissions:

5. WHAT IS THE KYOTO PROTOCOL

United Nations
Framework Convention on
Climate Change

The Kyoto Protocol is an international treaty outlining and regulating the efforts of its 37 member countries to reduce their greenhouse gas (GHG) emissions by 2012. Slovenia is among the 37 Annex I countries. Annex I countries agreed to reduce their collective greenhouse gas emissions by 5.2% from the 1990 level.

191 states have signed and ratified the protocol.The only remaining signatory not to have ratified the protocol is the United States. The protocol is legally binding and was entered into force on 16 February 2005.

Source: Wikipedia

Signing is optional, indicating an intention to ratify the Protocol.
Ratification means that a party agreed to cap emissions in accordance with the Protocol.

List of Kyoto Protocol signatories:
http://en.wikipedia.org/wiki/List_of_Kyoto_Protocol_signatories#cite_note-increase-5

Task 5A **Find out the CO_2 reduction commitment for the following countries for 2012:**

Slovenia		
United Kingdom		
Mauritius		
Croatia		
USA		

Task 5B **Is the Kyoto protocol going to change the world for the better? Express your opinion and add two arguments to support it.**

In my opinion…

_____

_____

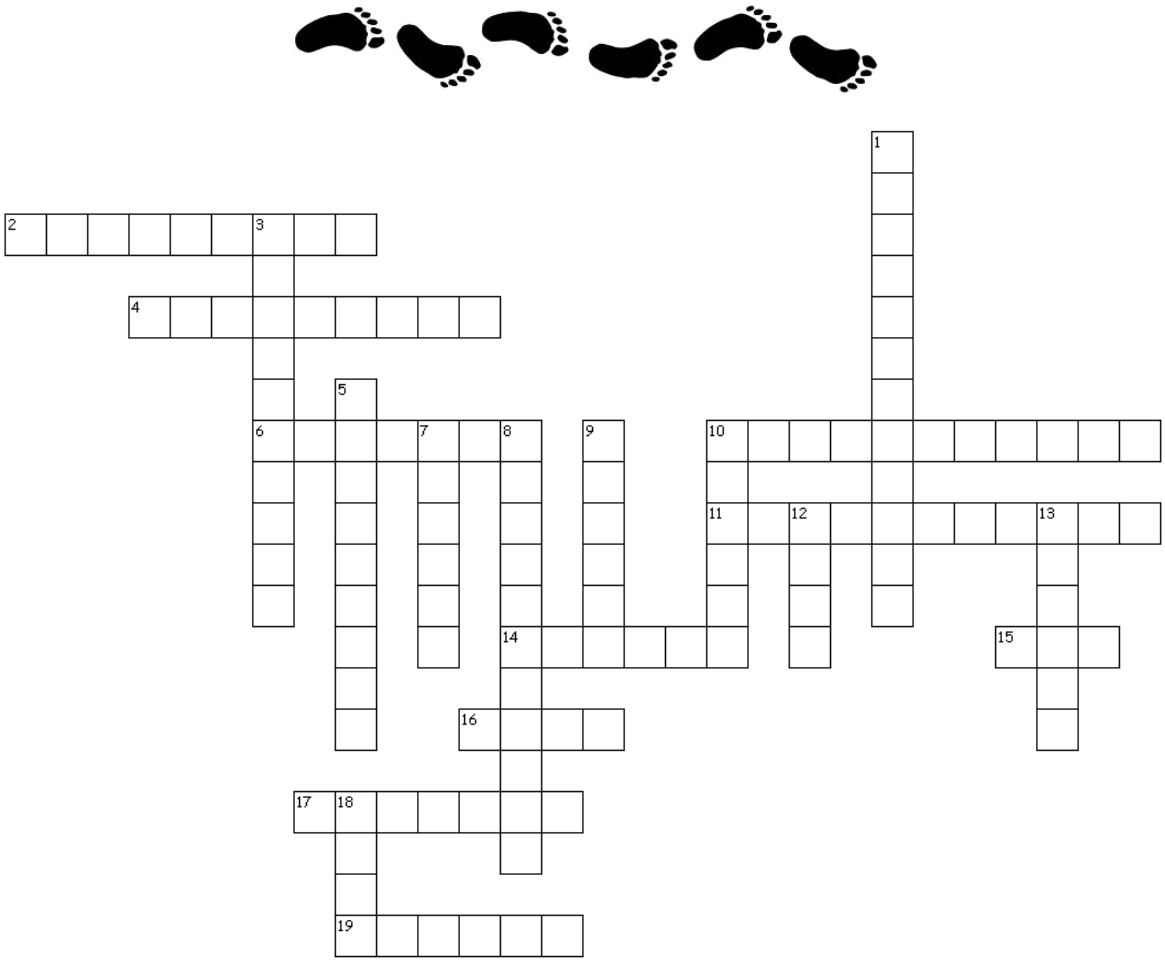
_____

_____

_____

6. CROSSWORD

Task 6 **Complete the crossword by translating the clues in English.**



Across

2. onesnaženje
4. gospodinjstvo
6. povprečje
10. poraba
11. dihanje
14. kisik
15. vsota
16. oddajati
17. zasteklitev
19. spopadati se, soočiti se

Down

1. prispevek
3. izolacija
5. obnovljiv
7. količina
8. okolje
9. pogodba, sporazum
10. ogljik
12. zamenjati
13. povzročiti
18. podstrešje

Created by Puzzlemaker at DiscoveryEducation.com

Unit 4

SOLAR POWER

Didactical solar generators on the roof of SŠTS, Šiška

1. LEARN A FEW FACTS ABOUT SOLAR ENERGY

Task 1A Read the text and learn a few facts about solar energy.

1. Solar Energy **is measured** in kilowatt-hour. 1 kilowatt = 1000 watts.

2. 1 kilowatt-hour (kWh) = the amount of electricity required to burn a 100 watt light bulb for 10 hours.

3. According to the US Department of Energy, an average American household used approximately 866-kilowatt hours per month in 1999 costing them $70.68.

4. About 30% of our total energy consumption **is used** to heat water.

5. A home solar system **is** typically **made up of** solar panels, an inverter, a battery, a charge controller, wiring and support structure.

6. Sunlight travels to the earth in approximately 8 minutes from 93,000,000 miles away, at 186,282 miles per second.

7. Da Vinci predicted a solar industrialization as far back as 1447.

8. In one hour more sunlight falls on the earth than what is used by the entire population in one year.

9. A world record was set in 1990 when a solar powered aircraft flew 4060km across the USA, using no fuel.

10. About 2 billion people in the world are currently without electricity.

11. Accounting for only 5 percent of the world's population, Americans consume 26 percent of the world's energy.

12. Electric ovens consume the most amount of electricity, followed by microwaves and central air conditioning.

13. Shell Oil predicts that 50% of the world's energy will come from renewable sources by 2040.

Adapted from:
http://www.facts-about-solar-energy.com/facts-about-solar-energy.html, June 2012

Task 1B Watch the video and write down facts that you have found most fascinating.

Video (June 2012):
http://www.metacafe.com/watch/3434094/solar_power_amazing_facts_they_dont_want_you_to_know/

_____

_____

_____

_____

2. SOLAR PV MODULES

Task 2A **Watch the video SOLAR POWER MODULES and supply the text with information.**

Video (6 minutes): http://www.ourplanet.org.uk/pv-modules-video.asp, June 2012

There are two types of solar _____ :

- _____for making hot water and
- _____, PV, also known as solar panels or modules for making electricity.

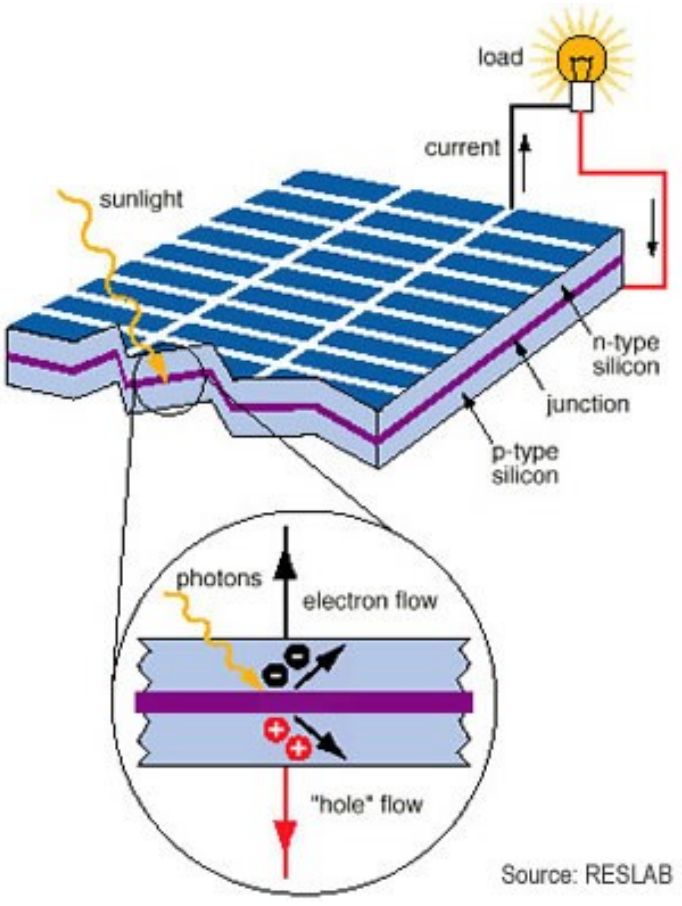
Photovoltaic cells are joined together in _____. They are connected with small _____. Sunlight is being _____into electricity by using PV cell. The electricity is travelling down the wires to power the motor. The motor turns the wheel. The panels need to be facing _____.

A PV module needs light to work. _____ shows how well it's working. When there is no sunlight at all, the voltmeter would read zero. PV modules are often _____ on roofs to avoid shading. It's plenty of space there and they aren't _____ by trees.

Task 2B **Write an abstract about solar modules.**

There are two types of solar panels: _____ _____ that produce _____ _____, and _____ (PV) that produce _____.

PV panels are known as PV _____ and they are made up of many PV _____.
PV modules _____ sunlight into _____.
PV modules work _____ in direct sunlight, when there is no _____.



Task 2C Watch the video HOW PV MODULES ARE MADE and fill in the gaps.

Video (5:45): http://www.ourplanet.org.uk/how-pv-modules-made.asp , June 2012

A PV module is _____ cells.

Electricity _____from the PV module _____ _____ into the building.

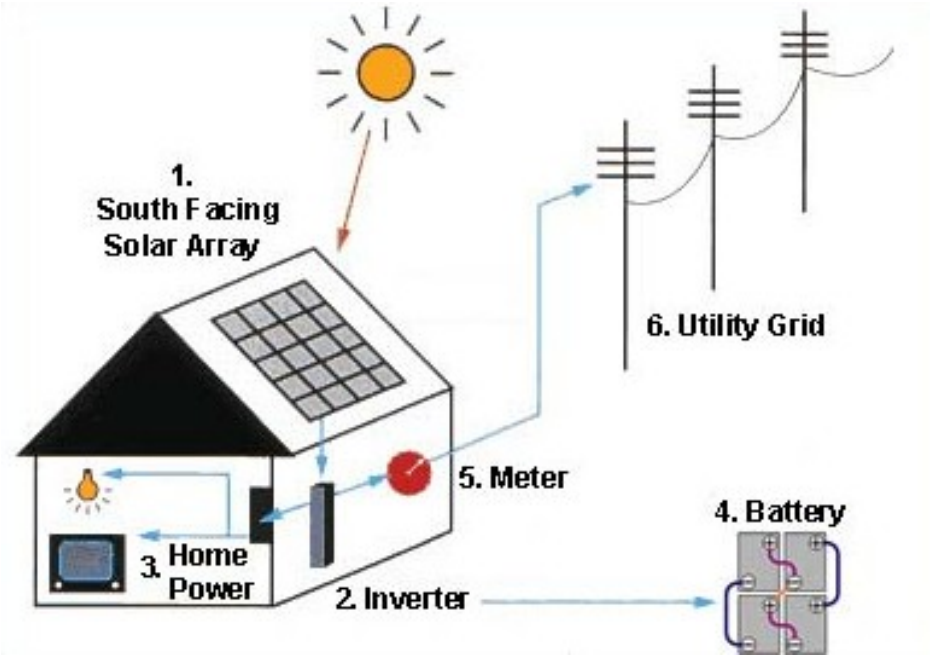
The electricity generated by PV module has to be _____ by an_____

into the form we normally use.

The _____ shows you how much energy is being _____.

Task 2D Watch the video HOW A PV ARRAY WORKS and fill in the gaps.

Video: http://www.ourplanet.org.uk/how-pv-array-works.asp, June 2012



Each cell is made up of billions and billions of _____ _____. When sunlight hits the silicon, the _____ are not too _____ and go to one side of the cell ready to be used as electricity. When the PV module is connected to the _____, the _____ stop flowing from the plus side. This _____ energy or electricity into the grid.

3. SOLAR THERMAL ENERGY

Task 3A Read the text and study the schemes.

Solar thermal energy (STE) is a technology for harnessing solar energy for thermal energy (heat). Solar thermal collectors are classified as low-, medium-, or high-temperature collectors.

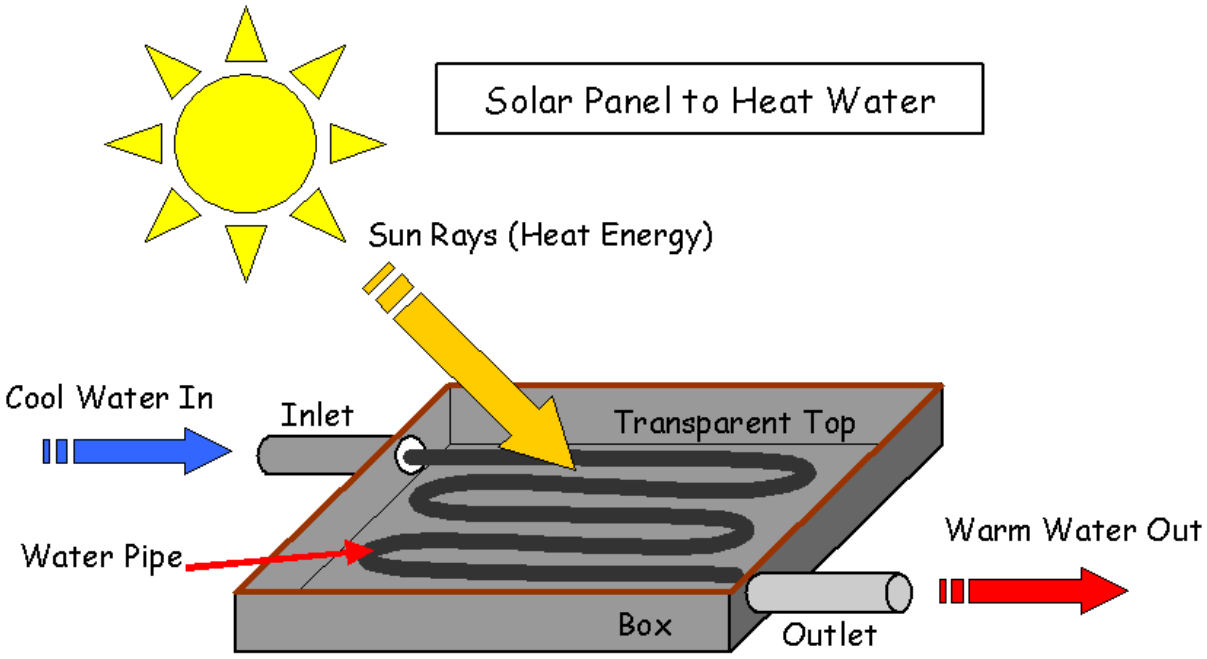
- **Low temperature collectors** are flat plates generally used to heat swimming pools.
- **Medium-temperature collectors** are also usually flat plates but are used for heating water or air for residential and commercial use.
- **High temperature collectors** concentrate sunlight using mirrors or lenses and are generally used for electric power production.

STE is different from photovoltaics, which converts solar energy directly into electricity.

How do solar panels work:

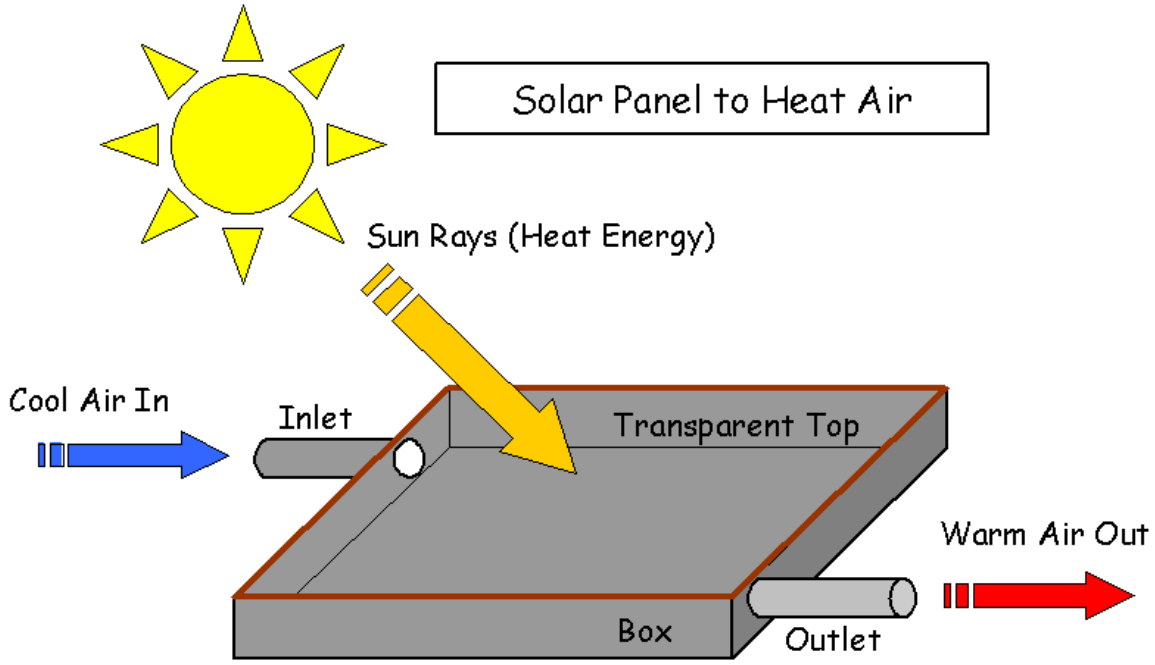
Solar panel to heat water

A simple example of a solar panel is a closed box with a top made of a transparent material such as glass or plastic. The sun shines through the glass and heats up the inside of the box. The inside of the box is often painted black so that it absorbs more heat which is later used to heat air or water.



Solar panel to heat air

A system that uses solar thermal energy to heat air is not complex. A transparent top is attached to a box. The box has an inlet pipe for cool air. The cool air can be pushed into the box using a fan. The cool air moves through the inlet pipe into the box.



Inside the box the air is warmed by the heat energy from the sun rays. As more cool air is pushed into the box the warm air is forced out the other end of the box through the outlet pipe. The warm air can now be used to heat something like your home. Some very large systems use a solar panel on the roof of a house to heat a whole room. The warm air in that room is then blown through vents to heat the whole house.

Adapted from *:http://en.wikipedia.org/wiki/Solar_thermal_energy; http://www.makeitsolar.com/images/Solar_Panel_03C.GIF*

Task 3B **Now have a look at the "solar panel to heat water" scheme and in your own words describe how it functions.**

_____

_____

_____

_____

_____

_____

Task 3C **Watch the video and decide whether you would harness solar thermal energy if you had your own house. Express your opinion using phrases right below.**

Video: http://www.youtube.com/watch?v=w9Oy3VOPEgs, 7,32 min, June 2012

Imagine you were building a new house. Would you harness solar thermal energy?

Expressing Opinions

- I (personally) think/believe/feel…
- Personally, I believe/think/feel…
- In my (personal) opinion/view…
- I imagine/suppose/reckon…
- Do know what I think? I think…
- The way I look at it/see it…
- It appears/seems to me…
- If you ask me…
- I'd say that…
- As far as I can tell…
- To the best of my knowledge…
- I'm pretty/quite sure that…
- I'm fairly certain that…
- It's quite obvious that...

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4. SOLAR POWER PLANT ON THE ROOF OF SECONDARY SCHOOL OF TECHNICAL PROFESSIONS ŠIŠKA

Task 4A **Watch the ppt SOLAR POWER PLANT IS BORN made by Luka Cimerman, student of SŠTS Šiška.**

http://www.google.si/search?hl=en&biw=768&bih=454&output=search&sclient=psy-ab&q=luka+cimerman+power+plant+was+born&btnK= , February, 2013

Task 4B Read the text and learn about the solar power plant on the roof of SŠTS Šiška.

Building a solar power plant in 2007 brought us three big advantages:

- By doing so we did our bit for the environment by producing green electricity
- We started raising awareness about renewable energy amongst pupils and the local community
- We use it as a teaching resource

Main generator, 22 kW_p
Photo: Zdravko Žalar

Students learn to install PV modules

Inverters

This solar power plant is a result of the economic partnership of our school with the public utility service – Elektro Ljubljana. Our school offered them the roof and they installed a solar power plant in exchange. The electricity that is produced belongs to the company Elektro Ljubljana. They also maintain the power plant. There are **5 different generators** on the roof top.

1. The first is **THE BIGGEST**; it covers the roof. It is not oriented **directly towards the south**, but is the **closest to it**. It would not be cost efficient to adapt the angle of the roof inclination, as the effect would not be worth it. If the inclination angle of the roof was changed by 45 %, the effect would be only 15 percent better. This would not be economical.

2. The second generator is called the **OPTIMAL** one. It is oriented directly towards the south.

3. The third generator is **HORIZONTAL**. This one has proved to be very efficient, even more than the 2- axis tracking system, especially when the weather is misty or foggy. The diffused light falls on it like rain drops.

4. The fourth generator is a **2-AXIS SOLAR TRACKING SYSTEM**, navigated by a satellite, with a built-in computer (GPS) and it keeps following the sun. It "corrects" its position every minute.

Monitoring and engineering diagnostics of the plant
Photo: Zdravko Žalar

5. The fifth is a **TUBULAR GENERATOR**. Its advantage is that photovoltaic rods are able to catch rays from any direction, so they don't need to be tilted to point at the sun.

Task 4C **Visit the monitoring workshop, where the operation and the results of each generator are monitored, have a look at all displays and fill in the chart below.**

Date and time of the observation:	**The amount of electricity produced during the observation:**	**The amount of electricity produced since the plant was opened:**	**The amount of CO_2 that has <u>not</u> been produced since the plant was opened:**
1. Roof generator			
2. Optimal generator			
3. Horizontal generator			
4. 2-axis solar tracking generator			
5. Tubular generator			

Task 4D **Which of the generators would you install on the roof of your home? Justify your decision with two arguments in about 70 words.**

I decided to install _____

_____

_____

_____

_____

_____

_____

_____

_____

5. THE ADVANTAGES AND DISADVANTAGES OF SOLAR POWER FOR EVERY PLUS THERE IS A MINUS…

Task 5A **Discuss the pros and cons of solar energy in class. Then read the text.**

Pros of Solar Energy:

Availability: The main feature of solar energy is that it is available in abundance and throughout the day time.

Cost: It is totally free and no one is going to charge you for using solar energy…

Pollution and Remains: When solar energy is tamed, there is actually no combustion happening, thus no pollution.

Price: Depending upon the market, oil prices may vary. But solar power generation and utility does not depend on market variations.

Machinery and Maintenance: There is no machinery involved in the generation of electricity and power. Thus there are fewer maintenance problems and breakdowns. No spare parts cost as in case of generators…

Renewable: Unlike fossil fuels it is totally renewable for all practical purposes.

Lesser running cost and **zero health hazards.**

Government Grants: Local Governments and NGO's are granting funds for those who use and implement new solar powered domestic appliances for the daily requirements.

Cons of Solar Energy:

The initial installation cost

If you want to make use of the solar power during **night time**, then you have to use a separate storage device to store the solar energy.

Also if the climate is **cloudy or rainy** or during winter season, then one cannot produce power from solar energy.

The installation on the roofs of your house may not be suitable with **the angle of incidence** of the sun light, thus making it less suitable for power generation.

The power generated **may not be sufficient** enough to support your entire domestic needs. Also this form of energy is not suitable for industries as the power demand is too high.

Technically, **D.C power is produced** by the solar cells. For using it, this has to be converted into A.C before using it.

Task 5B **Write in about 120 words why you would recommend your best friend to use solar energy? He is hard to be convinced.**

_____

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Task 5C **Match the highlighted words from the text with the meanings below.**

renewable ● climate ● remains ● AC ● grant ● sufficient
hazard ● feature ● vary ● DC ● maintenance ● initial

1. a characteristic _____
2. that can be renewed _____
3. a possible source of danger _____
4. all that is left after other parts have been used up _____
5. to change _____
6. weather _____
7. direct current _____
8. alternating current _____
9. the work of keeping something in proper condition; upkeep. _____
10. a sum of money provided by a government _____
11. first _____
12. enough _____

6. GLOSSARY

Task 6 **Translate the words into Slovene or English**.

INVERTER			sončni kolektor
BATTERY			prozoren
SOLAR INSOLATION			absorbirati, vsrkati
WIRING			greti
SUNLIGHT			izkoristiti
RESISTANCE			celica
PV MODULE			kabel
PV ARRAY			prikazovalnik
SILICON			mreža
VOLTMETER			povezan v mrežo
GRID			elektron
STAND-ALONE SYSTEM			sprostiti
DIRECT CURRENT			ploščica, opeka
ALTERNATING CURRENT			polprevodnik
PEAK LOAD			začetni strošek
INSTALLATION COST			sončna celica
THE ANGLE OF INCIDENCE			razsmernik
MAINTENANCE			pretvornik
SUFFICIENT			neposredna osvetlitev
POWER DEMAND			električni krog
RUNNING COST			el. tok
HEALTH HAZARD			ozemljitvena zanka
GOVERNMENT GRANT			priključitvena omarica
WATER PIPE			omrežje
CONDUCTOR			dvo-osno sledenje soncu

SERRIAL CONNECTION			usmernik
GENERATOR			krmilnik
MULTICRISTALLINE			točka najvišje moči

7. CHECK YOUR KNOWLEDGE

Task 7 Fill in the gaps using words from the list.

capture ● cells ● convert ● direct ● generate ● roof ● semiconducting ● silicon ● field tiles ● transparent ● generates ● faces ● overshadowed ● strong ● light ● below

Solar electricity systems _____ the sun' s energy using photovoltaic _____.

The cells _____ the sunlight into electricity.

PV cells don' t need _____ sunlight to work – you can still _____ some electricity on a cloudy day.

PV cells are panels which you can attach to your _____ or walls. Each cell is made from one or two layers of _____ material, usually _____. When light shines on the cell it creates an electric _____ .

Grey “solar tiles” look like roof _____. You can use _____ cells on conservatories.

The strength of a PV cell is measured in kilowatt peak (kWp) – that' s the amount of energy the cell _____ in full sunlight.

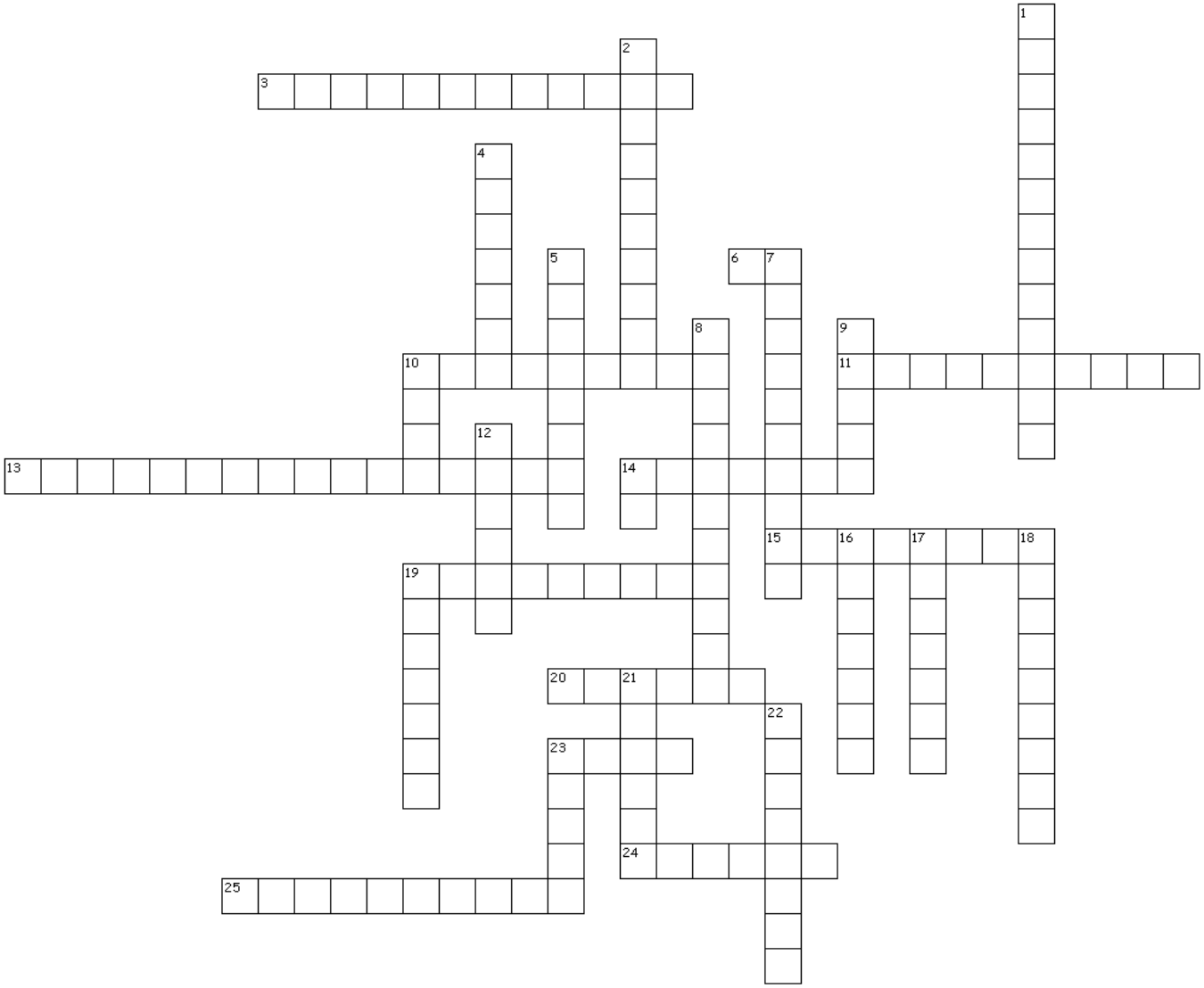
Is solar energy suitable for your home?

- You' ll need a roof or wall that _____ within 90 degrees of south.
- It can' t be _____by trees.
- The roof should be _____ enough. Solar panels are not _____.
- In England and Scotland the planning permission is not needed , as long as the home solar electricity systems are _____ a certain size.

8. SOLAR POWER CROSSWORD

Task 8 **Translate the clues in English.**

SOLAR POWER



©http://puzzlemaker.discoveryeducation.com/code/BuildCrissCross.asp

Across

3. PV **6.** izmeničen tok **10.** kolektor
11. upornost **13.** polikristalen **14.** prikazovalnik
15. izpostavljenost **19.** prevodnik
20. vsrkati **23.** omrežje **24.** nevarnost
25. zadosten

Down

1. polprevodnik **2.** izklopiti **4.** začetni
5. razsmernik **7.** krmilnik **8.** pretvornik
9. mreža-panelov **10.** celica **12.** ožičenje
14. enosmerni-tok **16.** fotonapetostni panel
17. silicij **18.** elektroni **19.** tok **21.** stikalo
22. ustvariti **23.** subvencija

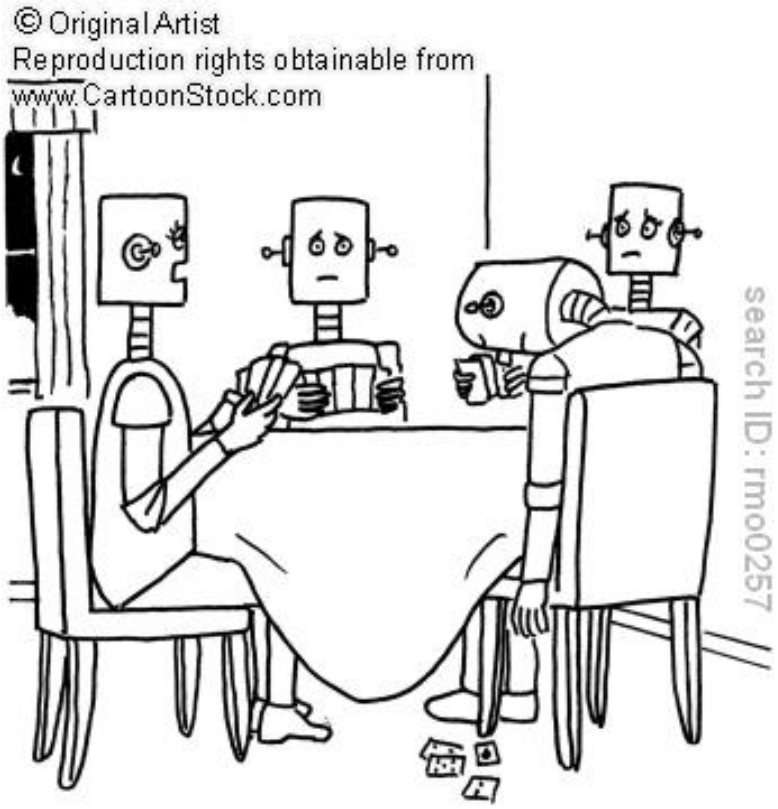
9. EXTRA VIDEOS

If you would like to learn more, there are a few interesting videos to see.

1. **PS 10 Solar thermal power station**
http://www.solarthermalpower.it, 3,40 min
http://www.youtube.com/watch?v=0OkqJw1oTMk&feature=related

2. **Solar Islands (TM)**
http://www.youtube.com/watch?v=D1XyR3YOVZQ&NR=1 2,46 min

3. **How It's Made - Solar Panels, 4,37 min**
http://www.youtube.com/watch?v=qYeynLy6pj8



"He is not much fun in the evenings – he' s solar powered."

Appendix

Education and Culture
Lifelong learning programme
LEONARDO DA VINCI

Photos taken by teachers of SŠTS Šiška during their educational visit to The Plataforma Solar de Almeria (PSA), which is the largest European centre for research, development and testing of concentrating solar technologies (more info: http://www.psa.es/webeng/index.php) and other places in Spain.

The visit was funded by the European project Leonardo de Vinci in 2008.

Education and Culture
Lifelong learning programme
LEONARDO DA VINCI

This is a Solar Tower Power Plant CESA-1, with 300 heliostats with 40 m² each, 7 MWth, 83 m height.

NOTE: A power tower is a large tower surrounded by tracking mirrors called heliostats. These mirrors align themselves and focus sunlight on the receiver at the top of tower. Collected heat is then transferred to a power station below.

Education and Culture
Lifelong learning programme
LEONARDO DA VINCI

If you use mirrors and stream the sunlight (above), the final result can be a hole in an iron plate (below).

Education and Culture
Lifelong learning programme
LEONARDO DA VINCI

Flat plate thermal system for water heating deployed in front of the University of Malaga, Spain

The heated water is used in the university swimming pool.

LDV mobility project, February 2013. Students and their mentor teacher visited Seville and took this photo of the PS10 Solar Power Plant.

The **PS10 Solar Power Plant** is the world's first commercial concentrating solar power tower operating near Seville in Spain.
The 11 megawatt (MW) solar power tower produces electricity with 624 large movable mirrors called heliostats.
PS10 produces about 23,400 megawatt-hours per year.

Source: Wikipedia

Unit 5

WIND POWER

Wind is a form of solar power, created by the uneven heating of the Earth's surface.

Wind power plant on Srednja šola tehniških strok Šiška, photo: SŠTS

Guess the technical specifications of the wind generator on the roof of SŠTS.

Weight:
Rotor diameter:
Start up wind speed:
Kilowatt hours/month @ avg. wind speed:
Maximum wind speed:
Rated power:
… and the price:

1. DESCRIPTION OF A WIND FARM

Task 1 Watch the video about the California wind farm and answer the following questions. Guess the answers before watching the video.

Video: Crazy Windmills, *source: http://www.youtube.com/watch?v=Gu3EyzOYpGY&NR=1 , 1:56, June 2012*

San Gorgonio Pass wind farm
In the middle of nowhere in the Southern California desert there are thousands of windmills providing electricity to surrounding cities. The San Gorgonio Pass is one of the windiest places on earth. Cool coastal air is forced through the pass and mixes with the hot desert air, making the San Gorgonio Pass an ideal place for steady, wind-generated electricity.

1. How far from Los Angeles is the wind farm and how many wind turbines does it have?
2. Why and when was the wind farm built?
3. How many people get power from the farm?
4. How high are the towers and how much do the generators weigh?
5. What is the length of a blade? Is it possible that it is half the length of a football field?
6. How much energy does each mill produce an hour?
7. How much energy does a typical household consume per month?
8. What is the price of a wind mill?
9. Who were the wind mills engineered by?

2. ADVANTAGES AND DISADVANTAGES OF WIND POWER

Task 2A **Every medal has two sides and wind power has both, advantages and disadvantages. Read the following statements and add A for an advantage and D for a disadvantage at the end of each statement.**

1. The wind is free and with modern technology it can be captured efficiently. ____

2. Once the wind turbine is built the energy it produces does not cause greenhouse gases or other pollutants. ____

3. The strength of the wind is not constant and it varies from zero to storm force. This means that wind turbines do not produce the same amount of electricity all the time. There will be times when they produce no electricity at all. ____

4. Many people feel that the countryside should be left untouched, without these large structures being built. The landscape should be left in its natural form for everyone to enjoy. ____

5. Although wind turbines can be very tall each takes up only a small plot of land. This means that the land below can still be used. This is especially the case in agricultural areas as farming can still continue. ____

6. Wind turbines are noisy. Each one can generate the same level of noise as a family car travelling at 70 mph. ____

7. Many people find wind farms an interesting feature of the landscape. ____

8. Many people see large wind turbines as unsightly structures and not pleasant or interesting to look at. They disfigure the countryside and are generally ugly. ____

9. Remote areas that are not connected to the electricity power grid can use wind turbines to produce their own supply. ____

10. When wind turbines are being manufactured some pollution is produced. Therefore wind power does produce some pollution. ____

11. Wind turbines are available in a range of sizes which means a vast range of people and businesses can use them. Single households to small towns and villages can make good use of range of wind turbines available today. ____

12. Large wind farms are needed to provide entire communities with enough electricity. For example, the largest single turbine available today can only provide enough electricity for 475 homes, when running at full capacity. How many would be needed for a town of 100 000 people? ____

Adapted from: http://www.technologystudent.com/index.htm, June 2012

Task 2B **Express your thoughts on the advantages and disadvantages of wind power? Use the expressions below.**

In my opinion... ● The way I see it... ● If you want my honest opinion... ● According to…
I'm afraid I disagree. ● I don't think so. ● Not necessarily. ● I'd say the exact opposite.
What's your idea? ● What do you think? ● How do you feel about that?
Do you have anything to say about this? ● What do you think? ● Do you agree?

3. WIND TURBINES

Task 3A **Read the text about different types of wind turbines and answer the questions below.**

Wind turbines convert the kinetic energy from the wind into mechanical energy which is then used to drive a generator that converts this energy into electricity.

Three-blade turbine on the roof of Secondary School of Technical Professions Šiška

Typical components of a wind turbine: gearbox, rotor shaft and brake assembly

Horizontal and Vertical Axis Turbines

Wind turbines come in two types; horizontal axis and vertical axis. Horizontal axis turbines are the more familiar 'windmill' type where the blades rotate in a vertical plane about a horizontal axis and the turbine is dynamically rotated on its tower to face the wind.

Vertical axis turbines do not need orientation into the wind, although the earlier versions, sometimes known as 'eggbeater' turbines required a power source to start rotating because of their high torque. More recent innovations have helical blade designs that have low torque and can operate without external power. Vertical axis turbines are particularly suited to small wind power applications because they have a small environmental impact and no noise, but have not yet scaled up to the 5MW + turbine size of horizontal axis designs.

Commercial Onshore Wind Farm Projects

Modern large scale wind turbines have rotor diameters in excess of 100 metres, tower heights in excess of 300 feet (91.44 m)and are substantial structures weighing hundreds of tonnes. These projects require very large capital investments and lengthy periods of planning approval including local consultation and impact assessment on the environment, aviation, aesthetics and wildlife. Electricity generators have a financial incentive to invest in large-scale wind generation as the government has set a requirement that all UK power suppliers must source a rising proportion of their energy from renewable, currently 7.9% rising to 20% in 2020.

Adapted from: http://www.therenewableenergycentre.co.uk/wind-power/; http://www.helixwind.com/en/; http://www.ecogeek.org/wind-power/1112 , June, 2012

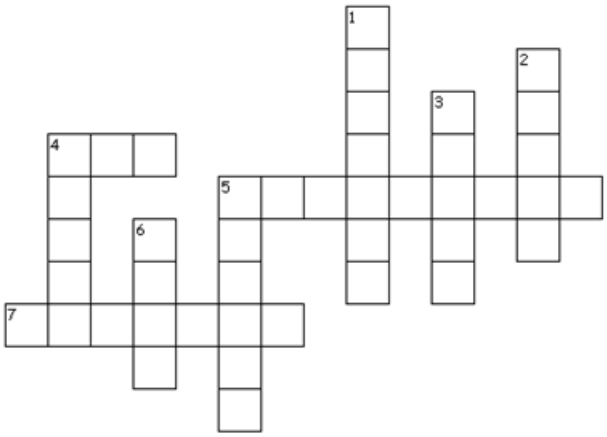
1. What exactly do wind turbines do?
2. How many types of wind turbines are there and which are they?
3. What are the more recent innovations to the wind turbines?
4. What are the positive and negative aspects of vertical axis turbines?
5. What are your thoughts on the modern large scale wind turbines?

Task 3B Watch the videos below and then explain in your own words how wind turbines work.

Wind Turbines:
http://www1.eere.energy.gov/multimedia/video_wind_turbines.html, 2:16 , June 2012

How wind turbines work:
http://www.ourplanet.org.uk/how-wind-turbines-work-video.asp, 5:16, June, 2012

Task 3C **Fill in the crossword. You will find the answers among the highlighted words in the text.**

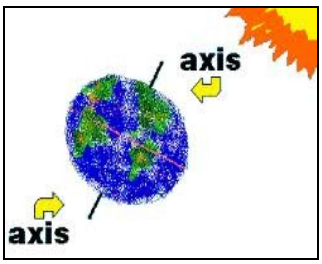


Across

4. large-scale **5.** stimulus **7.** having the shape of a spiral

Down

1. change **2.** push **3.** rotating part of an electrical or mechanical device **4.** flat surface that rotates and pushes against air **5.** have an effect upon **6.** the center around which something rotates



4. DO WIND TURBINES MAKE NOISE? ARE THEY UGLY? YOU BE THE JUDGE.

Task 4A **Watch the video "Do Wind Turbines Make Noise?" and then express your own opinion.**

Video: http://www.youtube.com/watch?v=JD0v9_zV2uk , 2:42, June 2012

The video compares the sounds and sights of wind turbines at Fenner Wind Farm in central New York and the sounds and sights we are surrounded by every day.

Task 4B Write abstracts.

1. Advantages and disadvantages of wind power.
Use the following key words: free, greenhouse gases, pollution, wind strength, manufacturing, landscape, noisy, ugly.

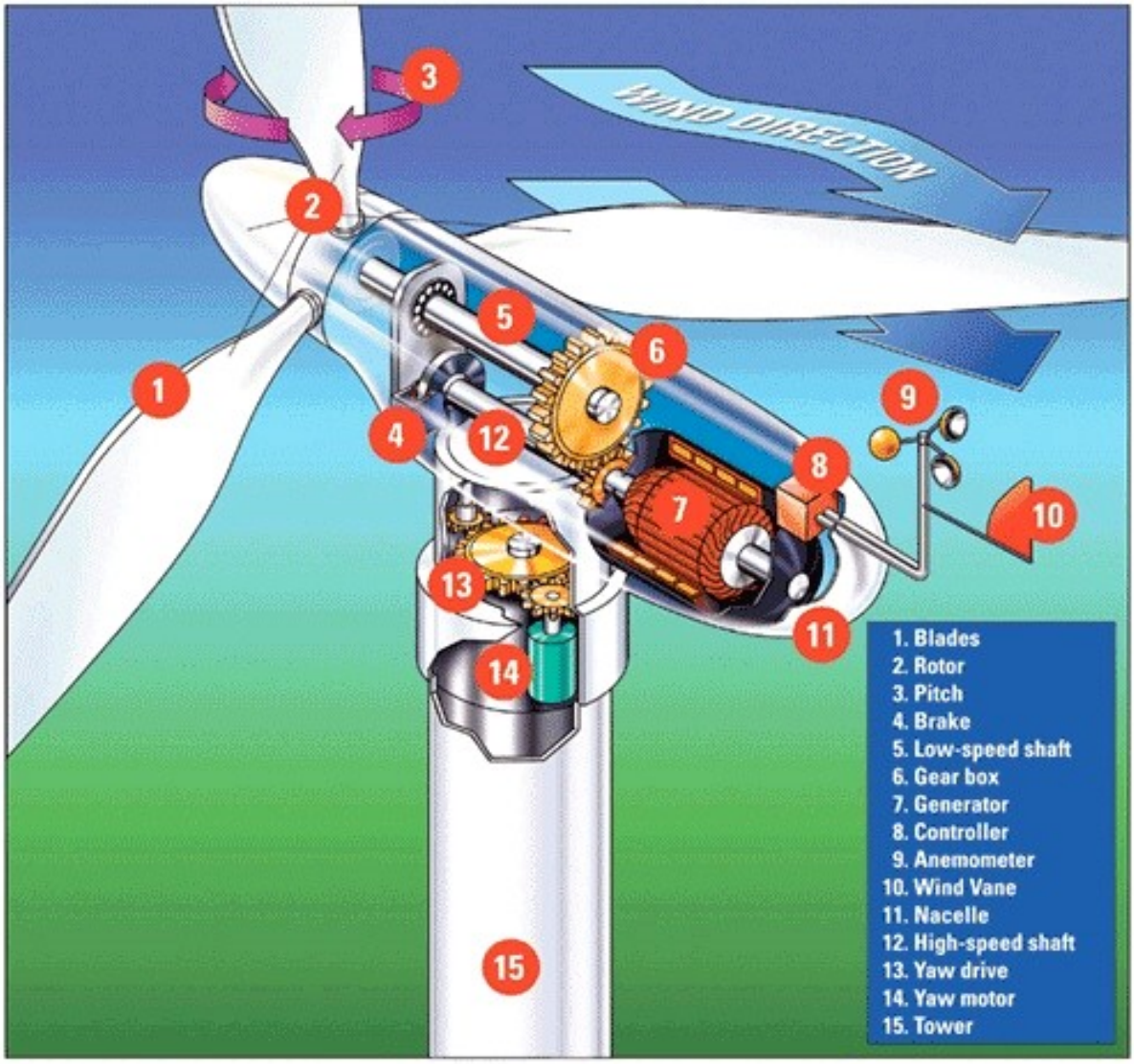
The main advantage of wind turbines is that the wind they capture is absolutely free.

2. Wind turbines
Use the following key words: horizontal, vertical, helical, axis, blade, rotor, rotate, torque, diameter.

There are two types of wind turbines, horizontal axis and vertical axis turbines.

5. COMPONENTS OF A WIND TURBINE

Task 5A **Study the wind turbine picture dictionnary.**



Source: http://jp190.k12.sd.us/Classes/Digit-al/Photos/Turbine%20Parts.jpg, June, 2012

Translations in Slovene

1. elise
2. rotor
3. nagib lopatic
4. zavora
5. gred za manjšo hitrost
6. menjalnik
7. generator
8. krmilnik
9. anemometer – merilec hitrosti vetra
10. repna lopatica
11. ohišje
12. gred za večjo hitrost
13. pogon za spreminjanje smeri
14. motor za spreminjanje smeri
15. stolp

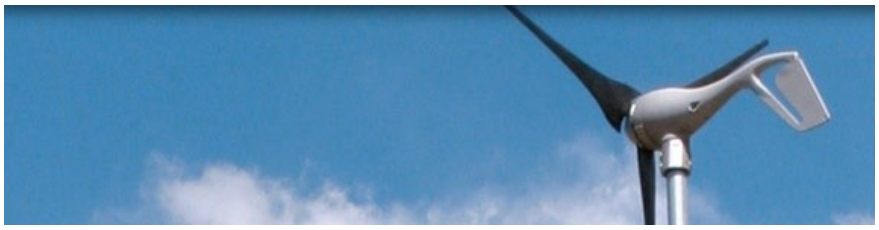
Task 5B Write in the names of the components according to their functions:

Component	Function
1. BLADE	Most turbines have either two or three blades. Wind blowing over the blades causes the blades to "lift" and rotate.
2.	In the science of motion, a yaw is a rotation around an axis. The yaw drive is used to keep the rotor facing into the wind as the wind direction changes.
3.	Blades are turned, or *pitched*, out of the wind to control the rotor speed and keep the rotor from turning in winds that are too high or too low to produce electricity.
4.	The generator converts the mechanical power from the rotating parts into electricity.
5.	The rotor turns the low-speed shaft at about 30 to 60 rotations per minute.
6.	A disc brake, which can be applied mechanically, electrically, or hydraulically to stop the rotor in emergencies.
7.	Gears connect the low-speed shaft to the high-speed shaft and increase the rotational speeds from about 30 to 60 rotations per minute (rpm) to about 1000 to 1800 rpm, the rotational speed required by most generators to produce electricity.
8.	Rotates at high speeds and drives the generator.
9.	The controller starts up the machine at wind speeds of about 8 to 16 miles per hour (mph) and shuts off the machine at about 55 mph. Turbines do not operate at wind speeds above about 55 mph because they might be damaged by the high winds.
10.	Measures the wind speed and transmits wind speed data to the controller.
11.	A wind turbine sits on a tower made from tubular steel, concrete, or steel lattice (patterns). Because wind speed increases with height, taller towers enable turbines to capture more energy and generate more electricity.
12.	Measures wind direction and communicates with the yaw drive to orient the turbine properly with respect to the wind.
13.	The nacelle is the cover housing that contains the gear box, low- and high-speed shafts, generator, controller, and brake.
14.	The yaw motor powers the yaw drive.
15.	A rotor is the rotating part of a mechanical or electrical device. The blades and the hub together are called the rotor.

6. WIND GENERATOR ON THE ROOF OF SŠTS ŠIŠKA

Task 6 **Read the original technical specifications of the wind generator that is set up on the roof of the Secondary School of Technical Professions Šiška.**

Technical specifications for AirX: http://ebookbrowse.com/air-x-spec-pdf-d295058866 , June, 2012



Please find out the basic data for a friend who has been considering the possibility to install the generator on the roof of his summer house. He is especially interested in the following information:

Teža vetrnega generatorja	
Premer nosilne cevi	
Premer glavnega rotorja	
Kakšna je zmogljivost generatorja? (nazivna moč)	
Koliko kilovatnih ur na mesec bo generator proizvedel pri hitrosti vetra okoli 5m/s?	
Nazivna napetost	
Katera je največja hitrost vetra, ki jo vetrna turbina še prenese?	
Kako je turbina zaščitena pred preveliko hitrostjo vetra?	
Iz česa so narejene vetrnice?	
Kakšen je krmilnik?	
Koliko časa velja garancija?	

APPENDIX

Education and Culture
Lifelong learning programme
LEONARDO DA VINCI

SŠTS Šiška teachers' study visit to Tarifa, a large wind farm in the south of Spain

Photos taken by teachers of SŠTS Šiška during the visit, which was funded by the European project Leonardo de Vinci in 2008.

Strong winds blow over the Strait of Gibraltar area, for this reason Tarifa is both a paradise for wind surf, kite surf and wind farm turbines generating electricity.

One of the first wind turbines ever built in Europe (Tarifa, Andalusia, south of Spain)
photo: SŠTS Šiška, LDV 2008

Education and Culture
Lifelong learning programme
LEONARDO DA VINCI

A visit to a wind power plant near Granada owned by the Spanish company Iberdrola. As you can see, a wind turbine is a very tall construction.

photo: SŠTS Šiška, LDV 2008

Education and Culture
Lifelong learning programme
LEONARDO DA VINCI

A wind and solar power plant in the middle of an almond field, controlled by transmission lines carrying electricity over Sierra Nevada, south of Spain.
photo: SŠTS Šiška, LDV 2008

A wind power plant near Granada, Spain
photo: SŠTS Šiška, LDV 2008

Unit 6

HYDROELECTRIC POWER

Ontario, Canada

Vuhred

Location: Slovenia
Operator: Dravske Elektrarne Maribor
Configuration: 3 X 20.4 MW Kaplan
In operation since: 1956-1958

1. How does a hydroelectric power plant work?
2. Generating methods
3. Inside the power plant
4. Advantages and disadvantages of hydro energy
5. Learn more

1. HOW DOES A HYDROELECTRIC POWER PLANT WORK?

Task 1A Watch the video about how a hydroelectric power plant works.

Video: http://www.youtube.com/watch?v=cEL7yc8R42k&feature=related, June 2012, 2:11

Task 1B Read the text. Supply the gaps with words in bold. There are a few too many.

The Amazing Power of Water

volume ● power ● alternating ● rapids ● bottlenecks ● force ● generator flow ● harness ● convert ● dam ● blade

When watching a river roll by, it's hard to imagine the _____it's carrying. If you have ever been white-water rafting, then you've felt a small part of the river's _____. White-water rapids are created as a river, carrying a large amount of water downhill, _____through a narrow passageway. As the river is forced through this opening, its _____ quickens. Floods are another example of how much force a tremendous _____of water can have.

Hydropower plants _____water's energy and use simple mechanics to _____that energy into electricity. **Hydropower plants** are actually based on a rather simple concept - water flowing through a _____ turns a turbine, which turns a _____.

Adapted from: http://en.wikipedia.org/wiki/Hydroelectricity, June 2012
http://science.howstuffworks.com/environmental/energy/hydropower-plant1.htm, June 2012

Task 1C Read the definition of "hydroelectric power" and copy-paste unfamiliar words.

Hydropower, **hydraulic power**, **hydrokinetic power** or **water power** is **power** that is derived from the **force** or **energy** of moving water, which may be harnessed for useful purposes. Prior to the development of **electric power**, hydropower was used for **irrigation**, and operation of various machines, such as **watermills**, **textile** machines, **sawmills**, dock **cranes**, and domestic **lifts.** Worldwide, 20% of the world's electricity is generated from water, and accounted for about 88% of electricity from renewable sources.

Adapted from http://en.wikipedia.org/wiki/Hydropower, June 2012

_____

_____

_____

_____

_____

Task 1D **Watch the video and compare the quantity of produced energy with the water level.**

Video: http://www.dem.si/eng/hydropowerplantsandgeneration/howiselectricpowergenerated, June 2012

2. GENERATING METHODS

Task 2 **Read and draw a scheme. Use links for help.**

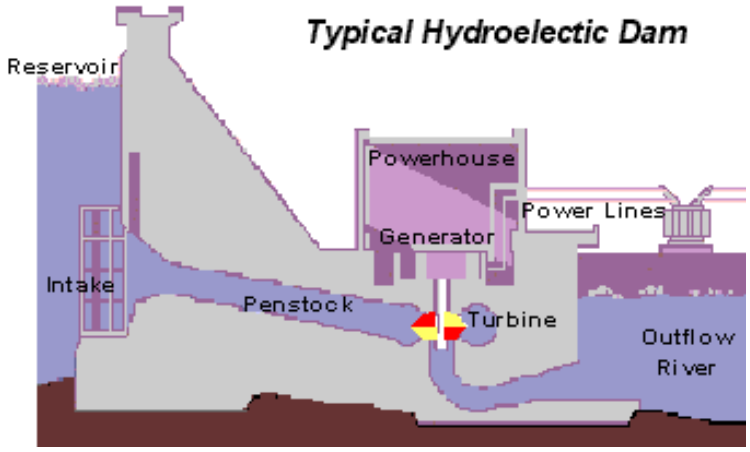
Generating Methods	How it works	Draw a simple scheme
CONVENTIONAL (DAMS) http://weepingsikkim.blogspot.com/2008/09/storage-based-hydel-projects-to-run-of.html	Most hydroelectric power comes from the potential energy of dammed water driving a water turbine and generator. The power extracted from the water depends on the volume and on the difference in height between the source and the water's outflow. A large pipe (the "penstock") delivers water to the turbine.	
PUMPED STORAGE http://www.tepco.co.jp/en/challenge/energy/hydro/power-g-e.html	This method produces electricity to supply high peak demands by moving water between reservoirs at different elevations.	
RUN-OF-THE-RIVER http://www.treehugger.com/files/2008/08/1000-megawatts-run-of-river-hydro-british-columbia.php	Hydroelectric stations are those with small or no reservoir capacity, so that the water coming from upstream must be used for generation at that moment, or must be allowed to bypass the dam.	
TIDE http://visual.merriam-webster.com/energy/hydroelectricity/tidal-power-plant/tidal-power-plant.php	A tidal power plant makes use of the daily rise and fall of ocean water due to tides.	
UNDERGROUND http://en.wikipedia.org/wiki/Churchill_Falls_Generating_Station	An underground power station makes use of a large natural height difference between two waterways, such as a waterfall or mountain lake. An underground tunnel is constructed to take water from the high reservoir to the generating hall.	

3. INSIDE THE POWER PLANT

Task 3A **Read the text and answer the questions.**

How Hydroelectric Power Works

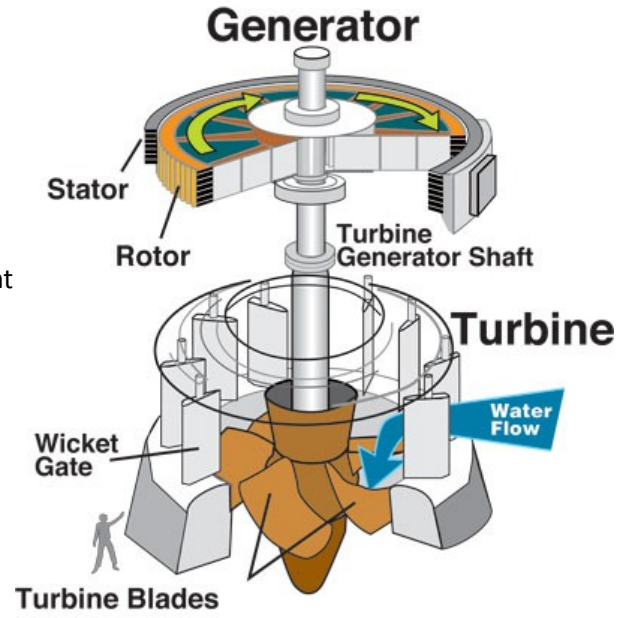
So just how do we get electricity from water? A power source is used to turn a propeller-like piece called a turbine, which then turns a **metal shaft** in an **electric generator**, which is the motor that produces electricity. A hydroelectric plant uses falling water to turn the turbine. Take a look at this diagram (courtesy of the Tennessee Valley Authority) of a hydroelectric power plant to see the details:



The theory is to build a dam on a large river that has a large drop in **elevation**. The dam stores lots of water behind it in the reservoir. Near the bottom of the dam wall there is the water intake. **Gravity** causes it to fall through the penstock inside the dam. At the end of the penstock there is a turbine propeller, which is turned by the moving water. The shaft from the turbine goes up into the generator, which produces the power. Power lines are connected to the generator that carries electricity to your home and mine. The water continues past the propeller through the tailrace into the river past the dam. By the way, it is not a good idea to be playing in the water right below a dam when water is released!

As to how this generator works, the Corps of Engineers explains it this way:

"A hydraulic turbine converts the energy of flowing water into mechanical energy. A hydroelectric generator converts this mechanical energy into electricity. The operation of a generator is based on the principles discovered by Faraday. He found that when a magnet is moved past a **conductor**, it causes electricity to flow. In a large generator, electromagnets are made by **circulating** direct current through loops of wire wound around stacks of magnetic steel laminations. These are called field poles, and are mounted on the perimeter of the rotor. The **rotor** is attached to the turbine shaft, and rotates at a fixed speed. When the rotor turns, it causes the **field poles (the electromagnets)** to move past the conductors mounted in the stator. This, in turn, causes electricity to flow and a voltage to develop at the generator output terminals."



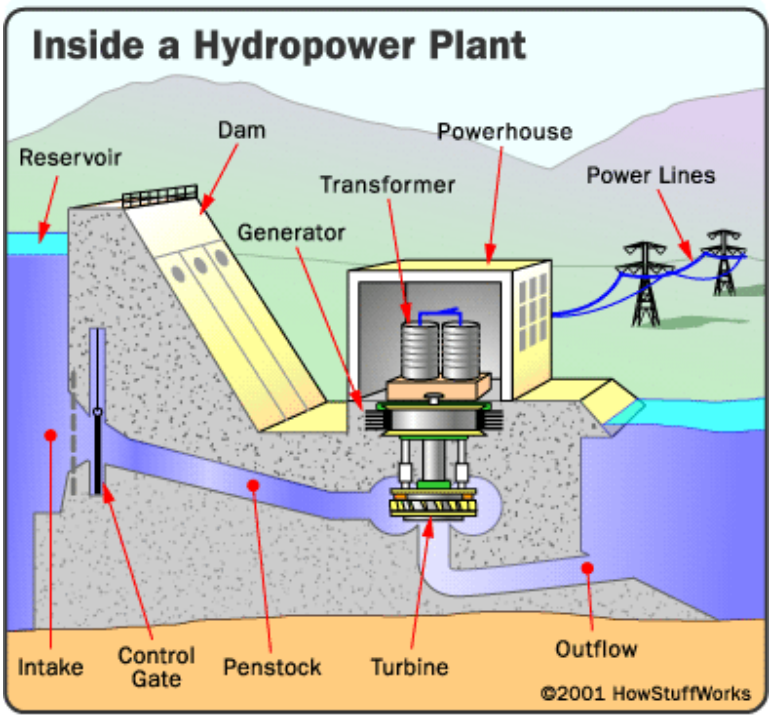
Adapted from : http://ga.water.usgs.gov/edu/hyhowworks.html, June 2012

1. How is a propeller-like piece of hydroelectric plant called?
2. What is turned by a turbine?
3. Where is metal shaft placed?
4. What turns the turbine?
5. Where is the water stored?
6. Where is the water intake found?
7. What causes water fall through the penstock?
8. What is found at the end of the penstock?
9. How is the part which produces power called?
10. How is electricity carried to your home?
11. What does a hydroelectric generator do?
12. Where can we find the rotor?

Task 3B Use the words on the left in sentences.

metal shaft	
elevation	
gravity	
conductor	
rotor	

Task 3C **Study the scheme and match the words with the correct definitions.**



Key words:

generators

intake

turbine

power lines

transformer

outflow

penstock

dam

	A _____ is a sluice or gate that controls water flow, or an enclosed pipe that delivers water to hydraulic turbines.
	Out of every power plant come four wires: the three phases of power being produced simultaneously plus a neutral or ground common to all three. Power line transmission is closely related to Power Distribution Grids.
	Most hydropower plants rely on it because it holds back water, creating a large **reservoir**. Often, this reservoir is used as a recreational lake.
	Used water is carried through pipelines, called **tailraces**, and re-enters the river downstream.
	Gates on the dam open and gravity pulls the water through the **penstock**, a pipeline that leads to the turbine. Water builds up pressure as it flows through this pipe.
	As the turbine blades turn, so do a series of magnets. Giant magnets rotate past copper coils, producing **alternating current** (AC) by moving electrons.
	Placed inside the **powerhouse** it takes the AC and converts it to higher-voltage current.
	The water strikes and turns the large blades of a turbine, which is attached to a generator above it by way of a shaft. The most common type of turbine for hydropower plants is the Francis Turbine, which looks like a big disc with curved blades. A turbine can weigh as much as 172 tons and turn at a rate of 90 revolutions per minute (rpm).

Task 3D **In about 80 words explain how the hydroelectric power plant works. The scheme on the previous page can help you.**

4. ADVANTAGES AND DISADVANTAGES OF HYDROENERGY

Task 4A **Read the statements about hydro energy and decide whether a statement is a disadvantage (D) or an advantage (A).**

Elimination of the cost of fuel.	
Large reservoirs required for the operation of hydroelectric power stations result in **submersion** of extensive areas **upstream** of the dams, destroying biologically rich and productive land.	
While some carbon dioxide is produced during manufacture and **construction** of hydroelectric dams, they themselves do not burn fossil fuels so they do not directly produce carbon dioxide.	
When water flows it has the ability to transport **particles** heavier than itself **downstream**. This has a negative impact on power stations. **Siltation** can fill a reservoir and reduce its capacity to control floods.	
The sale of electricity from hydroelectric plant will cover the construction costs after 5 to 8 years of full generation.	
Hydroelectric power stations that use **dams** would submerge large areas of land **due to** the requirement of a **reservoir**.	
Reservoirs created by hydroelectric **schemes** often provide facilities for water sports, and become tourist attractions.	
Hydroelectric projects can be **disruptive** to surrounding aquatic **ecosystems** both upstream and downstream of the plant site.	
In many areas the most cost-effective sites have already been exploited.	
Multi-use dams installed for **irrigation** support **agriculture** with a relatively **constant** water supply.	
It has been note the tropical regions that the reservoirs of power plants in tropical regions may produce **substantial** amounts of methane. This is due to plant material in flooded areas **decaying** in an anaerobic environment, and forming methane, a potent **greenhouse gas.**	

Generation of hydroelectric power changes the downstream river environment. Water exiting a turbine usually contains very little suspended **sediment**, which can lead to scouring of river beds and loss of riverbanks.	
Changes in the amount of river flow will **correlate with** the amount of energy produced by a dam. Lower river flows because of **drought**, climate change or upstream dams and diversions will reduce the amount of live storage in a reservoir therefore reducing the amount of water that can be used for hydroelectricity. The result of diminished river flow can be power **shortages** in areas that depend heavily on hydroelectric power.	
Because large conventional dammed-hydro facilities hold back large volumes of water, a failure due to poor construction, terrorism, or other cause can be catastrophic to downriver **settlements** and infrastructure. Dam failures have been some of the largest man-made disasters in history.	
Where the reservoirs are planned the people living there need to be **relocated**. In February 2008 it was **estimated** that 40-80 million people worldwide had been physically displaced as a direct result of dam construction.	

Task 4B Translate the words from the text into Slovene.

English	**Slovene**	**English**	**Slovene**
elimination, n		disruptive, adj	
submersion, n		irrigation, n	
up/downstream, adj		agriculture, n	
construction, n		constant, adj	
particle, n		decay, v	
siltation, n		sediment, n	
due to, prep		correlate with, v	
scheme, n		drought, n	
estimate, v		shortage, n	
relocate, v		settlement, n	

Task 4C **In about 100 words write about advantages and disadvantages of hydroelectricity.**

5. LEARN MORE

Task 5A **Have a look at the list of largest hydroelectric power stations in the world and fill in the gaps with online information:**

http://en.wikipedia.org/wiki/List_of_largest_hydroelectric_power_stations, June 2012

The biggest dam in the world is _____ in _____.

The _____ in _____produces maximum electricity annually.

The area flooded when building Churchill Falls in Canada was _____ $km^{2.}$

If you'd like to compare the data with the Slovene ones, watch and compare:
http://www.dem.si/eng/hydropowerplantsandgeneration/generaldata, June 2012

Task 5B **Watch the two videos.**

Video 1: http://www.youtube.com/watch?v=P-70reesprE, 0:37 min, Itapu dam, February 2013
Video 2:http://www.youtube.c om/watch?v=D7_rzojvKdE 2,3 min, Hoover dam, June 2012

Task 5C **Solve the wordsearch.**

HYDROELECTRIC ENERGY

R W R A T E R E I S L I F E G L G C R X	DAM
T O O E I A E L A Q V S U R P E N E K M	ELECTRICITY
H K T Y N J M E V Q Z G A D N H M R M A	ELEVATION
O D A O Y Y B C Z N J V E E S R I Q X G	GENERATOR
N J T A R W F T A V I B R N O V C V Z P	GRAVITY
X O S X V B P R V T R A E F E B U U X D	INTAKE
W A I X J M T I Y E T O S R X Q L J H K	OUTFLOW
T O B T X Y F C V O S N B X E C M O M K	PENSTOCK
C E L M A G C I R T A A I L Y K W E Q V	POWERLINES
S O K F I V R T W R N E V Q N Y S O D B	RESERVOIR
Q E G M T Y E Y T K R I O V R E S E R F	RIVERBANK
S O N Q A U S L N D N O S I T M L H E W	RIVERBED
K H K I Y D O H E U F Y D V O V V Y K C	ROTOR
A C A F L G X N F Y E Z B A I R X V A Y	SHAFT
Z S O F K R L A F H S N I R Z X Q I T E	STATOR
V L N T T H E S M N A P R R X L H R N G	TRANSFORMER
H D E X S D K W J T Q A D R K J H V I H	
Z C B B P N Y Q O F Q M E H Q X U C F H	
S N Y N T D E Y I P N R D J K E M Z C U	__ __ __ __ __ __ __ __ __ __ __ __
Q S K O P N C P N D Z Z G P S S M B H E	

APPENDIX

The Evolution of Hydropower

Windmills, one of the first inventions powered by water

A micro-hydro facility in Vietnam

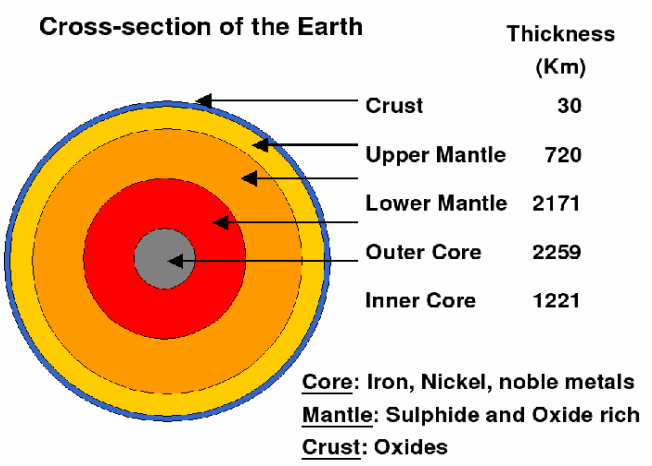
The Itapu dam, the Parana river, Brazil

Moste, the first hydroelectric power plant on the Sava river, Slovenia, built in 1952

Unit 7

GEOTHERMAL ENERGY

"Geothermal" comes from the Greek words geo (earth) and therme (heat). So, "geothermal" means "earth heat".



Steam rising from the Nesjavellir Geothermal Power Station in Iceland.

1. WHAT IS GEOTHERMAL ENERGY AND WHERE IT COMES FROM

Geothermal energy is thermal energy generated and stored in the Earth.
Thermal energy is the energy that determines the temperature of matter.
Earth's geothermal energy originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%)

The amazing power of geothermal energy

Task 1 **Watch the videos about the Old Faithful Geyser and Fly Geyser and compare them.**

Old Faithful, Yellowstone National Park: http://www.youtube.com/watch?v=LWrklFuYnb0 , 0:32, June 2012
Fly Geyser in the Black Rock Desert, Nevada: http://www.youtube.com/watch?v=h9jh-IeUnR0, 1:14, June 2012

Old Faithful

Eruptions can shoot 14,000 to 32,000 l of boiling water to a height of 32 to 56 m lasting from 1.5 to 5 minutes. The average height of an eruption is 44 m.

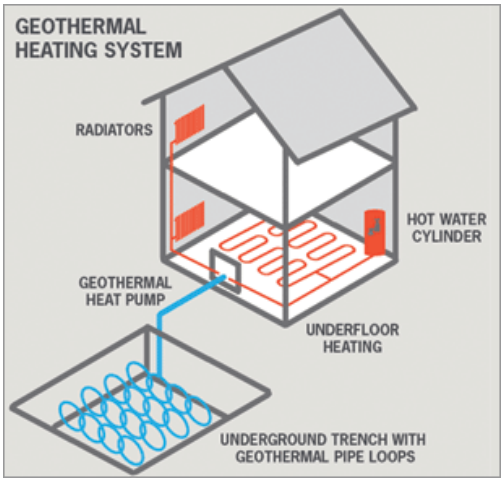
Between 1983 and 1994, four probes containing temperature and pressure measurement devices and video equipment were lowered into Old Faithful. The probes were lowered as deep as 22 m. Temperature measurements of the water at this depth was 118 °C.

Source: Wikipedia

2. GEOTHERMAL HEATING

Task 2A **Imagine that you are building your own house somewhere in the future and that you would like to be as energy independent as possible. You are aware of the fact that water is warmer a few metres below the ground.**

How could you benefit from it?
Discuss the possibilities with a school mate.



Task 2B **Have a look at the video that is a brief introduction to geothermal heating, a cleaner and more sustainable source of energy. Then read the adapted tapescript and fill in the missing words.**

Video: *http://www.youtube.com/watch?v=h1LMFyCgs14 , 1:17, June 2012*

Geothermal heating

Seasons come and go. In the summer months it can be quiet warm and in the winter very cold. While the temperature of the surface of the earth changes with the seasons, the temperature of the ground below surface does not. Even at just two metres under the ground it is about _____ Celsius all the year round. Geothermal takes advantage of this _____ temperature and uses it _____.

So, how does it work? First, a large hole is made into the ground and filled with a series of pipes. A special, _____, constantly runs through the pipes. In the winter heat from the ground is absorbed into the pipes and pushed _____ where it can be circulated throughout the house.

In the summer, the process is reversed. Heat from the house is absorbed into the pipes and pushed downwards where it can be stored within the _____.

So, what are the _____ of geothermal heating? Well, for one, you can save a lot of money. Geothermal uses way less of energy to operate and this means that heating bill that is up to 80% _____ than that of the traditional heating system.
Secondly, geothermal doesn' t run on _____ like oil and gas and therefore produces significantly less _____.

Geothermal is a cleaner, _____ source of energy.

3. GEOTHERMAL POWER PLANTS

Geothermal power plants use the natural heat of the earth to generate electricity for homes and businesses.

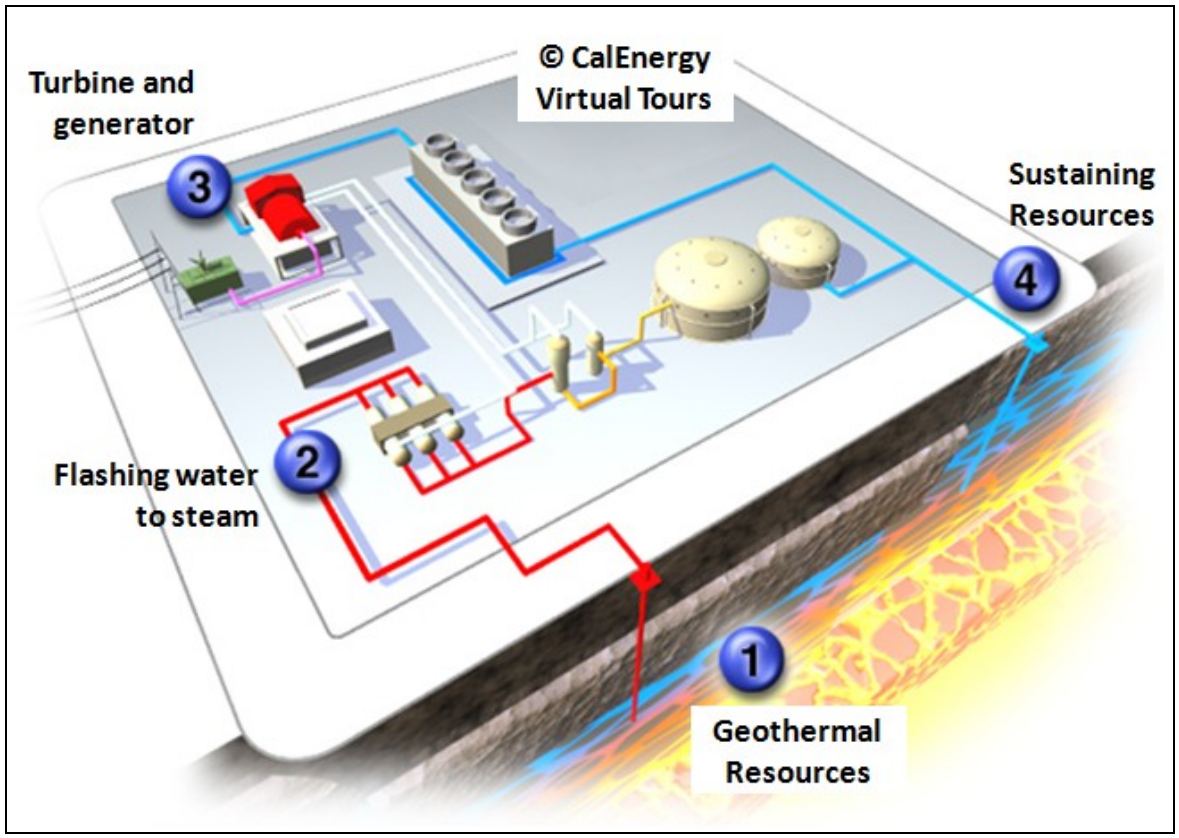
Geothermal power is a renewable source of energy and does not rely on coal or other fossil fuels to create electricity.

Geothermal Energy in California

Because of its location on the Pacific's "ring of fire" and because of tectonic plate conjunctions, California contains the largest amount of geothermal generating capacity in the United States.

Task 3 How do Geothermal Power Plants work?

Watch the video from the California-based company, CalEnergy.
http://www.youtube.com/watch?v=Bl-oxDZDfqI, 4:45, June 2012



Welcome to one of CalEnergy's geothermal power plants. Unlike other power plants that reply on coal or other fossil fuels to create electricty for homes and businesses, geothermal power plants use superheated fluids from the earth's geothermal resources to generate electricity.

1. Geothermal resources

The natural heat of the earth creates geothermal resources. This heat comes from molten rock, called _____, located at the earth's core deep below the geothermal resource. Over thousands of years, rainwater seeps through cracks in the earth's surface and collects in underground reservoirs. The magma heats the water until it becomes a _____.

To reach the superheated fluid, _____ are drilled 5,000 to 10,000 feet below the surface of the earth. These wells, called production wells, bring the superheated fluid to the earth's surface where it can be used to generate electricity for homes and businesses.

2. Flashing water to steam

This geothermal power plant uses crystallizer-reactor clarifier technology, a process that turns the geothermal superheated fluid into _____ while removing solids from it. The steam is used to drive a _____ and generate electricity. All remaining geothermal fluids are injected back into the reservoir for reuse.

Under its own pressure, superheated fluid from the geothermal resource flows naturally to the surface through production wells. As the liquid flows toward the surface, the pressure decreases, causing a small portion of the fluid still within the well to separate or "_____" into steam.

At the surface, the superheated fluid and steam mixture flows through surface pipelines and into a wellhead separator. Inside the separator, the pressure of the superheated fluid is reduced. This causes a large amount of the superheated fluid to rapidly vaporise and flash into _____ steam. The geothermal fluid that is not flashed into steam in the wellhead separator flows to a second vessel, called a standard-pressure crystallizer, where an additional amount of _____ steam is produced.

The flash process continues in the low-pressure crystalliser. The remaining fluid is again flashed, this time at a lower pressure, to produce _____ . All of the low-pressure, standard-pressure, and high-pressure steam is delivered to a turbine. The fluid that is not flashed into steam flows into the reactor clarifier system and is then returned to the geothermal reservoir through injection wells.

3. Turbines and generator

Turbines are the primary piece of equipment used to transform geothermal energy into _____ energy. Pressurised steam created from the geothermal superheated fluid flows through pipelines to large steam turbines. The force and energy in the steam is used to spin the turbine _____. The turbines turn a shaft directly connected to an electrical _____. An electrical charge is created when magnets rotate within the generator. Large copper bars carry the electrical charge to a step-up _____ outside the plant. Within the transformer, the voltage is increased before the power is sent to the power lines that carry it to homes and businesses.

4. Sustaining resources

Geothermal energy is a sustainable resource because, with proper management, a geothermal resource can remain a renewable source of energy. Water trapped deep within the earth will naturally replace the superheated fluid that is drawn from the geothermal resource through surface wells. However, it is possible to deplete the geothermal resource by removing fluid faster that it can be naturally replaced. To help prevent this, the steam used in the geothermal power plant passes through a _____ that turns it back into fluid. At this stage, it's possible to recover from _____ the geothermal fluid before it's injected back into the earth. This condensed fluid, along with the fluid that did not flash to steam, is injected back into the underground reservoir. _____ naturally reheats the fluid so it can be used again.

CalEnergy Geothermal Power Plant, California

Source: Landmark-ca, June 2012

4. GLOSSARY OF KEY WORDS

Task 4 Translate the key words in Slovene.

Crystallizer-reactor clarifier technology /
A process for removing silica from geothermal resources while creating steam used to generate electricity, then returning the heat-depleted geothermal fluids back into the reservoir for reuse.

Flash Steam Power Plant /
A geothermal power plant that converts – or flashes – hot water from a geothermal reservoir below the surface into steam, which is used to generate electricity. This is the most common type of geothermal power plant.

Fossil Fuels /
Fuels formed millions of years ago from decayed plants and animals. Oil, coal and natural gas are fossil fuels.

An oil rig - pumps oil from deep underground

A coal mine - large quarry diggers carve out the resource.

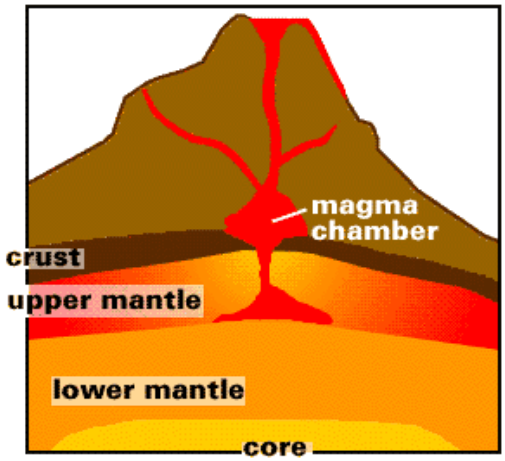
Generator /
A machine that converts mechanical energy into electrical energy.

Geothermal Energy /
Heat generated by natural processes within the earth. Primary energy resources are hot, dry rock; magma (molten rock); and hydrothermal (water/steam from geysers and fissures).

Low Pressure Crystallizer /
A device that removes silica from geothermal fluids and develops low-pressure steam.

Low Pressure Steam /
Steam (pure water vapor) that is at 250 degrees Fahrenheit and one atmosphere of pressure.

Magma /
Molten rock within the earth that can be used as a heat source for geothermal energy.



Mechanical Energy /
Energy created through the use of machines or equipment.

Production Well /
A well that is being used to deliver geothermal resources to a geothermal power plant.

Standard Pressure Crystallizer /
A device that removes silica from geothermal fluids and develops standard pressure steam.

Standard Pressure Steam /
Steam (pure water vapor) that is at 340 degrees Fahrenheit and eight atmospheres of pressure.

Step-up Transformer /
A device used to increase the voltage in an electrical current.

Superheated Fluid /
A fluid, like water, that is heated above its boiling point without turning into steam.

Sustainable /
The ability to keep in existence for a long period of time.

Transformer /
A device used to change the voltage and current in electricity.

Turbine /
A device for converting the flow of a fluid (air, steam, water or hot gases) into rotational motion.

Voltage /
The amount of electrical force, measured in volts, which exists between two points.

5. HELSINKI'S UNDERGROUND DATA CENTER & THE WORLD'S LARGEST HEAT PUMP PLANT

Good News!
from Finland

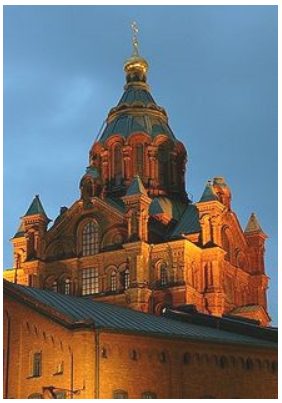
It is possible:

- to use wastewater to heat and cool houses
- to use heat produced by servers to heat houses

Task 5A **Watching the video, pay special attention to the eco-efficient data centre and fill in the gaps in the text.**

Video : Helsinki's Underground Data Centre (video, from 3:28 on)
http://www.datacenterknowledge.com/archives/2011/02/21/video-helsinkis-underground-data-center/, 5:47, February 2013

District cooling equipment in the cave housing the Uspenski data centre.



Uspenski Cathedral, Helsinki

CNN's Richard Quest looks at Helsinki's _____city – a vast network of man-made _____ and caves that houses much of its industrial infrastructure, including coal storage and a huge district _____ and _____systems.

One of the newest tenants of the city's subterranean section is a new data centre developed by utility Helsingen Energia and ISP Academica. The _____ megawatt facility is located _____meters below the Uspenski Cathedral, a historic church.

The data centre uses cold _____ in its _____ system, while the waste heat produced by the_____ is piped via a _____ pump into the district heating network to heat Helsinki buildings and the residents' domestic hot water. When the hall is full of computers, the heat it produces is enough to heat up to _____ large single-family houses in Helsinki.

Task 5B Read the article about the largest heat pump plant in the world that uses wastewater to heat and cool houses.

Write out the key words individually and compare your choice with other students in your group.

Katri Vala heating and cooling plant

Heat from waste water

The facility excavated under the Katri Vala Park houses the world's largest heat pump plant, producing district heat and cooling in a single process. Various parts of a similar type of production are used elsewhere in the world, but so far have not been combined in this way.

The rock cave of the heating plant is excavated under the Katri Vala Park, a few kilometres from Helsinki city centre. The cave is at a depth of 25 metres from the ground level.

Utilisation of wasted energy

A high volume of purified wastewater, the heat of which is utilised in district heat production, flows in the wastewater outfall tunnel 24 hours a day. In winter, heat energy is obtained with heat pumps from purified wastewater, which is led from the Viikinmäki central waste water treatment plant to the sea. In winter, the necessary district cooling energy is obtained direct from the sea with heat exchangers.

In summer, heat energy is transmitted from the return water in district cooling, in which case the heat pumps produce both district heat and district cooling. If all of the heat produced in the summer season is not needed, the extra heat can be condensed into the sea.

An environmentally sustainable production solution

Heat pumps enable the utilisation of sea water and the wasted heat from waste water in production. The carbon dioxide emissions of the Katri Vala heating and cooling plant are 80% smaller than those of alternative production solutions, such as separate heat production with heavy fuel oil or building-specific cooling production with compressor technology.

The plant is remote controlled. The production output of the plant is 90 MW of district heat output and 60 MW of cooling output.

Adapted from: http://www.helen.fi/energy/katri_vala.htm, June 2012

	**A key·word, also a key word, is** **1.** a word that serves as a key, as to the meaning of another word, a sentence, passage, or the like **2.** a significant or descriptive word **3.** a word used as a reference point for finding other words or information.

My KEY WORDS from the text about *Katri Vala heating and cooling plant* are*:*

1.	5.	9.
2.	6.	10.
3.	7.	11.
4.	8.	12.

Task 5C Write a short abstract.

What is an abstract?

An abstract is a condensed version of a longer piece of writing that

- highlights the major points covered;
- concisely describes the content;
- and reviews the writing's contents in abbreviated form.

Why are abstracts so important?

The practice of using key words in an abstract is vital because of today's electronic information retrieval systems.

Titles and abstracts are filed electronically, and key words are put in electronic storage. When people search for information, they enter key words related to the subject, and the computer prints out the titles of articles, papers, and reports containing those key words.

Thus, an abstract must contain key words about what is essential in an article, paper, or report so that someone else can retrieve information from it.

The Helsinki Eco Solutions

Abstract

HOW TO WRITE AN ABSTRACT

Writing a good abstract requires that you explain what you did and found in **simple**, **direct language,** so readers can then decide whether to read the longer piece of writing for details or not.

FOLLOW THE SIX STEPS.

1. What is the topic of your project work?	**The purpose of the project work is to study/describe/explain...**
2. What is it used for?	**It is used for ...-ing**
3. Where is it used?	**It is used in ... to...**
4. What is it made of? or/and What are its parts?	**It is made of ... It consists of ...**
5. What are its advantages?	**Its (dis)advantages are .../that it can...**
6. Add other important information (specific for your topic)	**In addition, it...**

FIND 5 TO 10 KEYWORDS AND EXPLAIN THEM.

EXAMPLE:

ENGLISH	SLOVENE	PICTURE, DEFINITION or EXAMPLE SENTENCE
1. wind turbine	*vetrna turbina*	

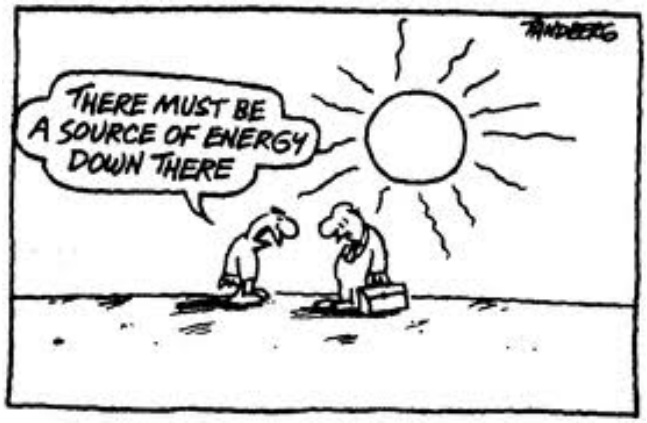
USE AT LEAST 3 LINKING WORDS:

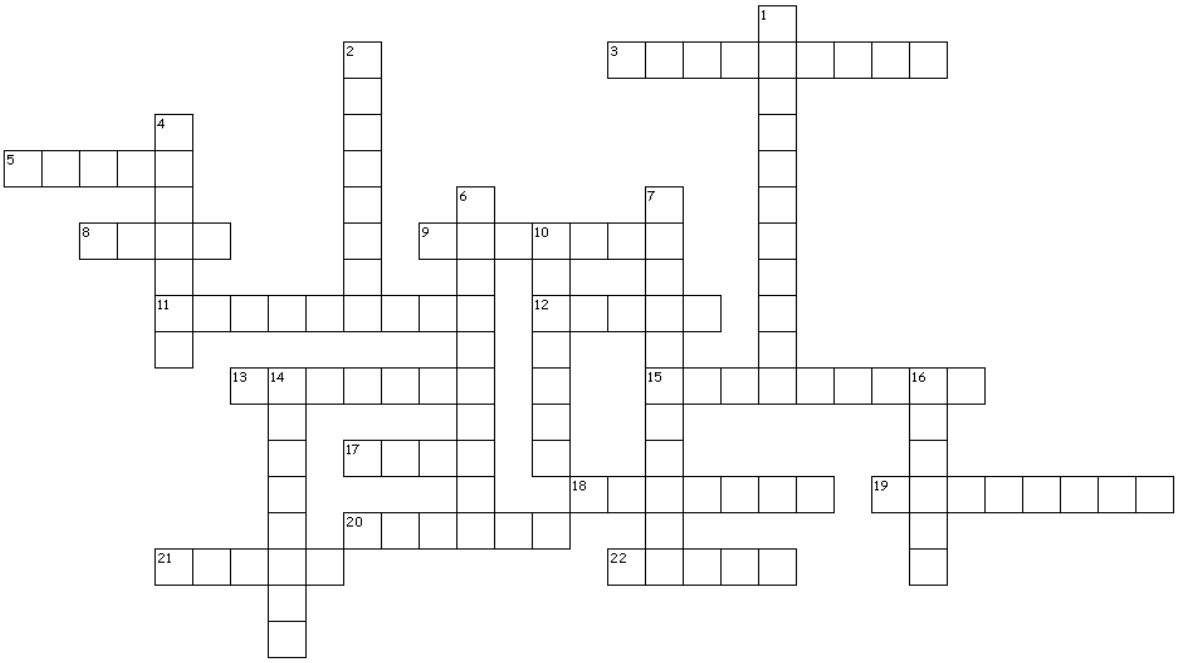
although
on the other hand
it is also...
not only...but,
...too
another point is that...
on the plus side...
morover
one (dis)advantage is that...

! USE SPELL CHECK.

! WRITE DOWN KEYWORDS WHEN YOU COME ACROSS THEM IN THE ENGLISH TEXT, NOT AT THE END ONLY.

Task 5D Fill in the crossword puzzle.





Across **3.** krožiti **5.** sonda **8.** vrtina, jašek, vodnjak **9.** napetost **11.** debelina **12.** ponovno uporabiti **13.** navzgor **15.** rezervoar, vodni zbiralnik **17.** jedro **18.** toploten **19.** vir **20.** stopljen **21.** tekočina **22.** para

Down **1.** trajnosten **2.** izbruh **4.** izčrpati **6.** stalen **7.** meritev **10.** turbina **14.** cevovod **16.** vbrizgati

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APPENDIX

Education and Culture
Lifelong learning programme
LEONARDO DA VINCI

SŠTS Šiška teachers' study visit to Finland – to explore renewable sources of energy in Finland.

Katri Vala heating and cooling plant, the world's largest (7000m2) heat pump plant.

Photos taken by teachers of SŠTS Šiška during their visit, which was funded by the European project Leonardo de Vinci in 2010.

Katri Vala heating and cooling plant has been excavated in a rock cave, at depth of 25 metres, a few kilometres from Helsinki.

The plant gets its energy from the purified waste water that travels through the plant where the thermal energy of the water can be recovered and conducted further into the district heat network.

The district heat output of the plant is 90 MW, which corresponds to the heating need of a town of 18 000 inhabitants. District cooling, then, can be produced with an output of 60 MW.
http://nordicgbc.org/programme/excursions/

APPENDIX - 2

Education and Culture
Lifelong learning programme
LEONARDO DA VINCI

SŠTS Šiška teachers' study visit to Iceland – to explore geothermal energy and geothermal energy in education.

Photos taken by teachers of SŠTS Šiška during their visit, which was funded by the European project Leonardo de Vinci in 2012.

Renewable energy provides 100 percent of the electricity production in Iceland, with about 70 percent coming from hydropower and 30 percent from geothermal power.

Sulphur springs

There are about 250 geothermal areas in Iceland.

Iceland's five major geothermal power plants not only generate electricity for nearly one-third of the country, but also provide nearly 90 percent of the heating needed for water and buildings.

The Hellisheiði Power Station is the second largest geothermal power station in the world, and the largest in Iceland.

The capacity is 303 MW of electricity and 133 MW of hot water, with a target capacity of 400 MW.

Once the full capacity of the power plant is reached, it would rank as the largest geothermal power station in the world, in terms of installed capacity.

A state-of-the-art power plant

Control room of the plant

Apart from space heating, one of Iceland's oldest and most important usages of geothermal energy is for heating greenhouses.

Iceland is an island located in the North Atlantic Ocean east of Greenland and immediately south of the Arctic Circle.

It is a highly developed country with the population of approximately 320,000 people.

Reykjavík is the capital and the largest city in Iceland.

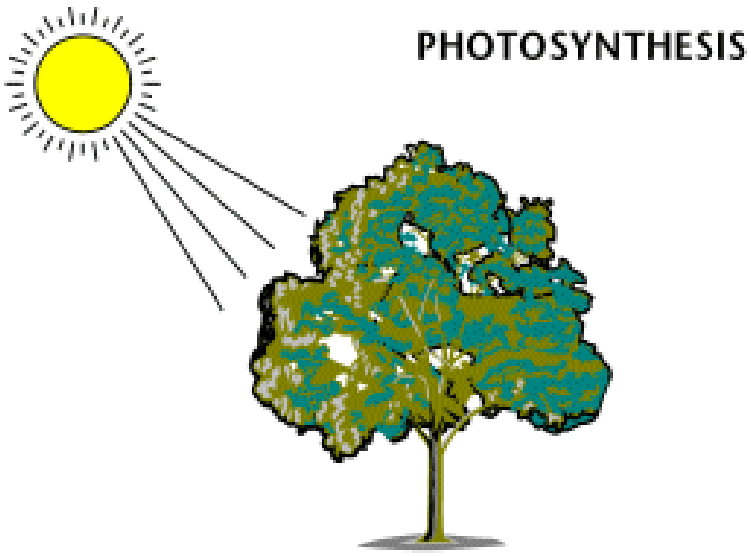
Unit 8

BIOMASS

Plants use and store carbon dioxide (CO_2) when they grow.

When plants burn or decompose, they release CO_2.

Replanting plants, crops or trees etc. ensures that the $C0_2$ is reused.



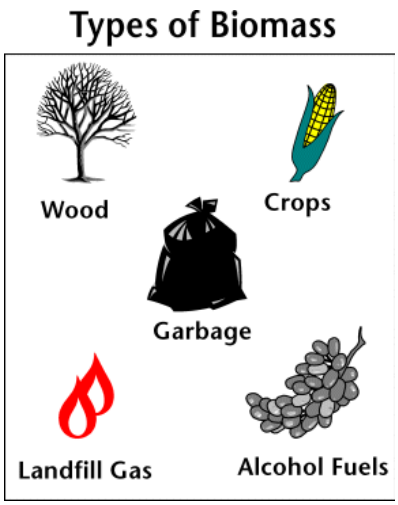
In the process of photosynthesis, plants convert radiant energy from the sun into chemical energy in the form of glucose – or sugar.

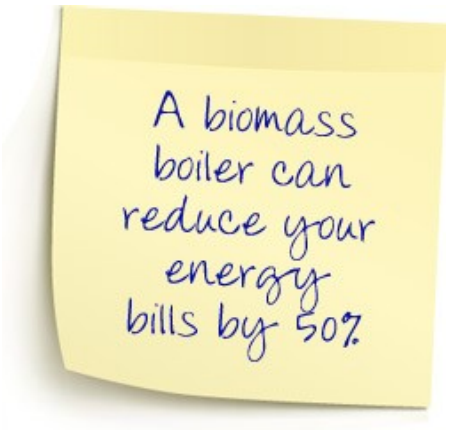
water	+	carbon dioxide	+	sunlight	→	glucose	+	oxygen
$6\ H_2O$	+	$6\ CO_2$	+	radiant energy	→	$C_6H_{12}0_6$	+	$6\ 0_2$

WHAT IS BIOMASS?

Biomass, as a renewable energy source, is biological material from living, or recently living organisms. As an energy source, biomass can either be used directly, or converted into other energy products such as biofuel.

Source: Wikipedia, June 2012



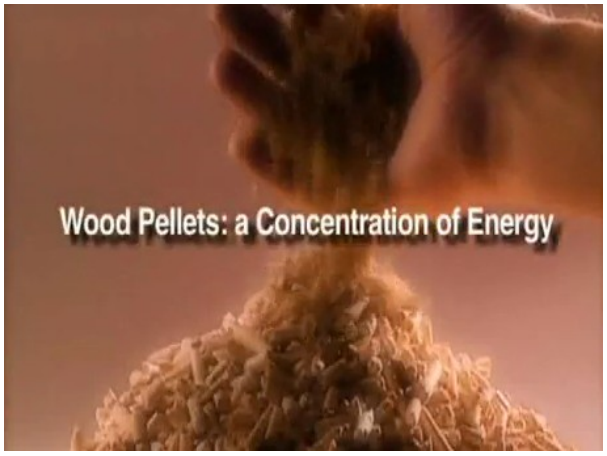


Task 1 **Watch the video about the production of wood pellets and fill in the gaps in the text below.**

WOOD PELLETS are made from low-grade by-products of the wood processing industry such as dry sawdust and shavings, produced in large quantities.

The material is compressed under high pressure and extruded through a mould to form pellets. The heat they produce is comparable to domestic heating oil, however, they are approximately 40% cheaper and require less storage space than lower density fuels such as wood chips.

Video:
Wood Pellets Production Plants – TVM:
http://www.youtube.com/watch?v=9k689pM3yok,
3:36, February, 2013



Key words:

wood pellets, renewable energy,
turn-key wood pellets production plant

Renewable Energy Through Biomass

The technology to _____ biomass, such as TVM machines, is increasingly efficient and _____.

The use of _____ _____ as fuel could become a leading player not only in household systems but most of all in _____ and industrial plants.
Wood pellets are a _____ of energy.

The unlimited _____ of biomass on the planet, originating from forests, generates enormous amounts of _____ wood waste that creates serious problems because the unaerobic fermentation of the biomass produces _____ gas, which is more damaging than CO2 in the global warming mechanics.

The simple mechanical transformation of _____ _____ into pellets makes it possible to obtain an incredible _____ fuel with a high _____ value and of reduced _____ that is easy to _____ and transport.

TVM Turn-Key Wood Pellet Plant

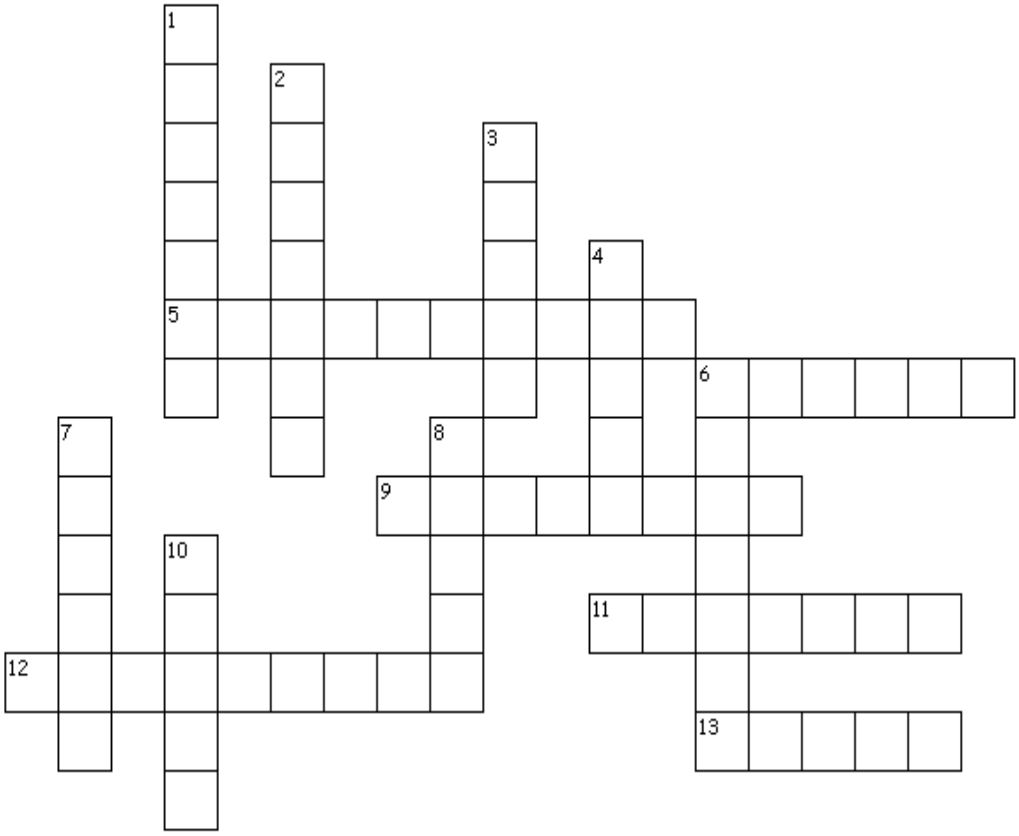
Mechanical _____ transport the wood waste from the _____, in which it is stored, to the preparation phases of the product before it is dried.

The dried material then undergoes further homogenisation processes before being moved to the _____ _____, which shapes it into pellets.

Once the pellets have cooled down, they can be stored in bins to be transported _____ or put in bags and placed onto _____ to be sent to civil or industrial systems.

Wood is a typical source of biomass

Task 2 **Complete the crossword by translating the clues in English.**



ACROSS

5. ekološki
6. skladišče
9. tekoči trak
11. ogrevanje
12. obnovljiv
13. shraniti

DOWN

1. na ključ
2. izkoriščati
3. vlažen
4. odpadki
6. biomasa
7. paleta
8. razpuščen
10. preša

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APPENDIX

Education and Culture
Lifelong learning programme
LEONARDO DA VINCI

SŠTS Šiška teachers' study visit to Finland – to explore how biomass is used in Finland

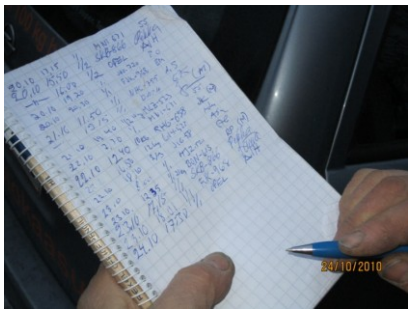
Photos were taken by teachers of SŠTS Šiška during their visit, which was funded by the European project Leonardo de Vinci in 2010.

Finnish Bioenergy Association goal: 3 TWh more biogas production by 2020

Biomass potential:

	Technically feasible by 2015 (TWh)
Municipal solid waste	0.5-0.8
Food industry	0.2-0.3
Sewage sludge	0.2
Manure and straw	3.1-13.6
Energy crops (set aside cropland only)	2.1
Landfill gas	0.7
Total	6.7-17.6

http://www.iea-biogas.net/_download/publications/country-reports/2012/Country%20Report%20Finland_Outi%20Pakerinen_Moss_04-2012.pdf



One of the world's first small-scale biogas upgrading systems was introduced in 2002 in Laukaa, Finland.

A biogas plant can transform manure, plants and waste into usable heat, electricity and methane fuel.

The Kalmari biogas plant in Laukaa produces 150 MWh of heat annually, which otherwise would have needed an equal amount of fossil fuel to produce.
The plant also produces 75 MWh of electricity. The rest biogas of the plant is upgraded to fuel cars.

New refuelling station was opened in March 2011 → 50 biogas vehicles fuelling, ~1000 MWh sold in 2011.

Unit 9

WASTE MANAGEMENT

1. WHAT IS WASTE MANAGEMENT?

Waste management is the collection, transport, processing or disposal, managing and monitoring of waste materials.

The term usually relates to materials produced by human activity, and the process is generally undertaken to reduce their effect on health, the environment or aesthetics.

Source: Wikipedia

Task 1 Check the Environment Statistics of municipal waste generation by person per year. (NationMaster)

According to Statistical Office of the Republic of Slovenia, the amount of municipal waste in Slovenia in 2009 was 449 kg per capita, which means 1.2 kg of municipal waste per capita per day.

Write down the amount of waste generated per person per year for the following countries:

Slovenia	USA	Denmark	Austria	Japan	Finland	Mauritius
449						

2. WHAT CAN BE DONE?

Task 2A Listen to the song and complete the lyrics.

Video: Reduce, Reuse, Recycle!:
http://www.youtube.com/watch?v=loeHhmUh-nE&feature=related, 2:58, June 2012

The 3 Rs – by Jack Johnson

Three it's a magic number
Yes it is, it's a _____ number
Because two _____ three is six
And three times six is eighteen
And the _____ letter in the _____ is R
We've got three R's we're going to talk about today
We've got to learn to
_____, Reuse, Recycle.

If you're going to the market to buy some _____
You've got to bring your _____ bags
and you learn to reduce your _____
And if your brother or your sister's got some cool _____
You could _____ before you buy some more of those.

_____, we've got to learn to reuse
And if the first two R's don't _____
And if you've got to make some _____
Don't _____ it out
_____, we've got to learn to recycle,
We've got to learn to
_____, _____, _____ .

Task 2B Now read the lyrics and check your answers.

Video The 3 R's Lyrics: http://www.youtube.com/watch?v=USo_vH1Jz7E, 2:56, , June 2012

Task 2C Write down five things that you could easily reduce, reuse or recycle and add two arguments for one thing in each group.

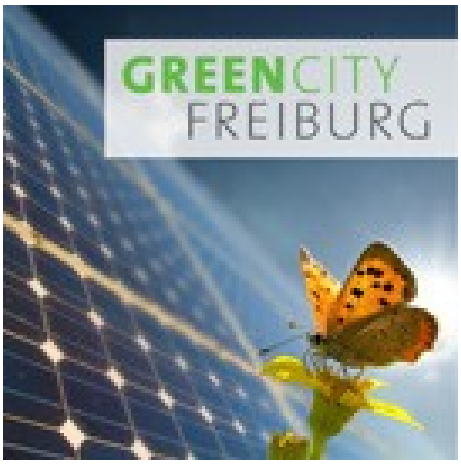
Reduce:					
Reuse:					
Recycle:					

Arguments:

3. THE WASTE MANAGEMENT CONCEPT IN FREIBURG

FREIBURG, south Germany, is one of the 3 of the greenest cities in the world to visit.
We just do it ! Freiburg - Green City: *http://www.youtube.com/watch?v=esv5czVf5L0, February 2013, 3:38*

Freiburg is internationally well known for its environmental approach and its extensive use of solar energy and other renewable sources.



"Z'Freiburg in de Stadt/sufer isch's un glatt" [A German rhyme saying: In Freiburg's city, it's clean and pretty], rhymed Johann Peter Hebel over two-hundred years ago. Nowadays, Freiburg's citizens are doing their best to keep it that way. Recycling of paper, plastics, organic material has been **wholeheartedly** taken onboard by those living here to the extent that the volume of garbage per capita is **markedly** below state and national average.

Refundable Container Concept and Financial Incentives

The city itself **sets a good example** by using paper, of which approximately 80 percent has been recycled. A recycling concept was introduced in 1991, which was supported across all sectors, with even the SC Freiburg soccer team agreeing to support the initiative. Waste avoidance is rewarded by a system of incentives: benefits for the use of textile diapers, discounts for collective waste disposal pooling and for people who **compost** their own green wastes.

Treatment of Non-Recyclable Wastes

Since 2005, non-recyclable waste from the region is **incinerated** at a plant in the Industrial Park Breisgau, located 20km south of Freiburg. The plant practices waste disposal safety by maintaining high environmental standards. It supplies energy to 25,000 households. Energy generated from the fermentation of bio-organic wastes covers one percent of Freiburg's energy demand.

Waste Consulting and Teaching

The waste disposal management concept of 2008 defines "avoidance before recycling before depositing" as the future strategy. Avoidance and waste separation show us the way out of the "**throwaway" society**, towards more informed and sustainable **consumer** behaviour.

Adapted from: http://www.fwtm.freiburg.de/servlet/PB/menu/1144339_l2/index.html, June 2012

Task 3A Match the highlighted words in the text with the definitions below.

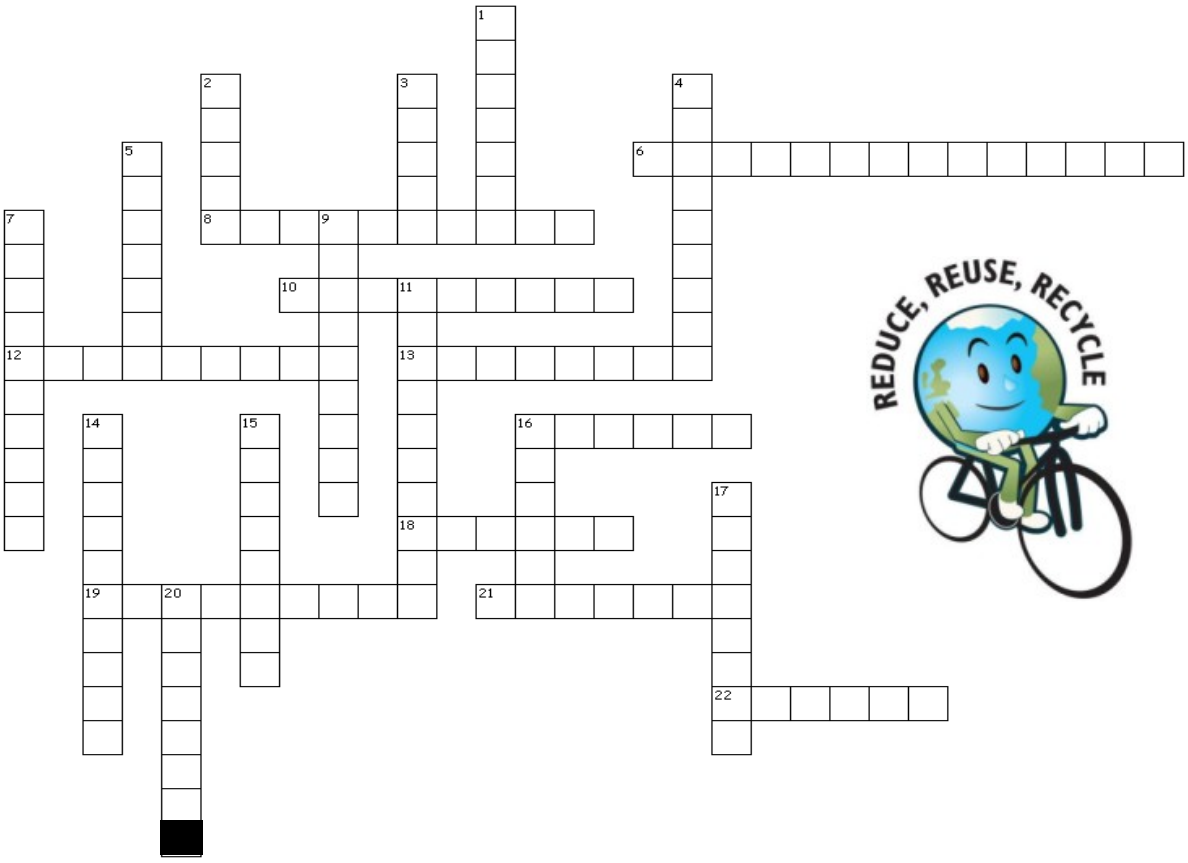
1. burnt to ashes	
2. without reserve	
3. in a clearly noticeable manner	
4. behave in a way that other people should copy	
5. human society strongly influenced by consumerism	
6. act, manner, or method of handling or dealing with someone or something	
7. something that encourages action, stimulus, motivation	
8. convert (vegetable matter) to compost	
9. a person who uses goods or services	

Task 3B Answer the questions about the waste management concept in Freiburg and compare it with the one in your city/town/village.

1. Where is Freiburg and why is it internationally well known?
2. What have the citizens been doing wholeheartedly?
3. How much of recycled paper do the citizens use?
4. What have they been doing with non-recyclable waste since 2005?
5. How is waste avoidance rewarded?
6. How much energy do they generate from the fermentation of bio-organic wastes?
7. What does the strategy “avoidance before recycling before depositing” mean?

Task 3C Compare the waste management concept in Freiburg to the one in your town.

Task 3D Complete the crossword by translating the clues in English.



ACROSS

6. z vsem srcem, popolnoma
8. osemnajsti
10. komunalni mestni
12. spodbuda, motivacija
13. potrošnik
16. nagraditi
18. količina
19. izognitev
21. korist
22. besedilo

DOWN

1. državljan(ka)
2. ponovno uporabiti
3. odpadki
4. obnašanje
5. reciklirati
7. statistika
9. gospodinjstvo
11. sežgati
14. iniciativa, pobuda
15. razločno
16. zmanjšati
17. pomnožiti
20. organski, biološki

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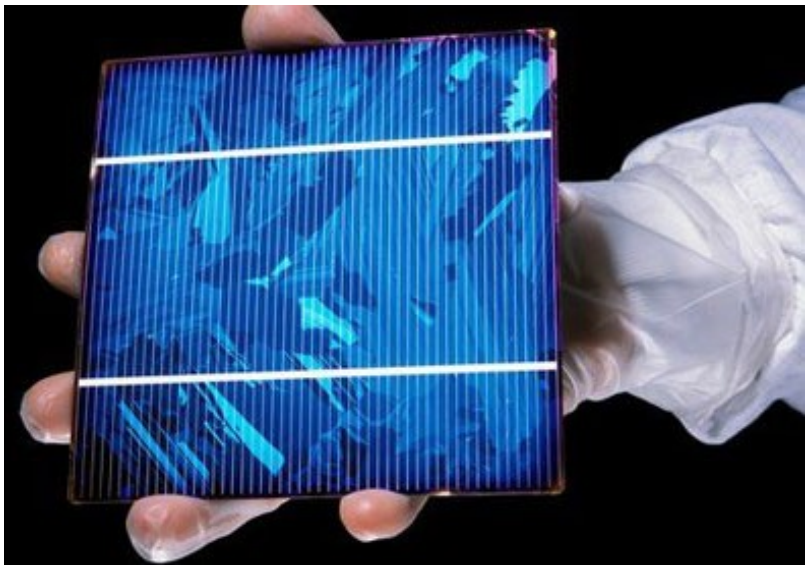
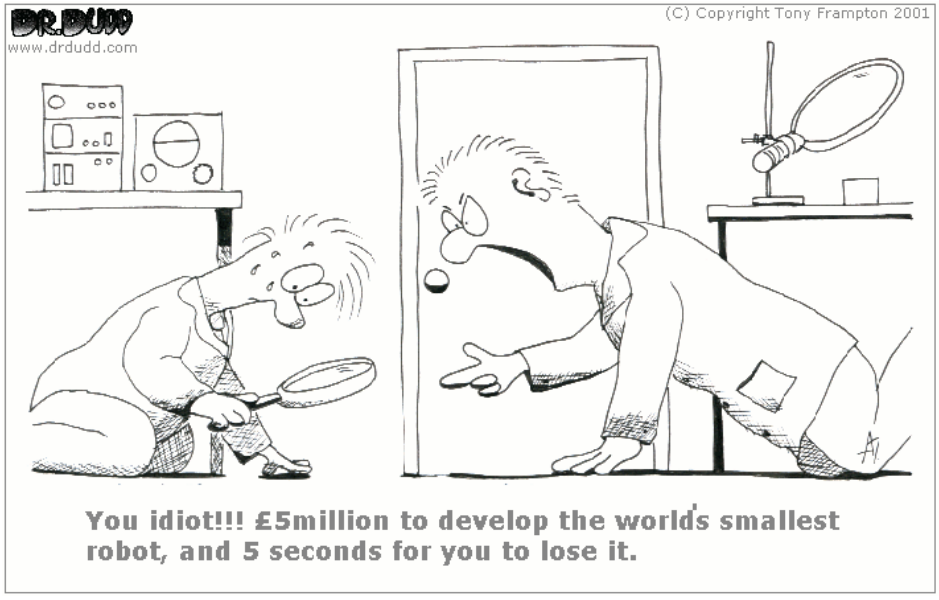
Unit 10

NANOTECHNOLOGY

Can nanotechnology provide cheaper solar energy?

Nanoscientists are working on some bright ideas to develop cost-efficient materials that can be used to produce and store energy more efficiently – but are they viable?





1. HOW NANOTECHNOLOGY WORKS

There's an **unprecedented** multidisciplinary convergence of scientists dedicated to the study of a world so small, we can't see it -- even with a light microscope.

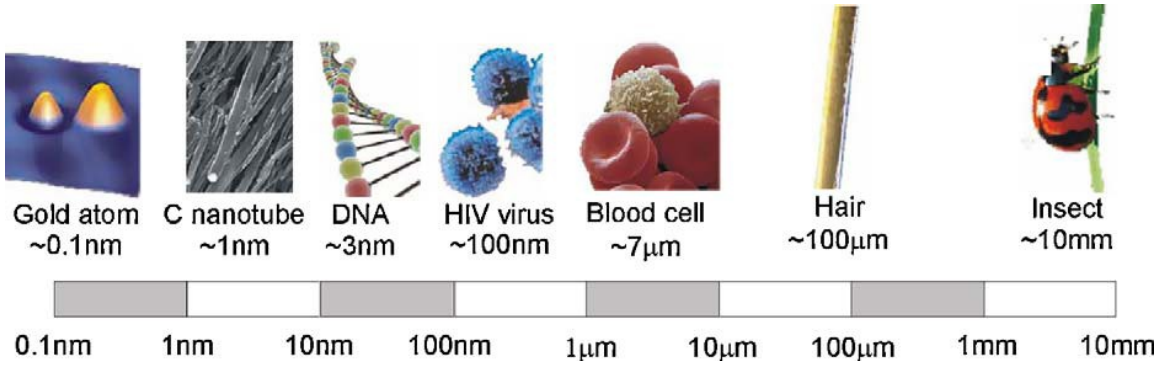
That world is the field of **nanotechnology**, the realm of atoms and **nanostructures.**

Nanotechnology is so new, no one is really sure what will come of it. Even so, **predictions** range from the ability to reproduce things like diamonds and food to the world being **devoured** by **self-replicating** nanorobots.

In order to understand the unusual world of nanotechnology, we need to get an idea of the units of measure involved.

A centimetre is one-hundredth of a meter, a millimetre is one-thousandth of a meter, and a micrometer is **one-millionth** of a meter, but all of these are still huge compared to the nanoscale.

A **nanometre (nm)** is one-billionth of a meter, smaller than the wavelength of visible light and a hundred-thousandth the **width** of a human hair [source: Berkeley Lab].



Length scale and some examples related

As small as a nanometer is, it's still large compared to the atomic scale. An atom has a diameter of about 0.1 nm. An atom's nucleus is much smaller -- about 0.00001 nm. Atoms are the building blocks for all matter in our universe. You and everything around you are made of atoms.

Nature has perfected the science of **manufacturing matter molecularly**. For instance, our bodies are assembled in a specific manner from millions of living cells. **Cells are nature's nanomachines**. At the atomic scale, elements are at their most basic level. On the nanoscale, we can potentially put these atoms together to make almost anything.

Adapted from: http://www.howstuffworks.com/nanotechnology.htm, June, 2012

Task 1A You will find the answers to the following questions in the previous text.

1. What is the realm of nanotechnology?
2. Are the scientists sure what will come of it?
3. Do some scientists predict nanorobots will reproduce food?
4. Do some scientists predict nanorobots can devour the world?
5. How big is a nanometre (nm)?
6. Is an atom bigger than a nanometre? What is an atom' s diameter?
7. How are cells called in the text?

Task 1B Write two advantages and two disadvantages of using nanotechnology and add arguments.

While nanotechnology is seen as the way of the future and is a technology that a lot of people think will bring a lot of benefit for all who will be using it, nothing is ever perfect and there will always be pros and cons to everything.

You can read more about advantages and disadvantages of nanotechnology on this website:

http://nanogloss.com/nanotechnology/advantages-and-disadvantages-of-nanotechnology/#ixzz1ydg4yPFz , June 2012

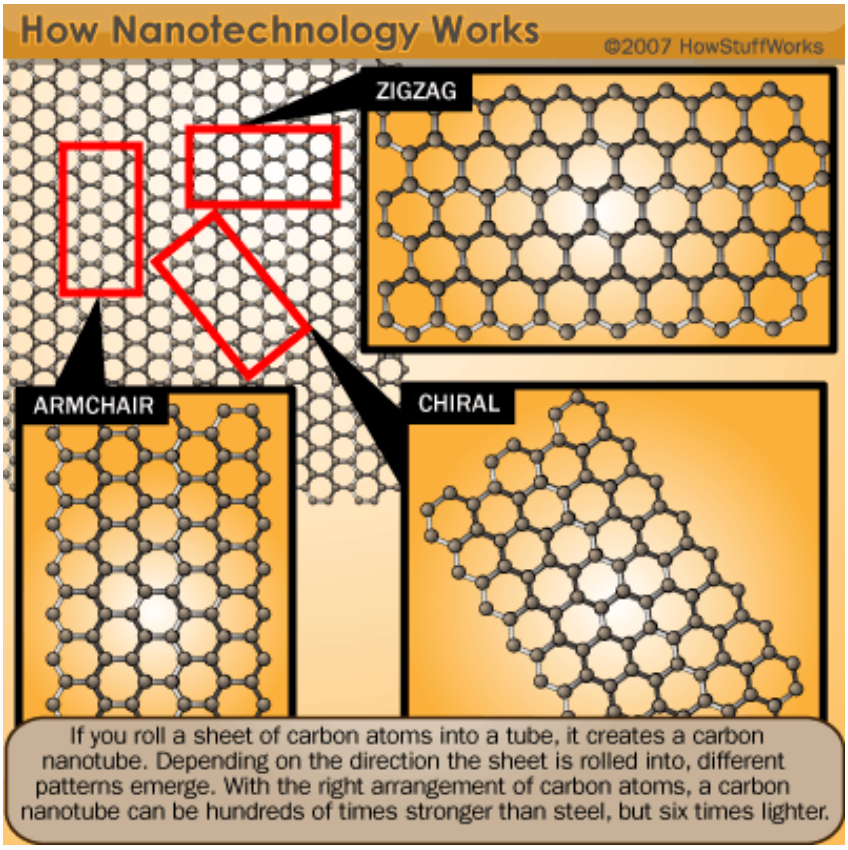
2. ECO-FRIENDLY NANO-BUILDING – SCIENCE FICTION?

Task 2A **Watch the video by Prof. Danijel Rebolj - Nano-building, concept and conditions for implementation, and complete the sentences below.**

Video: *TEDxMaribor-Prof. Danijel Rebolj-Nano gradnja, koncept in pogoji za implementacijo: http://www.youtube.com/watch?v=TB8On2guCoI, 11:36, June 2012*

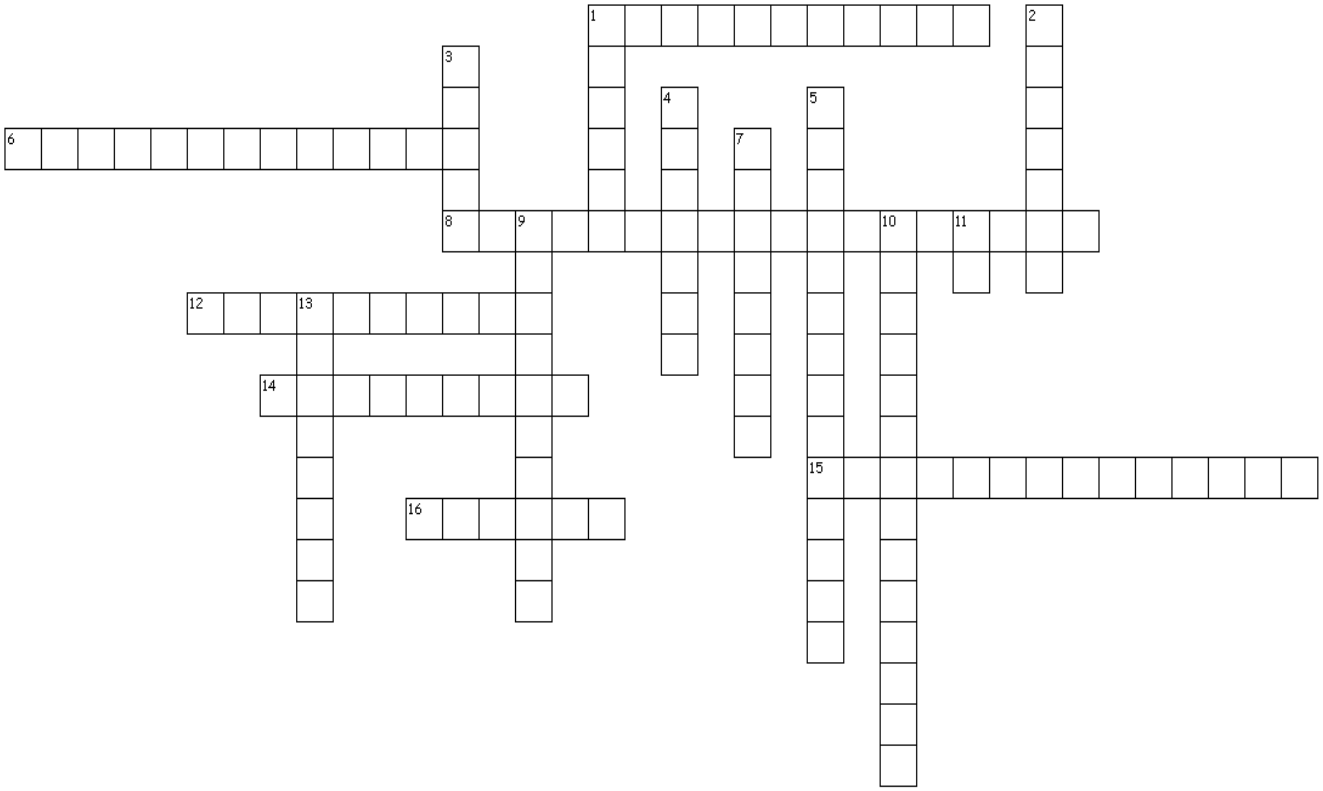
TED conferences are riveting talks by remarkable people, free to the world.

1. About one fourth of our population can not afford _____.
2. Building **pollutes** the _____.
3. **Nanorobots** will be able to use _____ as the only source of energy.
4. Bio nanorobots will extract carbon from _____ from the air.
5. We **estimate** the time to build a house to be about _____ a day.
6. There are no negative _____ on the environment.
7. How long will it take to develop this technology? It is expected to be about _____.
8. Carbon nano tubes are hundred times stronger than _____.
9. The bio nanorobots will do the work exactly as _____.



A carbon nanotube can be hundreds of times stronger than steel, but six times lighter.

Task 2B Complete the crossword by translating the clues in English.



Across

1. molekularno
6. brez primere, nezaslišan
8. stotisočinka
12. napoved
14. milijardinka metra
15. ena tisočinka
16. žreti

Down

1. snov
2. onesnaževati
3. širina
4. napovedati, prerokovati
5. nanotehnologija
7. ocenjevati
9. nano roboti
10. samoreproducirati
11. okrajšava za nanometer
13. premer

Created by Puzzlemaker at DiscoveryEducation.com

Let's Go Green: Sources

Unit 1

Conserve Energy Future
http://www.conserve-energy-future.com/EnergySources.php, June 2012

Need.org
http://www.need.org/needpdf/infobook_activities/ElemInfo/IntroE.pdf, June 2012

Seerpress.com
www.seerpress.com,http://www.alternate-energy-sources.com/energy-saving.html, June 2012

Task 4
http://blog.mindjet.com/tag/video, http://wiki.answers.com,http://www.sloveniapartner.eu/en/business-environment/energy-and-sustainable-energy-sources/
http://www.solarschools.net/resources/stuff/non_renewable_energy.aspx, www.peopleandplanet.org, www.conserve-energy-future.com (June 2012)

Unit 2

Green Innovation
http://www.greeninnovation.co.uk/new/cheap-solar-panels.html

Once fashion
http://www.oncefashion.com/2012/05/07/the-cost-of-making-wood-pellets/

How Stuff Works
http://science.howstuffworks.com/environmental/energy/geothermal-energy.htm

There Cycle Times
http://therecycletimes.com/category/wind-energy/

Renewable Energy World
http://www.renewableenergyworld.com/rea/news/article/2011/03/nova-scotia-joins-surge-on-tidal-power

Montana's official website
http://www.dnrc.mt.gov/wrd/water_proj/hydro/hydropower.asp

Renovate Europewww.renovate-europe.eu, Eliminate Trans-fatwww.sanstransvls.com, http://ec.europa.eu/energy/publications/doc/2011_energy2020_en.pdf, http://www.greenwoodusa.com/blog/category/market-trends/, http://www.euractiv.com/energy/64-new-power-be-renewable-over-next-decade-news-497859energy supply nuclear energy renewable energy, http://solutionsims.blogspot.com/2011/06/renewable-energy.html

Task 1B
http://www.renewableenergyworld.com/rea/tech/home, www.renovate-europe.eu, www.sanstransvls.com, http://ec.europa.eu/energy/publications/doc/2011_energy2020_en.pdf, http://www.greenwoodusa.com/blog/category/market-trends/

Unit 3

Cover
http://nicholaspmiller.com/gpage2.html

What is carbon dioxide
http://www.carbonfootprint.com/carbonfootprint.html

What is global warming
http://www.thefreedictionary.com, http://en.wikipedia.org

Photos:

CO_2
http://www.nskeurope.ru/cps/rde/xchg/eu_en/hs.xsl/environment.html
http://www.istockphoto.com/stock-photo-9856730-carbon-dioxide-emissions-reduction-sign.php
Footprints: http://mysite.verizon.net/vzepir4z/footprints/index.html

Cartoons:
http://www.cartoonstock.com/directory/b/battery_powered.asp

Unit 4

Images, June 2012

http://www.cartoonstock.com/
http://ropphotography.blogspot.com/
http://www.co.marin.ca.us/depts/cd/main/comdev/advance/
http://www.brighthub.com/environment/renewable-energy/articles/62881.aspx?image=63552
http://www.brighthub.com/environment/renewable-energy/articles/62881.aspx?image=63553

Unit 5

San Gorgonio Pass wind farm:
http://en.wikipedia.org/wiki/San_Gorgonio_Pass_Wind_Farm , June, 2012

Crossword:
http://www.ecofriend.org/entry/new-wind-turbines-ensures-safety-for-birds/;
http://www.mbgnet.net/sets/temp/seasons.htm; http://syigroup.en.made-in-china.com/ June, 2012

Do wind turbines make noise (images)
http://www.whatssogreataboutperth.com/http://www.examiner.com/nationalhttp://www.sxc.hu/photo/912405, June 2012

Wind Turbine field:
http://researchgroups.msu.edu/system/files/content/Final%20Presentation%20-%20Group%2011.pdf, June 2012

Task 3a (photo):
http://profilefacts.blogspot.com/2010/10/wind-power-profile.html, June 2012

Unit 6

Images, June 2012

http://ecoble.com/2009/09/10/alternative-power-hydroelectric-potential/
http://www.industcards.com/hydro-slovenia.htm
http://kraji.eu/slovenija/vrhnika_star_maln/slo
http://en.wikipedia.org/wiki/Hydroelectricity
http://www.worldtourismplace.com/itaipu-dam-one-of-seven-wonders-of-the-modern-world/
http://www.gis.si/turizem_zirovnica/content/he-moste

Unit 7

Cover photo:
http://hsb.iitm.ac.in/~jm/ARCHIVES/Mar-April05/articles_file/earth_files/EarthCrossSection_latest_html_12a4ebdc.png

Geothermal heating:
http://www.sutmundo.com/quick-guide-geothermal-heating/
http://energyinformative.org/save-money-with-geothermal-heating-and-cooling/

Geothermal power plants
http://www.energy.ca.gov/geothermal/

Glossary of key words
Fossil fuels: http://www.discoveringfossils.co.uk/fossilfuels.htm
Magma: http://www.webquest.hawaii.edu/kahihi/sciencedictionary/M/magma.php

Helsinki data centre
http://en.wikipedia.org/wiki/Uspenski_Cathedral,_Helsinki
Photo: Jakke Nikkarinen/Helsingin Energia

Key words:
http://www.thefreedictionary.com , http://dictionary.infoplease.com/

Abstract:
http://www.emeraldinsight.com/index.htmhttp://leo.stcloudstate.edu/bizwrite/abstracts.html
http://editknow.com/blog/

Crossword cartoon:
http://ecogenerator.blogspot.com/2011/06/first-polymer-solar-thermal-device.html

Unit 8

Cover:
http://library.thinkquest.org/06aug/01335/biomass.htm

Photos:
http://www.gotapellets.rs/

Cartoon:
http://oecotextiles.wordpress.com/category/biomass-2/

A biomass boiler:
http://www.greenenergydoctor.co.uk/biomass-boilers/

Unit 9

Task 1: Environment Statistics
http://www.nationmaster.com/cat/env-environment

Cover picture:
http://www.portcoquitlam.ca/Dynamic/Page3299.aspx

5 greenest cities in the world:
http://www.treehugger.com/natural-sciences/5-of-the-greenest-cities-in-the-world-to-visit.html, June 2012

Photos:
http://www.freiburg.de/servlet/PB/menu/1245537_l2/index.html

Unit 10

Cover picture:
http://www.guardian.co.uk/nanotechnology-world/can-nanotechnology-provide-cheaper-solar-energy

Length scale:
http://nanomol.es/publications/Nanotechnology%20for%20Sustainable%20Energy.pdf

Photos:
The Nano-tech Revolution:
http://teslaschool.org/tag/building/

Nanotubes, How Stuff Works:
http://science.howstuffworks.com/nanotechnology2.htm

Molecular construction:
http://www.cosmosmagazine.com/node/172