

Renewable Energy

LET'S GO GREEN! 2020

Student's Book



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

Dr. Seuss, The Lorax

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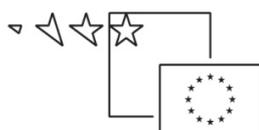
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June 2012 (revised October 2020)



Zavod
Republike
Slovenije
za šolstvo



Naložba v vašo prihodnost

OPERACIJO DELNO FINANCIRA EVROPSKA UNIJA
Evropski socialni sklad



REPUBLIKA SLOVENIJA
MINISTRSTVO ZA IZOBRAŽEVANJE,
ZNANOST, KULTURO IN ŠPORT

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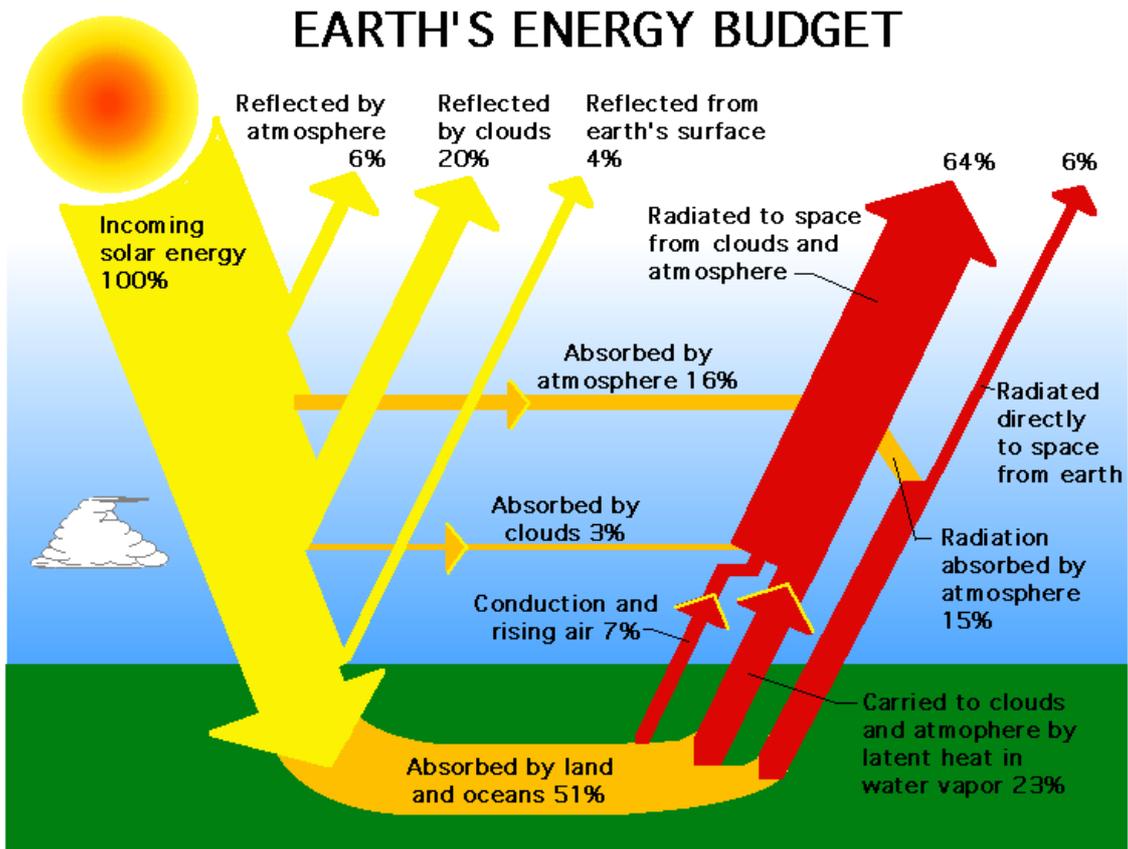
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Unit 1

ENERGY

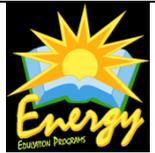


Look at the scheme and discuss the earth's energy budget.

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.

<p>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.</p>	
<p>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.</p>	
<p>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.</p>	
<p>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.</p>	
<p>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.</p>	
<p>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.</p>	

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 energy sources are, 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.

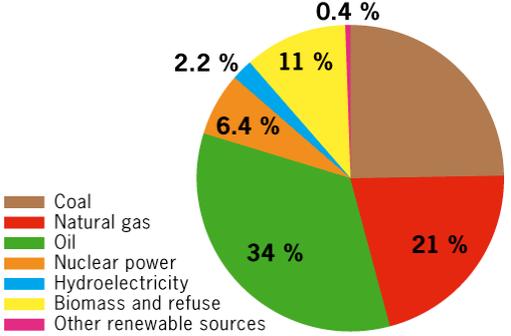


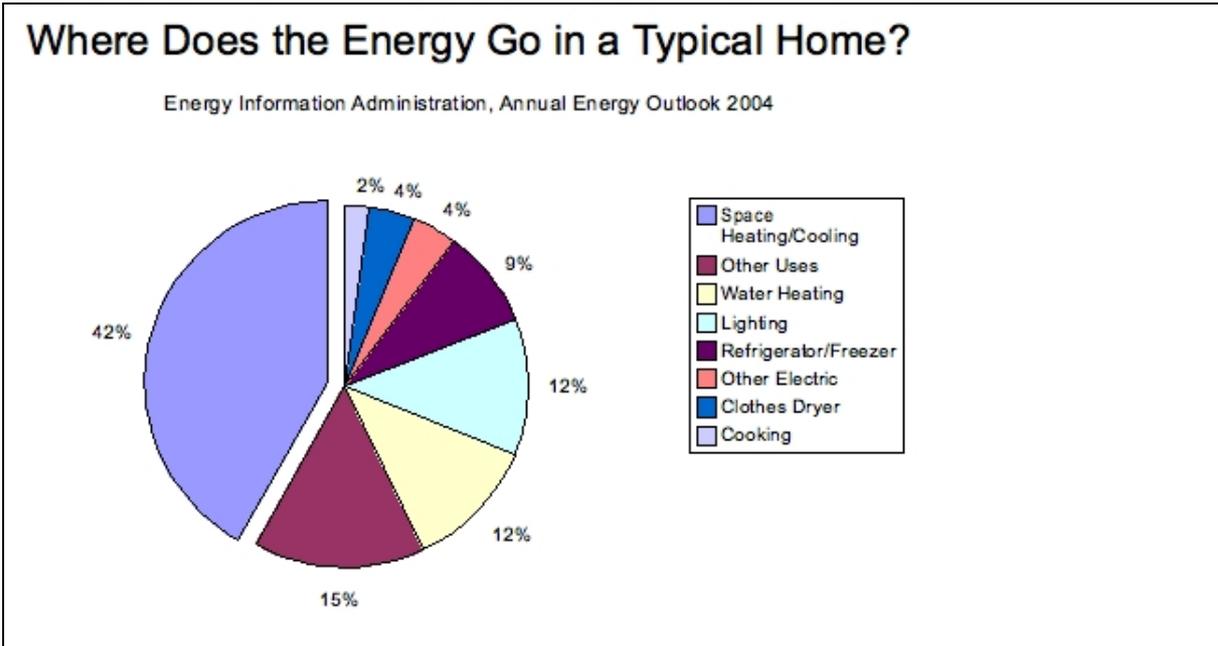
What would you do if there was no electricity or gas or petrol? How would you:

- | |
|---|
| 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? |

2. ELECTRICITY GENERATION IN SLOVENIA AND AROUND THE WORLD

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

<p>According to the Organization of American States' Office for Sustainable Development, the average American household uses about 10,000 kWh yearly.</p>	<p>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.</p>
<p>An average school uses 1500 kWh a day.</p> 	<p>An Example of a Typical Coal-Fired PowerStation</p>  <p>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.</p> <p>A single coal-fired power station unit can power many thousands of houses as well as large industry.</p> <p> GENERATING ELECTRICITY FROM COAL (09:28)</p>
<p>Imports by Energy Product</p> <p>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%)</p>	<p><i>The structure of energy consumption in Slovenia:</i></p>
<p>World dependence on different energy sources</p> 	<ul style="list-style-type: none"> • <i>buildings (heating, ventilation/air-conditioning): 43%,</i> • <i>transport: 31%,</i> • <i>buildings other 6%,</i> • <i>other 20%.</i>



1. What is Slovenia's biggest energy source?
2. What is 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	

PRESENTATION TIPS (Make notes based on the following structure.)

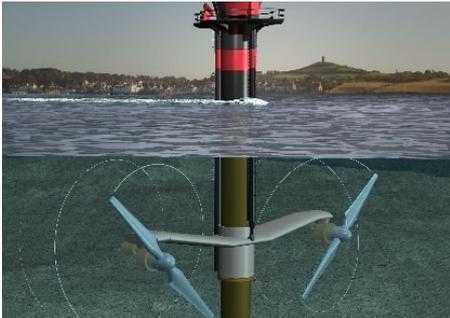
✓	Sections
	(1) Definition - What is energy?
	(2) Examples or applications (where it is used) - What are the different forms of energy? Where is energy used? Where was it used in the past?
	(3) How it works - Explain the earth's energy budget. How do power stations work?
	(4) Pros and cons - Focus on the different sources of energy discussed in the unit.
	(5) Your personal experience and/or personal opinion - Describe your household's energy usage. What, according to you, is the energy source of the future?

NOTES

NOTES - *continued*

Unit 2

RENEWABLE ENERGY



1. WHAT IS RENEWABLE ENERGY?

Task 1A Watch the video and fill in the gaps accordingly.



20% RENEWABLE ENERGY BY 2020 (03:56)

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

 <p><i>PSA, south of Spain Photo: SŠTS (LDV European Project)</i></p>	<p>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.</p>
 <p><i>One of the Europe's oldest 'modern' windturbines in Tarifa, south of Spain Photo: SŠTS (LDV European Project)</i></p>	<p>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.</p>
 <p><i>Hydroelectric power Credit: US Army Corps of Engineers</i></p>	<p>When this water vapor turns into rain or snow and flows downhill into rivers or streams, its energy can be captured using _____.</p>
 <p><i>Switchgrass crops can be harvested to make biofuels. Credit: Warren Gretz</i></p>	<p>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 _____.</p>

 <p><i>NASA uses hydrogen fuel to launch the space shuttles. Credit: NASA</i></p>	<p>_____ 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.</p>
 <p><i>The Earth's heat-called geothermal energy-escapes as steam at a hot spring in Nevada. Credit: Sierra Pacific</i></p>	<p>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.</p>
 <p><i>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.</i></p>	<p>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.</p>

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? Watch the video at the end for more ideas.

I think...

I don't think...



TOP 10 ENERGY SOURCES OF THE FUTURE (13:12)

PRESENTATION TIPS (Make notes based on the following structure.)

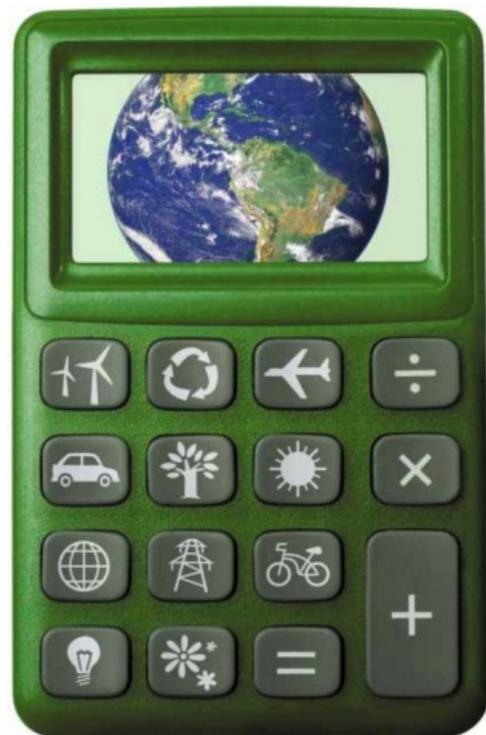
✓	Sections
	(1) Definition - What is renewable energy?
	(2) Examples or applications (where it is used) - What are the different forms of renewable energy? Why is renewable energy important?
	(3) How it works - How can renewable sources of energy be harnessed to produce electricity?
	(4) Pros and cons - Focus on the different sources of renewable energy discussed in the unit.
	(5) Your personal experience and/or personal opinion - Express your opinion on all the renewable sources of energy covered in this unit.

NOTES

NOTES - *continued*

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:

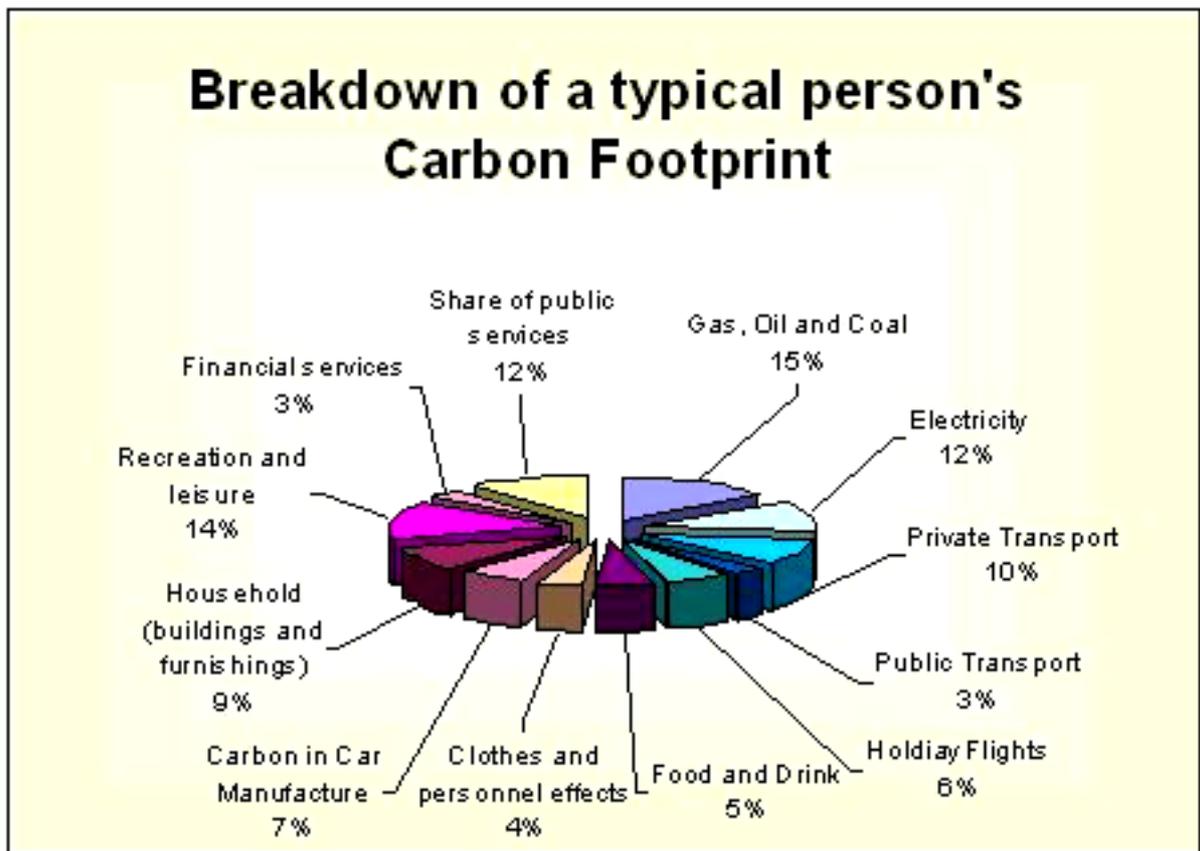
Fuel type	Unit	CO ₂ emitted per unit	Each of the following activities add 1 kg of CO₂ to your personal carbon footprint: <ul style="list-style-type: none"> • Travel by public transportation (train or bus) a distance of 10 to 12 km (6.5 to 7 miles) • Drive with your car a distance of 6 km or 3.75 miles (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!)
Petrol	1 litre	2.3 kg	
Diesel	1 litre	2.7 kg	
Oil (heating)	1 litre	3 kg	

The world-wide average is **4 tonnes** of carbon 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:

Source: <https://ourworldindata.org/per-capita-co2>

Carbon dioxide emissions (CO₂), metric tons of CO₂ per capita - in 2018:



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

CARBON DIOXIDE, CO₂, 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 global warming and complete the story.



NONE LIKE IT HOT! (01:43)

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 2B According to what you have learnt about carbon footprint so far, mark the statements as true (T) or false (F).

		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 CO ₂ .		
4	One litre of petrol emits one kilogram of CO ₂ .		
5	Operating my computer for 32 hours emits less than one kilogram of CO ₂ .		
6	Production of five plastic bags adds 10 decagrams of CO ₂ to my personal carbon footprint.		
7	The world-wide average is 1 ton of carbon dioxide (CO ₂) per person per year.		
8	The average of all industrialised nations is about 11 tons of carbon dioxide (CO ₂) per person per year.		
9	According to OurWorldinData Slovenia produced 6.95 tons of CO ₂ per person in 2018.		
10	According to OurWorldinData Mauritius produced 15 tons of CO ₂ per person in 2018.		

3. CALCULATE YOUR CARBON FOOTPRINT

Task 3A Ready to act? Use the CO₂ calculator (www.carbonindependent.org) to find out about your carbon footprint. Make notes on the following items and be ready to discuss them in class.

HOUSEHOLD

- Electricity
- Gas
- Heating
- Car usage

PERSONAL

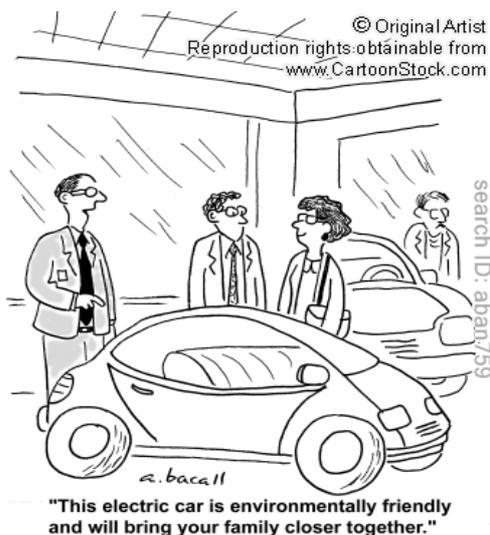
- Food
- Health and education
- Bus
- Train
- Flights
- Miscellaneous

	<p>My yearly carbon footprint is</p> <p>_____</p> <p>tonnes of CO₂</p>
---	---

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

1. household	A. the distance that a vehicle has travelled, measured in miles
2. tariff	B. a journey by plane to a destination and back to the original departure point
3. mileage	C. milk, eggs, cheese and other milk product
4. organic	D. a biological process in which organic waste is allowed to decompose under carefully controlled conditions
5. dairy	E. the people living together in one house collectively
6. composting	F. fit or suitable to be eaten; not poisonous
7. edible	G. produced or practised without using artificial chemicals
8. miscellaneous	H. a list of fixed prices that are charged by a company for a particular service (e.g. electricity)
9. return flight	I. a machine that is designed to do a particular thing in the home, such as preparing food, heating or cleaning
10. household appliance	J. consisting of many different kinds of things that are not connected and do not easily form a group

1	2	3	4	5	6	7	8	9	10



4. CARBON FOOTPRINT REDUCTION

Task 4A 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. ...)
- 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:	

Task 4B Watch the video HOW TO REDUCE YOUR CARBON FOOTPRINT and write down the tip given about each of the following points.



HOW TO REDUCE YOUR CARBON FOOTPRINT (02:32)

About...	Tip
Thermostats	
Electronics	
Bulbs	
Laundry/dishwashing	
Buying food	
Buying coffee	
Water	
Trees	
Car trips and other means of transportation:	
<i>Bonus question: What do we learn about methane in the video?</i>	

Task 4C Translate the following expressions into English.

Slovenian	English
1. Občutek odgovornosti	
2. Zamenjaj žarnice z žarilno nitko	
3. Vačne žarnice	
4. Peri, ko je stroj poln	
5. Bio – nesezonska zelenjava	
6. Velika platnena torba	
7. Prinesi svojo skodelico za kavo	
8. Ustekleničena voda	
9. Voda iz pipe	
10. Drevesa zmanjšujejo toplogredne pline	
11. Združi svoja potovanja	

5. WHAT IS THE PARIS AGREEMENT?

The Paris Agreement is an international treaty that sets out a global framework to avoid dangerous climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C. It also aims to strengthen countries' ability to deal with the impacts of climate change and support them in their efforts.

The Paris Agreement is the first-ever universal, legally binding global climate change agreement, adopted at the Paris climate conference (COP21) in December 2015.

The EU and its Member States are among the close to 190 Parties to the Paris Agreement. The EU formally ratified the agreement on 5 October 2016, thus enabling its entry into force on 4 November 2016. For the agreement to enter into force, at least 55 countries representing at least 55% of global emissions had to deposit their instruments of ratification.

Adapted from: https://ec.europa.eu/clima/policies/international/negotiations/paris_en

Task 5A Find out the CO₂ reduction commitment made by these countries as part of the Paris Agreement.

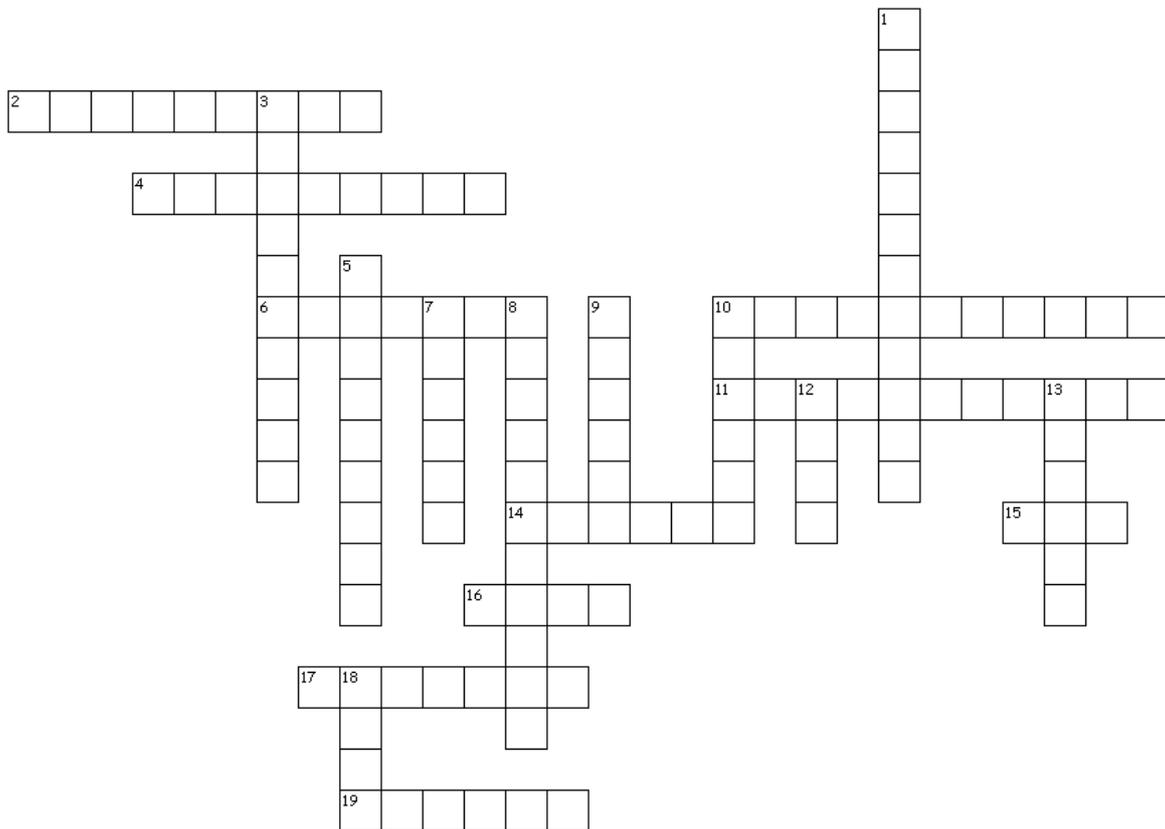
Slovenia		
United Kingdom		
Mauritius		
Croatia		
USA		

Task 5B Is the Paris agreement 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

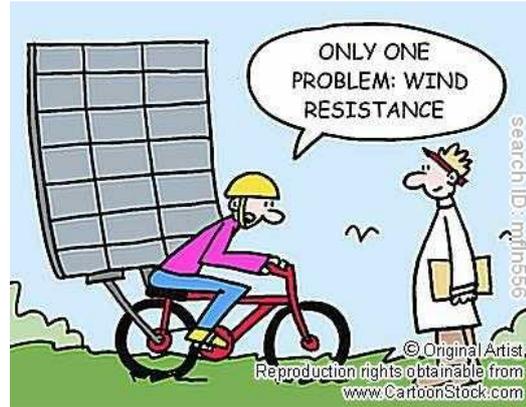
Created by Puzzlemaker at DiscoveryEducation.com

PRESENTATION TIPS (Make notes based on the following structure.)

✓	Sections
	(1) Definition - What does the term <i>carbon footprint</i> mean?
	(2) Examples or applications (where it is used) - Give examples of some of the daily activities that contribute to an individual's carbon footprint. Why is it important these days for companies to calculate their carbon footprint?
	(3) How it works - Explain the process of calculating one's individual carbon footprint. Explain the global warming mechanism and the greenhouse effect. What is the Paris Agreement? Why is it significant?
	(4) Pros and cons - What are the positive and negative impacts of individuals and companies trying to reduce their carbon footprint?
	(5) Your personal experience and/or personal opinion - How can we reduce our individual carbon footprint? What are the steps that you are personally willing to take?

NOTES

NOTES - *continued*



Unit 4

SOLAR POWER



Didactical solar generators on the roof of SŠTS, Šiška

1. Learn a few facts about solar energy
2. Solar PV modules
3. Solar thermal energy
4. Solar power plant on the roof of SŠTS Šiška
5. Advantages and disadvantages of solar power
6. Glossary
7. Check your knowledge
8. Crossword



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.



AMAZING FACTS ON SOLAR POWER (02:12)

2. SOLAR PV MODULES

Task 2A Watch the video HOW DO SOLAR PANELS WORK? and supply the text with information.



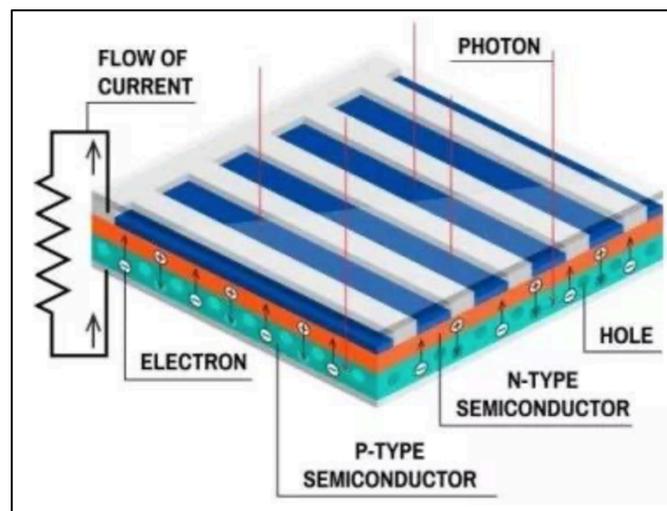
HOW DO SOLAR PANELS WORK? (02:37)

Solar panels are made of smaller units called solar _____, with the most common ones being made from _____.

Each cell contains two different layers of the semiconductor material. The _____ layer has extra electrons, while the _____ layer consists of extra spaces for the electrons, also called _____.

Tiny particles from sunlight, called _____, trigger the movement of electrons across the two layers. The mobile electrons are first collected by thin metal fingers at the top of the cell and then channelled out via an external _____, ready to do electrical work.

Each cell only generates _____ a volt, but you can string them together in _____ to get more power. 12 _____ cells are enough to charge a cell phone.

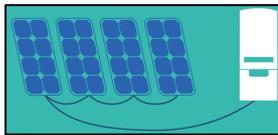


The Photovoltaic Effect

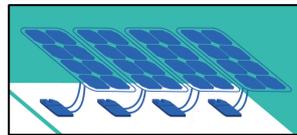
Task 2B Watch the video UNDERSTANDING SOLAR INVERTERS and answer the questions.



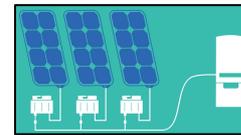
UNDERSTANDING SOLAR INVERTERS (02:28)



String inverters



Microinverters



Power optimizers

1. What is the function of a solar inverter?
2. Name one advantage and one disadvantage of string inverters.
3. What are the optimal conditions to use string inverters?
4. What is the main advantage of using microinverters?
5. What is the benefit of conditioning electricity from each module in a plant running on power optimizers?

3. SOLAR THERMAL ENERGY

Task 3A Read the text and study the scheme.

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.

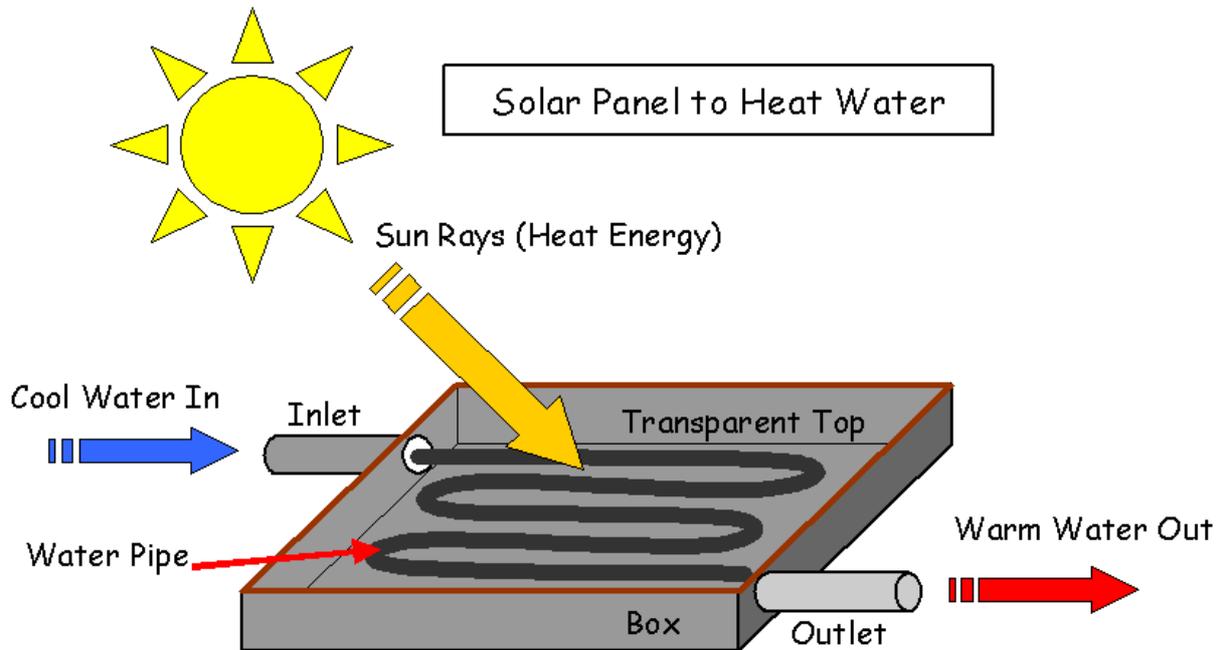
- **Low temperature collectors** are flat plates generally used to heat swimming pools.
- **Medium-temperature collectors** are also usually flat plates but are used for heating water or air for residential and commercial use.
- **High temperature collectors** concentrate sunlight using mirrors or lenses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

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.



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

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

Task 4A 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 4B Form meaningful sentences about the school's solar power plant by matching each phrase on the left to its corresponding one on the right.

- | | |
|--|--|
| 1. The horizontal solar power generator... | ... due to its photovoltaic rods. |
| 2. The tubular generator is able to catch rays from any direction... | ... corrects its position every minute so that it keeps following the sun. |
| 3. One of the generators is called the optimal one... | ... is the one located on its inclined roof. |
| 4. The biggest solar power generator at our school... | ... because it is oriented directly towards the south. |
| 5. The 2-axis solar tracking system... | ... is especially efficient when the weather is misty or foggy. |

Task 4C 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 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 are 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.

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
OVERSHADOWED			elektron
STAND-ALONE SYSTEM			sprostiti
DIRECT CURRENT			ploščica, opeka
ALTERNATING CURRENT			polprevodnik
PEAK LOAD			začetni strošek
INSTALLATION COST			sončna celica
THE ANGLE OF INCIDENCE			cevni generator
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

SERIES CONNECTION			usmernik
GENERATOR			krmilnik
MULTICRISTALLINE			točka najvišje moči

7. CHECK YOUR KNOWLEDGE

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

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

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

The cells _____ 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 _____.

Gray “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.

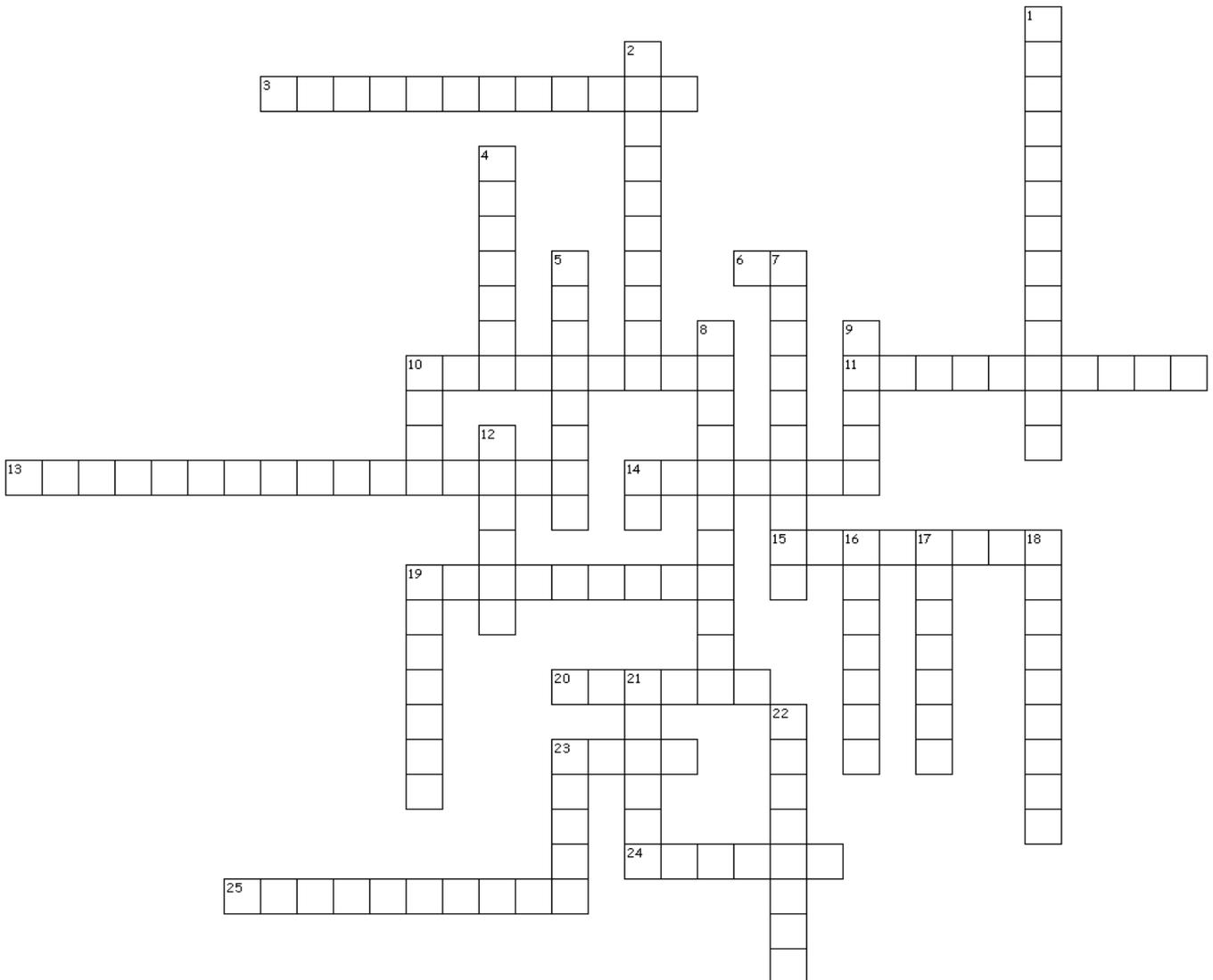
Is solar energy suitable for your home?

- 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, 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

Appendix



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.





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.

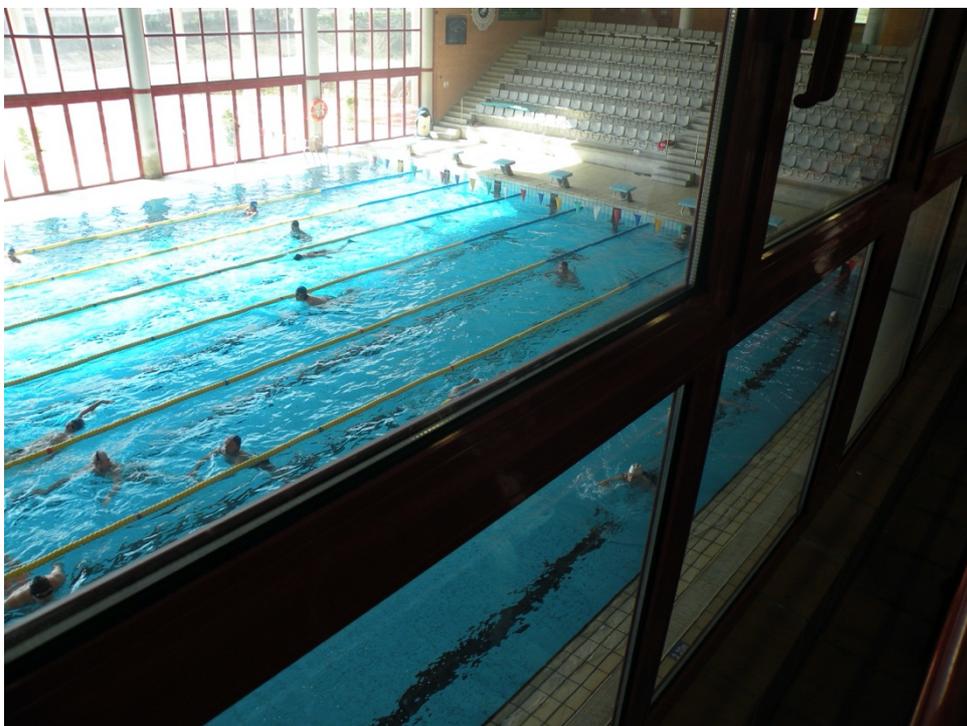


If you use mirrors and stream the sunlight (above), the final result can be a hole in an iron plate (below).





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.

PRESENTATION TIPS (Make notes based on the following structure.)

✓	Sections
	(1) Definition - What is solar energy? Can you recall some of the interesting facts on solar energy that were covered at the beginning of this unit?
	(2) Examples or applications (where it is used) - How can we benefit from solar energy?
	(3) How it works - How do PV modules work? How do solar thermal panels work?
	(4) Pros and cons - Evaluate the sun as an energy source, focussing especially on solar power and solar thermal systems.
	(5) Your personal experience and/or personal opinion - Do you own any device that is solar-powered? How about your household's energy solutions? What is your opinion on using solar energy for electricity production?

NOTES

NOTES - *continued*

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 **CRAZY WINDMILLS** about the California wind farm and answer the following questions. Guess the answers before watching the video.



CRAZY WINDMILLS (01:56)



San Geronio 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 Geronio 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 Geronio 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 windmill?
9. Who were the windmills engineered by?

2. TYPES OF WIND TURBINES

Task 2A 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.



Photo: Zdravko Žalar (SŠTS)

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.

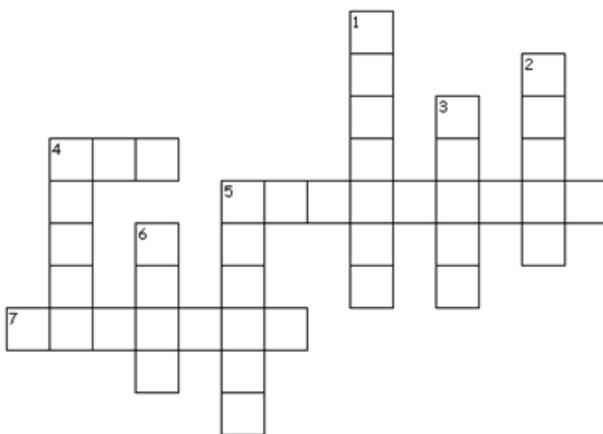
Commercial Onshore Wind Farm Projects

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.ecoqeeq.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 2B Fill in the crossword. You will find the answers among the highlighted words in the text.

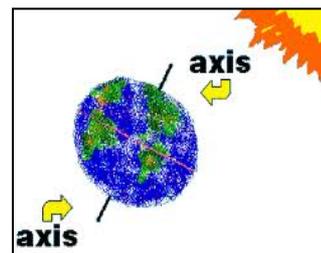


Across

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

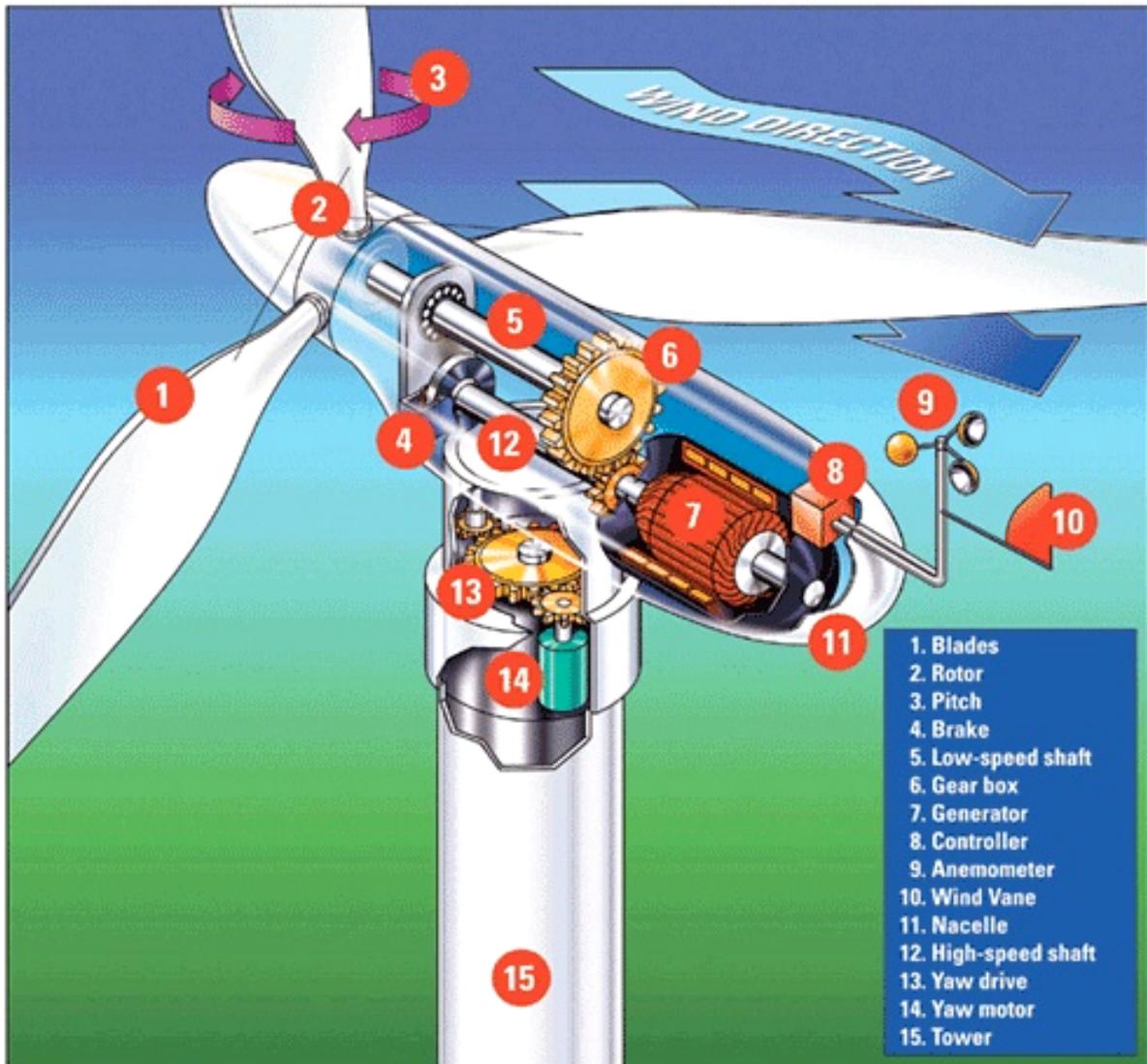
Down

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



3. HOW DO WIND TURBINES WORK?

Task 3A Study the wind turbine picture dictionary.



Source: <http://ip190.k12.sd.us/Classes/Digit-al/Photos/Turbine%20Parts.jpg>, June, 2012

Translations in Slovene

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

4. WIND GENERATOR ON THE ROOF OF SŠTS ŠIŠKA

Task 4 Read the original technical specifications of the wind generator that is set up on the roof of the Secondary School of Technical Professions Šiška.



AIR-X WIND TURBINE SPECIFICATIONS



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. They are 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 zaščiten pred preveliko hitrostjo vetra?	
Iz česa so narejene vetrnice?	
Kakšen je krmilnik?	
Koliko časa velja garancija?	



5. ADVANTAGES AND DISADVANTAGES OF WIND POWER

Task 5A 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 5B 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?

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

Task 6A Watch the video “Do Wind Turbines Make Noise?” and then express your own opinion.



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.



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



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



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

PRESENTATION TIPS (Make notes based on the following structure.)

✓	Sections
	(1) Definition - Define the terms <i>wind energy</i> , <i>wind power</i> and <i>wind turbine</i> .
	(2) Examples or applications (where it is used) - What are the different types of wind turbines? What other uses of wind energy are you aware of?
	(3) How it works - Explain how a typical wind turbine works.
	(4) Pros and cons - What are the well-known pros and cons of using wind to produce electricity?
	(5) Your personal experience and/or personal opinion - What is your personal opinion on using wind energy for electricity production?

NOTES

NOTES - *continued*

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. The amazing power of water
2. Hydro Power: Generating methods
3. Inside the power plant
4. Advantages and disadvantages of hydro energy
5. Learn more

1. THE AMAZING POWER OF WATER

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

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 _____.

Task 1B Watch the silent video and appreciate the amazing power of water. Then, briefly discuss the content of the video with a classmate, using the words covered in task 1A.



THE AMAZING POWER OF WATER (02:01)

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

2. HYDRO POWER: GENERATING METHODS

Task 2A Read and draw a scheme. Watch the video HYDRO POWER and use the included links for help.



HYDRO POWER (01:32)

Generating Methods	How it works	Draw a simple scheme
<p>CONVENTIONAL (DAMS) Help: VIDEO</p>	<p>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.</p>	
<p>PUMPED STORAGE Help: VIDEO</p>	<p>This method produces electricity to supply high peak demands by moving water between reservoirs at different elevations.</p>	
<p>RUN-OF-THE-RIVER Help: VIDEO</p>	<p>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.</p>	
<p>TIDE Help: http://visual.merriam-webster.com/energy/hydroelectricity/tidal-power-plant/tidal-power-plant.php</p>	<p>A tidal power plant makes use of the daily rise and fall of ocean water due to tides.</p>	
<p>UNDERGROUND Help: http://en.wikipedia.org/wiki/Churchill_Falls_Generating_Station</p>	<p>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.</p>	

Task 2B Watch the video **A SMART WAY OF HARNESSING HYDRO ENERGY** and answer the questions.



A SMART WAY OF HARNESSING HYDRO ENERGY (02:22)

1. Almost 75% of Australia's energy comes from _____.
 - a) coal
 - b) natural gas
 - c) nuclear power
 - d) hydro power
2. Which island is thought to hold the answer to Australia's energy needs?
 - a) Cook Islands
 - b) Fiji
 - c) Tasmania
 - d) New Zealand
3. Which of the following forms of energy are mentioned as part of the solution provided by the above-mentioned island? (***select all that apply***)
 - a) Hydro
 - b) Wind
 - c) Solar
 - d) Nuclear
4. Which variant of hydro power is suggested as a complement to other existing renewable energy systems?
 - a) Offshore
 - b) Storage
 - c) Run-of-river
 - d) Pumped storage
5. Which of the following statements are true about the above-mentioned variant of hydro power? (***select all that apply***)
 - a) It will be put to use when the other types of renewable energy plants cannot fully meet the demands of the power grid.
 - b) The pumps will be powered by Australia's coal-powered plants.
 - c) Water is captured and stored in two places.
 - d) It is ideal for the island because it has many steep hills.



Australia and the Pacific islands

DID YOU KNOW?

The Hydro Power Plant at Avče (along the River Soča) is the only pumped storage hydro power plant in Slovenia.

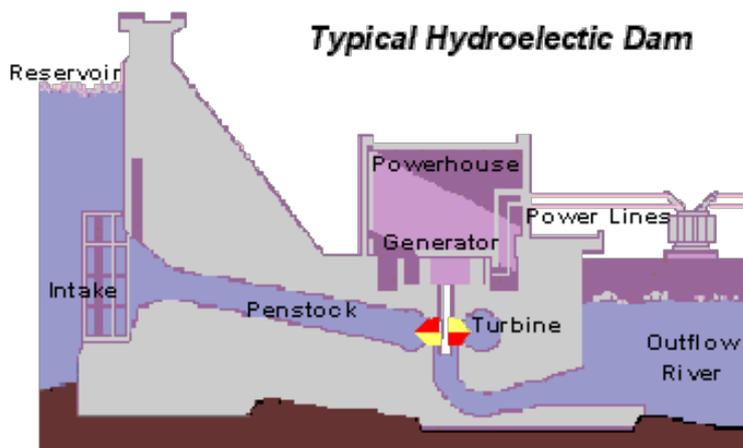


3. INSIDE THE POWER PLANT

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:

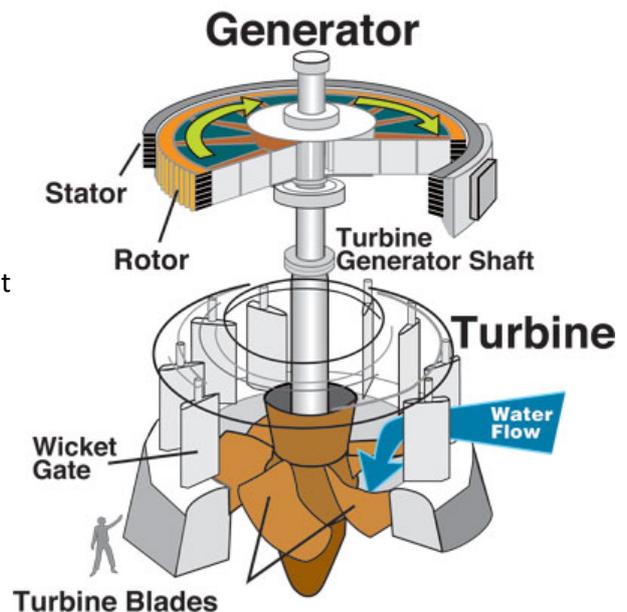


The theory is to build a dam on a large river that has a large drop in elevation. The dam stores lots of water behind it in the reservoir. Near the bottom of the dam wall there is the water intake. Gravity causes it to fall through the penstock inside the dam. At the end of the penstock there is a turbine 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."



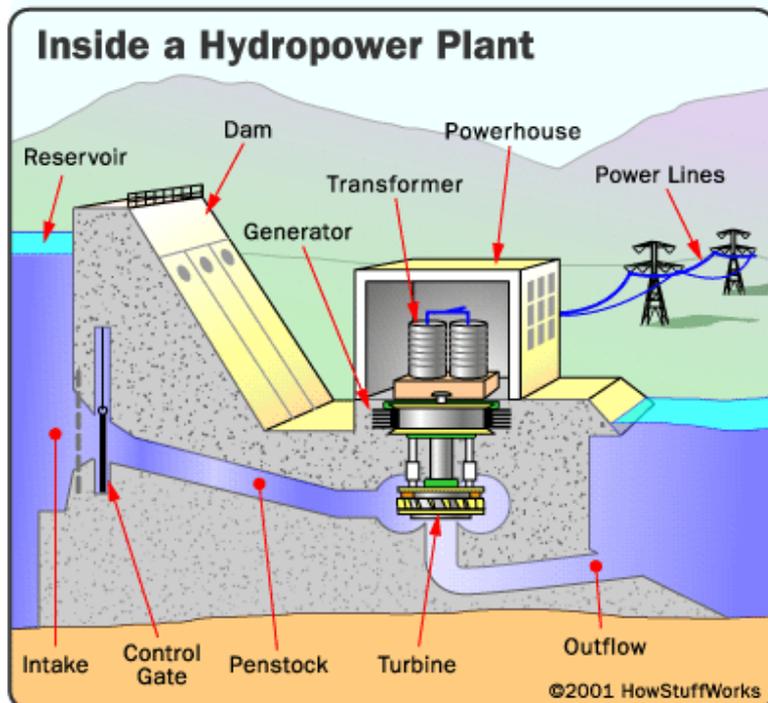
Adapted from: <http://ga.water.usgs.gov/edu/hyhowworks.html>, June 2012

1. Which part of the hydroelectric plant is referred to as a propeller-like piece?
2. What causes the above component to spin?
3. What connects the above component to the generator?
4. What is the function of the generator?
5. What do we call the structure which stores the water? What do we learn about its relative position with the hydroelectric power station?
6. What causes water to fall through the penstock?
7. How is electricity carried to your home?
8. What did Faraday find out about magnets and conductors?
9. What are the field poles (electromagnets) mounted on the rotor made of?
10. Where are the conductors mounted? <i>Can you guess why this part was given such a name?</i>

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
- control gate
- turbine
- power lines
- transformer
- outflow
- penstock
- dam

	a barrier that regulates water released from the reservoir to the power generation unit
	Four of them come out of the power station, three of which are used to carry the three phases of power that are produced simultaneously and another one responsible for the neutral or ground common to all three phases.
	Most hydropower plants rely on it because it holds back water, creating a large reservoir. Often, this reservoir is used as a recreational lake.
	the area where used water re-enters the river downstream
	the pipeline in which water builds up pressure as it is lead to the turbine
	Inside these machines, 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.
	It can weigh as much as 172 tons and turn at a rate of 90 revolutions per minute (rpm), as the water strikes its large blades. It is attached to a generator above it by way of a shaft.

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

4. ADVANTAGES AND DISADVANTAGES OF HYDRO ENERGY

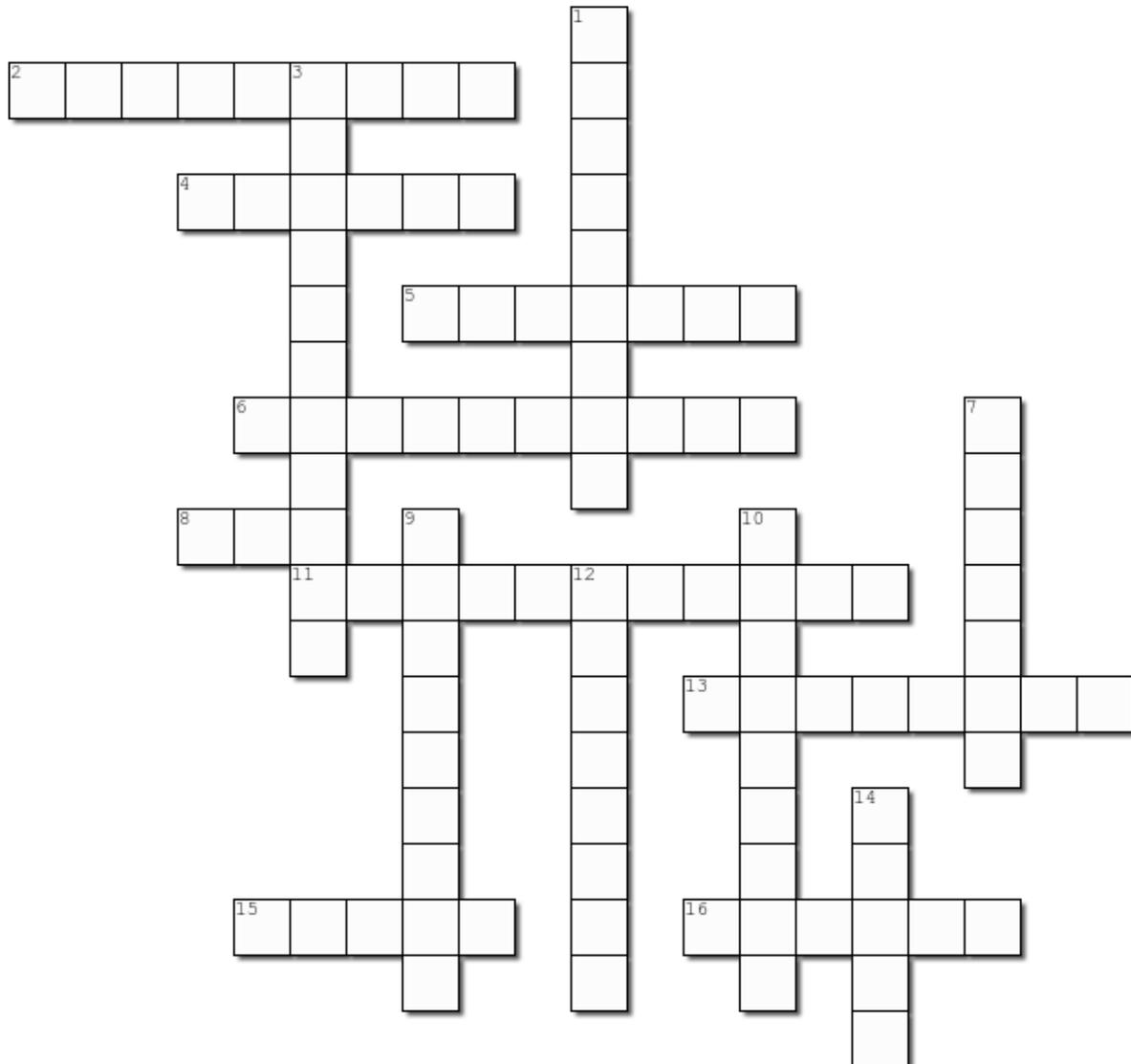
Task 4A Read the statements about hydro energy and decide whether a statement is a disadvantage (D) or an advantage (A).

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 a 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 noted 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 5C Solve the crossword by translating the clues into English.**HYDROELECTRIC ENERGY**

Across	Down
2. nadmorska višina	1. rezervoar
4. stator	3. transformator
5. gravitacija	7. iztok
6. daljnovodi	9. generator
8. jez	10. rečni breg
11. elektrika	12. struga
13. dotočni cevovod	14. gred
15. rotor	
16. vnos	

APPENDIX

The Evolution of Hydropower



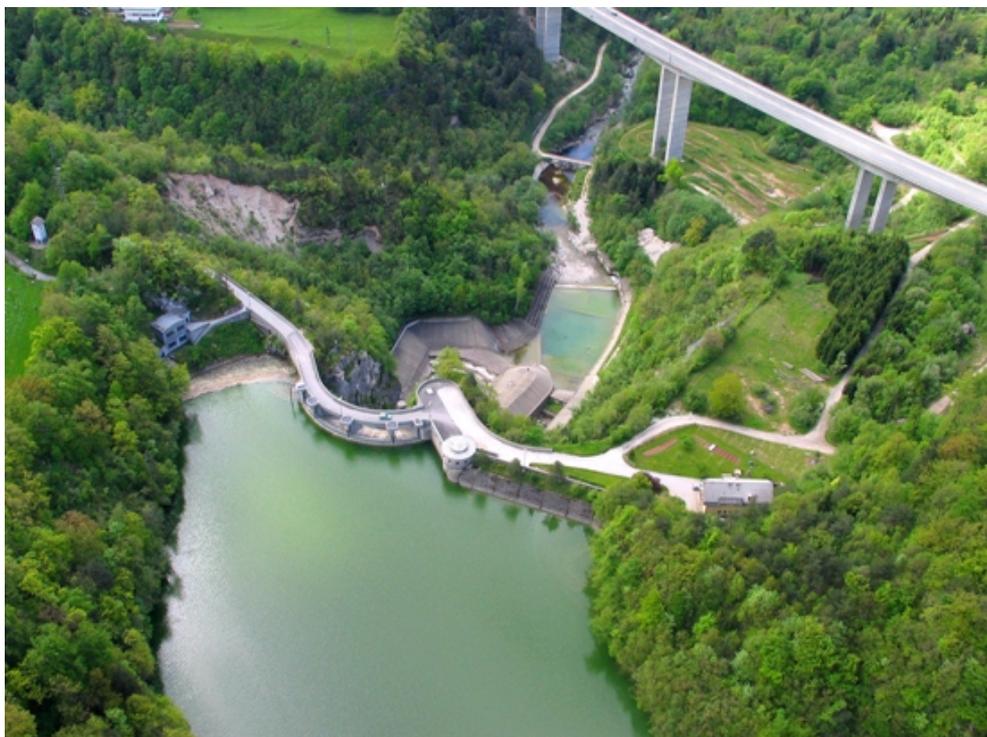
Windmills, one of the first inventions powered by water



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

PRESENTATION TIPS (Make notes based on the following structure.)

✓	Sections
	(1) Definition - What is hydro power?
	(2) Examples or applications (where it is used) - What are the different types of hydro power plants? What other uses of hydro energy are you aware of?
	(3) How it works - Explain how a typical hydro power plant works.
	(4) Pros and cons - What are the well-known pros and cons of using hydro energy to produce electricity?
	(5) Your personal experience and/or personal opinion - What is your personal opinion on using hydro energy for electricity production?

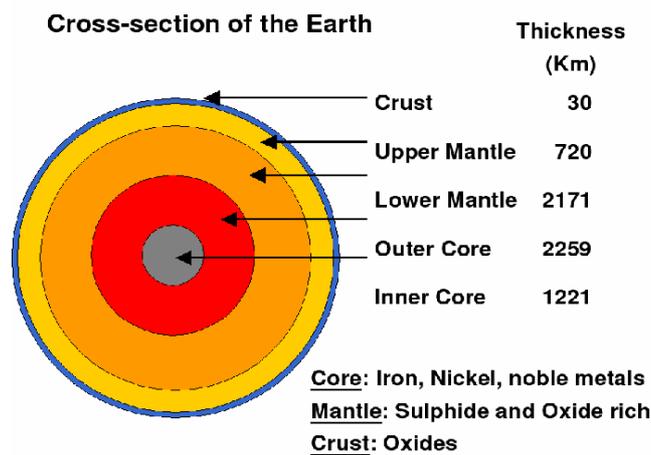
NOTES

NOTES - *continued*

Unit 7

GEO THERMAL 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?

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 (00:32)



FLY GEYSER IN THE BLACK ROCK DESERT, NEVADA (01:14)



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.

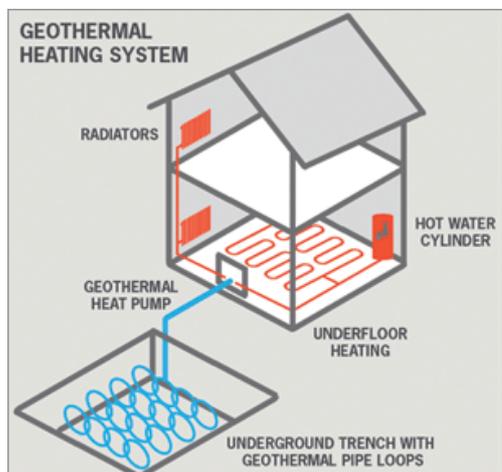
Between 1983 and 1994, four probes containing temperature and pressure measurement devices and video equipment were lowered into Old Faithful. The probes were lowered as deep as 22 m. Temperature measurements of the water at this depth was 118 °C.

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 Watch the brief introduction to geothermal heating. Then read the adapted tapescript and fill in the missing words.



WHAT IS GEOTHERMAL HEATING? (01:17)

Geothermal heating

Seasons come and go. In the summer months it can be quite 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 _____.

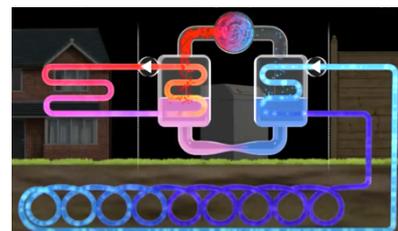
So, what are the _____ of geothermal heating? Well, for one, you can save a lot of money. Geothermal uses way less of energy to operate and this means that heating bill that is up to 80% _____ than that of the traditional heating system. Secondly, geothermal doesn't run on _____ like oil and gas and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

Task 2C Watch the video HOW A GROUND SOURCE HEAT PUMP WORKS and then fill in the gaps accordingly.



HOW A GROUND SOURCE HEAT PUMP WORKS (03:08)

1. The purpose of a geothermal heat pump is to absorb _____ heat from the ground, transport, concentrate and release it somewhere else, for space and water heating.
2. The anti-freeze mix transfers heat from the ground to a heat exchanger called the _____.
3. A heat transfer fluid, also known as the _____, absorbs heat from the anti-freeze mixture, boils into gas and then goes on to the next stage.
4. The _____ is the area in the heat pump responsible for increasing the temperature of the above-mentioned gas.
5. Inside the _____, heat from the hot gas is transferred to the water that circulates around the property.
6. For every kW of electricity it uses, this heat pump generates _____ kW of energy.



3. GEOTHERMAL POWER PLANTS

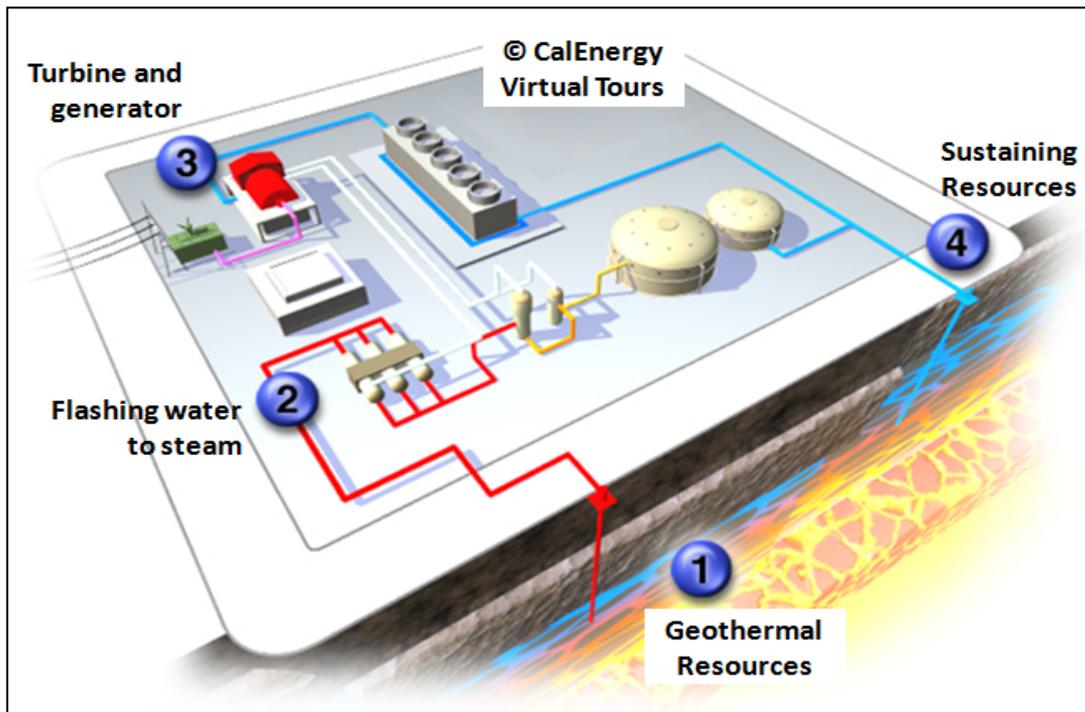
Geothermal power plants use the natural heat of the earth to generate electricity for homes and businesses. Geothermal power is a renewable source of energy and does not rely on coal or other fossil fuels to create electricity.



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 3A Study the following diagram of a geothermal power plant owned by the company CalEnergy. Then, try explaining to your classmate how the plant works.



Task 3B Now, watch the video CALENERGY'S GEOTHERMAL POWER PLANT for a detailed explanation of the plant's operation. Make a list of the key details that were not covered in your preliminary discussion.



CALENERGY'S GEOTHERMAL POWER PLANT (04:45)

Task 3C Watch the video again and fill in the gaps in its incomplete tapescript below.



CALENERGY'S GEOTHERMAL POWER PLANT (04:45)

Welcome to one of CalEnergy's geothermal power plants. Unlike other power plants that rely on coal or other fossil fuels to create electricity 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 than 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.

Task 3D Read the above tapescript again and answer the questions.

1. How is the superheated fluid formed?	
2. What are production wells?	
3. What are the three types of steam produced in the system?	
4. What are injection wells used for?	
5. What causes the blades of the turbine to rotate?	
6. How is the output voltage increased before distribution?	
7. How does the power plant ensure that the geothermal resource never depletes?	

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 /

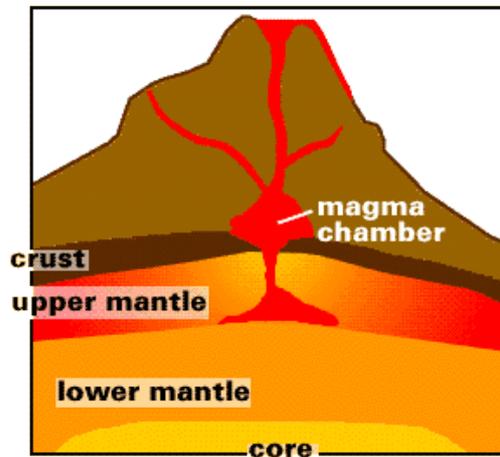
A device that removes silica from geothermal fluids and develops low-pressure steam.

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

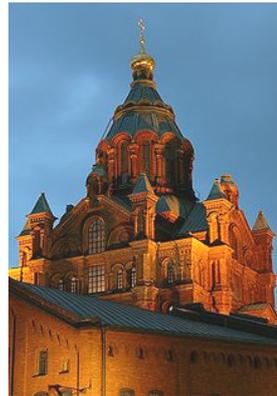
Task 5A Watching the video, pay special attention to the eco-efficient data centre and fill in the gaps in the text.



HELSENKI'S UNDERGROUND MASTER PLAN (05:48)



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 center developed by utility Helsingin Energia and ISP Academica. The _____ megawatt facility is located _____ meters below the Uspenski Cathedral, a historic church.

The data center 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, photo: SŠTS Šiška, EU LDV project, 2010

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

	<p>A key-word, also a key word, is</p> <ol style="list-style-type: none"> 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.
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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.

<p>What is an abstract?</p> <p>An abstract is a condensed version of a longer piece of writing that</p> <ul style="list-style-type: none"> • highlights the major points covered; • concisely describes the content; • and reviews the writing's contents in abbreviated form. <p>Why are abstracts so important?</p> <p>The practice of using key words in an abstract is vital because of today's electronic information retrieval systems.</p> <p>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.</p> <p>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.</p>	
---	---

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	

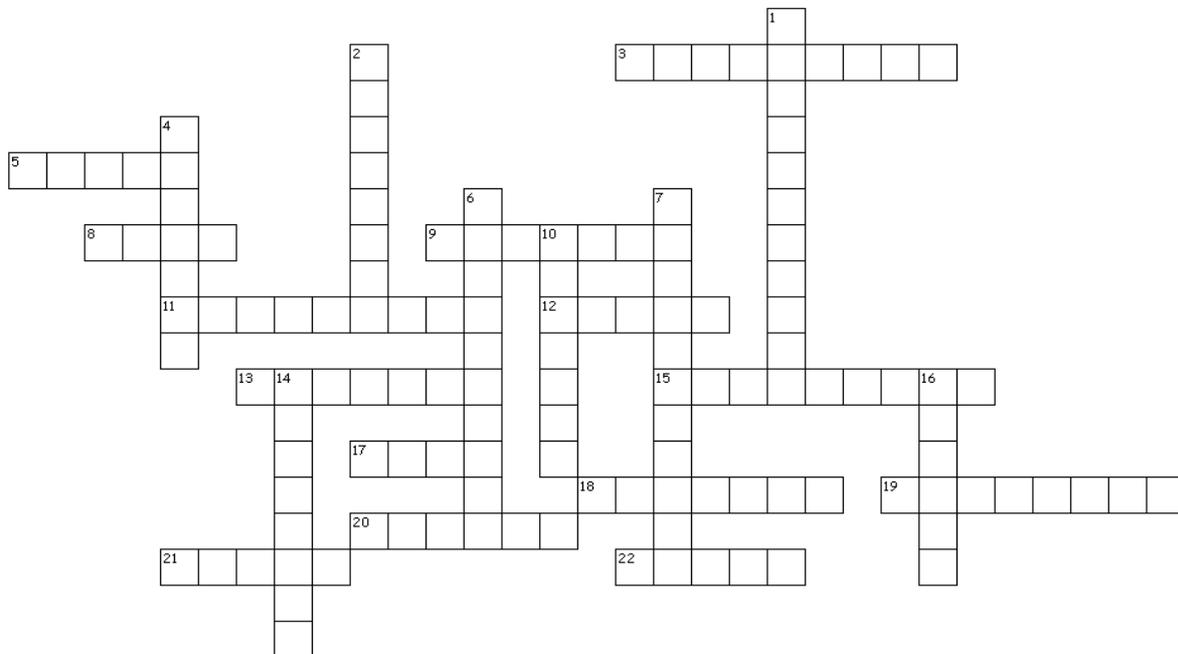
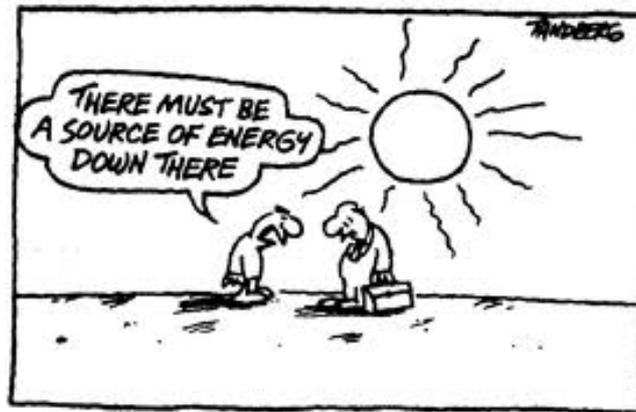
USE AT LEAST 3 LINKING WORDS:

although
 on the other hand
 it is also...
 not only...but,
 ...too
 another point is that...
 on the plus side...
 moreover
 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. © Photo: Polona Petrovčič



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



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.

PRESENTATION TIPS (Make notes based on the following structure.)

✓	Sections
	(1) Definition - What is geothermal energy, where does it come from, and in what forms?
	(2) Examples or applications (where it is used) - Give examples of natural phenomena that are a result of geothermal energy. What are the uses of geothermal energy?
	(3) How it works - Explain how a geothermal power plant works. Explain how geothermal energy can be used to heat and cool homes. Explain how a ground source heat pump works. Describe Helsinki's underground masterplan.
	(4) Pros and cons - What are the pros and cons of the applications of geothermal energy explained in this unit.
	(5) Your personal experience and/or personal opinion - What is your personal opinion on geothermal systems? Would you have such a system installed at your place? Why (not)?

NOTES

NOTES - *continued*

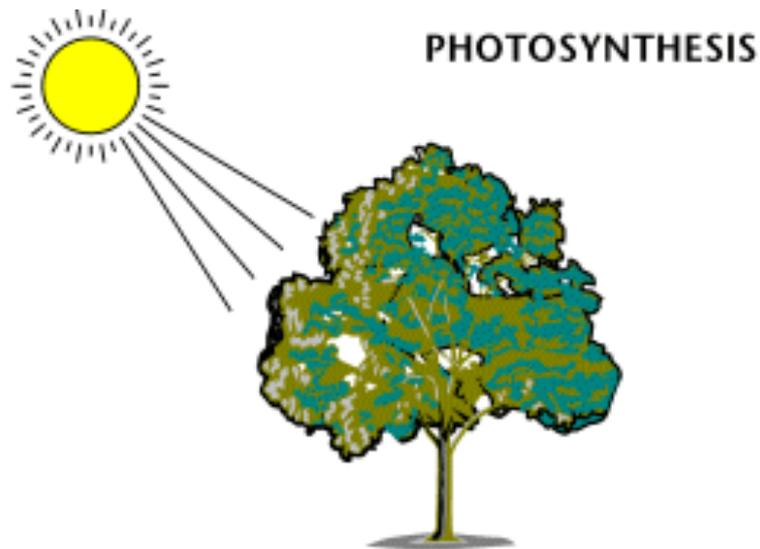
Unit 8

BIOMASS

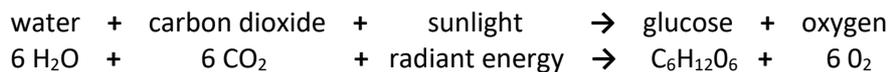
Plants use and store carbon dioxide (CO₂) when they grow.

When plants burn or decompose, they release CO₂.

Replanting plants, crops or trees etc. ensures that the CO₂ is reused.



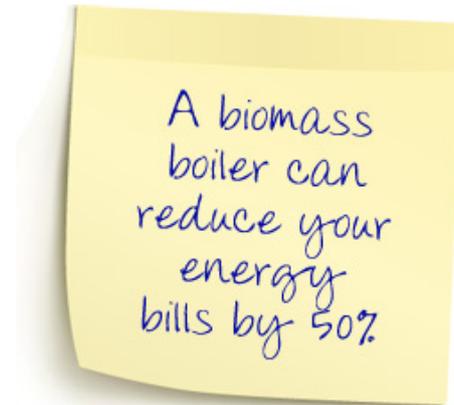
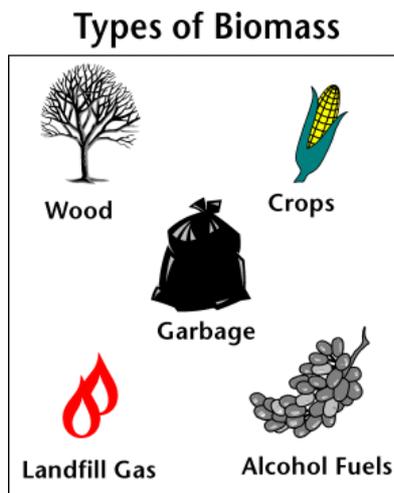
In the process of photosynthesis, plants convert radiant energy from the sun into chemical energy in the form of glucose – or sugar.



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 **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.

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



WOOD PELLETS PRODUCTION PLANTS - TVM (03:36)

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 anaerobic 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.

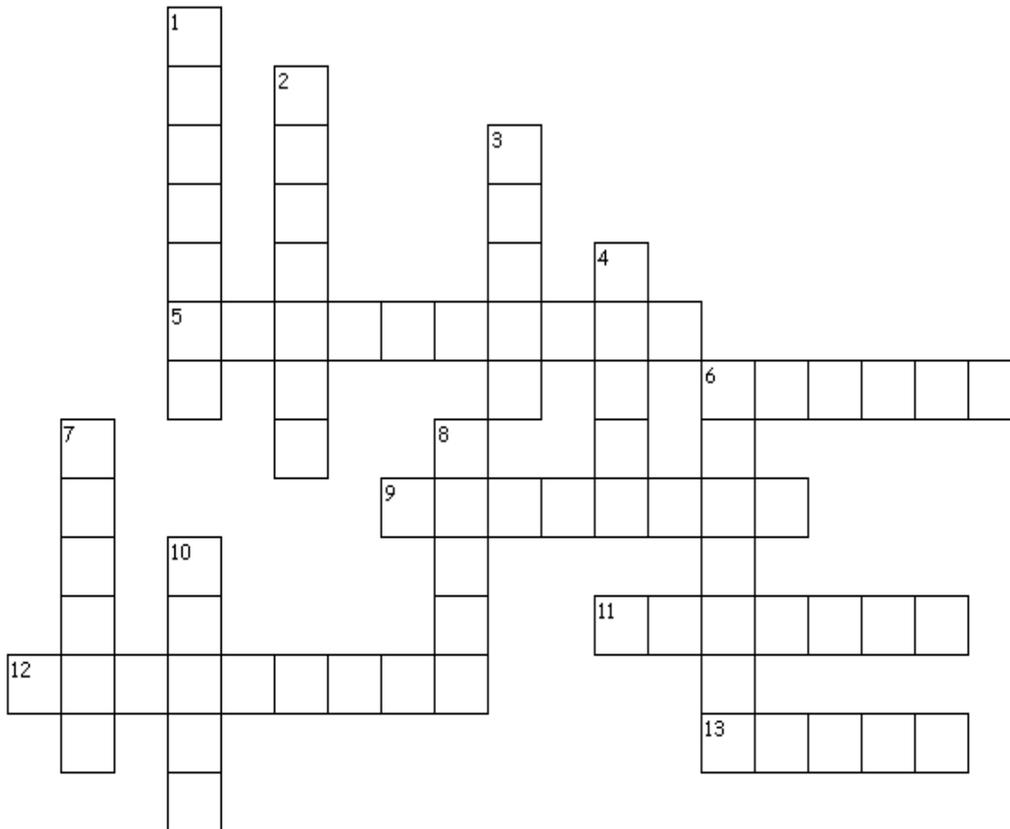
The dried material then undergoes further homogenisation processes before being moved to the _____, which shapes it into pellets.

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

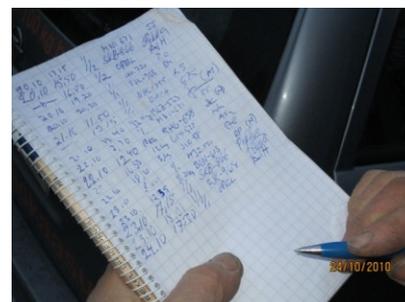
Photos were taken by teachers of SŠTS Šiška during their visit, which was funded by the European project Leonardo de Vinci in 2010.

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.

PRESENTATION TIPS (Make notes based on the following structure.)

✓	Sections
	(1) Definition - What is biomass?
	(2) Examples or applications (where it is used) - What are the forms that biomass exists in? Describe the potential of biomass as a source of energy.
	(3) How it works - Explain how biomass can be used to generate electricity. How do biomass-based heating systems work? Can you recall how wood pellets are made?
	(4) Pros and cons - What are the well-known pros and cons of using biomass as a source of energy?
	(5) Your personal experience and/or personal opinion - What is your personal opinion on biomass as an energy solution?

NOTES

NOTES - *continued*

Unit 9

WASTE MANAGEMENT

CITY OF PORT COQUITLAM

CLEAN, EMPTY AND DRY RECYCLABLES:

- Newspaper and paper, including envelopes, computer and writing paper
- Shredded paper (preferably in plastic bags)
- Plastic bags (bagged together)
- Boxes – cereal, cracker, standard and corrugated
- Magazines and phone books
- Milk jugs (rinse)
- Tin cans and pie plates (rinse)
- Pizza boxes (without food residue)
- Plastics (codes 1, 2, 3, 4 and 5)

FOOD SCRAPS, FOOD-SOILED PAPERS AND PLANT/YARD TRIMMINGS:

- Meats, fish, bones, seafood shells
- Eggshells
- Pasta, rice, baked goods, desserts
- Dairy, oils, butter, sauces
- Coffee grinds/filters, tea bags/leaves
- Vegetable/fruit peels, seeds, pits
- Food-soiled uncoated paper products – pizza boxes, paper plates, napkins, etc.
- Wood chopsticks, skewers, stirsticks
- Grass clippings
- Branches, twigs and Christmas trees (no tinsel/flocking) in pieces up to 3" diameter and 40" long
- Leaves, weeds and plant trimmings

NO: plastics of any type, plastic bags (including biodegradable and compostable plastic-type bags), metal, foil, recyclables, construction/renovation materials, household garbage, pet waste, kitty litter

WHERE DOES IT GO?

Food Scraps, Yard Trimmings GREEN CART

Clean Paper, Plastic, Tins BLUE CART

Whatever's left LANDFILL CART

What goes into each cart

THINGS THAT DO NOT GO INTO THE GREEN OR BLUE CART:

- Regular household garbage
- Styrofoam plates, cups, chips (bagged)
- Plastics (codes 6 and 7) and of unknown origin
- Non-fluorescent light bulbs
- Diapers

NO: glass, styrofoam, needles, diapers, light bulbs, construction/renovation materials, paint cans, motor oil containers, medical waste

NO: pet waste, construction/renovation materials, recyclables, yard trimmings, hazardous materials, medical/special waste, electronics

More info and disposal alternatives:
www.portcoquitlam.ca/greencart

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.

Task 1 Search the web for these countries' municipal waste generation by person per year.

According to the United Nations Statistics Division, the amount of municipal waste in Slovenia in 2016 was 463 kg per capita, which means 1.27 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
463 (2016)						

2. WHAT CAN BE DONE?



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



THE 3 Rs – BY JACK JOHNSON (02:44)

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.



THE 3 Rs – LYRICS (02:44)

Task 2C Write down two things that you could easily reduce, reuse or recycle and add one argument for each.

I could reduce...	Argument
EXAMPLE: <i>The amount of non-biodegradable plastic I use</i>	<i>It can cause long-term pollution, block drains and harm animals.</i>
1.	
2.	
I could reuse...	Argument
1.	
2.	
I could recycle...	Argument
1.	
2.	

3. THE WASTE MANAGEMENT CONCEPT IN FREIBURG

FREIBURG, south Germany, is one of the 3 of the greenest cities in the world to visit.



FREIBURG – GREEN CITY (03:37)

It 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.

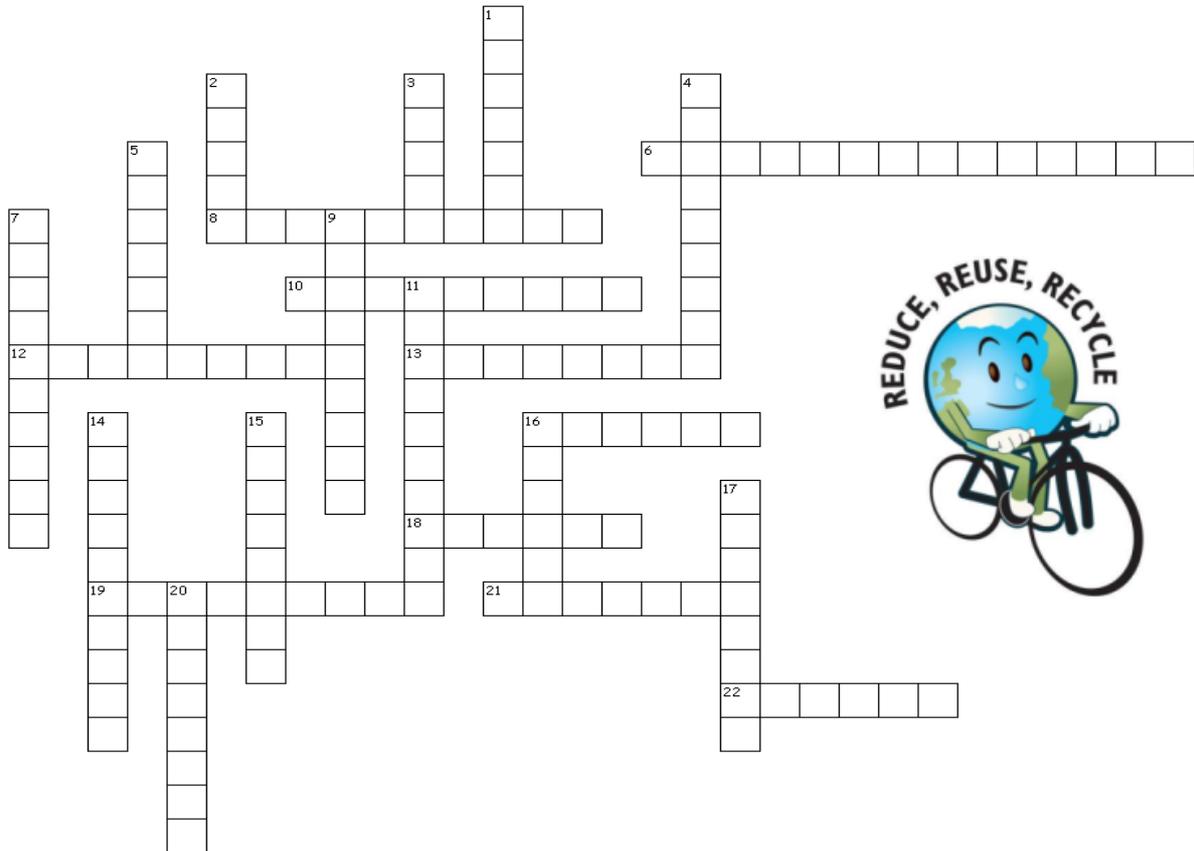
1. burnt to ashes	
2. without reserve	
3. in a clearly noticeable manner	
4. behaves in a way that other people should copy	
5. human society strongly influenced by consumerism	
6. act, manner, or method of handling or dealing with someone or something	
7. things that encourages action, stimulus, motivation	
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.

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. različno
- 16. zmanjšati
- 17. pomnožiti
- 20. organski, biološki

Created by Puzzlemaker at DiscoveryEducation.com

PRESENTATION TIPS (Make notes based on the following structure.)

✓	Sections
	(1) Definition - What is waste management?
	(2) Examples or applications (where it is used) - Give examples of the types of waste that are usually generated because of our daily activities.
	(3) How it works - Explain the 3Rs mentioned in this unit. How can our daily routines be adapted to serve this philosophy?
	(4) Pros and cons - Think about the positive and negative impacts of reducing your general consumption, reusing items more often than not and eventually recycling them.
	(5) Your personal experience and/or personal opinion - Describe your lifestyle and personal approach to waste management. Name two things that you could easily reduce, reuse or recycle and give one argument for each.

NOTES

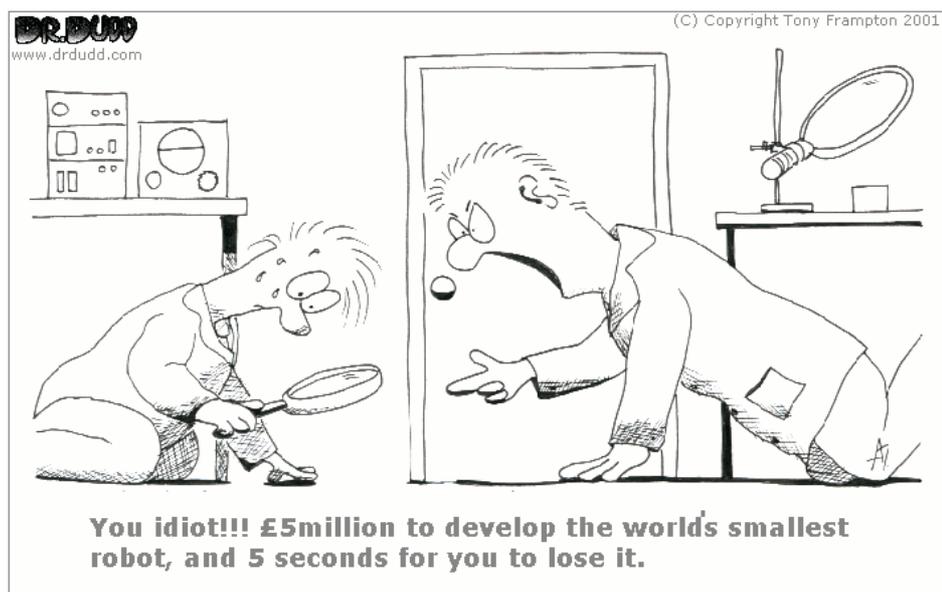
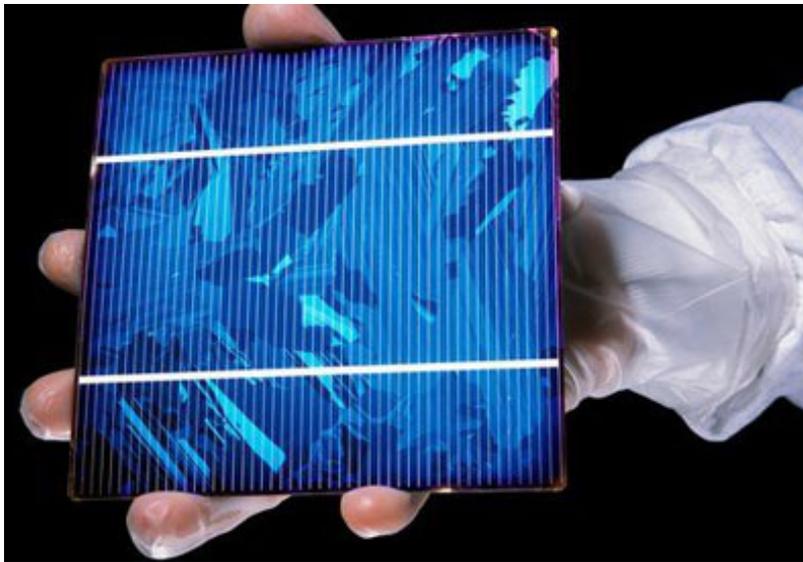
NOTES - continued

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.

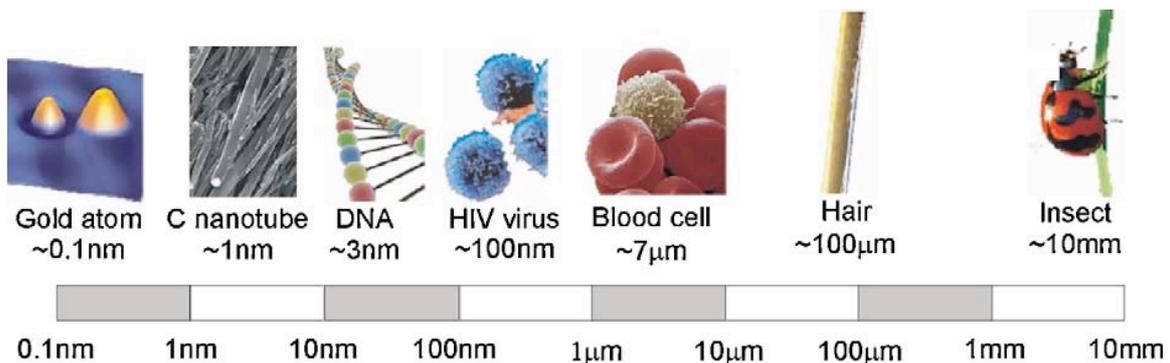
That world is the field of **nanotechnology**, the realm of atoms and **nanostructures**.

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:

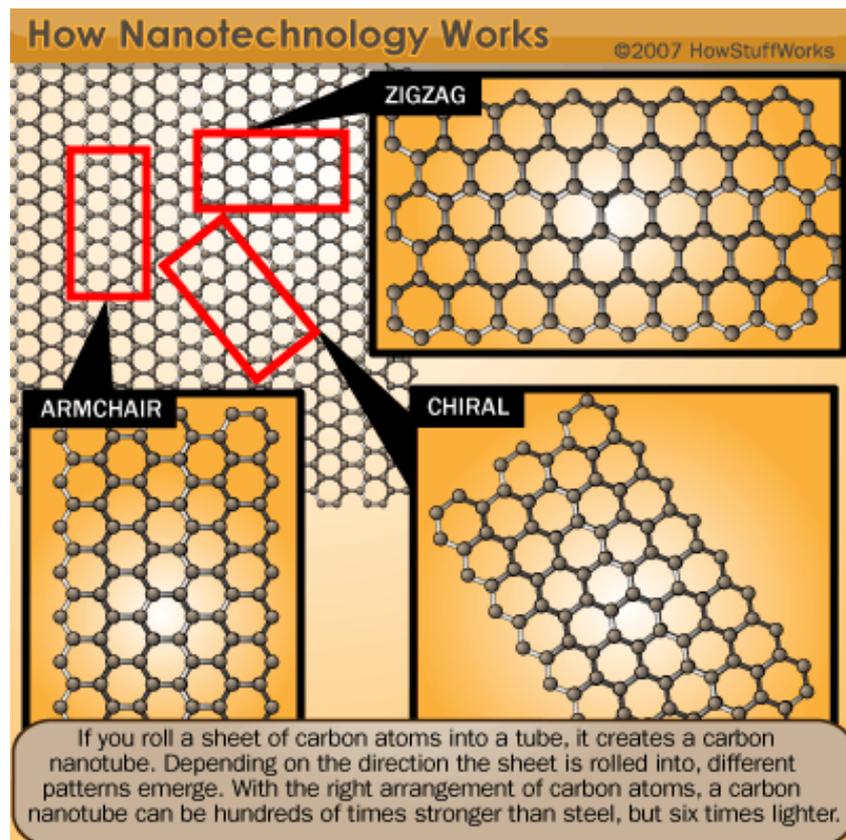
<http://nanogloss.com/nanotechnology/advantages-and-disadvantages-of-nanotechnology/#ixzz1ydg4yPFz>, June 2012

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

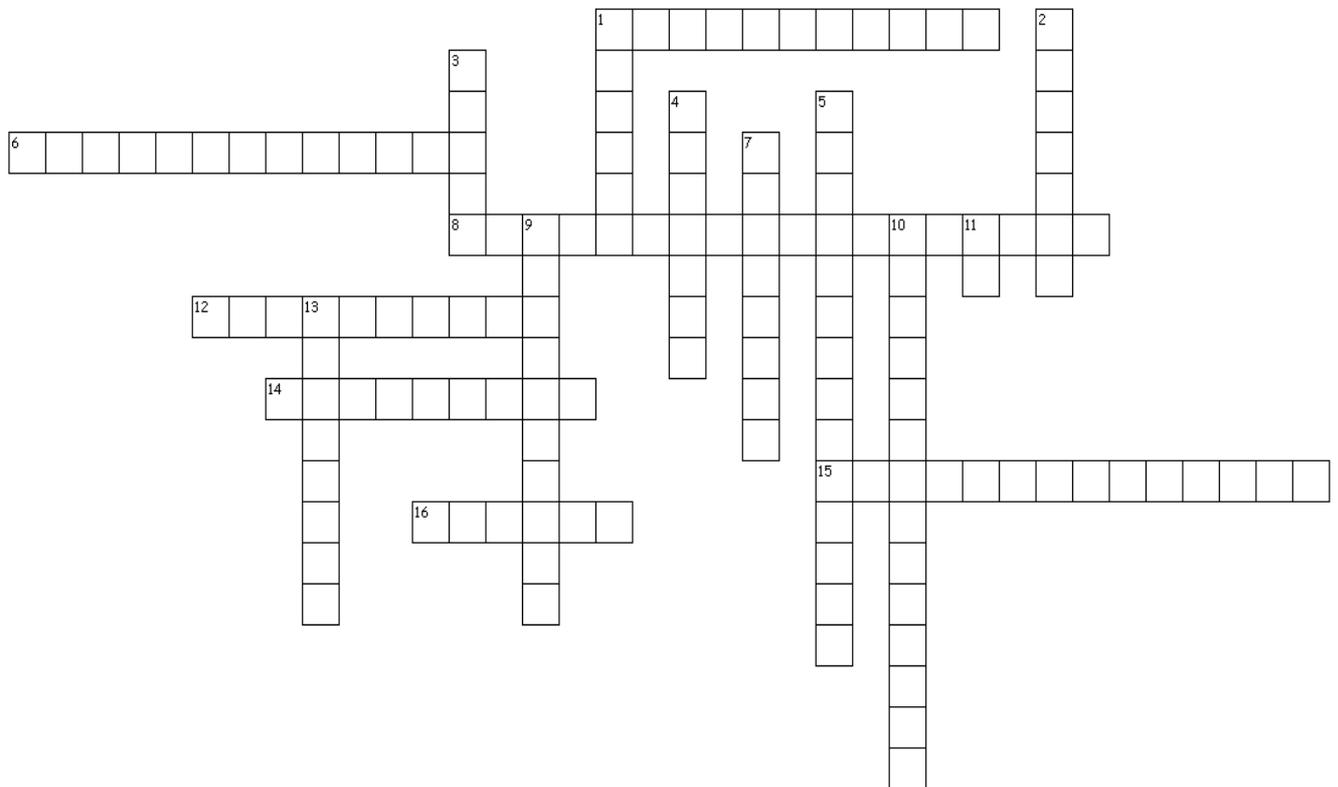
Task 2A TED conferences are riveting talks by remarkable people, free to the world. Watch the video TEDx - NANO GRADNJA by Prof. Danijel Rebolj and complete the sentences below.



1. About one fourth of our population cannot 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](#)

Task 2C Watch the documentary about nanotechnology.

HOW WILL NANOTECHNOLOGY CHANGE THE WORLD? (53:43)

PRESENTATION TIPS (Make notes based on the following structure.)

✓	Sections
	(1) Definition - What is nanotechnology?
	(2) Examples or applications (where it is used) - Name some applications of nanotechnology.
	(3) How it works - Explain how nanotechnology works. Explain how it could revolutionise the construction industry.
	(4) Pros and cons - What are the advantages and disadvantages of nanotechnology?
	(5) Your personal experience and/or personal opinion - Do you use any product that involves nanotechnology? What is your opinion on the future uses of nanotechnology described in this unit? Can you think of other potential future uses of nanotechnology?

NOTES

NOTES - continued