Food and Agriculture Organization of the United Nations

SUSTAINABLE DEVELOPMENT GOALS

7 AFFORDABLE AND CLEAN ENERGY

YUNGA LEARNING AND ACTION SERIES

working for Zero Hunger

Energy Challenge Badge

YOUTH & UNITED NATIONS GLOBAL ALLIANCE

YUNGA

FAO :: UNECE :: UN-ENERGY :: WAGGGS :: WOSM

This booklet is intended as a guide for teachers and youth leaders. These individuals are responsible for the development of programmes and activities that are suitable for their group and should provide the required supervision and safety precautions to ensure all participants are safe and sound.

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The YUNGA Challenge Badges are developed to support the achievement of the Sustainable Development Goals (SDGs). This Challenge Badge supports the realization of SDG 7.

This Challenge Badge supports the UN Decade of Sustainable Energy for All (2014–2024).

YOUTH AND UNITED NATIONS GLOBAL ALLIANCE (YUNGA)

Energy Challenge Badge

Developed in collaboration with

Food and Agriculture Organization of the United Nations

UNECE

UN-Energy

SCOUTS Creating a Better World

The World Association of Girl Guides and Girl Scouts (WAGGGS) and the World Organization of the Scout Movement (WOSM) endorse this educational badge framework for use by Guides and Scouts around the world, adapting it as necessary to their local needs and requirements.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS | 2019

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WELCOME

Energy is central to nearly every major challenge and opportunity the world faces today – jobs, security, climate change, food production or increasing incomes – access to energy for all is essential!

Can you imagine living without energy? It's impossible! Our lives literally are surrounded by energy, but we don't often stop to think about why energy is so important. We use energy to cook our food, to heat or cool our homes, for light when it's dark, to move around and much more. Globally, people are using more and more energy. However, right now, not everyone has all the energy they need. Meanwhile, most of the energy that people use comes from burning energy sources that are damaging our planet and our health. To promote access to clean and renewable energy for all people, the period 2014–2024 has been declared the "Decade of Sustainable Energy for All". The United Nations (UN) has been actively fighting to eradicate poverty and encourage sustainable development. In 2014, the UN created Sustainable Development Goals (SDGs) to stimulate action in 17 areas and transform the world. One of the goals is dedicated to sustainable energy – Goal 7 to ensure access to affordable, reliable, sustainable and modern energy for all (p. 9). There is enough clean renewable energy in the world for everyone; however we need to plan and work together to make sure that everyone can get energy when and where they need it.

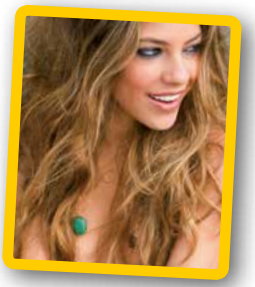
TAKE this booklet and EXPLORE, PLAY and DISCOVER – and while you're having fun, maybe you can even come up with some clever ways to help save energy in your home! After all: YOUR actions and ideas to save energy today will help you to make a difference in the world. Energy is part of everything we do every day!

So let's use energy responsibly!

THE ACTIVITIES OF THE YOUTH AND UNITED NATIONS GLOBAL ALLIANCE ARE SUPPORTED BY THE FOLLOWING AMBASSADORS:

Anggun

Carl Lewis



Debi Nova

Fanny Lu

Lea Salonga

Nadeah

Noa (Achinoam Nini)

Percance

Valentina Vezzali

YUNGA AMBASSADORS

BE SAFE AND SOUND!

DEAR LEADER OR TEACHER,

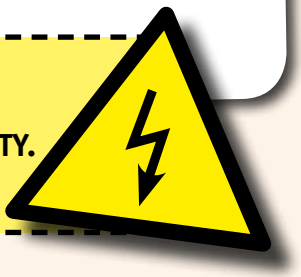
The Challenge Badges are designed to support you in undertaking educational activities. However, as you will be implementing these activities in different contexts and environments, it is up to you to ensure that the activities you choose are appropriate and safe. This document contains a number of suggested activities to help your group learn about energy; however, do not feel restricted to this content – why not see what other things you can come up with in your groups.

Practical activities such as those in the second half of this booklet are a fantastic way to learn about the importance and uses of energy. Nevertheless, it is important to take some precautions to ensure nobody gets hurt. Energy has many uses all around us, but for example electricity is very dangerous. This is why it is important to learn how to properly use and control energy. Plan carefully and make sure you have enough adult support to keep you safe, especially when you are near sources of electricity or fire, and in general to any source of energy. Young children should be supervised by an adult at all times. Please consider the general precautions on the next page and carefully evaluate which other safety issues need to be taken into account before undertaking any activity.

ELECTRICITY KILLS!

DO NOT GO NEAR OR PLAY WITH ELECTRICITY.

ALL ACTIVITES MUST BE SUPERVISED



SOME GENERAL PRECAUTIONS TO CONSIDER INCLUDE:

LOOK AFTER YOURSELVES

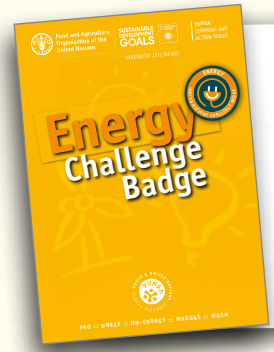
* Be careful when using sharp objects and electrical appliances.
* Do not touch power lines and stay away from utility boxes.
* Do not touch the inside of electrical appliances.
* Do not put fingers or other things into electrical outlets.
* Always turn off a light at the switch before changing a bulb.
* Keep electrical appliances away from water and use dry hands to plug or unplug electrical appliances.
* Pull gently when unplugging electronic appliances and tuck away electrical cords.
* Do not put metal objects in the toaster or microwave.
* Do not plug a bunch of appliances into one outlet or extension cord.
* Do not climb on power poles and touch or climb trees that are near power lines.
* Stay inside during thunder and lightning storms and turn off the television and computer.
* Do not fly kites near power lines or during a lightning storm.
* In some activities, you have the option of uploading pictures or videos to Web sites such as YouTube. Always make sure that everyone in the pictures or video, and/or their parents, has given their permission before you post anything online.

LOOK AFTER THE NATURAL WORLD

* Treat nature with respect and always leave nature the way you found it.
* Recycle or reuse the materials used in the activities as much as possible.
* Do not pollute the environment – if you cannot find a bin, take your rubbish home.
* Make sure that you have permission from the relevant people to carry out special activities or experiments.

SUSTAINABLE DEVELOPMENT GOALS

The Youth and United Nations Global Alliance (YUNGA) actively supports the achievement of the Sustainable Development Goals (SDGs) through the development of initiatives, activities and resources such as the United Nations Challenge Badges and by promoting and encouraging young people to be active citizens in their communities. Additional Challenge Badges are being developed to further support the SDGs.



This Energy Challenge Badge specifically supports goal number 7:

7 AFFORDABLE AND CLEAN ENERGY

ENSURE ACCESS TO AFFORDABLE, RELIABLE, SUSTAINABLE AND MODERN ENERGY FOR ALL.

The SDGs succeeded the Millennium Development Goals in 2015 and are a set of targets that governments, civil society organizations, United Nations agencies and other entities are working towards achieving by 2030 to ensure a more sustainable future for all.

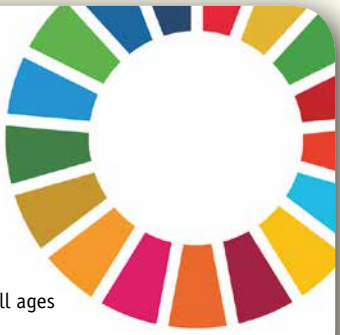
SUSTAINABLE DEVELOPMENT GOALS

Find out more about the Sustainable Development Goals on p. 112 and at:

www.fao.org/yunga/global-citizens/sdgs/en **and**

https://sustainabledevelopment.un.org/topics/sustainabledevelopmentgoals

THERE ARE 17 SDGs:



1 – NO POVERTY
End poverty in all its forms everywhere

2 – ZERO HUNGER
End hunger, achieve food security and improved nutrition and promote sustainable agriculture

3 – GOOD HEALTH AND WELL-BEING
Ensure healthy lives and promote well-being for all at all ages

4 – QUALITY EDUCATION
Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

5 – GENDER EQUALITY
Achieve gender equality and empower all women and girls

6 – CLEAN WATER AND SANITATION
Ensure availability and sustainable management of water and sanitation for all

7 – AFFORDABLE AND CLEAN ENERGY
Ensure access to affordable, reliable, sustainable and modern energy for all

8 – DECENT WORK AND ECONOMIC GROWTH
Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

9 – INDUSTRY, INNOVATION AND INFRASTRUCTURE
Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

10 – REDUCED INEQUALITIES
Reduce inequality within and among countries

11 – SUSTAINABLE CITIES AND COMMUNITIES
Make cities and human settlements inclusive, safe, resilient and sustainable

12 – RESPONSIBLE CONSUMPTION AND PRODUCTION
Ensure sustainable consumption and production patterns

13 – CLIMATE ACTION
Take urgent action to combat climate change and its impacts

14 – LIFE BELOW WATER
Conserve and sustainably use the oceans, seas and marine resources for sustainable development

15 – LIFE ON LAND
Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

16 – PEACE, JUSTICE AND STRONG INSTITUTIONS
Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

17 – PARTNERSHIPS FOR GOALS
Strengthen the means of implementation and revitalize global partnership for sustainable development

LET'S LOOK IN MORE DETAIL AT

GOAL 7

TO ENSURE ACCESS TO AFFORDABLE, RELIABLE, SUSTAINABLE AND MODERN ENERGY FOR ALL

Why is this important?

Our daily lives revolve around having reliable and affordable energy. This is important for all sectors, starting from business, medicine and education to agriculture, infrastructure, communications and high-technology. Not having access to energy supplies limits human and economic development.

ENERGY is also the main contributor to climate change as it is responsible for around 60% of total greenhouse gas emissions released in the atmosphere.

How many people are without electricity?

Around 1.2 billion people, which is one in five people in the world, do not have access to electricity. The majority of these people live in Africa and Asia.

Not having access to electricity, women and girls have to spend hours traveling to get water, clinics are not able to store vaccines for children, many school children cannot do their homework at night, and people are not able to run their businesses.

Another 2.8 billion people depend on wood, charcoal, dung and coal for cooking and heating, which leads to 4 million premature deaths a year because of indoor air pollution.

What can we do to fix these problems?

Countries can speed up the move towards affordable, reliable and sustainable energy systems by increasing the use of renewable energy resources, encouraging energy efficient practices, and promoting clean energy technologies and infrastructure.

You can also help fix some of the energy issues. This Energy Challenge Badge will teach you how you can make a difference in the world.

What are the targets of Goal 7?

7.1: By 2030, ensure everyone gets access to affordable, reliable and modern energy (in particular access to clean fuels and technologies).

7.2: By 2030, increase substantially the share of renewable energy in the global energy mix.

7.3: By 2030, double the improvement in energy efficiency.

7.a: By 2030, enhance international cooperation in access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote using energy infrastructure and clean energy technology.

7.b: By 2030, expand infrastructure and improve technology for supplying modern and sustainable energy for all, especially in poorer countries and small islands.

Why don't you explore with your group which 'targets' you could contribute towards achieving in your local community? If you have access to a smartphone, you could then create and record your actions using the SDGs in action app: **https://sdgsinaction.com**

THE CHALLENGE BADGE SERIES

Developed in collaboration with United Nations agencies, civil society and other organizations, the YUNGA Challenge Badges are intended to raise awareness, educate and motivate young people to change their behaviour and be active agents of change in their local communities. The Challenge Badge series can be used by teachers in school classes as well as by youth group leaders, especially Guide or Scout groups.

To see existing badges go to www.fao.org/yunga. To receive updates on new releases and other YUNGA news, register for the free YUNGA newsletter by emailing yunga@fao.org.

YUNGA has or is currently developing badges on the following topics:

AGRICULTURE: How can we grow food in a sustainable way?

BIODIVERSITY: Let's make sure no more of the world's glorious animals and plants disappear!

CLIMATE CHANGE: Join the fight against climate change and for a food secure future!

ENERGY: The world needs a healthy environment as well as electricity and heat – how can we have both?

FORESTS: Forests provide homes for millions of plant and animal species, help regulate the atmosphere and provide us with essential resources. How can we ensure they have a sustainable future?

GENDER: What actions can be taken to ensure a more equal and fair world for girls and boys, women and men?

GOVERNANCE: Discover how decision-making can affect your rights and equality among people around the world.

HUNGER: Having enough to eat is a basic human right. What can we do to help the 1 billion people who still go hungry every day?

NUTRITION: What is a healthy diet and how can we make food choices that are environmentally friendly?

THE OCEAN: The ocean is mesmerizing and amazing. It helps regulate temperatures on Earth, provides us with resources and much, much more.

SOILS: Without good soil, nothing grows. How can we take care of the ground under our feet?

WATER: Water is life. What can we do to safeguard this precious resource?

CREATING BEHAVIOUR CHANGE

We work with young people because we want to support them in leading fulfilling lives, help them prepare for their futures, and for them to believe that they can make a difference in the world. The best way to make this difference is by encouraging young people to embrace long-term behaviour change. Many current social and environmental problems are caused by unhealthy or unsustainable human behaviour. Most people need to adapt their behaviour, and not just for the duration of a project, such as working on this badge, but for life. Young people today know that doing good is more than an extracurricular activity: it's about how you lead your life for the benefit of the current and future generations. Small changes to your daily behaviour can really help us create a brighter future.

So what can you do?

There are some proven ways of promoting behaviour change so, to increase the long-term impact of this Challenge Badge, try to do the following:

FOCUS ON SPECIFIC, ACHIEVABLE BEHAVIOURAL CHANGE
Prioritize activities that target very clear and specific behaviour change (e.g. "turn off the computer and other electrical appliances when you have finished using them", rather than generally saying "save energy").

ENCOURAGE ACTION PLANNING AND EMPOWERMENT
Put young people in charge: let them choose their own activities and plan how to carry them out.

CHALLENGE CURRENT BEHAVIOUR AND TACKLE BARRIERS TO ACTION Encourage participants to scrutinize their current behaviour and think about how it could be changed. Everyone has excuses for why they don't behave in a particular way: lack of time, lack of money, not knowing what to do… the list goes on. Encourage young people to voice these excuses and then find ways around them.

PRACTISE ACTION SKILLS You'd like to take public transport more often? Collect and practise reading timetables, plot out routes on a map, take a walk to the bus stop, find out what the fare is, do a trial journey. You'd like to eat more healthily? Try lots of healthy foods to see which you like, experiment with recipes, learn how to read food labels, create meal planners, visit the shops to find healthy foods on their shelves, prefer local and seasonal food, and reduce wastes. Keep practising until it becomes a habit.

SPEND TIME OUTDOORS No one is going to look after something they don't care about. Time spent in natural environments – whether that is the local park or a pristine wilderness – encourages an emotional connection with the natural world that is proven to lead to more pro-environmental behaviour. Using public spaces, even those in a city centre, and getting involved with communities are excellent ways of building ownership and a sense of responsibility for the environment and other individuals around us.

GET FAMILIES AND COMMUNITIES INVOLVED Why change the behaviour of just one young person when you could change the behaviour of their entire family, or even the whole community? Spread your message more widely: showcase what you have been doing for the local community and encourage young people to pester their family or friends to join in. For an even bigger impact, get political and lobby your local or national government.

MAKE A PUBLIC COMMITMENT People are far more likely to do something if they agree to do it in front of witnesses or in a written statement – why not take advantage of this?

MONITOR CHANGE AND CELEBRATE SUCCESS Behaviour change is hard work! Revisit tasks regularly to monitor achievement and reward continued success in an appropriate way.

LEAD BY EXAMPLE The young people you work with look up to you. They respect you, care about what you think and want to make you proud. If you want them to embrace the behaviour you are advocating, then you must lead by example and make those changes yourself.

TIPS ON UNDERTAKING THE BADGE WITH YOUR GROUP

In addition to the suggestions for encouraging behavioural change, the following ideas are intended to help you develop a programme to undertake the Challenge Badge with your group.

STEP 1 INVESTIGATE

Encourage your group to learn about energy, its importance in the world and its connection to people's quality of life. Start by raising participants' awareness about the extent of our dependence on energy – for doing schoolwork, earning a living, food production, etc. Explain the two interrelated energy challenges: the need to increase energy access around the world so that everyone can benefit from electricity and heat; and the need to ensure that the environment is not harmed while doing so, by using clean and renewable energy. Explain how lack of access to energy affects all aspects of people's lives and how this delays development in general. Then discuss with the group how our individual choices and actions can help make a positive difference.

STEP 2 SELECT

Apart from the compulsory activities, which ensure that participants understand basic concepts and issues related to energy, participants are encouraged to select the activities that best match their needs, interests and culture. As far as possible, let the participants choose which activities they want to do. Some activities can be done individually, others in small groups. If you have another activity that is especially appropriate for your group or area, you may also include it as an additional option. You can also ask the young people if they can think of any activities they would like to do on this topic.

STEP 3 ACT

Allow enough time for the group to carry out the activities. Support and guide them through the process but make sure they carry out their tasks as independently as possible. Many activities can be conducted in several different ways. Encourage participants to think and act creatively when undertaking their activities.

STEP 4 DISCUSS

Have participants present the results of their Challenge Badge activities to the rest of the group. Do you notice any changes in their attitudes and behaviour? Encourage participants to think about how their daily activities depend upon availability of energy and affect the environment. Discuss the experience and reflect on how they can continue to apply it in their lives.

STEP 5 CELEBRATE

Organize a celebration for those who successfully complete the badge curriculum. Invite families, friends, teachers, journalists and community leaders to participate in the celebration. Encourage your group to present the results of their project to the community in a creative way. Award them with certificates and Challenge Badges (see resources and additional information on p. 172).

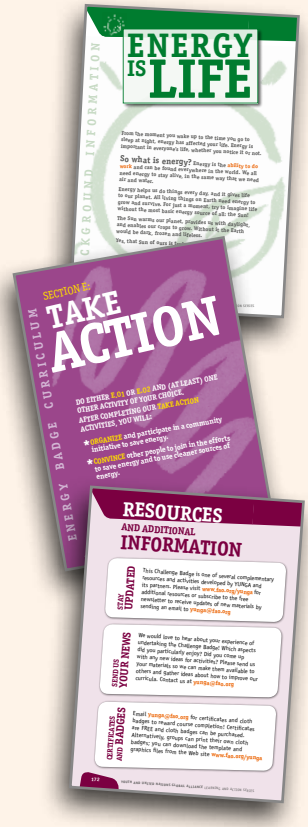
STEP 6 SHARE WITH YUNGA!

Send us your stories, photos, drawings, ideas and suggestions:
yunga@fao.org

Find out more about YUNGA and creating a YUNGA Tribe at:
www.fao.org/yunga

BADGE STRUCTURE AND CURRICULUM

The Energy Challenge Badge is designed to help educate children and young people about the crucial role that energy plays in our daily lives and on our planet. This booklet will help you develop an enjoyable and engaging educational programme appropriate to your class or group.



The **first part** of the booklet includes basic **background information** on relevant educational topics, aiming to help teachers and youth leaders to prepare their sessions and group activities without having to search for the information. The badge looks at the different types of energy, different sources of energy and their uses, and what steps we can take to conserve and manage energy more sustainably. It also suggests and encourages actions you can take to raise awareness in the community about the importance of energy.

The **second part** of the booklet contains the **badge curriculum**: a range of activities and ideas to stimulate learning and motivate children and young people to engage in energy issues.

Additional resources, useful Web sites and a glossary explaining key terms (that are highlighted in the text like this) are provided at the end of the booklet.

Badge structure

For ease of use and to ensure that all the main topics are addressed, both the background information (pp. 28–135) and the related activities (pp. 136–170) are divided into five main sections:

A. **ENERGY IS LIFE**: introduces basic facts about the importance of energy to life on Earth.

B. **ENERGY SOURCES AND IMPACTS**: looks at the major energy sources and environmental impacts.

C. **ENERGY USE**: describes different kinds of energy and what people use energy for every day.

D. **ENERGY FOR A BETTER WORLD**: explores the connection between energy and development.

E. **TAKE ACTION**: suggests ideas to help you save energy in your everyday life and raise awareness in the community.

Requirements: To earn the badge, participants must complete one of the two compulsory activities at the beginning of each section, plus (at least) one additional activity from each section, chosen individually or as a group (see graphic on p. 20). Participants can also complete additional activities considered appropriate by the teacher or leader.

Section A: ENERGY IS LIFE

1 compulsory activity (A.1 or A.2) & at least 1 optional activity (A.3 - A.16)

+

Section B: ENERGY SOURCES AND IMPACTS

1 compulsory activity (B.1 or B.2) & at least 1 optional activity (B.3 - B.13)

+

Section C: ENERGY USES

1 compulsory activity (C.1 or C.2) & at least 1 optional activity (C.3 - C.17)

+

Section D: ENERGY FOR A BETTER WORLD

1 compulsory activity (D.1 or D.2) & at least 1 optional activity (D.3 - D.14)

+

Section E: TAKE ACTION

1 compulsory activity (E.1 or E.2) & at least 1 optional activity (E.3 - E.17)

=

Energy Challenge Badge
COMPLETED!

Age ranges and appropriate activities

To help you and your group select the most appropriate activities, a coding system is provided to indicate the age group(s) for which each activity is most suitable. Next to each activity, a code (for example "Levels 1 and 2") indicates that the activity should be suitable for five to ten year olds and eleven to fifteen year olds.

However, please note that this coding is only indicative. You may find that an activity listed at one level is suitable for another age group in your particular circumstances. As teachers and youth leaders you should use your judgement and experience to develop an appropriate curriculum for your group or class. This could incorporate additional activities not listed in this booklet but that allow you to achieve all the educational requirements.

LEVEL

1 **Five to ten years old**

2 **Eleven to fifteen years old**

3 **Sixteen plus years old**

REMEMBER!

The key objectives of the Challenge Badge are to educate, inspire, stimulate interest in learning about energy issues and motivate individuals to change their behaviour and create local and international action. However, most of all, the activities should be **FUN**! Participants should enjoy the process of earning the badge and learning about energy and its importance.

SAMPLE BADGE CURRICULA

The sample curricula for the different age groups below provide examples of how the badge could be earned and are intended help you in developing your own programme.

LEVEL

1 **Five to ten years old**

2 **Eleven to fifteen years old**

3 **Sixteen plus years old**

Each activity has a specific learning aim, but in addition to this, children will have the opportunity to learn more general skills, including:

* TEAMWORK
* IMAGINATION AND CREATIVITY
* OBSERVATION SKILLS
* CULTURAL AND ENVIRONMENTAL AWARENESS
* NUMERICAL AND LITERACY SKILLS

SECTION	ACTIVITY	LEARNING OBJECTIVE
A Energy is life	**A.2: Food Chain Drawings** (p. 137)	To learn about local food chains and their role in the carbon cycle.
	A.4: Sun Beams (p. 138)	To understand how the Sun influences life on Earth.
B Energy sources and impacts	**B.1: Energy Generation Model** (p. 145)	To understand how electricity impacts the environment and how renewable energy technology works.
	B.3: Energy Game (p. 146)	To learn about different energy resources.
C Energy use	**C.1: Routine Energy** (p. 151)	To become aware of the different forms of energy that you use every day.
	C.6: Jumping Jacks Energy (p. 153)	To understand the difference between potential energy and kinetic energy.
D Energy for a better world	**D.1: Can You Guess the Goal?** (p. 159)	To understand how energy affects the achievements of the Sustainable Development Goals.
	D.5: Globe Game (p. 160)	To understand how people are linked to one another throughout the world.
E Take action	**E.2: Energy Pledge Tree** (p. 165)	To take action and to inspire others to act on energy issues.
	E.5: Energy Saver Reminders (p. 166)	To use energy more efficiently in your home and school.

LEVEL

1 Five to ten years old

2 **Eleven to fifteen years old**

3 Sixteen plus years old

As in Level 1, each activity in Level 2 has a specific learning aim, but also fosters additional, more general skills including:

* **TEAMWORK AND INDEPENDENT STUDY SKILLS**
* **IMAGINATION AND CREATIVITY**
* **OBSERVATION SKILLS**
* **CULTURAL AND ENVIRONMENTAL AWARENESS**
* **RESEARCH SKILLS**
* **PRESENTATION AND PUBLIC SPEAKING SKILLS**
* **ABILITY TO PRESENT AN ARGUMENT AND DEBATE**

SECTION	ACTIVITY	LEARNING OBJECTIVE
A Energy is life	**A.1: Sunny Stories** (p. 137)	To understand the role of the Sun in different cultures or religions.
	A.5: Growing Experiment (p. 139)	To learn about the importance of the Sun for plants to grow.
B Energy sources and impacts	**B.2: Scoping It Out** (p. 145)	To encourage hands-on learning about one kind of energy resource.
	B.7: Presenting Fossil Fuels (p. 147)	To understand the advantages and disadvantages of fossil fuels.
C Energy use	**C.2: Electronics-Free Challenge** (p. 151)	To engage in fun activities that don't use electricity.
	C.10: Electricity Safety Checklist (p. 155)	To learn about how to keep yourself safe around electricity.
D Energy for a better world	**D.1: Energy to the Rescue** (p. 159)	To understand how energy affects the achievements of the Sustainable Development Goals.
	D.7: Health Inspection (p. 161)	To learn about the impacts of pollution on the environment and on people's health.
E Take action	**E.2: Achieving the Goals** (p. 165)	To think of ways to take action on Sustainable Development Goals.
	E.3: Earth Hour (p. 166)	To raise awareness about sustainable energy use among family and friends.

LEVEL

1 Five to ten years old

2 Eleven to fifteen years old

3 Sixteen plus years old

General skills a Level 3 curriculum seeks to develop include:

* **TEAMWORK AND INDEPENDENT STUDY**
* **IMAGINATION AND CREATIVITY**
* **OBSERVATION SKILLS**
* **CULTURAL AND ENVIRONMENTAL AWARENESS**
* **TECHNICAL SKILLS AND THE ABILITY TO RESEARCH COMPLEX ISSUES**
* **PRESENTATION AND PUBLIC SPEAKING SKILLS**
* **ABILITY TO PRESENT AN ARGUMENT AND DEBATE**

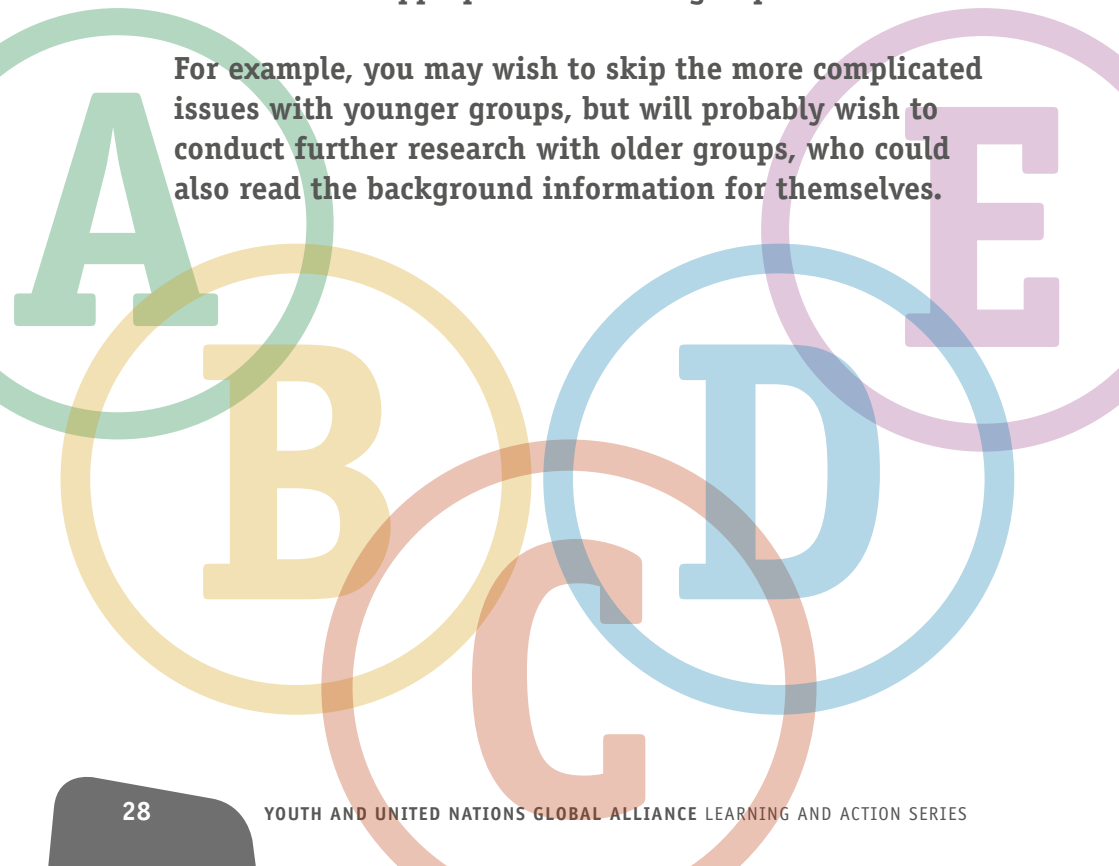
SECTION	ACTIVITY	LEARNING OBJECTIVE
A Energy is life	**A.1: Sunny Stories** (p. 81)	To understand the role of the Sun in different cultures or religions.
	A.11: Heating of the Earth (p. 83)	To learn how different parts of our world are heated by the Sun.
B Energy sources and impacts	**B.2: Scoping It Out** (p. 145)	To encourage hands-on learning about one kind of energy resource.
	B.11: Writing for Renewables (p. 149)	To motivate activism for renewable energy.
C Energy use	**C.2: Electronics-Free Challenge** (p. 151)	To engage in fun activities that don't use electricity.
	C.15: Energetic Edibles (p. 157)	To learn about energy in food production processes.
D Energy for a better world	**D.1: Energy to the Rescue** (p. 159)	To understand how energy affects the achievements of the Sustainable Development Goals.
	D.13: Community Energy Debate (p. 163)	To learn about how different groups in the community play a role in addressing environmental issues.
E Take action	**E.1: Energy Pledge Tree** (p. 165)	To take action and to inspire others to act on energy issues.
	E.12: Community Energy Campaign (p. 169)	To initiate and carry out a campaign relating to an energy topic that is important to you.

BACKGROUND INFORMATION

The following section provides an overview of key issues relating to energy. It aims to help teachers and youth leaders prepare their sessions and group activities without having to search for the information.

Naturally, not all the materials will be required or appropriate for all age groups and activities. Leaders and teachers should therefore select the topics and level of detail most appropriate for their group.

For example, you may wish to skip the more complicated issues with younger groups, but will probably wish to conduct further research with older groups, who could also read the background information for themselves.



A ENERGY IS LIFE

Energy from the Sun
Energy from the Earth
Carbon = Nature's energy
Living in a greenhouse

B ENERGY SOURCES AND IMPACTS

Forms of energy
Non-renewable energy
Renewable energy

C ENERGY USE

Energy in the world
Energy at home

D ENERGY FOR A BETTER WORLD

Energy = Development
SDGs help us see the interlinkages in our world

E TAKE ACTION

Actions for governments and decision-makers
Actions for YOU!

ENERGY IS LIFE

From the moment you wake up to the time you go to sleep at night, energy has affected your life. Energy is important in everyone's life, whether you notice it or not.

So what is energy? Energy is the **ability to do work** and can be found everywhere in the world. We all need energy to stay alive, in the same way that we need air and water.

Energy helps us do things every day, and it gives life to our planet. All living things on Earth need energy to grow and survive. For just a moment, try to imagine life without the most basic energy source of all: the Sun!

The Sun warms our planet, provides us with daylight, and enables our crops to grow. Without it the Earth would be dark, frozen and lifeless.

Yes, that Sun of ours is truly a star!

In today's world, we don't just use energy to survive, though. We depend on it for living comfortable lives, doing our studies and having fun. Energy comes in different forms: light, heat, electricity, sound and motion. Energy is used to grow and cook our food, bring us water, light up our homes, fuel cars, buses, ships and planes and can help keep us warm in winter and cool in the summer. Our body burns energy from the food we eat to walk, run and play. People's quality of life and countries' entire economies depend on energy.

Given how important energy is in our lives, you might be in for a bit of a shock: our world faces two big energy challenges:

* Over 1.2 billion people do not have access to electricity, and 2.8 billion use wood, charcoal and coal to light and heat up their homes and cook food. This is the cause of many health and social issues that we will explore in more detail in later sections.
* In most countries where modern energy services are available, the electricity is produced by methods that are damaging and polluting to the environment as well as being short lived.

However, we all can work together to find ways of getting and using energy. Therefore, to solve the above challenges, the United Nations has launched the Decade for Sustainable Energy for All (SE4ALL), which has the objectives of:

1. ensuring universal access to modern energy services;
2. doubling the global rate of improvement in energy efficiency; and
3. doubling the share of renewable energy in the global energy mix.

"Energy alone is not sufficient for creating the conditions for economic growth, but it is certainly necessary. It is impossible to operate a factory, run a shop, grow crops or deliver goods to consumers without using some form of energy."

World Energy Outlook, 2004

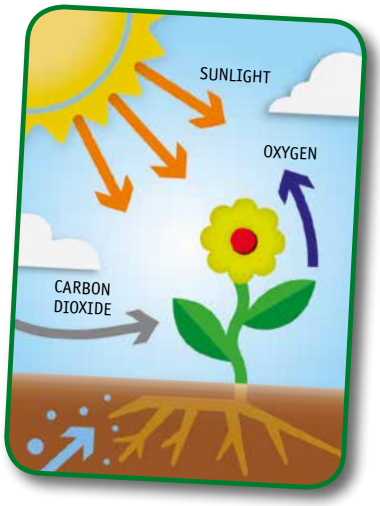
Let us start from the beginning. **Where does energy come from?** There are two main sources of energy on our planet – energy that comes from the heat and light of the Sun and energy that comes from heat deep inside the Earth. Let's take a closer look at these two sources of energy.

ENERGY FROM THE SUN

Our Sun (which was formed over four and a half billion years ago, shortly before Earth formed), provides the energy to sustain life on Earth. Its energy warms our planet, provides us with light, and makes it possible for plants to grow. Energy from the Sun gives life to all **ecosystems** on Earth. The Sun warms the atmosphere, helping to create winds and waves, which, in turn, are important sources of energy, too (learn more about them on p. 36). Let us see some examples on how the Sun's energy is used and converted into other forms of energy on Earth.

Photosynthesis

Plants are able to convert **light energy** coming from the Sun to chemical energy (sugars). This process is called **photosynthesis**. In Greek, "photo" means light and "synthesis" means putting together. Through **photosynthesis**, plants use the energy of sunlight to "fuse" together **water vapour** and together to produce sugar. Sugar molecules are like little batteries that store energy until they are needed by the plant to grow.

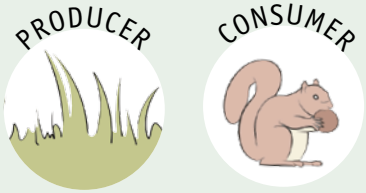


DID YOU KNOW?

The sunlight that shines on the Earth in just one hour could meet world energy demands for an entire year! The problem is that we don't have the technology to store and distribute all this energy yet – keep working on it, scientists!

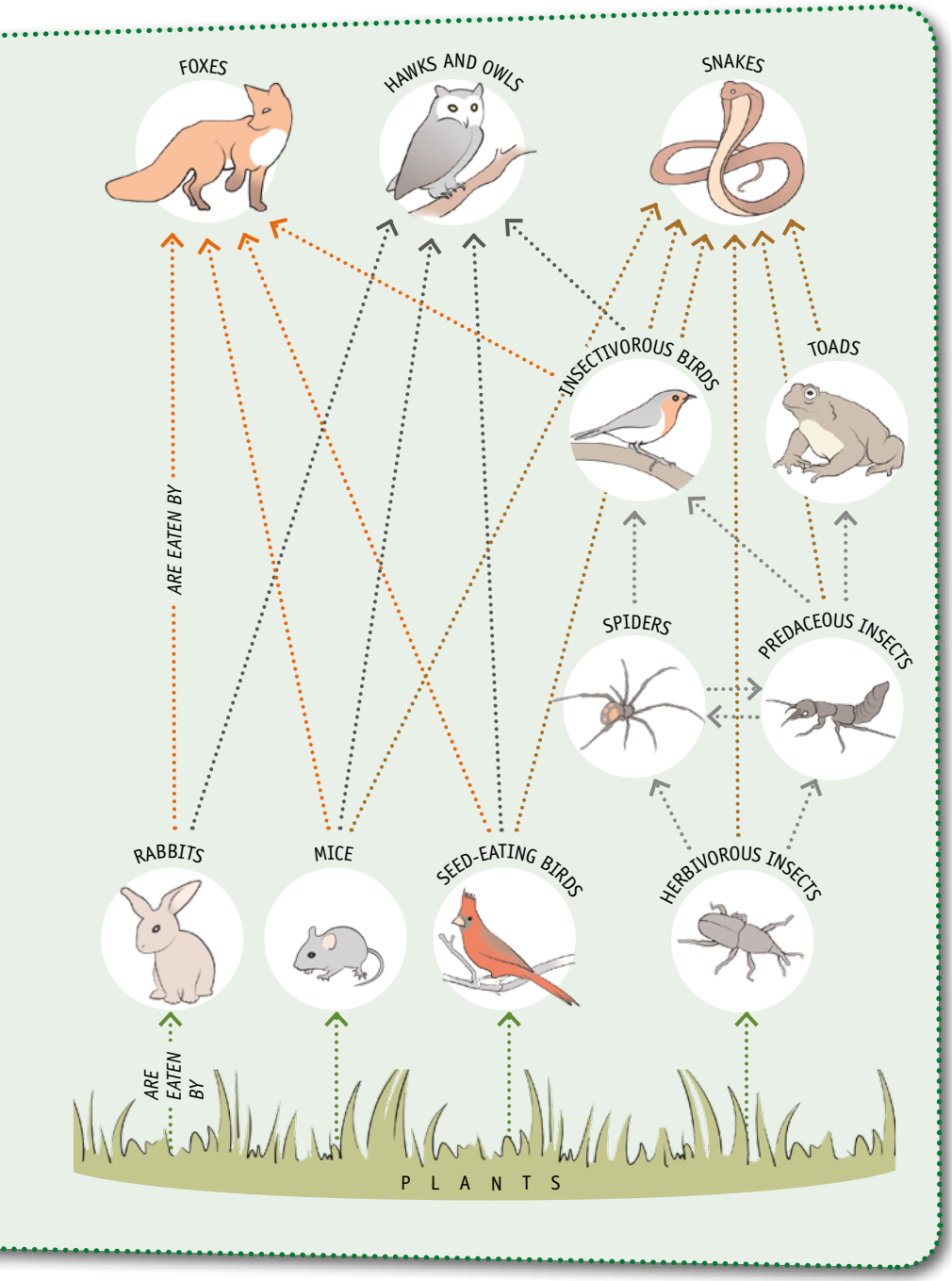
FOOD CHAIN

The words "**food chain**" might make you imagine food strung together, but that's not what we mean here. It refers to the way each living thing gets food, and how energy is passed from creature to creature. Since plants make their own food through **photosynthesis**, they are called producers. Plants, phytoplankton, algae, and some bacteria are the only organisms that are able to take light energy and convert it into chemical energy (i.e. sugars). Almost all other living beings, or **organisms**, including us cannot make their own food; they get energy either directly by eating plants or by eating other animals that get their energy from plants: they are called consumers. Energy and **nutrients** flow through a **food chain** when animals eat other animals or plants. All organisms add **nutrients** into the soil through their waste products and when they **decompose** after they die, which helps plants to grow. In this way, plants and animals rely on one another in the **food chain**!



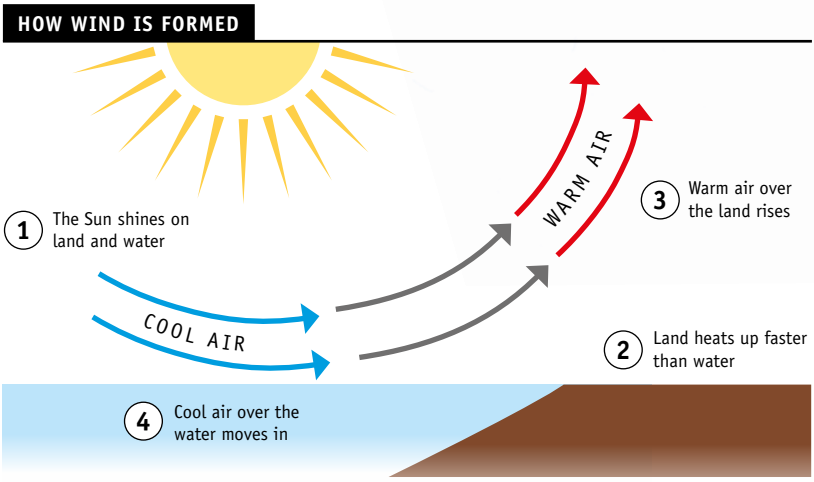
For example, a simple food chain can begin with grass, which is eaten by rabbits. Rabbits are then eaten by foxes. In reality life is more complex and animals eat a variety of different plants or other animals. This is how we end up with a food web.

Find out more:
www.exploringnature.org/db/detail_index.php?dbID=2&dbType=2t


FOXES
HAWKS AND OWLS
SNAKES
INSECTIVOROUS BIRDS
TOADS
ARE EATEN BY
SPIDERS
PREDACEOUS INSECTS
RABBITS
MICE
SEED-EATING BIRDS
HERBIVOROUS INSECTS
ARE EATEN BY
PLANTS

Winds and waves

Believe it or not, we have the Sun to thank for wind and waves, too! While light energy from the Sun starts the **food chain**, the **heat energy** from the Sun reaches the earth and warms the Earth's surface and atmosphere, and creates winds and waves. Different land and water areas on the Earth's surface (such as forests, ice sheets, sandy deserts and the ocean) absorb different amounts of heat, so some parts of the Earth's surface warm up faster. This uneven heating causes winds. But how does the heating of the land affect the air? When areas of land or water get warmer, the air above them gets warmer as well. Then, the warmer air rises. Can you think of why this warmer air rises? Think about a hot air balloon – the hot air inside the balloon is less dense (weighs less relative to the space it takes up) compared with the cold air outside, so it rises up. When the warm air rises into the **atmosphere** (air surrounding the Earth), it pushes the cool air down towards the Earth's surface. This moving air is wind. **Wind energy** helps pollinate plants, and birds use wind energy to help them fly. When winds blow across the ocean, they push

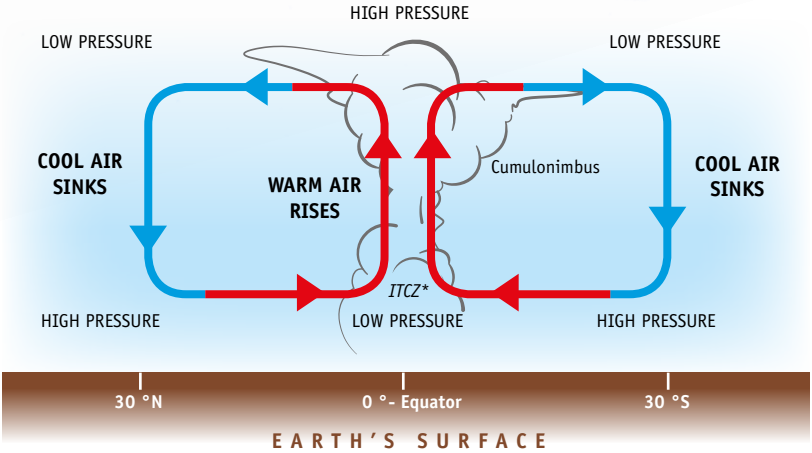


water upwards. When the wind has passed, the water sinks again. So winds cause the rising and falling of waves, and stronger winds produce bigger waves.

What are the global wind patterns?

At the global scale, wind is caused by differences in air pressure, which are produced by differences in temperature. Cool air produces high air pressure and warm air produces low air pressure. Warm air wants to rise and as it does the cool air will move in and replace the warm air, causing wind.

- At the equator, the Sun shines directly down on Earth. The air heats up and rises, leaving low pressure areas behind.
- At about 30 degrees north and south of the equator, the warm air from the equator starts to cool and sink.
- Between 30 degrees and the equator, most of the cool sinking air moves back to the equator.
- The rest of the air flows towards the poles.



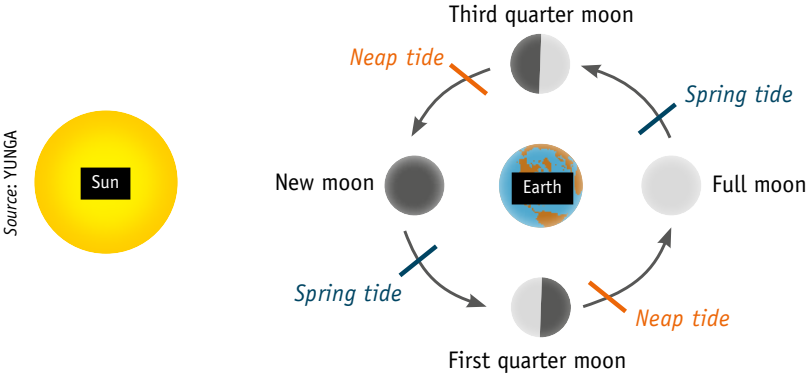
* Intertropical Convergence Zone

Tides

The ocean is always moving. Around the world, the sea level is rising and falling because of tides. Tides are formed from the pull of gravity from the Moon and the Sun on Earth, as well as the spinning of the Earth. There are different cycles of a tide because the Moon rotates around the Earth and the position of the Sun changes. For example, throughout the day 2 high and 2 low tides happen (but some places get only 1 of each):

1. Sea level rises
2. High tide is reached (sea level at its highest)
3. Sea level falls
4. Low tide is reached (sea level is at its lowest)

The difference between the highest and lowest tide is called **tidal range** and varies over a two-week cycle. In the open ocean **tidal range** is usually 60 cm, but near the coast the **tidal range** can be larger. The largest **tidal range** is called *spring tide*, and the smallest **tidal range** is called *neap tide*.



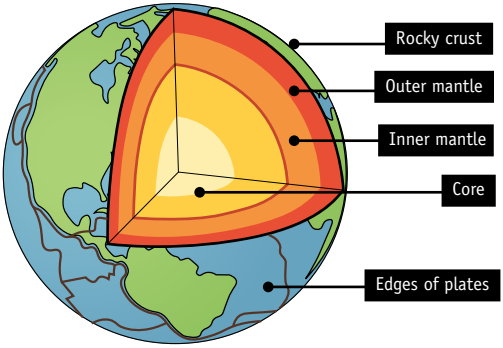
Did you know that we can use tides to produce energy? **Tidal energy** is energy created from the movement of the water; read further on p. 82.

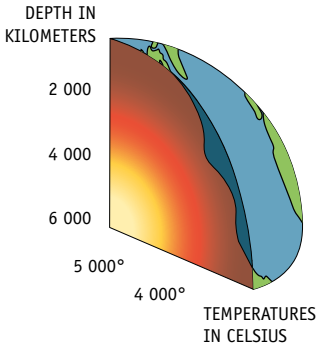
You can find out more about tides in the **OCEAN CHALLENGE BADGE.**

ENERGY FROM THE EARTH

The next time you complain about how hot the summer is, feel glad you're nowhere near the centre of the Earth. At 6 000 degrees Celsius (10 830 degrees Fahrenheit), the core (centre) of the Earth is the hottest part of our planet! The core contains **heat energy** left over from when the Earth formed over four billion years ago. However, there are also minerals that produce heat underground. This occurs through the breakdown of **radioactive** particles.

THE EARTH'S CRUST & TEMPERATURES INSIDE THE EARTH





DID YOU KNOW?

At the Earth's core, temperatures can be even hotter than the surface of the Sun. For every 100 metres you go below ground, the temperature of the rock increases about 3 degrees Celsius. (Or for every 328 feet below ground, the temperature increases about 5 degrees Fahrenheit.) There is so much heat in the Earth's core that it is enough to **power** 15 times the world's **electricity** production – that is a lot of **electricity**! So here's another potential source of energy scientists still need to work out how to harness...

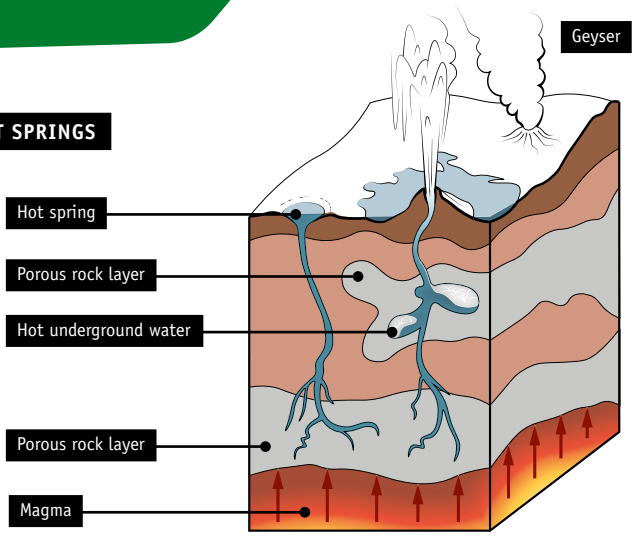
Source: Sustainable Energy for All

JOURNEY TO THE CENTRE OF THE EARTH

In this science fiction novel (written in 1864 by Jules Verne), a professor, his nephew and a guide descend into a volcano to get to the centre of the Earth. Many adventures follow...

You wouldn't want to try this journey yourself (you might get cooked!), but how about writing your own story about it? What do *you* imagine the centre of the Earth to be like?

GEYSERS AND HOT SPRINGS



Have you ever seen pictures of a volcano? That is the **heat energy** coming from the Earth in action. This energy is also called **geothermal energy**. The word geothermal comes from the Greek language: *geo* (earth) and *therme* (heat).

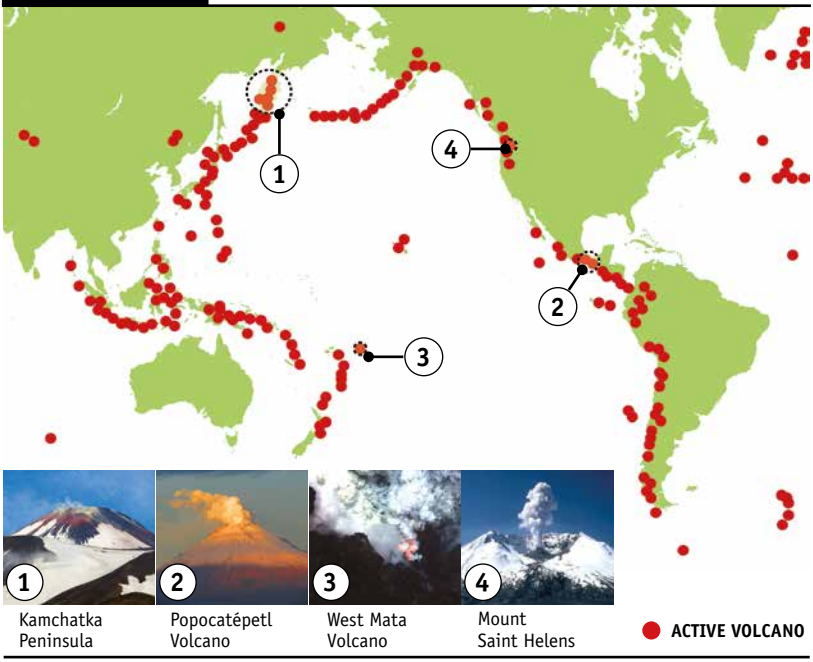
So where can **geothermal energy** be found? Geothermal reservoirs (geothermal storage) are deep underground and cannot be easily detected above ground, but **geothermal energy** pushes its way to the Earth's surface through:

* **Hot springs**: Warm water that is heated by rocks deep inside the Earth. People (and some animals) enjoy bathing in the warmth of the water in hot springs.
* **Geysers**: Water that flows straight up into the air near volcanic areas. This is caused by a build-up of pressure from boiling or almost boiling water in underground springs because of the heat from volcanic rocks.

At Hot Water Beach in New Zealand, at low tide, hot water bubbles up through the sand. You can dig your own spa pool and lie back and relax for a couple of hours!

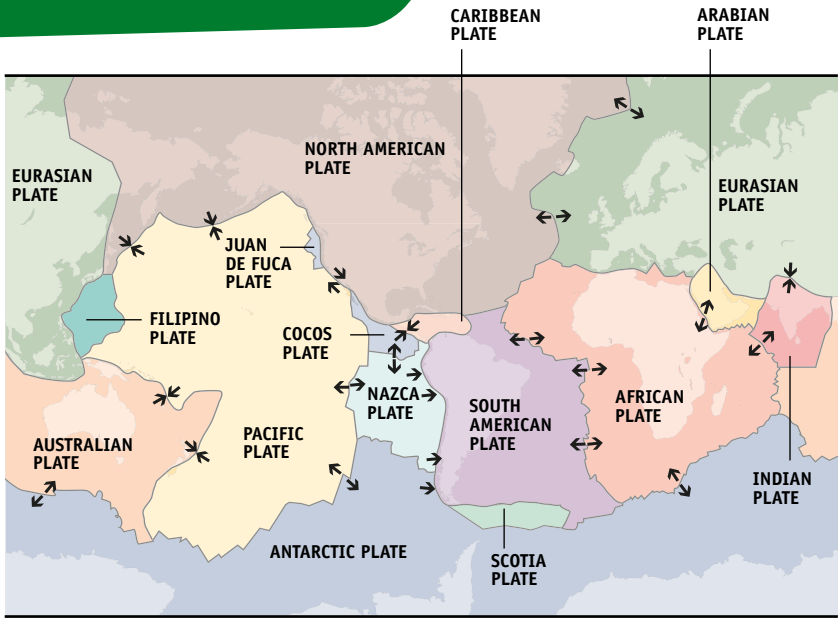
One of the most active areas of **geothermal energy** in the world is around the Pacific Ocean called the "Ring of Fire".

THE RING OF FIRE



Geothermal energy also has other impacts on the surface of the Earth (also called the **crust**), where we live. The rocky outer crust is broken into different pieces called **tectonic plates** (often just called "plates"), including seven big plates and many smaller plates. Look at the map of the big plates on p.43. Which plate do you live on?

The Earth's **heat energy** causes these plates to move around. These plates are like big rafts that are floating on the soft **mantle** part of the Earth. The plates are 80 to 400 kilometres thick (50 to 250 miles) and usually move a few centimetres each year. The movements of these plates over time helped create some of the biggest mountains in the world. Can you guess what else happens when the plates move around?



The movement of the Earth's plates causes:

* **Volcanoes**: Hot, molten rock from the Earth's core known as magma spills onto the Earth's surface (where it is then called lava). This is caused by movements of the plates and pressure from molten rock inside the Earth.
* **Earthquakes**: Vibrations and shaking of the Earth's surface. This happens when the Earth's plates move in different directions or "rub" together.
* **Tsunamis**: Fast-moving waves in the ocean that can be caused by underwater earthquakes, volcanic eruptions or movement of the plates.

These natural events can be dangerous to people, plants and animals. However, these can be controlled by careful management, and we can still appreciate the life and environments near hot springs and volcanoes.

Find out more:

www.geology.sdsu.edu/how_volcanoes_work/index.html

http://kids.discovery.com/tell-me/curiosity-corner/earth/natural-disasters

CARBON = NATURE'S ENERGY

We have just learned about the two main sources of energy on our planet. But let's take a look at an essential element for all life – carbon; understanding how it moves will help us to understand the biological processes and factors that influence them. **Carbon** is present throughout the natural environment in many forms. It is a building block of life and a form of stored energy. All living things on Earth, even the human body, consist of **carbon** and rely on it as a fuel for life in one way or another.

DID YOU KNOW?

Carbon makes up about 18 percent of the human body. So if you weigh 100 pounds, your body contains around 18 pounds of carbon.

The carbon cycle

Carbon can be found in the ocean, air, and even rocks. **Carbon** is always moving around. The movement of carbon is known as the carbon cycle. Through following the carbon cycle we can also study the flow of energy on Earth, as most of the chemical energy (p. 50) needed for life is stored in organic compounds as bonds between carbon atoms and other atoms.

In the **atmosphere**, carbon is attached to **oxygen** and is then called **carbon dioxide** (CO_2).

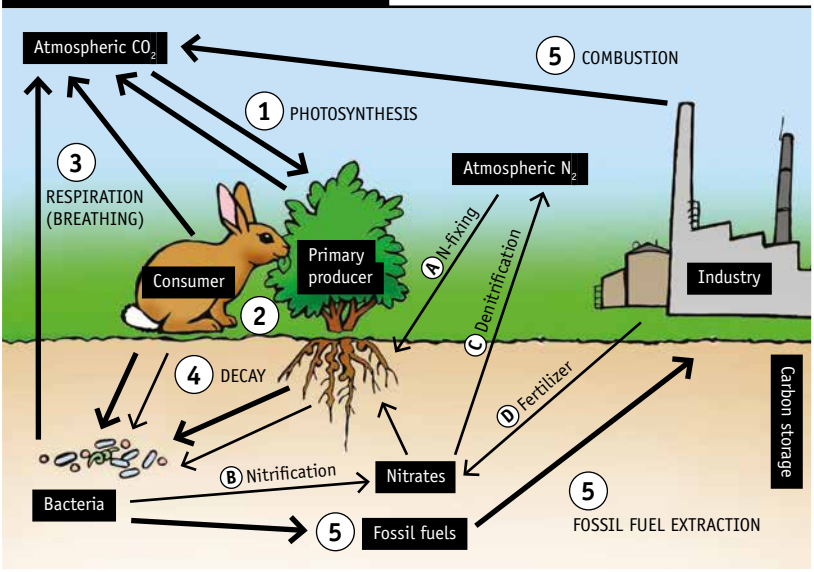
1. Plants use **carbon dioxide**, water from the soil and sunlight in a process called **photosynthesis** to produce food and energy. The **carbon** they absorb from the air becomes part of the plant.
2. Animals that feed on the plants pass the **carbon** compounds along the **food chain**.

3. Most of the **carbon** the animals consume is converted into **carbon dioxide** as they breathe (also known as respiration), and is released back into the **atmosphere**.

4. When the animals and plants die, the dead **organisms** are eaten by decomposers in the soil and the **carbon** in their bodies is again returned to the soil or to the **atmosphere** as **carbon dioxide**.

5. In some cases, plants that die and are buried deep in the ground over millions of years can turn into **fossil fuels** like coal and oil. When people burn **fossil fuels**, this **carbon** is released into the **atmosphere** as **carbon dioxide**.

THE CARBON AND NITROGEN CYCLES



Source: Adapted from YUNGA, Emily Donegan

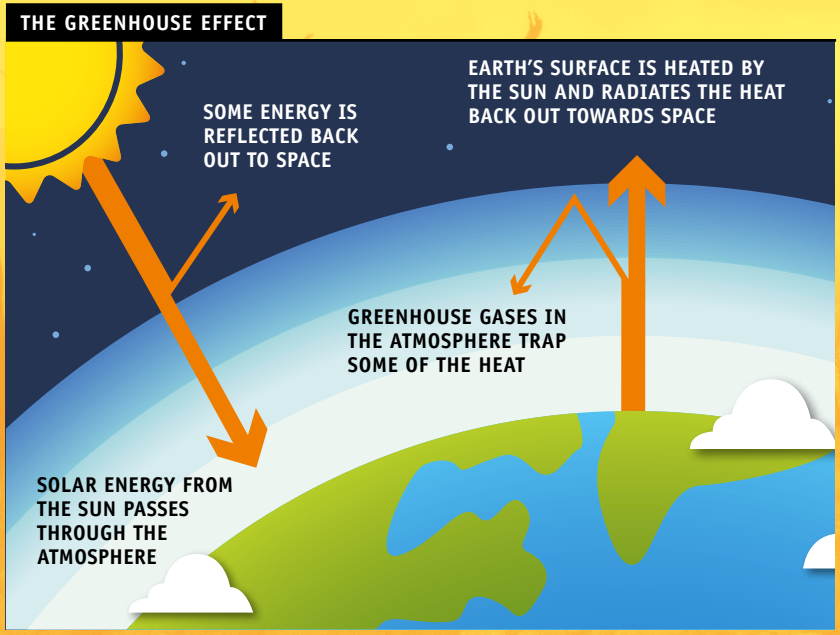
More to explore:

www.youtube.com/watch?v=nzImo8kSXiU

https://earthobservatory.nasa.gov/Features/CarbonCycle/

LIVING IN A GREENHOUSE

Have you ever been inside a greenhouse? You might have noticed it gets very warm in there. Certain gases in the Earth's **atmosphere** are known as **greenhouse gases** because they act a bit like the transparent glass or plastic in a greenhouse: they let heat from the Sun in, but don't let all of it escape again. This is called the **greenhouse effect**. Up to a certain point, this is a good thing: without the greenhouse effect, Earth's average temperature would be around -18 degrees Celsius (0 degrees Fahrenheit). That's too cold for us! Thanks to the **greenhouse effect**, the average temperature on the planet is around 14 degrees Celsius (57 degrees Fahrenheit). **Greenhouse gases** include **water vapour**, **carbon dioxide**, **methane**, **nitrous oxides** and **ozone**.



But you can't have too much of a good thing, and that's what's happening with **carbon dioxide**. The levels of **carbon dioxide** in the **atmosphere** are at the highest they have been in four million years, and this is making our planet heat up, causing **climate change**. Humans directly influence the amount of **carbon dioxide** in the **atmosphere**: three-quarters come from the burning of **fossil fuels** when we drive cars, operate factories, etc., and the remainder comes from other sources, including **deforestation**, with the result that there are fewer trees to absorb **carbon dioxide**. People are already being affected by **climate change**, which has caused an increase in extreme weather events and disasters in recent years, including droughts, floods, hurricanes and tropical storms.

Explore more watch the following video:
www.youtube.com/watch?v=x_sJzVe9P_8

Learn more about this topic through the **CLIMATE CHANGE CHALLENGE BADGE**

ENERGY SOURCES AND IMPACTS

As we have seen in the previous section all energy originally came from the Sun or from the centre of the Earth.

Humans have learned to use different energy sources over the centuries, all have their benefits but also their negative impacts. The challenge is to educate people on their energy use as well as to develop new technologies that will help people all around the world access better energy sources that are affordable, reliable and safe.

In this section, you will learn more about some of the common energy sources used today.

HOW DO WE MEASURE ENERGY?

Different kinds of energy are measured in different ways. Some units for measuring energy are: joules, calories, ergs, kilowatt-hours and British thermal unit (BTU). You can always convert one unit to another. Have you heard of these units relating to the energy in your food or **electricity** usage?

Let's look at an example: the amount of energy in a piece of buttered toast is about 315 kilojoules (315 000 joules). This is the same amount of energy that you would need to walk for 15 minutes. This is also the amount of energy used by a 60-watt light bulb in 90 minutes! However, if you switch to energy-efficient lightbulbs, they will shine as bright as 60-watt light bulbs but use less energy (for example, 11-watt), last 10–15 times longer and cost 5–10 times less.

Power is the rate at which energy is used, and is measured in watts. Did you know that a person sitting quietly produces 100 watts of **heat energy** per second? That is the same amount of energy that is needed to **power** a 100-watt light bulb every second!

FORMS OF ENERGY

Scientists define energy as the **ability to do work**, and work is defined as what happens when **a force that is applied to an object moves that object**. Let us now explore the different forms of energy.

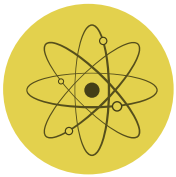
Potential energy

Potential energy is stored or resting energy in an object. **Potential energy** is measured in joules, abbreviated as J. **Potential energy** can be divided into four types of energy: chemical, mechanical, nuclear and gravitational energy.

Chemical energy: energy that is stored in chemical bonds of atoms and molecules. Some examples of using chemical energy include batteries, biomass, petroleum, natural gas and coal. It can only be seen when a chemical reaction takes place. For example, in a battery, there are chemicals that are used when needed. When you put a battery inside a battery-powered toy car, nothing happens. This is because the battery's energy is potential. When you switch on the car, the potential chemical energy is converted into kinetic energy. Also, when people burn wood in a fireplace or burn petroleum in a car's engine, which is a form of chemical energy that is converted to thermal energy. Another example is food: when we eat the chemical energy stored in food is released during digestion. The energy produced keeps us warm, maintains and repairs our body and makes us able to move.

Mechanical energy: energy that is stored in objects by tension and motion. In fact, mechanical energy is often defined as the ability to do work. For example, compressed springs or stretched out rubber bands. A common scene in some parts of the world is a "wind farm". High-speed

winds are used to do work on the blades of a turbine. The mechanical energy of the moving air gives the air particles the ability to apply force and move the blades.



Nuclear energy: energy that is stored inside an atom and that holds the nucleus of an atom together. Nuclear energy can be used to produce heat and electricity. For example, nuclear power plants use it to generate heat.

Gravitational energy: energy that is stored in an object's height. A high and heavy object has a lot of gravitational energy. For example, when you ride a bicycle down a steep hill and your bike picks up speed (our advise is ...better to slow down), this is gravitational energy converting into motion energy. **Hydropower** is an example, where **gravity** forces water down through the turbine to generate **electricity**.

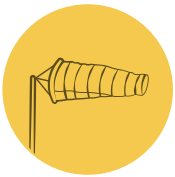
Kinetic energy

Kinetic energy is the energy that is in motion. Any object that has motion – vertical or horizontal – has kinetic energy. For example, moving water and wind are examples of kinetic energy. **Electricity** is also kinetic energy as it involves tiny movements of particles that you cannot see.

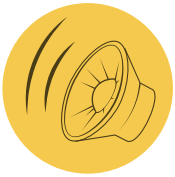
There are five types of kinetic energy:

Thermal energy: or heat, is created by movements of tiny particles in an object. The faster these particles move, the more heat is generated. Matches are a great example of thermal energy. Geothermal energy is thermal energy of the Earth.

Radiant energy: energy that travels by waves or particles, particularly electromagnetic radiation such as heat or x-rays. Virtually anything that has a temperature gives off radiant energy like the heat emitted from a campfire. Sunshine is light and can be an example of radiant energy too, because it provides heat from the Sun to the Earth through radiation, which is possible by electromagnetic waves.



Motion energy: stored in the movement of objects. Faster moving objects have more energy stored. Energy is needed to get an object moving, and energy is released when an object slows down. Wind is an example of motion energy.



Sound: energy is created when a force causes an object or substance to vibrate. For example, you have all been to a musical concert before, and have probably noticed the different sizes of instruments. The larger instruments tend to have a deeper sound while the smaller ones have a higher pitch (vibration).

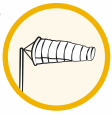
Electrical energy: energy that is created by movement of tiny particles called electrons. These electrons are moving in an electrical circuit. For example, a toaster, television or a cell phone. Lightning during a thunderstorm is also an example of electrical energy in nature.

Energy can be converted between the two forms. For example, let's take a roller coaster. (*Source*: **https://www.enwin.com/kids/electricity/types_of_energy.cfm**)

When it arrives to the top, it has **potential (gravitational) energy**.

When it is going up, it is using **kinetic (motion) energy** because the energy is in motion.

When it goes down, **kinetic energy** is used again.



© Wikimedia/Dusso Jamladde

WHAT IS ELECTRICITY?

Take a look around your home: how many everyday items run on **electricity**? The list is likely to be very long – life would be tough without **electricity**.

Electricity is a form of energy, it is all around us – powering technology like our cell phones, lights and computers. It's tough to escape it in our modern world. But where does it come from? How is it that we plug in an **appliance** and it magically works? Well, it's not magic. It all starts with **atoms**, which, are the smallest of all particles. Everything, absolutely everything, is made of **atoms**. The centre of an **atom** is called the nucleus, which contains **protons** and **neutrons**. Then there are **electrons**, which move quickly around the protons and neutrons. This quick movement is what creates electricity. We can't see **electrons**, but they certainly improve our lives!

However, electricity can still be seen in nature – like in lightning as we just read. Back in 1752, a man named Benjamin Franklin, curious about lightning, conducted a rather dangerous experiment. He tied a metal key to a kite and went out into a thunderstorm to fly the kite. Just as he predicted, **electricity** (lightning) from the storm clouds flowed down the string, and he received a mild electrical shock. This proved that lightning is, in fact, **electricity** and the experiment paved the way for many more experiments working out how to harness **electricity**.

Why was Benjamin Franklin shocked?

Fortunately, we don't have to go around flying kites in thunderstorms to do so (in fact we should never do such a thing as it's far too dangerous)! Most of us use **electricity** provided by **power plants**. **Power plants** use different sources of energy (see Section C) to produce **electricity**. They convert these different forms of energy (e.g. **chemical**, **nuclear** or **mechanical**) into **heat energy** and steam. The steam is used to spin **turbines** (**mechanical energy**), causing magnets to spin around copper wires. By moving big magnets towards or away from the copper wires, **power plants** make **electrons** that travel along **power lines** to give people **electricity**.

Electricity travels in loops, so it travels along **power lines** to buildings and homes and then it travels back to the **power plant**. When we turn on a light switch, the **electrons** flow through the whole loop from the **power plant** to your light and back to the **power plant**. When you turn the same switch off, you stop the connection in the loop, meaning the **electricity** no longer reaches your light, so the light is off.

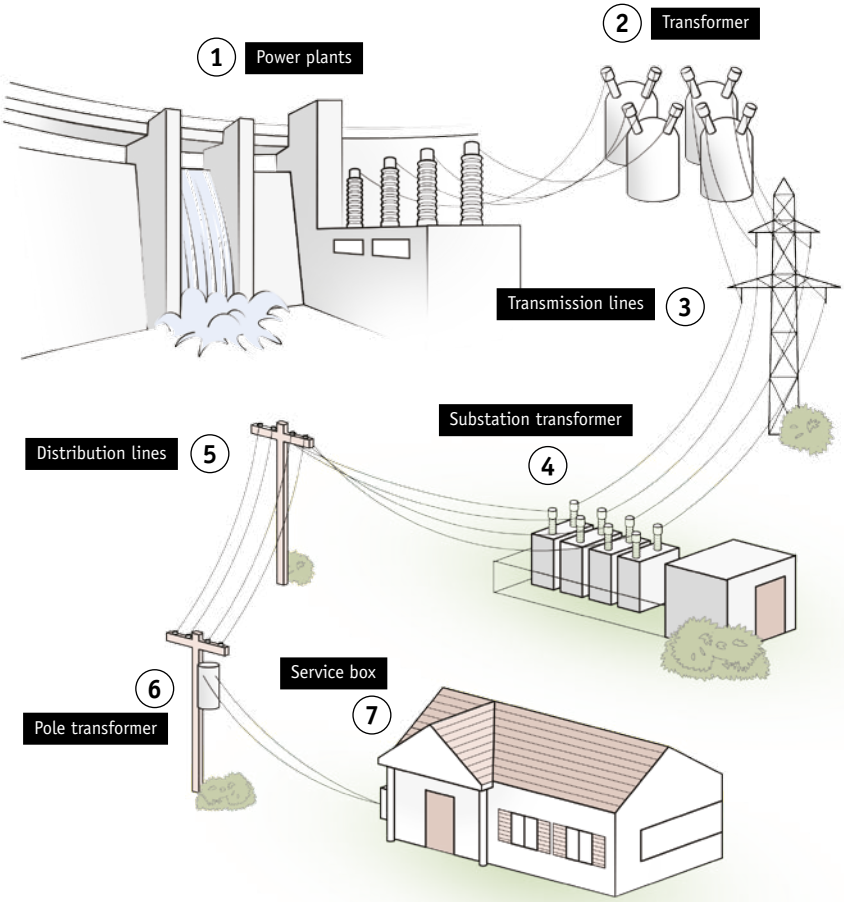
ELECTRICITY IS AN IMPORTANT ENERGY FORM, BUT IT CAN BE VERY DANGEROUS!

Refer to the Be Safe and Sound section (p. 6) of this booklet for more tips on how to keep yourself safe around electricity.

The electric journey

Have you wondered how **energy** travels from **power plants** to our homes? Well, take a look at the electric journey, also called electric grid (network for delivering **electricity**), shown in the picture on p. 57.

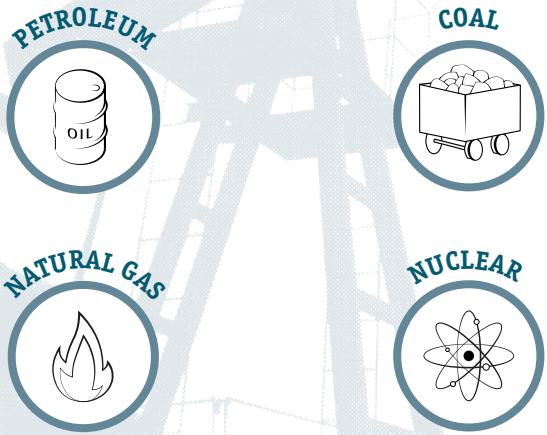
1. **Power plants**: If you remember from Section B (p. 48), there are several ways **electricity** is made at power plants: thermal power plants use fossil fuels,, **hydropower** plants use water and **nuclear** power plants split atoms. Thermal and nuclear power plants use steam to turn a turbine while hydropower plants use potential energy. The **turbine** spins a big magnet inside a coil of wire. **Heat** energy in the steam and potential energy are converted into **mechanical** energy. The **mechanical** energy created in the **turbine** is converted into **electrical** energy in the **generator**.
2. **Transformer**: **Electricity** travels from the power plant through wires to a step-up transformer. The tranformer increases the pressure of the electicity (also called voltage) allowing it to travel long distances.
3. **Transmission lines**: **Electric** current travels through wires to the transmission lines. These lines can carry large amounts of energy over long distances.
4. **Substation transformer**: **Electricity** reaches the substation transformer, where the electricity level is lowered so that it can be used in communities.
5. **Distribution lines**: From the substation transformer, **electricity** current travels to distribution lines, which are sometimes above or below ground.
6. **Pole transformer**: **Electricity** reaches the pole transformer, which lowers the **electricity** level once more to be used in our homes. In some places where lines are underground, you can find a transformer box instead of a pole.
7. **Service box**: At this last stage, **electricity** travels into a service box (where the electric meter is) to be ready for use in our homes. You can flick a switch to turn on the lights now!



However, not all **electricity** generated at the **power plants** reaches your home. About 8 percent of electric power is lost during this journey (*Source*: World Bank, 2013). Heat, which is essential for hot water supply and district heating, is also generated at the power plants, but in general is lost in conventional power generation methods. A combined heat and power plant (CHP) is a possible way to effectively extract both heat and electricity from fossil fuels and increase energy efficiency. This type of power generation is now drawing attention as a measure against global warming.

NON-RENEWABLE ENERGY

Some energy sources are called non-renewable energy because they are limited, and we will only be able to use these energy resources until they run out. Non-renewable energy resources include fossil fuels (coal, petroleum and natural gas) and nuclear energy.



FOSSIL FUELS

Over millions of years, the **geothermal energy** in the Earth's crust helps turn dead plants and animals into usable energy sources called **fossil fuels**. **Fossil fuels** have formed because some remains of plants and animals that lived millions of years ago (also called fossils) – yes, millions! – were exposed to heat and pressure deep under the earth while they were **decomposing**. Heat from inside the Earth and pressure from soil and rock changes these fossils into oil, natural gas and coal. As it takes millions of years to make or "renew" more fossil fuels we call them non-renewable. We are currently using the fuels that were made more than 65 million years ago. Once this is gone, it's gone for good!

Fossil fuels contain lots of **carbon** (an element that makes up all living things), which releases energy when it is burned. Currently just under 70 percent of the world's electricity is produced using fossil fuels. This means that they are still a key source of global energy supply. At the same time, fossil fuels, especially petroleum-based ones, are used for transportation as well. However, this is not the best situation as when fossil fuels are burned they produce greenhouse gases and other chemicals that pollute the air and cause climate change. These problems are explained more in the 'Environmental Impacts' sections under 'Petroleum (Oil)', 'Coal' and 'Natural Gas' later in the chapter. Due to the problems that are linked to fossil fuels, we need to develop future energy systems that highly reduce the use of such energy sources.

Petroleum (Oil)

Petroleum (commonly called **oil**) is a liquid **fossil fuel** (**chemical energy**) that was formed from dead animals and plants in a marine (water) environment. Over millions of years, the remains were covered by layers of mud. **Petroleum** can be thick like black tar or as thin as water. A lot of **oil** is stored underneath the ocean and along shorelines. We use it in different forms: gasoline, diesel fuel, kerosene and heating oil.

How to get petroleum

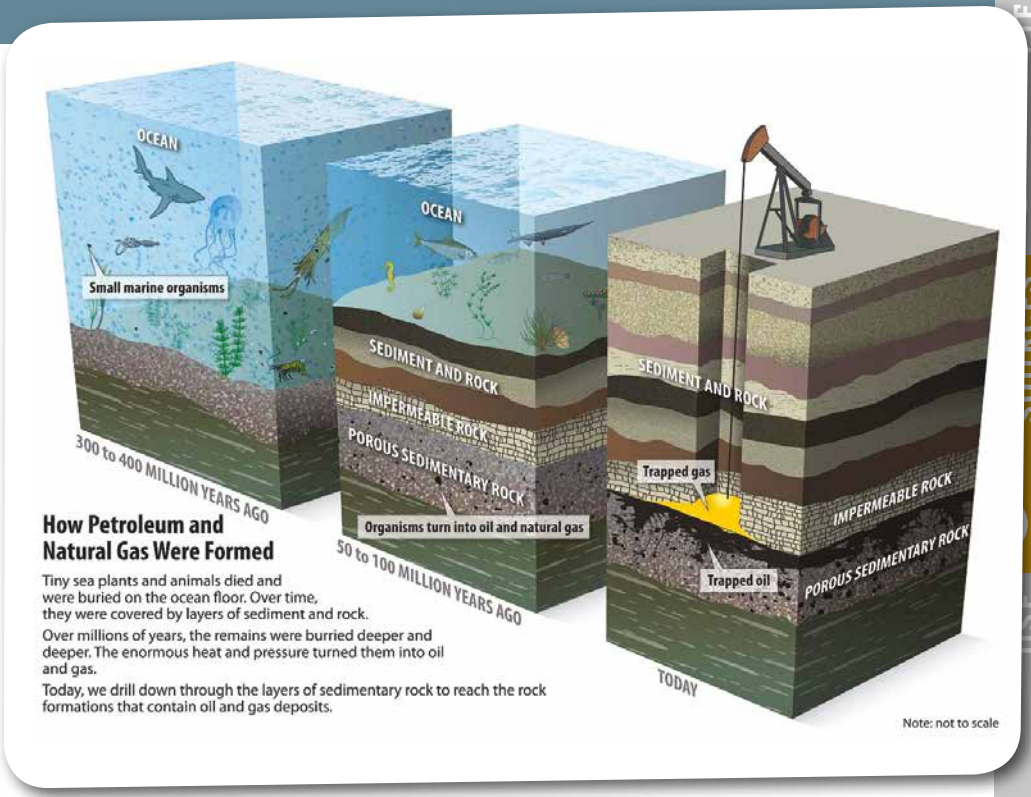
To extract oil from the ground, workers drill into rocks where **petroleum** is buried. The **petroleum** gets pumped out of the wells (usually 1.5 kilometres or 1 mile deep), and refineries separate the **petroleum** into different types of products and usable fuels. Then **petroleum** products are transported by ships, trucks and **pipelines**. We burn **oil** in engines and in **oil** burners.

Example of uses

- ★ Fuel for planes, cars, trucks, buses, boats and farm machinery
- ★ Products made from petroleum: plastic, ink, crayons, soaps, deodorant, eyeglasses and CDs
- ★ Production of electricity through power plants or generators
- ★ Heating through boilers and other appliances

Ancestral energy

Here's a weird thought: it may well be thanks to an unknown creature that prowled the Earth thousands of years ago that you can enjoy your daily bus ride or turn on your kitchen gas stove...



How Petroleum and Natural Gas Were Formed

Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of sediment and rock.

Over millions of years, the remains were burried deeper and deeper. The enormous heat and pressure turned them into oil and gas.

Today, we drill down through the layers of sedimentary rock to reach the rock formations that contain oil and gas deposits.

Environmental impacts

Burning petroleum releases greenhouse gases into the atmosphere, pollutes the air and causes acid rain, just like burning other fossil fuels. The burning of petroleum products also releases carbon dioxide that is linked to global warming. Air pollution from cars and factories that use petroleum damages human health, especially children, as it irritates the lungs and causes cancer.

Oil spills at extraction sites or during transportation of oil can have terrible consequences for ecosystems, especially marine life. As most oil floats, during oil spills animals swimming on the sea surface or on the shore are greatly affected. Animals such as seabirds and sea otters can be harmed as they get really cold and can even die (think about it: sea otter's fur and bird's fluffy feathers usually keep them warm; when they are stuck down

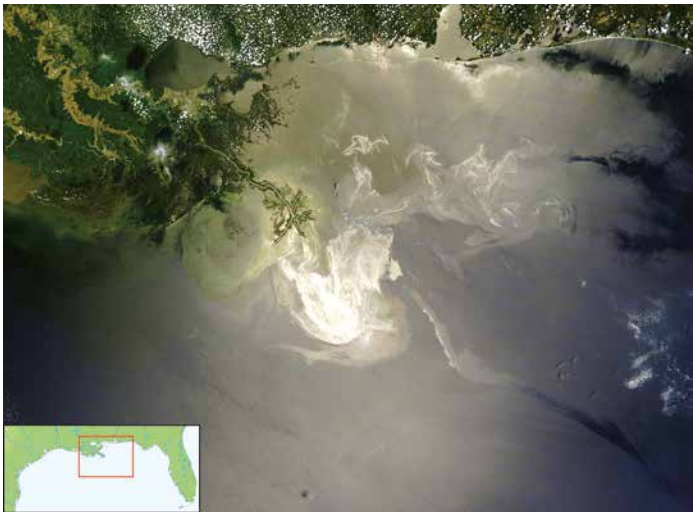
by oil, however, this insulation doesn't work anymore). Other consequences of **oil** spills include poisoning all kinds of life and injuring animals' eyes and lungs.

Find out more:
www.eia.gov/kids/energy.cfm?page=oil_home-basics

DEEPWATER HORIZON OIL SPILL

A recent example was the Deepwater Horizon oil spill in 2010. The oil spill happened in the Gulf of Mexico and is considered the largest marine oil spill in history. Natural gas blasted out of an oil well and caused an explosion in the drilling machines. The leak resulted in 4.9 million barrels of crude oil spilled out, damaging animal and plant habitat.

Source: http://kids.britannica.com/comptons/article-9544332/Deepwater-Horizon-oil-spill-of-2010



Natural gas

Natural gas is a **fossil fuel**. Much like oil, natural gas formed from decayed plants and animals that over time where covered by mud. Pressure and heat changed these remains into tiny bubbles of high-energy gases that you cannot see, smell or taste. As a safety measure, the smell of rotten eggs is added to **natural gas** so that people can smell when there are leaks and know that they need to do something about it – **inhaling too much natural gas can be deadly**.

Natural gas is mainly made up of a **greenhouse gas** called **methane** and compared to other **fossil fuels** it is considered a relatively efficient, clean and economical energy source, as it produces less wasted **heat energy** and fewer emissions of air pollutants and carbon dioxide.

How to get natural gas

The extraction of **natural gas** starts by geologists (scientists that study the structure of the Earth) surveying the area and studying the types of rock that are found near gas and oil deposits. Once they have found the right place, the drilling can begin. Some of the areas are on land, but mostly they are deep in the ocean. Wells are drilled down and gas flows up the wells to the surface

of the ground. This gas is collected, and toxins are removed from the gas. Then the gas is cooled so that it becomes a liquid. It is transported as a liquid as it takes up to 600 times less space when liquid. After being transported, **natural gas** is transferred into a **pipeline** where it is no longer cooled, so it becomes a gas again. It is then used directly in homes (e.g. in gas cooking stoves) or is burned to produce heat and **electricity** at **power plants**.

Examples of uses

- ★ **Electricity** through gas power plant
- ★ Cooking fuel, heat homes and heat water
- ★ Fuel for process heating and for combined heat and power systems
- ★ As raw material to produce chemicals, fertilizer and hydrogen
- ★ Fuel for buses, trucks and cars
- ★ Used to make paper and cement
- ★ An ingredient in glues, **fertilizers**, plastics, medicines and other products

Environmental impacts

Natural gas extraction is a noisy process that can disturb animals in nearby **ecosystems**. Although burning **natural gas** releases less **greenhouse gases** than burning other **fossil fuels**, it still pollutes the air and contributes to **climate change**. Other environmental threats include earthquakes and even gas leaks from the areas where **natural gas** is extracted or from damaged **pipelines** causing air and water pollution.

Find out more:
www.eia.gov/kids/energy.cfm?page=natural_gas_home-basics

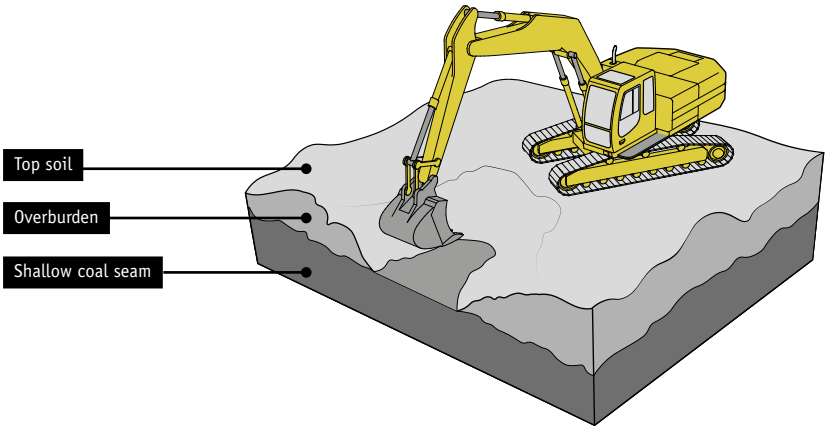
Coal

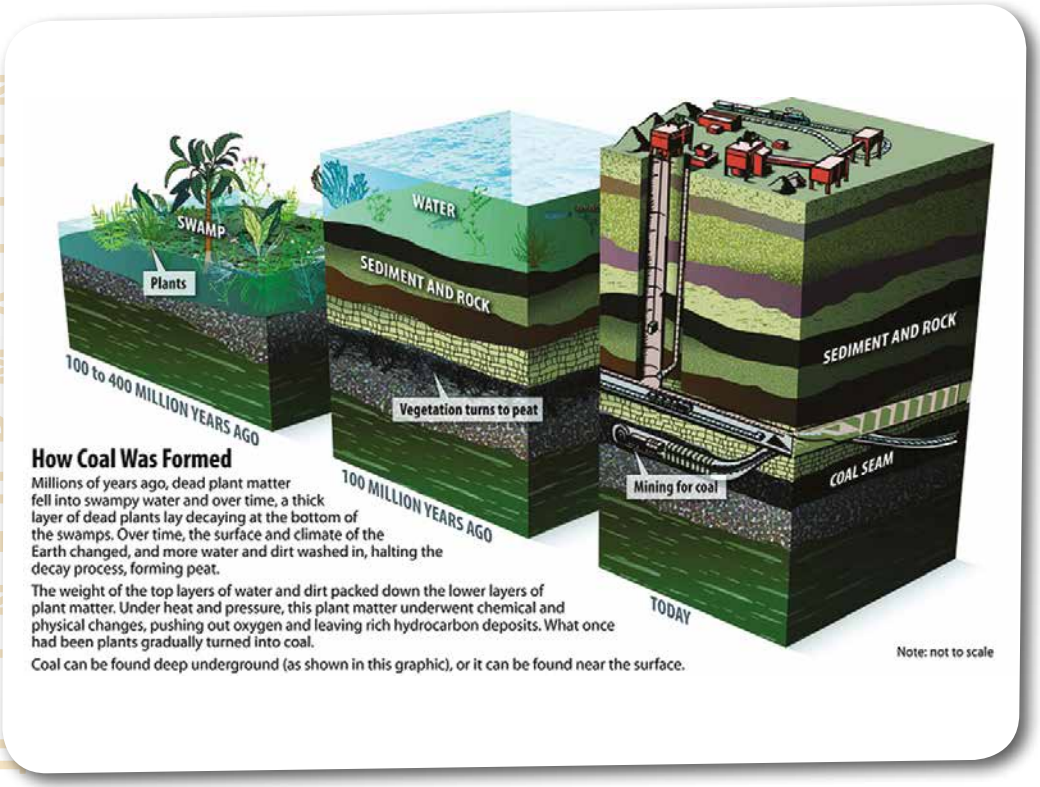
Coal is a **fossil fuel** that is made mostly of **carbon**. **Coal** originated from a layer of dead plants at the bottom of swamps hundreds of millions years ago, which was then covered by layers of water and dirt that locked the energy of dead plants inside. Applied heat and pressure from top layers turned the plant remains into **coal**. It is a brownish-black rock found below the soil, and is a relatively cheap source of energy – it is the world's biggest source of energy for **electricity**. It is mined all over the world, and the largest amounts of **coal** are found in United States of America, the Russian Federation, China, Australia and India.

How to get coal

To extract **coal** from the ground, **coal** miners use either surface mining (removing the soil and land to dig out the **coal**) or underground mining (using underground tunnel systems and special machines to dig out the **coal**). Then the coal is processed to remove other rocks and unwanted materials, and is transported

SURFACE MINING





How Coal Was Formed

Millions of years ago, dead plant matter fell into swampy water and over time, a thick layer of dead plants lay decaying at the bottom of the swamps. Over time, the surface and climate of the Earth changed, and more water and dirt washed in, halting the decay process, forming peat.

The weight of the top layers of water and dirt packed down the lower layers of plant matter. Under heat and pressure, this plant matter underwent chemical and physical changes, pushing out oxygen and leaving rich hydrocarbon deposits. What once had been plants gradually turned into coal.

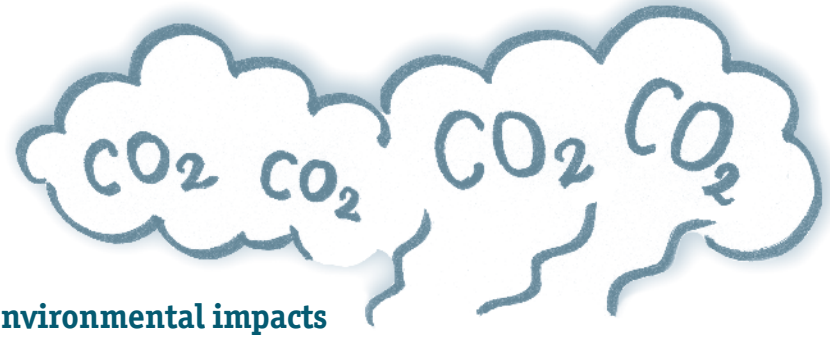
Coal can be found deep underground (as shown in this graphic), or it can be found near the surface.

by trains and ships to **power plants**. At the **power plants**, the **coal** is burned to produce **heat energy**, which is converted to **electricity**. New technologies make it possible to burn coal in a way that produces less air pollution, by removing some of its **pollutants** before it is burned.

Example of uses

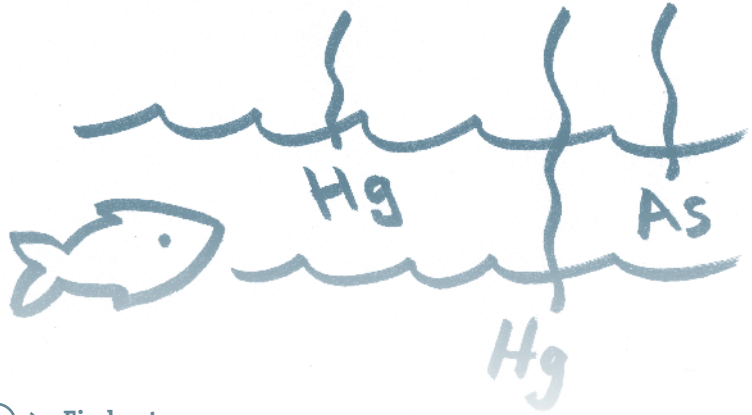
- ★ **Electricity** through power plants
- ★ Steel and cement industry use coal to produce steel and cement
- ★ Paper factories burn coal to produce **heat**
- ★ By-products are used to make plastics, synthetic fibres, **fertilizers** and medicines

- ★ Ash left over from burning coal is used to make roads and cement products
- ★ In some countries, coal is still used to heat homes



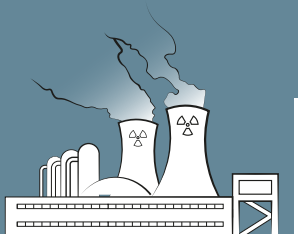
Environmental impacts

Burning **coal** emits more **carbon dioxide** than other **fossil fuels**, and mining and burning **coal** can cause air and water pollution, and **acid rain**. The explosives used in **coal** mining can also damage **ecosystems**, including plants, animals and soil. Underground coal fires can also cause wildfires on the ground. After **coal** is burned, mercury and other heavy metals remain, polluting water sources and fish, if they are not stored carefully.

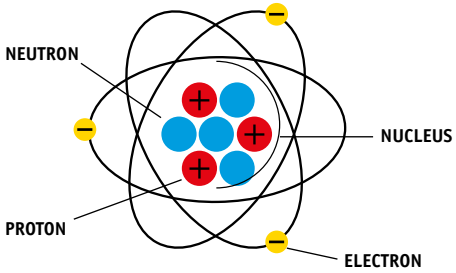


Find out more:
www.eia.gov/KIDS/energy.cfm?page=coal_home-basics

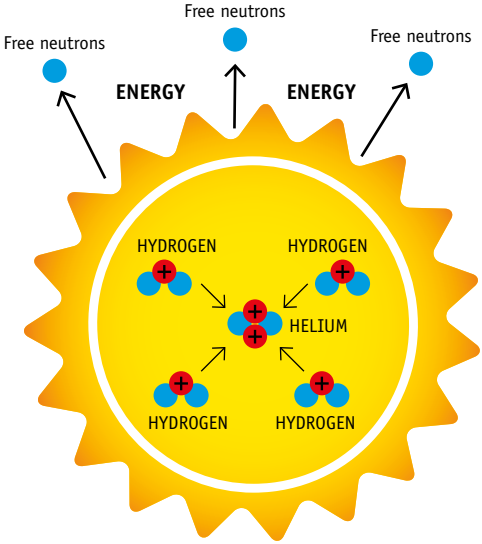
Nuclear



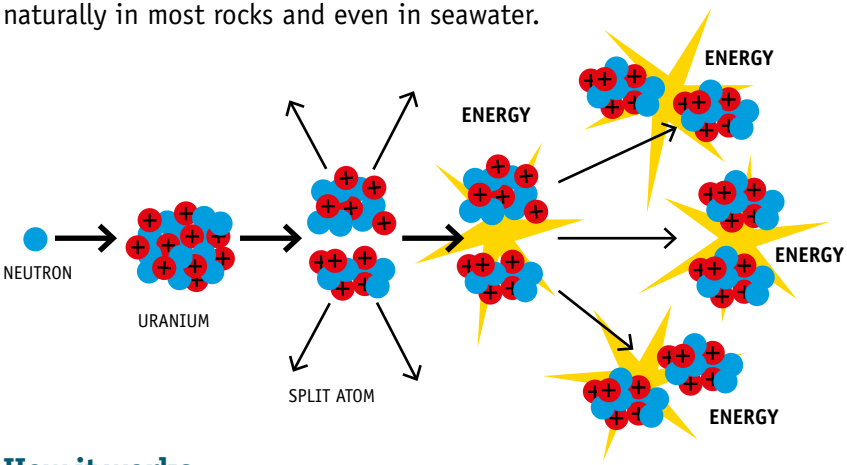
Nuclear energy is energy in the centre (**nucleus**) of an **atom**. Atoms are tiny particles that form every object in the universe. The nucleus of an atom consists of tiny particles of **protons** (+ positive charge) and **neutrons** (no charge). The electrons (– negative charge) move around the nucleus. Nuclear energy holds the nucleus in an atom together, and it is possible to release this energy in two ways: nuclear fusion and nuclear fission.



Nuclear fusion is energy released by combining atoms or fusing them together to create a bigger atom. For example, the Sun produces energy by **nuclear fusion**. Though we do not yet have the technology to use **nuclear fusion** to produce energy on a large scale, the Sun, once again, is a step ahead of our hard-working scientists: inside the Sun, hydrogen atoms are busy fusing to produce a larger atom: helium. As the helium is formed, extra heat and light energy are also produced – and that is why the Sun is hot and bright!



Nuclear fission is energy released by splitting atoms to make smaller atoms. For this, we use **uranium** atoms. **Uranium** is a heavy metal that is used to produce **nuclear energy**. It occurs naturally in most rocks and even in seawater.



How it works

Uranium is mined using different techniques, and can even be collected from ocean water. **Uranium** atoms are split apart in the **nuclear fission** process at **power plants**. This releases heat energy, which, much like in power plants that use **non-renewable energy**, is used to heat water so it becomes steam, which in turn spins the turbines that generate our electricity. Water from a nearby lake, river or ocean is used to cool **power plant** equipment, and then the water is returned to the water body. Nuclear power plants shut down every 1.5 years to remove used **uranium**, known as nuclear waste (also called **radioactive** waste). It is crucial that this waste is stored safely, as nuclear waste can remain dangerous to people and the environment for thousands of years.

Uses

- ★ **Electricity**
- ★ Heat
- ★ Fuel for ships, aircraft and submarines

- ★ Nuclear batteries are used in space probes and some medical implants
- ★ Nuclear (radioactive) substances are used for x-rays, various scanners, ultrasound to diagnose patients and treat some illnesses
- ★ Radiation is used to sterilize medical equipment
- ★ Nuclear particles help measure the amount of air whipped into ice cream!

Environmental impacts

The major problem with **nuclear energy** is the radioactive waste that is left after producing electricity. The radioactive waste can remain radioactive and dangerous for human health for thousands of years. Some radioactive waste is stored underground or at ground level by using a sealing barrier such as clay or concrete that stops the waste escaping into the atmosphere. The barrier is covered by a layer of soil or rocks. The spent fuel used in nuclear power plants is stored in specially designed containers and sealed for centuries so they do not contaminate the environment. The exposure to radioactive particles can be dangerous to people, and in the case of spills and accidents, the released nuclear radiation can penetrate and pollute soils, animals, plants and water, harming **ecosystems** as the particles pass through the **food chain**. Water used to cool power plant equipment is released back into water bodies as warm water, which can be harmful to the environment and fish.

On the positive side, **nuclear energy** produces fewer **greenhouse gases** than burning of fossil fuels, and it is possible to produce a lot of **electricity** using relatively small amounts of **uranium**. The United States of America, France and Japan are currently the leading producers of **nuclear energy**.

Find out more:
www.nrc.gov/reading-rm/basic-ref/students/science101.html

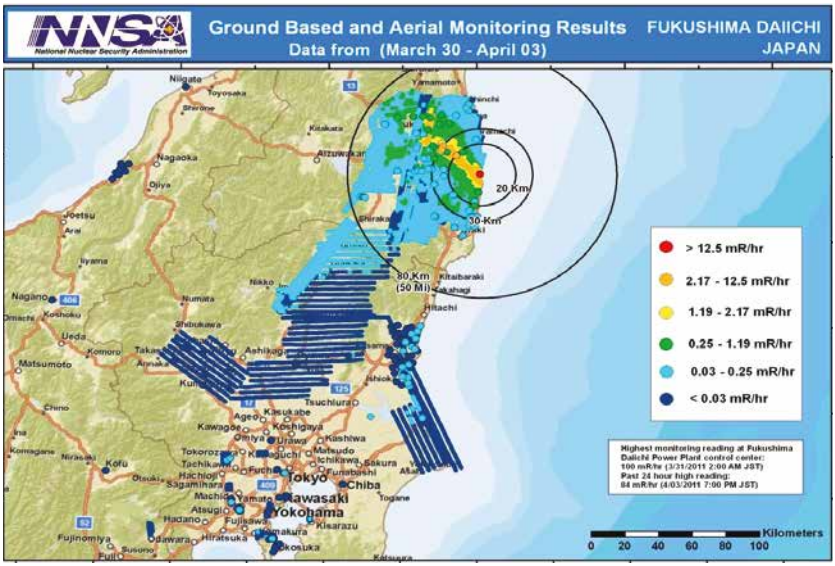
NUCLEAR EXPLOSIONS IN CHERNOBYL AND FUKUSHIMA

The Chernobyl nuclear power plant accident in April 1986 brought great disruption and damage to Ukraine and its neighbouring countries such as Belarus and the Russia Federation. It is estimated that 70 percent of the radioactive materials that fell down on the European continent was concentrated in these three countries. In 1986, approximately 116 000 people within the radius of 30 km of the reactors were forcibly evacuated and many villages were ruined.

Source: www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/chernobyl-accident.aspx

Following a major earthquake in Japan, a 15-metre tsunami (huge sea waves) disabled the power supply and cooling of three Fukushima Daiichi reactors, causing a nuclear accident in March 2011. As a result, more radioactive waste was released into the ocean and air. It is still uncertain whether it will be safe to eat foods produced in the area, but many fisheries and farmers received reputational damage and thus they have had to close their business.

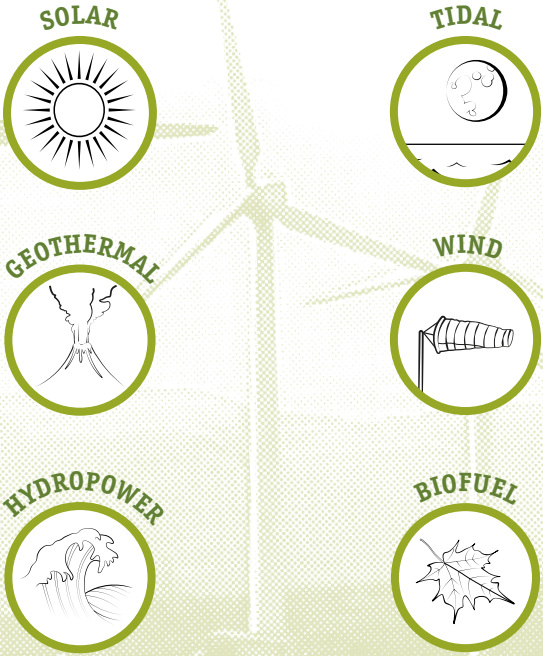
Source: www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/fukushima-accident.aspx



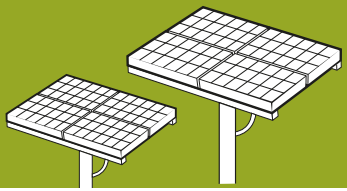
© Courtesy of the NNSA. Source: Wikimedia Commons

RENEWABLE ENERGY

Renewable resources are considered to be unlimited sources of energy. Renewable energy is also called "clean energy" and "green power" as the impact on the environment and the pollution due to its use is quite limited (apart from bioenergy which we will see below). Although renewable energy produces limited greenhouse gas emissions, during the production of the power other types of pollution such as noise pollution and damage to other natural resources does still occur. However, in many cases these impacts are minimal compared with the pollution created from the burning and extraction of fossil fuels. Types of renewable energy include solar, geothermal, hydropower, tidal, wind, biomass and biofuels. Let's check them out!



Solar



Solar is the Latin work for "Sun". **Solar energy** is therefore **radiant energy** from the Sun that reaches the Earth. Using energy from the Sun is the most **sustainable** form of energy as it has less of an impact on the environment than capturing and using other sources of energy. So, why don't we use **solar energy** for everything, since we have such a huge supply of it? As already mentioned, we don't yet know how to store the **energy efficiently**. Actually capturing the sunlight is also not easy. It shines all over the planet but only a little bit reaches any one spot. On cloudy days, much of the light never reaches the ground at all. In addition, we also need energy when the Sun is not shining (for example, people want to turn their lights on in the evening). This is one of the biggest challenges that we will need to solve if the Sun is going to become a major supplier of energy.

DID YOU KNOW?

In only 1 hour the Sun radiates enough energy to supply the world for a whole year!

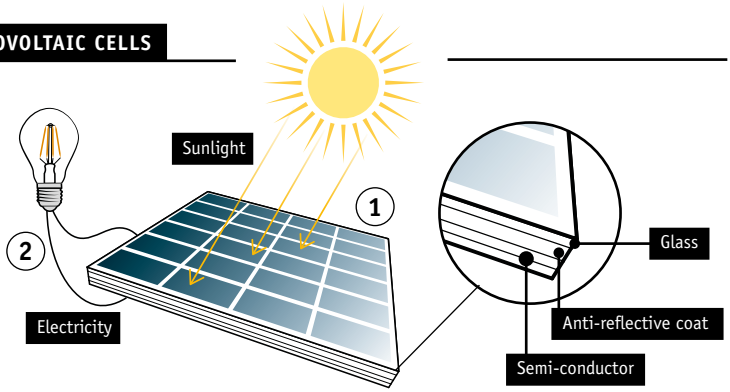
How it works

There are different types of technologies that use solar power to generate **electricity**. Let's focus on two examples here.

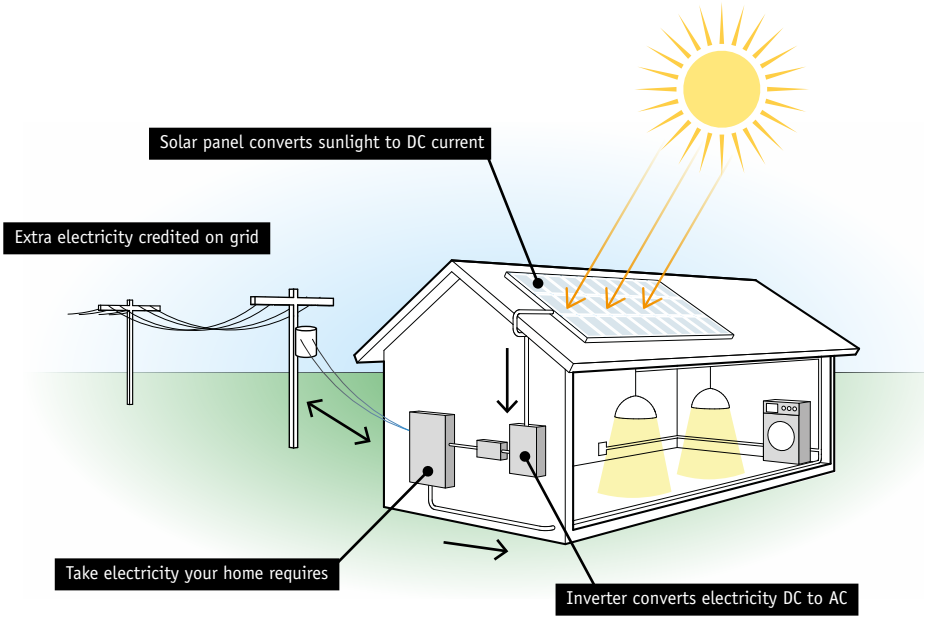
Solar panels

Maybe you have seen solar panels on houses, parking lots and electronic road signs or even on your calculator! They absorb sunlight and convert it into **electricity**. Solar panels are made up of groups of photovoltaics (PV for short) – "photo" means light and "voltaics" means **electricity**. They convert solar radiation from the Sun into direct **electricity**. Solar cells can be small or big, from simple systems in calculators to big solar cell farms. PV cells are made up of semi-conductor material (silicon). Photons in

PHOTOVOLTAIC CELLS



the sunlight reach the surface of the photovoltaic cell (1), and electrons will be attracted to the surface causing an electric circuit to be created between top and bottom layers of the PV cell. The semi-conductor converts the light into electricity (2).

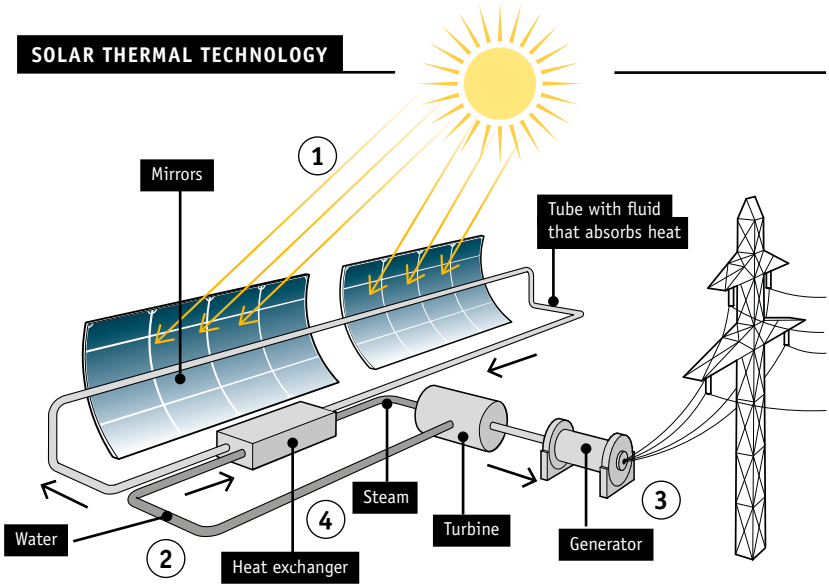


To use solar panels on top of houses, it is important to understand that the **electricity** the solar PV cells produce is in the form of direct current (DC). A house should have an inverter to convert DC to alternative current (AC) so it can be used by our home appliances (tv, computer, washing machine, refridgerator, etc.). If you place enough such PV cells on your home, you might even generate more **power** than you need, which you can then sell back to the electric grid.

Solar water heating

Solar energy can be used directly to heat water, to heat homes and to light buildings. Some solar technologies use the Sun's energy to heat fluids that produce steam to create **electricity**. It works by having lots of mirrors or reflectors (1) that concentrate sunlight to heat a special kind of liquid in a tube. The heat from this liquid boils water (2) to produce steam. Steam then spins a turbine, which is connected to a generator (3) to produce **electricity**. The steam is then cooled and turns back into water (4) that can be recycled, reheated and turned into steam again.

SOLAR THERMAL TECHNOLOGY



Uses

- ★ Used by plants to make food
- ★ Light our homes
- ★ Heat water, homes, greenhouses and swimming pools
- ★ **Electricity**
- ★ Recharge calculators, wrist watches and solar batteries
- ★ Cook foods within a solar oven
- ★ Dry clothes, fish and other foods
- ★ Remove salt from seawater

Environmental impacts

Solar energy is considered clean as it does not pollute air or water and does not release greenhouse gas emissions. However, **solar cells** use some toxic materials and chemicals that can be harmful to the environment. Desert **ecosystems** that have lots of sun sometimes also have sensitive **ecosystems** that may be damaged by the construction of solar **power plants**. So before setting up solar panels in an area, it is important to assess the **ecosystem** and the sensitivity of the plants and animals in a particular area.

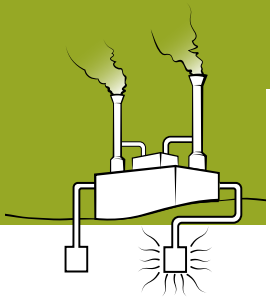
Find out more:
www.eia.gov/kids/energy.cfm?page=solar_home-basics

DID YOU KNOW?

The world's largest solar **power plant** is in the Mojave Desert, in the United States of America. A host of robot-controlled mirrors cover over 14 km^2 of desert (154 football pitches), repositioning themselves as the Sun travels across the sky in order to reflect its light onto three 69-storey tall towers that generate steam.

Source: www.sciencekids.co.nz/sciencefacts/energy.html; http://mic.com/articles/82417/9-things-to-know-about-the-world-s-largest-solar-plant-in-california

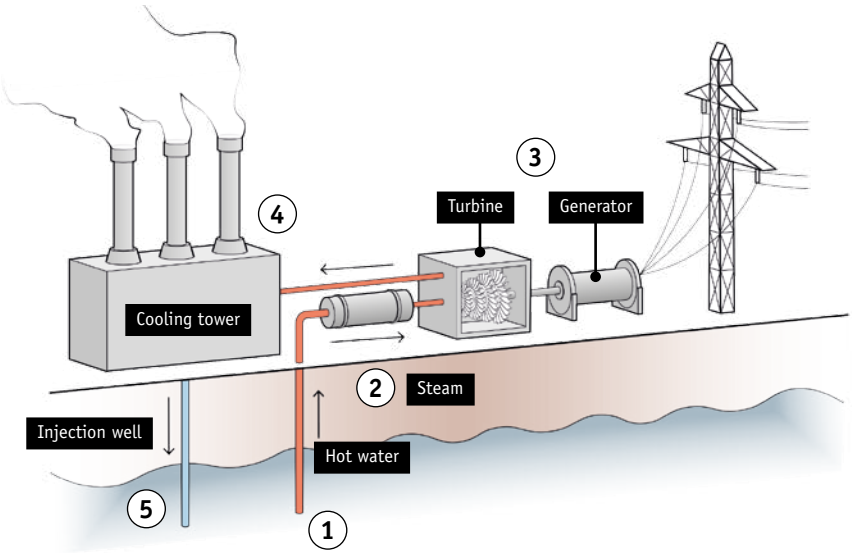
Geothermal



As you learned earlier, **geothermal energy** (**heat energy**) is heat from the Earth. Geothermal fluid is a mixture of pressurized water and steam. Iceland, which is an island with lots of volcanoes, is a world leader in using **geothermal energy**. Iceland has five major geothermal **power plants** that supply almost 90 percent of the heating and hot water in the country.

How it works

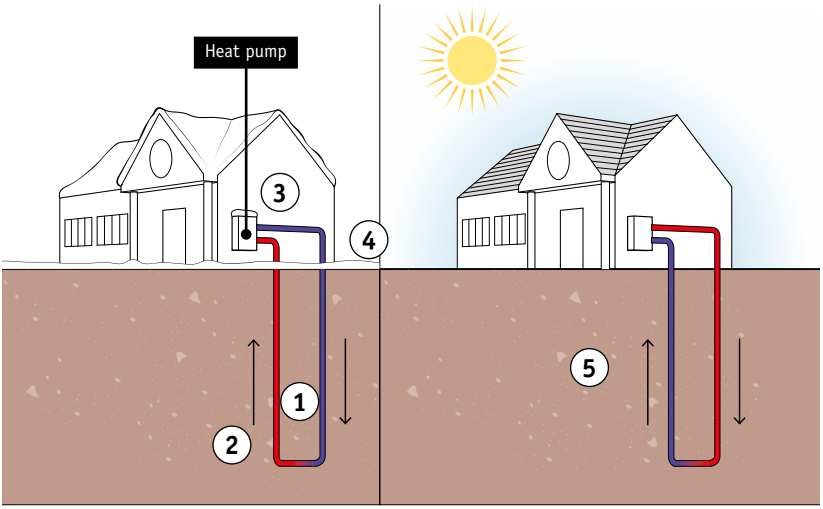
To get **geothermal energy** out of the ground, people dig deep wells and pump hot fluids from underground to the Earth's surface. There are different types of geothermal **power plants** that use this heat energy from the Earth to heat homes and to produce **electricity**. Some geothermal power plants use hot steam or geothermal fluids to produce **electricity**. It works by pumping hot water (1) from underground through a well under high pressure.



Water then reaches the surface (2) and the pressure is reduced, which turns water into steam. After that, the steam turns the turbine (3) that is connected to a generator to produce electricity. Then, the steam goes into cooling tower (4), where it is cooled off and turned into water again. The water is pumped back underground through an injection well (5).

At the household level, geothermal heat pumps use the constant temperatures of the ground to heat and cool homes and buildings. This is possible since the ground is warmer than the outdoor air temperature in the winter, and the ground is cooler than the air temperature in the summer. In this system, water or refrigerant moves through several pipes (1). When it is cold, the water or refrigerant is heated up as it travels through the pipes in the ground (2). Heat from the ground is pumped into homes (3) in the winter. After the water cools down and heat is used up, it is pumped back to the ground (4). In summer, heat is pumped out of homes, so it works in reverse compared with winter (5). This is one of the most efficient and cost effective ways to heat and cool homes.

GEOTHERMAL HEAT PUMP



DID YOU KNOW?

In some parts of Iceland, hot water runs from geothermal power plants under pavements and roads to help melt ice.

Uses

- ★ **Electricity**
- ★ Heating and cooling homes
- ★ Heating swimming pools, greenhouses and fish ponds
- ★ Industrial processes such as pasteurizing milk
- ★ Drying crops to make animal feed
- ★ Recreation for bathing and spas

Environmental impacts

Geothermal **power plants** release a small amount of **carbon dioxide** into the air, but have low **greenhouse gas emission** levels compared with other sources of energy. When the ground is drilled for **geothermal energy**, this can damage natural features such as hot springs. The process of removing geothermal fluids, including gases, steam and water out of the ground removes natural heat from the environment. Extracting geothermal fluids can also cause land to sink since removing geothermal fluids can release pressure from underground. Another environmental problem is that when the heavy metals that are found in geothermal fluids are released into rivers or lakes they can cause pollution and damage drinking water.

Find out more:
www.teara.govt.nz/en/geothermal-energy/page-1

Hydropower

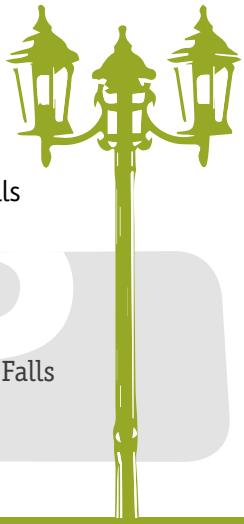
Hydropower is the energy found in running water (which is a kind of **mechanical energy**). The amount of energy available in moving water depends on its flow or fall. Fast-moving water contains a large amount of energy, like water falling from a great height, such as Niagara Falls. Since the late 1800s, **hydropower** has been used to create **electricity**, using **dams** and even energy from tides and waves in the ocean. Those waves aren't just good for surfing! The top **hydropower** producing countries are China, Canada and Brazil.

How it works

Hydropower is created when water flows through a pipe and pushes against blades in a **turbine** (1) to spin a **generator** (2) to produce **electricity**. A common type of **hydropower** uses water that naturally flows through a river or stream, and this flow of water can be controlled through the construction of a **dam**. **Dams** are created when a barrier is built across a stream or river to block the flow of water. This water flow can be controlled by opening and closing gates or pipes, so that water flows to create **electricity** when it is needed.

Uses

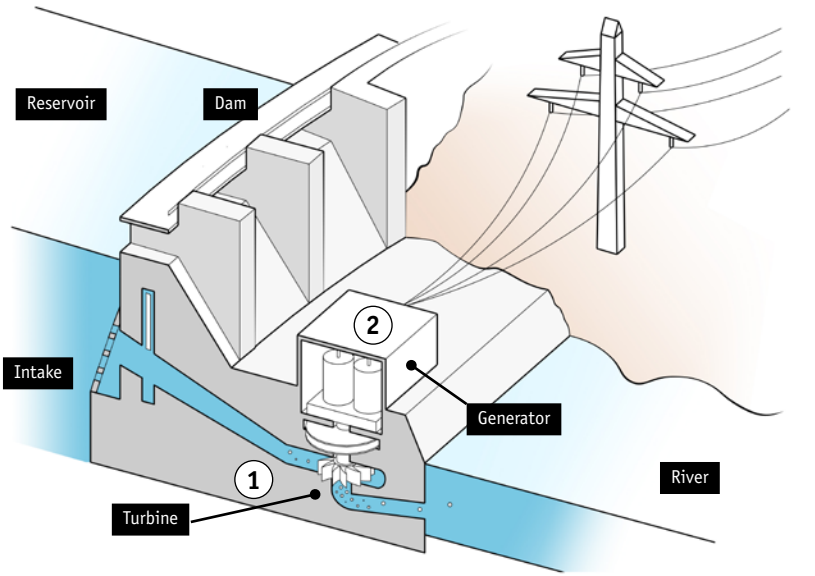
- ★ **Electricity**
- ★ Irrigation
- ★ Powering machinery in factories
- ★ Watermills for grinding flour and running sawmills



DID YOU KNOW?

In 1881, the street lamps in the city of Niagara Falls were all powered by hydropower!

HYDROELECTRIC DAM



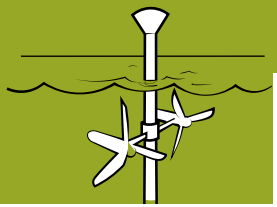
Environmental impacts

It may be a popular form of **renewable energy**, but even **hydropower** is not entirely environmentally friendly. Building large **dams** can hurt wildlife and **ecosystems**, both upstream of the **dam** and downstream, due to changes in water flows. When **dams** block the natural flow of rivers, this can even lead to flooding. Since **dams** can disturb natural **ecosystems** for fish, many **dams** have special devices called "fish ladders" to help fish move up waterways to lay their eggs. Also, even though water is **renewable**, some **dams** use water faster than it can be replaced by the underground water sources and rainfall.

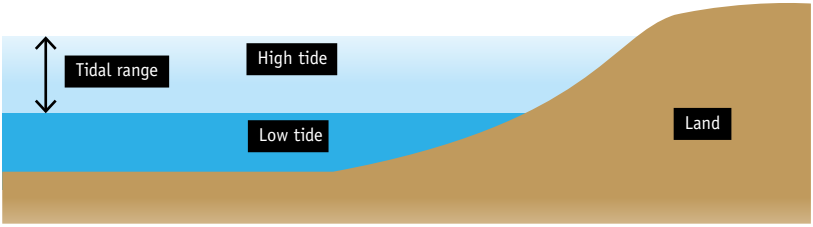
In hydropower, but in all renewable energy production and use, it is important to adapt a water-energy nexus approach which pursues the positive synergies of water management and renewable energy development.

Find out more: www.kids.esdb.bg/hydro.html

Tidal



Tidal energy is energy created by the tides in the ocean. Tides are created by the gravitational pull from the Moon and the Sun, and the spinning of the Earth. A lot of energy can be used from this movement of water. Near the coast, the water level can reach up to 12 metres. But, only 20 locations in the world have a large enough **tidal range** (above 3 metres) to be able to install tidal plants.



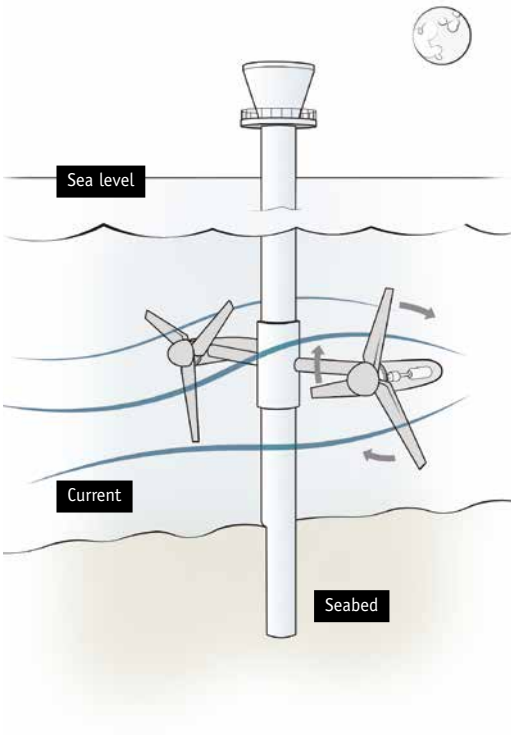
How it works

There are three ways we can use power from the tides: tidal barrages, tidal fences and tidal turbines.

- ★ **Tidal barrages**: They work like a dam. When the tide rises, the reservoir of water fills up. When the tide falls, the dam lets the water out. Water moving in both directions can rotate the blades of the turbines to generate **electricity**.
- ★ **Tidal fences**: They are similar to tidal barrages in that they contain several vertical turbines. The **turbines** form a fence between two land masses. When the tide rises and falls, the turbines spin and create **electricity**.
- ★ **Tidal turbines**: They are individual turbines that are put in places with a strong tidal flow.

However, tidal power is not that popular yet because of the expensive technology required to build in order to generate electricity from tides. The cost of installing and maintaining tidal power plant is too expensive. In addition, not many places in the world are suitable for tidal energy and it generates energy only for 10 hours because tides only last that long.

TIDAL TURBINE



Uses

- ★ **Electricity**
- ★ Grinding grains
- ★ Pillars for bridges and roadways
- ★ Protect the coast in high storms

Environmental impacts

Tidal energy is **renewable** and clean as it does not produce any waste or pollution. In addition, tidal power is predicable because tides are predictable, which makes it a reliable source of energy. However, it has some minor environmental impacts. Large tidal barrages can make it harder for migrating fish. Spinning turbines can cause harm to animals and fish.

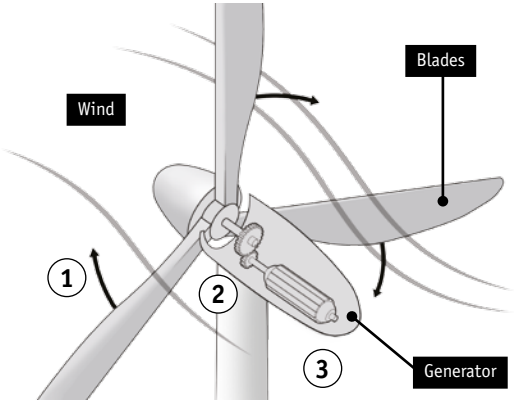
Find out more: www.kids.esdb.bg/ocean.html

Wind

Wind energy, or moving air, contains **mechanical energy** in the same way as moving water. As you know, wind is caused by the uneven heating of the Earth's surface. Wind will be around for as long as the Sun shines! The countries with the largest amounts of **electricity** produced from **wind energy** are the United States of America, China and Germany.

How it works

We capture the wind's energy using wind **turbines**, which work best in windy areas that are higher, such as the tops of hills, open plains or near the coastline. Wind **turbines** usually have three blades, which can reach speeds at the tip of the blades of over 320 kilometres per hour (200 miles per hour). That's pretty fast: this also happens to be the top speed of the world's fastest trains, the Hayabusa bullet trains in Japan and France's TGV. The shape of the blades causes the air pressure to be uneven (higher on one side and lower on the other) on each side of the blade, and this makes the blades spin (1)! The blades turn a shaft that is connected to a **generator** (2), which converts the **mechanical energy** from wind **turbines** into **electricity** (3). You can find wind **turbines** in large groups called wind farms or by themselves in different places. On the coastline, wind **turbines** can be built on floating structures and are called offshore wind farms. Wind **turbines** are on tall



towers since the wind is faster high above the ground. Some wind **turbines** can move so that they can face the best angles to capture the wind.

Uses

- ★ **Electricity**
- ★ Water pumps to pump water out of the ground
- ★ Helping to move cargo ships and vehicles
- ★ Charging batteries
- ★ Grinding grains
- ★ Recreational sports such as sailing, kite-flying and windsurfing

This might blow you away...

As early as 200 BC, people in China and the Middle East used windmills to pump water and grind grain!

Environmental impacts

While **wind energy** produces clean, non-polluting **electricity**, there are some drawbacks. **Wind energy** is not a stable source of energy, since winds vary throughout the day and by different seasons. Alternative sources of energy must be used when the wind isn't blowing. A problem with wind **turbines** is that they are large, and some people do not like the sight and sound of wind turbines in different landscapes. It can also be expensive to build new wind **turbines** and the **power lines** to transport energy from a wind farm to homes. **Wind turbines** are expensive also because their lifespan is 20 years and so they need to be replaced more often than non-renewable **power plants**. Another negative impact that wind **turbines** have on the environment is that they require the use of rare earth minerals such as neodymium, which need to be mined using **fossil fuels**.

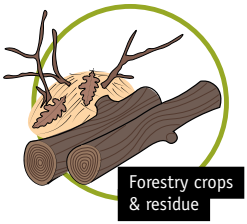
Find out more:
www1.eere.energy.gov/wind/wind_how.html

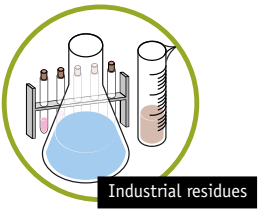
Biomass and biofuels

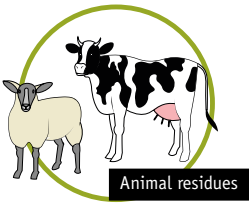
Biomass is a living material that comes from plants and animals, such as wood, dried vegetation, cow manure and food scraps. **Biomass** contains stored energy from the Sun. Plants absorb the Sun's energy during **photosynthesis**, which converts the **solar energy** into **chemical energy**. When the plants die, the **chemical energy** is trapped inside and can be released by burning. This **chemical energy** in **biomass** is released in the form of **heat**. This kind of **renewable energy** that is created through **biomass** is called **bioenergy**.

Wood is the single most important source of **renewable energy**, providing over 9 percent of the global total energy supply (*Source*: FAO, 2008). Wood is a traditional and crucial source of energy that is still the main source of energy in some developing and developed countries, where it provides basic energy for cooking and heating. The United States of America, Brazil and the European Union are the main producers of **bioenergy** as they produce the most **biofuel**.

BIOMASS SOURCES







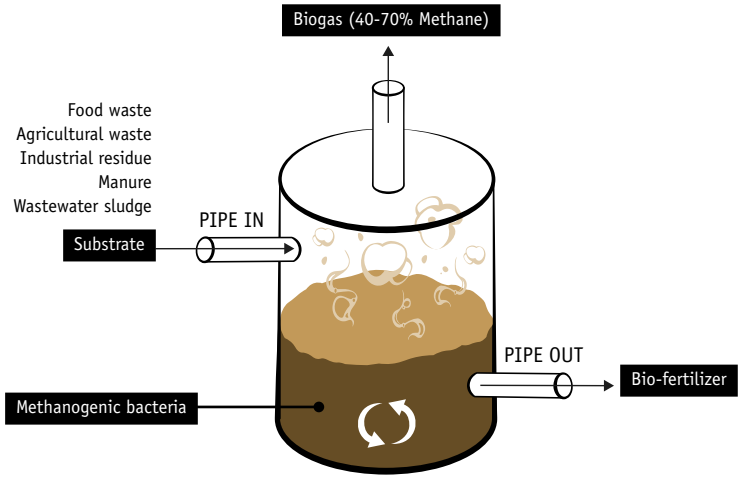
However, using wood for **biomass** has an environmental impact as cutting down trees faster than they can grow back results in **deforestation**. Planting new trees to replace those that were cut down can help to some extent and other sources of **biomass** can also be used such as the use of waste from plants and animals. Currently residues in agriculture, livestock and industry are often left and municipal solid waste is sometimes illegally abandoned, even though these are potential energy sources! Unfortunately, this happens due to the high transportation cost and the undeveloped market for these materials. Scientists have work to do also in this case.

How it works

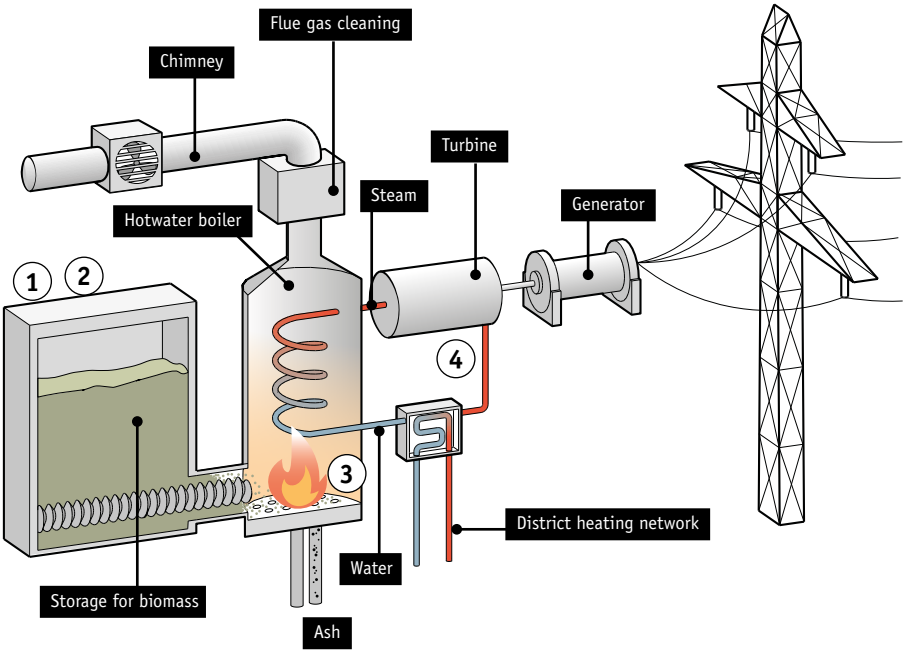
We can get power from **biomass** in three ways:

- ★ The first way is when **biomass** is burned, energy is released as **heat**, which can be used for cooking and heating homes. In bioenergy plants, the released **heat** can also be used to turn water into steam that spins a **turbine** and generates **electricity**.

BIOGAS REACTOR



- The second way is when **biomass** in converted into a gas fuel called **biogas**. Biomass such as organic garbage, agricultural waste and human waste in landfills (1), decomposes and releases a gas called **biogas** (2). Some farmers produce **biogas** in tanks on their farms called digesters: they put **biomass** and water into tanks without air, which produces **biogas** as the materials **decompose**. **Biogas** is burned directly or used to produce steam (3) that spins a **turbine** (4) and generates **electricity**. Read p. 93 for more details of how **methane gas** can be captured to generate **electricity**. **Biogas** can be also converted to **natural gas**, which is used for cooking, heating and generating electricity, though this process is expensive.
- The third way is when **biomass** is converted into liquid fuels called **biofuels**. There are different types of biofuels but the



main ones are ethanol and biodiesel. **Ethanol** is made from starchy and sugar crops (e.g. sugar cane, corn and beets), and is used as a fuel in transportation.

On the other hand, biodiesel is made from oily crops (e.g. rapeseed, soy, algae and oil palm). Biodiesel can also be made from animal fats and waste cooking oil. Biodiesel is expected to be a cleaner-burning replacement for petroleum diesel fuel.

Uses

- ★ **Wood and wood processing waste** – burned for heating in buildings, cooking, to produce process **heat** in industry, and to generate **electricity**
- ★ **Agricultural crops and waste materials** – burned as fuel for vehicles, farm equipment and trucks or for cooking, or converted to liquid **biofuels**
- ★ **Food, yard and wood waste in garbage** – burned to generate **electricity** in **power plants** or converted to **biogas** in landfills
- ★ **Animal manure and human sewage** – converted to **biogas** that can be burned as a fuel for vehicles, farm equipment and trucks or for cooking

Environmental impacts

Burning **biomass** such as wood emits **carbon dioxide** and other **pollutants** into the air, just like the burning of **fossil fuels**. This can be harmful to people, especially when wood is burned indoors for heating and cooking. Another major drawback of **bioenergy** is that **biofuels** require land for growing – land that is otherwise forest or could be used for food crops. Since there is a growing population in the world, having enough food for all people is important, but people also need energy. An additional drawback of **bioenergy** is the use of **fertilizers** and other chemicals, which can cause water pollution. For example, producing **fertilizers** for growing the crops consumes a lot of energy.

It is important to note that much of the use of **biomass** is through traditional burning of firewood in developing countries, where people have no alternative sources of energy and depend on **bioenergy** for basic cooking and heating. This makes investing in **biofuels** an issue for discussion: is it possible to feed all people in the world and still produce and use **biofuels** with no harm to the environment? What do you think?

WHY AREN'T WE USING RENEWABLE ENERGY ALL THE TIME?

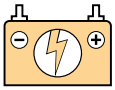
Renewable energy has many advantages. First, it is renewable – meaning it comes from limitless sources. Second, it is clean so has minimal impact on the environment as it produces little or no water and air pollution. Lastly, **renewable** energy does not emit greenhouse gases and so it does not contribute to climate change. So why are we not using renewable energy all the time?

Technical challenges: because **renewable energy** systems are relatively new, we do not yet have all the technologies developed to make them as widely used as **fossil fuels**.

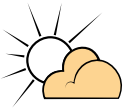
Costs: using **fossil fuels** is cheaper, because all the components and materials are already in place and most people do not want to pay more to develop **renewable energy** systems. Especially, collection and transportation of biomass are often costly.

Against this backdrop, research and development (R&D) is being promoted all over the world to promote biofuel production from non-edible biomass such as lignocellulose. These are called second-generation liquid biofuels that do not directly compete with food.

Find out more:
www.eia.gov/energyexplained/index.cfm/data/index.cfm?page=biomass_home



Storage of energy: it is difficult to store wind and sunshine so we need new technologies (like huge batteries!) that can capture and store energy so that we can access this energy when we need it.



Weather dependent: solar and wind **renewable energy** sources depend on the Sun and wind to generate electricity. When it is cloudy or there is no wind, we would produce less energy and would not be able to provide electricity to everybody.

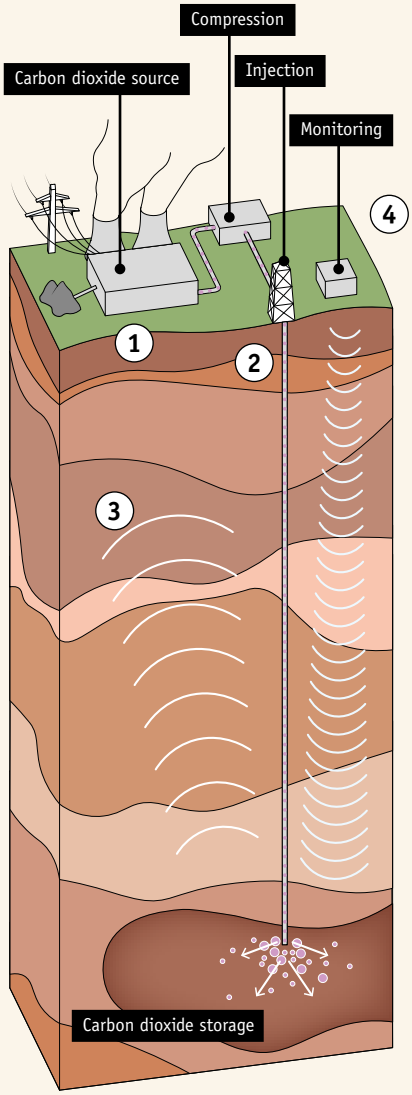
Large areas required: to produce large amount of energy, **renewable energy** may needs lots of land to place solar panels and wind farms. However, this land might have been used for other reasons so there is a debate on whether we should compromise this land for **renewable energy**.

ENERGY INVENTION

Number 1: Carbon capture and storage

Currently, most of our energy is generated using power plants that burn **fossil fuels** and emit lots of **carbon dioxide** to the atmosphere. Scientists are inventing ways to capture that **carbon dioxide** from the power plants and factories to safely store it underground and stop it from warming our planet.

Carbon dioxide emissions (1) are captured at the power plant or factory to stop their release into the atmosphere. Then, the captured **carbon dioxide** (2) is transported through a pipeline into underground where rock formations can store it safely and permanently. The **carbon dioxide** is pumped deep underground (3). Lastly, the site is monitored (4) to make sure that the **carbon dioxide** would not escape back up to the atmosphere or into underground drinking water sources. Discuss with your class what are the advantages, disadvantages and risks of using such technologies.



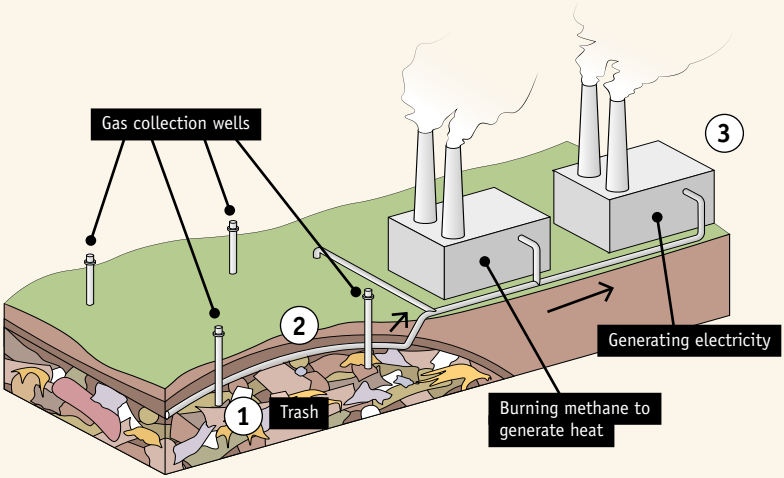
Number 2: Methane capture and use

Another **greenhouse gas** that is warming our planet is **methane** gas. Did you know that **methane** is 25 times more powerful at trapping heat in the atmosphere than **carbon dioxide** is? **Methane** is also the main component in **natural gas**.

Do you ever wonder where does the trash (rubbish) you throw away end up going? Well, the trash that cannot be recycled or reused most likely ends up in landfills. The trash produces **methane** as it decomposes. So, scientists invented a way to capture that methane gas from landfills to then burn it and generate **electricity**, heat buildings or provide enough power for garbage trucks. Capturing **methane** before it goes into the atmosphere would also help reduce the effects of **climate change**.

So, the invention works by first taking the trash that is decomposing in landfills and producing **methane gas** (1). Then, as **methane gas** rises to the top of the landfill is goes into gas collection wells where it is collected (2). Lastly, **methane gas** is burned (3) to generate **heat** or **electricity**.

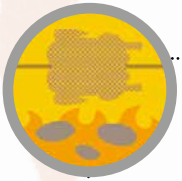
Methane gas can also be captured in farm digesters, which are huge tanks that contain manure and other waste from animals like cows and pigs.



ENERGY USE

People throughout history have found different ways to harness and use energy.

The first known use of fire was in the territory now known as China (**460 000 BC**).



The Chinese were the first to begin burning coal for heating and cooking (**2000 BC**).

In **500 BC**, Socrates in Greece suggested to build houses facing to the South. In winter, this meant that the Sun would shine directly in to the porch area, heating the inside space. In summer, the Sun was directly overhead, providing shade and a place to keep cool.

460 000 2000 500

BC AD

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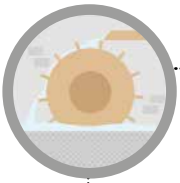
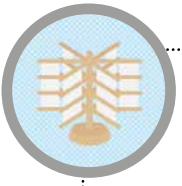


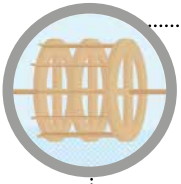
Greeks also invented a vertical water wheel to produce energy to power mills to grind grain into flour and pump water (**100 AD**).



In **644 AD**, in Persia (now known as Iran), windmills with a vertical axis were first used to grind grain.

Windmills with a horizontal axis were introduced in Europe to grind grain (in the **1100s**). European windmills, which used four blades and rotated on a horizontal axis, became very popular in the following years.

In **1200**, commercial **coal** mining first began in England, which later became a major fuel for industries.



In **1582**, England, specifically London, established its first waterwheels and built its first waterworks.

100 **644** **1100** **1200** **1582**

People have also depended, for a long time and even now in some countries, on **biomass** such as wood for cooking and heating. However, this resulted in a major cut down of forests up to the point that there were very few wood sources available. Europe started to use **coal** as their main source of energy (**1690**).

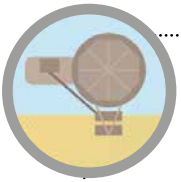
1690

Previously, ancient civilizations relied on using different energy resources that we still use today – using **natural gas** to heat water, using **geothermal energy** to heat homes, and using **oil** floating on the tops of ponds to fuel lamps. However, only after 1850 did the world stop relying only on the Sun and wood as major sources of energy and a big change in energy usage took place. This change came about during the Industrial Revolution (1760 to 1850) when **coal** replaced wood as the major fuel supply.

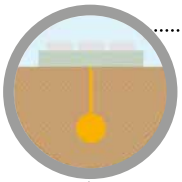
In **1748**, in the United States of America, the first commercial **coal** production began. The invention of the steam engine, during the Industrial Revolution, also popularized the use of **coal**. The steam engine converts **chemical energy** from coal into **mechanical energy** to fuel machines, locomotives (e.g. trains or trams), ships and cars.

1700s

During the nineteenth century, the next major energy revolution occurred with the first **oil** well drilled in Pennsylvania, United States of America, and crude **oil** was processed into kerosene, which was used for lighting. In **1872**, Thomas Edison invents the electric light bulb and with that in **1882**, he builds the world's first electrical power plant in New York, United States of America. The power plant used **steam**-powered generators that were operated on **coal** to generate **electricity**. In the same year, in Wisconsin, United States of America, the world's first commercial-scale hydroelectric power plant opens. At first, the power plant only powered three buildings, two paper mills and one home, but after that, the Waverly House Hotel became the first hotel to use electric light from this hydroelectric power plant.



In **1888**, the first windmill to generate **electricity** was built in Ohio, United States of America.

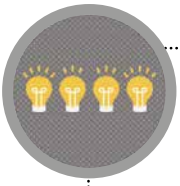


The Americans continued to lead the way by opening the world's first **geothermal** district heating system in Idaho. Water was piped from hot springs to power 200 houses and 40 businesses in town.

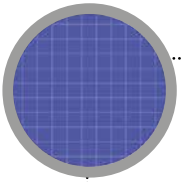
1800s **1888** **1892**

On the Colorado River, the world's largest hydroelectric power plant was built called the Hoover Dam (**1935**).

The emergence of cars and other vehicles in the United States of America made **petroleum** the most consumed fuel (**1950**).



The following year Idaho opens its first **nuclear** power reactor to generate **electricity**.



In the **1980s**, scientists began to realize that burning **fossil fuels** drives **climate change** and began thinking of alternative sources of energy. **Solar power** was officially born in **1974** when Joseph Lindmayer developed a silicon photovoltaic cell to use **solar power**.

1935 **1950** **1951** **1974**

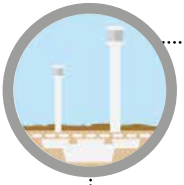
Another **renewable energy** source was the world's first wind farm in New Hampshire, United States of America (**1980**). The wind farm had 20 **wind turbines**, but the **turbines** kept breaking. Despite the failure of the wind farm in New Hampshire, **wind turbine** installations became popular throughout the country and in northern Europe.

The following year (**1981**), the first large-scale solar-thermal power plant called Solar One was opened in California, United States of America. It used 1 818 mirrors to follow the path of the Sun to reflect its energy into a large central tower.

In **1986**, the world was shocked as the largest and worst **nuclear** disaster happened in Chernobyl, Ukraine. The area is still uninhabitable to this day.

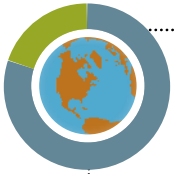
Another devastating **nuclear** disaster happened in **2011** on the coast of Japan, when the Fukushima nuclear power plant exploded due to an earthquake with a magnitude of 9.0 and strong tsunami (huge sea waves). The nuclear crisis level reached level 7.

1980 **1981** **1986** **2011**



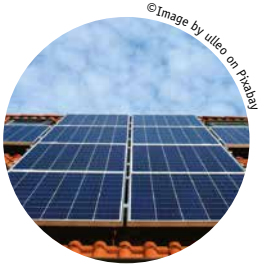
In 2013, the world's largest concentrated **solar power** generation plant called Ivanpah was opened in California South Mojave Desert.

2013



Today, **fossil fuels** and **nuclear energy** make up about 80 percent of the world's **energy consumption** (*Source*: UN Energy).

2018



©Image by ulleo on Pixabay

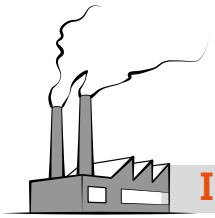
We are currently exploring and inventing technology that will let us use energy resources in ways that are cleaner and more environment friendly. This involves using energy from **renewable resources**.

THE FUTURE

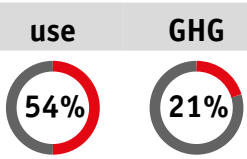
Illustrations taken from https://www.switchmybusiness.com/resources/the-evolution-of-energy-sources-a-visual-timeline

ENERGY IN THE WORLD

Now you know a lot about the history of energy and you probably realized that humans are using a lot of energy that is mostly not renewable and this is damaging our environment. We also have a big challenge ahead of us: as the world's population grows, our energy usage is going to grow too. Each individual needs to therefore find ways to use less energy and use greener energy. But before we look at this, let's start by looking at the different ways in which we're consuming energy in our world today.



Industry

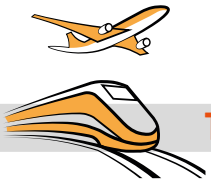


Industry is responsible for 54 percent of the world's energy use and 21 percent of global greenhouse gas emissions (*Source*: US Energy Information Administration and IPCC). The industrial sector includes manufacturing (e.g. factories that produce goods, such as electronics, textiles and other household goods) as well as mining and construction. Industries that are known for using a lot of energy resources include those that work with chemicals, metals (especially steel and aluminium), minerals, paper and food. The industrial sector also includes the energy used in mining for coal, petroleum and natural gas. Industries that use a lot of energy have grown significantly since 1970, but have also become more energy-efficient in recent years.

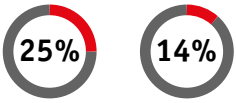
Here are some possible ways to reduce emissions from industry;

* **Improve energy efficiency**: government can introduce policies for promoting use of energy-efficient industrial systems and equipment.

* **Replace energy generated from fossil fuels with that from renewable sources**: industry requires huge amounts of energy, but most is generated through using fossil fuels. Renewable energy sources can play an important role in making industry more eco-friendly with its low-emission nature. Many solar panels can be laid on roofs of factories to generate electricity.



Transportation



About 25 percent of energy used throughout the world is used for transport (*Source*: US Energy Information Administration). People travel and products are transported throughout the world every day. We trade goods – sending grains, plastics, textiles and other products in large containers by trains, trucks and ships all around the world. People also transport fuel sources through **pipelines**. People are travelling more, and more people are using more intensive forms of transportation such as airplanes and cars, in addition to using less-energy intensive forms of transportation such as trains, buses, ferries and bicycles. There are more than 600 million cars on the roads today, and it is likely that there will be 2 billion cars on the road in 50 years' time.

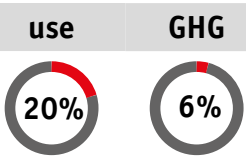
Cars, buses, trucks, trains, airplanes and other vehicles burn **fossil fuels** and are responsible for 14 percent of our greenhouse gas emissions in the world (*Source*: IPCC). Scientists and engineers are thinking of how to create vehicles that would use less energy and are better for the environment.

Here are some of their ideas:

* **Fuel-efficient cars**: use less gasoline and/or diesel (a liquid from **petroleum**) than other cars to drive the same distance. If less **petroleum** is burned then less **carbon dioxide** is released into the atmosphere.

* **Alternative fuel vehicles**: run on fuels other than gasoline, like natural gas or hydrogen (gas that in combination with oxygen will make water).
* **Electric vehicles**: have an electric motor instead of an engine. Electric vehicles have large batteries that store energy to power them, and you can just plug them in to refuel. These vehicles do not directly pollute the environment (but they use electricity from fossil fuel power plants). However, if solar and wind energy is used to produce electricity for them, their carbon dioxide emissions are very small.
* **Hybrid-electric vehicles**: have engines that burn gasoline, but can work as electric cars. These cars can go twice as far using the same amount (or gallon) of gasoline than a typical gasoline-powered car.

Buildings

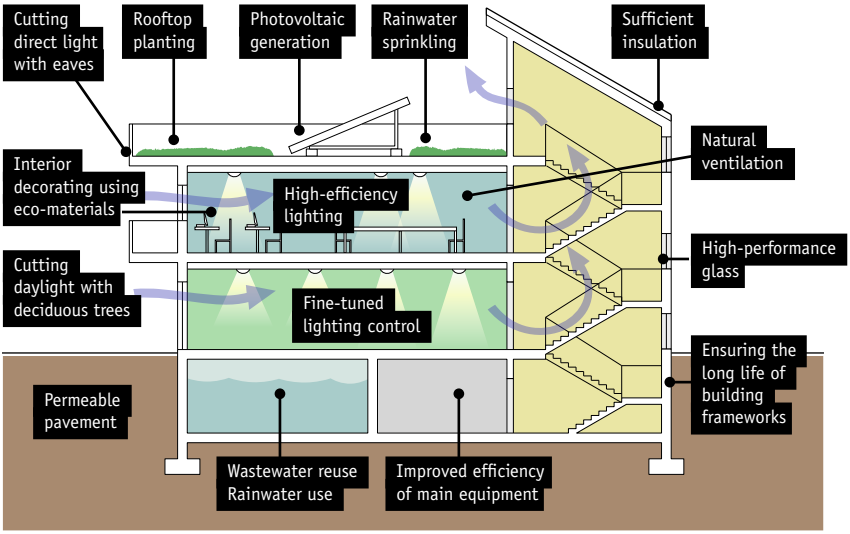


Buildings consume 20 percent of the world's energy use, which includes residential and commercial buildings (*Source*: US Energy Information Administration). Buildings also produce 6 percent of global greenhouse gas emissions (*Source*: IPCC).

Commercial buildings

Commercial buildings can be retail stores, restaurants, hotels, hospitals, office buildings, and leisure and recreational facilities (*Source*: US Energy Information Administration). Different commercial building activities have specific energy needs, but in general energy is mostly used for space heating, cooling and lighting. For example, service buildings, like shopping malls, dry cleaners and gas stations, use 15 percent of the total energy consumed by commercial buildings; offices – 14 percent; education buildings – 10 percent; and health care, such as hospitals and medical offices, – 8 percent (*Source*: EIA).

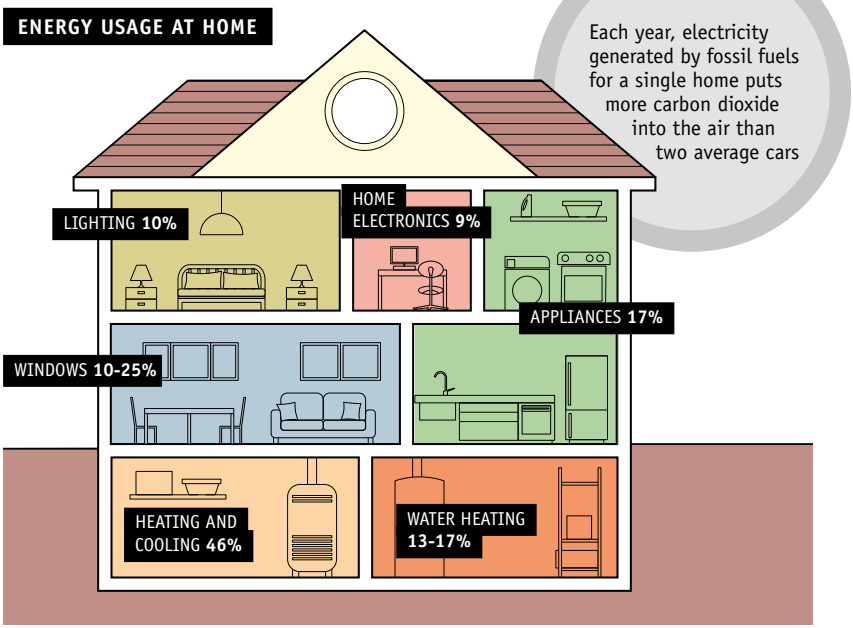
Reducing emissions from commercial buildings can be achieved through improved insulation, double glazing, high efficiency and fine-tuned lightning control, middle floor and rooftop planting, high reflection paint, etc.



Residential buildings (home)

Think about all the ways we use energy in our everyday lives at home. Most of the energy we use at home is for heating and cooling, lighting and **appliances**. The amount of energy that a home uses depends on the design and size of the home and the number and efficiency of energy-using **appliances** within the home.

Let 's see the average energy usage in a home in the United States of America. As you can see from the picture, most of our energy is used for space heating or cooling (46 percent). Some homes use **natural gas** and fuel oil for that purpose. Another big energy use is water heating (13–17 percent). Water heaters use **electricity** to heat water for cooking, cleaning, bathing and space heating. **Appliances** in the kitchen, such as refrigerators, washing machines and toasters,



use 17 percent of energy in the form of **electricity**. **Electricity** is also used for lighting (10 percent) and home electronics (9 percent), which are telephones, televisions, computers and other gadgets. However, not all energy is used in your home – some of it is lost in the form of **heat**. Windows can be responsible for 10–25 percent of your heating loss (for more information check p. 107).

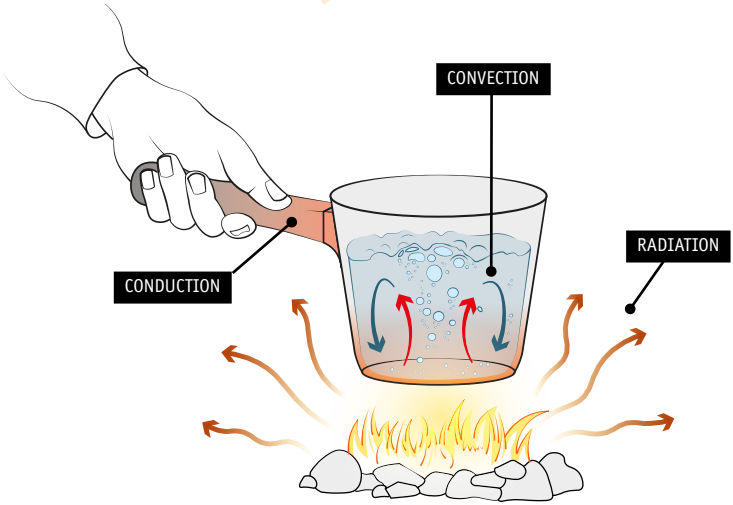
However, there are homes that use much less energy than that shown in the picture. Buildings that are designed to be **energy efficient** are often called "ecohouses". These buildings and homes tend to have better insulation, tightly sealed windows and use natural lighting. Simple actions such as fixing draughty windows can help save energy in buildings (see other tips on p. 108). Making buildings more **energy efficient** can save energy and money over a lifetime. Best yet: "zero-energy" buildings are so well designed that they produce all the energy they need themselves, e.g. through **solar** or **wind energy**.

FORMS OF HEAT ENERGY AT HOME

Do you remember the different forms of energy discussed in Section B (p. 48)? At home, one example of energy can be found in the form of **heat**. **Heat** flows from a hot to a cold object. More specifically, it can travel in three ways: **conduction**, **convection** and **radiation**.

Conduction: Transfer of **heat** occurs when two solid objects of different temperatures are placed in direct contact with each other. **Heat** energy of the warmer object moves into the cooler object until both objects have the same temperature. For example, you decide to touch the handle of the pot after it has been placed onto a stovetop for several minutes and now the handle is hot too. This happened because **heat** was conducted through the portion of the pot in contact with the stovetop all throughout the rest of the pot.

Convection: Transfer of **heat** occurs in liquids and gases (fluids) when particles in liquid and gases move into an area of different temperature. **Heat** makes the liquid and gas expand and rise upwards. The hot liquid or gas gives up its **heat** energy to cooler parts of the liquid or gas. Air inside a room can be heated by **convection**. Taking a radiator as an example: it puts warm air (gas) out at the top and draws in cooler air (gas) at the bottom.



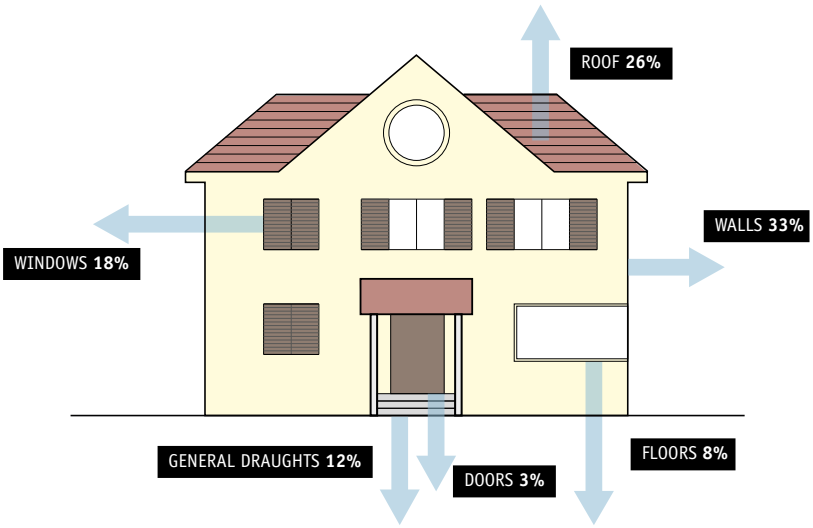
Radiation: Transfer of **heat** in the form of radiation (waves) emitted by a hot object. This **radiation** is absorbed by a cooler body causing its temperature to increase. This is how **radiation** from the hot Sun reaches the cooler Earth and heats it up. When the Sun goes behind a cloud, the **radiation** is blocked and the Sun cannot heat the Earth as much. For example, when you place your cold hands over a warm fire, after some time you feel your hands are getting warmer. That is because the **heat** energy is transferred by **radiation** from the fire to you.

Heat transfer at home

The problem with **heat** is that it transfers from warm to cold places and it can escape from your warm home to the cold outside or the hot heat from outside can get inside your cool home.

In the following section we investigate how we can keep our houses as a nice temperature without using too much energy.

HEAT LOSS FROM AN UNINSULATED HOME



For cold climates:

* **Conduction**: **Heat** is travelling through solid material. Your house is standing on top of cold soil or rock, so **heat** escapes down the floors directly into the Earth by **conduction**. **Heat** is lost through the walls and roof of your home by **conduction**.
* **Convection**: Hot air rises and circulates in the house, and the **heat** can escape through gaps in the roof, doors and windows.
* Radiation: Your house also radiates **heat** (**radiation**) into the atmosphere through walls, the roof and windows.

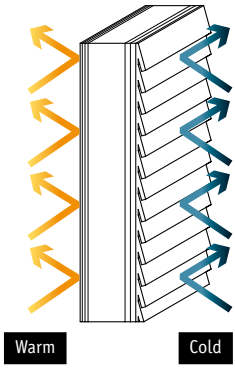
For hot climates:

* **Conduction**: **Heat** is travelling through solid material so on hot days, **heat** is **conducted** into your house through walls, windows and the roof. Therefore, **heat**-reflecting roofs, insulation and energy efficient windows can be used to help reduce the **heat conduction**.
* **Convection**: Hot air rises and carries the heat from walls and ceiling away and upwards causing a circulation throughout your home.
* **Radiation**: Sunlight is a main source of **heat** and through **radiation** can **heat** up your home. Therefore, in hot climates, it is important to put shades on windows to block this **radiation**.

Solutions to heat transfers

So what are the potential solutions to **heat** transfers in your home? Here are some examples:

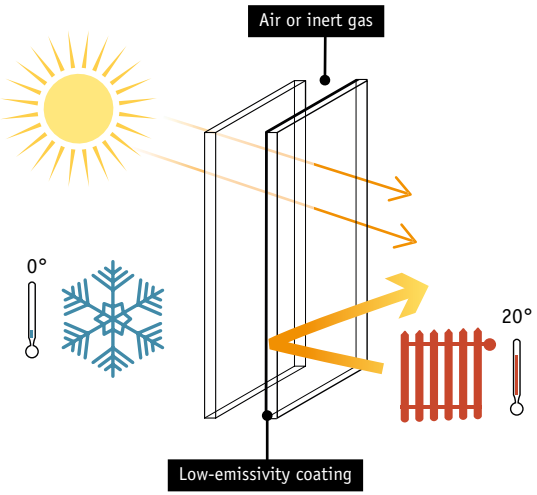
Wall insulation: Insulation is a clever trick that keeps your home warmer in cold climates and cooler in hot climates. Many homes have what are called cavity walls, which consist of two walls with an air gap between. Heat transfer by **conduction** can be reduced if you use special insulation material in the gap between these two layers that traps air. This is good because



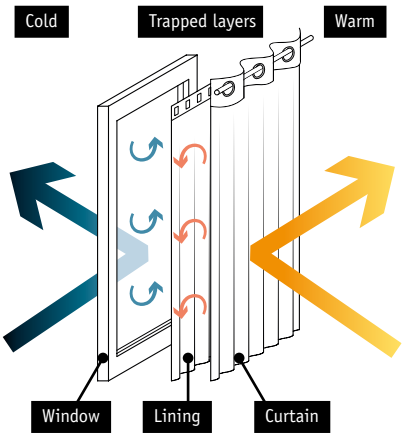
heat cannot travel through gases (like air). Insulation material also stops air from circulating and causing **convection**.

Roof (or loft) insulation will stop heat travelling through by **conduction** and also stop air from circulating and causing **convection**.

Double glazing are windows that have two panes of glass separated by a sealed vacuum or air. The gap prevents **heat** transfers by **conduction** and **convection**. The extra pane of glass will reflect more light and **heat radiation** back into your home to keep it warm in cold climates, but it can also reflect sunlight (**radiation**) to keep your house cool in hot climates. Some homes have triple glazing.

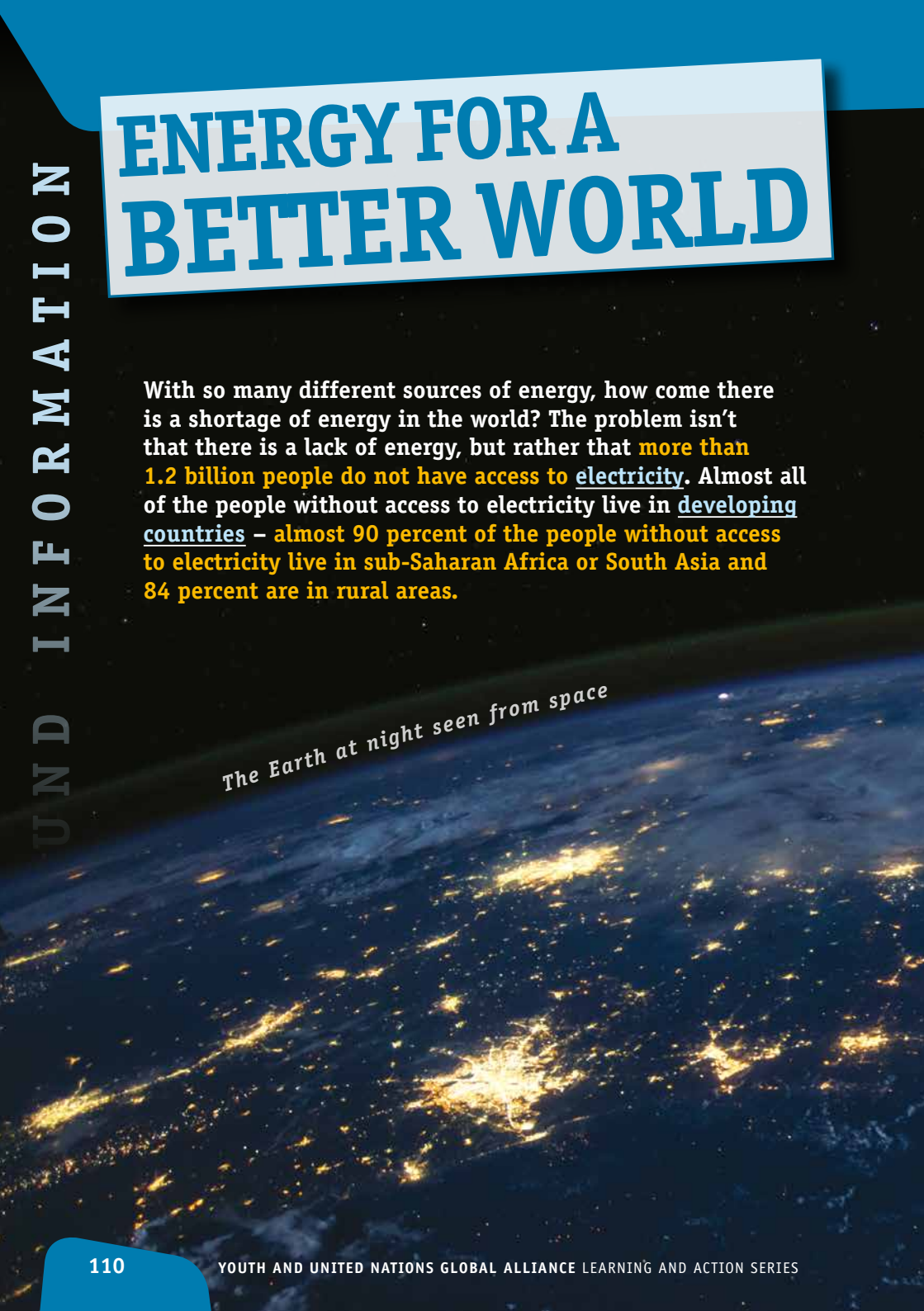


Curtains: Curtains trap lots of air between the fabric and window and stop the air from moving. The more air you trap between the fabric and window the better your curtains will serve as heat insulators. Curtains or window coverings are good for hot climates too as they provide shade from sunlight (**radiation**).



ENERGY FOR A BETTER WORLD

With so many different sources of energy, how come there is a shortage of energy in the world? The problem isn't that there is a lack of energy, but rather that more than 1.2 billion people do not have access to electricity. Almost all of the people without access to electricity live in developing countries – almost 90 percent of the people without access to electricity live in sub-Saharan Africa or South Asia and 84 percent are in rural areas.



The Earth at night seen from space

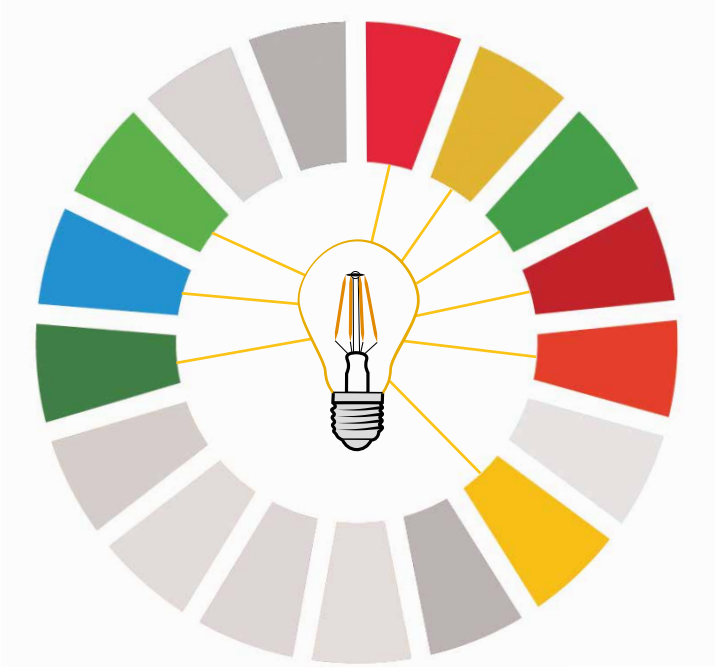
Access to electricity helps to improve people's lives, and it is crucial to win the fight against poverty. In more advanced countries, issues of energy access are referring not to the physical access to the infrastructure and the grid but as a quality issue in terms of energy affordability, reliability and sustainability.

WHAT IS SUSTAINABILITY?

You probably hear a lot about **sustainability**, particularly talking about the environment. So, what exactly does it mean? It refers to the way in which we humans use the natural environment – doing so **sustainably** means acting responsibly about the products we consume to not damage the environment and maintain our resources (support plant, animal or human life). Making sure that our actions are **sustainable** means protecting our Earth for future generations, plants and animals so they can live well too.

ENERGY = DEVELOPMENT

In 2015, the United Nations set 17 goals, called the Sustainable Development Goals (SDGs), aiming to end world poverty, improve health and education, protect our planet, fight climate change, and ensure prosperity for all by 2030. Making sure that more people have access to electricity is very important for achieving these goals. This is because there are clear links between access to energy and development. Let's take a look at how achieving some of these goals depends on access to energy.



You can read more about the **Sustainable Development Goals** here: **www.un.org/sustainabledevelopment/sustainable-development-goals/**

ENDING POVERTY AND HUNGER

Access to modern energy helps reduce poverty (SDG 1: No poverty) and hunger (SDG 2: Zero hunger) in so many ways. Here are just a few examples:

* **Raising incomes**: Having access to stable and reliable electricity allows the creation of industries in developing countries. Basic lighting at home and work allows people to do their homework/jobs for longer hours, helping them to do better and earn more and overall reduce poverty around the world.

* **Food security**: Our ability to grow and produce food depends heavily on access to energy, for example, pumping water for food production needs reliable energy. We are now 7 billion people on the planet and by 2050 our population is expected to increase to 9 billion. A billion people in the world already live in hunger, and feeding the planet is an issue that will only grow more serious. This means we need to use energy more efficiently in agriculture.

Have a look at the **ENDING HUNGER CHALLENGE BADGE** *to learn more*

* **Reducing waste**: Energy enables us to refrigerate and store foods for longer, which helps reduce the amount of food that spoils during hot weather.

* **Access to water**: Access to electricity can help people to access safe drinking water through water pumping. Improving farming: Being able to pump water also helps farmers irrigate their crops, and energy also fuels farming machines! This enables farmers to increase the amount of crops they produce. So when poor farmers have access to energy, they have more potential to move out of poverty (*Source*: FAO).

* **Creating jobs**: There are many people who have jobs relating to energy all over the world. There are jobs in research and engineering to improve energy technologies. There are also jobs in mining energy resources, in creating equipment for energy, and many more related to getting energy to people. And when people have access to energy, even more jobs are created in businesses, factories, hospitals, schools and shops. Access to energy also allows people to grow crops and to deliver products. So energy helps create lots of different jobs for people, which helps people to earn more – and income generation is the key to reducing **poverty**. Find more about energy-related jobs here: **http://climatekids.nasa.gov/menu/dream**

© FAO/Alessia Pierdomenico

HEALTH

Achieving better health for all also depends on energy.

- **Cooking safely**: Switching from **biomass** and coal to improved cooking fuels and stoves will reduce household air pollution and decrease the risk of respiratory infections, chronic lung disease and lung cancer.
- **Boiling water**: Better access to energy allows households to boil water, which reduces the occurrence of water-borne diseases.
- **Staying connected**: Energy access is also needed for communication and transport services, which are necessary for emergency health care.
- **Good health care**: The smooth running of health clinics and hospitals depends upon **electricity** and modern energy services. After all, different kinds of equipment such as x-ray machines and oxygen machines that help save people's lives in hospitals need **electricity**. Even ambulances need energy. And electric fans in hospitals that are important for preventing the spread of bacteria and diseases through the air rely on energy, too.
- **Heating and cooling**: Access to energy means people can have heating and cooling systems in their homes, which is important during extreme cold or hot weather conditions. People are likely to get sick if their bodies are very cold or too warm for a long time.

DID YOU KNOW?

The air pollution inside homes that burn **biomass** is often worse than the outdoor pollution in highly polluted cities (*Source*: UNDP). Over 4 million people, mostly children, die each year from this kind of household air pollution.

Source: World Health Organization

EDUCATION

You might think the only connection between energy and education is finding the energy to drag your sleepy self out of bed in the morning to get ready for school. And while yes, that does require energy, there are also many other ways in which the two are wired together:

* **School instead of fuel**: In poor communities, children commonly spend a lot of time collecting fuelwood, fetching water and cooking. Access to improved cooking fuels or technologies will mean they have time to attend school and do homework.

* **Lighting up**: Electricity is also important for education because it not only enables the use of technologies such as computers, but also provides basic lighting needs, extending the activities that can be done at home in a day.

DID YOU KNOW?

There are some cool and creative solutions to help provide energy needs in **developing countries**! New **renewable energy** technologies that can help children and youth at schools in **developing countries** include merry-go-rounds and cycle machines that generate **electricity**! When children play they generate **electricity** for their school. The students can even use it to charge special rechargeable lamps for their studies at home. What other creative ideas can you think of for generating **electricity**?

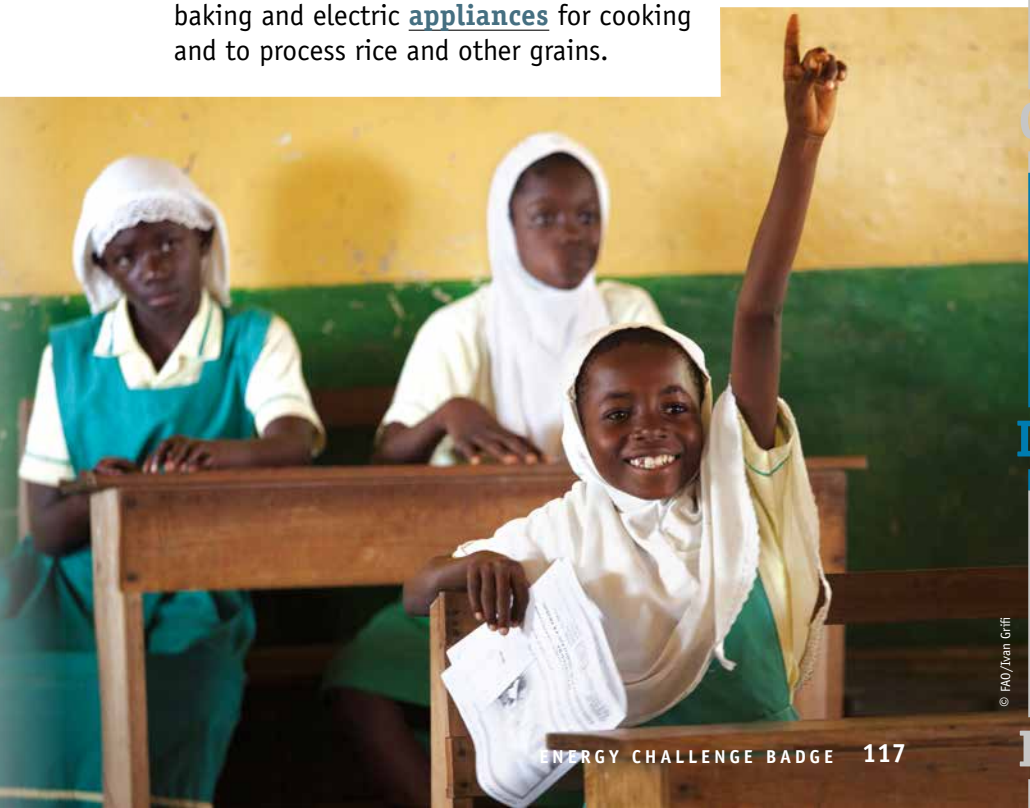
GENDER EQUALITY

Yes, energy plays a role in ensuring equal rights for women and men, too. Here's how:

* **Girl power**: In many countries, it is the women's task to collect firewood, and often they have to carry heavy loads over long distances, which can be dangerous and also harmful to their health. Access to **electricity** and modern fuels means they won't have to do that anymore, freeing up their time to do a job and increase their household income.

* **Safer streets**: Also, lighting in the streets improves the safety for women and girls at night, which enables them to attend night schools and take part in community activities.

* **Saving time and effort**: Ensuring equal access to labour-saving and time-saving **appliances** such as water pumps, ovens for baking and electric **appliances** for cooking and to process rice and other grains.



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INFORMATION

AFFORDABLE AND CLEAN ENERGY

Yes, the seventh sustainable development goal is entirely dedicated to energy and more specifically making sure that everyone has access to affordable, reliable, sustainable and modern energy!

Energy as a challenge and as an opportunity: As you are currently finding out, energy is central to nearly every major challenge and opportunity that the world faces today and is therefore very important with regard to the success of the other SDGs. Whether this is related to jobs, security, increasing incomes or food production, energy is essential to them all. However, using unsustainable forms and sources of energy and the pollution that it causes is currently threatening the world that we live in.

DID YOU KNOW?

800 000 children's lives would be saved every year by replacing smoky indoor fires and stoves with modern energy appliances.

ENVIRONMENT

The SDGs include goals on protecting the environment (SDG 14: Life below water, SDG 15: Life on land) and climate (SDG 13: Climate action), and it is impossible to talk about energy without discussing environmental sustainability.

* **Modern energy usage hurts the environment**: We've already taken a look at **fossil fuels**, which, as you know, take their toll on the environment in numerous ways, and are a key contributor to **climate change**. **Climate change** is already happening and is expected to worsen. Some of its potential effects include harming agriculture and threatening the world's food supply, reducing water supplies and quality (SDG 6: Clean water and sanitation), causing the spread of malaria, dengue fever and other diseases, and harming **ecosystems** and **biodiversity**.

> Energy is the main contributor to climate change, accounting for 60 percent of the total global greenhouse gas emissions (*Source*: UN)!

* **Energy poverty or lack of access to modern energy also hurts the environment**: Wait, what? Yes, it *does* sound like a contradiction. But take a moment to examine the impacts of energy poverty: using wood as a cooking fuel means cutting down forests. As you know, trees absorb **carbon dioxide** from the **atmosphere**, so cutting them down contributes to **climate change**. **Deforestation** also damages soil and increases the risk of flooding. Also, smoke from traditional **biomass** cooking stoves contributes to global warming. So, as you can see, there are no simple answers!

✱ **To plug in or not to plug in?** So hold on a second. In poor parts of the world, millions are without access to **electricity** and clean cooking facilities, which not only damages the environment, but also makes the fight against **poverty** harder. Meanwhile, the industrialized world has the opposite problem: harming the environment through energy use.

In other words, we need to increase energy access to all people to help economic growth, but *reduce* energy usage in order to protect the environment? How's that supposed to work?

✱ **Enter SE4ALL:** The answer is that we need to achieve *sustainable energy for all* – energy that is accessible, cleaner and more efficient. In addition to SDG 7: Affordable and clean energy, the UN has declared the decade 2014–2024 as the Decade of Sustainable Energy for All. SE4ALL states that achieving **sustainable** energy will not only protect our environment, but has a host of other advantages as well. According to the UN, "**Sustainable** energy enables businesses to grow, generate jobs, and create new markets. Millions more children can study after dark. Countries can grow more resilient, competitive economies. With **sustainable** energy, countries can leapfrog over the limits of the energy systems of the past and build the clean energy economies of the future."

WHAT IS SUSTAINABILITY?

The International Year of Sustainable Energy for All took place in 2012. In that same year the United Nations General Assembly unanimously declared the decade 2014–2024 as the Decade of Sustainable Energy for All, underscoring the importance of energy issues for sustainable development and for the elaboration of the post-2015 development agenda.

In adopting the resolution, the General Assembly reaffirmed its determination to make sustainable energy for all a reality. It called upon Member States to stimulate efforts to make sure that all people have access to sustainable modern energy services. It stressed the need to improve access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy services and resources for sustainable development and highlighted the importance of improving energy efficiency, increasing the share of renewable energy and cleaner and energy-efficient technologies.

See what you can do to help meet the SE4All's objectives:

ensure **universal access** to modern energy services;

2x

double the global rate of improvement in energy efficiency; and

2x

double the share of renewable energy in the global energy mix.

Check out:
www.un.org/en/events/sustainableenergyforall/
www.se4all.org/

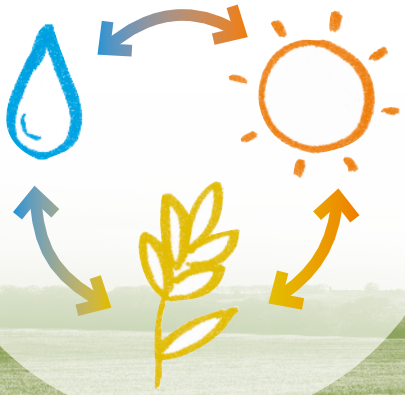
If you think they seem tough, look at these facts:

* With good leadership, the Government of Viet Nam managed to increase **electricity** access by **1 960 percent** in just 35 years!
* 222 million people in the world have gained access to **electricity**.
* 125 million people (more people than in Mexico) have gained access to clean, modern cooking fuel.
* Our use of modern renewable energy has increased by 4 percent per year.

SDGs HELP US SEE THE INTERLINKAGES IN OUR WORLD

The Sustainable Development Goals help us to understand how the world is interlinked and how one issue or activity will often affect another issue.

For example, water, energy and food security are often interlinked and this is commonly called the 'water, food and energy nexus'.



To give you an idea, water is required for agriculture so that we can produce food. Energy is also needed to help pump water to the fields, for the tractors and machinery used in the production processes and to transport the food products to consumers. That food that we then eat is what provides us as humans with energy to go to school or to work and to be generally happy and healthy. Agriculture currently uses 70 percent of the global water supply and the food production and supply chain accounts for around 30 percent of global energy consumption (*Source*: UNWater)!

So water, energy and food production are all very much dependent on each other and unsustainable practices can cause negative impacts on the others. For example, using water to irrigate crops can help to increase levels of food production, but it can also reduce the flows of rivers and reduce the potential to create energy from hydropower. Unsustainable agricultural practices (including food losses and waste) can use a lot of energy which may produce greenhouse gas emissions that cause climate change, which will affect our water supplies and food production.

In the past global leaders have tried to solve the problems associated with water, energy and food supply as separate issues, but this has never worked.

The SDGs provide us with a GLOBAL INITIATIVE to solve these issues together as one and across national boundaries.

TAKE ACTION

ACTIONS FOR GOVERNMENTS AND DECISION-MAKERS

Governments play an important role in achieving **sustainable** energy for all. A total of 85 governments in **developing countries** have already joined the "Sustainable Energy for All" initiative. These countries will carry out strategies to improve their energy systems by focusing on energy policies, programmes for ensuring access to electricity, methods for using energy efficiently and plans for producing more renewable energy.

In many countries, there are different government policies to promote **renewable energy** and to decrease **greenhouse gas** emissions. Some examples include:

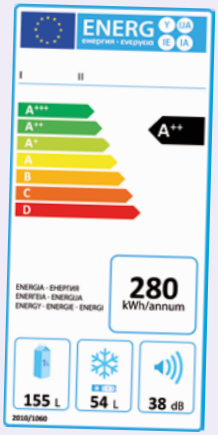
* **Financial strategies** involving money, in the form of loans (money that is borrowed and needs to be paid back) and subsidies (grants that do not need to be paid back) to encourage people to invest in equipment for **renewable energy**. Financial strategies can also discourage the use of **fossil fuels**, such as government-funded cheap public transportation options or taxes on fossil fuels.

DID YOU KNOW?

Ghana is the first country to develop a national action plan for "Sustainable Energy for All". Ghana's action plan includes increasing **renewable energy** access to all of its citizens, with the goal that 10 percent of the country's energy production will be **renewable energy** by 2020. A Renewable Energy Act in Ghana will help increase **renewable energy**. Ghana has already made great strides in improving **electricity** access with a national plan to promote **electricity** access. When this initiative started in 1989, only 25 percent of the population in Ghana had access to **electricity**, but today the Government's financial strategies have led to more than 67 percent having access to **electricity**. So Ghana is a great example of how country-led action can promote **renewable energy** access.

* **Standards** on individual appliances (e.g. European Union energy label) and building codes (e.g. the Energy Environmental Design [LEED] rating system that sets standards for buildings and homes using **energy efficient** building designs), or national vehicle emission standards that determine emissions from vehicles.
* **Information and education** providing information to people about the behavioural changes and products available to promote energy efficiency in people's everyday lives.

The European Union energy label is a standard for labelling appliances (e.g. light bulbs, washing machines, etc.) on their use of energy. How efficiently the appliance is using energy is rated by class from A (most efficient) to G (least efficient). However, recently technologies have started becoming so energy efficient that new labels had to be invented, such as A+, A++, A+++. So next time you see this colourful sticker on your fridge, you can tell how efficiently it uses energy:



International organizations

A number of international organizations promote energy-related initiatives and strive to reduce greenhouse gas emissions. These organizations work on energy issues worldwide.

United Nations-Energy supports countries in promoting access to energy resources, developing renewable energy resources and improving energy efficiency. **www.un-energy.org**

United Nations Development Programme (UNDP) provides knowledge and resources to help countries develop solutions to reduce poverty. Energy activities focus on strengthening countries' abilities to expand electricity access, to create policies and to finance energy initiatives.
www.undp.org/content/undp/en/home.html

United Nations Economic Commission for Europe (UNECE) works on sustainable energy to improve access to affordable and clean energy for all and help reduce greenhouse gas emissions and the carbon footprint of the energy sector in Europe. UNECE promotes international policy dialogue and cooperation among governments, energy industries and other stakeholders. **www.unece.org/energy/se/com.html**

The United Nations Framework Convention on Climate Change (UNFCCC) is working to get national governments to commit to cutting down national **greenhouse gas** emissions to help prevent the negative impacts of **climate change** on the environment. **http://unfccc.int/2860.php**

Food and Agriculture Organization of the United Nations (FAO) provides knowledge about methods and technologies to help countries move towards energy-smart (energy efficient and sustainable) agriculture practices. **www.fao.org/energy/en/**

Intergovernmental Panel on Climate Change (IPCC) is a group of scientists that study **climate change**, which is useful for developing policies relating to **climate change** and energy usage. **www.ipcc.ch**

International Energy Agency works towards finding solutions to energy and environmental concerns. Promotes reliable, affordable and clean energy through different methods including workshops and training for students. **www.iea.org**

World Bank Group (WBG) supports **developing countries** in providing clean **electricity** to households, through financing, policy advising, partnerships and sharing knowledge. **www.worldbank.org**

Non-governmental organizations

In addition to the international organizations, there are many different organizations working on energy issues in **developing countries**. Some of these organizations are social enterprises, which aim to improve people's lives and to give them the tools and skills to earn better incomes and access to energy resources.

Solar Sister empowers rural women to start solar businesses that sell solar lamps to people in their communities. This helps communities save money and energy by replacing lamps that use expensive fuel (kerosene) with solar-powered lamps. Find out more: **www.solarsister.org**

People Centered Economic and Business Initiative (IBEKA) develops community-owned, small-scale **hydropower** in Indonesia. Read more about it here: **http://ibeka.netsains.net**

Shri Kshethra Dharmasthala Rural Development Project (SKDRDP) empowers families to invest in **renewable energy** systems such as **biogas** plants and solar home systems in India. Find out more: **www.skdrdpindia.org**

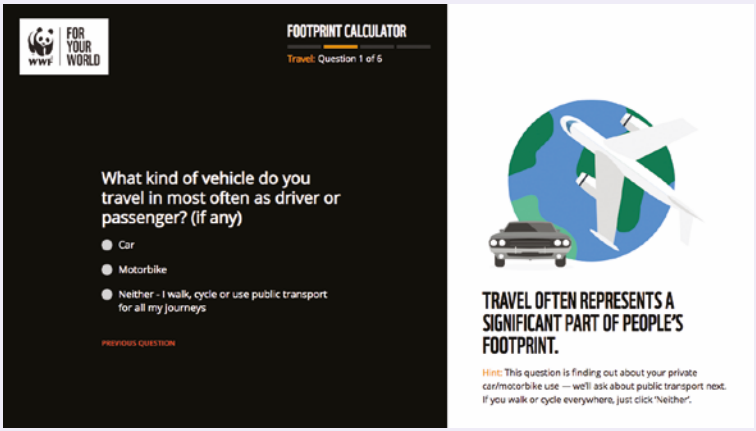
ACTIONS FOR YOU!

We need to save and conserve energy when we can to be sustainable and to tackle **climate change**. Making some small changes in your daily life will help you to use less energy and to reduce your **carbon and environmental footprints**.

CARBON FOOTPRINT

Do you know how big your footprint is? Your **carbon footprint** is the amount of **carbon dioxide emissions** produced from your activities (e.g. transportation, **electricity**, heating and cooling and cooking). It is a way to measure your environmental impact, and **carbon footprints** can also be used to measure and compare emissions from the production of different products. At home, the electricity, gas heating, the cars we drive, and even the trash we throw away, all contribute to your **carbon footprint**.

Try this simple carbon footprint calculator:
https://footprint.wwf.org.uk/#/



Think of ways you can reduce your carbon **footprint**. Here are some examples (additional ones are on the following pages):

Water: Turn the water off while brushing your teeth and try taking shorter showers, since heating and pumping water require energy.

Home: Unplug your electronic devices! Did you know that any electronic device that you have at home (TV, DVD player, Xbox) uses power even when it is turned off?

Transport: Ride a bicycle or walk instead of taking a car. Taking public transportation is also a good way to reduce your individual carbon footprint.

Food: Choose food and drinks wisely. For example, eat less beef, pork and lamb and consume plant-based protein sources such as lentils and nuts as well as more seasonal and local fruits and vegetables.

Lighting: Change old incandescent light bulbs to new light-emitting diode (LED). They can use up to 20 times less electricity to give the same light.

Waste: Reduce, reuse and recycle! For example, you can use reusable grocery bags, drink tap water instead of bottled water, use fewer food containers, and recycle everything (e.g. paper, cans, glass and plastic)

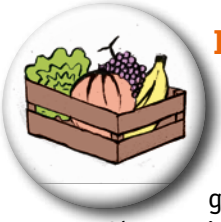
Find more tips here:
www.un.org/sustainabledevelopment/takeaction/

Everyone can make a difference! Energy efficiency and conservation are not just for scientists and policy-makers to figure out. Each of us can make a difference. Yes, that means you! There's a lot to be done: we need to use renewable energy resources and promote access to electricity for people everywhere. Here are ten ideas to start you off:

MAKE ENERGY CHANGES IN YOUR HOME

Install energy efficient light bulbs. Turn off lights, computers and other electronics when you do not need them. Fix any draughty doors and windows. Hang your laundry outside to dry instead of using a tumble dryer. Use less energy for heating and cooling (even a couple of degrees make a big difference). Do your homework by a sunny window instead of turning on the lights. Keep the refrigerator door closed. If the heat is on, keep the windows and doors closed.

See the **CLIMATE CHANGE CHALLENGE BADGE** *for additional ideas.*



EAT ENVIRONMENTALLY FRIENDLY FOODS

Choose foods that are produced with less energy or not imported from far away, such as eating locally produced fruit, vegetables and dairy products. Or try growing your own foods in small pots or in a garden. Also, eating less red meat helps save forests, as millions of hectares of forest are destroyed in order to turn the land into grass pastures for cows. As you know, forests help us tackle climate change. Explore recipes that do not contain beef and see if you can find alternative meals once a week that contain legumes and pulses (that also contain protein) instead of meat. See the Nutrition Challenge Badge for lots of other ideas.

REDUCE YOUR WASTE

Buy the correct quantities of food that you need so none is wasted. When you do have leftovers, conserve and eat the next day so you don't have to throw away. Buy foods and products with minimal packaging, and only buy things that you really need. Find ways to avoid throwing away plastic: switch to a reusable water bottle, use a cloth bag for shopping and use reusable containers and covers for storing leftover food.

REUSE THINGS

Before recycling something or throwing it away, see if you can find a way for it to be reused in some way. For example, reusing cardboard for an art project, sewing an old shirt into a bag or donating books to a school. Use newsprint to wrap gifts. Shop at thrift, charity or second-hand stores. Use reusable shopping bags that you can take with you when you shop. Bring your own reusable mug or water bottle with you. When you can, fix old things instead of buying new ones.

RECYCLE PAPER, ALUMINIUM, PLASTIC AND GLASS

If you do not have recycling in your area, then find out about how to start a recycling programme in your community or school. Compost food scraps if possible.

CONSCIOUS TRANSPORT

Use transportation methods that produce less **greenhouse gas emissions**, such as walking, cycling, public transit or carpooling whenever possible. When you are waiting in your car when the car is parked, turn off the engine.

CHOOSE ENVIRONMENTALLY FRIENDLY RECREATIONAL ACTIVITIES

Some recreational activities require equipment or machines that use lots of energy resources, such as motorboats, video games, computer games and televisions. Take part in recreational activities such as reading, drawing, board games and ball sports that use less energy resources.

VOLUNTEER WITH AN ENVIRONMENTAL ORGANIZATION

There are lots of ways we can help protect the environment and to save energy as part of a group. Find out about environmental organizations in your area and get involved!

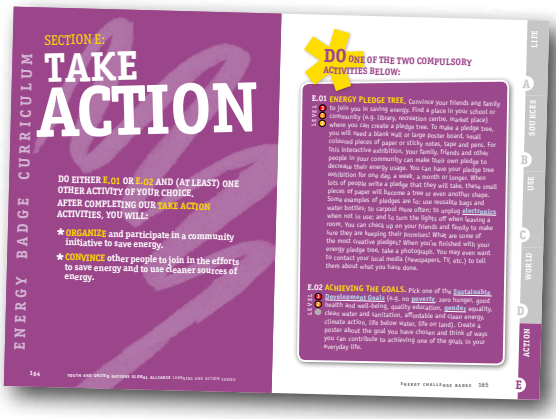
SPREAD THE WORD

The more we learn about energy and the impacts of energy on our environment, the more we are likely to want to take action. Use the facts you will discover doing this Challenge Badge to motivate your friends, family and local community to join in the effort to use energy responsibly.

GET POLITICAL

You can contact your local representatives to let them know you support projects that promote **sustainable** energy technologies and more efficient use of energy. If you (or members of your family) are about to vote in an election, how about finding out which politicians support policies that consider energy and the environment?

You'll find many more ideas in the curriculum activities in Section E of this badge (p. 164).



So now you have no excuses!

USE YOUR CREATIVE ENERGY AND START MAKING A DIFFERENCE!

SECTION A:

ENERGY IS LIFE

DO EITHER A.01 OR A.02 AND (AT LEAST) ONE OTHER ACTIVITY OF YOUR CHOICE.

AFTER COMPLETING OUR ENERGY IS LIFE ACTIVITIES, YOU WILL:

* **UNDERSTAND the importance of energy for life on Earth.**
* **IDENTIFY food chains in your area.**

DO ONE OF THE TWO COMPULSORY ACTIVITIES BELOW:

A.01 SUNNY STORIES. Since humans have existed on the planet, we have used the Sun's energy (**solar energy**). But the Sun's influence on human life extends far beyond our need for energy. Throughout history, people "worshipped" the Sun and had sun gods. Visit your school or local library and do some research about the Sun's role in a particular culture or religion. Then prepare a museum style exhibit of your findings, with drawings and explanations, and present it at your next meeting.

LEVEL 3 2 1

A.02 FOOD CHAIN DRAWINGS. What are some of the animals and plants that live in your community? Find out about some of the **food chains** in your local area. Draw a picture of a **food chain**, and you can even try to draw out a **food web** showing links between **food chains** in your area. Then think about your favourite meal. Does your favourite meal include only producers? Or does it also include higher **organisms** on the **food chain**? Try drawing the **food chain** from the items in your food back to the producers. If your favourite meal includes only producers (such as grains, fruits and vegetables), then you will not be able to draw a **food chain**. In this case, choose an animal that people eat in your culture and draw the **food chain** from that particular animal to producers. The **food chain** is one small part of the **carbon cycle**. How is the **food chain** connected to the **carbon cycle** in your community?

LEVEL 3 2 1

CHOOSE (AT LEAST) ONE ADDITIONAL ACTIVITY FROM THE LIST BELOW:

A.03 WIND PUSH. In your group, try to think about all of the ways that winds help different **organisms**, including both plants and animals. Have you ever seen pollen or leaves blowing in the wind? Or have you seen birds flying in the direction of the wind? If possible, fly a kite with your group on a windy day. Be sure to fly your kite in an open area, away from people and electrical lines. You may notice that the wind is strong enough to keep your kite in the air, or maybe it was a bit difficult to fly your kite if there was not so much wind. Observe how birds, pollen and other parts of plants move in the wind. What would happen if there was no wind? Try running in the same direction of the wind and then running against the wind. Did you feel a difference? Why not try making a pinwheel and seeing how it spins at different speeds depending on how strong the wind is. Instructions for a pinwheel can be found here: **www.firstpalette.com/Craft_themes/Nature/pinwheel/pinwheel.html**. Make sure you stay safe and get help from your teacher or group leader when using scissors and pins!

LEVEL 1

A.04 SUN BEAMS. Make a mobile of the Sun! Draw a circle and attach eight beams coming out of it. Write on each of the beams one way that the Sun's energy influences life on our Earth (e.g. gives us light, helps plants grow, creates winds). Cut a small hole in the centre, and hang the Sun so that you have a mobile reminding you about what the Sun does!

LEVEL 1

A.05 GROWING EXPERIMENT. How does the Sun help plants to grow? Learn about how the Sun helps plants to grow through **photosynthesis**! Then try growing two or more plants in small pots, milk cartons or other leftover food packaging. Plant some seeds from your favourite fruits or vegetables and watch them grow! Remember that plants need water, sunlight, **nutrients** in soil and air to grow. Once the plants start growing, you can do an experiment – put one of the plants in a dark place in your home or classroom, and put one of the plants in a place with lots of sunlight for one week. Keep watering each plant a little each day. Do you notice a difference in the plants? Why is this so?

LEVEL ● 2 1

A.06 CARBON CYCLE CHIMES. Write a song about the **carbon cycle** so that it is easy to remember. Share your song with the rest of your group or with friends.

LEVEL ● 2 1

A.07 LINGUISTIC ADVENTURES. Give each group member a different country (you can get a list at **www.un.org/en/members**). Then, individually, find out what the word for "energy" is in that country's main language. Come back together and share your findings. Have a contest to see who can remember the word for "energy" in the most languages, and then come up with a fun tongue twister by mixing and matching the different words.

LEVEL ● 2 1

ενέργεια 能源
energía energia
طاقة энергия

A.08 WINDS AND WAVE DANCE. In your group, learn about how the Sun warms the Earth to create winds and waves. Can you explain how the Sun creates winds and waves? Be inspired and choreograph a "wind and wave dance" about the uneven heating of the Earth and how this creates wind and waves. Then present your dance in front of your family or friends. You may even want to make up a song to go with your dance. If you are a really creative dancer, you may also want to make up a dance about how **carbon** travels through the air, the water and different plants and animals.

LEVEL 3 2 1

A.09 WORLD OF CARBON. Learn about the **carbon cycle**! Then visit a local forest, nature reserve, beach, farm, park or other outdoor area and observe plants and animals. What kinds of plants and animals do you see? Did you see any water? Did you see any dead plants or fallen leaves? Then, in your next group session, discuss or create a poster to explain how each animal and plant gets **carbon** and then releases **carbon** back into nature and the air. If you want, you can even discuss how water and forests are part of the **carbon cycle**. Learn more here: **www.kidsnewsroom.org/climatechange/carbon_cycle_version2.html**

LEVEL 3 2 1

A.10 GREENHOUSE EFFECT. Are you curious about how the **greenhouse effect** really works? You can do a simple experiment to see the effects of a greenhouse. For this experiment, you will need two small thermometers, a jar or other see-through container, a clock or watch, and a sunlamp or a sunny place for the experiment. Place

LEVEL 3 2

both thermometers in a sunny area. Cover one of the thermometers with an upside-down jar. For every minute for ten minutes, record the temperature on both thermometers. Was there a difference in the temperatures inside the jar and outside of the jar? How is this similar to the **greenhouse effect**? Find out more about this experiment here: **http://sln.fi.edu/tfi/activity/earth/earth-5.html**.

A.11 HEATING OF THE EARTH. LEVEL 3 2 Some parts of the Earth heat faster than others, due to different types of surfaces, colours and other factors. Have you ever noticed different air temperatures in sunny areas versus shady areas? This uneven heating of the Earth causes winds and waves. Do you think that water or land absorb more heat? How do you think that the colour of land surfaces influences how much heat is absorbed (e.g. ice, sand and dark soil)? Find out through an experiment to see how different coloured soils and water absorb and retain heat! You will need a sunny area or a strong lamp, three pie pans (or plates), dark soil, light-coloured sand, water, three thermometers and a watch. Fill the pans to the same level: one with soil, one with sand, and one with water. Put one thermometer into each. Place the pans or plates under a strong lamp or in the Sun, and record the temperature once each minute for ten minutes. Then put the pans into a shady area and record the temperatures each minute for another ten minutes. You can also experiment with wet soil, dry soil, grass clippings, or other types of coverings. Which surfaces in your area absorb the most amount of heat from the Sun? Read more about this experiment here: **www.ucar.edu/learn/1_1_2_5t.htm**.

A.12 BAKING WITH BUBBLES. Carbon dioxide bubbles help baked goods rise! This means that there are carbon dioxide bubbles in pancakes, many kinds of breads, cakes and other sweet treats. You can make these bubbles using yeast or other acid-based chemical reactions such as with baking soda and an acidic ingredient such as buttermilk or lemon juice. Bake something that includes yeast or baking soda as an ingredient! If you are using yeast, be sure to leave time for your dough to rise before baking. Find your own recipe or you can try this bread recipe: **www.projects-for-kids.com/food-projects/dough.php**

LEVEL 3 2 1

A.13 ACTING OUT THE CARBON CYCLE. Learn about the carbon cycle and make a video about it! You can make a skit, cartoon, or use other creative techniques to be part of your video about the carbon cycle. Alternatively, instead of making a video, you can perform your skit or present your creative piece in front of your parents or other people. Learn more about the carbon cycle here: **http://c03.apogee.net/contentplayer/?coursetype=kids&utilityid=gcpud&id=16174**

LEVEL 3 2

A.14 TALKING ABOUT CHANGE. Do some research about the carbon cycle and climate change. How do people affect the carbon cycle? Do you think that fossil fuel consumption is affecting the Earth's climate? Or what would you say is causing changes in the climate? Find facts and information to support your argument. What can we do about it? What are the potential impacts of climate change? Are they already happening anywhere in the world? Have a discussion/debate with your group about your findings.

LEVEL 3

A.15 CLIMATE CHANGE ARTICLE. How is climate change impacting the people and the environment in your community? Read some newspaper articles about climate change in your area. Then write your own newspaper article about why climate change is happening and how it is affecting energy sources and energy production in your community or country. You may also want to research how climate change influences natural events such as volcanoes, earthquakes and tsunamis. Find out which parts of the world will be most affected by climate change and why.

LEVEL 3

A.16 Do any other activity approved by your teacher or leader.

LEVEL 1 2 3

SECTION B:

ENERGY SOURCES AND IMPACTS

DO EITHER B.01 OR B.02 AND (AT LEAST) ONE OTHER ACTIVITY OF YOUR CHOICE.

AFTER COMPLETING OUR ENERGY SOURCES AND IMPACTS ACTIVITIES, YOU WILL:

- **KNOW which sources of energy you use in your community and how energy technologies work.**
- **RECOGNIZE some of the environmental impacts of common energy sources.**

DO ONE OF THE TWO COMPULSORY ACTIVITIES BELOW:

B.01 ENERGY GENERATION MODEL. What types of energy are used in your country? Are there **hydropower** plants, wind **turbines** and/or nuclear **power plants**? Draw a map of your country and mark the different types of energy usage in each region. Are there any energy resources being mined in your country? All forms of **electricity** generation, whether from **fossil fuels**, **hydropower** or nuclear power, have some level of environmental impact. Do research to learn the different ways that different energy resources and their usage affect the environment. Then choose one source of **renewable energy** and use recycled materials to build a model of it and its surroundings (e.g. a cardboard wind **turbine**). Present it in your next meeting/class, explaining how this form of **electricity** generation works, and how it impacts the environment.

LEVEL 3 2 1

B.02 SCOPING IT OUT. Take a trip to a place where energy is produced. You may choose to visit places such as a wind farm, **hydropower dam**, nuclear **power plant** or solar **power plant** to learn about energy production. Arrange to go on a tour or talk to a member of staff, if possible. How is the energy produced? What kind of impacts does this energy have on the environment? Who uses the energy that is produced? What are the challenges with this energy system? Create a newspaper-style article to report what you saw and learned about on your visit.

LEVEL 3 2 1

CHOOSE (AT LEAST) ONE ADDITIONAL ACTIVITY FROM THE LIST BELOW:

B.03 ENERGY GAME. This game is a variation of the "Bean Game" using different motions for different sources of energy. For this activity you need a big room or outside space and designate one person to be the caller. Begin by walking or jogging around the area. The caller says one of the energy sources, and then all of the players take the appropriate action:

LEVEL ● ● ①

- **Coal** – curl up in a ball on the floor
- **Hydro** – run around being a river/backwards and forwards being a wave (can do both depending on age)
- **Solar** – sunbathe
- **Gas** – hold nose
- **Nuclear** – cross arms in front of you and "vibrate" around room
- **Geothermal** – crouch down and warm hands on floor
- **Biofuel** – pretend to be a plant/a cow

Be creative and make up additional rules after everyone learns the basic motions. After playing the game, see who in your group can name all of the energy sources.

Source: **www.teachingideas.co.uk/pe/beans.htm**

B.04 WIND OR SHINE. Make a song about **wind energy**, using the refrain and chorus of Bob Dylan's *Blowing in the Wind*, or choose *Here Comes the Sun*, by the Beatles and make it on **solar energy**.

LEVEL ● ② ①

B.05 THAT OLD GEEZER. Geysers are a source of **geothermal energy**. A famous geyser is "Old Faithful", located in Yellowstone Park in the United States of America, thus named because it erupts at regular, predictable intervals. Are there any natural sources of **geothermal energy** in your area, such as hot springs or geysers? If yes, visit the area as a group and take photos and write down any observations. Present your findings to friends and family. If there are no such sites, then pick a famous one anywhere in the world and prepare a collage of photos, information and random facts about it.

LEVEL 2 1

B.06 POWER PLANTS. Agriculture both consumes and provides energy. Have each member of your group pick a **biofuel** crop, and prepare its "autobiography", talking about how much energy it both consumes and produces. What is it used for the most? Where does it grow? Present to the group without actually naming the crop. The rest of the group should guess which crop it is.

LEVEL 3 2 1

B.07 PRESENTING FOSSIL FUELS. Split into groups and pick one **fossil fuel** source per group, e.g. **coal**, **natural gas**, etc. In your group, prepare as thorough a presentation as possible about your topic. You can make a slideshow, or a poster, or even a papier-mâché model of it. Try to make it as colourful and interesting as possible. What are the advantages of this **fossil fuel**? What are the disadvantages? How widely is it used in the world? In your next meeting, each group will present their work.

LEVEL 3 2 1

B.08 FUN IN THE SUN. Conduct a simple **solar energy** experiment to get an idea of how much **power** is contained in a relatively small amount of sunlight, and create some artwork while you're at it! Follow the instructions at this site: **www.green-planet-solar-energy.com/solar-energy-education-8.html**

LEVEL 3 2 1

B.09 COMMUNITY RENEWABLE ENERGY. Find out what kind of energy is powering your home and/or your school. Is it **renewable energy**? If not, find out what kinds of **renewable energy** sources are available in your community. If there are **renewable energy** providers in your area, talk to your parents about switching. You may even want to talk to your teacher about how you can use energy more efficiently in your school and community.

LEVEL 3 2

B.10 RESEARCH GEOTHERMAL. **Geothermal energy** is **heat energy** that is deep underground. It can be used to heat homes and to produce electricity in parts of the world that have access to **geothermal energy** close to the surface of the Earth. Do some research about **geothermal energy** to learn more! Does anyone in your community use **geothermal energy**? If so, what kinds of geothermal systems are being used in your community? If not, find out if using **geothermal energy** is a possible energy option in your community. Figure out if your **community** could save electricity and money from using a geothermal system.

LEVEL 3

B.11 WRITING FOR RENEWABLES. Find out about what kinds of **renewable energy** resources are in your country by doing some research. What percentage of the energy comes from **renewable resources**? If you think it should be more, write a letter to your government urging them to invest in more **renewable energy** resources and to promote measures and investments for energy efficiency. Make it clear why you think it is important, and why you want them to take action. Encourage friends and family members to write letters too!

LEVEL 3

..... [Your address]

..... [Date]

Dear ... [name of Minister]

I am writing to express my concern that only 10 percent of our electricity comes from renewable energy sources, this is first not competitive for our economy but most of all its causing climate change and other environmental damage. If we look at our neighbors we can see that your country is far behind and we can learn from the options they have adopted...

B.12 FOOD VS FUEL. **Biofuels** are controversial, and some people believe that using crops to produce **biofuels** harms the world's food supply. Research the issue to understand the pros and cons of **biofuels**. Then pick a side and debate the issue with other members of your group. Who won your debate? What was the reason for this?

LEVEL 3

B.13 Do any other activity approved by your teacher or leader.
LEVEL 1 2 3

SECTION C:

ENERGY USE

DO EITHER C.01 OR C.02 AND (AT LEAST) ONE OTHER ACTIVITY OF YOUR CHOICE.

AFTER COMPLETING OUR ENERGY USE ACTIVITIES, YOU WILL:

- **Be FAMILIAR with different kinds of energy that you use every day.**
- **Be able to TAKE DECISIONS to use less energy in your everyday life.**

DO ONE OF THE TWO COMPULSORY ACTIVITIES BELOW:

C.01 ROUTINE ENERGY. What is energy? Try to explain what energy is in your own words. On a piece of paper, write or draw some of your activities that you do every day (e.g. eating, brushing teeth, walking to school, taking a bus, playing football, doing homework, singing and dancing, watching television, washing dishes, cooking dinner, etc.). Which forms of energy do you use for your different activities? Choose one of your daily activities and present to your group which form/s of energy are involved in the activity. How is energy converted from one form to another? Can you think of how the energy from the Sun contributes to your daily activities?

LEVEL 3 2 1

C.02 ELECTRONICS-FREE CHALLENGE. Lots of young people throughout the world spend an increasing amount of time each day using **electronics** including mobile phones, computers and televisions. How much time do you spend using **electronics** each day? For this challenge, you will find out how many hours in a day you can live without using electronic devices. During this period you may choose to engage in activities such as going for a walk, playing a sport, reading a book, helping your parents or neighbours, dancing or doing your homework. Make a chart for your one-month challenge, and write down what you did during your electronics-free periods and how many hours you managed each day. What was the hardest part of this challenge? What did you learn from the challenge? Do you think you can continue after your challenge month is up or even increase the amount of time you don't use **electronics** per day? Go on you can do it!

LEVEL 3 2 1

CHOOSE (AT LEAST) ONE ADDITIONAL ACTIVITY FROM THE LIST BELOW:

C.03 REDUCE, REUSE, RECYCLE. For this activity, you will need three cardboard boxes: a large box (e.g. shipping box; 100 cm), a medium box (e.g. fruit box; 50 cm) and small box (e.g. small gift box; 10 cm). Label the large box REDUCE, the medium box REUSE, and the small box RECYCLE. Reduce, reuse, recycle is a process that is in this order for a reason. Recycling still needs lots of energy, so it is best to reduce and reuse what we already have. Stack the boxes in different ways to see how to make the most stable structure. Discuss that the process is most stable and effective when following the order – reduce, reuse and recycle. Write on the different boxes what you can reduce, reuse, and recycle. Everyone identifies one change they can make in their own life, such as using a reusable water bottle instead of buying bottled water and recycling the bottles. Put this into practice! (*Source*: Girl Guides Australia).

LEVEL 1

C.04 ENERGY AND GRAVITY. For this demonstration of **potential energy**, kinetic energy and **gravity**, you will need a small toy car (or a small ball or other object that rolls) and a surface that you can use as a ramp. Rest or hold the small toy car at the top of the ramp. At the top of the ramp, the object has **potential energy**. Give the car a small push so that it rolls down the ramp. The force of your push converts the **potential energy** (stored energy) in the car into **kinetic energy** (moving energy). In this case, the force of your push and the force of **gravity** convert the ball's **potential energy** into **kinetic energy**. Try to think of other ways that you can demonstrate and visualize kinetic and **potential energy**. Learn more here: **www.phoenixlearninggroup.com/Images/Custom/Kinetic_and_Potential_Energy.pdf**

LEVEL 1

C.05 REDUCING MY CARBON OUTPUT. In this game, you stand in a circle and pass a ball randomly around the circle while music is playing. When the music stops, whoever is holding the ball gives one example of something simple THEY can personally do to reduce their **carbon footprint**. Some examples include: always turning off the lights when leaving a room, turning off and unplugging **electronics** when not in use, and boiling only the amount of water that is needed. (*Source*: Girl Guides Australia).

LEVEL 1

C.06 JUMPING JACKS ENERGY. What is the difference between **potential energy** and **kinetic energy**? **Kinetic energy** is moving energy while **potential energy** is energy that is ready to move. Stand in an X position with arms above shoulders and legs apart in an inverted V. In this position, you are storing **potential energy** and are getting ready to convert that energy into moving **kinetic energy**! Do a jumping jack (move your arms towards your sides and jump your legs and feet together)! When you move your arms and legs, you are creating **kinetic energy**, and when you pause, you are holding **kinetic energy**. Discuss other examples of kinetic and **potential energy** in everyday life (e.g. a ball lying at the top of a hill has **potential energy** and a ball moving has **kinetic energy**; a car filled with gas has **potential energy** and a moving car has **kinetic energy**) Learn more here: **www.phoenixlearninggroup.com/Images/Custom/Kinetic_and_Potential_Energy.pdf**

LEVEL 1

C.07 ENERGY IN THE PAST. People in the past lived with different technologies and used different energy sources from those you use today. Talk to an older person, such as a grandparent, about what kinds of energy they used when they were children. Did they have access to **electricity**? Did they have a television or computer at home? What kinds of fuel did they use to cook? How did they keep the house warm? What did they do for light? Do you think they used more energy back then or do you use more energy today? Create a table comparing the answers of your grandparents with your answers to these questions and then discuss the differences with the rest of your group.

LEVEL 2 1

C.08 ENERGY EXPERIMENT. How does energy change from one form to another? One way that energy changes from one form to another is through a chemical reaction. For this experiment, you will need baking soda, vinegar and a big bowl. Pour a tablespoon of baking soda in a big bowl. Then add a little bit of vinegar. What happens? What do you see? The bubbles that you see are actually **carbon dioxide**! What you are seeing is **potential energy** changing into **kinetic energy**, or a liquid changing into moving bubbles and a gas. Learn more here: **www.sciencekids.co.nz/experiments/vinegarvolcano.html**

LEVEL 2 1

C.09 SOLAR COOKING. Perhaps in your next meeting you can try some *al fresco* cooking using the energy of the Sun by making your own solar oven. Learn how at this site: **www.hometrainingtools.com/build-a-solar-oven-project/a/1237**. If you can't rely on sunny weather, how about building your own water **turbine**? Here's how: **bit.ly/GYifJJ**.

LEVEL 3 2 1

C.10 ELECTRICITY SAFETY CHECKLIST. How can you keep yourself safe when you are using energy at home? Review the "Safe and Sound" section in the introduction to this Challenge Badge. Make a checklist of things that you think are important to do at home to keep you safe. Then take a walk through your home with an adult to make sure that it is safe (e.g. make sure that electric cords are tucked away so no one falls over them, check to see that electric cords are not torn, and see if there are any outlets that have too many extension cords and plugs). Do fireplaces have guards, are there fire alarms, etc. Speak with your parents about using **electricity** and other energy sources safely in your home. You can also make a checklist for how to use **electricity** and other energy sources safely in your school. How can you be prepared for power shortages (power cuts) at home? Make a plan to have flashlights and batteries ready if needed.

LEVEL 3 2 1

C.11 FORMS OF ENERGY. Learn about the different forms of energy (**kinetic**, **potential**, **mechanical**, etc.) on p. 50. Divide yourselves into groups of four to five participants, and assign each group member an energy form and think about the characteristics of that form of energy (e.g. **potential energy** is always waiting; **mechanical energy** is like a robot). Write a short play that clearly demonstrates the differences between energy forms and then perform it to the rest of your group or friends and family. Can they guess which form of energy each person is pretending to be?

LEVEL 3 2

C.12 MEASURING ENERGY. Look up the various units related to measuring energy, e.g. joule, kilowatt hour, calorie, horsepower, etc. Learn what each is used for. How do any or all of them apply in your daily life? Try and think of all the things that you do during a day that require energy and the units of energy you would use to measure how much energy you have used. Look at electricity and gas bills and how much you are paying for energy and how much you are using. How can you reduce your bill and be more efficient? Share your findings with your group.

LEVEL 3 2

C.13 ENERGY EFFICIENT BUILDINGS. Visit a house or building that produces its own energy using solar panels or other technologies that make it more **energy efficient**. What kinds of building materials were used? How is the house **energy efficient**? What are the challenges with such a system? Why not make a model or drawing of this house that can be displayed in your classroom or meeting area, labelling all the parts that make the house energy efficient?

LEVEL 3 2

C.14 ENERGY EATS. Split into two teams and do some research with your group to prepare cards with food items and corresponding cards stating the energy used in their production. You don't have to stick to foods, but can expand into other items involved in food production. For example, a fishing boat consumes energy, as does the manufacture of **fertilizers**, pesticides, etc. Then shuffle up the cards and exchange them with the other team. The winning team is the one that first correctly matches each item to its corresponding **energy consumption** card. Are you surprised at the results you found?

LEVEL 3 2

C.15 ENERGETIC EDIBLES. Did you know that different foods take different amounts of energy to produce? For example it takes around 25 times more energy to produce one calorie of beef than to produce one calorie of corn for human consumption. Pick your favourite food and do some research to find out how much energy is used in its production. What type of energy is typically used in its production? Compare notes with the rest of the group. Whose favourite food is the most "energy-hungry?" Prepare a list of all the foods in increasing order of their **energy consumption**. Do your findings make you want to change some eating habits? Plan a meal that does not require very much energy, such as cooking local vegetarian food with as few packaged and processed products as possible. Cook your meal together with your group or on your own. Challenge yourself to try a new recipe or even make up your own recipe. Do you like the food that you prepared?

LEVEL 3 2

C.16 MAKING A BATTERY. Are you really curious about **electricity**? You can conduct your own experiment with **electricity** at home by making batteries! Batteries are everywhere in our daily lives – in cars, cell phones, hearing aids and calculators. To make a homemade battery, you will need a potato, a nail, a penny, some bits of metal wire and a flashlight. Follow the instructions here: **http://stemplanet.org/content/homemade-battery**. Make sure you have an adult on hand to help you with sharp objects.

LEVEL 3 2

DO NOT PLAY WITH REAL BATTERIES, THEY ARE DANGEROUS!

C.17 Do any other activity approved by your teacher or leader.

LEVEL 1 2 3

SECTION D:

ENERGY FOR A BETTER WORLD

DO EITHER D.01 OR D.02 AND (AT LEAST) ONE OTHER ACTIVITY OF YOUR CHOICE.

AFTER COMPLETING OUR ENERGY FOR A BETTER WORLD ACTIVITIES, YOU WILL:

- **KNOW about energy-related problems in your country and in other countries.**
- **Be able to THINK creatively about how we can help.**

DO ONE OF THE TWO COMPULSORY ACTIVITIES BELOW:

D.01 ENERGY TO THE RESCUE. Split into eight groups and pick one **Sustainable Development Goal** per group (e.g. no **poverty**, zero hunger, good health and well-being, quality education, **gender** equality, clean water and sanitation, affordable and clean energy, climate action, life below water, life on land). Try to come up with as many ways you can think of that energy affects this goal's achievement. The group with the most entries wins.

LEVEL 3 2

D.02 CAN YOU GUESS THE GOAL? Divide yourselves into groups of four to five members. As a team pick one of the **Sustainable Development Goals** and keep it a secret from the other teams. Be creative and write a short play that talks about the goal you have chosen without saying the name of the goal. Perform the play in front of the rest of the group. Let them guess which goal you picked.

LEVEL 3 2 1

CHOOSE (AT LEAST) ONE ADDITIONAL ACTIVITY FROM THE LIST BELOW:

D.03 CREATIVE ENERGY. Let your imaginations run wild and write a short story that involves an innovative way of generating **electricity**. For example, people can pedal this energy bike to **power** an mp3 player and a light bulb: **www.globalactionplan.org.uk/energy-bike**. Come up with your own crazy idea and base your story around it. Is your idea feasible? What kinds of materials would you need to make **electricity** using your great idea? Draw or even try to make a model of how to make **electricity**.

LEVEL 3 2 1

D.04 CARBON GRADING. Look up **CO_2** emissions by country. Where does your country stand? What do you think are the reasons for its position compared with other countries of the world? Produce a poster to display your findings – try to be as creative as possible – you could even draw a map! Find out **CO_2** emissions by country here: **https://footprint.wwf.org.uk/#/**

LEVEL 3 2 1

D.05 THE GLOBE GAME. Think about how you are connected to other countries. Where were your clothes made? Where does your food come from? Where does your energy come from? Once you have done some thinking and discussing, you are ready to play! You will need an inflatable globe. Stand in a circle and take turns throwing an inflatable globe to each other. When you catch the globe, point to a country to which you have a connection, and say what that connection is to the group. Examples are: "the cereal I had for breakfast was made from rice from China", "my shirt was made in India", or "my favourite football player comes from Mexico". An alternative way to play this game is to use a ball, and to come up with a country example without the help of the globe.

LEVEL 1

D.06 ARTICULATE ENERGY. In a group, create a set of cards, each labelled with an energy-related word, such as "renewable", "clean", and "sustainable". Be as creative as possible! Then mix all the cards up. Play a game of articulate, where you take turns drawing cards and explaining the word without using the word or saying "it begins with". The rest of the group will try to guess the word. If your group gets really good at guessing the words with only a few clues, then you may want to challenge yourself with charades – act out one word, while your friends guess which word you are acting out.

LEVEL 2 1

D.07 HEALTH INSPECTION. Prepare a quiz for your family or friends about pollution-related facts. They might be surprised by the answers. Ask them questions like: Where is the worst air pollution? What causes air pollution in your community? Use this Web site as a starting point in your research: **www.who.int/mediacentre/factsheets/fs292/en/index.html**. If you are really interested in energy and health issues, invite an expert to speak to your group about pollution and how to keep yourself safe.

LEVEL 2 1

D.08 INTERNATIONAL IDEAS. Do you have friends from other countries? Talk to them about energy habits where they come from. What is "greener" about their lifestyle? What is "greener" about yours? For example, in many cities in Pakistan, the government enforces "load-shedding", where the electricity is switched off for several hours each day in order to save energy. If you have friends who have experienced this, ask them how they passed the time with no electricity. What can you learn from each other?

LEVEL 3 2 1

D.09 BRIGHT IDEAS. There are loads of great ideas and projects for **energy efficiency** out there. For example, solar-powered drip irrigation is helping farmers in Benin and a small-scale hydro plant in Tajikistan is bringing **electricity** to homes and schools. Learn more here: **www.sustainableenergyforall.org/about/success-stories**. Choose one of the projects and prepare a presentation about it for the group as a whole. Can you see it being implemented in your own area?

LEVEL 3 2

D.10 SOCIAL IMPACTS. **Power plants** can have both positive and negative consequences on different communities. **Power plants** give people access to **electricity**, but they can also have harmful effects on the environment and have health and other social impacts. Is there a **power plant** in your community? Or, do some research about a **power plant** in another community within your country or even outside your country. How does the **power plant** impact the people living nearby? If you live near the **power plant**, you may want to ask people in your community how they feel the **power plant** has affected them. Or you may choose to learn more about how people living nearby are impacted by reading newspaper articles or other articles on the Internet.

LEVEL 3 2

D.11 POWER HUNGRY. As you know, different parts of the world have different levels of access to modern energy services and clean cooking facilities. For this game you will need a world map and a computer that is connected to the Internet, where one member of the group can look up information about energy **poverty** or availability around the world. The rest of the group takes turns in going up to the map, closing their eyes and pointing to any place on the map. They will then describe the energy situation in that region. If you have no idea, guess as best you can! After each person's turn, the person at the computer states how close (or far off!) they

LEVEL 3 2

were and provides the actual facts. Information can be found at these sites: **data.worldbank.org/topic/energy-and-mining** and **www.iea.org/weo/slide_library.asp**.

D.12 ENERGY AND POVERTY. There is a direct link between access to energy and **poverty**. Access to energy sources such as **electricity** can help families and communities improve their lives. As a group, brainstorm the ways that poverty reduces the chances of having access to **electricity**. Then brainstorm how access to **electricity** can help a family and a community out of **poverty**. (*Source*: Girl Guides Australia).

LEVEL 3

D.13 COMMUNITY ENERGY DEBATE. To reduce our global **carbon footprint**, different people in your community need to work together. Divide into two or three equal teams. Each team will represent a different group in your community, such as business, government, community groups or youth groups. Choose a specific energy issue in your community, such as the use of plastic bags, subsidies for **renewable energy**, construction of a new energy plant or recycling plastic bottles. Each team will brainstorm and discuss the group's values and perspectives on the particular issue. Think about ways in which the group you are representing can contribute to a solution to reduce the community's environmental impacts. Then hold a community debate where the teams try to come up with a solution to the energy issue together, to reduce the **carbon footprint** of a community. Was it challenging to come up with a solution when each group had different opinions? (*Source*: Girl Guides Australia).

LEVEL 3

D.14 Do any other activity approved by your teacher or leader.

LEVEL 1 2 3

SECTION E:

TAKE ACTION

DO EITHER E.01 OR E.02 AND (AT LEAST) ONE OTHER ACTIVITY OF YOUR CHOICE.

AFTER COMPLETING OUR TAKE ACTION ACTIVITIES, YOU WILL:

- **ORGANIZE and participate in a community initiative to save energy.**
- **CONVINCE other people to join in the efforts to save energy and to use cleaner sources of energy.**

DO ONE OF THE TWO COMPULSORY ACTIVITIES BELOW:

E.01 ENERGY PLEDGE TREE. Convince your friends and family to join you in saving energy. Find a place in your school or community (e.g. library, recreation centre, market place) where you can create a pledge tree. To make a pledge tree, you will need a blank wall or large poster board, small coloured pieces of paper or sticky notes, tape and pens. For this interactive exhibition, your family, friends and other people in your community can make their own pledge to decrease their energy usage. You can have your pledge tree exhibition for one day, a week, a month or longer. When lots of people write a pledge that they will take, these small pieces of paper will become a tree or even another shape. Some examples of pledges are to: use reusable bags and water bottles; to carpool more often; to unplug **electronics** when not in use; and to turn the lights off when leaving a room. You can check up on your friends and family to make sure they are keeping their promises! What are some of the most creative pledges? When you're finished with your energy pledge tree, take a photograph. You may even want to contact your local media (newspapers, TV, etc.) to tell them about what you have done.

LEVEL 3 2 1

E.02 ACHIEVING THE GOALS. Pick one of the **Sustainable Development Goals** (e.g. no **poverty**, zero hunger, good health and well-being, quality education, **gender** equality, clean water and sanitation, affordable and clean energy, climate action, life below water, life on land). Create a poster about the goal you have chosen and think of ways you can contribute to achieving one of the goals in your everyday life.

LEVEL 3 2

CHOOSE (AT LEAST) ONE ADDITIONAL ACTIVITY FROM THE LIST BELOW:

E.03 EARTH HOUR. Earth Hour is a global awareness event about **climate change** and **energy consumption**. It takes place on a Saturday in March each year. For Earth Hour, many people turn off their lights, and partake in activities that do not require **electricity** or other forms of energy. Is there an Earth Hour event taking place in your community already? Join in the Earth Hour event, or plan your own! If you choose to plan your own Earth Hour event, you can plan it on the day that Earth Hour is celebrated, or you may choose to celebrate Earth Hour on a day of your choice. You can find out more here: www.earthhour.org

LEVEL 3 2 1

E.04 GOING AGAINST THE CURRENT. Think of all the ways you use energy each day. If you had to sacrifice just three energy-reliant activities, how would it affect your life? Try it out for a day and keep a diary of how it affected you. What did you miss the most? The least? How do your answers compare with your friends?

LEVEL 1

E.05 ENERGY SAVER REMINDERS. Make energy savings reminders that you can post in your home, school or group meeting place. Write reminders such as 'turn off the lights', 'unplug **electronics** when not in use', 'turn off the water when you brush your teeth', etc. on post-it notes, index cards or small pieces of paper. Post the reminders near light switches, **electronics** and sinks. Make a list of all the different ways energy is used in your home, school and group meeting place and show people how much saving has been achieved with them being careful and sustainable.

LEVEL 1

E.06 ENERGY ART SHOW. Make art projects that you can display somewhere in your community, such as in your school, a library, hospital or recreation centre. You may choose to make art relating what kinds of energy you want to have in our future world. Or you can also choose another energy theme. You may choose to paint pictures or to make art by reusing materials that could otherwise be recycled. When you display your artwork, be sure to include some information about why energy is important.

LEVEL 3 2 1

E.07 SAVING ENERGY AT HOME. Make a list of all the different ways energy is used in your home. If possible find out how much fuel or **electricity** is used per week or month through the year. Do you and your family use **energy efficiently** in your home? Is there room for improvement? For example, energy-saving appliances, led lighting, draught control on windows and doors. And turning down your thermostat by just a degree can reduce the energy used in heating your home by 10 percent. Find more tips and ideas here: **www.energysavers.gov/tips**. Try to implement some energy saving tips in your home. Did you manage to make any changes in energy usage in your home? Speak with your family about what you all can do to reduce your energy usage. Maybe you can get extra pocket money for the money saved on electricity and gas bills **:o)**

LEVEL 3 2 1

E.08 GREEN SCENE. Throw an **Energy Efficient** Party in your community that will demonstrate ways to save energy. From using food that consumes less energy, to using cups and plates that can be washed and reused, to using **energy efficient** light bulbs. Make it the most energy-friendly party possible! Create little cards that explain how each item is in keeping with **sustainable** energy goals.

LEVEL 3 2 1

E.09 WASTE NOT, WANT NOT. Did you know that roughly one-third of the food produced for people to eat gets lost or wasted? Have you ever thought about how much energy is wasted along with that? In the United States of America alone, the energy equivalent of about 350 million barrels of **oil** a year could be saved by reducing food wastage. Start noting how much food, if any, goes to waste in your house. Keep a diary of your observations. Then talk to your family about how you can reduce waste. Find tips and ideas here: **www.thedailygreen.com/going-green/community-tips/reduce-food-waste-460708**. After a week, compare notes with your friends: which food-saving ideas worked? Which ones didn't?

LEVEL 3 2 1

E.10 LIGHTS, CAMERA, ACTION! As a group, make a short presentation or film to educate people in your community about how to save energy every day. Think about what people can do as individuals to save energy, and consider which energy saving actions are most relevant for your community. Feel free to use costumes, props, drawings or other materials in your short film. Alternatively, prepare a skit about how to save energy and perform it for your classmates or other people in your community.

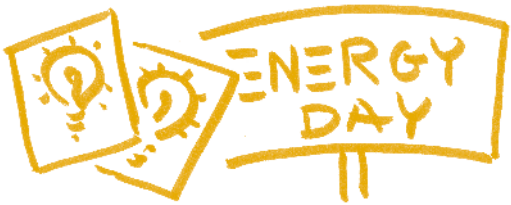
LEVEL 3 2 1

E.11 BLOG IT! Create a group blog about energy. You can write about the importance of **sustainable** energy for all and your ideas for using energy more efficiently on a daily basis. Liven it up with poetry, essays and stories about energy written by all the members of your group. Be creative – why not update the blog every day with a different energy saving tip or a news story about energy. Send the link to your friends and family and invite them to follow and comment on your blog.

LEVEL 3 2 1

E.12 COMMUNITY ENERGY CAMPAIGN. A campaign is when people work together to reach a common goal. Think of an energy campaign that you can do in your community to reach an energy goal that is important to you. Some examples of goals for your campaign can be to increase the number of people who use reusable water bottles at school, to educate people about the recycling programmes in your community, or to increase energy savings in your school or community centre. Join an existing environmental campaign or start your own with your friends. Come up with a creative plan to achieve your goal.

LEVEL 3 2



E.13 FUND YOUR FAVOURITE. As a team, look into different projects for energy access around the world. You can get started here: **www.practicalaction.org/energy** or **www.powertheworld.org**. Which projects interest you the most? Pick one, and then find ways to raise funds and awareness for the project of your choice. Perhaps you can hold an arts and crafts show with art made from recycled materials, or a raffle.

LEVEL 3 2

E.14 ENLIGHTENING AND EMPOWERING. As a group, organize an event to spread the word about energy efficiency. Hold an "Energy Awareness Day," and create fun posters and flyers with tips for saving energy. Visit these sites for ideas:
www.alliantenergykids.com/EnergyandTheEnvironment/SavingEnergy/022391
www.tvakids.com/electricity/conservation.htm

LEVEL 3 2

E.15 ENERGY POLICY. What kind of government policies do you have in your country that promote **renewable energy** or to decrease **greenhouse gas emissions**? Find out if you have any policies, financial incentives or energy standards on products, or even energy education initiatives funded by your government. If possible, have a look at actual energy policy text to get a better idea of what your country is doing. How can the policy be improved? Or what kinds of policies would you recommend? Discuss with your group to see what kinds of ideas you come up with together. Do you think that it is important to have energy policies? Come up with reasons to support your answer. Do any of these policies affect you personally? How?

LEVEL 3

E.16 LOW-IMPACT CAMPING. Plan an energy-conscious camping outing for your group. Carefully plan your camping trip so that you minimize your **greenhouse gas emissions** on your outing. Think about how you will get to the camp, what you will eat, how you will dispose of your waste and what kinds of activities you will do. Come up with creative ways to minimize your **carbon footprint** on your camping trip and to be as energy-efficient as possible.

LEVEL 3

E.17 Do any other activity approved by your teacher or leader.

LEVEL 1 2 3

CHECKLIST

Keep track of the activities you are undertaking with this checklist. When you show that you have completed the activities, you will have earned the Energy Challenge Badge!

NAME OF PARTICIPANT: .....

AGE OF PARTICIPANT: 1 (5–10 years) 2 (11–15 years) 3 (16+ years)

	Activity No.	Activity name	Date completed	Approved by (signature)
A Energy is life				
B Energy sources and impacts				
C Energy use				
D Energy for a better world				
E Take action				

RESOURCES AND ADDITIONAL INFORMATION

STAY UPDATED

This Challenge Badge is one of several complementary resources and activities developed by YUNGA and its partners. Please visit **www.fao.org/yunga** for additional resources or subscribe to the free newsletter to receive updates of new materials by sending an email to **yunga@fao.org**

SEND US YOUR NEWS

We would love to hear about your experience of undertaking the Challenge Badge! Which aspects did you particularly enjoy? Did you come up with any new ideas for activities? Please send us your materials so we can make them available to others and gather ideas about how to improve our curricula. Contact us at **yunga@fao.org**

CERTIFICATES AND BADGES

Email **yunga@fao.org** for certificates and cloth badges to reward course completion! Certificates are FREE and cloth badges can be purchased. Alternatively, groups can print their own cloth badges; you can download the template and graphics files from the Web site **www.fao.org/yunga**

WEB SITES

The following Web sites provide useful educational materials, including lesson plans, experiments, articles, blogs and videos, which could be useful when undertaking the Challenge Badge with your class or group.

EARTH DAY is celebrated every year on 22 April. This day is also known as International Mother Earth Day. Earth Day activities can range from environmental education activities to initiatives to promote energy efficiency within schools. Earth Day attracts more than one billion participants each year and includes action and education on issues such as energy efficiency and renewable energy. Find out more here: **www.earthday.org**

EARTH HOUR is held on a Saturday in March each year. Earth Hour is the largest event in the world where people come together to promote awareness about energy usage and climate change by turning off lights and electronics for one hour!
Get involved here: **www.earthhour.org**

ENERGY KIDS teaches children about different forms of energy and ways to save energy. You can find background energy information at: **www.eia.gov/kids**

ENERGY STAR KIDS contains fun games and activities for you to learn more about energy and how you can help conserve it. Check it out at: **www.energystar.gov/index.cfm?c=kids.kids_index**

Food and Agriculture Organization of the United Nations

FAO ENERGY has information about the connection between energy and agriculture here: **www.fao.org/energy/en/**

GENERATION AWAKE is an interactive environmental impact house with tips on saving energy in your home. **www.generationawake.eu/en**
You will find the Generation Awake consumption guide here: **www.generationawake.eu/guide/2720_Guide percent20EN_links.pdf**

GEOGRAPHY AND GEOLOGY FOR KIDS is an interactive geography textbook that includes sections about the carbon cycle and the atmosphere: **www.kidsgeo.com/index.php**

GLOBAL WIND DAY is held on 15 June each year. It is a worldwide event for educating and promoting the renewable energy potential of wind. On Global Wind Day, people can find out about wind energy by visiting wind farms, meeting experts and taking actions to support wind energy. Take part in the initiative here: **www.globalwindday.org**

NASA'S CLIMATE KIDS is an interactive platform with information and games about topics relating to climate change, including energy: **http://climatekids.nasa.gov/menu/energy/**

NATIONAL ENERGY EDUCATION DEVELOPMENT PROJECT provides information about energy for students and teachers. The Web site has PowerPoint® presentations about energy sources and links to other relevant Web sites: **www.need.org**

NATIONAL GEOGRAPHIC is an interactive Web site with articles, quizzes and learning games about global energy, and tips on saving energy: **http://environment.nationalgeographic.com/environment/energy/great-energy-challenge/**

NATURE CONSERVANCY provides a useful carbon footprint calculator: **www.nature.org/greenliving/carboncalculator/index.htm**

SUSTAINABLE ENERGY FOR ALL is a United Nations Web site that addresses the need for all people to have access to sustainable energy, including ways to achieve this by 2030: **www.sustainableenergyforall.org**

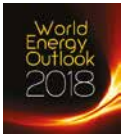
UNITED STATES DEPARTMENT OF ENERGY KIDS has lesson plans and fun activities for children and youth who want to save energy: **www1.eere.energy.gov/kids/games.html**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY has an interactive carbon cycle movie that you can watch here: **www.kidsnewsroom.org/climatechange/carbon_cycle_version2.html**

UN-ENERGY promotes publications, articles and events in the energy sector: **www.un-energy.org**

THE UNITED NATIONS ECONOMIC COMISSION FOR EUROPE (UNECE) is one of five regional commissions of the United Nations. UNECE is actively engaged in work related to the Sustainable Development Goals (SDGs). UNECE activities on energy can be found here: **www.unece.org/energy.html**. You can also find data and trends on renewable energy in selected UNECE countries here: **www.unece.org/energywelcome/areas-of-work/renewable-energy/unece-renewable-energy-status-report.html**

WORLD ASSOCIATION OF GIRL GUIDES AND GIRL SCOUTS (WAGGGS) Web site contains many resources and news on global issues, including activities relating to energy and the environment: **www.wagggsworld.org**



WORLD ENERGY OUTLOOK is a publication by the International Energy Agency that provides a wealth of information and analysis about energy, including energy poverty: **www.worldenergyoutlook.org**

WORLD ENVIRONMENT DAY is held on 5 June each year. On World Environment Day, people engage in different actions to protect our planet, including learning about climate change, food waste and renewable energy resources. Actions include communicating environmental messages through art and pledging to reduce environmental footprints. Learn more about it here: **www.unep.org/wed**

GLOSSARY

ACCESS: In this challenge badge, access refers to having affordable, available and stable access to electricity.

ACID RAIN: Any type of **precipitation** (e.g. rain, snow and sleet) containing acid that harms the environment, especially water **ecosystems** and forests. It is caused by **pollutants** in the air, mostly from the burning of **fossil fuels**.

APPLIANCE: Large machine that uses energy (usually **electricity** or **natural gas**), such as refrigerators, washing machines and water heaters.

ATMOSPHERE: A layer of gases in the air surrounding the Earth, including a mixture of nitrogen, oxygen and trace gases such as **greenhouse gases**. The atmosphere protects the Earth and keeps us warm due to the **greenhouse effect**.

ATOM: Everything in the world is made up of tiny particles called 'atoms'. These particles are like small 'building blocks'. Different atoms combine to make up **molecules** of different substances. **Electrons** are a part of atoms that can produce **electricity**.

BIODIESEL: a type of **biofuel** that is made from vegetable oils, animal fats and waste cooking oil. It can be used as fuel to power vehicles, generators and other uses.

BIODIVERSITY: A variety of plant and animal life in the world.

BIOENERGY: **Renewable energy** produced from the use of biofuels.

BIOFUEL: Fuels produced directly or indirectly from biomass. Biofuels can be solid, gaseous or liquid.

BIOGAS: A gas **biofuel** made from animal and plant materials. It is created when bacteria break down organic matter, releasing **methane** gas, creating a fuel that is similar to **natural gas**.

BIOMASS: Plant material and animal waste that is used as a fuel or energy source (e.g. wood, food scraps and cow manure).

CARBON: A non-metallic element that makes up all living things. It is everywhere – in your body, clothes, food, plants and animals

and in waste products. It is also in the ocean, air and rocks. When **organisms** change or die, they still contain **carbon**. **Carbon** in dead **organisms** turns into usable **fossil fuels**.

CARBON CYCLE: The continuous movement of the Earth's **carbon** through the air, the ocean, the environment and different **organisms**.

CARBON DIOXIDE: A colourless and odourless gas made up of **carbon** and oxygen, that makes up less than 1 percent of the air. The scientific name is CO_2. It is absorbed by plants and used in **photosynthesis**. People and animals exhale carbon dioxide when breathing. Burning **fossil fuels** and **biomasses** produces carbon dioxide emissions into the air, contributing to **climate change**.

CARBON FOOTPRINT: The total amount of **greenhouse gas emissions** produced by a person or group of people due to their **energy consumption** (e.g. transportation, **electricity**, heating and cooling and cooking). Carbon footprints refer to **greenhouse gas emissions** in terms of **carbon dioxide** equivalent (calculated using a special formula).

CHEMICAL ENERGY: **Potential energy** that is stored in chemical compounds and then released in a chemical reaction (e.g. batteries, **oil** and **coal**).

CLIMATE: The long-term average, or overall picture, of the everyday weather experienced in a location.

CLIMATE CHANGE: A change in the overall state of the Earth's **climate** (such as temperature and rainfall). It is caused by natural (e.g. volcanic eruptions, changes in ocean currents and changes in the activity of the Sun) and human causes (e.g. burning of **fossil fuels**).

COAL: A **fossil fuel** and a **non-renewable resource**. It is a brownish-black rock below the soil that is used mostly for **electricity**. It formed from the dead remains of trees, ferns and other plants that were buried under swamps millions of years ago.

CONDUCTION: Transfer of **heat** happens when two solid objects of different temperatures are placed in direct contact with each other.

CONVECTION: Transfer of **heat** happens in liquids and gases (fluids) when a fluid moves into an area of different temperature.

DAM: A barrier that blocks the flow of water across a stream or river. Dams store water, and when the water is released, it can be used to produce **hydropower** to make **electricity**.

DECOMPOSE: When the remains of dead plants and animals rot and break down into basic elements over time. Heat, light, bacteria and fungi play a role in this process. **Biogas** and **fossil fuels** are produced from materials that decomposed over short and long periods of time, respectively.

DEFORESTATION: Removing a forest or part of a forest (e.g. by cutting it down and burning it) to use the wood (e.g. to make paper or furniture) or to use the land for something else (e.g. farming or building on it).

DEVELOPING COUNTRY: A country that has little industrial and economic activity and where people generally have low income levels. This country is trying to become more economically advanced. The economies of most developing countries rely heavily on agriculture. Almost all of the people without access to **electricity** live in developing countries.

ECOSYSTEM: A community of living **organisms** (plants and animals) and non-living things (water, air, rocks, etc.) interacting in a certain area. **Ecosystems** don't have a defined size and can be as small as a puddle or as big as an entire lake. The whole world is one big, very complex **ecosystem**.

ELECTRICITY: The flow of electrical charges, created when tiny particles (**electrons**) move around freely. Examples include lightning and from energy sources such as **coal** or **natural gas**. Lighting is a form of electricity, and **electronics** and electrical **appliances** are powered with electricity.

ELECTRON: A particle that makes up **atoms**. Electrons have negative charges, and moving electrons create **electricity**.

ELECTRONICS: Things that use electricity when they are plugged into electrical outlets. Examples of electronics include televisions, computers and mobile phones.

ENERGY CONSUMPTION: The amount of energy that a person or group of people uses for their activities (e.g. transportation, **electricity**, heating and cooling, and cooking).

ENERGY EFFICIENT: The goal of reducing the amount of energy used or wasted. This can be achieved by energy-saving technologies (e.g. energy-saving light bulbs, home insulation systems, energy production systems that produce less waste **heat energy**) and through individual actions to save energy in daily activities.

ENERGY POVERTY: Energy poverty is when people do not have access to **electricity**, which can lead to many health and social issues.

ETHANOL: A type of alcohol used widely as **biofuel** in transportation.

FERTILIZER: A chemical or natural substances that is added to soil or land to increase the growth of plants.

FOOD CHAIN: The links between **organisms**, showing what eats what. Food chains show how energy passes among individuals, starting with primary producers (plants).

FOOD WEB: This is a more complicated version of a **food chain**, showing that more than one animal may have the same food source.

FORCE: A push or pull on an object, which can cause a change in movement. A force can change **potential energy** (stored or resting energy) into **kinetic energy** (moving energy).

FOSSIL FUEL: Fuels that are made from old plant and animal remains and take millions of years to form. Fossil fuels include **oil**, **coal** and **natural gas**. Fossil fuels contain lots of stored **carbon** or **methane**, which is burned to produce **electricity** and to produce energy for other uses. Fossil fuels are known to produce lots of **greenhouse gas emissions**, which contribute to **climate change**.

GENDER: The social roles that are based on being male or female. In many cultures, women and men have different responsibilities and roles in society. In **developing countries**, there are often big differences between what are considered men's and women's everyday responsibilities.

GENERATOR: A device that converts **mechanical energy** (e.g. from **turbines** and engines) into **electricity**.

GEOTHERMAL ENERGY: **Heat energy** originating from underground sources on the Earth.

GRAVITY: A **force** that pulls two objects toward each other, such as pulling a ball from the top of the hill to the bottom. Gravitational energy is **potential energy** stored in an object's height. A high and heavy object has a lot of gravitational energy.

GREENHOUSE EFFECT: **Greenhouse gases** in the **atmosphere** let heat from the Sun warm the Earth and trap some of the heat near the Earth, keeping the Earth warm.

GREENHOUSE GAS: Gases in the Earth's **atmosphere**, including **water vapour**, **carbon dioxide**, **methane**, nitrous oxides and ozone. These gases absorb energy from the Sun and trap some of this heat. This keeps the Earth warm, but too many greenhouse gases in the **atmosphere** are causing **climate change**.

GREENHOUSE GAS EMISSION: When natural systems or people's activities release **greenhouse gases** into the **atmosphere**. High levels of emissions come from burning **coal** for **electricity** and using **petroleum** for transportation.

HEAT ENERGY: The Earth and the Sun give us heat energy, which is also called thermal energy. **Power plants** use energy resources such as **coal** to produce heat energy and steam to make **electricity**. Heat energy is also often produced as waste energy by **power plants**, light bulbs and **electronics**.

HYDROPOWER: Energy that comes from the **force** of moving water (**mechanical energy**).

IRRIGATION: Watering of land to prepare it for agriculture.

KINETIC ENERGY: Movement or something at work. It is energy that an object has due to its movement or light. Forms of kinetic energy include **radiant energy**, **heat energy**, **mechanical energy**, **sound energy** and **electricity**.

LIGHT ENERGY: A form of **radiant energy** (**kinetic energy**) that includes light that people can see, such as light from lamps and from the Sun.

MICROORGANISM: A creature too small to be seen with the human eye alone, but which can be seen through a microscope.

MECHANICAL ENERGY: The energy of moving objects (**kinetic energy**) or stored energy (potential energy).

METHANE: A **greenhouse gas** that is found in **natural gas** and in **biogas**.

MOLECULE: When individual **atoms** stick together, they make up small clusters called 'molecules'. Different molecules make up different substances. A **carbon dioxide** molecule, for example, is made up of one **carbon** (C) **atom** and two oxygen (O) **atoms**, which is why it is called CO_2.

MOTION ENERGY: Energy stored in the movement of objects. Faster moving objects have more energy stored. Wind is an example of motion energy.

NATURAL GAS: A **fossil fuel** that is made up mainly of **methane**; it is burned to create usable **heat energy**. It is formed when **organisms** that built up in water are buried under ocean or river sediments in hot regions underground millions of years ago.

NATURAL RESOURCE: Living and non-living things that we can find in our environment, such as sunlight, water, air, soil, animals, forests, **fossil fuels** and food.

NEUTRONS: A particle in the atomic nucleus that has same mass as a proton but without an electric charge.

NON-RENEWABLE ENERGY: Energy produced from **non-renewable resources**. Types of **non-renewable energy** are **nuclear power** and energy produced from **petroleum**, **coal** and **natural gas**.

NON-RENEWABLE RESOURCE: A **natural resource** that cannot be made again in a short period of time if it gets used up, such as metals and **petroleum**.

NUCLEAR ENERGY: A type of **non-renewable energy** produced by a nuclear reaction in the metal **uranium**, which is found in rocks and seawater.

NUTRIENT: Chemicals that animals and plants need to live and grow.

OIL: A liquid fuel for energy that is usually from **petroleum**, but can also come from plant products (**biofuel**). Oil products from **petroleum** are commonly used to produce **electricity** and for other energy uses. (In this badge booklet, "oil" usually refers to **petroleum**).

ORGANISM: A living creature, like a plant, animal or microorganism.

OXYGEN: A colourless, odourless gas that we breathe.

PETROLEUM: A **fossil fuel** that is also known as **oil**. It is made up mainly of **carbon** and burned to create usable **heat energy**. **Petroleum** was created by **organisms** that built up in water and were buried under ocean or river sediments millions of years ago.

PHOTOSYNTHESIS: The process by which plants take in energy from sunlight together with **carbon dioxide** and water to make their own **chemical energy** that provides food for plants (sugars and other useful chemicals).

PIPELINE: A long pipe (usually underground) to transport **oil** and **natural gas**.

POLLUTANT: Chemicals or other harmful substances that can damage the environment and people's health. Burning **fossil fuels** and **biomass** produces air pollutants such as nitrogen oxides, sulphur dioxide and heavy metals. Some pollutants can have long-term impacts on health and the environment and cause **acid rain**.

POTENTIAL ENERGY: Stored energy in an object. Some kind of **force** is needed to turn potential energy into **kinetic energy**, such as the **force** of **gravity** to pull a ball down a hill. Forms of potential energy include **chemical energy**, **nuclear energy** and stored **mechanical energy**.

POVERTY: When people do not have enough money or access to resources to meet their basic needs, such as food, water, a place to live and education. Energy poverty is when people do not have access to **electricity**, which can lead to many health and social issues.

POWER: The measure of how much work is done in a certain amount of time. It refers to how fast energy is used or converted into another form of energy.

POWER LINES: The cables used to distribute electricity.

POWER PLANT: A central station that usually includes **turbines** and **generators** to produce **electricity**. Most power plants use **fossil fuels** to produce **electricity**, but more and more power plants use **renewable resources**.

PRECIPITATION: The process by which **water vapour** in the **atmosphere** condenses and falls in the form of rain, sleet, snow or hail.

PROTONS: A stable particle in the atomic nucleus with a positive electric charge.

RADIANT ENERGY: **Kinetic energy** that travels in space, such as **light energy** or radio waves.

RADIATION: Transfer of **heat** in the form of waves emitted by a hot object.

RADIOACTIVE: When an unstable **atom** loses energy to the environment around it. The breakdown of radioactive particles in the Earth produces **heat energy** deep underground. Strong radioactive materials can be dangerous to people and the environment, such as radioactive material left over from **nuclear energy** production. Radioactive particles lose their strength over long periods of time.

RENEWABLE ENERGY: Energy produced from **renewable resources**. Types of renewable energy include **geothermal energy**, **wind energy**, energy from **biomasses** and **biofuels**, **hydropower** and **solar energy**.

RENEWABLE RESOURCE: A **natural resource** that can be made again by the Earth's natural processes in a short period of time. Air, water, and forests are **renewable resources**.

SOLAR ENERGY: Energy from the Sun (a form of **radiant energy**) that can be converted into **electricity** and other forms of usable energy.

SOUND ENERGY: Energy from vibrations that you can hear (e.g. vibrating drum).

SUSTAINABLE/SUSTAINABILITY: The ability to maintain a steady level over time, such as maintaining a relatively steady amount of **natural resources**.

SUSTAINABLE DEVELOPMENT GOALS: A set of 17 goals that the United Nations adopted to end poverty and hunger, improve health and education, flight climate change and protect the environment by 2030.

THERMAL ENERGY (OR HEAT): Created by movements of atoms and molecules in an object. **Geothermal** energy is thermal energy of the earth.

TIDAL ENERGY: Energy created by the tides in the ocean. Tides are created by the gravitational pull from the Moon and the Sun, and the spinning of the Earth.

TIDAL RANGE: The difference between the highest and lowest tide. The largest tidal range is called *spring tide*, and the smallest tidal range is called *neap tide*.

TURBINE: A device that moves in a circular motion due to energy from wind, water, steam, gas or other fluids. Turbines convert energy from the flow of fluids and gases to **mechanical energy** (e.g. windmills and waterwheels). Almost all **electricity** is produced with some kind of turbine.

URANIUM: A heavy metal that is used to produce **nuclear energy**. It occurs naturally in most rocks and even in seawater.

WATER VAPOUR: The gas state of water that is produced from evaporation or boiling of liquid water. It is a **greenhouse gas** that occurs naturally in the air.

WIND ENERGY: Energy from moving air (**mechanical energy**). Wind energy is a **renewable energy** created by the uneven heating of the Earth's surface.

YOUR NOTES

ACKNOWLEDGEMENTS

Great gratitude goes to everyone who made the Energy Challenge Badge a reality. We would particularly like to thank the different organizations, and to all the enthusiastic Guides, Scouts, school groups and individuals all around the world who thoughtfully pilot-tested and reviewed the initial drafts of the badge.

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Some of the illustrations in this booklet are a selection from the over 20 000 drawings received from various drawing competitions. See our Web site (www.fao.org/yunga) or register to our free mailing list (email yunga@fao.org) to find out about current competitions and activities.

This document was developed under the coordination and editorial supervision of Reuben Sessa, YUNGA Coordinator and Youth Focal Point for FAO.

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www.sida.se

This badge was developed in collaboration with:

Food and Agriculture Organization of the United Nations

The Food and Agriculture Organization of the United Nations (FAO)

FAO leads global efforts to make sure that people have nutritious food for healthy lives. FAO works with resources relating to food production, including forests, fisheries and agriculture. FAO helps countries produce different types of nutritious foods, using energy in an efficient way. Serving all countries, FAO has also worked on projects with sustainable bioenergy. FAO is a source of knowledge and information, helping countries make policies and agreements to meet food and energy challenges.
www.fao.org/climatechange/youth/en

The World Association of Girl Guides and Girl Scouts (WAGGGS)

The World Association of Girl Guides and Girl Scouts (WAGGGS) is a worldwide movement providing non-formal education where girls and young women develop leadership and life skills through self-development, challenge and adventure. Girl Guides and Girl Scouts learn by doing. The association brings together Girl Guiding and Girl Scouting associations from 145 countries, reaching 10 million members around the globe.
www.wagggsworld.org

The World Organization of the Scout Movement (WOSM)

The World Organization of the Scout Movement (WOSM) is an independent, worldwide, non-profit and non-partisan organization that serves the Scout Movement. Its purpose is to promote unity and the understanding of Scouting's purpose and principles while facilitating its expansion and development.
www.scout.org

UN-Energy

UN-Energy is an organization with the purpose of creating a coherent approach within the UN system in the field of energy and to develop increased collective engagement between the UN and other key external stakeholders. UN-Energy supports countries in promoting access to energy resources, developing renewable energy resources and improving energy efficiency. Its role is to increase the sharing of information, encourage and facilitate joint programming and develop action-oriented approaches to coordination.

www.un-energy.org

The United Nations Economic Commission for Europe (UNECE)

UNECE's work on sustainable energy is designed to improve access to affordable and clean energy for all and help reduce greenhouse gas emissions and the carbon footprint of the energy sector in the region. It promotes international policy dialogue and cooperation among governments, energy industries and other stakeholders. The focus is on energy efficiency, cleaner electricity production from fossil fuels, renewable energy, coal-mine methane, natural gas, classification of energy and mineral reserves and resources, and energy security.

www.unece.org

THE YOUTH AND UNITED NATIONS GLOBAL ALLIANCE (YUNGA) IS A PARTNERSHIP BETWEEN UNITED NATIONS AGENCIES, CIVIL SOCIETY ORGANIZATIONS AND OTHER ENTITIES, WHICH DEVELOPS INITIATIVES, RESOURCES AND OPPORTUNITIES FOR CHILDREN AND YOUNG PEOPLE TO LEARN, GET INVOLVED AND MAKE A DIFFERENCE.

YUNGA ACTS AS A GATEWAY TO ALLOW CHILDREN AND YOUTH TO PARTICIPATE IN THE ACTIVITIES AND INITIATIVES OF THE UNITED NATIONS.

WE ARE MANY. WE ARE YUNGA!

PRINTED ON ECOLOGICAL PAPER
FSC (FOREST STEWARDSHIP COUNCIL) CERTIFIED

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The purpose of the United Nations Challenge Badges is to raise awareness, educate and, most of all, motivate young people to change their behaviour and be active agents of change in their local communities. Challenge Badges are appropriate for use with school classes and youth groups, and are endorsed by WAGGGS and WOSM. They include a wide range of activities and ideas that can easily be adapted by teachers or leaders. Additional badges are available or are being developed on a number of other topics, including: Agriculture, Biodiversity, Climate Change, Forests, Gender, Governance, Hunger, Nutrition, the Ocean, Soils and Water.

The ENERGY CHALLENGE BADGE is designed to show the crucial role energy plays for life on our planet as well as for our daily lives. The badge looks at the different sources of energy, considers how people use energy and how our planet is affected by it, and motivates young people to save energy and to engage in efforts to increase access to clean energy.

FOR MORE INFORMATION ON THIS AND OTHER MATERIALS CONTACT

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