A BSES - teri Initiative

OUR EARTH, OUR ENVIRONMENT, OUR LIVES

Build a Sustainable Future with Energy Efficiency and Clean Energy

BSES
BSES Rajdhani Power Limited

teri
The Energy and Resources Institute

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Message by CEO, BRPL

The greatest threat to our planet is the belief that someone else will save it.

—Robert Swan, the first person to walk to both the Poles

We live in a restless planet and cannot fully control or predict nature. Since the beginning of existence, we have exploited nature by cutting innumerable trees to build infrastructure and by killing animals for food. We have extracted minerals, crystals, and gems from the womb of the earth. We have taken and used whatever natural wealth there is to take and are now facing the grave consequences of nature's pushback. While it is impossible for any country to grow without using natural resources such as fossil fuels, we must realize that the earth's resources are not limitless—they are depleting fast, and this threatens our existence on the planet that we call home.

The modern world is beset with serious environmental issues. Tsunamis and hurricanes are sweeping across several parts of the globe, leading to a tragic loss of lives and destroying property worth millions. Closer home, recently, violent dust storms swept across parts of north India killing hundreds of people and destroying several houses. The damage recorded was the worst seen in the last two decades. One of the major causes of these deadly dust storms is increasing desertification (the process by which an area turns into a desert) in several north Indian states. In fact, given the high rate of desertification, we should be prepared for more intense and damaging dust storms in the future!

Perhaps the most challenging issue of the moment is climate change and global warming. Our excessive use of energy sources, such as coal and oil, has given rise to serious pollution problems and warming effects. Worse still, the enormous amount of solid waste we generate not only increases pollution but also indirectly bolsters global warming. Of late, India's capital Delhi has been in news for its massive air pollution. We are struggling to cope with the health risks it poses. It wouldn't be far off the mark to state that we are on the brink of an environmental crisis of sorts, and if we don't take charge of the situation now, things can only go downhill from here.

This book has been especially created to make you—the young minds who will steer the future—aware of the environmental issues we face and suggests simple solutions that go a long way in saving our natural resources. One of the foremost things we can do to protect the planet, and therefore protect us, is to save energy, switch to more sustainable energy sources (solar, wind, waste-to-energy), and reduce waste. This book is full of easy tips. It shows us the way to a more sustainable future and encourages us to build a greener, safer world. The road ahead is certainly an uphill climb, but there's enough reason to keep our hopes alive.

Amal Sinha,

CEO, BSES Rajdhani Power Limited (BRPL)

Message by DG, TERI

Very-poor air quality is the 'new normal' in the national capital of India. And if we don't address this problem with urgency, the city will soon become unlivable. For this reason, we need to cast a detailed eye on how we use energy: energy use is closely linked with pollution problems and the changing climate. And that's where this book is oriented.

It sharply focuses on the varied uses of energy and how they, along with several other urban–rural factors, create large-scale pollution problems. But pollution is not the only problem it deals with; rather, it takes a panoramic view of the current environmental situation and explains the causal link between energy, pollution, and climate change on a wider scale. This important book is a timely initiative to introduce young children to the idea of a sustainable lifestyle, which calls for conservation of energy as well as of other natural resources. Needless to say that caring for the planet is the only way to save it and ourselves. This comprehensive book, filled with many revealing case studies of environmental disasters, will be your first concrete step in that direction.

Ajay Mathur

Director-General, The Energy and Resources Institute (TERI)

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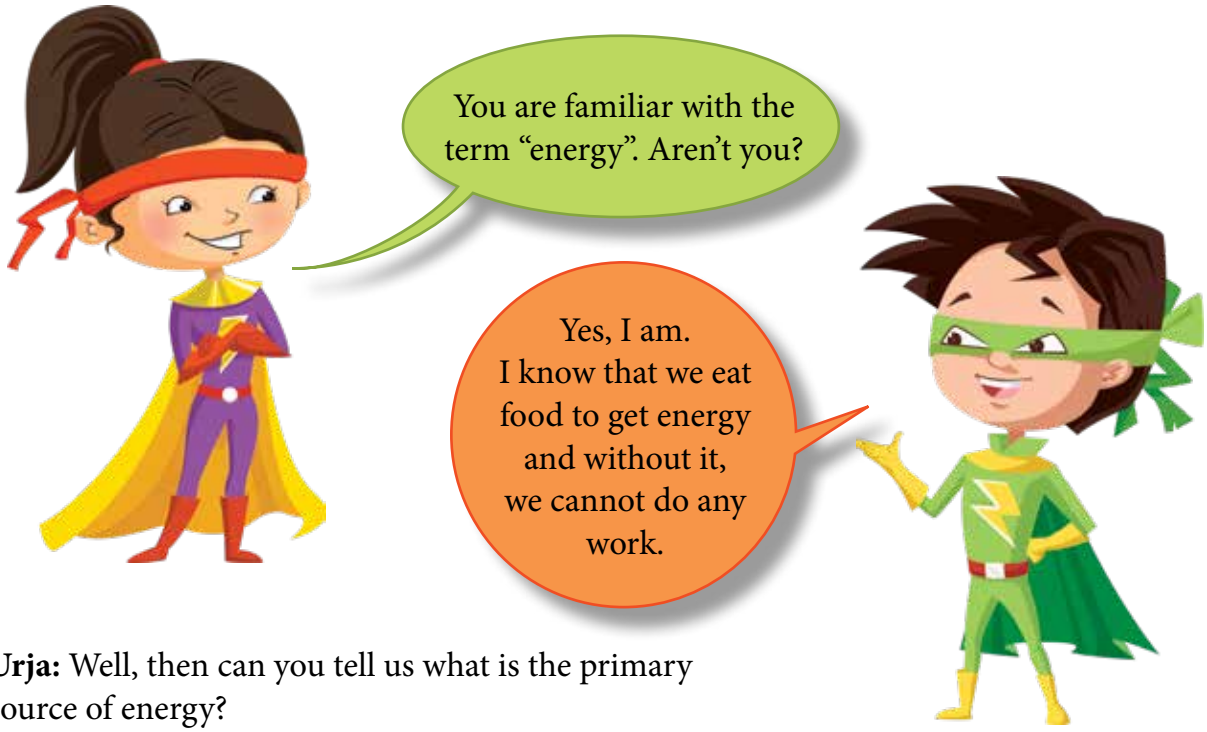
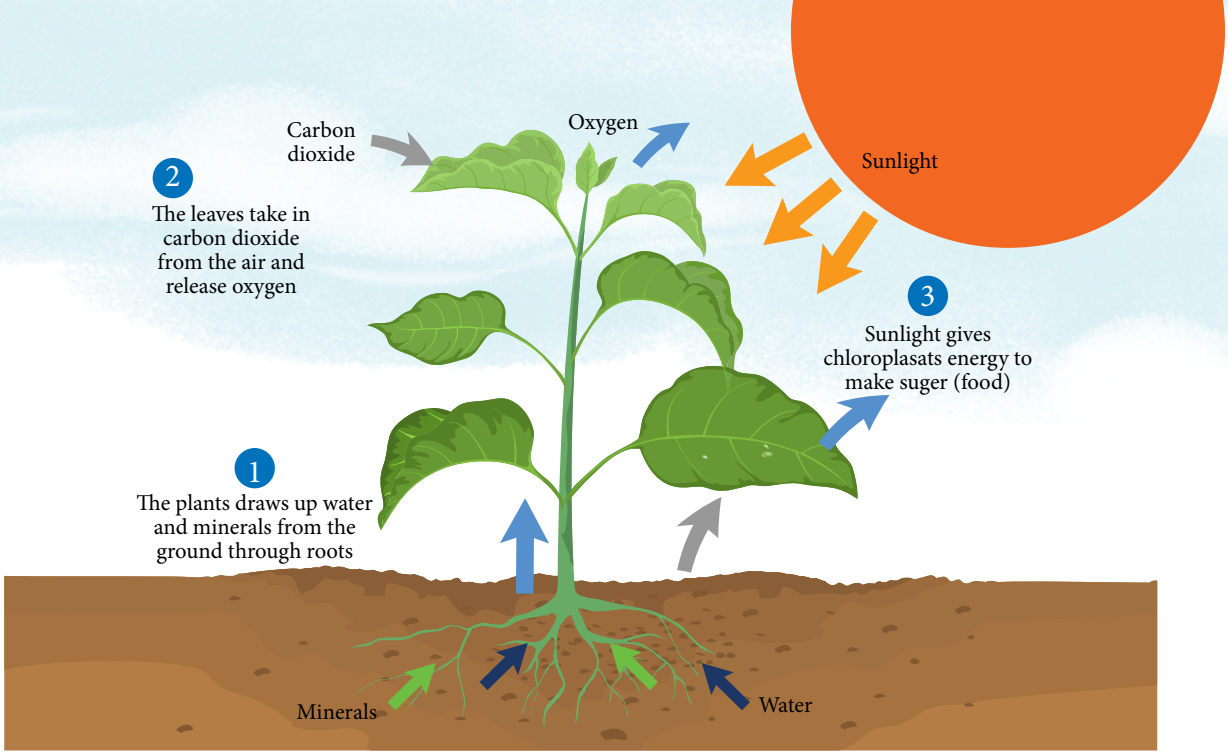
What Is Energy?



Urja: Well, then can you tell us what is the primary source of energy?
Prakash: It's food.
Urja: You are partially correct. Let's try and solve this riddle. The answer to the riddle will also be the answer to my question.

I rise in the morning,
And set in the evening.
I am the earth's closest star,
And I give you light and heat.
Can you tell me who am I?

Prakash: It's the "sun".
Urja: Easy wasn't it? To elaborate on your answer, the presence of light and heat helps plants to perform photosynthesis. During this process, the radiant energy of the sun is transformed into chemical energy. Here's how it does that:



The average rate of energy capture during photosynthesis is approximately 130 terawatts, about six times more than the total power used by humans.

As long as the sun shines, plants will take in sunlight, water, and carbon dioxide and continue the process of photosynthesis and keep providing us with food to eat and oxygen to breathe. During digestion, chemical energy is converted into heat that helps keep the body warm. This is eventually converted into mechanical energy that enables us to do work. So, it proves that energy can be found in many things and in various forms.

Energy can be in the form of chemical, electrical, heat (thermal energy), light (radiant energy), mechanical, and nuclear energy. It exists as light, heat, sound, mass, moving objects, fuel, chemicals, and electricity which are required to enhance our daily lives.

Urja: So, you do agree that the sun is the primary source of energy and life would be unsustainable without it?

Prakash: Yes.

Urja: Let's take a break now. I think you will be interested in another riddle? Here you go,

I have a "city" in my name,
I power TVs, cars, and video games.
When the sun goes down,
And the world is all dark,
I help the lights go on,

So you get your homework done.
Who am I?

Prakash: That's easy. The answer is "electricity"!

Urja: You're right. Electrical energy is used to power almost all the things that we use in our daily lives. Household appliances such as microwaves, refrigerators, geysers, water pumps, and so on all run on electricity and so do large factories, vehicles, and offices.

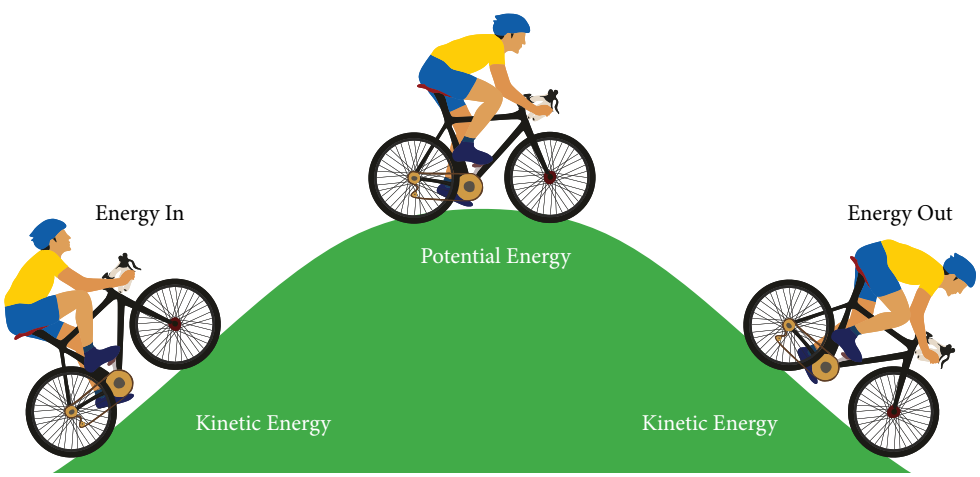
Prakash: But is there a way we can measure electrical energy or any form of energy?

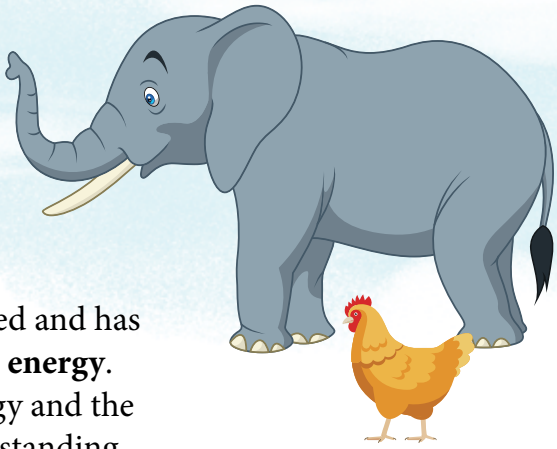
Urja: Yes. Energy is measured in different ways. One of the basic measuring units for energy is called British thermal unit (Btu). However, another measuring unit joule (J) is the one that is commonly used by scientists around the world. Like in the metric system, you can have kilojoules – kilo means 1000; 1000 J = 1 kJ = 1 Btu. Do you know it takes 2 million joules to make a pot of coffee?

The word "energy" derives from a Greek word "energeia". In 1802, Thomas Young was the first to use the term "energy" in the modern sense. He said, the product of the mass of a body into the square of its velocity may properly be termed its "energy".

Types of Energy

Urja: Don't you agree that energy makes us think of things that move – an exciting football match or riding a bicycle? But do you know that even stationary things, such as a coiled spring or water that is behind a dam have energy?



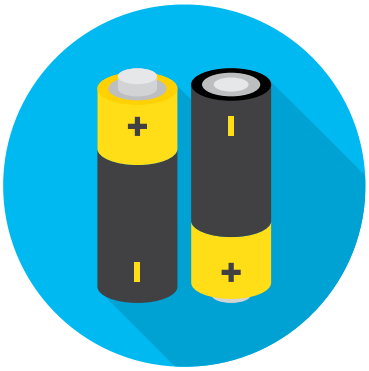


Let's get into the details of the types of energy. Don't fret if it gets too serious, we have some interesting activities to help you.

Energy can be divided into two types – **kinetic energy and potential energy**. The energy of a body formed due to its motion is known as **kinetic energy**. The energy that is stored and has a potential to make a change happen is **potential energy**. The heavier the object, more is its potential energy and the higher an object, it has more potential energy. A standing elephant will have more potential energy because of its weight, than a little chicken. Again, a diver standing on a high diving board has stored potential energy because of his position.

Forms of Energy

After understanding the two types of energy, let us read about the different forms of potential and kinetic energy.



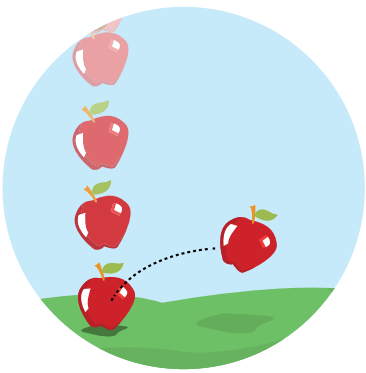
Forms of Potential Energy

Chemical Energy – Everything in the universe is made up of tiny units of atoms. For example, there are millions of atoms in a grain of salt. Energy that is stored in the bonds of atoms and molecules is called chemical energy. Any substance that can be used as a fuel contains chemical energy. Photosynthesis changes solar energy into chemical energy.

Mechanical Energy – What happens when you suddenly release a compressed spring ? The result is an example of stored mechanical energy. This type of energy is stored in objects by tension or compression and is called mechanical energy.

Nuclear Energy – The centre or the core of an atom is called nucleus. The nucleus of an atom comprises tiny particles – protons and neutrons. Then there are the electrons that revolve around the nucleus.
So, nuclear energy is the energy that keeps the nucleus (with its components) held together in an atom. If this type of energy is to be used, the energy has to be released from the atom. This energy is used in nuclear power plants by splitting atoms (nuclear fission) to produce electricity.

Gravitational Energy – Surely, you know the famous story of an apple falling on the head of the great scientist Newton. Due to this small incident he investigated and developed the theory of gravitation. Gravity is the force with which another body pulls any other body. Gravitational energy is the energy that is held by an object because of its high position in comparison to the earth's position. An object that is heavy and placed at a higher position will have more gravitational energy.



Forms of Kinetic Energy

Radiant Energy – If you notice carefully, you will see that any object which has light falling on it intensely becomes warm, which means that light carries energy. This type of energy is termed as radiant energy because of the way light radiates from its source, such as the sun or a light bulb. For example, soil absorbs the radiant energy from the sun, and its light and heat is used by the seeds to promote growth.

Thermal Energy – This type of energy is related to the temperature of an object. Temperature and heat are related but not interchangeable. Objects do not contain heat, they contain thermal energy. When thermal energy is transferred from or to an object, it is called heat. For example, it will be

incorrect to say that there is lot of heat in the iron. We can say that it has a lot of thermal energy and if we end up touching it, the energy will transfer in our body in the form of heat.

Motion Energy – The energy that is in an object as a result of being in motion is called motion energy. For example, if you raise an iron hammer to drive a nail into a piece of wood and move it with great speed downwards, this iron hammer will be said to possess motion energy.

Sound Energy – Sound travels in waves and when these sound waves travel outward from a sound source or a vibrating object, sound energy is produced. Sound waves are sources of pressure that travels through air, water, and other materials. The closer the ear is to the source of the sound, the easier it is for the listener. For example, try to strum the strings of a guitar. Share your observation with your friend.

Electrical Energy – This is the kinetic energy of moving charges in an electrical circuit. It is this energy that powers your lights, fan, and television. A very good example is the old-fashioned light bulb where electrical energy gets converted into both heat and light.

Urja: Let's create an energy log. List five activities that you performed today and write the type of energy that was used.

1. _____
2. _____
3. _____
4. _____
5. _____

Sources of Energy

Urja: Now that you know the types of energy, do you know the sources of the different energy?
Prakash: All the types? I thought "sun" was the source of energy.
Urja: You are partially correct. Sun is the primary source of energy, but there are various sources of energy which fall under the category of renewable and non-renewable energy. Again, these sources are present because of the presence of S-U-N.

Under the category of **renewable energy** or non-conventional energy some of the sources are – sun, wind, water, agricultural residue, firewood, animal dung, etc. The **non-renewable** sources are the fossil fuels such as coal, crude oil, natural gas, wood to some extent, etc.

Imagine your city free from air pollution — breathing clean, fresh air that is around you. This can be possible only if all machines are run on renewable sources of energy that do not pollute the air. Let us find out more about renewable energy.

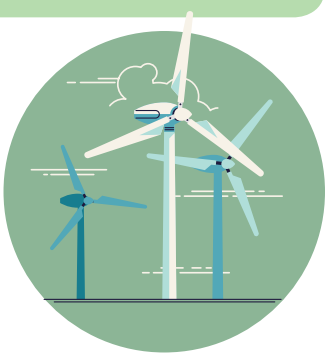
Solar Energy

As the day goes by, the sun burns up about four million tonnes of matter and releases huge amounts of energy. The earth receives about one-billionth of this energy, which then becomes the source of life on earth. The presence of this energy results in the life on earth, change of seasons, and so on. Solar energy is used by plants to synthesise food, where in solar energy is converted to chemical energy.

Uses: during transportation, electricity generation, cooking, pocket calculators, etc.
Energy Capsule: Kurnool, in Andhra Pradesh, is currently the site of the world's largest single-location solar park, which has a potential capacity of 1000 megawatts.

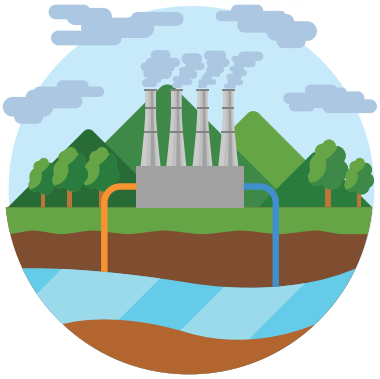
Wind Energy

The rotation of the earth, the uneven heating of the earth's atmosphere leads, and the irregularities of the earth's surface causes winds. The pattern of the wind flow is modified by the vegetative covers, earth's terrain, and forest cover. When this wind flow is harvested with the help of wind turbines, electricity can be generated.



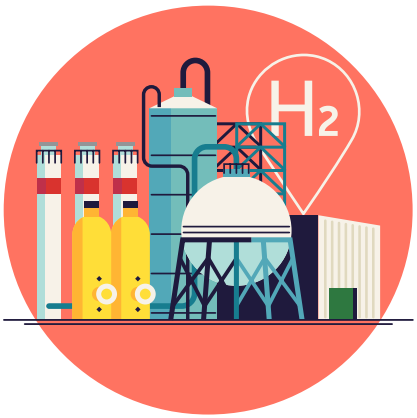
Uses: agriculture, water pumps and then we have wind-powered ships, adventure sports, etc.
Energy Capsule: Despite their differences, "windmill" and "wind turbine" are used interchangeably. Windmills generate mechanical energy, but do not generate electricity whereas wind turbines are highly evolved machines that harness winds kinetic energy and convert it into electricity.

Geothermal Energy



Heat is continuously produced inside the earth. Geothermal energy is produced as a result of the slow decay of radioactive particles inside the earth's crust which is a continuous process in rocks. Heat produced underground produces steam that is captured and used to move turbines. These rotating turbines are then used to power generators.

Uses: paper mills, preservation of fruits and vegetables, greenhouse heating in agriculture, electricity generation, etc.
Energy Capsule: The largest group of geothermal power plants in the world is located at The Geysers, a geothermal field in California, United States.



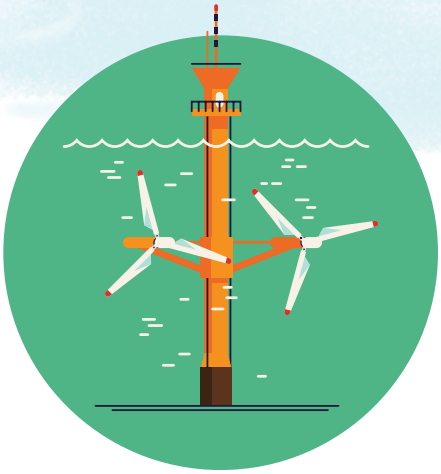
Hydrogen Energy

Hydrogen is the most plentiful element in the universe. Hydrogen is high in energy, yet an engine that burns pure hydrogen produces almost no pollution. Hydrogen is available only in bound form and not independently on the earth. Once it is separated, it can be used as a fuel for generating electricity.

Uses: source of fuel for vehicles, ships, rockets, industries, electricity generation, etc.
Energy Capsule: Hydrogen gets its name from the Latin word "hydrogenium", which means "something that forms water".

Tidal Energy

This type of energy is generated in the coastal regions because it can be harnessed using the rise and fall of tides. The kinetic energy of incoming and outgoing tides is converted into electrical energy. Although not yet widely used, tidal power has potential for large scale future electricity generation. Tides are more predictable than wind energy and solar power. The three different ways to get tidal energy are tidal streams, barrages, and tidal lagoons.



Uses: electricity generation
Energy capsule: Tidal Energy is the oldest form of renewable energy, which was used in the water mills by the Romans when they occupied England. It was later used for the same purpose, give power to the mills, along the shores of Spain, France, and Britain.

Wave Energy

Wave energy is also often referred to as wave power. When wind blows across the sea surface, it transfers the energy to the waves. The energy output is measured by wave speed, wave height, wavelength, and water density. The more strong the waves, the more capable it is to produce power.

Uses: electricity generation, desalinization of water and pumping water into reservoirs, etc.
Energy Capsule: Wave energy can be captured at three different locations in the sea: nearshore, offshore and far offshore.

Prakash: Aren't "tidal energy" and "wave energy" same?
Urja: Although tidal energy' and 'wave energy' sound similar and are usually used interchangeably, they are not the same. These are two different entities. Let us look at the difference:

Tidal Energy	Wave Energy
Harnessed from the rise and fall of sea levels	Harnessed from waves moving along the surface of the ocean
Caused by the gravitational pull of the moon and sun on the earth	Caused by wind
Intensity is affected by wind strength	Intensity is affected by location and position of the earth
Types of tidal energy include kinetic and potential energy	Types of wave energy include kinetic energy
Harnessed using barrages, dams, tidal fences, and tidal turbines	Harnessed using offshore and onshore systems
Discontinuous source of energy that is generated for about 6 – 12 hours at a time	Continuous source of energy

Hydroelectric Energy

Hydroelectric energy is energy derived from the motion of water. We call it hydroelectric energy because the initial source of energy is water. The kinetic energy present in the moving water can be harnessed into mechanical energy. When flowing water turns the blades of a turbine, it also turns the generator rotor which converts mechanical energy into electricity. In order to harness hydroelectric energy, a power plant needs to be set up in an area with flowing water. This may include a dam that blocks or diverts water and one or more reservoirs.

Uses: electricity generation
Energy Capsule: Hydropower was first used to grind corn in prehistoric times.

Biomass Energy

Biomass is organic material that comes from plants and animals. It is rightly called energy from waste because biomass fuel is generated from wooden scrap, forest debris, animal dung, and some waste residues. Biomass contains stored energy which is released when it is burned. By adding heat or chemicals to the biomass, a fuel is produced that can be burned to produce electricity.

Uses: domestic cooking and fuel in industrial production
Energy Capsule: More than 70 per cent of India's population depends upon biomass for its energy needs. The leading states for biomass power projects are Maharashtra, Uttar Pradesh and Karnataka each one having more than 1 gigawatt of grid-connected biomass power.

Nuclear Power

Nuclear energy is the energy in the nucleus, or core, of an atom. The energy is created through a specific nuclear reaction, which is then collected and used to power generators.

Uses: electricity generation, producing fertilizers, medicine, etc.
Energy Capsule: France is the world's leader in nuclear power, generating three-fourths of its total electricity using nuclear reactors.

Urja: These were the sources of renewable energy.
Prakash: That was quite an exhaustive list.
Urja: Now that you have learnt about renewable energy, can you guess or tell me about non-renewable energy?
Prakash: Going by the name, I think non-renewable energy is the energy that cannot be renewed.
Urja: You are correct. All machines run on some form of energy—some of these such as the fossil fuels – cause harm to the environment. Continue reading to learn more about these fuels and how you can conserve energy.

Fossil Fuels

When most people talk about the different sources of energy they list natural gas, coal and oil as the options – these are all considered to be just one source of energy from fossil fuels. Fossil fuels provide the power for most of the world, primarily using coal and oil. Oil is converted into many products, the most used of which is gasoline. Natural gas is starting to become more common, but is used mostly for heating applications although there are more and more natural gas powered vehicles appearing on the streets. The issue with fossil fuels is twofold. To get to the fossil fuel and convert it to use there has to be a heavy destruction accompanied by pollution of the environment. The fossil fuel reserves are also limited, expecting to last only another 100 years given the basic rate of consumption.

Uses: cooking, transportation, electricity generation, etc.
Energy Capsule: Fossil fuels are made up of hydrocarbons which store energy in the form of atomic bonds and energy is released when fossil fuels are burnt.

Urja: Using fossil fuels does present a grim picture and using renewable energy poses challenges such as expensive installation, space constraints, etc. However, there is another interesting way is which both thermal and electrical energy can be produced at the same time. This process is called cogeneration (CPC). Cogeneration or combined heat and power uses one source of fuel such as natural gas to generate two types of energy. It means, one source is used to produce two things making it cost effective.
Urja: Cogeneration ensures that a cleaner and less polluting form of energy is being produced. This means increased efficiency of energy conversion and use. Cogeneration is the most effective and efficient form of power generation.
Prakash: Is cogeneration a popular method?
Urja : Yes, and not only that, through this method a cleaner and less polluting form of energy is being generated. This means increased efficiency of energy conversion and use.

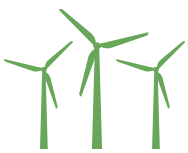
Urja: Did you know? Fuel cells are electro-chemical devices that convert the chemical energy of a fuel directly and very efficiently into electricity and heat thus doing away with combustion. For example, electric vehicles using fuel cells.

Ralegan Siddhi - This model village in India is a good example of proper use of renewable energy. The man behind this achievement is Anna Hazare.
Bermuda Triangle - Methane found in large concentrations in the seabed is also being thought of as an alternative, in fact the mystery of the Bermuda Triangle in the Atlantic ocean has been linked by certain scientists to this.

Intended Nationally Determined Contributions (INDCs)

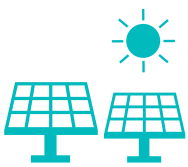
During the Conference of the Parties (COP21) of 2015, countries agreed to adopt measures to reduce and control GHG emissions of their countries. Countries publicly outlined what post-2020 climate actions they intended to take under the new international agreement, known as their Intended Nationally Determined Contributions (INDCs).

The climate actions communicated in these INDCs largely determine whether the world achieves the long-term goals of the Paris Agreement: to hold the increase in global average temperature to well below 2°C, to pursue efforts to limit the increase to 1.5°C, and to achieve net zero emissions in the second half of this century.



Wind energy

- Fifth-largest wind power producer in the world
- Wind energy accounts for 23.76 GW (65.2%) of the renewable installed capacity
- Aims to achieve a target of 60 GW of wind power by 2022



Solar energy

- Increased from 3.7 MW in 2005 to about 4060 MW in 2015
- Enhance solar power capacity to 100 GW by 2022
- Kochi Airport is the World's first airport to fully run on solar power

Forest cover

- Increased from 23.4% in 2005 to 24% in 2013
- An Additional carbon sink of 2.5 to 3 billion tonne of CO2 equivalent, created by 2030
- The long term goal is to bring 33% of geographical area under forest cover

INDCs

- Currently running one of the largest renewable capacity expansion programs in the world
- Will achieve 40% cumulative electric power installed capacity from non-fossil fuel resources by 2030
- Targets to lower the emissions intensity of its GDP by 33% to 35 % by 2030 below 2005 levels

Biomass

- More than 70% of the population depends on it
- Current installed capacity is 4.4 GW
- Aims to increase biomass installed capacity to 10 GW by 2022

Clean coal policies

- Nearly 61% of installed power capacity is coal-based
- All new large coal-based generating stations have been mandated to use the highly efficient supercritical technology

Source. UNFCCC

What Is Electricity?

Electricity

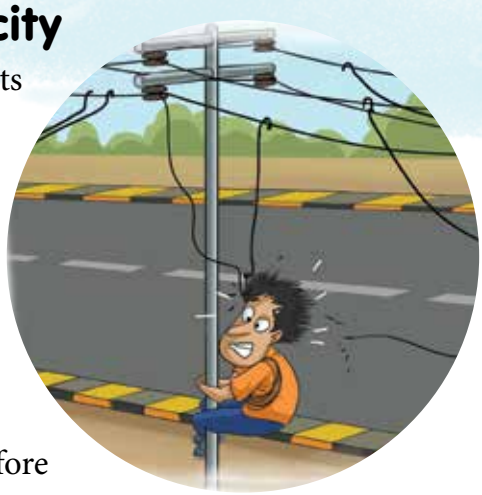
Imagine a world where you couldn't turn on a light, watch TV, play games, or even use the phone! Electricity makes one's home and school warm in the winter and cool in the summer. For your daily routine, one needs electricity. As one cannot live without water, one also cannot live without electricity. Electricity is a type of energy that was discovered over 100 years ago. The common ways of producing electricity is by converting different types of energy sources like coal, natural gas, solar, wind, and water. You may not even realize that electricity is a huge part of your everyday life. Electricity is the flow of electrical power or charge and it is one of the most widely used forms of energy.

How Is it Generated?

The heat energy (generated using energy sources) is used to boil water to produce steam for rotating the shafts of the turbine to produce electricity. Thus heat energy is converted to mechanical energy. This mechanical energy is converted to electrical energy by a generator.

Urja: Did you know electrical energy is measured in kWh (kilowatt hour)? One kWh is the electrical energy used or supplied when one kW of power is used or supplied for one hour.

Measures for Safe Use of Electricity



Electricity is utmost important to us but without its proper use, it can be equally dangerous to us.

Here are a few tips for keep you safe by using it properly:

- Don't play with any power sockets or push things into them.
- Don't keep electric cords very mismatched.
- Never climb the wall around an electrical substation.
- Always look up and look out for power lines before you climb a tree.
- Ask your parents to watch out for power lines when they're using a ladder, chainsaw or other outdoor equipment.
- Always keep electrical stuff far away from water.
- Always ask a grown-up for help when you need to use something that uses electricity.

Energy Use in Various Sectors

We use a great deal of energy in our daily lives. At home, in school, in shopping malls – everywhere! Our energy use can be broadly categorized into five sections — residential, commercial, transport, agriculture, and industrial.

Residential

We cannot imagine our lives without electricity. There isn't any activity that we can think of that can be done comfortably in the absence of electricity. Lighting, heating, cooling, entertainment are some activities that are energy dependent. Energy is even used in the form of coal or kerosene to prepare food in few of the households.

Let's Get Active

- List three appliances that you have in your house. Note their start time and stop time to calculate their usage . Here's how you can calculate energy usage: Consumption in a day = [(Capacity (Watt) X Number of operating hours (hr) in a day of the appliance)/1000] (kWhr). Prepare a chart and keep a tab on your expenses.

Commercial

Commercial sector includes shopping complexes, offices, hospitals, hotels, etc. Can you think of the equipment that is used in all these places along with the usual lighting, heating, and cooling requirements? The use of energy in commercial buildings is varied depending on its type. For example, energy use in a hospital would significantly vary from that of a warehouse and vice-versa. Largely most of the commercial building use energy for lighting and power to the appliances.

Let's Get Active

- Count the number of lights and fans in your classroom and estimate the total number in your school. Brainstorm with your teacher to prepare a plan to find ways to reduce the number of lights or fans.

Transport

Petroleum is used as the main source of fuel for transportation. This is one major contributor in the amount of greenhouse gases that is produced worldwide.

Let's Get Active

- Make a list of the different types of fuels used for transportation. Now that you know about renewable and non-renewable sources of energy, find alternative measures to combat GHG emissions during transportation.

Agriculture

This sector is a major consumer of commercial energy. Electricity and diesel are the two forms in which energy is consumed. The dependency of agricultural sector on crude oil and traditional form of electricity reduces the profitability of the farmer due to the increased cost of production in agriculture. Therefore, there is a need to assess energy trends in the agricultural sector.

Let's Get Active

- Request your teacher for a field trip to the nearest agricultural area. Interact with farmers and try to understand energy usage in agricultural sector. Remember there can be direct usage (like for irrigation, sowing) and indirect (like for production of fertilizers). Write a short report in your notebook on your experience as shared by the individual.

Industrial

Electricity and fossil fuels are the two main forms in which energy is consumed in the industrial sector. Generally, most of the industries use energy in some form or the other but there are some energy intensive industries that use the bulk of energy used in Industrial sector. For example, energy consumption in chemical industries is extremely high during the refining process. Similarly paper industry too has massive consumption of energy in most of its stages.

Let's Get Active

- Name some big industries and their products. Do you think there can be an alternative to their products that can be manufactured with less energy making them environment friendly? Share your observations with your class.

Energy Conservation and Its Efficient Use

People use energy for transportation, cooking, heating and cooling rooms, manufacturing, and so on. The choices people make about how they use energy—turning machines off when not in use or choosing to buy fuel-efficient vehicles and energy-efficient appliances—affects the environment and everyone's lives.

Efficiency and conservation are different but related.

The terms energy efficiency and energy conservation have distinct meanings: Energy efficiency is using technology that requires less energy to perform the same function. Using a light-emitting diode (LED) light bulb or a compact fluorescent light (CFL) bulb that requires less energy than an incandescent light bulb to produce the same amount of light is an example of energy efficiency.

Energy conservation is any behaviour that results in the use of less energy. Turning the lights off when leaving the room, and using daylight are both ways of conserving energy.

Virtually everyone benefits when individuals, companies, and entire communities reduce the amount of energy they use. The benefits come in the form of lowered utility bills, protection against rising energy costs, and decreased demand for construction of new energy projects. The latter can, in turn, translate into a cleaner environment and address climate change concerns if the construction of additional conventional fossil-fuelled power plants and additional mineral extraction (e.g., oil and gas drilling, coal mining) are avoided.

In general terms, energy efficiency is achieved through the application of technology, such as insulation upgrades, compact fluorescent bulbs / light-emitting diodes (CFLs /LEDs), high efficiency furnaces, and so forth. Energy conservation is achieved through behavioural changes, such as turning off lights when not needed, using household appliances differently, carpooling, and so forth.

Energy Conservation Measures

From putting a lid on a saucepan to buying an electric car, here's a list of ways to cut back your energy use, lower your bills and reduce your carbon emissions. Here are a few ways to conserve energy in our everyday lives:

In the kitchen

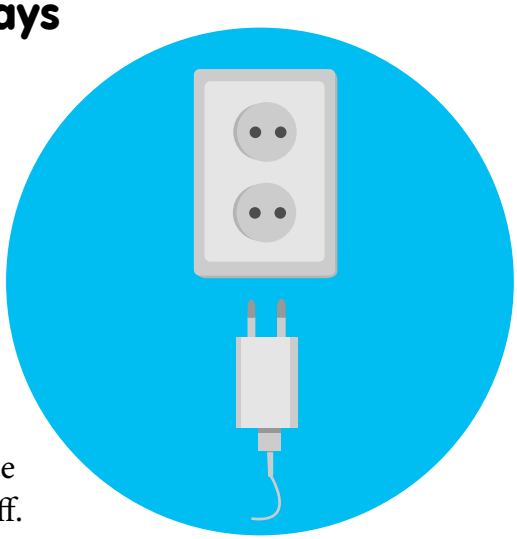
- If you're boiling water, use a kettle or put a lid on the saucepan; the water will come to the boil sooner and use less energy.
- And if you're boiling an egg, turn the heat off early and let the egg finish cooking in the residual heat.
- Don't place your fridge or freezer near a heat source (such as your cooker) or in direct sunlight.
- Don't let your fridge use too much energy by keeping it colder than it needs to be.
- Defrost your fridge and freezer regularly. The more ice builds up, the harder they have to work and the more energy they use. Even if they're supposed to defrost automatically, keep an eye on them to make sure the automatic function is still working.

How Does Housework Help to Conserve Energy?

Dirt and dust can clog appliances and devices so they don't work as well as they should. A clean home is an energy-efficient one – so find out here how to conserve energy with housework.

- Dust your light bulbs. The dust reduces their intensity, which could encourage you to buy higher-wattage bulbs than you actually need, or, if you've got dimmer switches, to keep the lights brighter than necessary.
- Three or four times a year, pull your fridge away from the wall and give the coils a good cleaning. Once again, leaving an accumulation of dust and grime means the fridge motor has to work harder.
- Clean filters! In appliances such as washing machines clean the filters to prevent any clogging and breaking down.
- An outdoor clothes line is the most energy-saving way to dry clothes – and a great example of how to conserve energy resources.

To Conserve Energy, Should I Always Switch Everything Off?



Wasting energy means you're also wasting money. If you want to know an easy way to save energy, just get into the habit of switching off any electrical appliances that aren't in use.

- Don't leave electrical devices on standby.
- Turn off the lights as you leave a room, unless you're coming straight back.
- If you've got ventilation fans in your kitchen or bathroom, don't leave them on for too long. Once they've cleared any condensation, switch them off.
- If you're not going to be using your computer for a while, switch it off rather than leaving it in screensaver mode.
- Take chargers out of the wall socket. Never leave them switched on, whether

they're for your mobile, your computer or laptop. They use power even when the device isn't charging.

Urja: You do agree with me that you spend a major part of your day in school? So why don't we look into some energy saving tips in schools and also while you travel:

Energy Conservation in Schools

- Switch off fans and lights when not required.
- Switch off all gadgets in the laboratory, once the experiments have been performed.
- Do not leave computers and other electrical equipment's in the stand-by mode.
- Close water taps properly and get them repaired if they are leaking.
- Install energy-efficient lighting systems, such as CFLs, LEDs.
- Educate students and staff about how their activities affect energy use.
- Utilize more natural light in classrooms.
- Windows should be large enough to allow free flow of air circulation. Window coverings and blinds should be adjusted to receive maximum direct sunlight.
- Conduct an energy audit to determine where energy can be saved.
- Make sure that office equipment and computers are turned off at the end of the day.

While on the Move

- Switch off the car engine at red lights.
- Avoid stop-start kind of driving as it consumes more energy than driving at a constant speed.
- Keep your vehicles well-tuned.
- Use public transport when and where possible.
- Carpool if travelling to the same destination on a regular basis.

Let's Get Quizzical!

1. Energy can be in the form of _____
   a) Chemical, electrical, thermal, radiant, mechanical, and nuclear energy
   b) Sun, moon, and stars
   c) Refrigerators, cars, bicycles, and scooters
   d) Natural and manmade

2. What is the BEE rating of all energy saving appliances known as?
   a) Appliance rating
   b) Energy saving
   c) Star rating
   d) None of the above

3. Energy efficiency means:
   a) Using less energy to provide the same service
   b) Saving enough energy for future use
   c) Not using energy at all
   d) None of the above

4. Which of the below-mentioned options would you consider most energy efficient?
   a) Incandescent bulbs
   b) CFLs
   c) Halogens
   d) LEDs

5. Which of these statements is correct?
   a) The heavier the object the lesser is its potential energy.
   b) The heavier the object, more is its potential energy and the higher an object, it has more potential energy.
   c) The higher the object, the more is its potential energy.
   d) The lighter the object, the more is its potential energy.

6. What is the primary source of primary energy?
   a) Neptune
   b) Pluto
   c) Mars
   d) Sun

7. What is cogeneration?
   a) Cogeneration is the process of extracting petroleum.
   b) Cogeneration is the method of generating light and heat at the same time.
   c) Cogeneration is the method of producing thermal and electrical energy at the same time.
   d) Cogeneration is the process of converting chemical energy to thermal energy.

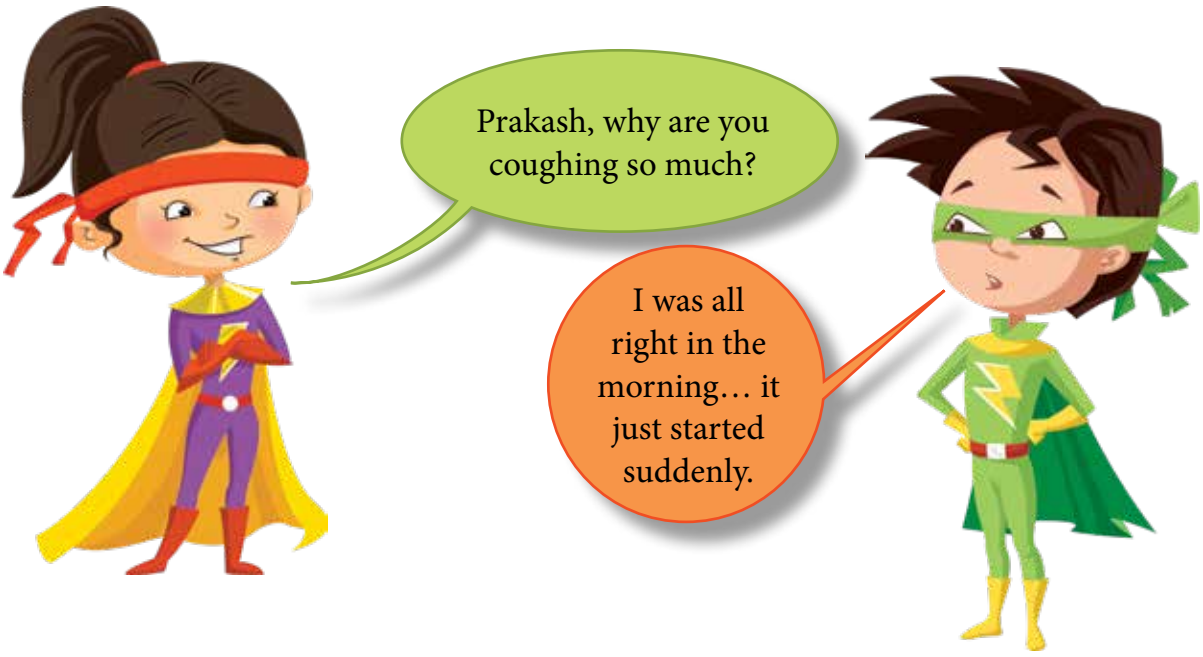
8. The full form of INDC is ___
   a) Intended Nationally Determined Contributions
   b) Internationally Determined Contributions
   c) Intended Nationally Determined Coalition
   d) International Disaster Control

9. Energy sectors can be broadly categorized into _____
   a) Residential and industrial
   b) Commercial and residential
   c) Residential, commercial, transport, agriculture, and industrial
   d) Transport and agriculture

10. All machines run on some form of energy – Choose the correct option.
   a) False
   b) True

Answers: 1. a, 2. c, 3. b, 4. d, 5. b, 6. d, 7. c, 8. a, 9. c, 10.b

Pollution Is Killing Us



Urja: Not your fault that Delhi is so polluted! It seems your coughing spree has been caused by the city's heavily polluted air.
Prakash: You think so? I'd love it if you tell me a little more about it.
Urja: Well, first things first! You already know that pollution occurs when something that doesn't naturally belong in an ecosystem is forcibly introduced into it. And any foreign substance introduced into the environment that causes pollution is called a pollutant. But it didn't happen overnight. Let's take a short walk back into history to know when it started.

When Did It All Begin?

Pollution has been a part of our lives since a long time. Soot samples in prehistoric caves showed that even the earliest of humans cooked food on unventilated fires which caused the soot to deposit in the caves. But things changed with the advent of the Industrial Revolution which triggered large-scale industrialization. Factories and mills began to dot the European landscape, beginning with the large towns of England. Britain's East India Company began to

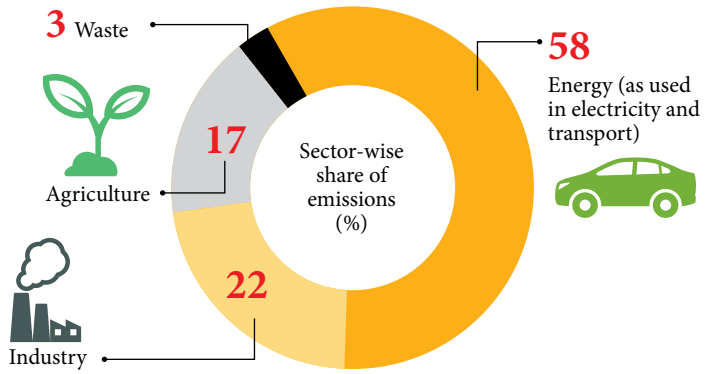
import large quantities of raw cotton from its colonies such as India, which was processed by manufacturing plants back in the country to make textiles. To run the machines and engines installed in these plants, fossil fuels such as coal, oil, and natural gas were used. Soon enough, large mining towns and industrial townships cropped up, and people poured into them to find work. This trend spread to the rest of the world and continues even to this day.

Urbanization

People move from rural areas to urban areas where industries are, because that is where jobs are. This leads to large-scale urbanization, which means more and more areas are cleared to make way for the development of roads, houses, and other infrastructure. But urbanization comes with its own set of problems. Massive amounts of natural resources (food, water, energy, and the environment) are used for building industries, providing transportation services, and for other consumption purposes. And the more resources people consume, the more waste and pollution they generate. Burning of fossil fuels and waste dumped in landfills emit toxic fumes and harmful GHGs such as carbon dioxide, methane, nitrous oxide, and others. As the global population continues to swell, a high rate of consumption causes the atmospheric GHGs to rise. This is a major cause of atmospheric pollution, which triggers climate change.

The Biggest Culprit

The energy sector is by far the greatest contributor to GHG emissions from human activity. Much of the energy needed to run vehicles and to generate electricity for industries and households comes from fossil fuels. According to the latest government data, India's energy sector is the biggest emitter of the country's overall GHG emissions (58%).



According to the medical journal *Lancet*, India topped the list of countries with the most pollution-related deaths in 2015!

Industrial Pollution

'Let's begin with industrial pollution.'

Any form of pollution that is caused by industrial practices is called industrial pollution. Its roots can be traced back to the eighteenth century when the Industrial Revolution kick-started in Europe. By the nineteenth century, industrialization had begun to spread to the rest of the world. Large-scale industrialization triggered several pollution problems. The harmful by-products and waste generated by factories or manufacturing plants are a major source of air, water, and land pollution.

Prakash: Hmm…so what kinds of industries cause pollution?

Urja: Well, power-generating plants, mining and metallurgical industries, processing industries, manufacturing units—you name it. Let's find out about the kinds of wastes produced by different industries and the types of pollution they cause.

Industry	Wastes produced	Type of pollution
Caustic soda	Mercury and chlorine gas	Air, water, and land
Cement	Particulate matter, sulfur dioxide, and nitrogen dioxide	Air
Distillery	Organic waste	Land and water

Industry	Wastes produced	Type of pollution
Fertilizer	Ammonia, cyanide, oxides of nitrogen, and oxides of sulphur	Air and water
Dye	Inorganic waste pigment	Land and water
Iron and steel	Smoke, gases, coal dust, fly ash, and fluorine	Air, water, and land
Pesticide	Organic and inorganic waste	Water and land
Oil refineries	Smoke, toxic gases, and organic waste	Air and water
Paper and pulp	Smoke and organic waste	Air and water
Sugar mills	Organic waste and molasses	Land and water
Textiles	Smoke and particulate matter	Land and water
Tanneries	Organic waste	Water
Thermal power	Fly ash and sulfur dioxide gas	Air and water
Nuclear power stations	Radioactive wastes	Water and land
Food processing	Alkalies, phenols chromates, and organic wastes	Water and land

Source: http://www.environmentalpollution.in/

Delhi's Polluting Industries

According to a recent report in the *Times of India*, around 70,000 to 100,000 small industries are operating in the residential/unauthorized areas of Delhi where industrial activity is not allowed. They add to the city's air pollution. In 1996, Delhi had banned the use of two highly polluting industrial fuels: furnace oil and petroleum coke. But paper mills, cement factories, brick kilns, and dyeing units located in the neighbouring areas of Delhi continue to use these fuels. Bhiwadi and Ghaziabad stand out for being serial offenders. However, all these industrial units have now been directed to either install pollution control technologies or switch to piped natural gas (PNG), which is a cleaner fuel.

What's the Cause?

The famous India Gate covered in a thick blanket of smog in November 2017

- Use of old technologies to produce high-end products that generate large amounts of waste. This is usually done to avoid high production costs involved in using new technologies.
- The enforcement of government policies to control pollution continues to be a major challenge. Many industries that cause large-scale pollution tend to bypass these regulations.
- India is the world's second-largest coal burner. Coal-fired power plants burn huge amounts of coal to generate electricity, a process during which GHGs are emitted into the atmosphere on a large scale. They generate massive amounts of particulate matter, ash, and the toxic sulfur dioxide gas. This deadly mix pollutes the air.

Particulate matter (PM) is a mixture of very fine air particles, including dust, dirt, smoke, and liquid droplets. When inhaled, this **major air pollutant** can travel deep into the lungs and cause breathing troubles.

- Large tracks of land are cleared to carry out mineral extraction and mining activities. Of the extracted ore, only a small part is valuable while the remaining is waste. The wastes generated during mining activities pollute land and the air. The contaminated byproducts of minerals stay in the soil surface for a long time, making it unfit for use.
- The industrial noise from construction sites, heavy machinery, large exhaust fans in factories, and equipment like drill machines causes a lot of noise pollution.
- Industries such as textile, paper, pulp and sugar manufacturing discharge huge amounts of cooling water and wastes into the nearby waterbodies. This organic load not only pollutes the water but also kills aquatic organisms.

Japan's Minamata Disaster

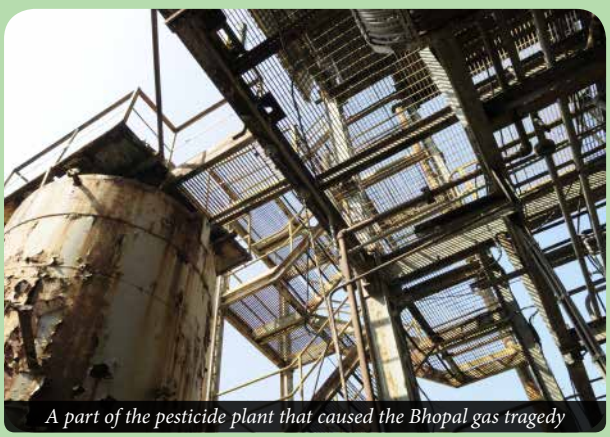
The year was 1956. Jitsuko Tanaka, then three years old, used to play on the beach with her older sister in the Japanese city of Minamata. One day, all of a sudden, both sisters found that they couldn't move their hands freely or walk properly. Three years later, Tanaka's sister died. They were the unfortunate victims of mercury poisoning in the Minamata Bay. The mercury was part of the wastewater

released into the bay by a nearby chemical factory. It contaminated the fish living in the bay, which in turn contaminated those who ate the fish. Over time, the Minamata disease that attacked the central nervous system of humans killed thousands of people. Those who survived continue to live with serious disabilities. The poisoning also killed local birds and domestic animals.

What Can Be Done?

- Planting trees make the ecosystem more stable because they absorb carbon dioxide. Plant trees in your residential area and water them regularly.
- Fight the 'energy vampires' such as microwaves, electric heaters, incandescent lamps, immersion rods, and other non-BEE star appliances. The more we save, the less we need to produce, and thus we reduce GHG emissions. So promote the efficient use of energy at the individual and household levels.
- Form small committees of pollution warriors with your friends. Encourage people in your locality to reuse, reduce, and recycle all industrial products.

Bhopal Gas Tragedy: A Case Study



A part of the pesticide plant that caused the Bhopal gas tragedy

The day was 3 December 1984. A little after midnight, a highly toxic gas called methyl isocyanate (MIC), leaked from the Union Carbide pesticide plant in Bhopal, the capital of Madhya Pradesh. By morning, the gas had floated to the rest of the city on the wings of the cool morning breeze. The city woke up to a chilling scene—people vomiting, struggling to breathe, their faces and eyes burning. Within a few hours, 3000 people had died due to inhaling the gas. This disaster is one of the biggest industrial accidents in history.

What Happened?

On the night of the accident, the water used for cleaning internal pipes found its way into a tank containing 42 tonnes of liquid MIC. This mixture produced massive volumes of gases, which put enormous pressure on the tank. As the pressure continued to rise, the tank cover gave way and, soon enough, the deadly gaseous mixture began to cloud Bhopal's streets.

The Tragedy Continues ...

As the years rolled by, the death toll reached 15,000. Not only humans, but around 2000 animals were also killed by the disaster. Women exposed to the gas gave birth to physically and mentally disabled children. Even today the accident site and the surrounding area are contaminated, because thousands of tonnes of hazardous wastes are still buried underground. It has also polluted the city's groundwater. Toxic wastes at the accident site have contaminated the affected area's soil.

Let's Get Active

- Divide the students into three groups: Group A (the government), Group B (scientists), and Group C (common people).

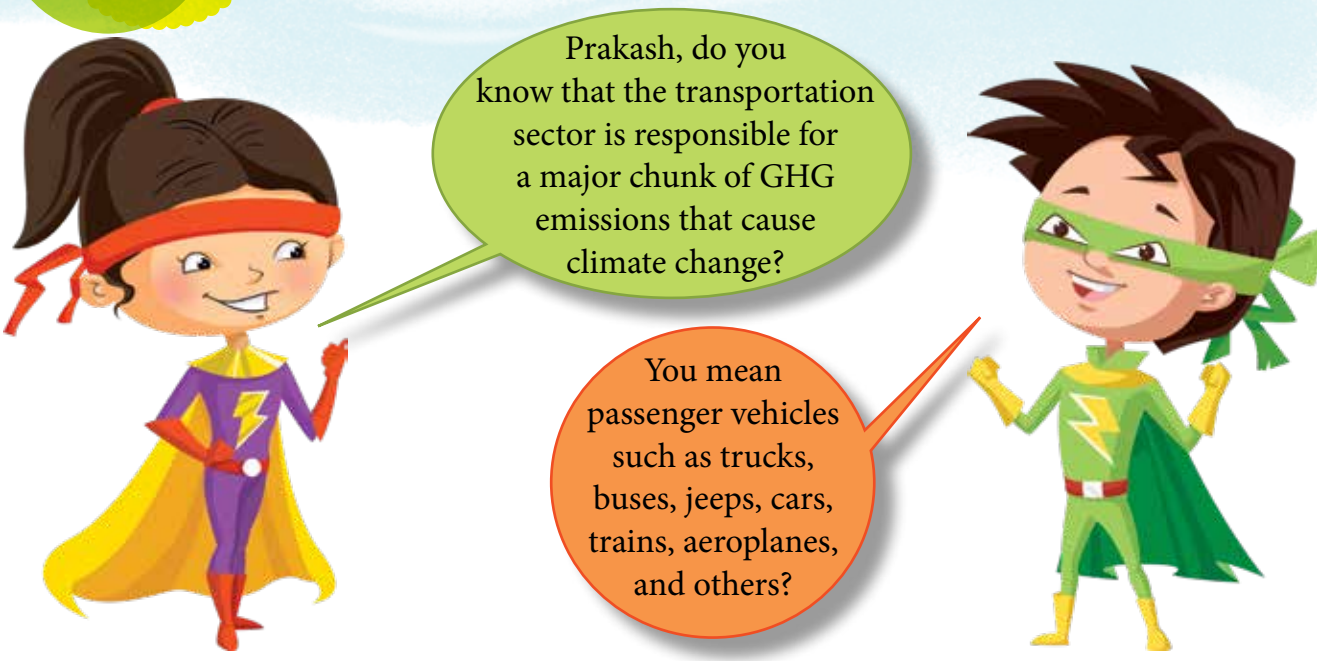
Group A	Group B	Group C
will discuss the lack of effective policies to control pollution and how flouting of the existing pollution laws leads to unplanned industrial growth.	will discuss how outdated technologies can be replaced with new ones and how the use of fossil fuels can be reduced. (Remember what you earlier read about renewable sources being environment-friendly?)	will discuss the nuisance caused by unplanned waste disposal and leaching of resources. This group will discuss how citizen participation can help reduce the impact of industrial pollution.

Share your learning with other groups and present to your principal during assembly.

- Running factories/industrial units in residential areas is against the law. Find out if there is any factory or industrial plant located near your house. It can be a cause of air, water, and noise pollution. Seek your parents' help to inform the police or the Resident Welfare Association (RWA) if there is a breach of law.

Of the world's twenty most polluted cities, thirteen are in India. Kanpur, Faridabad, Varanasi, Gaya, Patna, and Delhi are some of them.

Transport Pollution



Urja: Indeed! Toxic emissions from passenger vehicles cause a lot of air pollution. In fact, as per the Environmental Protection Agency (EPA), US, transportation alone accounts for about 14 per cent of the global carbon dioxide generated by humans.
Prakash: But how?
Urja: These vehicles are powered by internal combustion engines that burn petroleum or other fossil fuels. The combustion of fossil fuels emits noxious fumes that cause acid rain, smog, chronic lung problems, and also destroy the environment.
Prakash: But vehicles help us to move around—go to school, on vacations, and to the market! We can't do without them, can we?
Urja: Good point! So let me show you both sides of the coin.

The Beginning

Apart from helping people move from one place to another, transportation provides many economic gains. Around 78 years ago, when India was ruled by the British, salt was produced only at a few locations in the country. From there, it was transported to other parts of the country through vehicles that plied on the road. Soon enough, the British built railway networks in India. Railways connected the remote corners of India with the rest of the country and the world at large. This expanded trade, and reduced the cost of trading by providing access to low-cost routes. Besides, connectivity also boosted demand.

Growing Cost for the Environment

Prakash: This sounds great! Now we even have aeroplanes! But when did it really begin to go wrong?

Urja: Well, the growth of mobility and trade comes at a huge cost to the environment and human health. Vehicles are a major cause of pollution, which is linked to changes in global climate. Let's know more about their impact.

Direct impact	Indirect impact	Collective impact
Honking vehicles create noise pollution and vehicular lights are particularly responsible for causing light pollution after sundown.	Long-term exposure to loud noise leads to hearing loss and increases anxiety levels.	GHG emissions by passenger vehicles contribute to global warming/rising temperatures in a big way.
They emit carbon monoxide, nitrogen dioxide, and PM which pollute the air we breathe.	Particulates released by vehicles can cause breathing problems and heart diseases.	Soot/black carbon—produced by incomplete combustion of fossil fuels—is the second biggest source of global warming and is also linked to extreme weather events.
Fuel, chemicals, and hazardous wastes from passenger vehicles pollute rivers, lakes, wetlands, and oceans.	Water pollution caused by vehicles not only contaminates drinking water but also harms marine life.	Extinction of species and loss of habitat
Growth of transportation networks leads to clearing of farmlands and natural habitats. This changes the landscape and causes visual pollution.	Clearing of land to build transportation networks damages biodiversity and leads to the loss of wildlife.	Ecological imbalance
Fuels and oil spills from motor vehicle enter the soil and contaminate it.	Direct/indirect contact with polluted soil is dangerous to human health and can even cause cancer.	Loss of life and species

Delhi's Polluting Vehicles

Delhi, the world's most polluted city, has been compared to a 'gas chamber'. In the past few decades, Delhi's roads have seen a huge growth of vehicles. In fact, the state has more vehicles running on its roads than all the other metropolitan cities put together! They are a major source of air pollution. Government studies suggest that among the vehicles, trucks cause the maximum pollution, followed by two-wheelers and passenger cars. The other air pollutants are ash and smoke from power plants, dust from roads and fields around the city, and smoke from coal-based ovens.

Odd–Even Scheme: A Case Study

The Odd–Even scheme was first tried in the Chinese capital, Beijing, to control air pollution. It proved to be so effective that the Chinese government made it permanent. Delhi has been implementing it since 2015 (twice a year for 15 days) for brief periods every year. According to this scheme, private vehicles in the city will be allowed to run on alternate days on the basis of their registration numbers. For example, if the registration number ends with an odd digit, it will be allowed to run only on odd days. Similarly, registration numbers ending with even digits will run on even days. Trucks are also banned from entering the city before 10.30 pm and travel in state-run buses is free when the Odd–Even rule is operational.

Does It Work?

Government and independent studies show that unless other air pollutants in Delhi are controlled, this scheme will not achieve much. In fact, vehicles are the top polluter only in terms of emitting 'carbon monoxide', which is a single component

of polluted air. The others are sulfur oxide, PM, lead, nitrogen oxide, and ozone. Winter pollution in Delhi is caused mostly by power plants, refineries, and burning of crop stubble in the neighbouring Punjab and Haryana. Little wonder, then, that air pollution in the city spiked by 23 per cent during the second phase of the Odd–Even rule in 2017!

Urja: Prakash, do you know that petrol and diesel vehicles have been banned within 500 metres of the Taj Mahal in Agra? It was done because the white marble of the iconic monument was turning yellow due to air pollution.
Prakash: Really?! I will go to the library to find out more about this.

What Can Be Done?

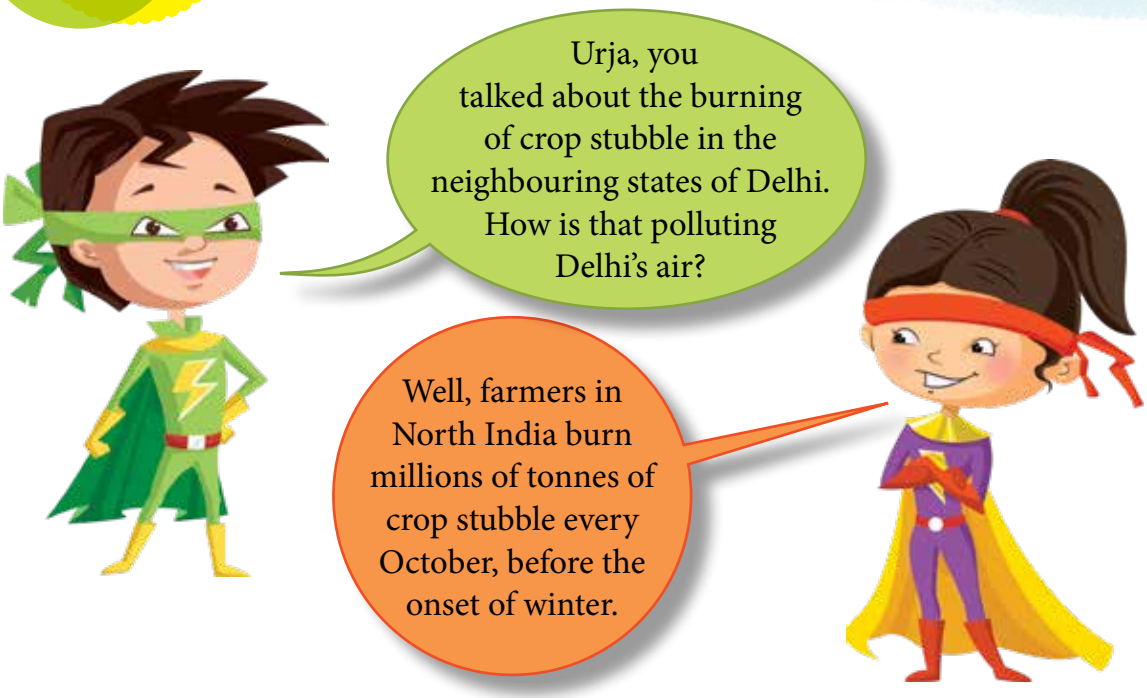
- Make greener choices. Use public transport more often, walk more, and carpool.
- In some parts of Delhi, battery-driven vehicles have been introduced for short distances. Use them whenever possible as they cause less pollution.
- Timely and proper servicing of automobiles not only limits harmful emissions but also improves fuel efficiency. Request your parents/ relatives to get their cars and two-wheelers serviced at regular intervals.

Ever noticed that some days there is a thick cloud of smog hanging over the city and the visibility is quite low? Smog—a mixture of smoke and fog—is the most familiar form of air pollution.

Let's Get Active

Urja: Prakash, time for some role play! Suppose you are an environmentalist who is trying to convince me to carpool instead of driving my car to office every day. Give me a few reasons that make me think about carpooling seriously. Why should I be worried about saving the planet? Also sketch a carpool sticker.

Agricultural Pollution



Urja: Last year, I read in *Hindustan Times* that an estimated 35 million tonnes are burnt in Punjab and Haryana alone to clear the fields for sowing the winter crop? This, along with other urban factors, triggers the heavy winter pollution in Delhi–NCR.
Prakash: Hmm … so even farming activities cause pollution?
Urja: Yes, it's called agricultural pollution, and it has been triggered by the ever-growing demand for food. But there are more ways in which agricultural activities cause pollution. Let's take a look at all of them.

What's the Cause?

Direct	Indirect
Agriculture is primarily an energy-intensive activity. A vast majority of water pumping for irrigation is done with the help of diesel or electric motors. Not only do electric pumps consume a lot of electricity, but they also pollute the air. Even diesel-based pumps eat up a lot of fuel besides polluting the environment.	Agricultural farms discharge large quantities of agrochemicals, organic matter, drug residues, and sediments into waterbodies. During heavy rainfall, traces of fertilizers and pesticides wash away into the nearest waterbodies and pollute them.
The process of tilling the land to prepare it for sowing the crop is a major energy guzzler. Tractors and other mechanized equipment used for tilling and harvesting are mostly powered by energy derived from fossil fuels. This causes air pollution. Overtilling leads to the release of GHGs from the soil besides causing soil erosion.	Commonly used pesticides—DDT, BHC, endrin, aldrin, dieldrin, and lindane—are absorbed by plants, and when plants decompose, they pollute the soil by becoming part of the earth and change its composition.
Cheap nitrogen fertilizers used in farms are made from ammonia, which in turn is made from natural gas. This process involves high production and environmental costs. The fertilizer-making process releases GHGs into the atmosphere and pollutes the air.	Nitrogen fertilizers used to increase crop yield get mixed with water and leach into the ground, which reduces soil fertility and pollutes groundwater. Drinking this polluted water has been especially linked with the Blue Baby Syndrome in infants.
Farm animals—cattle, goats, sheep, pigs, and chickens—are believed to account for 18 per cent of the global GHG emissions. Of this, 44 per cent emissions are in the form of methane. Improper disposal of animal manure and the associated waste continues to be a major source of environmental pollution.	Sometimes farmers introduce foreign species of plants and animals in their farms to control pests and weeds. This process is known as biological pest control. Over time, these foreign species start competing with the local plants and animals for natural resources. This leads to drastic changes in biodiversity.
Heavy metals (mercury, lead, arsenic) and radioactive minerals (uranium) are found in fertilizers obtained from metal-rich waste produced by steel industries.	These metals get mixed with the soil due to the repeated use of such fertilizers.

The presence of nitrates in drinking water is a major cause of the **Blue Baby Syndrome**, characterized by the blood's reduced ability to carry oxygen around the body. The disease mostly targets infants who may otherwise seem healthy but for blueness around the mouth, hands, and feet. Breathing troubles, vomiting, and diarrohea are some other symptoms of this syndrome. At its worst, the disease can cause death.

Nutrient Overload: A Killer of Aquatic Life

Fertilizer runoff from farms adds excess nitrogen and phosphorus into waterbodies, causing a nutrient overload. This leads to an abnormal growth of water plants and algae, known as algae bloom. This process is called eutrophication. These algae use up most of the water's oxygen, leaving very little for other aquatic life forms to survive on. Algae blooms also prevent sunlight from penetrating the water and thus affect photosynthesis in plants. As a result, plants are unable to restore the oxygen levels in water.

Low-oxygen levels cause major changes in marine ecosystems by killing fish, oysters, crabs, and other aquatic animals. Eutrophication can also produce carbon dioxide, which increases the acid levels of ocean water and slows down the growth of fish and shellfish in coastal ecosystems. Additionally, eutrophication produces bad tastes and odours. All waterbodies go through a slow-but-natural process of eutrophication, but human activities have speeded up this process in the last few decades.

What Can Be Done?

- Do not overuse pesticides and fertilizers in your gardens and farms. This will reduce chemical runoff into nearby waterbodies.
- Using the right quantity of fertilizers at the right time can reduce runoff.
- Eat locally grown food: this reduces the food miles (transportation cost of moving food items to the local markets), which means less dependence on fossil fuels and less GHGs.
- Never waste food because the transportation of food from fields to processing units and then to your local market eats up a lot of fuel.
- Avoid eating processed food and junk food. They are not only unhealthy but also costly to the environment.
- Over-cropping and overgrazing should be prevented so that soil quality could be maintained.
- The Indian government has recently unveiled a policy to solarize all agricultural pumps in the country. The farmer will have to bear only 10 per cent of this cost. Apart from this, all the grid-connected pumps will be linked with solar power.

Let's Get Active

Prakash: Friends, let's form different groups and visit the nearby farms to interact with our farmers. During the interaction, we will try to understand the water needs of different crops and the difference between rain-fed crops and those dependent on irrigation.

The global pesticide market is worth more than a whooping USD 35 billion. Now just imagine the amount of agricultural pollution that can be reduced if pesticides are replaced with organic manure!

Residential and Commercial Pollution

Urja: When you use public transport, traditional bulbs, and plastic bags; drink bottled water or other packaged drinks; and eat foods that are not grown locally, you—directly or indirectly—generate carbon dioxide. The amount of carbon dioxide produced by all your activities is your carbon footprint.
Prakash: I did have some idea that my activities harm the environment, but I didn't know that most of what I do increases my carbon footprint!
Urja: Not only that, the lighting, heating, and cooling at our homes contribute to everyday pollution, known as residential pollution. And even the malls and shopping complexes we so love to visit also a source of commercial pollution.
Prakash: Urja, do you mean that I contribute to pollution even when I visit a mall? How does that happen?
Urja: The things we use and the way we use them go a long way in causing residential and commercial pollution. Let's take look at all of them.

What's the Cause?

- Heating systems (portable kerosene cookers and heaters) or cooling systems (air conditioners and coolers) used at homes or commercial complexes such as offices, shopping malls, and hotels release PM, carbon dioxide, and black carbon into the indoors and outdoors.

Is My Air Conditioner Warming the Planet?

'Super GHGs' called hydrofluorocarbons (HFCs) are produced during the making of air conditioners (also refrigerators). They are thousands of times more powerful than carbon dioxide. But the good news is that air conditioners don't release any HFCs when in use, unless there is a gas leak or improper disposal of the air-conditioning unit. New HFC-free technologies are being developed, which will make the next generation of air conditioners more energy-efficient and pollution-free. But it will take many decades to phase out the existing HFCs.

- Last year, the number of registered vehicles in Delhi crossed the one-crore mark! Vehicles pollute the air during their manufacturing, operation, refuelling, and disposal. Car lights cause light pollution at night and honking is a leading cause of noise pollution. So remember: every time you drive to a mall with your parents, you are adding to the atmospheric pollution.
- Human sewage and animal manure pollute the soil by changing its chemical composition.
- Household or commercial e-waste, such as discarded mobile phones, TVs, scanners, and computers, is usually recycled. When it is dismantled and shredded before recycling, dust and large particulates escape into the environment. Low-value e-waste is often burnt, which releases toxins known as dioxins into the air.
- Improper disposal of solid waste and construction waste (a lot of which can't be recycled) pollute the soil by preventing proper drainage and increasing surface runoff. Chemical wastes from residential areas and leaking sewerage systems also pollute water systems.
- For a moment, just think of the electricity used to light commercial centres such as restaurants, discos, pubs, games, and malls. And now just think of the coal needed to generate this electricity. Rings a bell? If not, revisit the chapter on industrial pollution and read about coal-fired power plants. Most of the electricity is still produced by using non-renewable sources which cause a lot of pollution.

- Noise from kitchen mixers, vacuum cleaners, air conditioners, televisions, and music systems cause sound pollution. Even pet dogs barking at every shadow disturb others, especially at night.

The Deadly Chulha

Several households in rural India still use small earthen or brick stoves, known as chulhas, for cooking food. These stoves are fuelled by firewood and twigs. Incomplete combustion, whether in diesel cars or chulhas, produces PM, soot, and aerosols (tiny particles that absorb light and convert it into heat). Aerosols affect cloud formation and force changes in the rain pattern. When they fall on surfaces covered with snow, they make the ice melt faster. According to recent studies, the use of chulhas is the deadliest source of air pollution in India, responsible for around 25 per cent pollution-related deaths in the country.

In 2016, the Indian government launched the Ujjwala Yojana to provide free LPG (a non-polluting fuel) connections to poor people. According to multiple news reports, as of May 2018, 37 million people have benefitted from the scheme.

- Landscape lights used to beautify gardens and those used to highlight the architecture disturbs people and causes light pollution.
- Fertilizers, insecticides, and weed killers used in private gardens and public parks lead to chemical runoff into the nearby waterbodies. This pollutes drinking water and causes diseases like dysentery, hepatitis, and other parasite infections.
- Soaps and detergents used for laundry and car wash contain chemicals, such as phosphorous, which travel into the water systems through our drains, making the water unfit for use.
- Medical waste from homes also causes pollution if not discarded properly.

Choking Yamuna to Death

Delhi's Yamuna River is a tributary of the holy Ganges. The river whose water was described as 'better than nectar' by the first Mughal emperor Babur is today practically 'dead'. It has been killed by the city's residential and commercial

pollution. Large-scale migration to Delhi in search of jobs has put immense pressure on the Yamuna, which is the only source of water for more than 60 million Indians. Toxic chemicals from industries and sewage from more than 20 drains flow into the Yamuna every day. Today its streams are clogged with rubbish and can't feed in rainwater anymore.

In 2016, the Art of Living Foundation hosted a three-day cultural festival on the banks of the Yamuna. According to the National Green Tribunal (NGT), it polluted and damaged the Yamuna floodplains to the extent that it would now take Rs 42 crore and ten years to fix it. The floodplains lost almost 'all its natural vegetation', including tall grasses and water plants that provide shelter to several animals and insects. The NGT also slapped a fine of Rs 5 crore on the foundation. However, the matter is being debated in courts.

What Can Be Done?

- Turn off the lights when you leave a room. Switch off the TV or radio after you are done watching them.
- Say no to plastic bags at shops and malls. Always carry your own cloth bag to the market.
- Use natural products like compost instead of fertilizers in your gardens. Avoid over-watering and over-fertilizing your garden patch.
- When you have to throw away something, look for the nearest dustbin. Try to hold onto the trash until you find a dustbin.
- Instead of buying new books, try to borrow books from your friends or seniors. If possible, seek the membership of a public library.
- Tell those who drive in your family to not rest their foot on the clutch pedal while driving. If the clutch is not engaged for more than a minute, restart your vehicle to save fuel. Avoid congested roads and avoid driving during peak traffic hours. Replace old car batteries with new ones.
- Reduce the use of water and ask your parents to buy phosphate-free soaps and detergents.

- Discard toilet tissues, dust cloths, and other paper litter in a wastebasket instead of your toilet. Avoid flushing drugs or medication down the toilet.
- Reuse or recycle everything you can, from paper, plastic, aluminum cans, glass to used water.
- If someone you know uses a chulha, ask them to replace it with LPG gas connections. In fact, experiments are being carried out to design stoves in such a way that they cause less pollution.
- Law does not allow any construction activity in residential areas from 6 pm to 8 am. In case, you are disturbed by the noise of any construction activity around your house during this time, report this to your RWA.
- Donate clothes and furnishings so that they can be reused.
- And last but not the least, learn to appreciate nature and interact with the environment.

Let's Get Active

Urja: Prakash, do you know the difference between needs and wants? A need is something you can't live without such as food, shelter, and clothes. But a want is something you would like to have even though you may not really need it. So let's learn to prioritize our needs over our wants and look for ways to reduce our carbon footprint by making small changes in our life.

Things I will turn off when not in use	Things I will consume less (may include food items)	Things I will reuse/recycle

Dumping Your Waste? Check! Check!

Things required:

- Four waste samples: a piece of paper, a plastic packet, a banana peel, and a piece of aluminium foil
- Four glass jars
- Garden soil
- Paper cards for labelling the jars

Follow these steps:

- Fill each jar about half full with soil. Now take the four waste samples and put each of them in separate jars. Label the jars according to the name of the waste sample they contain.
- Add more soil to the jars so that the waste samples are covered entirely.
- Place all the jars in a warm and sunny place, like a window sill. Sprinkle water on the soil at regular intervals to keep it moist.
- After a week, dig up the waste samples and record the changes you see in each of them. Bury the waste samples back into the soil and remember to keep the soil moist. Dig up the samples every week for a month and record how they look each time. *Remember things that don't decompose quickly harm the environment.*

Observation after	Paper	Plastic	Banana peel	Aluminium foil
First week				
Second week				
Third week				
Fourth week				

Air pollution levels are measured on a numerical scale known as the Air Quality Index (AQI). The AQI scale runs from 0 to 500. In Delhi-NCR, the air quality keeps dipping to 'very poor' (301–400).

Let's Play the Pollution Game

Urja: Prakash, let's play a game. Look at the words inside the box. Think of the type of pollution each of them causes. Now arrange them under the right head. Remember many of the things mentioned in the box cause more than one type of pollution.

factories, street lights, fertilizers, pesticides, oil spill, chulhas, toilet paper, computers, detergents, mining, burning of fossil fuels, passenger vehicles, landscape lights, human sewage, animal manure, rubbish, kitchen leftovers, music systems, heaters, air conditioners

Air Pollution	
Water Pollution	
Soil Pollution	
Noise Pollution	
Light Pollution	

What's My Share?

Urja: 'Prakash, let's do a small exercise to figure out our individual role (direct or indirect) in GHG emissions that lead to pollution.

Activity	Kinds of activities	Impact
Use of electricity	Direct:	Pollution due to fossil fuels used at thermal power plants
	Indirect:	
Transportation	Direct:	Pollution due to combustion of fossil fuels
	Indirect:	
Consumer goods	Direct:	Waste generation and burning of fossil fuels
	Indirect:	
Use of paper and timber products	Direct:	Cutting of trees (deforestation)
	Indirect:	
Gadgets	Direct:	E-waste generation and burning of fossil fuels (to generate electricity used to charge gadgets)
	Indirect:	

Food products	Direct:	More fertilizer input to increase food production translates into more nitrous oxide (N_2O) emissions besides increased pollution from the fertilizer industry as well as the other polluting effects resulting from fertilizer runoff into waterbodies.
	Indirect:	
Handling of waste	Direct:	Transportation of waste leads to burning of fossil fuels and dumping of waste leads to emission of methane and other GHGs in the atmosphere.
	Indirect:	

So What's the Future?

Read ahead to know what the future is! And don't forget to do your own bit by recycling and saving electricity as much as you possibly can.

Renewable Energy

By now you already know about the problems plaguing our planet. With pollution rising to alarming levels, depletion of the ozone layer, and an ever-increasing need for fuel and energy, the picture looks quite grim. Doesn't it?

The future looks grim and scary. Do we not have a solution to these problems?

Urja: Of course, we have. There is a famous saying which goes something like this, "To every problem there is a most simple solution." Taking this cue, let's solve another riddle.

Nature has given me to you,
Although you treat me as something new,
I am the energy that has always been with you,
And if you use me, your worries will be very few.
Who am I?

Prakash: I think I know the answer. Is it "renewable energy"?
Urja: Yes. Aren't you smart?
Prakash: We did learn about the types of renewable energy in one of the earlier sections. Now I really want to learn more about renewable energy.

Delving Deeper into Renewables

Urja: Renewable or non-conventional sources of energy, not only cause less emission but are available locally. Their use can significantly reduce chemical, radioactive, and thermal pollution. They are viable sources of clean and limitless energy. Most of the renewable sources of energy are fairly non-polluting and considered clean.
Urja: Now, can you list the benefits of using renewable energy?
Prakash: I can give it a try.

Benefits

- As the name suggests, renewable energy is non-exhaustible.
- This type of energy is non-polluting; therefore there will be no emission of greenhouse gases in their consumption.
- Reduction of greenhouse gases will mean the planet becomes safe and healthy and so do its inhabitants.
- A healthy planet will ensure healthy people.

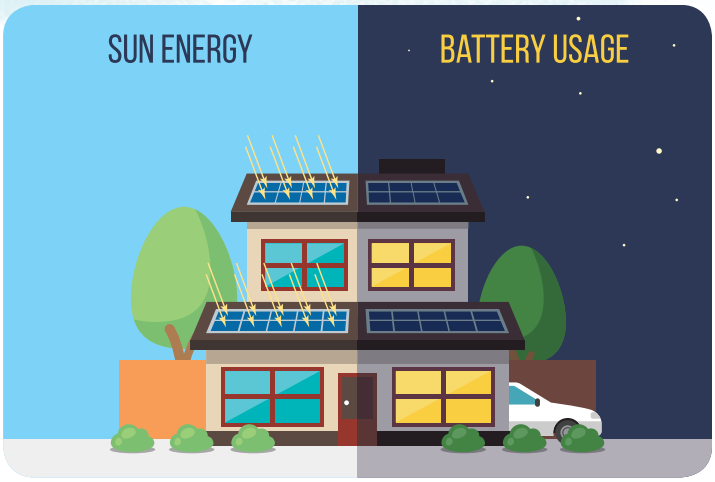
Urja: All your points are correct. Let me add one more point to your list. There are also economic benefits when we use renewable energy. We will considerably decrease our energy dependence on imported fossil fuels. This means we will save on our expenses!
Now before we move on to another topic, let's play a game.
Complete the table by finding the source of each form of renewable energy.

Energy type	Secondary source	Primary source
Hydroelectric Energy	Hydrogen	Sun
Wave Energy		
Tidal Energy		
Hydrogen Energy		
Geothermal Energy		
Wind Energy		
Solar Energy		

= S____N

Why Go Solar?

Urja: Congratulations on completing the table! Do you see that the primary source of all forms of renewable energy is the "sun"?
Prakash: Yes.
Urja: The continuous striking of earth by sunrays produces 173,000 terawatts of solar energy, which is 10,000 times more than world's total energy use. Solar energy is not only free, but is also clean and is sufficient for every living being on the planet. There are great environmental benefits in having solar panels supply electricity, rather than using coal and other fossil fuels. Don't you think it will be a good idea to work directly with the primary source?



Prakash: Yes, it will.
Urja: Which form of renewable energy do you think we should focus on?
Prakash: Solar energy. That should be the easiest.
Urja: Yes. You know that India is in the equatorial region and that is why we are blessed with abundant sunlight. India receives an annual sunshine of 2600 to 3200 hours, so we can use photovoltaic technology and convert solar energy into electricity for our needs such as lighting, heating, cooling, pumping, transport, etc.

Innovative Technologies

1. **Solar for grid connected electricity**: The rooftops of buildings like offices, malls, and even houses can be used for installing solar panels and generating our own electricity for our consumption. The excess electricity can be sold back to the electricity company. For example, BRPL has put solar systems on the rooftops of apartment blocks in Dwarka under its "Solar City" initiative.
2. **Solar for off-grid solutions**: In remote rural areas where electricity cannot be provided through poles and overhead wires, solar panels can be used to generate electricity and supply the load. For example, TERI has installed solar mini-grids in many villages across India for powering basic amenities like lighting, fans, and even television sets in the houses of people that cannot have a normal electricity connection.

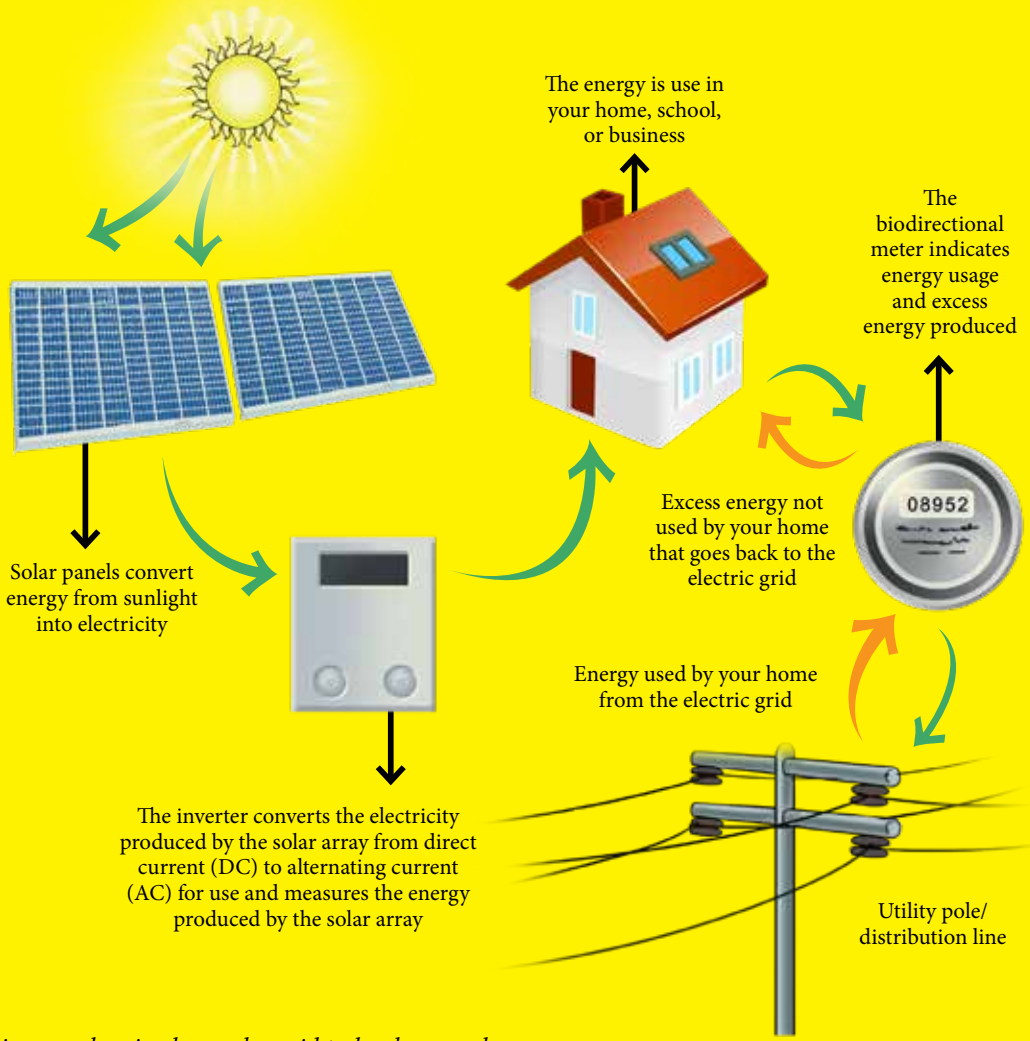


Diagram showing how solar grid technology works.

Delhi Goes Solar

As part of the city's green initiative to battle air pollution, Delhi people are being encouraged to install rooftop solar plants on their rooftops. Under this scheme, the MNRE will bear 30 per cent of the plant's cost. In fact, all the government-owned rooftops have been mandated to house a rooftop solar plant in the next five years. In its bid to turn Delhi into a 'Solar City', the Delhi government is giving a generation-based incentive of Rs 2 per unit to households coming forward for solar plant installation on a 'first come, first serve' basis.

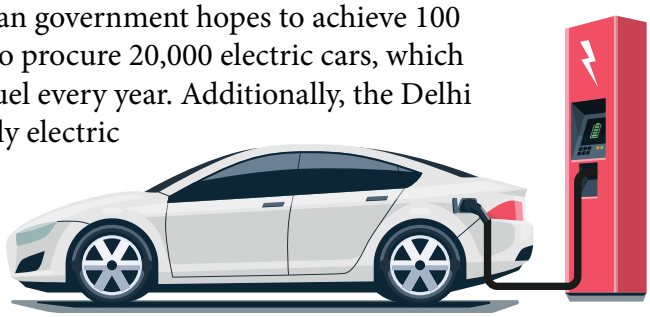
The difference between on-grid and off-grid is that, grid connected means that the solar system is tied to the local utility's grid that supplies electricity to the public *whereas* off-grid means getting electricity from a PV system with energy storage that is not connected to the public power supply system.

On-Grid

Off-Grid

Technology

- **Solar photovoltaic (PV)**: The solar photovoltaic technology is generally generated using a panel (hence solar panels). PV is a technology that converts sunlight (solar radiation) into direct current electricity by using semiconductors. When the sun hits the semiconductor within the PV cell, electrons are freed and form an electric current.
- **Solar thermal:** The solar thermal technology uses the sun's energy to generate low-cost, environment-friendly thermal energy, instead of using fossil fuels. This energy is used to heat water or other fluids, and can also power solar cooling systems. Solar thermal systems generate heat and differs from solar photovoltaic (PV) systems as they generate electricity.
- **Hybrid vehicles /battery-operated vehicles:** Hybrid electric vehicles combine the benefits of gasoline engines and electric motors. Along with being environment-friendly, the other big advantage of using hybrid and battery operated vehicles is fuel and energy efficiency. The Indian government hopes to achieve 100 per cent e-mobility by 2030. It plans to procure 20,000 electric cars, which are expected to save 5 crore litres of fuel every year. Additionally, the Delhi government plans to roll out 1000 fully electric buses on the streets of Delhi. It is also offering 50 per cent concession on registration charges for private cars with factory-fitted CNG kits.



BRPL: Know Your Power Distribution Company

BSES Rajdhani Power Limited (BRPL) is committed to providing reliable power supply at an optimal cost to its over 24 lakh metered customers, which translates to around a crore of Delhi's population residing in an area panning 750 sq. km in South and West Delhi. Being a pro-environment organization, BRPL is conscious of the environmental impact of its actions. It has been closely working with schools for creating energy warriors to champion the cause of the environment. Over the last few years, we have reached out to over 3.20 lakh students across 900 schools as part of our 'Energy Awareness Programmes'. BRPL is also actively taking steps to transform itself into a green power distribution company.

Greening the Power Portfolio

BRPL is committed to increasing the share of renewable energy in its power portfolio from the present <1 per cent to more than 20 per cent by 2020. To achieve this, BRPL will purchase over 400 MW of solar power and 250 MW of wind power from the Solar Energy Corporation of India and PTC India Limited at very attractive tariffs.

Furthermore, BRPL is promoting rooftop solar (especially in the residential sector) on a large scale. The discom launched India's first utility anchored demand aggregation initiative for the residential consumer in January 2018. Titled 'BRPL Solar City Initiative: Solarize Dwarka', the programme is now being expanded to other parts of South and West Delhi. As part of these efforts, BRPL has also energized over 720 (and counting) rooftop solar net metered connections—the largest by any discom in the country. With an installed capacity of over 25 MW, it plans to add at least another 25 MW in 2018–19. Since residential consumers are likely to play a big role in solarizing Delhi, we also encourage you to explore more about our solar rooftop programme at www.solarbses.com.

Energy Efficiency Initiatives and DSM programs

Behavioural Energy Efficiency Programme: Home Energy Reports

BRPL will develop and deploy India's first Behavioural Energy Efficiency (BEE) programme. As part of a pilot project covering 2 lakh customers in South and West Delhi, O Power (Oracle America Inc) will study individual lifestyle and energy consumption habits, provide insights on how energy is used at homes, and generate individual customized home energy reports. They will suggest ways to create energy-efficiency actions and corresponding savings.

Promotion of Energy Efficient Equipment

LED Bulbs and Tube Lights

BRPL, in collaboration with the EESL, is facilitating the distribution of highly subsidized LED bulbs in South and West Delhi. Since the launch of the scheme on 1 June 2015, over

37 lakh LED bulbs have been distributed. These are cumulatively leading to energy savings of a whopping over 80 million units per annum (vis-à-vis CFLs).

AC Replacement Scheme

BRPL has launched a limited period 'AC Replacement Scheme' in partnership with leading air-conditioner manufacturers. It is enabling consumers residing in South and West Delhi to exchange their old ACs with the new, energy-efficient, 5-star rated ACs at a substantial discount.

Energy-efficient Fans

BRPL, in partnership with Atomberg Technologies (an IIT/IIM alumni start-up), is facilitating the sale of energy-efficient Brush Less DC (BLDC) motor fans at heavily discounted prices for the residents of South and West Delhi. These fans are 50 per cent more efficient than the conventional ones.

Solar Pumps (More Energy Efficient)

BRPL has embarked on an ambitious programme, under which around 10,000 inefficient agricultural pumps will be replaced with the efficient solar ones. This will lead to energy savings of up to 120 million units over three years. It will also help in realizing the solar rooftop potential of around 500 MW in South and West Delhi.

Mitigating Pollution in Delhi

Electric Vehicles (EVs)

BRPL is committed to the promotion of EVs in the national capital by supporting the laying of EV-charging infrastructure across the city to reduce range anxiety. It is taking steps to establish public charging stations across South and West Delhi in association with EV manufacturers and the government authorities/ organizations. EV users can take advantage of these stations, which will have special concessional tariff as fixed by the Delhi Electricity Regulatory Commission. Simultaneously, BRPL has commenced replacement of its fleet with EVs in a phased manner.

Tree Plantation

Last year, the discom planted 15,000 saplings in its licensed area. This year, BRPL proposes to plant the same number of trees and has partnered with the CRPF to do so in their camps in South and West Delhi.

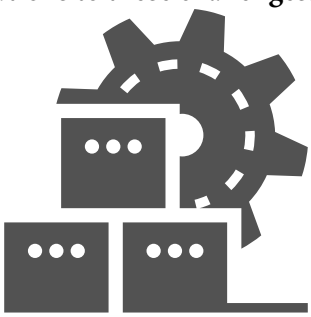
We wish you a happy learning and encourage you to contact us in case you need further information.
Abhishek Ranjan, Head, Renewable and EE & DSM Initiatives
Ph: +91-11-39997311, email: abhishek.r.aranjan@relianceada.com

Urja: Although solar energy is a great source of renewable energy, it comes with its fair share of challenges. Some of them are listed below:

- Only areas with optimal sun exposure are suitable for generation of solar energy
- Solar power cannot be used to generate electricity during night time.
- Solar energy is weather dependent. Electricity output from solar panels is less reliable when the weather is cloudy or with little- to-no sun radiation.
- Solar panels require inverters and storage batteries for night-time consumption.
- Large areas of land are required to install a solar plant; installation is also very expensive.

Scientists and engineers are working tirelessly to find solutions to these challenges. Here's a look at some of the solutions:

- Firstly, the design of the building should be as energy efficient as possible, which means making use of energy-conserving attribute. One unit saved equals to two units generated.
- We need more efficient semiconductors to increase energy production.
- Finding more efficient means for mass production of panels. This will bring down the cost of panels considerably.
- Energy storage systems should be used alongside, so as to avoid interruptions due to climatic and atmospheric changes.
- The energy transmission technology needs to be developed further to make it accessible to the masses.



Urja: Other than solar energy, India is also looking into some other forms of renewable such as wind energy, biomass energy, and hydrogen energy. Do you remember about INDC's? If you do then try completing Activity No. 2? If you don't then read it once again.

Let's Get Active

1. Team up with your friend and make a **solar cooker**. Don't forget to share what you cook!
2. You have read about the INDCs on p.18 . Make a chart about India's achievements under the INDCs.

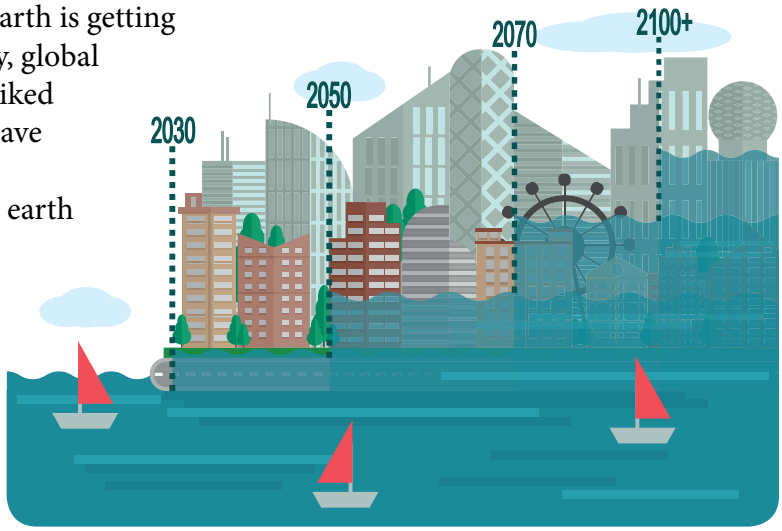
Renewable Is Sustainable

Urja, it appears that our lives are covered in a heavy blanket of pollution. It is causing so much damage to the environment and human health.

And it is also linked to changes in climate and global warming, especially air pollution. The pollution caused by power plants, vehicles, factories, and our homes traps heat around the earth, making it hotter.

The Earth Is Getting Hotter!

Melting glaciers, rising sea levels, dying cloud forests—there's no denying the fact that the earth is getting hotter. In the last half-century, global average temperatures have spiked at a record speed. Scientists have predicted acceleration in this weather trend. But why is the earth warming up this fast?
Air pollutants and greenhouse gases present in the atmosphere such as carbon dioxide, methane, nitrous oxide, and others absorb sunlight that bounces



off the earth's surface. They trap heat in the earth's atmosphere—think of a greenhouse's glass walls. This process is known as the 'greenhouse effect'. With the release of more air pollutants and greenhouses gases in the atmosphere, more heat gets trapped. This causes the temperatures to rise and leads to global warming.

When Did We Discover This?

This discovery can be credited to the Swedish chemist Svante Arrhenius. In 1895, he discovered that the greenhouse effect could be enhanced by human activities that produce higher amounts of carbon dioxide. Thus began a century-long research that refined our understanding of climate change.

Why Should We Care?

Climate change and global warming can have several destructive consequences.

- Higher temperatures are fuelling dramatic weather changes such as intense heat waves, frequent droughts and floods, heavier rainfall, and stronger hurricanes.
- Oceans are becoming more acidic by absorbing carbon dioxide. This not only threatens the aquatic ecosystem, but also leads to coral bleaching and many types of plankton that form the very base of the food chain.
- 70 per cent of the earth's fresh water comes from snow and ice. Global warming causes ice caps and glaciers to melt into the sea, turning fresh water into sea water. In the long run, this will make fresh water less available.

- The outbreak of infectious diseases, allergies, and asthma is more common now due to higher air pollution, increased pollen growth, and more pathogens and mosquitoes.
- Increased rainfall and flooding, along with the growth of new pests, can destroy agriculture and fisheries.
- Global warming will affect many changes in ecosystems. Species are migrating up the slopes and towards the poles. For example, the Atlantic mackerel has moved so farther north that Icelandic people can now easily catch this fish. In fact, marine animals are moving four times faster than land animals.

A Cycle of Destruction

Recent scientific studies have confirmed that air pollution and climate change are part of a destructive cycle—one worsens the other. Soot/black carbon—produced by incomplete combustion of fossil fuels, biofuels, and biomass—is a major component of polluted air. It is the second-biggest source of global warming, lagging only behind carbon dioxide, though it's warming impact is much stronger than the latter's. It is linked to extreme weather events such as heat waves and cyclones. It is also the main constituent of PM 2.5—very fine air particles that reduce visibility and travel deep into the human lungs.

The Silver Lining

Like methane, ozone, and HFCs, soot is a short-lived climate pollutant (SLCP) that remains in the atmosphere for shorter periods, ranging from a few days to slightly over a decade. Compare this with carbon dioxide that can remain in the atmosphere for hundreds of years! Therefore, experts believe that controlling SLCPs can go a long way in combating air pollution and its impact on climate change.

Do Some Pollutants Lessen Global Warming?

New research suggests that while pollutants such as carbon dioxide make the earth warmer, some others have a cooling effect and are actually slowing down global warming. According to Norwegian climate scientist Bjørn H. Samset, aerosols (such as sulfate) have actually reduced global warming by at least half-a-degree Celsius! Pollution caused by human activities such as burning tropical forests and fossil fuels increases the concentration of sulfate in the atmosphere. Samset says that if all human-induced aerosol emissions were to stop today, the world would get warmer by half-to-one degree Celsius in a span of just two years!

So What Needs to Be Done?

The most effective way to reduce pollution and fight climate change is to use renewable sources of energy instead of fossil fuels. Renewable energy is more sustainable and will not run out. It produces little to no waste products. This is not to say that countries are not using renewable energy already. India currently ranks fifth in terms of its renewable energy capacity. It is trying to shift from coal-based power generation to renewables in a big way. By 2030, we aim to produce 40 per cent of our installed electricity from non-fossil fuels.

It is often argued that switching to renewable energy alone is not the solution to the complex issue of global warming: we need to remove carbon from the atmosphere; this can be achieved by using your resources efficiently. However, it is one of the most important solutions for a green future.

Energy Conservation Tips

Lights Out

Make sure you always turn the lights off when you are the last one to leave a room at home or school.

Pack an ECO Lunch

Pack your lunch using reusable containers instead of plastic wrappers or bags.

Slip on a Sweater

Put on a sweater instead of turning the heat up when you are cold at home.

Bike or Walk

Try biking or walking to school instead of asking for a ride. It is fun and good for the environment.

Turn Off

Turn off and unplug stereos, radios, TVs, and clocks when you leave for holidays. These appliances have a stand-by function that uses energy even when they are turned off.

Game Over

Make sure your video games and computers are off before you leave the house. These electronic devices use lots of energy.

Smart Supplies

At school, use both sides of the paper. Also save and reuse unused chalk, pens, pencils, and art supplies.

Trash Talk

Remember the three Rs: reduce, reuse, and recycle. Put bottles, newspapers, and pop cans in your recycling box, or contact your local recycling centre for more information on recycling in your community.

Be a Smart Shopper

When someone in your family is buying an item, look for the recycled logo and make an effort to choose recycled or recyclable products for all your shopping.

Boosts Economic Development

According to the government data, in the last four years (2014-18), India's renewable energy sector has attracted investments worth $42 billion and our green energy projects have created more than 10 million labour-days of employment per year. This shows that increasing investment in the renewable sector can not only generate employment but also boost growth. Our renewable energy goals are ambitious and the future looks promising. Foreign investors are being encouraged to set up renewable energy-based power generation projects in collaboration with Indian partners. By 2022, we plan to add 227 gigawatt of renewable energy capacity to our existing output.

- **The National Green Tribunal (NGT) has completely banned burning of municipal solid waste in open spaces.**
- **In 2017, the atmospheric carbon dioxide levels skyrocketed to reach unprecedented levels (403.3 parts per million)—an event not seen in millions of years.**

Let's Get Active

Complete the table below by filling it with steps to save energy. Add as many steps as you can think of.

Reduce	
Reuse	
Refuse	
Recycle	
Recover	

Review your table and find out ways that you can implement in your daily lives.

How Energy Efficient Are You?

1. Are you concerned about saving electricity?
   a) Yes
   b) No
   c) Not all that much

2. When you charge your mobile phone, do you always 'switch off' after taking your phone off charge?
   a) Yes
   b) No
   c) I never notice/remember to consciously check.

3. Do you always make sure that electronic appliances (computers, TVs, music systems, and others) are not on standby mode when not in use?
   a) Yes
   b) No
   c) I never notice/remember to consciously check.

4. Do you always 'switch off' lights and fans when you leave the room?
   a) Yes
   b) No
   c) I never notice/remember to consciously check.

5. Are you equally concerned about saving electricity at your school and other public places?
   a) Yes
   b) No
   c) Sometimes

6. Have you recently participated in any workshop/competition/campaign on saving electricity that you found useful?
   a) Yes
   b) No
   c) At least not recently

7. What will you do if you see someone wasting electricity?
   a) Walk up to them and ask them to 'switch off' the appliance
   b) Depends on the place and the person concerned
   c) Ignore the situation

8. During summers, do you use air conditioners or coolers throughout the day?
   a) No
   b) Depends on how hot I am feeling at the moment
   c) Yes

9. Depending on their energy consumption, which of the following options will you choose for your home: LEDs, CFLs, or incandescent bulbs?
   a) LEDs
   b) The one that is reasonably priced
   c) Incandescent bulbs

10. While purchasing a new electrical appliance will you opt for BEE star labelling products with 5 star rating as compared to 1 star?
   a) Yes
   b) No
   c) Ratings do not matter

If you mostly scored A's, you are certainly an energy-efficient user. Way to go! :)

If you mostly scored B's, well, it seems like you need to think and make a few changes to your lifestyle!

If you mostly scored C's, you are aware, but still need to practise more energy-efficient measures!

The Green Quiz

1. Star labelling is provided by the Bureau of Energy Efficiency, Govt. of India, and displayed on electrical home appliances such as refrigerator, TV, air conditioner. More stars indicates more _____?
   a) Power
   b) Voltage
   c) Current
   d) Savings

2. Which of the following is an example of non-renewable energy source?
   a) Wind
   b) Geothermal
   c) Solar
   d) Petroleum

3. Greenhouse gases are those that can absorb and emit infrared radiation. Which of the following is not a greenhouse gas?
   a) Water vapour
   b) Ozone
   c) Oxygen
   d) Methane

4. Energy Saved is Energy Generated, implies that
   - Energy saved by energy conservation is lost and cannot be recovered
   - Energy requirement is reduced by energy savings
   - Amount of energy available for use by saving is more than the amount of energy saved
   - Energy requirement increases by saving energy

   Which of the above statements are correct?
   a) 1
   b) 2 and 3
   c) 1 and 3
   d) 1 and 4

5. Which of the following Refrigerator is most energy efficient?
   a) 5 star
   b) 4 Star
   c) 3 Star
   d) 1 Star

6. The unit for measurement of energy is?
   a) Megawatt
   b) Kilowatt hour
   c) Joule
   d) Calorie

7. Which of the following causes pollution?
   a) Wind energy
   b) Solar energy
   c) Fossil fuels
   d) Water

8. When you use energy from sun, it is called _____
   a) Fossil fuels
   b) Solar energy
   c) Wind energy
   d) Hydropower

9. Which of the following gives less light for the same wattage?
   a) Incandescent bulb
   b) Conventional tube light
   c) CFL
   d) LED

10. When is National Energy Conservation Day celebrated?
    a) 14 December
    b) 5 June
    c) 20 April
    d) 4 April

Answers: 1.d 2.d 3.c 4.b 5.a 6.c 7.c 8.b 9.d 10.a

Safe Solar Water

Realizing the potential of Sun's energy and its use in water purification

You will need

- Big glass bowl
- Glass tumbler
- Clean, dry, plastic sheet
- Salty water
- String
- Few glass marbles

Get started

1. Take a big glass bowl and pour two glassfuls of salty water in it.
2. In a glass tumbler, put a few glass marbles. Then put the tumbler inside the bowl.
3. Then tie a string around the mouth of the bowl to hold the plastic sheet in place.
4. Place a stone in the centre of the sheet, so that it slopes into the glass.
5. Keep the container out in the Sun and open it at the end of the day.
6. Test the water in the tumbler. Is it salty?
7. Also measure the water that you were able to collect in the tumbler. How much fresh water did you get?
8. How do you think water came into the tumbler? Discuss in class with your teacher and write your explanation.

Step 1

Step 2

Step 2

My Observations

- Is the plastic sheet dry? _____
- Are the galss marbles inside the inner tumbler still dry?_____
- Why do you think this happened?

_____

_____

- After the water turned into vapours, where did it go?

_____

_____

- Is the water inside the glass tumbler salty? _____
- What do you think happened?

_____

_____

What's Going On?

The water in the bowl contains salts dissolved in it. Water evaporates into water vapour leaving the salt and any other impurities behind. Water vapour condenses and forms droplets on the plastic sheet. This then flows down and falls into the glass tumbler.

BE CAREFUL

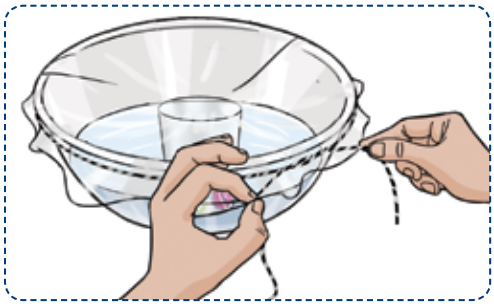
Place a heavy stone on the plastic sheet just above the glass tumbler. This is to make sure that clean water only flows down the tumbler.

NOTE TO THE TEACHER

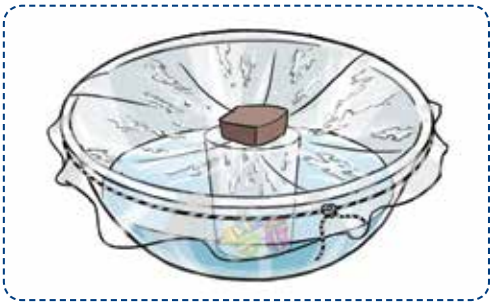
- This method of cleaning water by using Sun's energy was used during World War II, and it saved hundreds of lives. Find out more about it.
- Find out about some of the traditional methods of cleaning water.

EXPLORE FURTHER

Tell students that this is the simplest method to get clean water by using Sun's energy. This has been a practice since a long time and that the Basarva tribe in Africa obtains drinking water by a similar method.
Help students to understand the concept of evaporation and condensation. This activity can be also taken as an example to understand water cycle.



Step 3



Step 4

Pollution Perils

Understanding the impact of water pollutants on the aquatic life

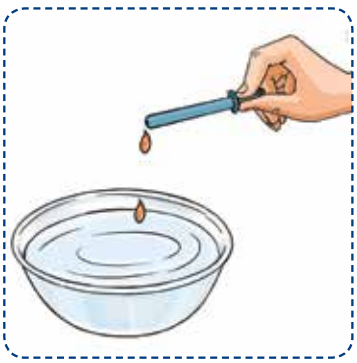
You will need

- 3 wide bowls, same size
- Water
- 3 feathers, preferably white
- 3 paper tissues, preferably white
- Blue food colour
- 2 tablespoon liquid detergent
- 2 tablespoon motor oil
- Forceps

Get started

1. Take three wide bowls of the same size and number them 1, 2, and 3.
2. Now fill bowl 1 with water, and add two drops of food colour in it. Repeat this step with bowl 2 and bowl 3.
3. Place a feather on bowl 1, so that it floats. After a minute or two, remove it with a pair of forceps. Now run a folded tissue paper on it. Do you notice a change of colour on the tissue?
4. Add 2 tablespoon of liquid detergent to bowl 2 and stir it gently. Float another feather on its water. After a minute or two, remove this feather with the forceps. Then run a fresh tissue paper on it. Do you notice a certain blue colour on the tissue paper?
5. Add 2 tablespoon of motor oil to bowl 3. Float a fresh feather on its water. After two minutes, remove the feather with forceps. What do you observe when you run a fresh tissue paper on the feather?
6. Record your observations in the format given below.

Step 1



Step 2

Step 3

My Observations

Bowl No.	Contents	Change seen on the tissue paper after running on the feather
1	Water + food colour	
2	Water + detergent	
3	Water + oil	

What's Going On?

Bird feathers are naturally waterproof because they have natural oil on them. Therefore, feather placed in bowl 1 repelled the water and did not get wet and so the tissue paper did not pick any colour. The feather placed in bowl 2 allowed the water to soak colour. The detergent dissolved the natural oil of the feather and water could flow through its surface and so the tissue picked the blue colour. The feather placed in bowl 3 became sticky and heavy in water due to the addition of oil. This is why when oil sticks to a bird's feathers, it causes them to mat and separate, impairing waterproofing. This also causes the waterbird from propelling forward and tires the bird completely.

BE CAREFUL

- Do not throw paints, oil, or varnish down the sink or toilet after your artwork is over.
- Educate your parents about the need to avoid throwing the remnants from ceremonies into the water.

NOTE TO THE TEACHER

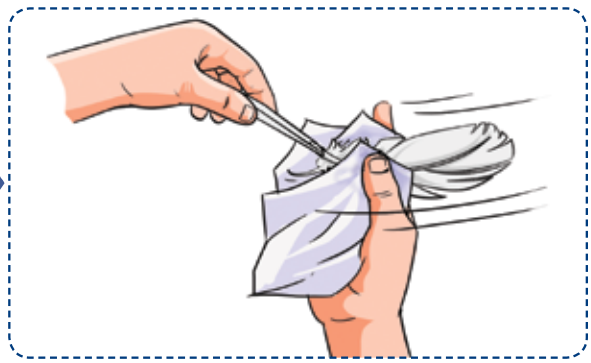
Hold a discussion with the students on:

- How would the pollutants – detergent and oil – spilt on a large scale affect the waterbirds?
- Do we have any right to mess up with the environment of these birds?
- Is there a way to clean the ocean, once these pollutants contaminate the waters?

EXPLORE FURTHER

- Find out what type of oils – light or heavy – cause more harm to the birds.
- How do the cleanup operations harm the marine life further?
- Which marine creatures are most affected by such oil spills?

Step 3



Step 3

How to Play

- Two or more children can play this game.
- Roll the dice and you can start playing only on getting 1.
- If you land on an ACTION, read the question and reply. Or else you will loose one turn.
- The one who reaches the end first wins the game. So, find a dice and you are now ready to play!

Are you a Protector of the Planet?

Play and Find Out!

1 — The planet is running out of energy

2 — You can help a lot too!

3 — Skip 1 turn. You need to think.

4

5

6

7

24

25 **ACTION** Think of three things that use lots of energy in the home.

26

27

28

29 **ACTION** Think of three things that use lots of energy in the school.

30

31

32

33 **MOVE 5 Spaces Ahead** Saved energy. Replaced old light bulbs with low energy-efficient LED bulbs.

34

35

36 **ACTION** Think of two ways you can save energy at home.

37

38

51

52

53

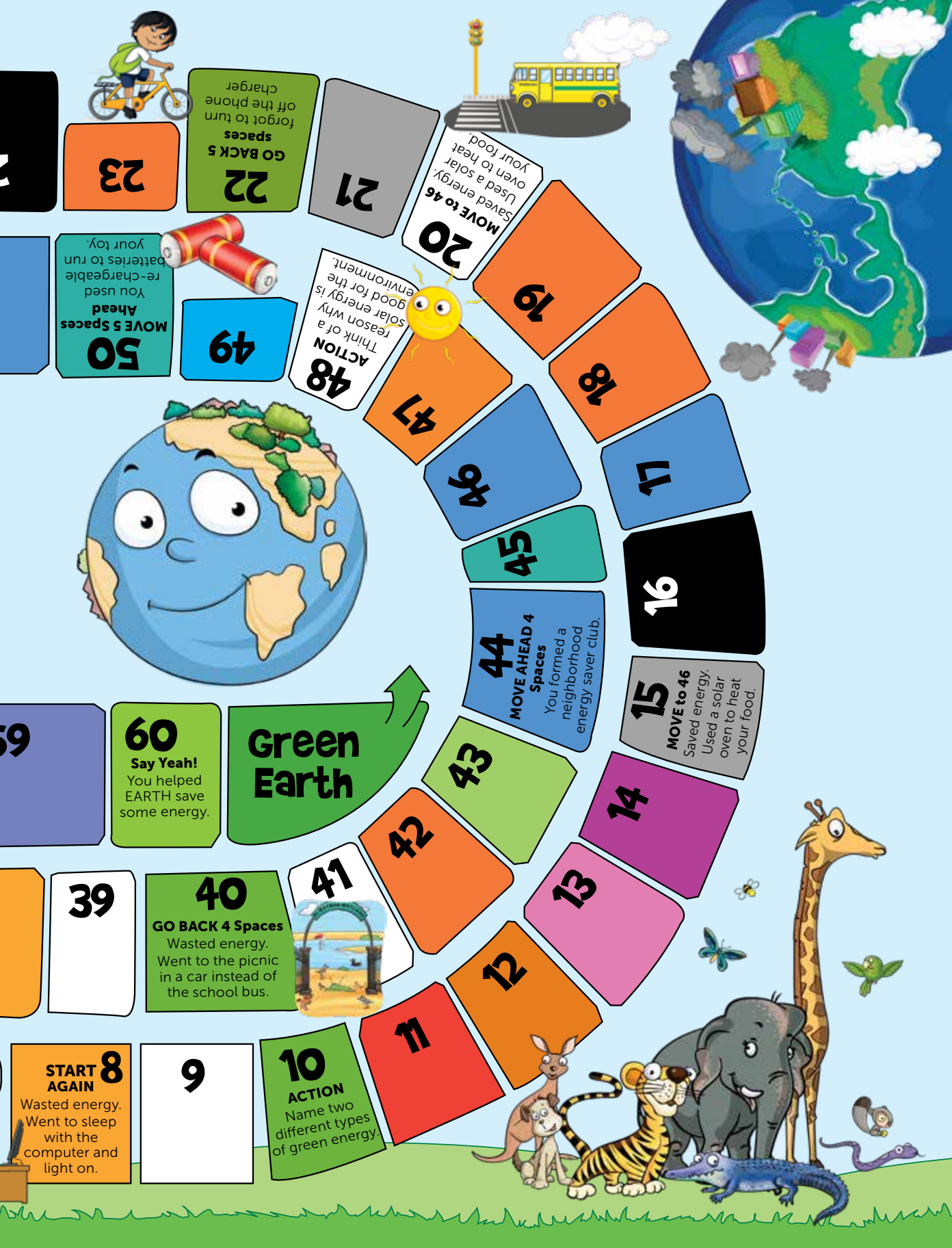
54

55 **Go BACK to 30** Wasted energy. You did not recycle your old cell phone.

56

57

58 **ROLL AGAIN** Saved energy. Used daylight instead of electricity to do your homework.


START AGAIN 8
Wasted energy. Went to sleep with the computer and light on.
9
10 ACTION
Name two different types of green energy.
11
12
13
14
15 MOVE to 46
Saved energy. Used a solar oven to heat your food.
16
17
18
19
20 MOVE to 46
Saved energy. Used a solar oven to heat your food.
21
22 GO BACK 5 spaces
Forgot to turn off the phone charger
23
39
40 GO BACK 4 Spaces
Wasted energy. Went to the picnic in a car instead of the school bus.
41
42
43
44 MOVE AHEAD 4 Spaces
You formed a neighborhood energy saver club.
45
46
47
48 ACTION
Think of a reason why solar energy is good for the environment.
49
50 MOVE 5 Spaces Ahead
You used re-chargeable batteries to run your toy.
59
60 Say Yeah!
You helped EARTH save some energy.
Green Earth

Evaluation

Name: _____

Class and section: _____

School: _____

Answer the following questions. **(6 marks)**

1. Which sector is the greatest emitter of India's overall GHG emissions?

   _____

2. What types of pollution is caused by oil refineries?

   _____

3. Which two highly polluting fuels are banned in Delhi since 1996?

   _____

4. Which pollutant poisoned the water of the Minamata Bay in Japan?

   _____

5. Which toxic gas caused the Bhopal Gas Tragedy in 1984?

   _____

6. In 2016, the Indian government launched a scheme to provide free LPG connections to underprivileged people? Name the scheme.

   _____

7. What kind of toxin is released by burning low-value e-waste?

   _____

8. The abnormal growth of water plants, also known as algae bloom, caused by fertilizer runoff into water bodies is also known as _____.
9. Which disease is caused by drinking water polluted by nitrogen fertilizers?

   _____

10. What is the most familiar form of air pollution?

    _____

11. In which year the ODD–EVEN Scheme first implemented in Delhi?

    _____

12. Caused by the incomplete combustion of fossil fuels, this is the second-biggest source of global warming. Name it.

    _____

Energy Audit at Home (6 marks)

It's important to keep a tab on the amount of energy you are consuming. And you can do that by being your own energy auditor. Fill in the below sheet to find out how much energy are you using and then think of ways to reduce your usage.

Category	Energy appliances	(a) Capacity in watts	(b) Number of fixtures	(c) Number of operating hours/day	(d) Consumption in a day [a x b x c/1000 (KWhr)]	(e) Consumption in a month (d x the number of days the appliance is used in a month)
Cooling appliances	Water cooler(s)					
	Ceiling Fan(s)					
	Table Fan(s)					
	Pedestal Fan(s)					
	Refrigerator(s)					
Lights/ lamps	Incandescent bulb(s)					
	Slim tube(s)					
	CFL(s)					
	Tube light(s)					
Heating appliances	Geyser(s)					
	Electric oven(s)					
	Iron					
Other gadgets	Computer(s)/ laptop(s)					
	TV(s)					
Total units consumed per month						

Divide the column e by the total number of people in your house, and you will get to know your monthly per capita power consumption. _____

Science of a Solar Grid

(4+4 marks)

Draw a diagram to show how the solar grid technology works. Also, suggest at least one innovative suggestion to use renewable energy in your neighbourhood and surrounding. Your suggestion should not exceed 75 words.

My Mini Solar Robot

Do you love robots? Time to make one! Form a small group (not more than 5–6 students) and make a cool and fancy mini solar robot that can walk around using sunlight. Given below are some of the main things that you will need for the project:

a mini solar panel	a small vibrator motor	a small piece of cardboard	at least two capacitors

You can experiment more if you want to make a more elaborate robot. Alternately, you can even make a solar oven or solar charger.

Energy issues are featured in every form of media on just about every single day. These issues baffle the minds of young and old alike. The internet is a great resource for our Qs and As; but usually either the complexity of the text makes it incomprehensible or the magnitude of the content makes the reader / learner nervous.

This book offers a balanced and well-informed perspective with a discussion about the outlook for the future. Burning issues such as pollution, energy conservation and efficiency, renewable energy, and sustainable living are addressed with expert views and case studies that augment the content and can be used to stimulate debate and aid in classroom. The organized and self-explanatory units provide a balanced and chronological presentation of information. The activities and audits are designed in a way that will create awareness of our surroundings and teach us to work in a team, and in turn help in building a nation with sensitized groups of citizens.

A BSES-teri Initiative

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The Energy and Resources Institute