Water As a Resource

Section 1: Hydropower: Dams

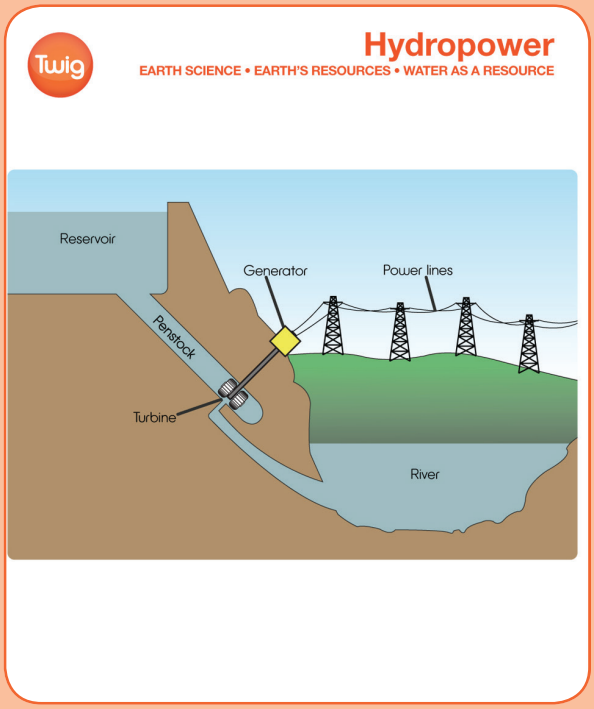
• Where does water gain its energy from?

Hydropower is the electricity generated by the energy of moving water. Hydropower can be achieved in several ways, although the most common is via the use of dams to control the flow of water in rivers. The water stored behind a dam contains what is known as potential energy, and when this water is released it falls rapidly under the force of gravity. The kinetic energy of the moving water turns a turbine, which then turns a generator to produce electrical energy. The amount of energy derived from a dam depends primarily on the volume of water driving the turbine and how high the dam is (that is, how much height the water is able to fall and thus gain kinetic energy).

• Suggested Film

- Hydropower

DIAGRAM 01:



• How do hydropower dams work?

The primary function of the dam is to retain water and release it in a controlled manner in order to generate electricity when it is needed. Ideally, the dam will have a large drop in elevation, from the reservoir to the outlet, in order to maximise the energy generated. The water can also run through a large pipe, or penstock, before it reaches the turbine in order to boost the power generated. Many dams have the capability to use excess power to pump water back to a higher elevation at times when energy requirements are low. This allows it to be released at times of higher demand, and in this way they are able to solve one of the problems encountered by many renewable energy technologies, by tailoring supply to demand.

Extension Question

Q1. Where are the world's largest hydropower plants?

The Three Gorges Dam, China, is the largest hydroelectric power plant in the world. Construction began in 1994 and the dam was completed in 2006. The building of this dam has caused great controversy due to the negative environmental, economic and social impacts. The Itapiú hydroelectric power plant, located on the Paraná River at the Brazil/Paraguay border, produces the most hydroelectricity in the world and provides energy to both countries.

• Suggested Films

- Hydropower

- Building the Hoover Dam

• What are the adverse effects of dams?

Although hydropower is renewable, relatively clean, and has the capacity to store energy until it is required, it does have significant adverse effects. The damming of rivers to produce reservoirs can significantly affect the environment both upstream and downstream of the dam, and can have a huge impact on ecosystems. Dams may obstruct the migration of fish upstream and affect their spawning patterns. The reservoirs created behind dams can fill in and affect the capacity of the dam to control floods, resulting in catastrophic failures if the dam overflows or breaches. Silting of reservoirs in tropical regions can cause the accumulation and release of large amounts of methane. Downstream of the dam, reductions in river flow can starve ecosystems of water and nutrients, and the water exiting turbines often contains a lot of energy, which can lead to scouring and erosion of river beds.

The Hoover Dam, Colorado River, USA

• Suggested Film

- Hydropower

Extension Question

Q2. What is the Hoover Dam?

The Hoover Dam was built (following an order from President Hoover) over a five year period in the 1930s. The dam is situated on the Colorado River, and is one of America's largest hydroelectric power plants.

Section 2: Hydropower: Waves and Tidal

• How do we harness tidal energy?

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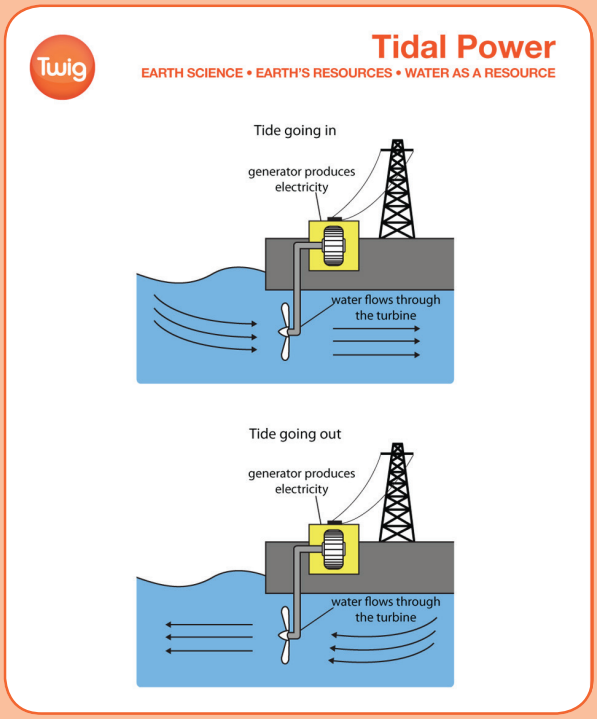


Hydropower can be generated by harnessing the energy of rising and falling tides, and converting this into electricity. The moving tides have kinetic energy which can power tidal turbines in the same manner as wind turbines. Energy can also be generated using tidal barrages. Tidal barrages are effectively dams across a tidal estuary and make use of the difference in potential energy between high and low tide. Tidal turbines are similar in design to wind turbines but have to be sturdier to resist the effects of water, they therefore capture much more energy. Tidal energy is relatively predictable for a given region, more predictable and regular than solar power or wind power, but it can be difficult to find regions with enough tidal range or high enough flow velocities to harness sufficient power.

Tidal power can be harnessed using large underwater turbines

Extension Question

Q3. Where is the largest tidal power plant?

The Rance power station, which was constructed in 1966 in France, is the world's biggest tidal power plant. A tidal barrage is located across the estuary of the Rance River, Brittany, to harness energy from the highest tidal range in France.

• Suggested Films

- Hydropower
- Marine Renewables

• How do we harness wave energy?

Waves are a reliable and predictable energy source

Waves contain a lot of kinetic energy when they are in motion, and they are an efficient transmitter of energy over large areas. Although, in general, the harnessing of wave energy relies on the up and down motion of waves, the energy of the waves can be captured in a variety of ways. Floating devices can use the rise and fall of waves to drive pumps; the motion of waves can be used to move water within a column and force air into a turbine; and structures can be built to concentrate waves into a reservoir to increase the energy collected. The best waves for generating wave power tend to be found at high latitudes and on the west coasts of continents.

• Suggested Films

- Hydropower
- Marine Renewables

• What are the disadvantages of tidal and wave energy?

The main drawback of tidal and wave energy is that the technology involved is still in relatively early stages compared to that of traditional hydropower plants, and implementing these methods can be expensive and experimental. The limited distribution of sites is also an issue, but developments are ongoing and tidal and wave power use may increase. Compared to dams, wave and tidal power structures have little environmental impact, but they can affect plants and animals in tidal estuaries and can disrupt other marine life. Tidal barrages can also affect the tidal estuary in many ways, including affecting recreation, and any sites near the shoreline will have a visual impact.

• Suggested Films

- Hydropower
- Marine Renewables

Section 3: Water Resources

• What else do we use water for?

As well as harnessing the energy from water, we also use it in almost all of our daily activities, either directly or indirectly. The human body needs to consume a certain amount of water every day just to stay alive, and we also use water to shower or bathe, to brush our teeth, and to clean our homes and cars. Even flushing our toilets requires several litres of water each time. Water is also used for industry, agriculture and transport, in the production of everything from the food we eat to the clothes we wear.

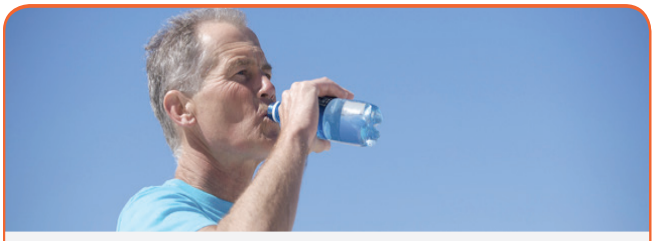
• Suggested Film

- Water As a Resource

• How is available water distributed across the world?

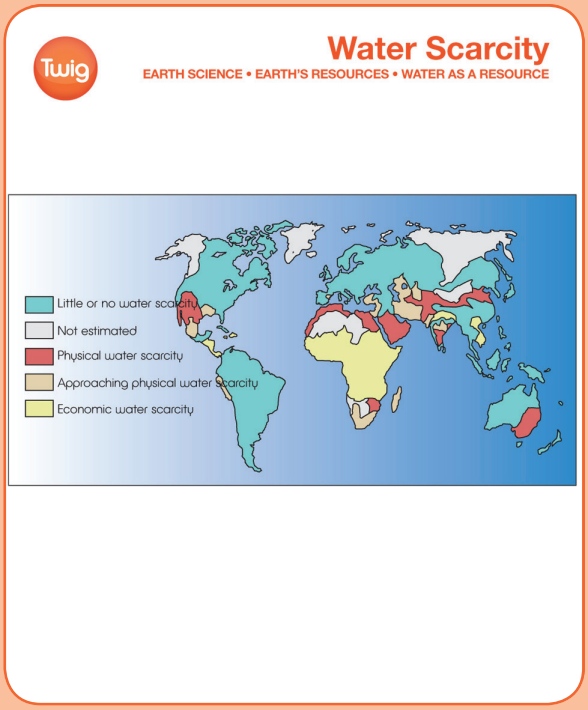
Although a large percentage of the Earth's surface is covered by water, this is largely in the form of salt water which is less suitable for use by humans than fresh water. Only around 3% of the water on Earth is fresh water, existing in the soil, in lakes and streams, locked up in the ice caps, and stored under the ground as groundwater. The amount of fresh water available for use by humans is not constant around the world, and over a billion people lack clean drinking water and in many countries water is scarce. Some countries suffer long-running droughts, whereas others have plenty of rainfall, but it is not spread out equally throughout the year. In addition to this, in many regions the water is contaminated.

When the demand for water is greater than the supply, a water shortage occurs. Although there is not a global water shortage, there are regions of the world that are chronically short of water, while others consume more than they require. Seawater can be converted to water we can use (potable water) by a process known as desalination, but this process requires significant energy input.



Only 1% of the world's water is suitable for human use

DIAGRAM 03:



• Suggested Films

- Water As a Resource
- Bottled Water: The True Cost

• What is predicted to happen to water resources in the future?

In general, as the world's population increases, consumption of water will also increase, and this may lead to greater regions of water shortage across the world. Climate change is likely to amplify the effects of regional water shortages, because many already dry areas will become drier still. Sea level rise could lead to flooding of existing fresh water sources, and rainfall could become more unpredictable. Many regions of the world rely on seasonal melting of glaciers for their water supply, and global warming could affect the balance in these regions. Because we do not yet fully understand how climate will affect water resources, the most important thing to do now is make our existing resources more secure, to conserve water where possible and make our use of water more efficient.

Bottled water contributes to a great deal of pollution and harmful emissions

• Suggested Film

- Water As a Resource

Extension Question

Q4. Why is bottled water bad for the environment?

The bottling of water can lead to a depletion of water supplies at the source. Energy, often from fossil fuels, must be used in the production of plastic bottles and in the transport of bottles around the world. The plastic used to make the bottles is often sent to landfill sites where it takes a long time to break down.

• Quizzes

Hydropower

Basic

• What structure is most commonly used in hydropower generation?

A – wall

B – tidal barrage

C – dam

D – fence

• Where are dams most commonly built?

A – rivers

B – lakes

C – seas

D – estuaries

• Which of the following is NOT true of hydroelectric dams?

A – they can provide water for arid regions

B – they can prevent flooding

C – they are a reliable energy source

D – they cause little disruption to habitats and ecosystems

• What are the three main sources of hydropower?

A – turbines, tidal power, dams

B – dams, tidal power, wave power

C – wave power, estuaries, tidal power

D – tidal power, turbines, dams

Advanced

• What type of energy does the water hold behind a dam?

A – electrical

B – chemical

C – potential

D – kinetic

• When water is released from a dam, what is that energy converted to?

A – electrical energy

B – chemical energy

C – potential energy

D – kinetic energy

• Which of the following is NOT true of wave power?

A – it is a reliable and predictable energy source

B – it has minimal environmental impacts

C – wave farms are inexpensive to construct

D – it produces more electricity than wind turbines

• The amount of energy generated by a hydropower station depends on

A – the type of rock it is built on

B – the height of the dam and the volume of water released

C – the length of the river upstream of the dam

D – the length of the river downstream of the dam

Water As A Resource

Basic

• Which of the following requires water?

A – agriculture

B – transport

C – industry

D – all of the above

• How much of the Earth's water is fresh water?

A – 3%

B – 13%

C – 33%

D – 66%

• Bottled water

A – has a lower carbon footprint than tap water

B – has little impact on the environment

C – is a waste of energy

• Which continents are affected by severe water scarcity?

A – Africa and Asia

B – Asia and South America

C – South America and Africa

D – Europe and Africa

Advanced

• How many people in the world do not have access to clean drinking water?

A – around 1 million

B – around 10 million

C – more than 10 million

D – more than 1 billion

• How will climate change affect water resources?

A – there will be more water worldwide

B – there will be less water worldwide

C – dry places will become drier worldwide

D – it is difficult to predict

• The most important thing to do with our water resources is

A – use them more efficiently

B – send them to areas with less water

C – make sure nobody else can access them

D – bottle water for the future

• What is the name of the process which converts sea water to water suitable for use by humans?

A – desalination

B – decontamination

C – desiccation

D – decoration

• Answers

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