

# PUMP IT UP

## Challenge

A new village has just been built in the Welsh mountains. It has 140 houses, 1 school, 3 local shops and a garage. They all need electricity to run their lights, heating and TVs. The builders were worried about the environment and so decided to investigate how they could use renewable energy - like wind or water power - to make electricity to help power the village.

### Before you start

Use your muscles, and see where the tubes go!

### Think about...

Is storing energy a good idea?

Where is the energy coming from in this exhibit?

Can you make the light/TV stay on for a long time?

Your challenge is to work out how to get electricity from this exhibit.

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Most power stations work by burning a fuel to turn a wheel or turbine that rotates a generator just like the exhibit. A generator does just what it says— it generates electricity! Some power stations use steam to turn the turbine and some use water.

1. Can you name some things that use electricity?

**Any electrical item could be included in the response here**

2. Can you name some types of energy other than electricity?

**Possible responses include: light, heat (thermal), sound, gravitational potential, kinetic, nuclear, elastic, chemical.**

3. Look at the picture of the exhibit.

Put the words into the boxes on the diagram.

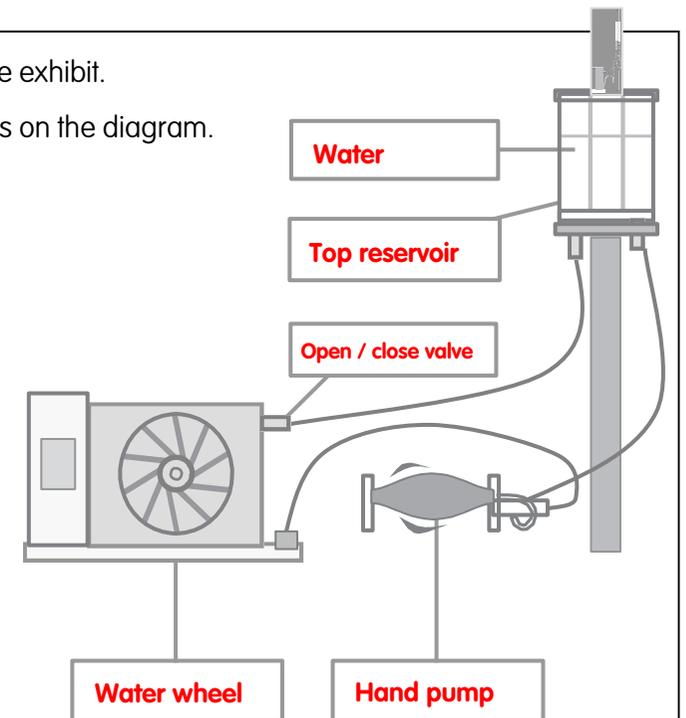
Hand pump

Water wheel

Top reservoir

Open/close valve

Water



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4. Can you explain what is happening to make the water wheel spin?

**The pump raises water into the top reservoir and increases the water's stored (gravitational potential energy). When the valve is opened the water flows downwards due to gravity and as it hits the wheel is converted into kinetic energy of the moving wheel.**

## 5. Experiment

1. Choose a position for the top reservoir and record the height in metres.
2. Turn the tap off.
3. Pump all of the water to the top of the reservoir.
4. Open the tap and let all the water run through the turbine.
5. The digital display shows the speed of the water in revolutions per minute (rpm)

a. Complete the table below for the rpm at 4 different heights.

	Height (m)	Revolutions per minute (rpm)
1		
2		
3		
4		

b. What pattern do you notice?

**The number of rpm increases as the height increases.**

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6. Based on what you found, suggest why the Welsh mountains might be a good place for a hydroelectric power station

**Water could be stored in reservoirs high up the mountains and when electricity is needed it could be released and used to turn turbines in a power station. This can generate electricity quickly, and close to where people need it. The rainfall in Wales is relatively high, which would help to keep the reservoirs full and reduced the amount of pumping required.**

## 7. Supply and demand

The National Grid Company supplies all the electricity in the United Kingdom and need to try and predict the amount of electricity needed at certain times of the year. Look at the times and days below.

Decide if the demand for electricity would be high, medium or low at the times below. Give your reasons.

**Suggested responses below: Students may choose to argue cases differently.**

Time	Demand	Reason
August afternoon	<input type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low	<b>Warmer weather, so heating off</b> <b>Long days, so less lighting required</b> <b>Summer holidays—people away/outdoors</b>
Christmas Day, 1pm	<input type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low	<b>Most electricity comes from workplace use and almost everybody is on holiday on Christmas Day</b>
Any Tuesday night just after EastEnders	<input type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low	<b>Most people back from work, but using electricity for domestic activities such as cooking and TV etc</b>
February midnight	<input type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low	<b>During the night electricity use falls, as most people as in bed (and have switched the heating off!).</b>
February evening	<input type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low	<b>A cold and dark month, so heating and lighting use will be high.</b>

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8. Sources of energy used for making electricity can be 'renewable' or 'non-renewable'. Renewable energy is replaced naturally, does not run out, and is generally less polluting. Give some examples below of each type of energy.

## Renewable

Means you can use it again!

Possible responses include:

Solar

Wind

Geothermal

Biomass (e.g wood)

Biogas (e.g methane from waste)

Hydrogen

Wave

Hydroelectric

Tidal

## Non-renewable

Means that once you have used it all up it is gone forever

Possible responses include:

Coal

Oil

Gas

Nuclear

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## 9. How much energy?

Using the formula below, work out how much energy (in joules) is stored as **gravitational potential energy** once you have pumped it.

**GPE = m x g x h**, where:

GPE = gravitational potential energy in joules (J)

m = mass in kilogrammes (kg)

g = gravitational field strength (**10 m/s<sup>2</sup>**)

h = height in metres (m)

Total mass of water = **2kg**

GPE = m x g x h

GPE = **2 x 10 x height in m**

GPE = J

Notes:

**This space is for students to do their calculation, if required**

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## 10. Energy transfers

Fill in the gaps with the words to describe energy transfers taking place in this exhibit.

Energy cannot be **created** or **destroyed**. Any process involves **transferring** energy from one form to another.

**Chemical** energy from your food allows you to do **work** which in turn allows you to turn the pump.

The water gains **potential** energy as it is pumped up to the top reservoir. When this water comes down the pipe it gains **kinetic** energy.

The energy of the fast-moving water is transferred by the water turbine and generator into **electrical** energy. This energy could be used to supply different electrical items.

transferring

chemical

created

electrical

work

potential

destroyed

kinetic

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## 11. Power stations and their energy stores

Power stations use energy to generate electricity. During this process they deplete an energy store in order to generate the electricity.

Complete the table below.

Power station	Type of energy	What is used to turn the turbine in the generator?
Hydro-electric	<b>Gravitational potential</b>	<b>Moving water</b>
Tidal	<b>Kinetic</b>	<b>Moving water</b>
Wave	<b>Kinetic</b>	<b>Moving water</b>
Wind	<b>Kinetic</b>	<b>Moving air</b>
Solar	<b>Light</b>	<b>No turbine—electricity generated directly in the panels</b>
Biofuels	<b>Chemical</b>	<b>Steam</b>
Coal fired	<b>Chemical</b>	<b>Steam</b>
Gas fired	<b>Chemical</b>	<b>Steam</b>
Geothermal	<b>Chemical</b>	<b>Steam</b>
Nuclear	<b>Chemical</b>	<b>Steam</b>
Oil fired	<b>Chemical</b>	<b>Steam</b>