poopower

A renewable source for generating electricity

YorkshireWater

poopower

Background Information

We've all heard and used the sayings 'Where there's muck there's brass' and 'Muck for luck.' They infer that from something dirty you can gain wealth or a benefit. Well, the UK water industry is literally taking this idea on board by using Poo Power to generate electricity at wastewater treatment plants. With the rising costs of gas and electricity, water companies see Poo Power as a renewable source for locally generated electricity, reducing their fuel bills, managing their businesses sustainably and reducing their carbon footprints.

On average each individual in the UK uses about 350 litres of water a day for a range of activities, including drinking, preparing food, cleaning, using the toilet and gardening. Multiple this figure by 60 million citizens, and add in water used through commercial activity, and one can appreciate the huge responsibility on the water industry in satisfying the country's needs. The vast majority of this water ends up as waste. All wastewater, such as when we flush the toilet and empty the sink, goes down the drain and into the network of sewers and on to the water and sewage treatment works.

Sewage treatment is the process that removes the majority of the contaminants from wastewater and produces both a liquid effluent suitable for disposal to the natural environment and a sludge. It includes physical, chemical and biological processes to remove physical, chemical and biological contaminants. At the simplest level, treatment of sewage and most wastewaters is through separation of solids from liquids, usually by settlement. By progressively converting dissolved material into solids an effluent stream of increasing purity is produced. Eventually the treatment removes unwanted constituents without affecting or altering the water molecules themselves, so that wastewater containing contaminants can be converted to safe drinking water.

During the treatment of wastewater and sewage, gases are released and increasingly water companies are realising the potential for using these gases as a source of energy. By harnessing the biogas, as it is known, companies can generate their own electricity to contribute to powering the machinery that is needed to treat the wastewater and sewage. This source of energy is known as **Poo Power.**

poopower in the classroom

Current curricula require pupils to learn about energy resources, including the advantages and disadvantages of generating electricity from renewable and non-renewable resources. Pupils may be aware of renewable energy sources such as wind, solar, water and biomass, but the existence of Poo Power will probably be something new and quite novel. Yet for thousands for years man and woman have used poo as a source of energy and even today, in countries around the World, poo is used as a fuel for cooking and heating.

The following activities have been developed for teachers to use to educate upper Key Stage 2 pupils (Year 5 and 6) and lower Key Stage 3 pupils (Years 7 to 9) about wastewater and sewage treatment and the use of poo as a source of energy. The materials can be used for class based work, home study, assembly preparation, extension activity and community outreach.

From the activities, pupils will:

- Identify the many ways in which water is used at home and in school, how much is wasted and how water can be used more efficiently
- Understand how waste water and sanitation has changed over time and identify some of the attitudes to poo power today
- Recognise the need to use more renewable sources of energy and the potential for biogas
- Recognise that poo can be used as a source of energy to generate electricity
- Become aware that animal and human waste is used in many countries as a source of energy

Curriculum areas covered are:

- Mathematics
- ICT
- English and Literacy
- Drama Studies
- History
- Geography
- PHSE/Citizenship
- Science
- Art and Design

Learning Objective

Pupils will assess how much water they use in a week, appreciate the amount that becomes wastewater and identify ways they can save water at home and at school

Key Stage 2

A week before the activity, ask the pupils to complete the primary Personal Water Use Chart for each day of the week. The Estimated Water Used column shows the average amount of litres of water used for each activity. Show pupils what a litre of water looks like so that they can visualise the amounts used. In class, ask the pupils to draw a graph of their own water consumption used during the week and ask them to compare their graph with the child sitting next to them. Next draw up a tally chart to show how much water has been used and wasted by the whole class during the week. Discuss the results and how the pupils can save water at home and at school.

As an extension activity, ask pupils to research how much water children in parts of Africa use in a week. How does their use compare with the pupil's own water consumption? Discuss their findings.

As a homework activity, ask the pupils to calculate the total amount of water used by their family over a week. In class, ask them to write a news article for their parents/guardians on their results and how they can all help save water at home.

Key Stage 3

A week before the activity, ask the pupils to complete the secondary Water Use Chart for each day of the week. Ask the pupils to calculate the estimated amounts of water used for each activity by:

- working out the volume of toilet cisterns
- calculating the volume of their bath
- estimating the number of litres used when having a shower
- measuring the amount of water used when brushing teeth with water running and with water turned off
- obtaining the amounts of water used by washing machines and dishwashers from manufacturers' instruction booklets
- measuring the amount of water used when washing a car

Ask the pupils, using ICT, to record their findings for presentation to the whole class. Discuss how the pupils can save water at home and at school.

Prepare an assembly to show the rest of the school how much water is sent down the drain during a week and how students and staff can use water efficiently.

personalwater**use**chart

Primary pupils

Activity	Sun	Mon	Tues	Wed	Thur	Fri	Sat	Total number of times	Estimated Water used (litres)	Total weekly water used
Washing face or hands									4	
Taking a shower									100	
Taking a bath									160	
Brushing teeth (water running)									8	
Brushing teeth (water turned off)									1	
Flushing toilet (standard flush)									20	
Washing dishes by hand									40	

wateruse**chart**

Secondary pupils

Activity	Sun	Mon	Tues	Wed	Thur	Fri	Sat	Total number of times	Estimated Water used (litres)	Total weekly water used
Washing face or hands										
Taking a shower										
Taking a bath										
Brushing teeth (water running)										
Brushing teeth (water turned off)										
Flushing toilet (standard flush)										
Washing dishes by hand										
Using a dishwasher										
Using a washing machine										
Washing a car										

Background Information

When we flush the toilet and empty the bath we probably have little concern as to what happens to the wastewater and sewage and the work of the water companies to dispose of the waste safely and hygienically. Modern technology and practices mean the disposal of waste is far more efficient and environmentally friendly. The development of Poo Power is an emerging use of the biogas created by the waste treatment as a means of generating electricity for use in the treatment works.

But it has not always been like this. Many older people will remember having to use an outside toilet, often just a wooden board with a hole in it and with no running water for flushing the waste away. Instead a common practice was to use ashes from the coal fire to cover the excrement to keep down the smell and number of flies. Local council workers were employed to shovel the waste into a wagon and take it away for disposal.

Gradually throughout the 20th century, networks of sewers were built so that flushing toilets could be installed in homes and the waste carried to treatment works. In many of our cities and towns some of these sewers are over 100 years. They are still used today.

Learning Objective

Pupils will learn how waste water and sewage treatment has changed over the years and identify some of the public attitudes and opinions to poo power today in relation to other sources of energy.

Key Stage 2

Invite a group of older people into the classroom to give a talk to the pupils on how waste water treatment and sanitation has changed since they were their age. Discuss the changes highlighting some of the key issues e.g. threat to health, odours, sea pollution and risk to bathers. Ask the pupils to write a story about what it would be like living in these times featuring the key issues discussed.

Discuss energy sources with the class and the opinions people may hold about them.
For example:

- Coal, oil and gas – non renewable so could run out, future energy supply issues, pollution
- Wind, solar and hydro – visual impacts, environmental impacts, intermittent energy provision
- Nuclear energy – safety issues, waste issues, location

Ask the pupils to think what opinions people may have about using poo as a source of energy. Discuss their responses and ask them to draw their favourite TV character with a caption above it which uses one of these statements or opinions. Display their characters with captions on the classroom wall.

It may be possible to invite a representative from the waste water treatment works into school to give a short presentation to the class or year group. Contact your local water company for more details. Contact details of the water companies in the UK can be found on www.water.org.uk.

Key Stage 3

To fully understand Poo Power it is always beneficial if pupils can see the activity first hand. Contact your local water company to see if it is using Poo Power and if the pupils can visit the plant to see the process and find out how the treatment of wastewater and sewage has changed in the past 50 years. Contact details for the water companies can be found on the Water UK website at www.water.org.uk

Arrange to visit a local community group or sheltered housing scheme coffee morning with a group of pupils. Ask the pupils to interview some of the older people about how sanitation and sanitation products have changed in their lifetime. After the visit, ask the pupils to prepare a report of their findings.

As an extension activity, ask the pupils to perform a short play or improvisation on how sanitation has changed over the years, based on their interview findings.

Ask pupils to carry out a survey amongst their family and peers to gauge their knowledge of Poo Power and their attitudes to using poo as a source of energy i.e. what do people think about it, what are their concerns, would they welcome the idea etc. This could be done in a broader context by seeking views on other sources of energy such as nuclear energy and wind power. Ask the pupils to prepare their findings using ICT for presentations to the class or to the whole school in an assembly.

could**poopower**light**our**homes**?**

Background information

To think that wastewater and sewage could be used to light our homes is unimaginable for most people. These activities seek to raise awareness of the existence of Poo Power as a source of energy. They focus on how electricity is generated from poo and an assessment of Poo Power in comparison with other sources of energy.

It would be useful to begin by explaining how electricity is generated through conventional resources. Most power plants burn fossil fuels to heat water, which turns to steam and drives a turbine that generates electricity, which is transmitted to our schools and homes.

Poo Power uses a biogas rich in methane which is extracted from the treatment of wastewater and sewage to drive the turbines. The biogas, predominantly comprising of methane, is produced when bacteria feed on human and animal waste. This process is known as anaerobic digestion and it is a great way to produce green energy, as well as getting rid of waste and the micro organisms that lurk in it. One of the simplest ways of describing anaerobic digestion to young people is the 'farting' of millions of tiny bugs within the waste, which produces the biogas.

Positively, when the biogas is burnt for generating electricity far less carbon dioxide is released than when fossil fuels are burnt. However, it is useful to note that using biogas in this way does have its limitations in that it takes the poo of 100,000 people to generate 51kW of electricity, enough for 500 light bulbs. (source www.upd8.org.uk)

The use of methane as a source of energy within local communities can sometimes be a contentious issue. Landfill sites and wastewater and sewage treatment plants now have facilities for extracting methane from the degrading waste and using it to generate electricity. But methane is often perceived by people as a dangerous gas, probably from their awareness of explosions in coalmines due to a build up of this gas.

could**poopower**light**our**homes**?**

Learning Objective

Pupils will learn about the importance of using renewable energy, the existence of poo power as a source of energy and how electricity is generated from poo.

Key Stage 2

Ask the pupils to identify appliances that use electricity in the home. Using a flow diagram, explain how fossil fuels are burnt in power stations to generate electricity for TV's, computers and play stations. Discuss with the pupils the differences between using poo and fossil fuels to generate electricity. For example, fossil fuels one day may run out but poo will not, poo is a clean renewable source of energy compared to polluting non renewable sources such as coal, oil and gas. Outline how poo can be used to generate electricity. Ask the pupils to design a cartoon comic strip about 'A Day in the life of Poo', showing:

- the start of its journey
- its travel along pipes to the treatment works
- its attack by micro organisms
- its conversion into a gas
- the generation of electricity
- the use of the electricity by the water company

In drama, choreograph the 'travel of poo to electricity' using the pupils as key elements of the process with some taking the role of 'the poo' at the beginning of the journey, others the micro organisms which attack it and break it down, others the gas which is released and used to generate electricity and so on. Ask the pupils to make props for their performance to be shown at an assembly or to parents during science week.

Key Stage 3

Ask the pupils to assess the potential for poo as a good energy source for the future. Ask the pupils to research poo as an energy source in the library and on the internet. Questions they will need to consider are:

- What is biomass?
- How can biomass be used as a source of energy?
- What are the energy changes involved in generating electricity from biomass?
- What is the use of poo as a biomass fuel?
- What are the pros and cons of using poo to generate electricity compared to fossil fuels?
- What is the potential for poo to supply plenty of clean and affordable electricity in comparison with other sources of energy?

could**poopower**light**our**homes**?**

From their research, ask the pupils to design an exhibition for the main hall or school foyer comparing poo as a future clean source of renewable energy to the polluting non renewable sources such as oil, coal and gas. This exhibition will raise awareness amongst parents, peers and visitors to school of the issues.

Facilitate a role play situation with the pupils where a local water company is informing the community around one of its wastewater and sewage treatment plants of its plan to extract methane to generate electricity. The scenario should focus on the pros and cons of the proposed plan. Roles for the pupils could include:

- The plant manager
- A representative of a local environmental group
- A former coal miner
- A local resident who wants the plant to close due to the smell
- A supporter of nuclear energy who sees nuclear energy as the only reliable source of clean energy
- A local councillor or MP who is a fervent advocate of renewable energy

poopowerforever!

Background Information

Poo Power is not a new thing. Animal and human waste has been used as a source of energy for many years in countries around the world where electricity and gas are scarce. Small biogas plants are common in South East Asia and Africa where animal dung is used as the fuel. In Australia, pig excrements are used to power farms and chicken poo has been used for generating electricity in the UK.

The use of human waste to generate electricity in more developed countries is relatively new. The use of Poo Power at wastewater and sewage treatment plants has already been mentioned, but even the London Science Museum is planning to turn the waste it gets from its 3 million visitors a year into electricity www.sciencemuseum.org.uk The processed waste could produce as much as 1,530 kilowatt hours of electricity a year. The technology is based on the use of a microbial fuel cell, an emerging technology that could one day even light our homes.

Unlike using biogas at the wastewater and sewage treatment plants to turn a turbine, the microbial fuel cell consists of a tube containing bacteria and wastewater is pumped through the tube and the bacteria feed on the organic matter. They release electrons through their membrane into a special carbon paper sheet at the end of the tube. This produces electricity like a mini-power station and also decreases the amount of oxygen in the water and cleans it.

Poo can also be used to heat homes. In Norway, householders are now heating their homes and offices by flushing the toilet. The sewage heat pump plant uses fridge technology to tap heat from raw sewage. Machines at the end of a 300 metre long tunnel in a hillside in central Oslo suck heat from the sewer and transfer it to a network of hot water pipes feeding thousand of radiators and hot water pipes in the city. It is believed to be the biggest heating system in the world using raw sewage (www.abc.net.au/science)

So is Poo the answer to all our future energy needs, as it has been to many thousands of people across the World for many years?

poopower**forever!**

Learning Objective

Pupils will be more aware of how animal and human waste is used around the World as a source of energy.

Key Stage 2

Ask the pupils to research the use of human and animal waste as a source of energy throughout the world. Information will be available in library books on energy and lifestyles in developing countries. The web site www.ashdenawards.org has good videos and pictures of using poo for energy in South East Asia and Africa and can be shown on the interactive whiteboard.

On a large map of the World, invite the pupils to locate where people are using poo for energy. Discuss with the pupils what these locations around the World have in common in terms of their development, human lifestyle issues, poverty etc. Compare and contrast these issues with life in the UK. Ask the pupils to draw pictures of examples of Poo Power they have found from their research. Use these pictures to make a frieze for the classroom or corridor.

Prepare a presentation for an assembly with the class to explain how people in developing countries depend on using poo for heating and cooking and how we take for granted our main energy source of natural gas which will not last forever. Could we be using poo to power our computers and game stations in the future?

Key Stage 3

Ask the pupils to research using the internet and library books how human and animal waste is used around the World as a source of energy. Ask them to graphically design a timeline showing the history and future potential of poo as a global source of energy, starting with the very basic use of animal waste for heating and cooking and including the current use in the UK water industry. Finish with its potential use at the end of the current century. Encourage the pupils to use their imagination for its use in the next 90 years!

In groups, ask the pupils to write a weekly diary illustrating the life of a teenager in a future that uses Poo Power as its main source of energy! Pupils could dramatise parts of their diary to perform to their peers or at a whole school assembly.

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Yorkshire Water Services Limited Western House Halifax Road Bradford BD6 2SZ
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