

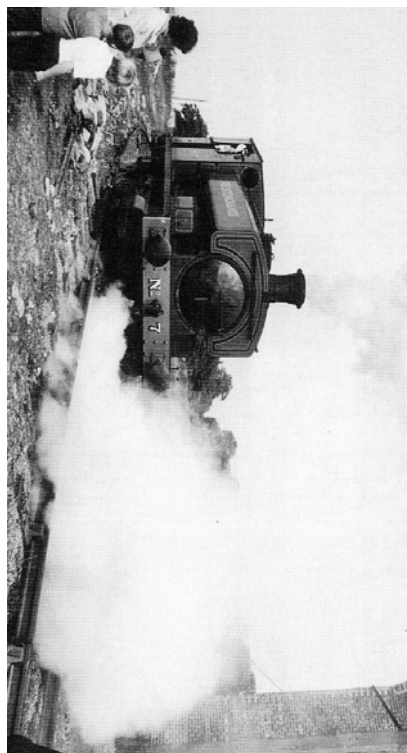
Horses Steam and Electricity at Prestongrange

A resource pack for teachers and students

This Resource Pack is one of a series offering an introduction to local history while fulfilling National Curriculum targets across a number of subject areas. It has been designed for the 5-14 age range and mixed abilities.

Contents

- 1. History***
- 2. Summary***
- 3. Glossary***
- 4. Timeline***
- 5. Curriculum Targets***
- 6. Activities***
- 7. Further Investigations***



1. A brief history of horses, steam and electricity at Prestongrange

The Lothian Coalfield

The Lothian coalfield is a basin-shaped series of layers or seams, interspersed with other material. Due to its basin shape, coal lies on or near the surface at the edge of the coalfield, or where the land surface is worn away by rivers or the sea.

Types of Mine

Mining began with 'drift mines', known as 'ingaun e'es (ingoing eyes), dug into the side of a river bed, shoreline or glen. A 'pit and adit' system used two tunnels - one to mine coal, the other to drain water. Later 'bell pits' were shafts dug into the earth and the coal hollowed out below, creating a circular chamber. Such mines were abandoned when the roof or sides threatened to collapse. In 'Stair Pits', coal was either carried up ladders or a spiral stair, or lifted by rope. By the 1600s, these pits were up to 90 feet deep and in many cases, the rope was tied to an axle on the surface, which was turned by horse or water power. These 'horse gins' were the first mine engines. Deeper workings brought danger from flammable and/or poisonous gas. In most pits, an underground fire circulated the air, often through a two-shaft system. But for Prestongrange, water, not air, was the major problem. Although demand was rising, flooding brought mining to a halt in 1746.

Horses

Horses hauled coal from the earliest days of mining. However, before the mid-18th century Turnpike system, which charged road users for their upkeep, roads were often impassable, especially in winter. But East Lothian mine owners were keen to share in industrial

expansion and the Tranent and Cockenzie waggonway, laid in 1722, was the earliest in Scotland. A horse pulling a coal wagon along its wooden track could pull about 48 cwt. up a slope, compared to a human bearer in a stair pit hauling about 3 cwt.

The 'horse gin' was the first attempt to supplement the use of human labour in the mines, but it was the 1842 Labour Act, preventing women and children under ten from working below ground, that encouraged the use of ponies underground. In 1858, 400 Shetland ponies were brought from the islands by one dealer alone. These ponies were well cared for: from 1842 until well into the 20th century, legislation restricted their numbers and laid down strict rules for their care and upkeep and use.

Steam

In 1705, Thomas Newcomen patented a steam engine which heated water to form steam and then cooled it inside a vacuum cylinder. Inside the cylinder, a piston rose and fell. This could, in turn, raise buckets of coal or water. These early steam engines were massive, stationary and costly to buy and erect, economic only for large mining ventures until James Watt modified Newcomen's design, separating the action of steam from condensation to create a more mobile, more easily maintained machine. In 1830, when steam pumps to remove water were installed, Prestongrange reopened.

Innovations in mining were matched by innovations in transport and by 1815, mobile steam engines had appeared. A steam locomotive, burning one ton of coal, could pull 550 tons of coal for 60

miles and by 1870, a national rail network linked coal mines to their markets at home and overseas. Many iron companies expanded thanks to this new rail network. Andrew Barclay of Kilmarnock, for example, supplied pump barrels, rams and valves for the Cornish Beam engine in 1905 and also built steam locomotives for Prestongrange. The demand for coal to fuel the growing iron industry (and for by-products, such as gas for lighting and coal-coke for smelting iron) rose throughout the 18th century. Seams were mined by "stoop and room", in tunnels supported by pillars of coal. From 1840 onwards, the "longwall" system used timber to support a wider coal face, but not at Prestongrange, due to its narrow seams. Water was drained by steam driven pumping engines, but, pre-1842, human bearers were cheaper and still carried coal in baskets or dragged wooden boxes from the face to the pit bottom. By 1838, wheeled wagons travelled underground roadways, many laid with rails.

By 1850 a mineral railway linked Prestongrange Colliery with the main East coast line and the Edinburgh-Glasgow line (opened in 1842). In 1876, Morrison's Haven harbour reopened, with a railway link to the mine and facilities for loading coal onto ships. Steam provided the power, but equipment was a combination of old and new: an 1872 inventory lists a gig engine, 'water engines' with boilers and "air pumping machines"

Electricity and hydraulics

From the mid 19th century onwards, interest grew in combining steam with compressed air or hydraulics to produce smaller, more powerful machines. By the turn of the 20th century, most Prestongrange workings extended seawards 300-900 feet below sea level.

Ventilation by fires was inadequate, but steam driven fans were bulky and costly. In 1906, a new ventilation shaft, No.3, was sunk. By 1900, an hydraulic engine, using water pressure to run the pumps, was supporting the steam-powered Cornish beam engine. Although use of electricity below ground was initially limited due to danger from sparks, by 1910, an electric turbine pump had been installed at the pit bottom. This drained water at 3 times the previous rate. There was also an elevator for raising dross. The advent of electricity brought an even greater weight of legislation. But electric engines were far easier to move and to operate than steam, and their applications seemed endless: safer lamps; improved coal cutting; more efficient ventilation, pumping, haulage and lifting; faster transport; automated loading and sorting. By 1897, Rudolph Diesel's design for an engine which combined oil with electrical power offered the prospect of a transformed railway network

Owners and Innovators

In 1830, Sir George Grant Suttie leased Prestongrange mine to Matthias Dunn, a Newcastle engineer. Sixty years after the mine closed, a new shaft was sunk, incorporating Dunn's 'tubbing' system of lining the shaft with iron. He also installed a steam-driven pumping engine. However, profits were seriously reduced by the cost of such work. Dunn gave up the lease and by 1840 the workings were flooded again.

In 1850, the Prestongrange Company took over, re-sinking Dunn's shaft (to the Beggar seam) as a pumping shaft and opening no. 2 shaft (the Jewel). This company was also responsible for buying and erecting the Cornish Beam engine, which powered three pumps: one 420 feet below the surface, another

halfway between the Great Seam and the surface and another at 766 feet, pumping water away at the rate of 650 gallons per minute.

In 1895, The Summerlee Company leased Prestongrange and remained until nationalisation in 1947. The early 20th century saw growth and expansion, not only at Prestongrange, but throughout Scotland. Improved boring techniques, shaft construction and haulage meant that coal could be lifted from even deeper workings and, by the late 1880s, refinements to cutting equipment produced mechanical coal cutters. Haulage above-ground remained largely unchanged during this time, but by 1841, high-pressure steam winding engines for underground haulage had been introduced: in 1900 the system at Prestongrange was Endless Rope Haulage, a continuous rope driven by two engines located on the surface. Human labour still separated coal from stone, but mechanised tumblers shook coal and fireclay free of surrounding matter and screens and riddles (metal grilles) sorted it into different sizes. Loading onto wagons was also mechanised. A washer for cleaning coal, the first in the county, was installed at Prestongrange in 1895 and a "jigger" conveyor, which carried coal along in pans, was installed in about 1907. Such extensive mining operations required an increased labour force. In 1900, Prestongrange employed 493, compared with 873 by 1910.

Deterioration

However, lack of investment and the challenge from alternative power sources in the later 20th century brought stagnation. By the 1940s, Prestongrange

still did not have a continuous belt conveyor for shifting coal and productivity was still tied to the speed of manual loading at the coal face.

Electrical power replaced steam only where this did not require significant alterations to tunnels and seam-workings, or where it was essential to maintain the workings.

From the late 1800s onwards, reduced profits brought disputes between owners and workers and when pits stopped production, maintenance could not be carried out. Some pits were permanently closed and machinery lost. Increasingly, mining relied on outmoded or elderly machinery. The air shaft at Morrison's Haven harbour had an electric winder, but a list of equipment in 1939 shows a steam hoist still in use at No. 2 pit. An electric engine ran the washer, but pumps and drilling equipment were of German, not British manufacture. In the 1940s, Prestongrange installed a mechanised coal cutter, but loss of manpower during wartime, the high cost of further mechanisation and loss of overseas trade meant the colliery was in the final stages of decline. By 1947, many of the mine's railway lines had been lifted. The only piece of new equipment was one extra washer. Nationalisation in 1946-47 brought a mood of optimism, but due to "rationalisation" large scale redevelopment was only undertaken where expense was justified in terms of profit. Along with 13 other East Lothian mines, Prestongrange was judged uneconomic and closed in 1962, bringing deep mining in East Lothian to an end.

2. Summary

Lothian Coalfield

The Lothian coalfield is a basin-shaped series of underground layers.

Types of Mine

Early mines were ‘**ingaun e’es**’, ‘**Pit and adit**’ and later, ‘**Bell pits**’. By the 1600s, ‘stair pits’ were up to 90 feet deep, with constant danger of flood or collapse and underground fires **circulated** air to **disperse** dangerous gases. Coal was carried up ladders or spiral stairs or lifted by a rope tied to an **axle** which was turned by horse or water power. These ‘horse gins’ were the first mine engines.

Horses

Before the mid-18th century, horses hauled coal along muddy, rutted roads until the ‘**Turnpike**’ system charged users for road **upkeep**. The Tranent and

Cockenzie waggonway, built in 1722, used horses to pull wagons along a wooden track. Ponies were increasingly used underground from 1832 onwards.

Steam

Floods closed Prestongrange in 1746, but it reopened in 1830, thanks to the steam **piston** engine designed by James Watt. By 1838, wheeled wagons travelled underground road and railways, and by 1876, a railway **network** linked Prestongrange to the rest of Britain and abroad.

Electricity and hydraulics

By 1900, mine **workings** were up to 900 feet deep. An **hydraulic pump** supported the steam-powered **Beam engine** and by 1910, an electric **turbine** pump and an elevator for raising **dross** were installed.

Owners and Innovators

In 1830 Matthias Dunn sunk a new **shaft** and installed steam pumping engines. In 1850, The Prestongrange Company also sank a shaft and installed the Cornish Beam engine. By 1900, after The Summerlee Company took over, an ‘**Endless Rope**’ system provided underground haulage. Cutting, shifting, sorting, cleaning, washing and loading coal was mostly mechanised.

Deterioration

After the mid-20th century the coal industry shrank thanks to **strike** action, **alternative** energy sources, low **investment** and lost **markets**. In 1962, the National Coal Board closed Prestongrange.

3. Glossary

Ingaun e'es

Early mines were called 'Ingoing eyes' because the holes looked like eyes in the hillside

Adit

An extra drainage tunnel dug below a mining tunnel

Bell Pit

Coal was hollowed out underground, creating a bell-shaped space

Circulate

Fire heats air, making it rise. Cold air fills the space, so the air is constantly moving

Disperse

Pockets of gas are disturbed by the movement of air and drift away

Axle

A rod with a wheel attached. Turning the rod turns the wheel. A rope tied to the wheel can be raised or lowered

Turnpike

A road with a gate across it to stop travellers and charge a fee

Upkeep

Care and maintenance

Piston

A moving cylinder. A rod attached to a piston can move machinery

Network

A system of railway lines

Workings

A mine or quarry

Hydraulic pump

A machine which uses water power to move a piston

Beam engine

A steam-powered engine with a wooden beam which pumps water

Turbine

A rotary engine with a circular motion usually used to produce electricity

Dross

Material left after coal is removed

Shaft

A mining tunnel dug from the surface, usually straight down

Endless Rope

A continuous rope travelling along tunnels and connecting the pit bottom to workings

Strike

Refusal to work. Strike action is used to force employers to improve working conditions

Alternative

A substitute. Alternative energy sources include gas, oil and wind

Investment

Money for improvements

Market

A place where goods are sold

4. Timeline

- 1150s** - Charter grants the Cistercian monks of Newbattle Abbey by Seyer de Quincy, Earl of Winchester to establish a coalworks and quarry between Whytrig Burn and the boundaries of Pinkie and Inveresk.
- 1308** - Act of Parliament forbids the use of coal in London due to smoke and fumes. Coal is used to heat large monastic and nobles' houses in Scotland whilst being associated with trade and industry.
- 1300s** - James V allows construction of Acheson's (now Morrison's) Haven. The Abbey is granted the right to transport coal from the workings beside the River Esk for shipment in small boats. Packhorses make the return journey with salt and with goods traded for the salt and coal shipped at the harbour.
- 1450s** - Accessible supplies of coal diminish while demand for coal increases.
- 1500s** - Scottish coal output is approximately 40,000 tons, but still from small scale workings. However, 6 tons of coal were needed to produce one ton of salt (salt was very profitable).
- 1609** - Export of coal forbidden.
- 1606** - Law reduces colliers to a form of slavery (serfdom).
- 1700** - Annual output of coal c4 million tons
- 1705** - Thomas Newcomen patents the steam engine.
- 1707** - Union of the Parliaments of Scotland and England sees the decline of the Prestonpans salt industry.
- 1722** - Tranent and Cockenzie Waggonway laid.
- 1741** - Evidence of the use of horse gins at Prestongrange.
- 1743** - Morrison's Haven harbour ceases trading.
- 1746** - Mining temporarily ceases at Prestongrange due to flooding.
- 1780** - James Watt successfully modifies Newcomen's design.
- 1800** - Total coal output for Britain is 10 million tons
- 1812** - William Murdoch perfects a method for extracting gas from coal for lighting.
- 1814** - Sir John Hope's Pinkie Railway between Pinkiehill and Fisherrow is constructed.
- 1815** - Tranent and Cockenzie Waggonway replaces wooden rails with cast iron.
- 1830** - George Grant-Suttie leases land at Prestongrange to Matthias Dunn
- 1830** - No 1 shaft sunk, re-opening the mine after more than 65 years.
- 1831** - Edinburgh and Dalkeith Railway ('Innocent Railway') constructed.
- 1838** - Waggon road at Prestongrange runs from pit bottom to working. Bearers replaced by wheeled rails.
- 1838** - Matthias Dunn gives up the lease of Prestongrange.
- 1840** - No. 1 shaft flooded.
- 1850s** - Turnpike System is introduced in Scotland.
- 1850** - The Prestongrange Company takes over the Prestongrange lease.
- 1850** - Opening of the mineral railway junction links Prestongrange Colliery with the main East Coast line.
- 1870** - Total output of coal in Scotland is 15 million tons.
- 1874** - The Cornish Beam Engine is installed at Prestongrange.
- 1878** - The Mining Institute of Scotland is established.
- 1893** - The Prestongrange Company fails.
- 1895** - The first mechanical washer for cleaning coal in Scotland is installed at Prestongrange.
- 1900** - 439 employed at Prestongrange Pit: 61 above ground and 378 below.
- 1905** - The Cornish Beam Engine has its pumping capacity improved.
- 1910** - 873 employed at Prestongrange: 153 above and 720 below (including many Irish immigrants).
- 1910** - An electric turbine pump is installed to pump water from Prestongrange.
- 1913** - Total coal output for Scotland 42 million tons.
- 1915** - total coal output for Scotland 35.25 million tons.
- 1945** - Total coal output for Scotland less than 20 million tons.
- 1946-7** - Nationalisation. The government takes over the coal mines.
- 1962** - Prestongrange Pit closes.

5. Curriculum Target: Knowledge and understanding of people in the past

STRAND	LEVEL C	LEVEL D	LEVEL E	LEVEL F
<p>People, events and societies of significance in the past: Developing an understanding of distinctive features of life in the past and why certain societies, people and events are regarded as significant</p>	<p>Describe the diversity of lifestyles of people in the past, eg the life of a peasant as opposed to a landowner</p>	<p>Describe some features of societies, people and events of the past and suggest why they might be considered significant</p>	<p>Explain the motives or actions of people in particular historical situations Explain the values or attitudes that characterised various societies in the past Explain why particular societies, people and events from the past are thought to be of significance</p>	<p>Apply knowledge and understanding of the motives or actions of people in particular historical situations and/or the values and attitudes of particular societies in the past to reach conclusions on a given historical issue or question</p>
<p>Change and continuity, cause and effect: Developing an understanding of change and continuity over time and of cause and effect in historical contexts</p>	<p>Make a comparison between present and past lifestyles/circumstances/features. What is different? What is the same? Give some reasons for differences and for aspects of continuity</p>	<p>Identify important features of a development that have changed over an extended period of time eg transport, role of women Explain in simple terms why these features were important and describe what effects they had on people's lives</p>	<p>Demonstrate a detailed knowledge and understanding of the main features of a particular event/development/attitude with regard to change and continuity Give some reasons to explain why a specific historical event/action/development took place and what the specific consequences were</p>	<p>Apply knowledge and understanding of the process of cause and effect to provide detailed explanation as to why a particular development/event took place and give balanced assessment as to the significance of its consequences</p>
<p>Time and historical sequence: Developing an understanding of time and how events in the past relate to one another in chronological sequence</p>	<p>Put a series of events with their dates in chronological order Use the words 'decade' and 'millennium' correctly</p>	<p>Explain the meaning of the terms 'bc' and 'ad' Place a number of events from a specific historical development on a timeline that crosses BC/AD divide</p>	<p>Explain the relationship between specific dates and the relevant century Name and place significant historical periods in chronological order</p>	<p>Compare and contrast timelines from a significant historical period in different parts of the world</p>
<p>The nature of historical evidence: Developing an understanding of the variety of types of historical evidence and their relative significance</p>	<p>Describe ways in which people remember and preserve the past, eg war memorials and suggest reasons why they should do this</p>	<p>Suggest a variety of sources of information about the past and what use they might be to someone studying a particular topic Explain the meaning of the term 'heritage' and give some examples, eg castles, literature</p>	<p>Suggest ways in which society's awareness of its own past can affect its present and future development eg devolution in Scotland, conflict/peace in Northern Ireland</p>	<p>Describe how heritage and evidence can be used in both positive and negative ways eg to promote social, economic or political ends</p>

5. Curriculum target: skills in social subjects

STRAND	LEVEL C	LEVEL D	LEVEL E	LEVEL F
<p>Preparing for tasks: Planning tasks in a systematic and logical way Identifying appropriate sources of information</p>	<p>Plan a sequence of activities for tackling an enquiry, class or homework task</p> <p>Suggest relevant sources of information that might assist in a particular task</p>	<p>Plan a sequence of tasks or procedures, adapting as required</p> <p>Identify a variety of straightforward sources from which relevant information might be collected</p>	<p>Plan appropriate strategies, resources and sequence of tasks or procedures, adapting as required</p> <p>Identify a variety of sources from which relevant information might be collected and give reasons for choice</p>	<p>Plan appropriate strategies, resources and sequence of tasks or procedures, adapting as required</p> <p>Identify a variety of sources, including complex ones, from which relevant information might be collected and give reasons for choice</p>
<p>Carrying out tasks: Selecting relevant information and/or equipment. Observe, measure, find, select, record Processing information in a variety of ways Evaluating the usefulness and reliability of information</p>	<p>Select and record specific information for a given purpose from a variety of sources available in the school or local community</p> <p>Select simple techniques to process/classify straightforward information in a variety of ways</p> <p>Distinguish in an elementary way between fact and opinion, fact/truth and fact/fiction</p>	<p>Select and use known enquiry methods and/or equipment to access, select and record relevant information from a variety of straightforward sources</p> <p>Select techniques to process/classify information in a variety of ways eg the results of a questionnaire</p> <p>Make simple judgements about usefulness/reliability of information/evidence</p>	<p>Select and use methods and/or equipment to access, select and record a range of relevant information from a variety of different types of sources</p> <p>Select techniques to process/classify information in a variety of ways, justifying choice</p> <p>Make judgements about what evidence is relevant/reliable, eg by reference to bias, exaggeration and selective use of information</p>	<p>Make independent use of suitable methods and techniques to access, select and record information from a range of sources, including complex ones</p> <p>Make independent use of techniques to process/classify information in a variety of ways, justifying choice</p> <p>Recognise when information is likely to be irrelevant, biased, or unacceptably inaccurate</p>
<p>Reviewing and reporting on tasks: Presenting findings in an appropriate and coherent way Presenting conclusions that are relevant to the purpose or issue</p>	<p>Present findings in a report, communicating key points clearly</p> <p>Present conclusions giving reasons</p>	<p>Present findings in an organised and appropriate manner</p> <p>Present conclusions and justify these with reference to evidence</p>	<p>Present findings in report (orally or in writing) showing clear organisation and appropriate specialist vocabulary</p> <p>Present conclusions that are well supported by reference to presented information</p>	<p>Present an extended report (orally or in writing) showing a clear and coherent argument or analysis</p> <p>Present detailed conclusions, or conclusions on more complex issues, that are well supported by reference to presented information</p>

6. Activities

Calculations:

1. A horse hauling a wagonload of coal along a railed track can pull about 48cwt. If a human bearer hauls 3 cwt, how many humans did 1 horse replace?

Answer _____

2. Electric winding equipment can bring four cars to the surface per wind. Each car contains 3 tons of coal and takes 20 seconds to raise the coal 1,250 feet. How many tons are raised in an hour?

Answer _____

3. Strata temperatures in Lothian coalfields rise about 1 degree Fahrenheit for every 70 feet of depth. If no.1 shaft, the Jewel, was 450 feet deep, what is the temperature increase from the surface?

Answer _____

Electricity:

Make a list of everything you can see that is powered by electricity.

List your answers under the following headings:

Lighting _____

Heating _____

Communication _____

Innovators:

Using the timeline (section 4) make a list, with dates, of the

inventions and equipment which made it possible for coal to be mined at Prestongrange.

Design:

At Prestongrange, an endless rope anchored within the mine was passed over a pulley on the surface. Cages went up and down the rope, carrying men and coal up or down.

Using construction material such as lego, junk and/or paper and glue, design your own winding mechanism. It must be able to lift **heavy** weights from **far** below

7. Further Investigations

For more information on the Prestongrange Estate, especially the Industrial Heritage Museum, try the following websites:
www.eastlothian.gov.uk/museums/index.html
www.prestoungrange.org

For more information about mining in Scotland, try the Scottish Mining Museum website at:
<http://www.scottishminingmuseum.com/>

For images from Scottish history: www.scran.ac.uk

For an excellent history website, try:
<http://www.bbc.co.uk/history/topics/>

For an experience of life in a miners' community in the early 20th century, try *The Bonny Pit Laddie*, by Frederick Grice, published in 1960

