Fossil fuels and minerals

Scotland has a wide range of geological resources that make a major contribution to the economy. They are used in the energy, construction and manufacturing industries and need to be carefully managed to ensure they are available for future generations.

Summary

Key messages

- Geological resources underpin a significant part of Scotland's economy, and are crucial to many aspects of modern life.
- In 2011 the total value of minerals produced onshore in Scotland was over £650 million, more than half of which was from coal.
- In 2011 oil and gas exports from Scotland were valued at £2.4 billion.
- Scotland still has significant coal reserves of almost 30 million tonnes.
- Current estimates suggest that there could be up to 24 billion barrels of oil equivalent still to be recovered.
- Our geological resources are not renewable and, therefore, need careful management to ensure they are available for future generations.

State and trend

State: Moderate - high agreement, high evidence

Trend: Stable - high agreement, high evidence

There is an explanation of the diagram and further information on how we carried out the assessments on the summary pages.

- Oil and coal resources continue to be exploited and will thus decline with time.
- Aggregates and mineral resources are also being gradually exploited.
- For all geological resources, there is potential for more usable reserves to be identified as technology improves.

Overview

Scotland's geological resources are all those materials that can be extracted from the earth and used in practical applications. They underpin a significant part of Scotland's economy, and are crucial to many aspects of modern life. They include fossil fuels (coal, oil and gas) for energy; materials used in construction; metallic minerals; and a wide range of other 'industrial minerals' that are used, for example, to make glass and ceramics. In 2011 the total value of minerals produced onshore in Scotland was over £650 million, while in 2011 Scottish Enterprise valued oil and gas exports from Scotland at £2.4 billion. Many of these resources are non-renewable and, therefore, need careful management.

Scotland's geological resources are part of its wider geodiversity, and have been exploited for thousands of years since early inhabitants used local stone for building and tool-making.

Lead and silver have been mined in Scotland since the 13th century, and some of the major deposits were known in Roman times. The Industrial Revolution in Scotland was largely driven by the availability of coal in the Central Belt, and most of Scotland's cities are built from local stone. Since the 1970s, the offshore oil and gas industries have boomed.

The range of geological resources found in Scotland underpins many aspects of our daily lives, being particularly important for energy and construction.

Scotland has abundant fossil-fuel resources, including onshore coal and offshore oil and gas. Some areas may also be suitable for the production of geothermal energy. Widespread areas of sand, gravel and hard rock can provide all the aggregates needed for construction and infrastructure development. There are many areas of rock suitable for use as building, paving and roofing stone, although these are currently only worked to a limited extent due to the availability of cheap imports. Some smaller deposits of certain industrial and metallic minerals also occur in Scotland. Groundwater is also an important resource.

State

Scotland has significant fossil-fuel and mineral reserves. Our land area and the sea bed around the coast are rich in fossil fuels, mainly onshore coal and offshore oil and gas. Extensive coal deposits are found in the Central Belt. Currently all coal mining in Scotland is opencast. At present there is permission for extraction of almost 30 million tonnes of coal at opencast sites. The main resources of oil and gas lie offshore and it is estimated that there could be up to 24 billion barrels of oil equivalent still to be recovered.

Scotland's varied geology provides extensive resources of raw materials for construction. Hard igneous rocks are widely quarried for aggregate. Industrial minerals such as barytes are also quarried. There are no metal mines currently working in Scotland. Important metal deposits (e.g. gold) are known to exist, however at present they are not economically viable.

The majority of Scotland's geological resources are non-renewable, and therefore need careful management to ensure they will be available for future generations.

Energy resources

Scotland's land area and the sea bed around the coast are rich in fossil fuels, mainly onshore coal and offshore oil and gas. Peat is also worked for fuel on a small scale.

Extensive coal deposits are found in the Central Belt, and have been mined on a large scale since the 18th century. In the past, coal was extracted from underground mines, but all coal mining in Scotland is now opencast. The total annual production of coal in Scotland has been in the range of 5–8 million tonnes since 1995, but has been falling since 2005 and dipped below 5 million tonnes in 2012 (for more information, see the Opencast Coal Survey 2012). Scotland still has a significant coal resource, with almost 30 million tonnes of coal at opencast sites that have permission for extraction, as well as other deposits, including deeper coal seams that are not currently being mined. Extensive exploration in the past means that the location of most coal deposits is well known[1].

In the future, some of Scotland's coal could be exploited through new technologies, such as underground coal gasification (UCG) or coal bed methane (CBM). UCG is a method of converting deep coal into a synthetic combustible gas while it is still underground, which allows energy to be extracted from coal that cannot be mined by conventional means. CBM involves extracting the methane that occurs naturally within coal seams, leaving the coal unaltered. The development of new methods such as these mean that Scottish coal could make a major contribution to the country's energy budget for many years to come. However, the use of coal would need to be balanced with the drive towards a low-carbon economy, for example, through the use of carbon capture and storage (CCS).

Oil was produced onshore in central Scotland from oil shales during the 19th century. Shale in this area may now offer the potential for shale gas extraction, through the use of hydraulic fracturing ('fracking'). However, the main resources of oil and gas lie offshore, in the North Sea and on the Atlantic margins west of Shetland, and those in the North Sea have been exploited on a large scale since the 1960s. Some 42 billion barrels of oil equivalent have been extracted from the sea bed around the UK since 1970. Although the North Sea is a mature oil and gas province, widespread exploration continues on the Atlantic margins, and ongoing exploration and development are expected to continue to prove new reserves. Current estimates suggest that, as long as the UK sea bed remains a competitive oil and gas province in which to invest, there could be up to 24 billion barrels of oil equivalent still to be recovered, and the industry will be active beyond 2050.

The longevity of the oil and gas industry will depend on the price of oil and gas, the tax regime and technological developments, as well as exploration and operational costs.

Oil and gas are currently Scotland's principal sources of fuel and power, although their contribution to electricity generation will reduce as renewables become more important.

Many oil and gas fields in the North Sea that are approaching or have reached the end of production could potentially offer appropriate locations for CCS. This involves capturing carbon dioxide from large emission sources such as power stations, and storing it in suitable rock deep beneath the earth's surface. Although CCS technology is currently at a developmental stage, research has shown that Scotland has large areas of rock that would be suitable for carbon dioxide storage.

In many areas, geothermal energy for heating can be extracted via ground-source heat pumps from the top 10–15 m of the ground, which is heated by solar radiation. The possibility that substantial reservoirs of geothermal energy exist at deep but accessible levels in some parts of the country is also now being investigated.

Construction resources

Scotland's varied geology provides extensive resources of raw materials for construction. Hard igneous rocks are common throughout much of Scotland, and these are widely quarried for aggregate, particularly dolerite in the Central Belt and granitic rocks elsewhere. Over 19 million tonnes of igneous rock were quarried in Scotland in 2011, with a large proportion coming from Scotland's only coastal superquarry at Glensanda, on Loch Linnhe, which has an annual production capacity of over 9 million tonnes. Smaller amounts of sandstone are also quarried for aggregate and building stone, and limestone and dolomite are quarried in a few localities for construction and agricultural purposes. Some aggregate is also dredged from offshore areas. Scottish aggregate is largely used within the UK, in road building and other infrastructure, but some is exported. Aggregate production was relatively stable during the decade up to 2008, but has since dropped due to the recession. Scotland has an abundance of hard rock for aggregate, which has the potential to supply domestic demand for many decades to come.

Deposits of glacial sand and gravel are common across Scotland, and were the main source of aggregate before the 1970s, but have since been overtaken by crushed rock[2]. They typically form relatively small deposits, and many of those close to urban centres have already been worked out or are not accessible for quarrying. Around 8 million tonnes of sand and gravel were quarried in Scotland each year from 2002 to 2010.

The great diversity of bedrock geology in Scotland is reflected in its substantial and impressive stone-built heritage. The local variations in stone type and architectural style that accompany the changes in local bedrock character – for example the extensive use of Rubislaw granite in Aberdeen and Craigleith sandstone in Edinburgh – provide many of Scotland's settlements with a distinctive identity and sense of place. Much of the stone-built heritage dates from the 19th century, when many hundreds of quarries throughout Scotland produced building stone. Today, only a handful of Scottish quarries supply stone for cladding buildings and paving, and much of the natural stone used today is imported from around the world.

Having been out of favour for many decades, the demand for local stone is now rising due to growing interest in using it in modern buildings, increased funding for the conservation of historic buildings and urban regeneration projects, and the need to repair decaying stone buildings. New and varied sources of local building stone will be required in future to meet the growing demand.

Industrial minerals

Relatively small amounts of clay and fire clay are worked for brickmaking. Talc, largely used for roofing felt, is worked in a quarry on the island of Unst in Shetland. Scotland has some deposits of silica sand suitable for glassmaking, largely in the Central Belt, where there are a small number of working quarries. A high-purity silica sand mine at Lochaline was closed in 2009. Around 500,000 tonnes of silica sand was produced in Scotland each year between 2002 and 2008. Scotland has significant resources of silica sand that could be worked in the future.

Barytes is an industrial mineral, which is principally used as a component of drilling mud in oilfields. Scotland has large deposits of barytes in the area around Aberfeldy, and these are currently worked at the Foss mine, which produced over 30,000 tonnes of barytes in 2011. A larger barytes deposit with measured resources of some 7 million tonnes exists nearby but is not currently worked.

Metallic minerals

No metal mines are currently working in Scotland, despite the country's long history of metal mining, with lead having been worked in the Leadhills area since the 13th century. The principal production of Scottish lead, together with small amounts of silver and gold, was at mines in the Leadhills–Wanlockhead, Tyndrum and Strontian areas. During the 19th and 20th centuries, substantial amounts of chromite were extracted from quarries on Unst, and iron ore from the Midland Valley[3].

Significant gold deposits are known to exist, particularly at Cononish, near Tyndrum, which has been mined on a small scale in the past and is currently being explored. Cononish is thought to have resources totalling 154,000 ounces of gold and 589,000 ounces of silver. Exploration for other gold deposits continues in the area, and other small gold prospects are known in a number of places in Scotland.

It is likely that there will be an increase in demand for the types of metals used in new technologies, such as electric cars and wind turbines. These metals include the rare earth elements, platinum, lithium and tantalum. Some of these metals are currently sourced from only a small number of mines across the world, many of them in central Africa, China or Brazil, and there are concerns about security of supply. There has been little or no systematic exploration for resources of most of these strategic metals in the UK, but potential deposits in Scotland are the subject of ongoing research.

Detailed mineral resource maps are available for some areas in the Central Belt of Scotland.

Figures 1 and 2 illustrate the amount and value of geological resources produced onshore in Scotland in 2011.

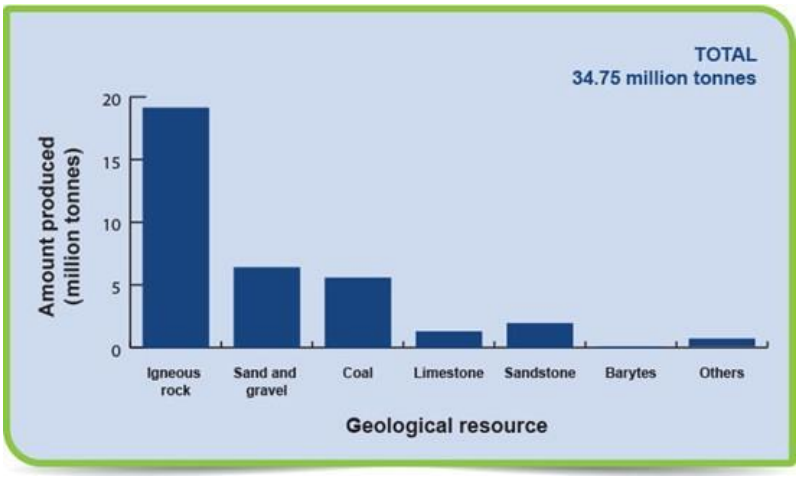

Figure 1: Geological resources produced onshore in Scotland in 2011 (excluding oil and gas)

Source: Based on data from the UK Minerals Yearbook 2012.

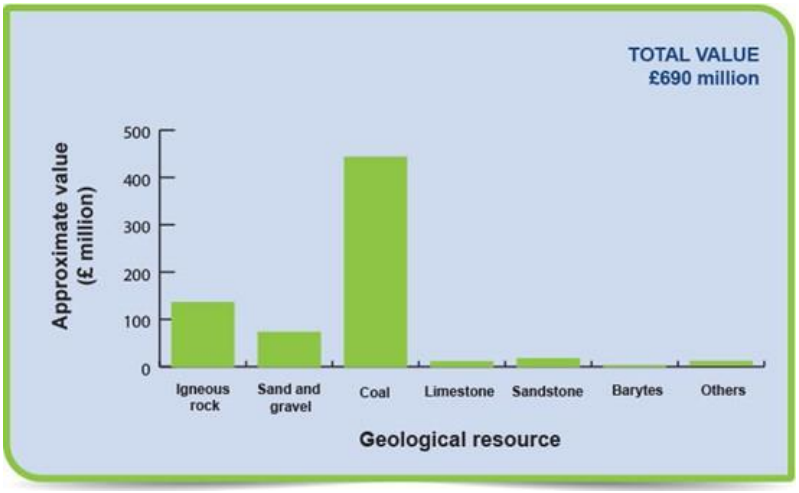

Figure 2: Approximate value of geological resources produced onshore in Scotland in 2011 (excluding oil and gas)

Source: Based on data from the UK Minerals Yearbook 2012.

Wider impacts of extracting resources

Any mining, quarrying or drilling is likely to have an impact on the local environment, economy and people. These impacts may be positive or negative, and may be temporary or permanent.

Potential negative impacts include air pollution by dust around quarries, noise pollution, waste, visual effects on the landscape, damage to the area's ecology and increased use of roads and railways. Positive impacts may include jobs and contributions to the local economy, and beneficial changes to the area's ecology.

Extraction is controlled by laws that require appropriate operation and subsequent restoration of all mine and quarry sites. Many mines and quarries have been sympathetically restored after working and some can become sites of importance for geodiversity and biodiversity.

However, mining and quarrying that predates current environmental legislation has left a legacy of environmental change. Some of these changes are negative, such as scarred landscapes, areas of contaminated land and water around mine dumps, groundwater pollution and subsidence above abandoned coal mines. Other impacts are more positive, such as the development of tourist attractions at old mines and the potential for geothermal energy from abandoned mine-waters.

Pressures affecting fossil fuels and minerals

The majority of Scotland's geological resources are non-renewable, and therefore need careful management to ensure they will be available for future generations.

The key pressures can be divided into three main groups:

- exploitation;
- demand and economic factors;
- environmental issues and resource sterilisation.

Exploitation

Many of Scotland's geological resources have been worked extensively, chiefly during the last century. This is particularly true of fossil fuels (coal, oil and gas), aggregates, barytes and lead. In most cases, it will be many years before deposits are exhausted, but it is important to note that their lifetime is finite. Scotland has significant resources of coal, hard rock for aggregate, barytes and silica sand, and exploitation at the current rates can be continued for many years.

Demand and economic factors

A major constraint on the exploitation of any geological resource is the demand for, and market value of, that resource. Mineral producers in Scotland have to compete in world commodities markets with cheaper imports from abroad, and production from many of Scotland's resources is only economic if the global price of that resource is relatively high. For example, mining for Scottish gold is only economic when the market price is high, due to very high production costs in Scotland.

Demand for energy resources is generally strong, although the recession that began in 2008 led to a notable slowing in demand.

Coal produced in the UK has had to compete with cheaper imported coal in the past, but an increase in international coal prices since 2005 has made UK coal more competitive (for more information, download the mineral profile for coal). Demand for barytes is directly linked to the level of exploration for oil and gas on the sea bed around the UK, as almost all Scottish barytes is used in the exploration industry as drilling mud.

Competition from cheaper imported stone has had a negative effect on the Scottish building-stone industry in recent decades. However, this is changing as the demand for natural stone grows, and planning regulations in some areas encourage the use of local stone in building repairs and in new buildings. The closure of so many former stone quarries means that it is often impossible to repair old buildings with the same stone that was used originally, so new or re-opened quarries will be required to repair historically important buildings to high conservation standards.

Increased demand for metals is likely to have some influence on the exploitation of Scottish mineral deposits in the near future. Recent high prices of gold led to a drive to re-open the gold mine at Cononish near Tyndrum, and begin further exploration in the surrounding area.

Environmental issues and resource sterilisation

Drilling, mining and quarrying to exploit geological resources can be damaging to the environment. For this reason, policies are in place to ensure extraction takes place in a sustainable and environmentally acceptable manner. In general, this means that well-planned extraction of the geological resource can be carried out in many areas.

However, the legacy of historic exploitation of mineral resources can result in pollution, for example when polluted water drains from abandoned mines into groundwater in some parts of Scotland.

Some of Scotland's geological resources are effectively sterilised – unavailable for us to use – because they occur underneath towns or areas that are already protected for landscape and environmental reasons. This is the case for many of the stone quarries that have been filled in and built upon as towns have expanded. An example of this is Craigleith Quarry in Edinburgh, which was the source of much of the sandstone for Edinburgh's New Town. The quarry has been built over and is now the site of a retail park.

It is anticipated that the long-term demand for Scotland's fossil fuels will be reduced as we move towards to a low-carbon economy. However, Scotland also offers the geological resources required for the storage of carbon dioxide generated by burning fossil fuels. Development of carbon capture and storage (CCS) would allow continued use of Scottish coal in a low-carbon economy.

References

1. *Rippon JH (2002) Coal. In: Trewin NH (ed.)* The Geology of Scotland, *pp 449-454. London: The Geological Society.*
2. *Gribble CD (2002) Bulk Minerals. In: Trewin NH (ed.)* The Geology of Scotland, *pp 455-460. London:*
3. *The Geological Society.Rice CM (2002) Metalliferous minerals. In: Trewin NH (ed.)* The Geology of Scotland, *pp 431-448. London: The Geological Society.*

What is being done

New technologies for extraction of geological resources, and for mitigation of environmental impacts, have the potential to ensure that Scotland's geological resources can be used for many generations to come.

Sustainable development of geological resources is an essential part of modern life. The vast majority of day-to-day objects contain components that have originated, at some stage, in the earth's crust. We rely on geological resources for energy production, building and construction, clean water, and the raw materials for everything from cars and mobile phones to cups and plates. Sustainable development of these resources means that they are extracted as efficiently as possible, with the minimum environmental impact. We should recycle resources wherever possible. Continued research into technologies for improved exploration, extraction, processing and recycling will improve the sustainability of the fossil-fuel and minerals industries.

Geological resources are mostly finite – that is, they will run out at some point in the future. Scottish planning policy has been developed to ensure that extraction takes place in a sustainable manner with an acceptable impact on the environment.

Scottish planning policy sets out policies relating to all minerals. It explains that:

- sufficient supplies of minerals should be provided to meet society's needs;
- the planning system should be used to encourage development at sites where impacts on communities and the environment are acceptable;
- mineral resources should be protected as far as possible;
- mineral consents will be reviewed every 15 years to ensure that extraction is carried out to modern working standards.

Separate policies apply to surface coal mining.

Further information on Scottish planning policy and how it relates to geological resources, including planning advice notes and fact-sheets on specific resources, can be found on the Scottish Government website.