British Geological Survey

Mineral Planning Factsheet

Brick clay

This factsheet provides an overview of **brick clay** supply in the UK. It is one of a series on economically important minerals that are extracted in Britain and is primarily intended to inform the land-use planning process. It is not a statement of planning policy or guidance; nor does it imply Government approval of any existing or potential planning application in the UK administration.

April 2022

Brick clay is the term used to describe **'clay, shale, mudstone and other such materials'** used in the manufacture of structural clay products, such as facing and engineering bricks, pavers, clay tiles for roofing and cladding, and vitrified clay pipes. Brick manufacture is by far the largest tonnage use and as such the indicative extraction tonnages and reserve and resource figures presented in this factsheet are based on statistics provided by the brick manufacturing sector. Some clay, shale, and mudstone is used for engineering purposes, such as lining and capping landfill sites, lining canals and ponds and for general construction purposes (fill).

Brick clays are fine-grained sediments or sedimentary rocks of different geological ages and compositions. These range from relatively soft, plastic clays to hard mudstones. Their chemical properties, which are related to their mineralogical composition, and physical properties, particularly grain size, are critical to determining their suitability for the manufacture of structural clay products. These properties affect the forming behaviour of the clay (the process prior to firing in which the ware is shaped), its behaviour during drying and firing, and also the final properties of the fired product. These properties include strength, water absorption (porosity) and frost resistance, and thus durability and performance in service. Importantly, they also affect aesthetic appearance, such as colour and texture, providing greater choice and style for architects and developers. Clay bricks (and tiles) are versatile and highly durable construction materials and one of the most visible components of the built environment. In addition to their functional use, they make an important contribution to local architectural styles in our cities, towns and villages. The variety of clay used gives rise to the distinctive regional variations in the appearance of the built environment. Some manufacturere specialise in handmade products for the repair of historic buildings.

Building showcasing use of bricks (Buckingham Green, London) ©Michelmersh.

Most facing bricks, engineering bricks and related clay-based building products are manufactured in large automated factories. These represent a high capital, long-term investment in plant and are increasingly dependent, therefore, on raw materials with predictable and consistent firing characteristics in order to achieve high yields of saleable products. Blending different clays to achieve improved durability and to provide a range of fired colours and textures is an increasingly common feature of the brick industry. Continuity of supply of consistent raw materials is important. Whilst in the past brick clay was usually consumed in brickworks adjacent to the quarry, today significant tonnages are commonly transported to other brickworks for blending purposes or to serve plants with limited or no associated clay reserves. Specialist pottery blends for the education, studio pottery and art markets are exported throughout the world.

Demand

Brick clays are used in the production of structural clay products, with the manufacture of 'facing' bricks being the most important use, accounting for well over 90% of demand. The major use of facing bricks is in the domestic housing market. These are bricks produced to high technical standards, so that they are resistant to the weather, and also have an attractive external appearance. The introduction of new, and more demanding standards for bricks in terms of durability is placing greater constraints on the types of clays that can be used. Most brick clays are red firing, but there is a significant demand for grey and buff/cream-coloured bricks for which fireclays have been traditionally used. Developers, architects and planners are demanding that new housing and other

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buildings have a 'traditional' appearance sympathetic to local vernacular styles. Brick manufacturers are able to manufacture bricks to different specifications, using different clay blends and stains to meet this need using a varied range of industrial minerals such as silica sand (see **Silica Sand** Factsheet). Great Britain is reported to be one of the largest markets in Western Europe for facing bricks. Brick clays are also used to make 'engineering' bricks, which are high strength, low porosity bricks used in load-bearing structures and in other technically-demanding situations. 'Paving' bricks are of special composition and dimensions to serve as paving and are designed for hard wear, low porosity and resistance to frost. Brick clays are used to manufacture other types of structural clayware, such as pipes for drainage and sewerage, and roof tiles. Large tonnages of clay, shale and mudstone are also used in the manufacture of cement (see **Cement** Factsheet). Small amounts are used in a process to make lightweight aggregate for block making.

Supply

Extractors' sales of 'clay and shale' for the manufacture of bricks, pipes and tiles were separately recorded by the *Annual Minerals Raised Inquiry* between 1974 and 2014. Sales between 2015 and 2020 were provided by the British Ceramic Confederation (BCC). Production since 1990 is shown in figures 1 and 2. Brick manufacture is the largest tonnage use of clays and accounts for around 95% of the clay extracted in this sector. Only small quantities of clay and shale are used in pipe and tile manufacture. In addition to clay and shale, fireclay, which in the past was a by-product of coal mining, is still an important raw material used in brick and pipe manufacture. The volume of fireclay used has significantly reduced over the years but it remains intrinsic to serving the buff/cream coloured market and for its inherently strong and resistant characteristics. These are critical properties for the studio pottery, education and art markets also.

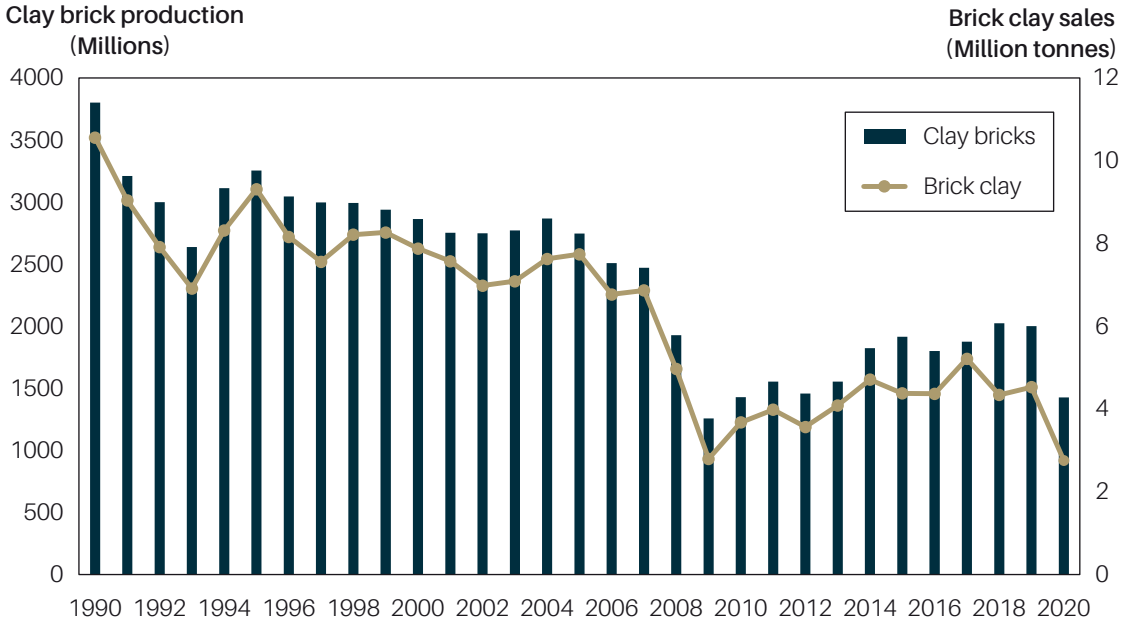

Figure 1 Great Britain: Sales of clay and shale for brick, pipe and tile manufacture and production of clay bricks, 1990–2020. *Source: 1991–2014 Annual Minerals Raised Inquiry, Office for National Statistics; 2015–2021 British Ceramic Confederation; Monthly statistics of building materials and components, DCLG/DTI/BERR/BIS/BEIS and Mineral Extraction in Great Britain, Office for National Statistics.*

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Modern brick making process (Eclipse Factory) ©Ibstock.

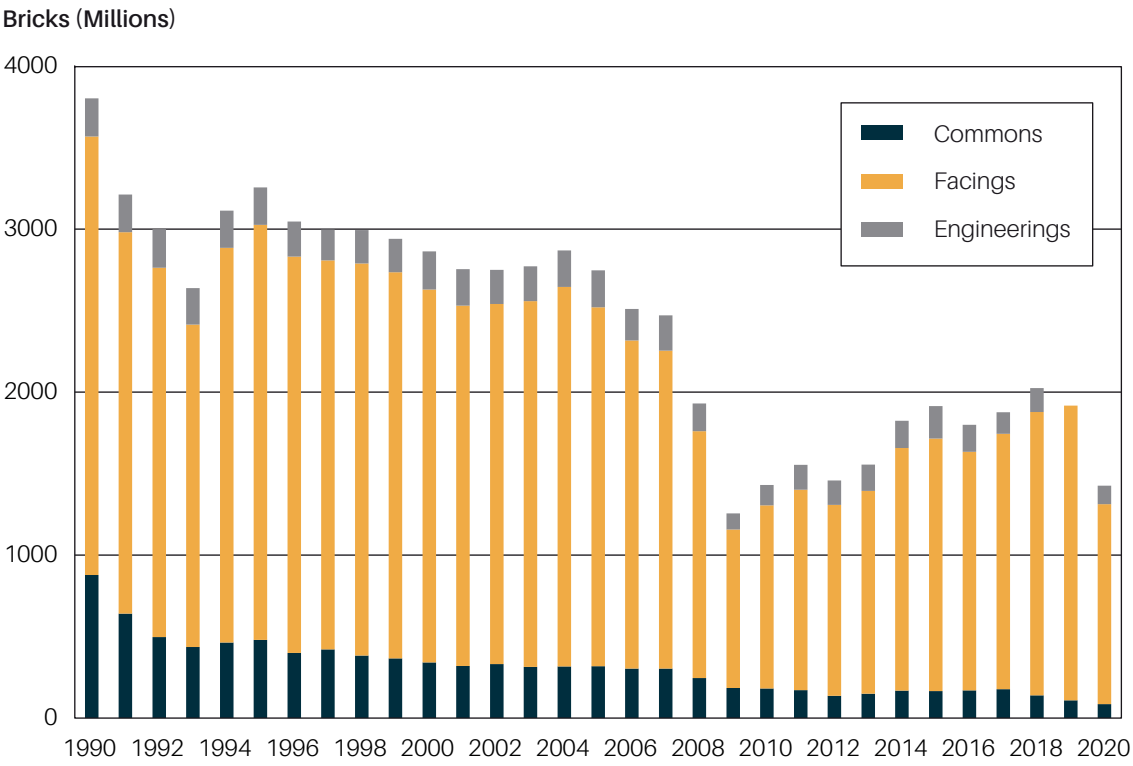

Figure 2 Great Britain: Production of bricks by type, 1990–2020. *Source: Monthly statistics of building materials and components (DCLG/DTI/BERR/BIS/BEIS).*

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Brick clay extraction now largely takes place in England reflecting the location of brick manufacturing capacity, which has reduced significantly since 2007 and is now based on fewer, but larger plants. The largest brick making region is the English Midlands accounting for over half of total production in Great Britain. As a general approximation, 3 tonnes of clay/shale are used in the manufacture of 1000 bricks. The decline in demand for 'brick clay' from over 16 million tonnes in 1974 to some 4 million tonnes in 2019 is broadly in line with the decline in the production of clay bricks (Figure 1). This was mainly due to the demise of 'common' bricks which have been replaced in the inner leaves of cavity walls in houses by concrete blocks and in internal walls by blocks and plasterboard. Brick production by type is shown in Figure 2. The 2008 recession also had a significant impact on brick production. The output of facing and engineering bricks has remained fairly static in recent years. Production was low in 2020 due to reduced demand as a result of the Covid-19 pandemic. Over 94% of all bricks are clay-based, the remainder being principally concrete bricks. Production of clay bricks has been around 1.5 to 2 billion a year during the past decade. Clay tiles have suffered severe competition from concrete roofing tiles, and the use of clay and shale in pipemaking has declined considerably due to competition from concrete and plastic pipes.

Historically, the UK's demand for clay construction products has been largely fulfilled through domestic production. Prior to the 2008 recession, production levels remained relatively constant over a number of years, reflecting strong product demand as well as high manufacturing capacity utilisation in the sector. The global economic downturn resulted in extremely difficult operating conditions across all major markets in the sector. Between 2008 and 2013, 30% of UK clay construction product sites closed permanently.

By 2013 the UK economy was more-stable and there was greater certainty in market conditions for clay construction product manufacturers. Product manufacturing did see a small increase and a handful of mothballed plants restarted production, however volumes remain significantly lower compared to pre-recession production levels. Around 70 clay construction product manufacturing sites now remain operational.

Table 1 UK imports and exports of clay bricks, tiles and pipes, 2016–2020. *Source: HMRC, UKTradeInfo.*

		Imports		Exports	
		Tonnes	£thousand	Tonnes	£thousand
Building bricks	2016	548 215	61 650	80 586	6 736
	2017	776 787	77 464	106 891	8 268
	2018	1 005 209	106 286	95 575	8 320
	2019	1 068 000	119 073	81 489	6 949
	2020	802 743	93 540	66 419	7 169
Roofing tiles	2016	73 928	21 065	3 029	1 921
	2017	109 946	29 558	3 333	1 883
	2018	107 284	29 966	2 880	1 609
	2019	122 201	27 374	2 966	2 037
	2020	116 022	28 911	2 715	1 827
Clay pipes and fittings	2016	95	1 508	2 241	4 317
	2017	98	1 579	7 688	3 440
	2018	129	1 526	3 589	4 269
	2019	122	1 815	5 197	5 034
	2020	46	696	3 152	2467

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Trade

Brick clay is not separately recorded in overseas trade statistics but is not likely to be traded because of its relatively low ex-quarry selling price and its high transportation costs. The UK is, therefore, almost entirely self-sufficient in brick clay. There is, however, international trade in manufactured clay-based building products and a summary of the main headings is shown in Table 1. The UK is a net importer of clay bricks and tiles and imports are on a rising trend. Imports accounted for around 20% of the clay brick market in 2019. The UK is a net exporter of clay pipes.

In recent years imports have reached unprecedented levels, accounting for 20% of brick sales and 30% of clay tile sales in 2019. These are mostly from Europe, with Belgium, Netherlands and Denmark the top import partners for bricks and France, Germany and Poland the top import partners for tiles. Import levels are expected to remain notably higher than pre-recession levels as product demand (for house building) is likely to be sustained.

Consumption

Brick clay consumption declined significantly between the 1970s and the early 1990s, mainly reflecting the decline in brick production due to the demise of the 'common' brick. There was a sharp decline in 2008 and a drop in 2020 due to the Covid-19 pandemic. Since 2014 annual brick clay production has been in the region of 5 to 6 million tonnes. In comparison, production of natural aggregates was about 195 million tonnes in the UK in 2019 (Bide et al, 2021). The principal markets for bricks are in:

- Private housing 70%
- Public housing 13%
- Non-domestic buildings 17%

House building is the principal consumer of bricks (and therefore brick clay). Across the UK there is a reasonably close positive correlation between brick production and house building. Thus, brick production (and thus the demand for brick clay)

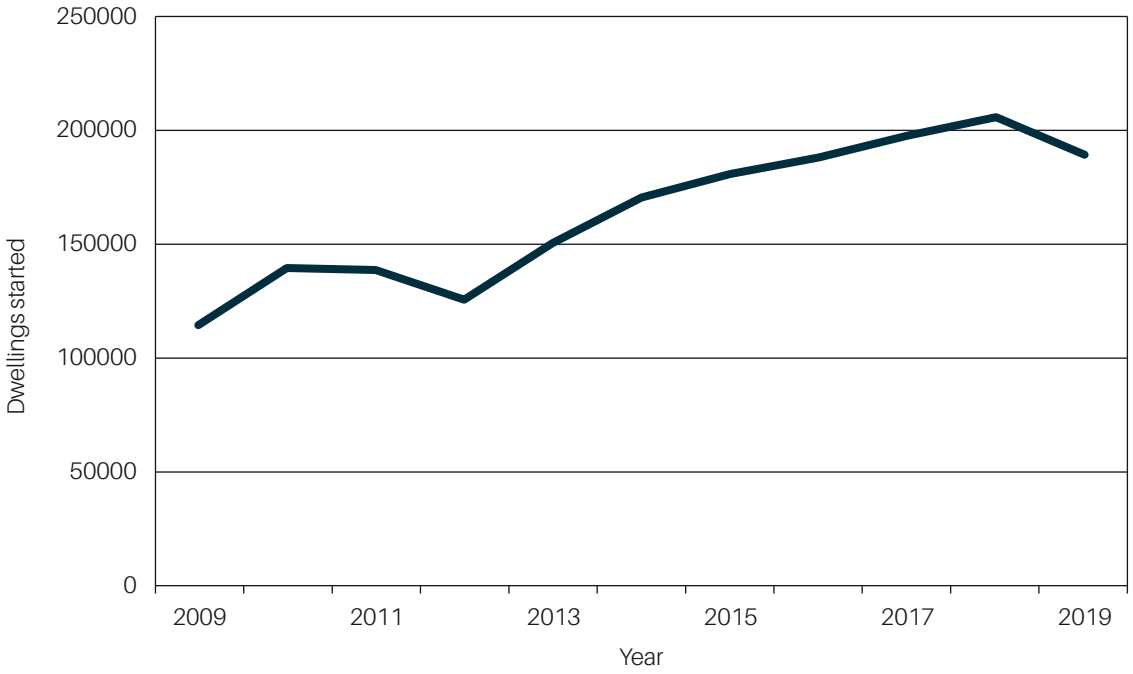

Figure 3 All permanent dwellings started in Great Britain 2009–2019.
Source: UK House Building: Permanent dwellings started and completed, UK Housing Statistics 2021, Office for National Statistics.

is closely linked to Government policies related to housebuilding stimulus and demand and associated construction. This increase in housebuilding (Figure 3) has to some extent partially decoupled from brick production, in part due to a trend toward higher density housing (with smaller houses and flats consuming fewer bricks per unit). However, given UK Government house building targets, demand for bricks, and therefore brick clay, is likely to remain strong if not increase over the next decade.

Economic importance

Clay and shale used in the manufacture of bricks, pipes and tiles are not generally sold on the open market but are consumed by the brick/pipe manufacturers themselves. The exception to this is fireclay, albeit in ever decreasing volumes (as noted above). Brick clay typically has a low unit value on an ex-quarry basis (roughly between £3 and £6 per tonne). At a production rate of around 6 million tonnes per annum, this equates to a total value of around £27 million a year. However, with the increasing trend towards blending, and the consequent movement of clay raw materials, the resulting delivered cost of clay to some brickworks is significantly greater. Nevertheless, while brick clay is a relatively low priced raw material, it supports a manufacturing industry of some considerable importance with a high value-added component. The total value of sales of clay-based construction products was £637 million in 2020. A breakdown of these sales by major product is shown in Table 2.

Bricks, pipes and tiles are themselves important building materials for the construction industry, which is a major sector of the economy. In 2019 the value of construction new work in Great Britain was £119 billion (Office for National Statistics, 2021).

Structure of the industry

The location of the brick manufacturing industry largely reflects the distribution of clay resources. The brick industry has undergone major rationalisation over the last two decades through mergers and acquisitions, and closures, with around 60 brickworks still operational (and an additional 10 works producing clay construction products such as tiles and pipes). Four companies, who collectively have over 90% of the market, now dominate brick manufacturing in the UK. These companies operate plants with capacities mainly in the range 30–100 million bricks a year, with some sites having a combined capacity that exceeds 100 million bricks. Consolidation has led to increased transport movements of some specialist clays, albeit in relatively small volumes.

The four main brick producers are Forterra, Ibstock, Michelmersh and Wienerberger (all of which have operations across the UK). The remaining market share (less than 5%) is taken by around ten smaller companies. Two companies account for almost all clay drainage pipe manufacture. These companies are Wavin and Naylor Drainage and both are based in the Penistone area of South Yorkshire. The three larg-

Table 2 Value of sales of clay-based construction products, 2016–2020. *Source: UK Manufacturers' Sales by Product Survey (Prodcom), Office for National Statistics.*

	£ million				
Product	2016	2017	2018	2019	2020
Clay bricks	540.9	602.7	595.2	612.1	520.5*
Clay tiles	105.0	110.4	104.9	96.7	76.2*
Clay construction products	31.8	31.3	32.1	28.2	24.7*
Clay pipes	s	s	19.4	s	15.1*

S suppressed. Small quantities of clay flooring blocks are also produced.

* Sales for 2020 were affected by the closure of brick works and a reduction in construction activity during the Covid-19 pandemic.

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est manufacturers of clay roof tiles are Sandtoft Roof Tiles (South Yorkshire), Marley (based in Staffordshire) and BMI Group (Warwickshire).

The majority of brick manufacturers are members of the British Ceramic Confederation (BCC), which is the trade association for the UK ceramic manufacturing industry. The interests of the clay pipes and roof tiles sectors are dealt with by the Clay Pipe Development Association and the Roof Tile Association.

Raw materials

A wide range of clays (including arisings from other mineral extraction operations such as coal) have been used in the past in the manufacture of structural clay products. Clays occur extensively in many parts of Britain and resources are, therefore, potentially very large. However, many clays are unsuitable for brickmaking. The extent of the principal brick clay resources is shown in Figure 4, although not all the areas shown will be suitable for the manufacture of structural clay products. The presence of other rock types, such as siltstone and sandstone, which may predominate in some areas, high overburden thicknesses and excessive amounts of impurities, such as carbon and gypsum, will also preclude working in some areas.

Sedimentary clays consist essentially of clay minerals and quartz, although many other minerals may occur in accessory amounts, which may considerably affect the suitability of the clay for brick manufacture. In a brick clay there must be sufficient clay minerals present to make it plastic to mould and to retain its shape prior to firing. Sufficient fluxing materials must also be present for the clay to vitrify (partially fuse to form a glass to give the product strength) at temperatures between 900–1100°C. An adequate proportion of non-plastic constituents, usually quartz, is also required to prevent excessive shrinkage and deformation during drying and firing. In good quality brick clays, the predominant clay minerals are kaolinite and illite. These impart desirable properties which are important in forming and firing the brick. Carbon and sulphur can have a major influence on firing performance and emissions, and low levels are preferred (< 1.5% and <0.1% respectively). The familiar red/brown colour of most bricks is due to the presence of iron minerals in almost all clays. However, the presence of carbonate minerals, such as calcite and dolomite, can produce

Traditional brick making process (Cradley Brick) ©Forterra.

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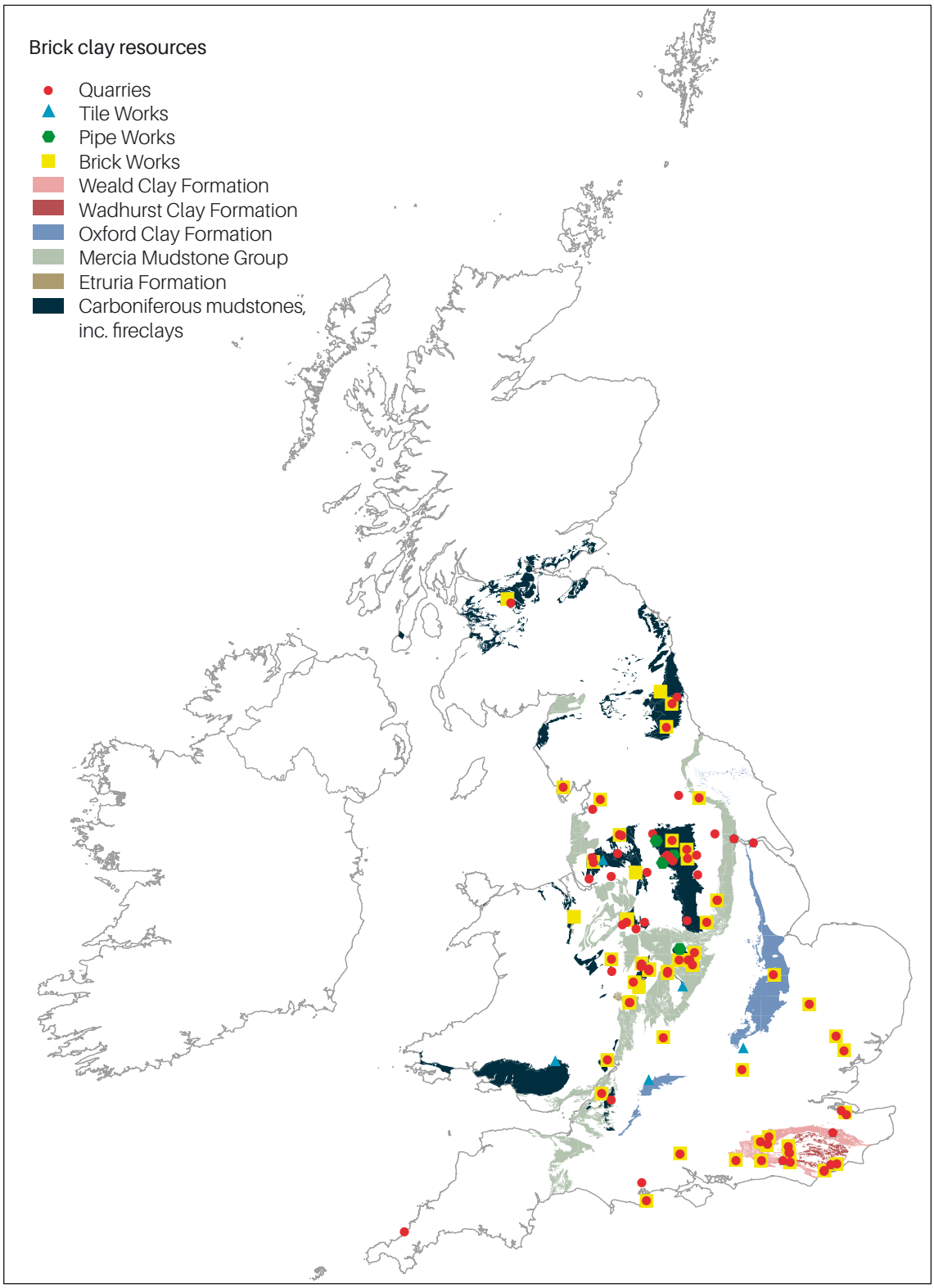

Figure 4 Great Britain: Distribution of the principal brick clay resources.

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paler-coloured bricks. Carbonate minerals must be in fine-grained form as coarse carbonate leads to a problem known as 'lime-blowing' (falling away of the surface of a brick due to expansion, following hydration of nodules of lime). Production of very pale buff/ cream 'through-colour' bricks is traditionally achieved by using fireclays with low iron contents. Durable yellow bricks (such as London 'stocks') are made from a mixture of clay and calcium carbonate (typically chalk).

With the reduction in the number of brick and pipe works, clay production has become concentrated on a much more limited range of clay resources. Modern brickmaking technology requires a high capital investment and is increasingly dependent, therefore, on raw materials with predictable and consistent firing characteristics in order to achieve high yields of saleable products. This ensures that raw materials (both clay and energy) are used optimally, an important objective of sustainable development. Blending different clays to achieve improved durability and to provide a range of fired colours and aesthetic qualities is a common feature of the brick industry.

Although other clays are used on a small-scale, the location of the industry tends to reflect the distribution of the principal brick clay resources. In approximate order of tonnage used in brickmaking these are as follows (Figure 6):

- Mercia Mudstone Group or 'Keuper Marl' (Triassic age) in the Midlands: Extraction and use of these clays is confined to the English Midlands, with their utilisation providing for an average annual brick production that exceeds 600 million (approximately 35% of the UK total). The mineralogy of parts of the resource most commonly gives rise to distinctive red, pink and pale-bodied bricks (due to the presence of carbonate minerals). Both extrusion and 'soft mud' are common manufacturing methods applied (see Extraction and processing section);

- Carboniferous mudstones, mainly in the North of England but also at one site in the South. Variable in quality, with only a small proportion suitable for brick manufacture (most are too high in carbon and sulphur). Despite this, they are a very important resource, accounting for almost 25% of UK production. Almost all bricks made from Carboniferous mudstones are formed by extrusion. Most clay drainage pipes are made from these clays;

- Etruria Formation or 'Etruria Marl' (Carboniferous age): High quality clay that is close in composition to the 'ideal' brick clay. Extracted and used solely from the Midlands (mainly Staffordshire and other parts of the West Midlands), accounting for approximately 20% of UK production. Bricks are made by both extrusion and soft-mud methods. Often used to 'sweeten' poorer-quality clays. Most clay roof tile makers use this material. Outcrop area is very restricted and parts have already been extensively sterilised by urban development;

- Weald and Wadhurst clays (Cretaceous age): Extracted solely in the South of England and the principal brick clay resource in South East England. Most production takes place to the south of London. Accounting for approximately 15% of UK production. Bricks are mostly manufactured using the 'soft mud' process;

- Peterborough Member or 'Lower Oxford Clay' (Jurassic age): Extraction of these clays is now confined to Cambridgeshire, where they are used in the manufacture of 'fletton' bricks. Their high carbon content requires an unusual manufacturing process (semi-dry pressed bricks fired in chambered kilns). Fletton bricks dominated brick production in England for 100 years, but there has been a severe reduction in usage of this clay over the last 30 years (due largely to high levels of pollutants emitted during firing) and the manufacture of these bricks is now restricted to one large production unit. Fletton bricks now make up only approximately 5% of UK production.

Minor brick clay resources are locally important and include fireclay associated with largely historic opencast coal operations, brickearth in Kent and Essex; the Reading Formation in Hampshire and the Chilterns; the Gault Clay in Kent, West Sussex and Hampshire; the Thanet Formation in Essex; Carboniferous and Devonian mudstones in South West England; the Skiddaw Group near Barrow-in-Furness and alluvial clays on Humberside. However, whilst locally important, in isolation none of these materials would be considered significant contributors to UK brick production.

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Reserves and Resources

In mineral planning, the terms 'reserves,' 'mineral reserves' or 'permitted reserves' commonly refer to the tonnage of mineral that has a valid planning permission for extraction (the 'governmental factor'), is geologically 'proven' (involving an appropriate level of site investigation data and analysis), and is of a proven acceptable quality for the intended purpose(s). 'Re-sources' and 'mineral resources' may not necessarily benefit from being covered by an extant planning permission, or may have some other restriction on their development, but in any event may confidently be expected to have any such incumbrances readily overcome/resolved at an appropriate point in the future (when they would then become 'reserves').

Clause 208 of The National Planning Policy Frame-work (NPPF, 2019) requires that:

"Minerals planning authorities should plan for a steady and adequate supply of industrial minerals by":

a) co-operating with neighbouring and more distant authorities to ensure an adequate provision of industrial minerals to support their likely use in industrial and manufacturing processes;

b) encouraging safeguarding or stockpiling so that important minerals remain available for use;

c) maintaining a stock of permitted reserves to support the level of actual and proposed invest-ment required for new or existing plant, and the maintenance and improvement of existing plant and equipment; and

d) taking account of the need for provision of brick clay from a number of different sources to enable appropriate blends to be made.

With specific reference to c) above, the NPPF (2019) states that *"reserves should be .. at least 25 years for brick clay".*

In consultation with the British Geological Survey (BGS) and in association with the production of this factsheet, the BCC has surveyed its members and compiled a dataset comprising up to date information on brick clay reserves and resources in the UK. This dataset is subdivided into the main UK brick making raw material geological formations (as listed above in the Raw

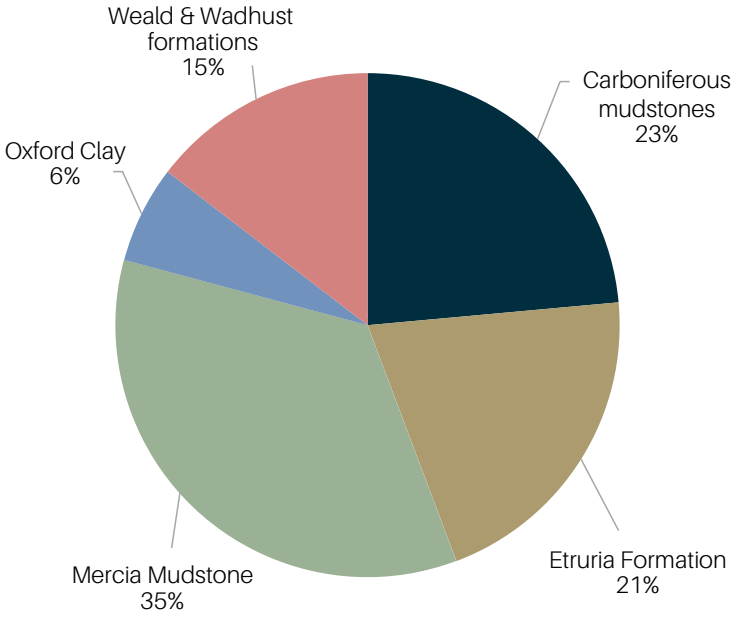

Figure 5 Great Britain: Brick production by major brick clay geological source, 2020. *Source: Survey of members by the British Ceramic Confederation, 2020.*

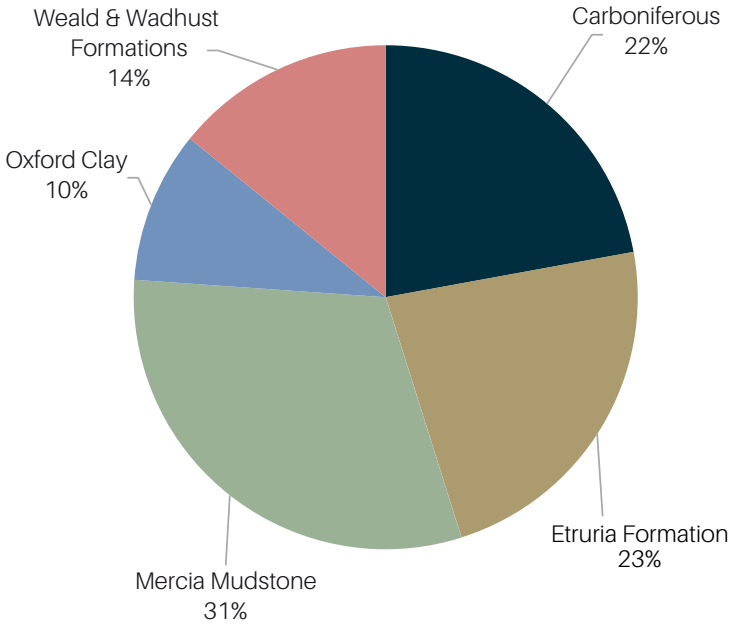

Figure 6 Great Britain: Brick clay total reserves and resources by major brick clay geological source, 2020. *Source: Survey of members by the British Ceramic Confederation, 2020.*

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Table 3 Brick production and reserves/resources of brick clay by geological source. *Source: Survey of members by the British Ceramic Confederation, 2020.*

Geological source of brick clay	Annual brick production (million bricks, average 2015–2019)	Total reserves and resources (million tonnes)
Mercia Mudstone Group (Triassic)	615	35
Coal Measures Group (Carboniferous)	415	25
Etruria Formation (Carboniferous)	365	26
Weald & Wadhurst formations (Cretaceous)	257	16
Oxford Clay Formation (Jurassic)	110	11
Clays from Recent/Quaternary deposits	s	s
Other brick clay sources that do not fall into any of the above categories	s	s

s = Suppressed, regarded as confidential by the producer — but relatively insignificant.

Materials section). Data are presented in Table 3 and figures 5 and 6.

This dataset has allowed the presentation of information and statistics not previously available. To respect confidentialities and other commercial sensitivities all data compiled by the BCC has been subjected to a degree of amalgamation, simplification and rounding. As such, whilst accurate and representative, data are to be regarded as illustrative. Further, it is only representative of the survey's 'snapshot' in time (reserves and resources as at 2020 and average extraction and production over the period 2015 to 2019, which is, prior to the impact of the Covid 19 pandemic).

All data collected was based on the raw materials (brick clays) that operators would confidently expect to work over the next 25 years.

In general terms, the UK brick industry has sufficient reserves and resources of brick clay to ensure brick manufacturing can continue to 2030. However, compliance with the NPPF requirement to maintain a 25-year landbank is limited. Additional resources of brick clay will be needed to ensure that the industry continues to operate into the future.

Relationship to environmental designations

Minerals can only be worked where they occur, and a number of clay resources are situated within Areas of Outstanding Natural Beauty, as are the associated manufacturing plants and infrastructure. Although, elsewhere clay resources are predominantly unaffected by national landscape designations, some may be affected by designations or potentially by future policy changes.

Extraction and processing

In the manufacture of bricks and other structural clay products, the term 'clay' is used relatively loosely, since the clay mineral content of the raw materials may vary from 20% to 80%. Non-clay minerals, such as quartz, iron oxide and calcium carbonate, can profoundly affect the colour and properties of the fired bricks, and materials such as carbon, sulphur and gypsum are important impurities.

The brickmaking process consists of several different stages: clay extraction; clay preparation (in which the raw material is reduced to a workable consistency for forming or shaping); forming; drying to remove moisture and to give the brick strength to retain its shape; and finally firing (Brick Development Association, 2017).

Brick clays are worked entirely by open pit methods. A range of equipment and working methods have evolved to meet the differing demands of deep or shallow quarries, uniform or heterogeneous deposits, soft clays or hard shales.

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Most bricks are formed or shaped principally by extrusion or the 'soft-mud' process. Extrusion accounts for just under 60% of production with soft-mud around 40%. The balance is manufactured mainly by a form of pressing (Flettons) or 'hand mades'. Extrusion involves forming a column of clay by pushing the material through a die at high pressure. The rectangular section column is then cut into bricks (known as 'wire-cut'). Most drainage pipes and clay roof tiles are also made by extrusion. In the soft-mud process, individual bricks are formed in a sand-lined mould from clay with a relatively high moisture content (known as 'stock' bricks). This process produces bricks with an irregular outline, often showing surface creases and sanded on all surfaces. The aesthetic properties of these bricks have resulted in a resurgence in their popularity. Although a very high proportion of soft-mud bricks are machine made, hand-making is still common, particularly in producing premium-quality facing bricks and complex shaped 'specials'.

The bricks are then dried prior to firing. Most are fired using natural gas in a linear kiln known as a 'tunnel kiln', which allows the process to proceed continuously and in which a line of cars loaded with bricks is pushed through a stationary firing zone. However, intermittent (batch) kilns are also used. The important changes relating to the development of brick properties result from the breakdown of the original clay mineral and the formation of new crystalline material and glass phases. The temperature at which vitrification (glass formation) occurs depends on the mineralogy of the clay. Vitrification usually begins at 900°C and is complete by 1050°C (or up to 1100°C in the case of more refractory fireclays). Vitrification gives the brick the strength and durability it requires to perform in service, as well as an attractive appearance. 'Facing' bricks are used in external walls where architectural appearance is important — they can be wire-cut or stock bricks. Wire-cut 'engineering' bricks are made to meet strict technical specifications for use in demanding situations where strength and durability are critical.

Conventional tunnel kilns normally require a 2–3 day firing cycle. However, rapid firing using roller hearth kilns with firing cycles as low as 30 minutes are used for some products, including tiles and vitrified clay pipes. In this process the product is continuously fed through a small diameter tunnel kiln on rollers. Rapid firing reduces energy consumption and overall emissions. However, these techniques require careful control of the mix of clays used to create the body composition of the brick. Many natural clays are unsuitable for rapid heating/cooling cycles. As a result, blending of clays and other minerals, in order to avoid these problems, is likely to increase with a consequent increase in demand for premium quality brick clays. Some clays used in pipemaking are subject to low temperature calcination prior to milling and extrusion.

By-products

A small number of brick clay sites have been known to produce saleable construction aggregate from overburden and interburden, thus optimising the use of all mineral resources at an already developed/developing site. In particular, sites in Carboniferous mudstones may also produce sandstone for use as a low-quality aggregate (see **Construction Aggregates** Factsheet) and have the potential to produce building stone (see **Building Stone** Factsheet). Conversely some sandstone quarries may also sell associated mudstone to local brick manufacturers. Some sites working Coal Measures mudstones may also produce small amounts of coal as a by-product. Sand and gravel are also occasionally produced from the superficial deposits overlying brick clays, such as the Peterborough Member in Cambridgeshire. Fired brick waste is sometimes sold as low-grade aggregate, particularly in eastern England where sources of primary fill material are scarce.

Alternatives/recycling

Some secondary materials and waste types can, in some circumstances, be used as a partial substitute for primary clay in the manufacture of bricks.

Although extensively used in the past, the use of colliery waste in brick manufacture is now very limited. Most colliery wastes are extremely variable, with carbon contents ranging from less than 5% to over 30%. This causes particular problems in mechanised brick manufacture, where consistency of the raw material is vital in maintaining product quality. These materials tend to show particularly high levels of emissions on firing.

Currently, around 9% of materials used in the manufacture of clay bricks are classed as Materials

Brick clay

Clay extraction site (Ibstock Quarry) ©Ibstock.

from Alternative, Recycled, or Secondary Sources (MARSS). Materials used include coal fines, coke fines ('coke breeze'), petroleum coke ('petcoke'), metal refining slag, crushed bricks and other ceramic products ('grog'), waste paper, sawdust, sugars, starch and mineral by-products. Substitution is limited by ensuring the same product performance characteristics (technical performance and durability) are met.

Concrete blocks, bricks, pipes and tiles are the main alternatives to clay products. Concrete blocks have now almost entirely replaced 'common' bricks in building interior and rendered exterior walls. Plasterboard and stud walling is replacing both clay and concrete products in internal walls. Other building materials such as steel, timber, glass, and natural and reconstituted building stone compete directly with clay-based products. Block pavers and roof tiles made from concrete compete with those made from fired clay. Fired clay drainage pipes compete with those made from plastic (smaller diameters) and concrete (larger diameters).

Many companies have produced Environmental Product Declarations for specific construction products, including clay roof tiles, drainage pipes and clay bricks. These assess the environmental impact of a product during its lifecycle. A generic Environmental Product Declaration has been produced for clay brick based on a minimum 150-year service life (GreenBookLive, 2022).

Brick structures are long lasting and easy to adapt for changing uses, which minimises the need for demolition. Where demolition is necessary re-use of bricks for matching style in conservation and other building work is common practice. Recovery of bricks, for re-use as bricks, is generally limited to those buildings which are more than 60 years old where lime mortars were used. Bricks of that age and older can, subject to careful selection and cleaning, have an appreciable 'new' life in new construction projects. This is due to the lower strength of lime mortars making them easier to separate from bricks. The end-of-life stage for brick can have positive environmental benefits including conservation of primary resources and lower carbon emissions. The Brick Development Association has produced a number of technical documents on the use and re-use of clay brick (Brick Development Association, 2022).

Brick buildings less than 60 years of age were normally constructed using Portland cement-based

mortars. These mortars have superior setting and bonding strength. The removal of cement mortar to enable bricks to be reused is not usually practical, but techniques are being researched to automate the disassembly of brick structures. Where adaptation or reuse is not feasible, the material can be recycled to produce secondary aggregate such as construction fill, capping layers and sub-base in road construction, and drainage blankets in civil engineering.

Effect of economic instruments

Clay extracted for brick manufacturing is exempt from the Aggregates Levy.

The UK is the first major economy to commit to 'net zero' carbon emissions by 2050 (where the amount released to atmosphere is balanced by that removed from it). The next three decades will see profound changes as the industry continues to decarbonise. As with other energy intensive sectors, ceramic manufacturers are regulated by energy, climate and environmental legislation. As the transition to net zero takes place in the UK, the industry is likely to face a range of changing economic and legislative drivers. Wider roll-out of energy- and resource-efficient production, alternative new technologies/ fuels (such as hydrogen, biomass and electricity), and tackling of process emissions (from clays) are all likely to play a role, as well as other emissions offsetting schemes. Integral to transition for the industry will be collaboration with government and other stakeholders, as well as the availability of support for development and implementation of these technologies. Energy/decarbonisation is therefore a key consideration in the long-term investment decision-making for businesses.

Although decarbonisation is a major focus, the drive for more energy- and resource-efficient production also ties in with the improved sustainability of brick manufacture. There are a number of other emerging environmental issues, such as biodiversity/ natural capital, changes to water abstraction regulations, and broader environmental legislation which also need to be taken into consideration.

Transport issues

Where brick clays are worked close to brickworks, covered conveyor belts can be used to transport the clay. There is, however, an increasing trend towards the import of clays and other raw materials from off-site into brickworks which, in the past, would have relied entirely on raw material from a 'captive', on-site pit. This trend is driven by technical innovation in brick, tile and pipe products, together with the implementation of more stringent technical standards, increasing use of automated manufacturing and tighter controls on kiln emissions. This has led to more blending to improve locally sourced clays used to manufacture bricks which both meet the highest technical specifications, and give the consumer maximum choice of colours and textures. This tendency is likely to increase, as product specifications become tighter. It is highly unlikely that this movement of clay will be by any other method than road. However, compared to movements of some other minerals (particularly aggregates), the volumes involved are small and haulage distance are generally short. The manufactured products are almost always transported to the market by road.

Planning issues

Planning issues centre on the environmental acceptability of the quarry and the manufacturing plant in any proposed location. All facilities for the manufacture of clay construction products require an environmental permit, either from the Local Authority and the Environment Agency as appropriate. Permits are site-specific and take into account, amongst other factors, the production methods and raw materials used, setting a range of plant operating conditions. In addition, a number of other issues are relevant.

The important role that bricks and related products play in determining the appearance and quality of the built environment is widely recognised. The variety of brick products contributes significantly to the rich regional and local architectural heritage of mainland Britain as well as the repair of traditional brick-built structures.

National Planning Policy

In England, national policies for minerals are contained in the National Planning Policy Framework (NPPF) with further Government guidance provided in the associated planning practice guidance. In Wales, national policies for minerals are presented in Planning Policy Wales (PPW), mineral technical advice notes (MTANs), circulars and policy clarification letters. Key national policies for the responsible extraction of natural resources in Scotland are set out in Scottish Planning Policy (SPP),

Brick clay

Restored clay extraction site (Kings Dyke nature reserve) ©Forterra.

and planning policies for minerals in Northern Ireland are set out in the Strategic Planning Policy Statement for Northern Ireland (SPPS).

Maintenance of supply — landbank

The need for significant capital investment in the brick clay industry, and also the need for blending of different clays, is recognised in the NPPF. Mineral Planning Authorities are to plan for a steady and adequate supply of brick clay by maintaining a stock of permitted reserves of at least 25 years for each pit/ brickworks, and must also take into account the need for provision of brick clay from a number of different sources. There is no specific landbank requirement unique to Brick Clay in PPW, SPP or SPPS.

Maintenance of supply — mineral safeguarding

As mineral resources can only be found where they naturally occur in the ground, which is not uniform throughout the UK, it follows that the need to maintain access to them for the future should be considered if non-mineral land uses are being decided by a planning authority. Mineral safeguarding is a mechanism in the planning system which ensures that this occurs. For most minerals, the mineral resource maps produced by the British Geological Survey have been used as the basis for defining mineral safeguarding areas, which may be supplemented by other available information. In Wales the majority of the decisions surrounding safeguarding areas were made at a national level and incorporated into Local Development Plans with accompanying policies, whereas in England safeguarding areas have been defined at a local level and shown on local policy maps. These are accompanied by criteria-based exemption policies to help guide decision making within these safeguarding areas. Further information on mineral safeguarding is provided in the *Minerals Safeguarding in England: Good Practice Advice*

(2011) and *Minerals Safeguarding Practice Guidance* (2019).

Environmental impacts associated with extraction

In most cases mineral operators (including brick clay operators) must provide a planning application and accompanying Environmental Statement to the Mineral Planning Authority (MPA), to assess the environmental impacts of an extraction proposal and how they are to be mitigated. The issues that should be addressed as part of the Environmental Impact Assessment process are listed in Regulations and can be agreed through consultation with statutory consultees and the MPA as part of a scoping process. These may include population and human health; biodiversity; land, soil, water, air and climate; material assets, cultural heritage and the landscape; and the interaction between all of these issues.

Restoration of sites

Most mineral sites are considered to be a temporary land use and planning policy seeks to ensure that land is reclaimed at the earliest opportunity. In the case of brick clay sites, extraction takes place over a longer time than many other mineral operations, and progressive or 'rolling' restoration (if suitable) minimises the area of land occupied by mineral working at any one time. Mineral operators are responsible for the restoration and aftercare of mineral sites or, in the case of default, the landowner. The most appropriate form of restoration is considered when local mineral plans are being made and also on a site-by-site basis by the mineral operator and MPA.

There are many different possibilities for the after use of mineral sites, such as creation of new habitats and biodiversity (providing 'net gain' opportunities), use for agriculture, forestry, recreational activities, waste management and the built environment (residential/ retail/ industrial). Some sites may be restored by landfill before being restored to these after uses.

Clay pits in particular are often suitable for taking non-hazardous waste because clay has a low permeability, meaning that pollutants cannot pass through the rock to the ground water. Landfill as a restoration option allows the ground level and landform to be returned to pre-extraction conditions. Inert waste (including soils and clays arising from excavating groundworks and tunnelling) can also be readily considered following clay extraction.

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Mineral Planning Factsheets for a range of other minerals produced in Britain are available for download from www.mineralsUK.com