UKQAA Ash Availability Report
Overview

This document provides an overview of fly ash and furnace bottom ash production and usage from coal fired power stations across the UK between 1999 and 2014. There is also some comparative analysis of furnace bottom ash production and usage in recent years. The operational coal fired power stations are:

- Aberthaw
- Cottam
- Drax
- Eggborough
- Ferrybridge
- Fiddlers Ferry
- Longannet
- Ratcliffe on Soar
- Rugeley
- West Burton
**Context**

Fly ash and furnace bottom ash can be used effectively as alternatives to virgin raw materials in the manufacture of low-carbon, high performance concrete, cement and other construction materials.

Since the 1990s there have been variations in the importance of the different sources of construction materials but the uptake of recycled and secondary materials like fly ash and furnace bottom ash has steadily increased.

Recent years have been challenging for the materials market as a whole due to the significant decline in construction and sales dipping as a result. As the market has begun to recover however, by some 11 per cent between 2012 and 2014, this growth is reflected in demand for fly ash.

In 2014, over three million tonnes of fly ash and 800,000 tonnes of furnace bottom ash were used in the manufacture of construction products and engineering materials. This translates to 70 per cent of the total fly ash produced and almost 100 per cent of the furnace bottom ash produced. This level of uptake was an industry high, particularly when compared with average demand over the last fifteen years.

This document tracks the supply and uptake of fly ash since 1999. It explores how a resurging materials market is leading to increased demand for fly ash and furnace bottom ash and how the ash industry is creating new opportunities for an increasingly sustainability focussed construction industry.

*Fly ash has a variety of applications including durable concrete blocks for house building*
Background

Fly ash and furnace bottom ash are versatile secondary materials that can be used for a variety of beneficial applications in the construction and engineering sectors, from concrete, bricks and blocks to engineering fill and land reclamation projects.

An effective pozzolana, or binding material, fly ash can be used in the manufacture of concrete and cement, reducing the amount of traditional materials needed in a cementitious mix. A fine, consistent material, fly ash creates quality, durable products which can resist chloride induced corrosion and chemical attack and minimise risk of early age thermal cracking. Fly ash can also be used successfully as an unbound secondary material, as fill for the construction of embankments for example.

Likewise, furnace bottom ash, which is of a similar composition to fly ash, is used as a lightweight aggregate in the manufacture of building blocks and structural lightweight fill material.

Fly ash and furnace bottom ash also provide significant practical and environmental benefits. The ashes are by products of the combustion process at coal-fired power stations and as such are readily available at locations across the UK. Stored in silos or stockpiled in ash fields, fly ash and furnace bottom ash is also easy to access, excavate and process. This means the ashes are straightforward to recover and resource efficient to manufacture – particularly when compared with virgin raw materials.

The use of fly ash and furnace bottom ash reduces the need to use virgin raw materials and lessens the impact of associated resource intensive processes involved with extracting them. This safeguards finite mineral resources and ensures greater sustainability. Overall, a more resource efficient manufacturing process route is used, with lower embodied carbon and a reduced environmental impact.

Fly ash was used in the low carbon development of championship golf courses at Celtic Manor
Production

Between 1999 and 2014 the UK’s coal-fired power stations have produced between four and seven million tonnes of fly ash and up to one million tonnes of furnace bottom ash each year.

Figure 1: Fly ash production 1999-2014

Figure 2: Furnace bottom ash production 1999-2014
The production of fly ash is directly linked to the UK’s energy mix – increasing when more coal is burnt and levelling off or decreasing when other energy sources take primacy, such as gas. The production of furnace bottom ash is linked with fly ash production, but the relationship each year is determined by the types of coal burnt and the combustion units operated.

Since the turn of the century, coal-fired power stations have remained important energy providers and fly ash production has been sustained, averaging over five million tonnes annually. Production peaked at seven million tonnes in the early 2000s as coal-fired power generation was relatively high and remained at over four million tonnes between 1999 and 2014 as reliance on coal power continued.

Ash production rose in the recent post-recession years as the energy market stabilised and coal-fired power retained a central role in the UK’s energy mix. As a result the availability and supply of fresh fly ash has remained largely consistent from year to year.

The future of coal
As highlighted by the Government’s recent announcement on coal-fired power, the role of coal-fired power stations in the UK will change in the coming years, impacting the production of fresh fly ash and furnace bottom ash. However, with an uncertain gas market and new nuclear and renewables still to be fully realised, coal power does look set to remain a central part of the UK’s energy mix in the near future. For example, the government’s recent Capacity Market Auction has shown that even up to 2021, coal power will play a significant role in providing energy production in the UK – securing sources of fresh fly ash and furnace bottom ash for some years to come.
**Uptake**

Between 1999 and 2014 the construction and engineering sectors have used an increasing proportion of the fly ash and furnace bottom ash produced.

![Graph: Production versus utilisation for fly ash from 1999-2014]

Since the turn of the century, uptake of fly ash as a proportion of production has steadily increased (Figure 3). Between 1999 and 2014 utilisation rates of over 50 per cent were typical, reaching around 70 per cent in 2007 and again in 2014.

Through this period there have been some important shifts in usage which explains the data above. In general, the acceptance of alternative materials has been on the rise since the 1990s due to increased awareness of the technical, practical and environmental benefits of using fly ash, as well as increasing commercial viability. As a result, the ash market has been buoyant since the turn of the century, with uptake remaining more than half of the fly ash produced annually for the majority of the period. These shifts can be explained as follows.

The increased fly ash utilisation from 2005 to 2007 specifically can be attributed to a single mine grouting project which consumed a large amount of by-product ash over an eighteen month period.

The plateau in consumption in the immediate post-recession period of 2009 to 2012, where utilisation remained relatively level at around three million tonnes, was related to a weak economy and a relatively slow construction industry. Projects were frozen or not taken forward and as a result demand for construction products and materials was low.

Following these years of recession, 2012-2014 were important years across the minerals and aggregates sector as the economy began to recover and demand for construction materials began to rapidly increase. In addition supply shortages in the mining and quarrying sectors also drew the construction industry away from traditional supply chains and towards the alternative materials market.
The boom in construction activity and the resurgence of the sustainability agenda under the Conservative government also encouraged architects, engineers and specifiers to redouble their efforts to develop and specify low-carbon, high-performance building materials.

As a result, uptake of fly ash increased markedly, with usage climbing well above recession levels. What’s more, this boost in uptake was despite a sharper dip in overall production, as shown in Figure 3. This growth continued into 2013 and 2014, with the percentage of consumption reaching record levels by the end of the period.

While detailed usage data for furnace bottom ash during the same period 1999-2014 isn’t available, according to figures from recent years, consumption is almost 100 per cent of production.

**Ash surplus**

While the data on fly ash utilisation shows a positive picture for the ash market, it also shows that despite uptake increasing, a significant amount of surplus fly ash is also produced year on year. Typically some two million tonnes are still sent to landfill annually, which now totals around 50 million tonnes. This represents strong opportunities for recovery and use of this valuable resource.

For example, in 2014, in addition to the four and a half million tonnes of fresh fly ash produced, approximately 141,000 tonnes of fly ash was obtained from temporary stockpiles for use in the construction industry. That autumn, the UKQAA also helped to launch a research and development project on the transformation of stockpile fly ash into EN450 quality ash (suitable for structural concrete or cement), in partnership with the University of Dundee. This project shows how innovation in the applications of fly ash is now developing the industry’s technical understanding of fly ash and maximising opportunities to exploit a readily available secondary resource in the future.

*Up to 50 million tonnes of potentially usable fly ash is available in stockpiles across the UK*
Applications

In recent years, fly ash and furnace bottom ash has been used in a wide variety of applications in the construction products and materials market.

![Figure 4: Applications of fly ash in 2014](image)

With an average of over five million tonnes of fly ash being produced annually, the figures also show that, while use of fly ash continues to grow, its applications are increasingly diversified.

During 2014, approximately 70 per cent of the fly ash produced (which equates to over three million tonnes) was used by the construction industry for a variety of building products and materials.

Uses varied, with 54 per cent of fly ash used for bound construction products and materials. Over 12 per cent was used in the manufacture of cement, while nearly 14 and a half per cent was used for Type I&II concrete additions (used in ready-mixed concrete and precast units). Over 27 per cent was used in conventional concrete blocks, AAC blocks, grouting, soil stabilisation and hydraulically bound materials.

In addition to these bound uses, almost three per cent of the total amount of fly ash produced was used for engineering fill and nearly 14 per cent was used for land reclamation and other unbound applications.

In addition to the varied consumption of fly ash, almost 100 per cent of the 800,000 tonnes of furnace bottom ash produced in 2014 was utilised as a lightweight aggregate.

Meanwhile, more than 141,000 tonnes of fly ash were also obtained from temporary stockpiles for use mostly in grouting or fill applications. This demonstrates the broad supply base of fly ash and the beneficial use of stockpile ash as well as fresh ash in a variety of construction products and materials.
Conclusion

The fly ash production and usage data from 1999 to 2014 and figures on furnace bottom ash highlight important trends in the supply and uptake of fly ash and furnace bottom ash in the early 21st century.

Firstly, the production trends show that despite peaks and troughs in demand, a steady supply of fresh fly ash and furnace bottom ash has remained. This has helped to bolster availability in the materials market overall and sustain interest in alternative materials.

Secondly, the usage trends show that the appetite for fly ash and furnace bottom ash as a low carbon, high performance material has remained consistent, despite changes in the energy market and the impact of economic recession on the construction industry. Demand is returning to pre-recession levels and the overall percentage of ash used relative to production is at another record level. This was notable during 2014, when despite a dip in production, utilisation rates of fly ash continued to climb. In addition, stocks of furnace bottom ash were also almost completely utilised.

Thirdly, as confidence in the alternative materials market has grown, manufacturers have also shown there is an increasing preference to use fly ash or furnace bottom ash in a greater variety of products and materials. This versatility of applications and the benefits of fly ash and furnace bottom ash more generally have become widely recognised and, in turn, contributed to increased uptake.

These trends underline two important points: supply of fly ash and furnace bottom ash has remained steady and there is a growing, diverse market for both. This highlights a change in the construction products market over the years and shows the prominence of coal ash as a low carbon, high performance material that can contribute to a sustainable materials market.

For more information about the UKQAA data referenced above, or how you can make use of fly ash or furnace bottom ash, please visit www.ukqaa.org.uk.