

### 1. Why is climate change important for the cement sector?

Climate change is very important to the cement industry for two key reasons; firstly, cement production releases carbon dioxide; and secondly, cement concrete products are needed to mitigate against climate change by producing thermally efficient high mass buildings and because cement concrete products will help society adapt to the effects of global warming e.g. drainage and flood defence.

The UK cement industry is engaged in a number of schemes and initiatives to reduce its CO<sub>2</sub> emissions through improved operations - UK CCL: UK ETS; EU ETS; WBCSD CSI; and company specific undertakings - and is implementing a carbon strategy that in the short, medium and long term, will reduce the profile of its carbon emissions to 2050.

### 2. How much CO<sub>2</sub> is released during cement manufacture?

By its nature, cement manufacture generates substantial quantities of carbon dioxide during the manufacture of the intermediate product 'clinker'. Emissions originate from the fuels burned in the kiln, ("fuel CO<sub>2</sub>") and these account for around 40% of the CO<sub>2</sub> emission. The decomposition of limestone during the 'calcination' process, ("process CO<sub>2</sub>") accounts for the remaining 60%. Consequently, even if sufficient biomass fuel sources were available to reduce the fuel component to a net emission of zero, the total emissions of CO<sub>2</sub> would only be reduced by ~40%.

The cement industry is ahead of most sectors of the economy concerning progress on emissions reduction and ahead of the UK as whole. Between 1990 and 2007, the industry reduced its carbon dioxide emissions by over 27% through energy efficiency improvements. As such the MPA cement member company emissions in 2007 were 3.7MtCO<sub>2</sub> less than in 1990.

Consequently, Carbon Capture and Storage presents one of the few opportunities to make large reductions, and the industry is currently exploring the feasibility of applying this technology.

### 3. Which technology is most appropriate for carbon capture in the cement industry?

The most comprehensive research to date has been carried out by IEA GHG R&D Programme<sup>1</sup> using consultants Mott MacDonald, involved the British Cement Association and experts from the UK cement industry. This research came to the conclusion that although further research is needed to address a range of technical barriers there are two potential techniques that could be

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applicable for capturing CO<sub>2</sub> from cement manufacture: Post-Combustion Capture and Oxy-Combustion Capture. Pre-Combustion capture is disregarded on the basis that it would only address the fuel part of the CO<sub>2</sub> emission.

### Post-combustion CO<sub>2</sub>-capture

- Post combustion capture is an 'end-of-pipe' technology that has the advantage of being able to be retrofitted to existing plant if space allows.
- It works by 'scrubbing' the exhaust gases with a solvent (most likely an amine), the solvent is then regenerated using steam and the high concentration CO<sub>2</sub> gas is compressed for transport. Additional power and steam needs could be supplied by a Combined Heat and Power (CHP) plant.
- The key constraints for this option are: SO<sub>x</sub>, NO<sub>2</sub> in the flue gas (potential interference with the absorption); space for the capture and compression equipment; availability of steam for amine regeneration.
- All the major technical issues could, potentially, be addressed using existing technology but the main barrier to its application is the cost of deploying these technologies;
- The cost per tonne of CO<sub>2</sub> emissions avoided is substantially higher than using oxy-combustion, mainly due to the large capital costs of the Combined Heat and Power plant and the flue gas desulphurization, (FGD) plant.

### Oxy-combustion CO<sub>2</sub>-capture

- Oxy-combustion is at an earlier stage of development than post-combustion and its use would require the fundamental re-design of a cement plant.
- Many technical issues centre on burning the raw materials in an oxygen rich environment either in the precalciner or potentially in the kiln itself. Research on this and how product formation may be affected by high CO<sub>2</sub> concentrations is also needed.
- However, the predicted cost per tonne of CO<sub>2</sub> emissions avoided is about 40% of that for post-combustion capture.
- Retrofitting this technology is not really an option unless the plant is undergoing a major re-fit.

#### 4. How would CO<sub>2</sub> be transported and stored?

The work of the British Geological Survey<sup>2</sup> has improved the knowledge of potential storage sites around the UK but regulatory controls and legal liabilities are at the early stages of development. It is unlikely that the cement industry will get too involved in storage sites and will look to third parties for the development of this important part of the CCS chain.

The volumes of CO<sub>2</sub> generated by individual cement installations are too small to warrant dedicated pipelines connected to either potential off-shore or on-shore storage sites. Consequently, a strategic CO<sub>2</sub> pipeline infrastructure is needed for high volume emitters in the power generation sector with connection nodes for smaller industrial emitters. Such a project could be funded by CO<sub>2</sub> auction revenues from the EU Emissions Trading Scheme. Until a strategic infrastructure pipeline network is in place this represents a significant barrier to CCS deployment in the non-generation sectors. Although, CO<sub>2</sub> transport benefits could be gained from the co-location of power generation and industrial CO<sub>2</sub> emitters.

#### 5. What will carbon capture in the cement industry cost?

Exhaust gas from a cement kiln contains about 25% CO<sub>2</sub> – appreciably higher than in coal fired power generation (about 14%). Although the concentration of CO<sub>2</sub> in the exhaust gas makes cement CO<sub>2</sub> capture an attractive proposition when compared to power generation, economies of scale make it more expensive. A single 2GW coal fired power station emits approximately the same amount of CO<sub>2</sub> as the whole of the UK cement industry.

IEA GHG (2008) have estimated that a post-combustion capture fitted cement plant could cost around €558m (more than twice the cost of a non-CCS equivalent) but providing a potential emissions avoided efficiency<sup>i</sup> of 77%. An equivalent output oxy-combustion plant, however, could cost €327m (25% more expensive than the non-CCS plant) but at an emissions avoided rate of 52%.

Operational costs are potentially considerable too; they double for the post-combustion option and increase by 25% for oxy-combustion compared to non-CCS plant.

Although these costs make the oxy-combustion plant comparatively attractive it must be noted that oxy-combustion is at a much earlier stage of

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<sup>i</sup> Based on emissions avoided including power import and exports

development compared to post combustion and for cement making it would radically change the design and operation of the kiln.

**6. How long will it be before we see carbon capture in the UK cement industry?**

Industrial scale CCS in the UK cement industry will not take place until there is a fully developed transport and storage network and the development of this will depend upon HM Government's interest in CCS.

The determination of what constitutes "capture ready" plant will not be possible until there is a proven technological route, i.e. until there is clarity on what technology is required. Until then it is not possible to specify how a new plant could be designed, what size of scrubbing equipment is required &c.

Grant and funding availability for industrial CCS will help to promote the construction of pilot plant. Pilot plants will be crucial to further the knowledge in the cement sector and ultimately provide evidence for the speed at which CCS can be universally deployed, if proven to be technically and economically possible.

Following this work, further laboratory and pilot plant experimental work needs to be undertaken to clarify these theoretical possibilities.

**7. What measures will assist the deployment of CCS in the cement industry?**

There are three components to the business case for CCS:

- Legal, commercial, and logistic (i.e. infrastructure) aspects of the transfer and storage of the captured carbon dioxide;
- Practical demonstration of applicability of carbon capture to cement manufacture under operational conditions;
- Justification of investment costs/ projected cost of carbon dioxide within emissions trading scheme applicable at the time.

With regard to these:

- MPA Cement has been a member of the Carbon Capture and Storage Association, (CCSA), since 2006 with the objective of ensuring that the developing legislation in the area of CCS incorporates its potential use by the cement industry.

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- The IEA GHG feasibility study has provided an assessment of two options for CCS in cement manufacture, but further laboratory and pilot plant studies are required before the commercial issues can be addressed, incentives are needed to accelerate further technical work;
- One suggestion has been that a containerized capture facility might be used under different process conditions both in cement manufacture and other industrial processes. This approach would have the advantage of shared costs with other sectors.
- Through the Emissions Trading Group (ETG) and other bodies, BCA is working with government on the details of the post-2012 EU Emissions Trading Scheme. The details of the EU ETS will ultimately set the price for carbon that will be factored into future investment decisions for CCS. Effective use of hypothecated auction revenues for industrial CCS will help to provide certainty for CCS investments.

### **8. What research is being undertaken in the cement industry?**

Following on from the IEA GHG study, the European Cement Research Association (ECRA) has initiated a research programme resulting from its CCS report<sup>3</sup>. MPA Cement is represented on the research steering committee and is closely following the progress of this research to identify some of the technological knowledge gaps in relation to both post-combustion capture and oxy-combustion in the cement industry. This research is an international collaboration of cement companies, national associations and technology manufacturers and will disseminate the results of the research throughout the ECRA membership and thus propagate CCS knowledge throughout the industry.

### **9. What is the MPA Cement CCS policy?**

MPA Cement will continue to support its members by utilising the following opportunities:

- Contribute to the policy development of CCS in the UK through the continuation of its membership of the Carbon Capture and Storage Association (CCSA), a globally recognised association in the CCS field.
- Contribute to the European Cement Research Association (ECRA) CCS research initiatives by supporting the international network of cement industry representatives to improve CCS knowledge in relation to cement manufacture.

- Keep informed of the latest climate change policy developments with the BCA membership of the UK Emissions Trading Group, supplemented by industry relations with Government and regulatory agencies.
- Seek incentive and funding opportunities for the development of CCS in the cement industry.
- Coordinate an effective collective response to CCS for cement manufacturers in the UK.
- Publicise knowledge of CCS research to develop further interest in CCS and cement.

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<sup>1</sup> IEA GHG (2008) IEA Greenhouse Gas R&D Programme (IEA GHG), "CO<sub>2</sub> Capture in the Cement Industry", 2008/3, July 2008.

<sup>2</sup> <http://www.bgs.ac.uk/science/CO2/ukco2.html>

<sup>3</sup> ECRA (2007) Carbon Capture Technology - Options and Potentials for the Cement Industry Technical Report TR 044/2007 European Cement Research Academy GmbH. July 2007. <http://www.ecra-online.org/ecra/>