Corus response to HM Treasury consultation document:

Carbon capture and storage: A consultation on barriers to commercial deployment

Introduction

Corus is an international metals group that manufactures, processes and distributes steel and aluminium products and provides related services in design, technology and consultancy.

Corus has manufacturing operations in many countries with major plants located in the UK, the Netherlands, Germany, France, Norway and Belgium, as well as sales offices and service centres all over the world. Corus serves the construction, automotive, packaging, mechanical engineering, metal goods and electrical engineering sectors.

Corus is organised into four divisions (Strip Products, Long Products, Distribution and Building Systems and Aluminium) and employs 48,200 people. Turnover in 2005 was £10,140m (approximately €14,600m) and group operating profit was £680m (approximately €980m).

Europe, principally the EU, is the most important market for Corus for both its steel and aluminium products, accounting for 81% of total turnover in 2004. The Group's steel divisions accounted for 89% of total turnover in the same period.

The Group produces carbon steel by the blast furnace and basic oxygen steelmaking method at three integrated steelworks in the UK at Port Talbot, Scunthorpe and Teesside, and at one in the Netherlands at IJmuiden. Engineering steels are produced using the electric arc furnace method at Rotherham. Corus produced 19.5 mt of liquid steel in 2004.

Production of steel from its basic raw material, iron ore, using current technology, is a carbon intensive process. The blast furnace is the dominant method used by Corus and by the large majority of European and world-wide steelmakers. Within the blast furnace the naturally occurring ore is reduced by carbon, in the form of coke and coal. This means that the oxygen in the ore is chemically attached to carbon to form a mixture of carbon monoxide and carbon dioxide gases. These gases, together with nitrogen from the air blast (from which the process is named) form an important fuel gas called Blast Furnace Gas (BFG). BFG is collected and used as a fuel in our works.

Corus Environmental Policy

The Corus Environmental Policy states:

" We are committed to minimising the environmental impact of our operations and our products through the adoption of sustainable practices and continuous improvement in environmental performance."

There are eight contributing policy principles:

- Compliance
- Management Systems

- Continuous Improvement

– to improve the environmental performance of our processes and products through research and development of new technologies, preventing and reducing emissions and releases, minimising waste and controlling noise.

- Sustainable Development

– to contribute to sustainable development by using energy, water and raw materials more efficiently, thus optimising our use of natural resources.

- Product Stewardship
- Monitoring and Reporting
- Suppliers and Contractors
- Local Communities and Biodiversity

Corus actively pursues these policy principles and, as a result of the introduction of new technologies, such as continuous casting, and continuous improvements in process performance, the carbon consumption per tonne of steel has decreased significantly over many years. The modern, large, blast furnace, such as operated by Corus, is now a very efficient process and, as theoretical limits of efficiency are approached, further improvements are increasingly difficult. Nevertheless an important part of our research and development effort is aimed at continuing, incremental, improvements in process efficiency.

However, Corus, together with other major steel producers in the EU, recognises the need for further, more significant, reductions in our CO_2 emissions which will not be achievable by incremental improvements in process efficiency.

The ULCOS Project

To respond to this challenge, Corus, together with other EU steelmakers, industrial and academic partners, have entered into a major research project, financially supported by the EU via the Framework 6 and Research Fund for Coal and Steel programmes, with the aim of achieving a significant reduction in CO_2 emissions to atmosphere. That project is called ULCOS (Ultra Low CO_2 Steelmaking).

ULCOS is a €44m (£30m), part EC funded, multi-partner, research & development initiative to investigate new steel production processes that would significantly reduce CO_2 and other greenhouse gas emissions compared to current production methods.

The ULCOS consortium comprises 48 European companies and organisations led by a core group of steel producers including Corus. The consortium is further composed of suppliers to the steel industry, research institutes, small/medium sized businesses and universities.

The maximisation of the usage of steel scrap is a clear way to reduce the energy requirements in steelmaking and this is an essential recycling objective being pursued by the steel industry. However, it is recognised that production of metallic iron from its ores will continue to be the dominant production route for the foreseeable future and so the ULCOS project is aimed at reducing CO_2 emissions from steelmaking based on iron ore reduction. Steel production based solely on the melting of scrap is, therefore, excluded from the ULCOS scope.

A self-selected and somewhat arbitrary target of 50% reduction in atmospheric CO_2 emissions from the iron ore reduction route, compared with good practice blast furnace operation, has been adopted. It is recognised that this target cannot be reached by a continuation of the incremental improvement approach and so it forces a re-examination of iron and steel making process options.

ULCOS is envisaged as a phased initiative, with the current project aimed at process research and evaluation leading to the selection and specification of one, or at most two, breakthrough technologies which will meet the ULCOS emissions reduction target. This first evaluation phase began in September 2004 and will last 5 years. This will be followed by a second pilot phase, also expected to last 5 years. Commercial implementation will depend on the outcome of development work, taken together with reviews on the technical, economic and environmental viability.

Broadly speaking, the first phase of the ULCOS project is following three strategies to reduce CO_2 emissions. These are:

- Improved efficiency of carbon usage

    - Using process integration techniques
    - Modifications to the blast furnace
    - New coal based processes

- Replacement of fossil carbon as the reducing agent
    - Natural gas
    - Hydrogen
    - Electrons (through electrolysis)
    - Biomass

- CO_2 Capture and Storage (CCS)

<u>CO_2 Capture and Storage in ULCOS</u>

CCS technology will be required for some of the new processes under investigation in ULCOS. The feasibility of linkage of these new ironmaking processes with known CCS methods has been studied and the most promising integration options have been identified. The development of such a linked ironmaking and CCS process will be part of the main ULCOS research project.

A further scenario has also been evaluated. This is the interim case of using CCS technology within existing iron and steel works in order to reduce emissions of CO_2. The results of the study have shown that there are significant differences and, in some respects, advantages for the linkage of a CCS unit to a blast furnace compared with the application for post-combustion capture in a power plant. The differences are in the higher CO_2 concentration and pressure of Blast Furnace Gas. This could lead to somewhat lower costs of CO_2 capture in the BFG case compared with power plant applications.

However, technical uncertainty exists over the ability of CCS technology to operate efficiently and continuously when linked to a high productivity blast furnace. BFG contains some minor components, both in the form of dust and low concentrations of other gases, and their long-term effects on CCS performance are unknown. This technical uncertainty must be resolved as a first step towards potential full scale deployment of CCS in the steel industry.

Barriers to Commercial Development of CCS in the Steel Industry

<u>What CO_2 savings could be delivered by CCS in the steel industry?</u>

It has been estimated that, globally, the steel industry accounts for between 5% and 6% of man-made CO_2 emissions to atmosphere. (J.P.Birat, "The Challenge of Global Warming to the Steel Industry, A European Viewpoint", POSCO Conference, Pohang, Korea, Sept 2002). Although relatively low in overall comparison to the emissions from power generation, transport, housing and commercial buildings, individual steel industry sources can be large.

In the UK Corus operates blast furnaces on three sites: Redcar (1 furnace), Scunthorpe (4 or 3 furnaces, depending on production levels) and Port Talbot (2 furnaces) which, in total, produce approximately 10 million tonnes of liquid iron per year. The furnaces vary in size and production rates and, using average data, an estimated 6 million tonnes of CO_2 could be captured from BFG before its subsequent use as a fuel in the works. This would be the most advantageous application of CCS because:

- The CO_2 concentration and pressure of BFG are relatively high compared with combustion flue gases
- There are few, but large, CO_2 sources, 1 per furnace, which would simplify integration.

If CCS were also applied to the flue gases after combustion of BFG in other operations within the various plants, up to a further 6 million tonnes of CO_2 per annum could be captured.

These applications would be similar to post-combustion CO_2 capture from a power plant and would be complicated by the larger number of smaller sources within the works.

It is stressed that these numbers do not represent the total CO_2 emissions from the Corus UK plants, but they are estimates of the total quantities of CO_2 that could be captured by high efficiency CCS installations if technical & economic constraints could be overcome. No account is taken of the extra energy required for capture, compression, transport and injection at storage sites which would add to the cost estimates quoted below.

How do potential CO_2 savings compare with other options for reducing carbon emissions?

As previously stated, the EU steel industry as a whole, and Corus as part of that industry, is carrying out research, in the ULCOS project, aimed at a 50% reduction in CO_2 emissions. Full application of CCS to BFG and flue gases, as indicated above, could meet the ULCOS target but so may one, or more, of the new ironmaking process technologies under investigation in ULCOS.

Incremental improvements in existing process efficiency, whilst important, could not achieve comparable cuts in carbon emissions.

What are the different technological options currently available and in development for each stage of the CCS process – and what are the costs of these options?

A feasibility study of the application of:

- Amine absorption (e.g. MDEA)
- Physical solvent (e.g. Selexol)
- Adsorption (PSA, VPSA)
- Membrane separation
- Cryogenics

to BFG applications has been carried out within ULCOS. As a result of the higher CO_2 concentration and higher pressure of BFG compared with flue gases, a combination of VPSA and cryogenic purification appears to be the favoured option from technological, economic and environmental considerations.

This is not the case for the flue gas applications, which are quite similar to power plant flues. In those cases our feasibility studies show an economic preference for amine scrubbing.

In our studies we have adopted the CO_2 purity (>90%) and pressure (110 bar) specified by the EU Framework 6 Integrated Project ENCAP. CO_2 transport would be by pipeline to injection points in geological storage sites. These could be oil wells for EOR, depleted gas fields or deep saline aquifers. Our sites at Teesside and Scunthorpe are well placed for transport to sub-sea storage sites in the North Sea.

The basis for the feasibility study was a composite EU benchmark plant (not a real one) producing 4 million tonnes of steel and capturing 2.3 million tonnes of CO_2 per year from BFG. Investment costs of between 140 and 190 million Euro have been estimated, depending on the technology chosen. Including amortisation over a 15-year life, CO_2 capture costs of between 27 and 40 Euro per tonne of CO_2 captured have also been estimated. It is stressed that these are preliminary estimates only, which are very dependent on the price of electricity. If current UK electricity prices are used, these costs could be underestimated by up to 12 Euro per tonne CO_2 captured.

At what level of market readiness are these various technological options?

As previously stated, technical uncertainty remains over the integration of CO_2 capture technologies to a blast furnace. These uncertainties must be resolved, ideally by a demonstration installation, before a full-scale plant could be contemplated.

What would be the costs and benefits of early adoption of this technology in the UK steel industry?

Ironmaking technology has been refined and developed over the last 200 years and the blast furnace is an efficient method of converting iron ore into liquid iron for further refinement into steel. However, a blast furnace installation is expensive (150 million Euro or more per furnace) and lasts for a long time. From "new", a typical blast furnace may be relined after some 12 years of operation before being considered for a more comprehensive rebuild after some 25 years of operation. Whilst newer technology resulting from the ULCOS programme may be beginning to be implemented from around 2020/2025, there will be a very significant number of conventional blast furnaces in operation now and to be built before then that will still be in operation beyond 2030/2035.

From the work done so far, capture and storage of CO_2 emissions from the ironmaking process could act as an interim solution depending on the results of longer-term research solutions, which may themselves involve CCS. However, there are significant technical uncertainties which need resolution through large-scale trials before such technology could be considered ready for application, whether as an interim method applied to existing ironmaking operations, or as part of a "breakthrough" technology in ironmaking.

Such trials involve significant cost and a strong risk of failure. Therefore, in the public interest, whilst a company may be willing to undertake such trials on production equipment and to meet a major part of the costs, they should also be supported from the public R&D budget.

What scope is there to develop and use CCS within the current regulatory framework?

To encourage the further development and deployment of CCS, the regulatory framework needs to change. Our biggest concern is that as the EU ETS is presently devised, i.e. a regional cap & trade system with an underlying allocation process that shifts with each successive phase, there is no real incentive to invest in carbon reduction technology. In fact, the system encourages output reduction, not investment in operational efficiency. If a new technology, such as CCS, were to be deployed, there is every likelihood that the future allocation would be reduced, negating the value of the investment in generating CO_2 credits that can be sold to cover the costs.

From 2013, a move to a sector-based regional baseline and credit system, with allowances awarded for better than standard performance, could provide a more positive incentive for commercial implementation of a number of forms of technology, including CCS.

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