RESOURCE EFFICIENCY FACTSHEET

Manufacture of Non-Metallic Mineral Products Sector

The sector

The non-metallic minerals manufacturing sector (NACE division 23) is a broad sector that includes the following activities:

- Manufacture of glass products
- Manufacture of refractory products
- Manufacture of clay building materials
- Manufacture of other porcelain and ceramic products
- Manufacture of cement, lime and plaster
- Manufacture of articles of concrete, cement and plaster
- Cutting, shaping and finishing of stone
- Manufacture of other non-metallic mineral products

Non-metallic minerals includes manufacturing activities related to a single substance of mineral origin such as mined or quarried sand, gravel, stone and clay (an example is the manufacture of lime from limestone). It also includes: the manufacture of glass and glass products (e.g., flat glass, hollow glass, glass fibres, technical glassware, glass insulators etc.); tiles and baked clay products; ceramic products (including tableware, sanitary fixtures, insulators and technical products); and cement and plaster (from raw materials to finished articles).

In an Irish context it is the most significant manufacturing sector in terms of greenhouse gas (GHG) emissions, emitting c. 2.4 million tonnes of CO^2 equivalents in 2014 from the manufacture of cement alone. This is almost twice the total emissions from the entire Food and Beverages manufacturing sector (which is the next highest sector) and over one third of the GHG emissions from all manufacturing sectors.

Manufacturing in the non-metallic minerals sector involves the consumption of significant quantities of materials, (including limestone, gypsum, cement, clay and aggregates), water, fossil fuels, alternative fuels and electricity. CSO PRODCOM data indicated total sales of 15.8 million tonnes for the sector in 2014.

The production of ready-mixed concrete was the largest single product sold at c.4.8 million tonnes in 2014. That year, the next largest product in tonnage terms was cement at 2.4 million tonnes. Economically, the sector is also obviously very significant and in 2014 the CSO recorded 8,450 employees in the division.

Policy

The manufacture of cement has historically incorporated principles of the Circular Economy such as the replacement of virgin raw materials and fossil fuels with discarded resources from other sectors. Examples include the incorporation of waste materials into concrete such as ground granulated blast furnace slag, ground waste glass and recycled concrete. As the outputs of this sector are inputs to the construction sector many of the EU policies and initiatives cover activities in both sectors.

The Cement Sustainability Initiative[1] (CSI) is a global effort by 23 major cement producers with operations in more than 100 countries. It was established with the support of the World Business Council for Sustainable Development (WBCSD) and of independent stakeholders in 1999. In terms of resource efficiency the CSI has an objective of Improving eco-efficiency through improved practices in quarrying, energy use and waste recovery and reuse. Irish Cement is a member of CSI.

The EU Communication[2] on resource efficiency opportunities in the construction sector (2014) focuses on resource efficiency through the use of material indicators in the building's life-cycle.

Resource Efficiency Initiatives

Many of the larger Irish producers in the sector (including all the cement manufacturers) are members of the SEAI large industry energy network (LIEN) group[3], addressing energy efficiency and energy use reduction.

Substitution of fossil fuels with combustible waste with a net positive calorific value is already practiced in the cement sector. There are additional opportunities to part-replace raw materials with wastes including recycled construction and demolition waste, ground glass and blast furnace slag. The emissions associated with the handling and transport of over 25 million tonnes of raw materials and products is also an area where significant improvements can be achieved (in overall terms), for example with the replacement of fossil fuels with biofuels and using more energy efficient equipment or releasing less greenhouse gases (including NOx reduction from heavy diesel engines).

The production of cement clinker by heating limestone to temperatures above 950°C is the main energy consuming process. Due to the inherent chemistry of the process, emissions from limestone calcination cannot be reduced through energy-efficiency measures or fuel substitution (substituting fossil fuels with high calorific wastes or biomass), but can be reduced through the production of blended cement (adding granulated blast furnace slag from iron production, or fly ash from coal-fired power generation). An extensively used performance indicator in cement production is $kgCO_2e$ tonne of product produced. Key performance indicators used by the CSI[4] to track sustainability in fuels and materials are:

- Specific heat consumption of clinker production (MJ/tonne clinker)
- Clinker/cement ratio (%)
- Biomass fuel rate (% of thermal energy consumption)
- Alternative fuel rate (% of thermal energy consumption)
- Alternative raw materials rate (% total raw materials for cement production)

Materials

There are approximately 200 ready-mix concrete plants[5] in Ireland (using significant quantities of sand, aggregates and cement). In 2014, there was approximately 4.7 million tonnes of ready-mixed concrete consumed in Ireland. There is capacity to produce up to 20 million tonnes of ready-mix concrete in Ireland, a legacy of the building boom in the last decade. Limestone, shale, bauxite, iron ore and gypsum are used to produce cement and lime is manufactured from limestone. Gypsum is also used in the manufacture of plasterboard construction products.

The main user of non-metallic minerals is the construction sector[6], NACE divisions 41-43, (aggregates are used in the production of ready-mix concrete, concrete products, bituminous mixes and asphalt, and fill materials). The domestic material consumption of non-metallic minerals in 2014 was 34 million tonnes as shown in Table 1:

Table 1: Domestic Extraction and Domestic Material Consumption of Non-Metallic Minerals (Selected from CSO table EAA12)

Net Material Accumulations of Non-Metallic Minerals (,000 Tonnes) by Component	2014
Domestic Extraction	32.8
Trade Imports	3.8
Trade Exports	2.5
Domestic Material Consumption	34

In the cement manufacturing sector in 2014 approximately 4.5 million tonnes of raw materials (of which approximately 80% is limestone) was used to produce c.2.8 million tonnes of cement.

CASE STUDY: MATERIAL SUBSTITUTION IN THE PRODUCTION OF READY-MIX CONCRETE

The waste material ground granulated blast-furnace slag (GGBS), the main by-product in molten metal production, is used as an additive to cement in the manufacture of ready mix concrete, thereby reducing the quantity of cement required. Ecocem Ireland[7] imports blast-furnace slag into Ireland where it is ground and granulated in their Dublin processing plant. Portland cement consists of 95% clinker, whereas Portland-slag cement contains less clinker but contains blast furnace slag in the range of 6 to 35%.

Reuse of External Waste

Substitution of fossil fuels with waste unsuitable for material recycling is a good example of resource efficiency best practice. The use of waste as a secondary fuel is common in cement production. Waste suitable for use as a fuel includes refuse derived fuel, high calorific value waste tyres, meat contaminated plastics and non-recoverable industrial solvent wastes. The IPPC/IED licences of cement manufacturers were examined to determine the types of wastes permitted:

- One company is licensed to burn waste meat and bone meal, agricultural products and residues, biomass fuels, waste wood, wastewater treatment plant sludge, SRF (solid recovered fuel) and TDF (tyre derived fuel), and liquid recovered fuel (including waste solvents).
- Another is licensed to accept refuse derived fuel and solid recovered fuel (paper, cardboard, plastic, textiles and timber).
- One plant is licensed to accept waste meat and bone meal, TDF (tyre derived fuel), and solid recovered fuel as secondary fuels.
- Another plant has, at the time of writing, submitted a planning application for a proposal to use alternative fuels and to use alternative raw materials.

One company is licensed to accept alum filter cake (dewatered drinking water sludge replaces 50% of the shale and bauxite used), recycled glass (as a replacement for sand), recycled coal and peat ash (as a non-hazardous replacement for limestone) and recovered gypsum as secondary raw materials in the cement making process.

Ground waste glass, fly ash[8] (a waste by-product from coal burning electric power plants) and ground slag (a by-product of iron and steel manufacturing) can also be used in cement. Quarried material can also be substituted by construction and demolition waste.

CASE STUDY: WASTE AVOIDANCE AT ORAN PRECAST

Oran Precast produces hollow core flooring by casting a continuous narrow slab of concrete. This is then cut to length. Prior to implementation of an EPA Cleaner Greener Production Project, the marking out of the cutting positions was carried out manually. Errors in marking out led to a large volume of waste. Implementation of a bed plotter directly linked to the design office CAD system significantly reduced such errors. Since implementation, there has been zero measuring defects. Plant capacity has improved by 20% through the elimination of this waste.

Water

Significant quantities of water are used in the production of ready-mix concrete (typically 15-20% or 700,000 to 940,000 t.p.a. based on 2014 output). The use of harvested rainwater is ideal for concrete manufacture (plants located in or near quarries can avail of a ready supply of rainwater from the quarry). Irish Cement uses recovered quarry water in equipment cooling[9]. Irish Cement used recovered quarry water in equipment cooling. Water is added to lime in the hydrating process (Clogrennane Lime consumes c. 24,000 t.p.a. of water at their Carlow plant).

Energy

The cement, lime and magnesite industries are very energy intensive. In the cement industry, energy typically accounts for about 40% of production costs, while in the lime production energy it typically accounts for 60% of production costs[10]. Part substitution of fossil fuels with wastes is typically employed in the cement manufacturing sector in Ireland. Clogrennane Lime burns natural gas in their Carlow kiln and petcoke in Ennis[11].

Potential energy improvements in cement[13] production include:

- Better insulation of rotary kiln or preheater/precalciner in order to reduce radiation losses (except in the sintering zone).
- Improvement of the cooler efficiency (optimization of grate cooler operation or installation of highly efficient internal equipment in planetary or rotary cooler).
- Reduction of false air in-leaks at kiln seals or at the preheater.
- Reduction of internal dust circulations in cooler, kiln or preheater (improves the internal counter-current heat transfer).
- Modification of the raw mix in order to decrease the sintering temperature which in turn will also reduce heat losses.

[1]http://www.wbcsd.org/Projects/Cement-Sustainability-Initiative/Cement-Sustainability-Initiative-CSI
[2]http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1411482206636&uri=CELEX:52014DC0445
[3]http://www.seai.ie/Your_Business/Large_Energy_Users/LIEN/Member_Companies/
[4]https://www.wbcsdcement.org/index.php/key-issues/fuels-materials/key-performance-indicators
[5]http://www.irishconcrete.ie/industry-at-a-glance/
[6]http://www.irishconcrete.ie/industry-at-a-glance/
[7]http://www.ecocem.ie/
[8]https://www.nrmca.org/aboutconcrete/
[9]http://www.irishcement.ie/sustainability/sustainability-performance/water-consumption/
[10]http://eippcb.jrc.ec.europa.eu/reference/BREF/clm_bref_0510.pdf
[11]http://www.epa.ie/licensing

Further Information

BAT (Best Available Techniques) Reference Document (BREF) Cement, Lime and Magnesium Oxide Manufacturing Industries.
http://eippcb.jrc.ec.europa.eu/reference/BREF/clm_bref_0510.pdf

European cement research academy
https://ecra-online.org/homesite/

International Energy Agency (IEA) Cement roadmap
https://www.iea.org/publications/freepublications/publication/Cement.pdf

Cleaner Production Opportunities in Cement Manufacturing Sector:
http://www.gcpcenvis.nic.in/Experts/Cement%20sector.pdf

The National Pre-Cast Concrete Association (NPCA) in the USA produces guidance on sustainability in the sector:
http://precast.org/sustainability/
http://precast.org/wp-content/uploads/2011/05/The-Little-Green-Book-of-Concrete.pdf

ClimateTechWiki (An Energy Saving Platform for technology transfer), Energy Efficiency and Saving in the Cement Industry:
http://www.climatetechwiki.org/technology/energy-saving-cement

Resource Efficiency in Priority Irish Business Sectors

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This factsheet is one of seven that accompanies the main report of the EPA research project: Efficiency in Priority Irish Business Sectors (2014-RE-DS-1). Other factsheets are available on the following sectors: Food and Beverage, Retail, Pharmaceutical and Chemical, Accommodation and Food Service. There is also an overall factsheet. The main report is available at www.epa.ie.

Resource Efficiency in Priority Irish Business Sectors