



BUILDING A SUSTAINABLE FUTURE FOR IRELAND

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FOREWORD

The cement industry in Ireland is built on solid foundations and due to continuous investment throughout its 75 year history is now ranked amongst the most modern and energy efficient in Europe.

In the last decade alone, over €300m has been invested in improving the energy efficiency of the four cement plants in Meath, Westmeath, Limerick and Cavan. Specific developments of note include the introduction of new CEM II cements based on the addition of locally available limestone and fly ash to traditional Portland cement clinker and the move to replacing traditional fossil fuels with alternative fuels.

While the industry has invested appropriately at the cement production stage to ensure the sustainability of its processes and products, it is important to view the sustainability credentials of cement throughout the life cycle of the material for which it is primarily produced - concrete. Concrete is the most flexible, durable and widely used construction material known to man and is fundamental to modern civilisation. Cement is the key binding material within concrete.

This publication addresses issues relating to the sustainability of cement and concrete in Ireland. It outlines the achievements of the cement industry to date and the rationale for the sustainable development of the sector into the future.

The members of CMI believe that the significant investments at the four cement plants in Ireland in process and product improvement represent a solid basis for further sustainable developments into the future. CMI also believes that the focus should now move to maximising the inherent sustainability benefits of concrete in use, as the construction industry moves to build the Ireland of the 21st century.

The invention of concrete was a key milestone in human evolution. The great simplicity, affordability, strength, durability and multi-functionality of concrete make it the essential component of all construction from simple foundations up to the complex and often awe-inspiring structures of our modern built environment. Concrete allows architects, engineers, community planners and homebuilders to realise their vision and create diverse buildings and spaces of great beauty, comfort and form. But the role of the material goes beyond that.

Concrete structures are tougher and last longer than those built with other materials and require little maintenance. Concrete works extraordinarily well underwater and underground. It has excellent fire resistance and acoustic properties. It absorbs and releases heat, acting as a natural air conditioner and this specific quality known as ‘thermal inertia’ means concrete can and will in future make a much greater contribution to the energy efficiency of the built environment.

However, concrete would be nothing without the special ingredient or glue which makes all this possible - the grey powder known as cement. Cement is manufactured in nearly every country in the world from different types of quarried stone, principally limestone, and other locally available materials depending on geographic location. A key requirement for sustainable cement manufacture is that its core ingredient materials are available locally and in abundant supply.

The modern cement manufacturing sector in Ireland has a proud 75 year history as a strategically important indigenous industry, today supporting the jobs of over 2,000 people directly and indirectly.

It comprises four manufacturing plants with adjacent quarries located in counties Meath, Westmeath, Limerick and Cavan. There are also over 200 concrete manufacturing facilities operating in the Republic of Ireland supporting local economies and communities.

Over the past eight decades the industry has grown significantly and has continuously invested to ensure operations always incorporated “Best Available Technologies”. All plants are fully licensed by the EPA and operate to the highest international environmental standards.

The drive for resource and energy efficiency has led to significant investments and innovations in production processes and products. Despite the fact that the cement industry currently accounts for only 3% of Ireland’s carbon emissions, addressing these emissions has been a key element of all recent investments and has led to specific reductions of the order of 20% since 1990.

CONCRETE IS THE THIRD MOST USED SUBSTANCE ON EARTH AFTER AIR AND WATER, AND CEMENT IS THE SECRET TO ITS SUCCESS.

While predicting the future is always challenging, there is now an increasing focus on how the world will look and function as the 21st century unfolds. However, there are some distinct trends which we can foresee with some degree of certainty:

- Between now and 2050, the Irish population is expected to increase from 4.6 to 7 million.¹
- Population growth is expected to be largely concentrated in highly developed urban centres.
- Mitigation against climate change, and adaptation to climate change effects, particularly rising water levels, will require innovation in construction and building technology.

Cement and concrete will have a very important role to play in managing resources and providing solutions to deal with these challenges.

This publication outlines the key steps being taken with a view to the sustainable development of the cement industry in Ireland and also outlines the valuable contribution concrete can make to a sustainable built environment in the 21st century.



CARLOW THEATRE AND GALLERY

¹Source: CSO

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SUSTAINABLE CEMENT PRODUCTION

Sustainable cement production today takes place in modern dry process facilities incorporating “Best Available Technologies” defined at EU level.

The member companies of CMI are ensuring the sustainability of current operations by implementing best practice in resource efficiency, energy efficiency and responsible sourcing.

A key development in recent years has been the introduction by all companies of low carbon CEM II cements.



THERE ARE **FOUR** CEMENT PLANTS AND OVER **200** CONCRETE MANUFACTURING FACILITIES OPERATING IN THE REPUBLIC OF IRELAND EACH **SUPPORTING LOCAL ECONOMIES AND COMMUNITIES.**

2.1 CEMENT PRODUCTION PROCESS

All cement plants in Ireland since 1983 have utilised dry process technology. These plants include multiple stage pre-heating and modern milling technology, and in recent years have been upgraded to incorporate the use of alternative fuels to replace traditional fossil fuels.

All plants employ “Best Available Technologies” to ensure operation to world class environmental standards and are licensed by the Environmental Protection Agency in line with EU Directives.

Modern electrostatic and fabric filters ensure dust emissions are minimised in the production process and specialised abatement techniques for the reduction of nitrogen oxide emissions are employed.

Production of cement results in carbon emissions arising from de-carbonation of limestone (60%) and fuel burning (40%). The industry has addressed de-carbonation emissions through the introduction of CEM II cements which have a lower clinker content and has also addressed fuel emissions through energy efficiency investments and the introduction of alternative fuels.

The European Cement Standard EN 197-1 currently includes 27 types of common cements that can be grouped, based on composition, into five general categories (CEM I - CEM V).

The most widely used cement in Ireland has traditionally been CEM I Portland cement. CEM II composite cements, which incorporate limestone from Irish quarries and fly ash from Irish power plants burning coal, have more recently become the main cements used in the Irish construction industry. These products have a lower carbon footprint and the investments made by the industry will ensure their production and development on a sustainable basis well into the future.

STAGE 1

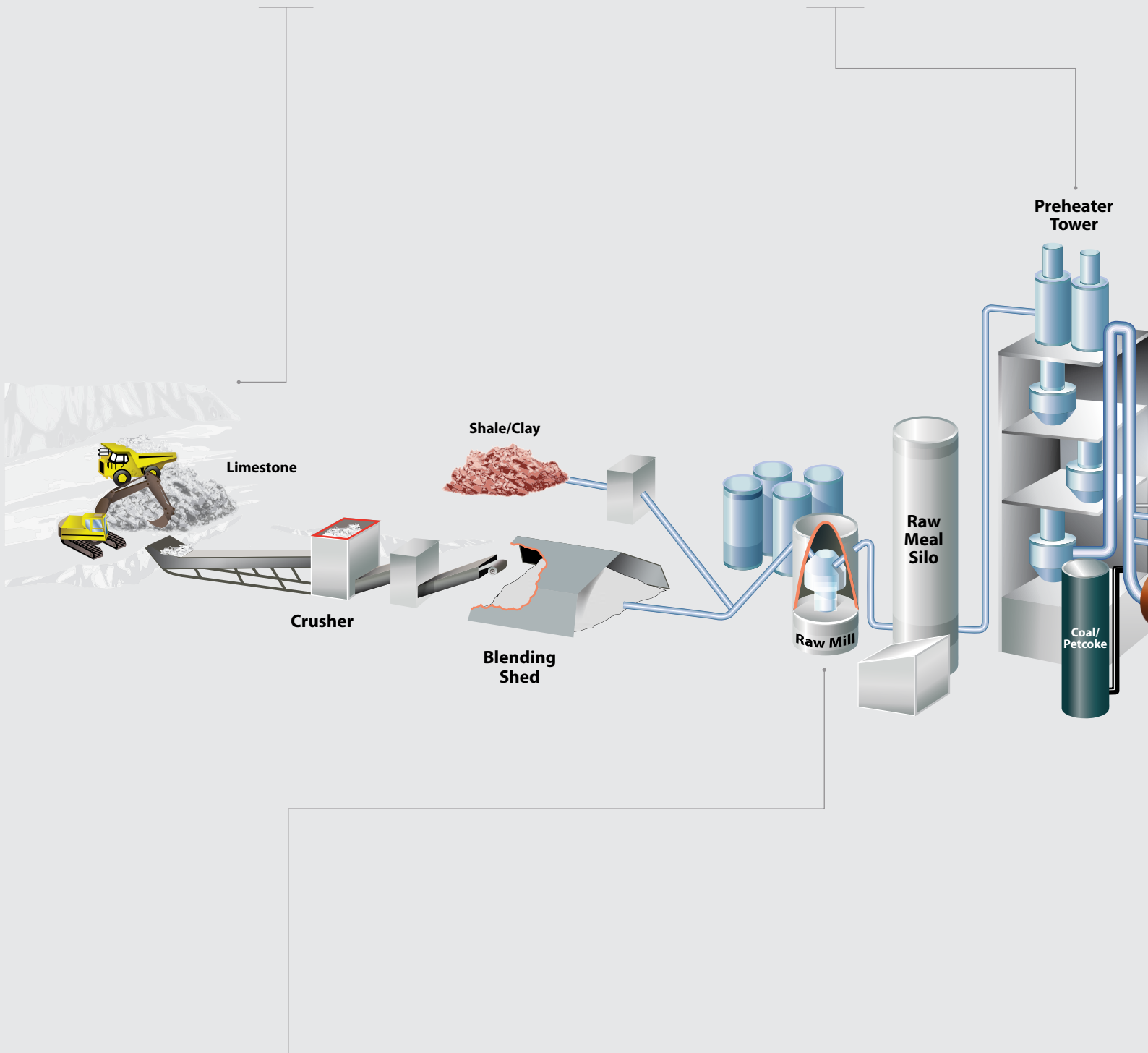
QUARRYING AND CRUSHING

The primary ingredients of cement - limestone (calcium) and shale/clay (silica) are sourced locally and then crushed and prepared for milling.

STAGE 3

PRE-HEATING

The raw meal is progressively heated as it passes through the pre-heater tower at temperatures of up to 900° C.



STAGE 2

RAW MILLING

The raw materials are then milled into a fine powder (raw meal) with the chemical composition carefully controlled for quality purposes.

LOWER CARBON PRODUCTION

CMI members employ raw material substitution, modern dry process kiln technology and clinker substitution with limestone and fly ash.

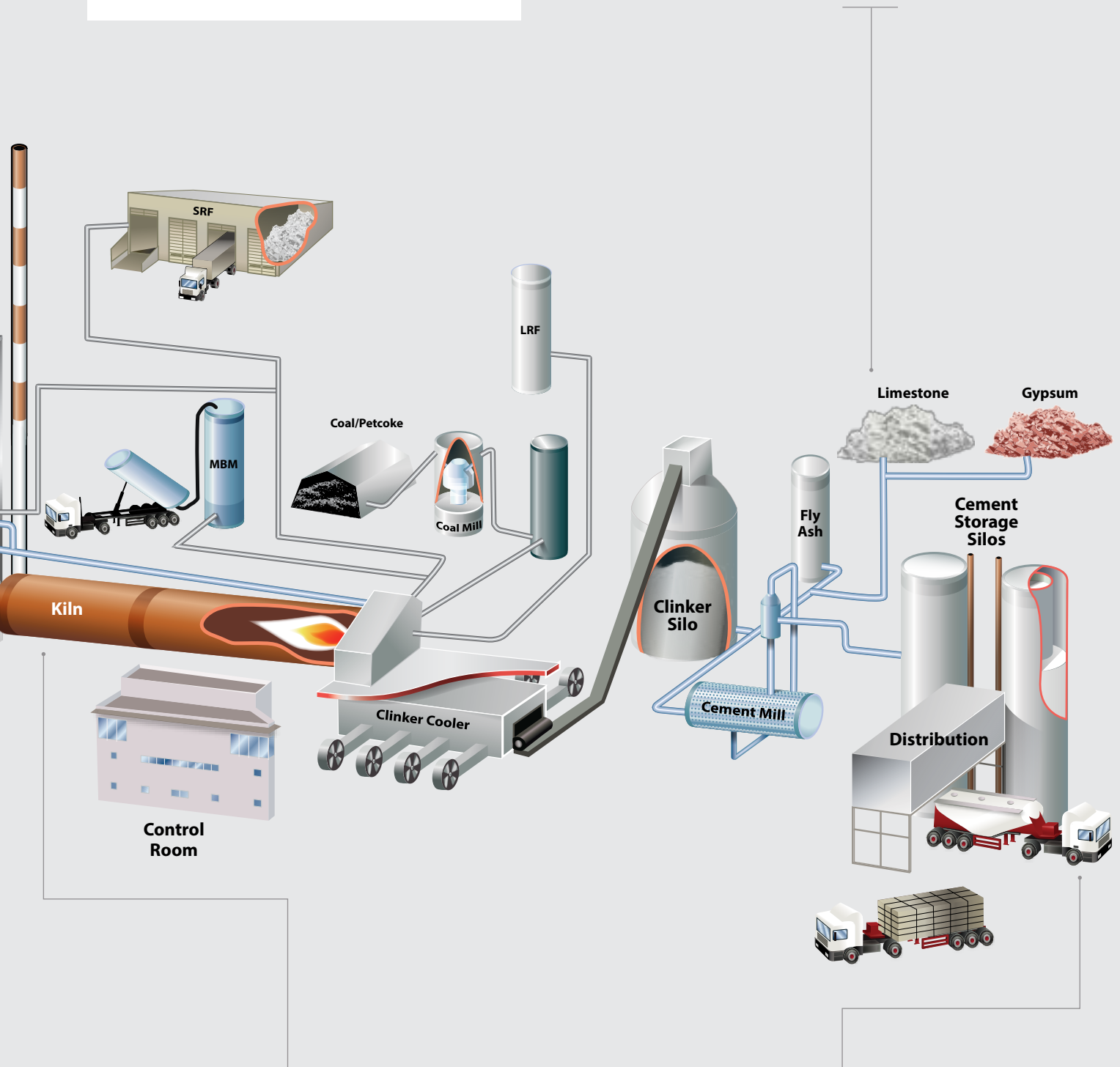
LOWER CARBON PRODUCTION

CMI members have successfully introduced Solid Recovered Fuels (SRF), Liquid Recovered Fuels (LRF) and Meat & Bone Meal (MBM) as greener alternatives to the fossil fuels that heat the kiln.

STAGE 5

CLINKER GRINDING

Limestone and/or fly ash together with gypsum are added to the cooled clinker at the grinding stage to produce CEM II cement.



STAGE 4

THE KILN

The hot raw meal passes through the rotating kiln where the calcium and silica minerals are transformed into cement clinker at 1,450° C.

STAGE 6

DISTRIBUTION

Automated bagging and bulk load out systems facilitate cement dispatch.

2.2 RESOURCE EFFICIENCY

ALTERNATIVE FUELS

- ✓ **Alternative fuels, which incorporate a high proportion of materials that would otherwise arise as wastes, are increasingly being used as fuel in the cement industry in Europe**
- ✓ **In Ireland, alternative fuels now account for 30% of the energy input to cement kilns, with one plant currently achieving a 60% substitution rate**
- ✓ **Cement production is ideal for the recovery of waste derived materials such as unrecyclable residues of paper, plastic, and other types of waste (solid recovered fuel), meat & bone meal and used solvents**
- ✓ **Aside from energy recovery, an additional benefit of using alternative fuels in cement kilns is that no residual ashes arise - all materials form part of the final kiln product, cement clinker**

Cement production is energy-intensive and fuel oil, coal and petcoke have been the traditional fuels used in the industry in Ireland. A transition to substituting a proportion of these fuels with alternative fuels has taken place over the past decade.

The use of alternative fuels has an immediate impact on the industry's carbon profile, and the industry is now utilising SRF, solvents and meat & bone meal. The unique process and energy requirements of the cement industry enable the use of fuel mixes that would not be suitable for many other industries. This ability to mix fossil fuels with local waste materials, biomass and industrial by-products is beneficial both from a resource efficiency and security of supply point of view.

Apart from the direct effects of replacing carbon-intensive fossil fuels with lower carbon intensity alternative fuels, there can also be indirect benefits.

Waste materials disposed of via landfill or by incineration give rise to their own greenhouse gas emissions, such as methane or combustion emissions.

By using these materials as alternative fuels in cement plants, these emissions are avoided. There are also transport-related benefits when local alternative fuels replace imported fossil fuels.

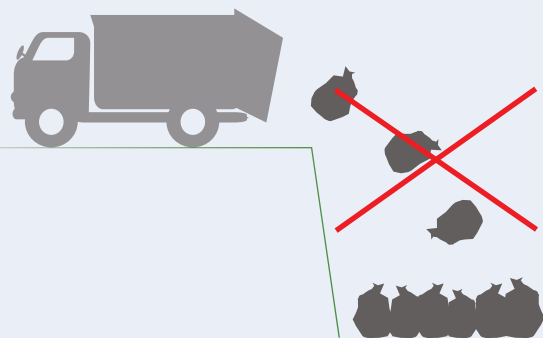
The use of alternative fuels in the cement industry is fully licensed by the EPA in accordance with EU Directives.

With the full availability of materials and the development of appropriate national infrastructure, it is estimated that the overall substitution rate in Ireland in the medium term could be expanded to 80%.

IN 2012 CEMENT PLANTS
IN IRELAND DIVERTED OVER

200,000

TONNES OF WASTE AWAY
FROM LANDFILL



RAW MATERIAL SUBSTITUTION

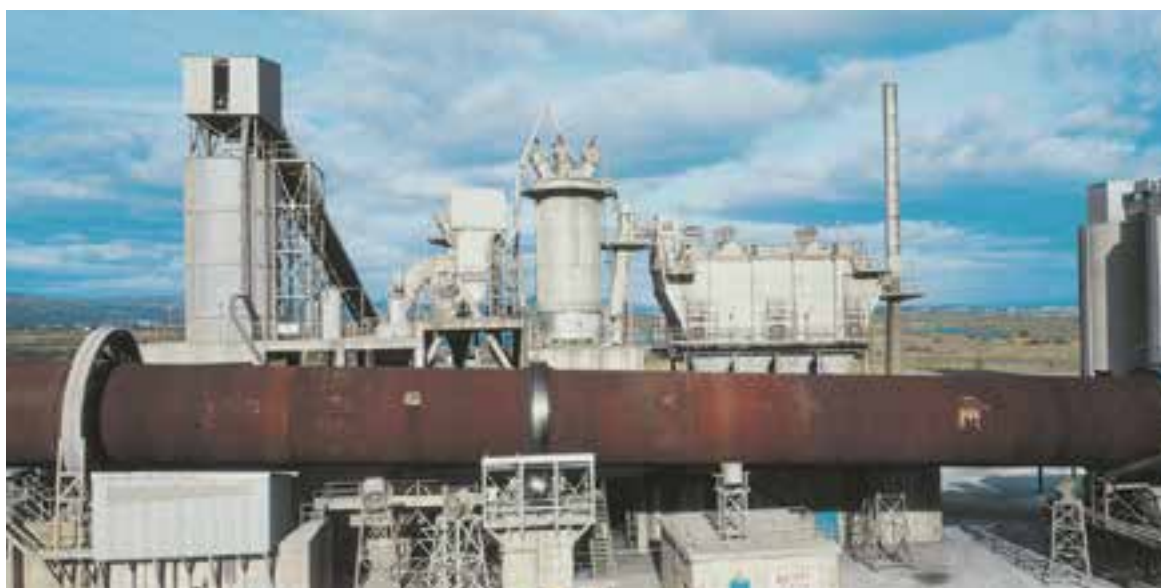
Traditionally the silica component required for clinker production was sourced from quarried shale. The key benefit from the use of alternative raw materials is a reduced need for quarrying virgin materials. In Ireland, overburden from the limestone quarries and fly ash from power stations are now used as an alternative source of silica to partially substitute quarried shale in clinker production.



LIMESTONE QUARRY

CLINKER SUBSTITUTION

- ✓ Clinker can be blended with a range of alternative materials, including finely ground limestone, fly ash arising from the burning of pulverised coal in power stations and blast furnace slag arising from pig iron production in the steel industry
- ✓ The clinker-to-cement ratio (percentage of clinker compared to other non-clinker components) has an impact on the properties of cement
- ✓ European Standards determine the extent, type and proportion of alternative main constituents that can be used
- ✓ Quality, availability and security of supply are also key issues relevant to any decision to use alternative materials with clinker in cement production
- ✓ CEM II cements now represent over 80% of cements used in Ireland



MODERN CEMENT KILN

Cement must be manufactured to conform to the harmonised European Standard EN 197-1, which lists 27 common cements according to their main constituents. The quality and consistency of cement is fundamental to the performance and durability of concrete.

The traditional cement used in Ireland has been Portland cement based on 95% clinker content. In order to reduce the carbon intensity of cement production, the industry in Ireland in the late 1990's researched the potential availability and sustainability of appropriate local materials to blend with clinker in the production process without compromising durability and performance.

The results of this work indicated that Portland limestone cements based on clinker and limestone, Portland fly ash cements based on clinker and fly ash and Portland composite cements incorporating both limestone and fly ash could all be produced, with similar performance to CEM I cement, and would best meet the requirements of the industry and its customers into the future. These CEM II cements have been successfully rolled out over the past decade by the member companies of CMI and now account for over 80% of cements used in Ireland. Specific carbon reductions of over 20% have been achieved in some products.

The industry also reviewed the potential for the use of blast furnace slag, a by-product from the production of pig iron in the steel industry abroad. Slag of suitable quality for cement production is available globally at a fraction (circa 5%) of current cement production.

This issue has been highlighted in the international literature relating to the industry for some years, most importantly in the Cement Technology Roadmap published by the International Energy Agency (IEA) and the World Business Council for Sustainable Development (WBCSD) in 2009.

In addition, there are substantial emissions associated with the production of slag in a blast furnace and significant issues can also arise relating to the quality and consistency of the material and the reliability of supply lines.

It was concluded in Ireland that the use of slag did not represent a sustainable basis for the development of cements with reduced carbon intensity in the short, medium or long-term.

The industry in Ireland has therefore concentrated its efforts on the production of composite cements using locally available limestone and fly ash in the knowledge that the key pillars of sustainability – social, economic and environmental – are being appropriately addressed.

↓ **OVER
20%**

**THE CARBON FOOTPRINT
OF A BAG OF CEMENT IN IRELAND
IS CURRENTLY OVER 20% LESS
THAN THAT OF A BAG IN 1990**



2.3 ENERGY EFFICIENCY

THERMAL ENERGY EFFICIENCY

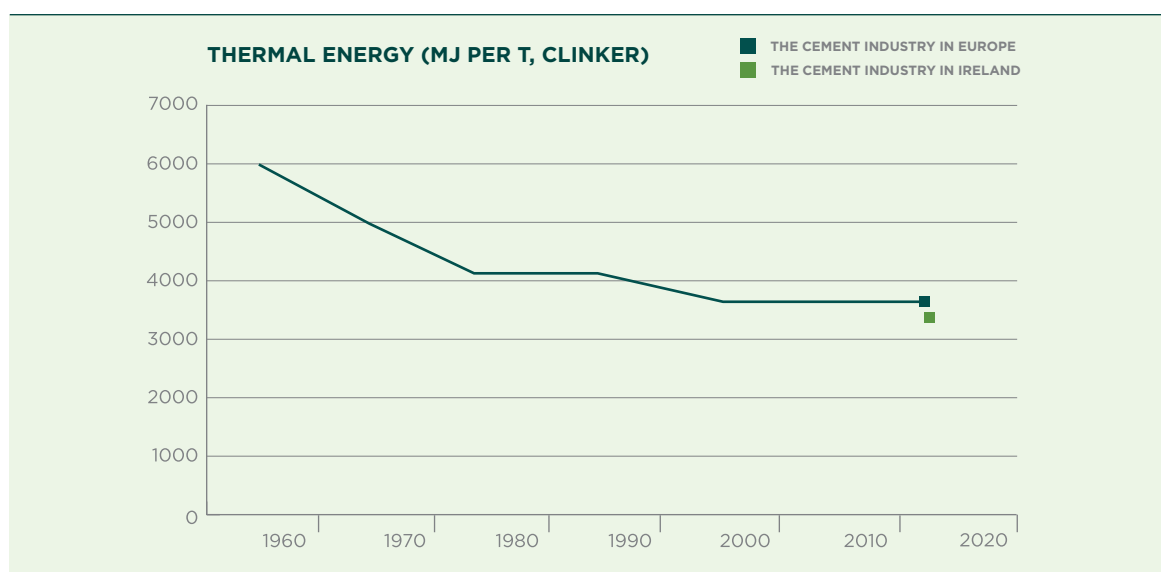
The manufacture of cement is energy intensive with significant thermal energy required to heat the calcium and silica bearing raw materials to a sufficient temperature to produce cement clinker, which is composed predominantly of calcium silicate minerals. Cement clinker is produced efficiently at material temperatures of 1,450°C. Gas temperatures of the order of 2,000°C are required at the burning zone of modern cement kilns to ensure this material temperature is reached consistently.

Early cement production utilised shaft kilns to produce clinker. These were then replaced with rotary kilns using the wet process, whereby the raw materials were fed in the form of a slurry to the kiln, thus requiring significant energy to drive off moisture even before heating the materials. With the advent of technology to transport fine powders, the dry process was introduced into Ireland in the early 1970's.

Modern dry process rotary kilns incorporating preheaters and a precalciner represent "Best Available Technology".

Approximately 40% of carbon emissions arising in clinker manufacture occur due to fuel burning and operating to best practice standards ensures carbon emissions are minimised.

- ✓ The average thermal energy needed across the EU to produce a tonne of clinker in 2011 was 3,730 MJ². The weighted average in Ireland is 3,538 MJ, confirming that the industry is operating at industry best practice standards



² World Business Council for Sustainable Development – Cement Sustainability Initiative; "Getting the Numbers Right" (GNR).

ELECTRICAL ENERGY EFFICIENCY

Cement manufacturing utilises electricity to crush and grind raw materials, to transport large quantities of materials and gases and to grind clinker. Continuous improvements to the production process have lowered electrical energy requirements to best practice standards.



MODERN VERTICAL MILLS HELP IMPROVE ENERGY EFFICIENCY

Cement production requires electric power at several stages - crushing, grinding and preparation of raw materials, clinker production, cooling and grinding.

Over 50% of electrical energy used in cement production is required in grinding raw materials and clinker. The application of modern vertical grinding techniques, mill separator technology and variable speed drives reduces the amount of electrical energy required throughout the production process.

Equipment in the cement plants in Ireland has been continuously modernised. The most notable developments, relevant to electrical energy use, have been associated with grinding technology.

Modern vertical mill technology has improved electrical energy efficiency by up to 30%.

2.4 RESPONSIBLE SOURCING

- ✓ **Irish Cement, Lagan Cement and Quinn Cement were the first companies in Ireland to be accredited to BES 6001 “Framework Standard for the Responsible Sourcing of Construction Products”**

Responsible sourcing of materials has become increasingly important for the procurement of building materials in both the public and private sectors and for material producers alike.

Various Standards and Schemes have been developed globally which assess responsible sourcing from material extraction through manufacturing, processing and supply chain management.

In 2008, the Building Research Establishment (BRE) in the UK published BES 6001 “Framework Standard for the Responsible Sourcing of Construction Products”, a responsible sourcing scheme, which allows assessment of products across a range of aspects such as management of supply chains, stakeholder engagement, quality and environmental management, greenhouse gas emissions and labour practices.

While separately pursuing their own Corporate Social Responsibility programmes in line with the overall sustainability agenda of CMI, the member companies applied for and were granted independent registration to BES 6001.

Irish Cement, Lagan Cement and Quinn Cement were the first companies in Ireland to achieve accreditation to this Standard, each achieving a ‘Very Good’ performance level.



2.5 LOW CARBON CEM II CEMENTS

CEM I cements based on Portland cement clinker have been the predominant cements used in Ireland since the foundation of the country's modern cement industry in the late 1930's. Product consistency and quality have contributed to a reliance on concrete, incorporating CEM I cement, throughout the construction sector, for all building and infrastructure needs, until recent times.

In response to Government requests in the late 1990's the cement industry began to research possibilities to reduce the carbon associated with cement manufacture. Aside from the continuous investments in energy efficiency improvements, the three companies independently researched the potential opportunities to reduce the clinker content of cement, in line with EU sustainability principles, using locally available materials.

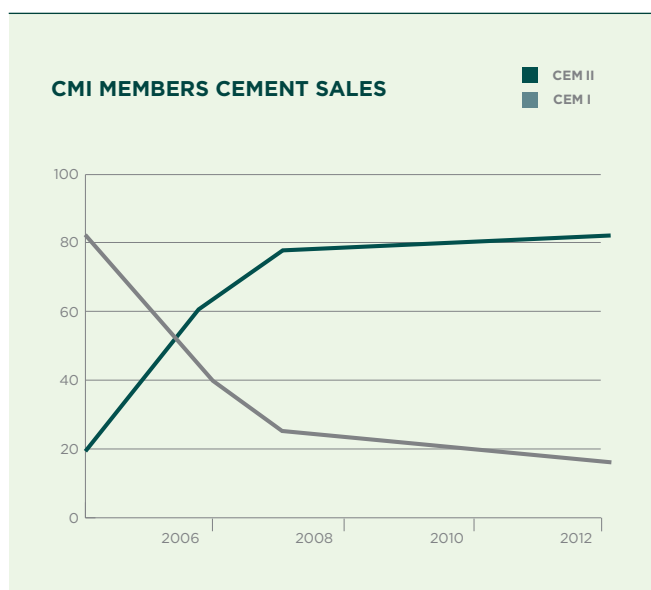
It was established that CEM II cements, incorporating unburnt limestone and fly ash from coal burning power stations could be incorporated with clinker in the production of CEM II cements in a manner such that the traditional reliability of performance of CEM I cements could be maintained.

From small beginnings in 2004, CEM II cements using locally available materials today account for over 80% of cements used in the Irish construction industry.

Traditional strength and durability performance have been maintained and the carbon footprint of products has been reduced by the order of 20%.

A technical report outlining the excellent performance characteristics of CEM II cements, produced by VDZ, the Research Institute of the German Cement Industry, has been published by CMI.

CEM I cements continue to be produced by the industry to serve the specific needs of the pre-cast concrete industry and export markets.



SUSTAINABLE CONCRETE CONSTRUCTION

- ✓ Concrete has significant thermal mass
- ✓ Concrete has excellent fire and sound resistance
- ✓ Concrete is economic
- ✓ Concrete is strong and durable and requires little maintenance
- ✓ Concrete is locally produced, locally used and sustains local communities
- ✓ Concrete is fully recyclable
- ✓ Concrete is the only material capable of delivering climate change adaptation infrastructure

CONCRETE AND THE ENERGY EFFICIENCY OF BUILDINGS

Energy consumption of buildings accounts for approximately 38% of total greenhouse gas emissions in Ireland and is one of today's major sustainability concerns.

Concrete buildings can achieve considerable energy savings during their lifetime because of the high level of **thermal mass** they deliver, meaning that the indoor temperature remains stable even when there are fluctuations in temperature outside. Concrete performs very well when holistic and accurate comparisons are made with other building materials. Energy savings of concrete structures during the in-use/operational phase are hugely significant.

The thermal mass potential of concrete can be maximised in building design, giving it a strong advantage over other materials and enabling construction of low-energy concrete structures that reduce energy usage from an average of 200-150kWh/m² to 50kWh/m², or even zero-emission buildings.

It is important that all sustainability assessments are carried out at the building level and take into account impacts over the complete life cycle.



COMMISSIONERS OF IRISH LIGHTS - DÚN LAOGHAIRE

CONCRETE RECARBONATION

During the lifetime of a concrete structure carbon dioxide in the air reacts with hydrated Portland cement clinker contained within concrete, a process known as recarbonation. At the end of their working life, concrete structures can be demolished. If the concrete is then crushed, its exposed surface area increases, also increasing the recarbonation rate.

Up to 25% of the carbon originally emitted in cement production can be re-absorbed. This is significant and indicates that concrete has the potential to act as a carbon sink of significance and it is expected that this will be taken into account in carbon calculations relating to building life cycle assessments.

CONCRETE RECYCLING

At the end of its life cycle concrete can be completely recycled in both cement and concrete production with benefits in energy and resource efficiency.



AVIVA STADIUM - CONCRETE RECYCLED AND USED ON SITE

EFFICIENCY IN DESIGN AND CONSTRUCTION

Modern design methodologies allow for the incorporation of slender elements using optimised concrete mixes. Concrete mix design is becoming increasingly sophisticated allowing the designer greater flexibility in function and form and, today, mix designs permit recycled and

reprocessed aggregates to be incorporated in concrete production. Improvements in admixture technology enhance the performance of cement and concrete at both the construction and use phase. Modern site management tools minimise site wastage.

GREEN PUBLIC PROCUREMENT IN IRELAND AND CONCRETE

The Green Tenders Action Plan published by the Irish Government notes that energy and carbon, resource use, responsible sourcing, wastage, durability, recyclability and disposal should be considered in relation to the choice of building materials and that sustainability assessments should span the complete life cycle of the building.

CMI members believe that concrete, appropriately designed into buildings and infrastructure, and sourced locally using sustainable materials such as CEM II cements, meet all the requirements of both the EU and the Irish Government in delivering a durable and sustainable built environment for the Ireland of the 21st century.

LOCAL EMPLOYMENT

THE IRISH CEMENT
MANUFACTURERS
SUPPORT APPROXIMATELY

2,000

DIRECT AND INDIRECT JOBS

ONE JOB IN
CONSTRUCTION
LEADS TO

TWO

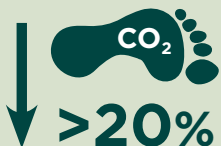
ADDITIONAL JOBS
IN THE ECONOMY

CEMENT AND CONCRETE ARE LOCALLY PRODUCED AND WILL SUSTAIN LOCAL COMMUNITIES IN IRELAND INTO THE FUTURE.

- ✓ CMI members support approximately 2,000 direct and indirect jobs
- ✓ Jobs maintained through recession by developing export markets
- ✓ Maximum utilisation of local goods and services



SUSTAINABLE PRODUCTION – TODAY



“BEST AVAILABLE TECHNOLOGY” UTILISED ACROSS THE INDUSTRY.

- ✓ Irish production plants among the most efficient in Europe
- ✓ €300 million invested recently in modern technologies
- ✓ Significant carbon reductions achieved
- ✓ Low carbon CEM II cements now the norm in Ireland



SUSTAINABLE CONCRETE CONSTRUCTION



- ✓ Thermal mass of concrete to make significant contribution to reduction in national carbon emissions through improved energy efficiency of buildings
- ✓ Durability of concrete key to extended building life cycle performance
- ✓ Concrete will deliver climate change adaptation infrastructure

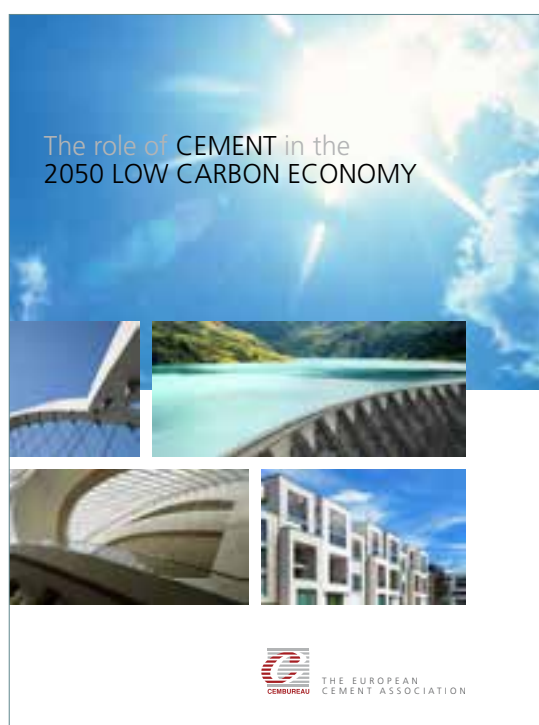
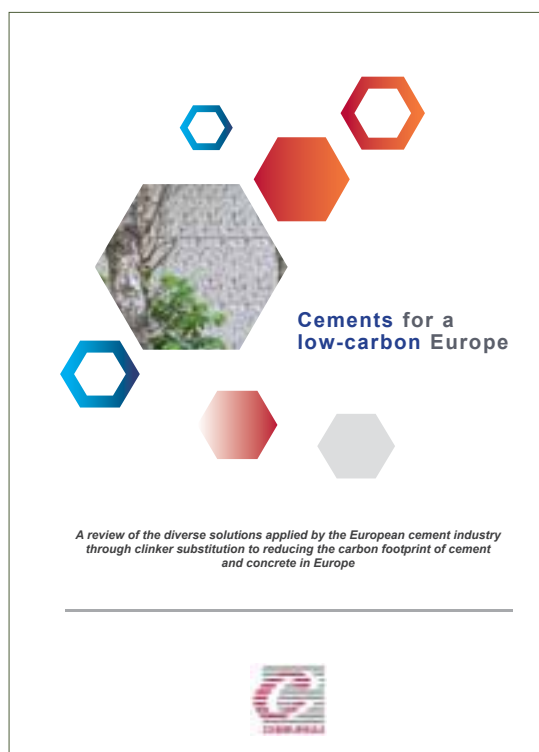


SUSTAINABLE PRODUCTION – FUTURE



- ✓ Investments made secure sustained employment
- ✓ Irish industry in line with the CEMBUREAU 2050 roadmap for carbon reduction:
 - 32% reduction on 1990 predicted with conventional technology
 - 80% reduction on 1990 projected with breakthrough technology
- ✓ Cement industry in Ireland supporting European Cement Research Academy (ECRA), including research on carbon capture









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