Summary of the technical report

A COMPETITIVE AND EFFICIENT LIME INDUSTRY

Cornerstone for a Sustainable Europe

Introduction

In 2011, the European Commission published a roadmap for moving to a competitive low carbon economy by 2050. It outlines an ambitious CO_2 reduction goal whilst keeping European industry competitive. We operate in a globalised economy, with global competition. Given the difference in energy costs and the rather flat growth curves of the European economies, this a bold goal.

The European lime industry, as energy and carbon intensive sector, looked at a wide range of options to contribute to the 2050 objective and move towards a competitive low carbon economy. Over the past 20 years, the European lime industry has lowered its emissions substantially, mainly by modernising plants and adjusting the fuel mix.

We started an in-depth analysis of how and what is possible now and in the future. We looked at all possible available options: substituting fuels, efficiency measures and even carbon capture.

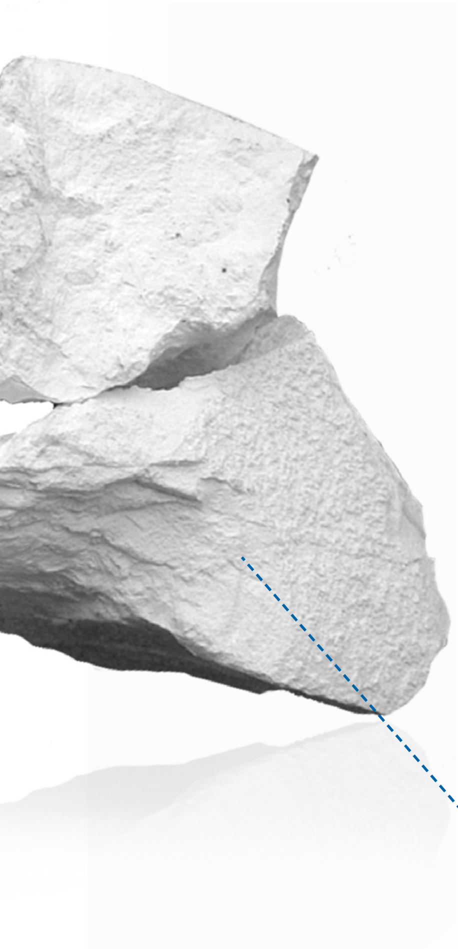
We identified many areas where we can make a difference. However, lime production is different from many other industries. Although, about a third of emissions are caused by burning fuels to heat the kilns and some electricity is used for grinding and other mechanical operations, the bulk of our emissions come from the raw material used: limestone. When heated, a chemical reaction takes place where limestone is transformed into lime and CO_2 is released.

These process emissions are inevitable and fairly constant per tonne of lime. Unless the carbon is captured, and used or stored, but its economic feasibility has to be looked at.

Lime is enabling key material for many sectors. Its unique properties enable other industries to reduce their carbon footprint. For example hydrated lime in asphalt makes transport more energy efficient transport. However, in this roadmap, we focused our research on what we can do ourselves.

Our industry is closely interconnected with other industries. We, therefore, looked at external factors and how they could impact us. Lime is used in a variety of industrial processes and its sustainability is intrinsically linked to that of others. We also examined the potential impact of the cost of carbon on the European lime industry and the risk of carbon leakage.

The priority of the sector is to deliver quality products manufactured in a sustainable way and respectful of the environment. The lime industry would like to call upon the EU to put in place the necessary instruments that will allow th economy to become a low carbon one, whilst maintaining the competitiveness of the European industry by supporting its role in a complete value chain. We outlined a series of possible policy measures to support the development of innovative technologies and keep Europe's industrial landscape economically vibrant.



What is Lime?

“It is the only mineral product that can be used to produce steel and sugar in the same day!”

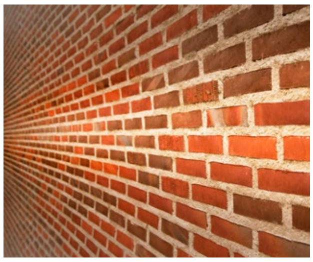
Lime is an essential but often unseen ingredient. Not only does it help the construction and manufacturing industries optimise their products, but it also supports the drinking water, food and farming sectors with its versatile and unique characteristics.

It is the only mineral product that can be used to produce steel and sugar in the same day! Lime is a highly important and diverse substance, due to its alkalinity and ability to purify and neutralise.

Lime is an important, and often irreplaceable component of many industrial sectors; from steel manufacturing to the construction materials, chemical industries and paper pulp.

Even though it was discovered in ancient times, today it is manufactured using the latest industrial processes and techniques. Lime products are used in a wide variety of applications in Europe, and worldwide. The average EU citizen indirectly uses around 150 g/day of lime products.



What is Lime used for?

The lime industry, through its multiple applications and its essential role for downstream industries, sits at the beginning of the value chain in Europe. Used in many products for everyday life, lime is probably the most versatile natural mineral product.

ENVIRONMENTAL PROTECTION

Lime is fundamental to promoting the healthy environment we live in. It is a diverse material that can make gases, solids and liquids less harmful to the natural environment. Being an alkali, lime is able to neutralise both natural and industrial acids. It can create inert solid wastes, which can be either disposed or recycled to allow other natural resources to be preserved. Lime treatment also ensures wastewater is clean enough to be returned to the natural environment. This means it can be used to treat both industrial effluent and sewage.

DRINKING WATER AND FOOD

Lime is essential in making our water clean. It regulates the pH levels, controls water hardness and helps to remove impurities from the raw water. This ensures it is both safe to drink and has a pleasant taste when it reaches our taps.

The use of lime in chicken farming provides an important food supplement to strengthen egg shells. It is also used in fish farming to control pH and create optimum water conditions as a fertiliser for crops.

MANUFACTURING

Lime proves to be a highly diverse ingredient for the manufacturing industry. It is fundamental to steel manufacturing. In a steelworks, lime is used to remove impurities to give steel the correct chemical composition. For each tonne of steel, up to 70 kg of lime is required. It is not possible to make steel without lime.

Lime is also used in plastic production, to remove water from material and rubber before setting. It can also be used to make fillers and coatings for paper.

CONSTRUCTION

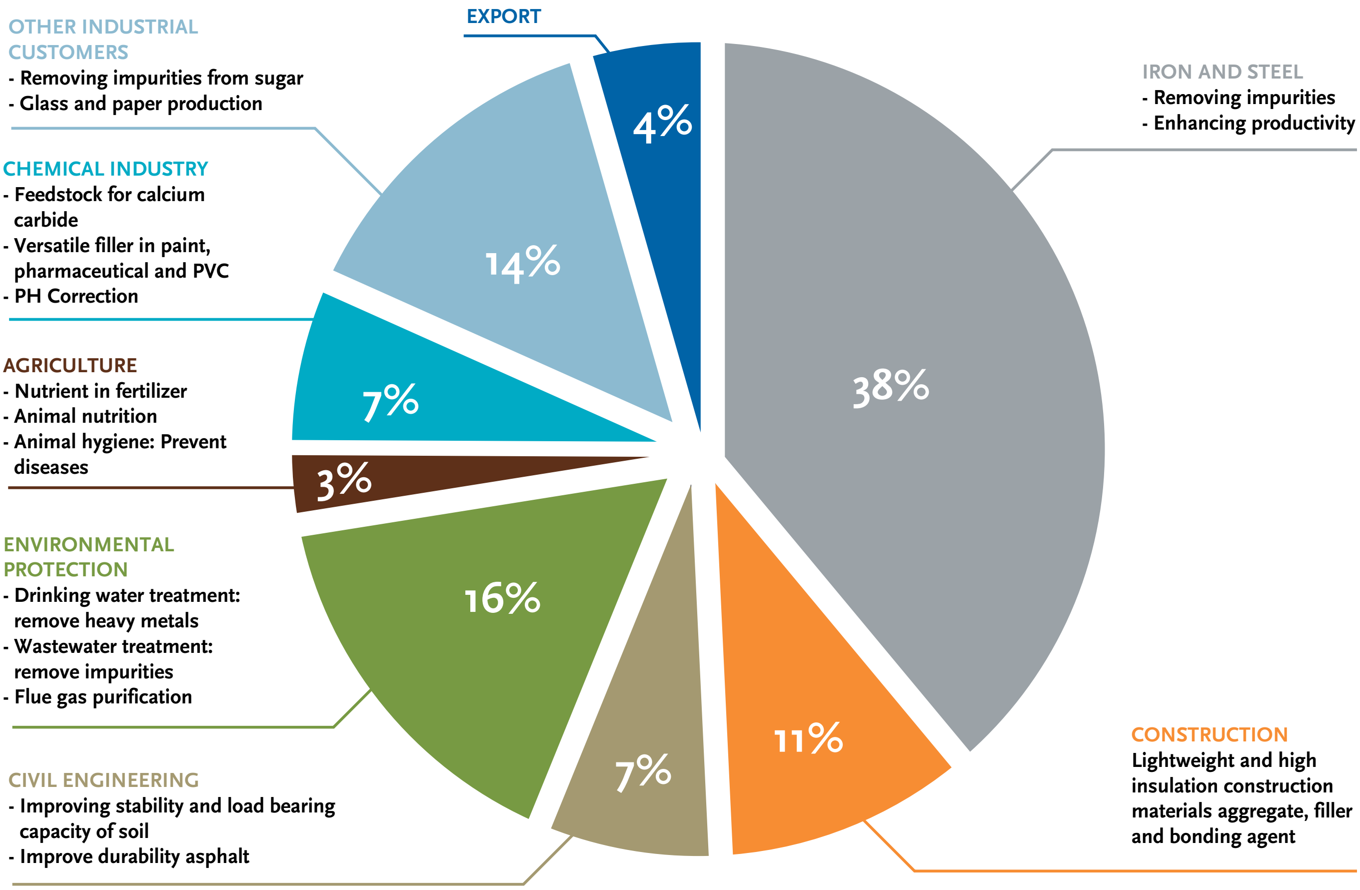
Lime is one of the world's oldest building materials; lime mortar being used even in Roman times. Today, it is a useful tool for restoration and can be applied to historical buildings as part of the renovation process, preserving their cultural heritage for many years to come.

It is also used in modern day buildings, such as houses and offices, due to its beneficial properties including breathability and flexibility.

Additionally, it is an important additive to prepare land for construction and is used extensively to stabilise soils.

"Used in many products for everyday life, lime is probably the most versatile natural mineral product."

OVERVIEW OF CUSTOMER MARKETS AND FUNCTIONALITY OF LIME PRODUCTS



How is Lime made?

1. Extraction

- In the quarry, controlled explosions used to break up **limestone** or **chalk rock**. This can dislodge up to 30,000 tonnes of rock in one explosion.
- The broken rock is then picked up at the quarry face by huge, mechanised excavators.

2. Crushing and Screening

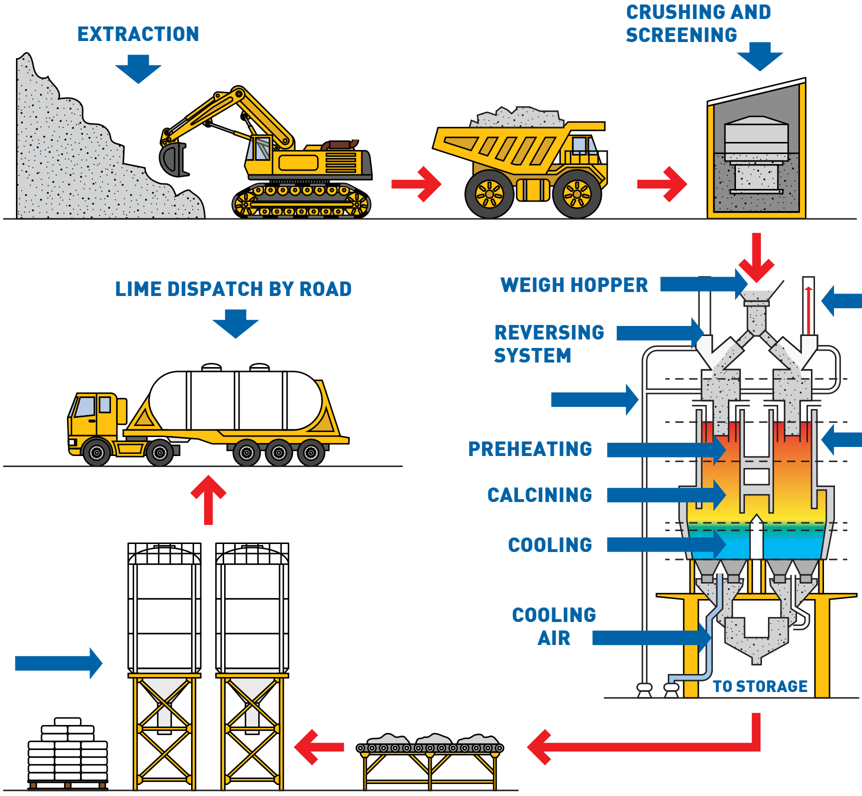
- Trucks then tip the rock into crushers, which break down the rock into smaller pieces.
- Screeners sort and separate the rock pieces into different sizes.

3. Emissions Control

- A number of filters and scrubbers control the dust and gases generated from burning the rock.

4. Fuels

- Different types of fuel are added to power the kiln.



5. The Kiln

- The rock is heated to 800ºC in the preheater and then from 1200ºC to 2000ºC to make **lime**.
- The burn temperature and time in the kiln depends on the type of rock that is used as the raw material.
- The kiln can either be horizontal or vertical.

6. Cooling

- The lime that leaves the kiln is cooled with air.

7. Hydration

- Sometimes after cooling, water is added to lime to make hydrated lime.
- The type of lime that is made depends on what the customer is using it for.

8. Storage and Dispatch

- Finished lime products are safely wrapped, packaged and stored on site.
- They are then sent to the customer by road, rail and even boats overseas.

A carbon intensive industry

Lime production is carbon intensive, however it is different from many other carbon intensive industries.

Its specificity is due to the fact that only a third of emissions comes from burning fuels to heat the kilns, but the bulk of our emissions come from a chemical reaction that happens during the production process.

Limestone is heated in a large kiln with temperatures above 1000°C, causing one of the two chemical reactions takes place:

- $CaCO_3$ (solid) + energy ➡ CaO, (solid) + CO_2 (gaseous) **(lime)**
- $CaMg(CO_3)_2$ (solid) + energy ➡ $CaMgO_2$, (solid) + CO_2 (gaseous) **(dolime)**

Since close to two thirds of our emissions are linked to these chemical reactions, options to mitigate these emissions are limited without capturing the carbon.

Lime (calcium oxide - CaO) is an alkali and the result of the chemical transformation of limestone. Given its rapid reaction with water, calcium oxide, also called burnt lime, is often referred to as quick lime.

Dolime or dolomitic lime (calcium & magnesium oxide - CaO.MgO) is the result of the chemical transformation of double carbonate of calcium and magnesium. Like lime, dolime reacts with water. CaO's affinity for water is higher than that of MgO.

Energy Use

HEAT CONSUMPTION

Producing lime requires heating limestone between 900°C and 1200°C. Maintaining these kinds of temperatures requires a substantial amount of energy. In 2010, the average fuel consumption is 4.25 GJ/tonne of quicklime.

Calcination is the most energy intensive step in the lime production process, thus the energy efficiency of the kiln has a large impact on emissions. Thanks to the optimisation of the production process, the lime industry has made a lot of progress in terms of energy efficiency, nevertheless, we looked at a multitude of ways to reduce energy consumption even further.

However, we are limited by the laws of physics and chemistry. The theoretical minimum energy required for the chemical reaction that transforms limestone to take place, is 3.18 GJ/ tonne of quicklime. This number assumes complete conversion of limestone into lime. In reality, not all limestone is converted to lime. For example, limestone typically contains 1% of water which evaporates in the kiln and leads to increased energy use.

Other aspects, such as the specification of the desired lime, grain size, humidity of the limestone, fuel quality and residual CO_2 content in the lime product all play a role as well.

Nevertheless, the type of kiln has a major impact on the energy consumption per tonne of lime.

OVERVIEW OF THE MINIMUM AND MAXIMUM HEAT CONSUMPTION PER KILN TYPE FOR QUICKLIME PRODUCTION (JRC, 2013 (BREF))

Kiln orientation:	Kiln type:	Heat use / consumption for quicklime production (GJ/tonne):
Vertical	Parallel flow regenerative kilns (PFRK)	3.2-4.2
	Annular shaft Kilns (ASK)	3.3-4.9
	Mixed Feed Shaft Kilns (MFSK)	3.4-4.7
Horizontal	Long Rotary Kilns (LRK)	6.0-9.2
	Rotary Kilns with preheater (PRK)	5.1-7.8
Other Kilns		3.5-7.0

The vast majority of plants in Europe are equipped with modern, energy efficient kilns and the less efficient ones are continually improved or will be replaced over time. However, as plants modernise and technology evolves, we will achieve improved thermal efficiency but options are very limited, not least by the theoretical minimum energy input.

FUELS

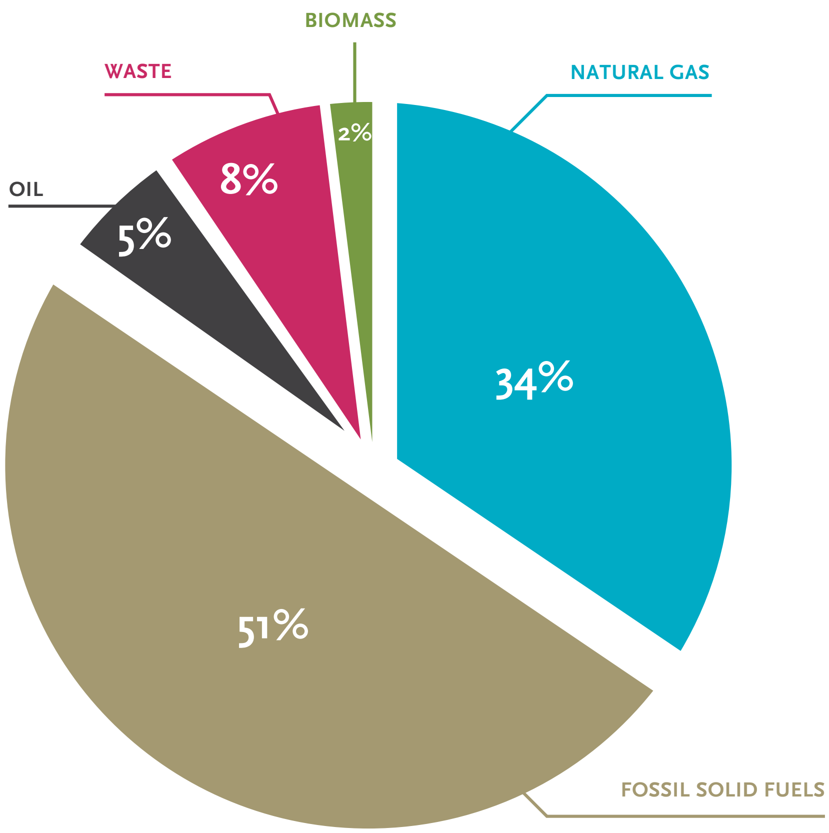
Currently, the European Lime industry uses a wide variety of fuels, including fossil fuels (natural gas, fossil solid fuels and oil), waste or biomass.

Fuel use can influence the product quality. Certain fuels can not be used for specifics application.

ELECTRICITY CONSUMPTION

The electricity consumption in lime manufacturing is relatively low. Electricity is mainly used for operating some of the kiln equipment and mechanically crushing the limestone. Electricity consumption varies, but it is estimated at ±60 kWh/t.

FUEL MIX 2010, (EULA, 2012).



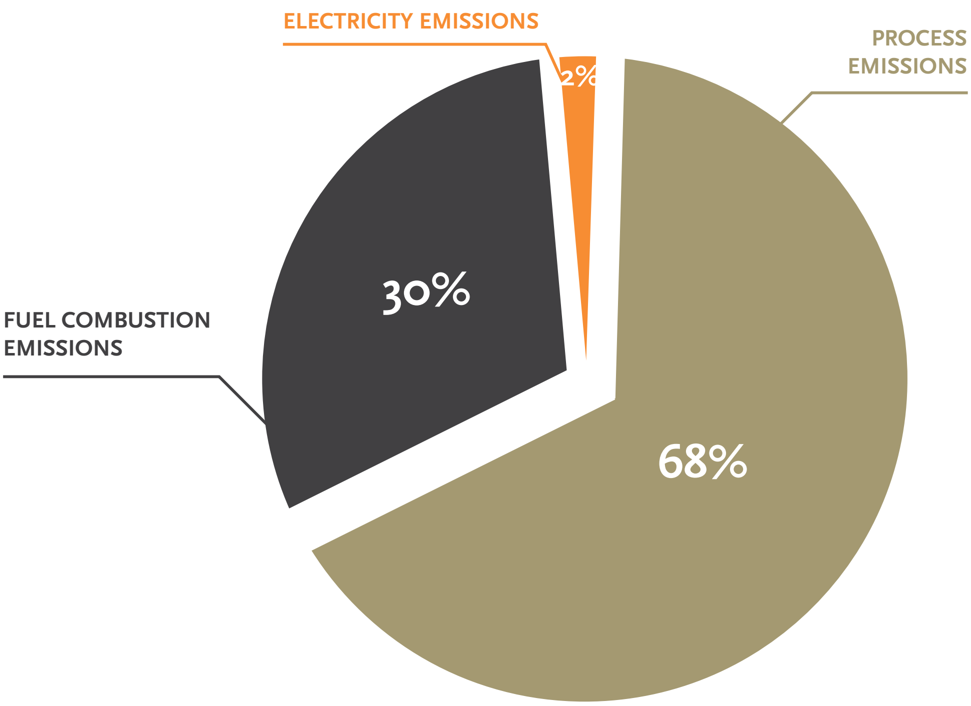
CO_2 Emissions

The CO_2 emissions from the lime industry come main from two sources.

- Heat production for the kilns. These emissions vary depending on the type of lime product manufactured.
  For example, dolime requires more energy than quicklime.
- The chemical process at the heart of lime production where CO_2 is released during the calcination process when limestone is transformed into lime.
  These emissions are constant and amount to 0.751 tonne of CO_2 per tonne of lime and 0.807 tonne of CO_2 per tonne of dolime.

Small amounts of indirect CO_2 are emitted during other parts of the production process, such as mining limestone or hydration, but they are insignificant compared to heat production and process emissions from calcination. Our exercise focused on these two main sources of emissions.

AVERAGE SHARE OF CO_2 EMISSIONS FROM THE MANUFACTURE OF LIME



Average share of various sources for CO2 emissions in the manufacture of lime for 2010

The total direct CO_2 emissions of the European lime industry – based on EUTL, the EU-ETS emissions registry are around 26 Mtonne of CO_2.

Given the split of emissions, our focus has been on reducing energy use and looking into solutions to capture the process emissions, even if CCS/CCU is not financially viable at this time.

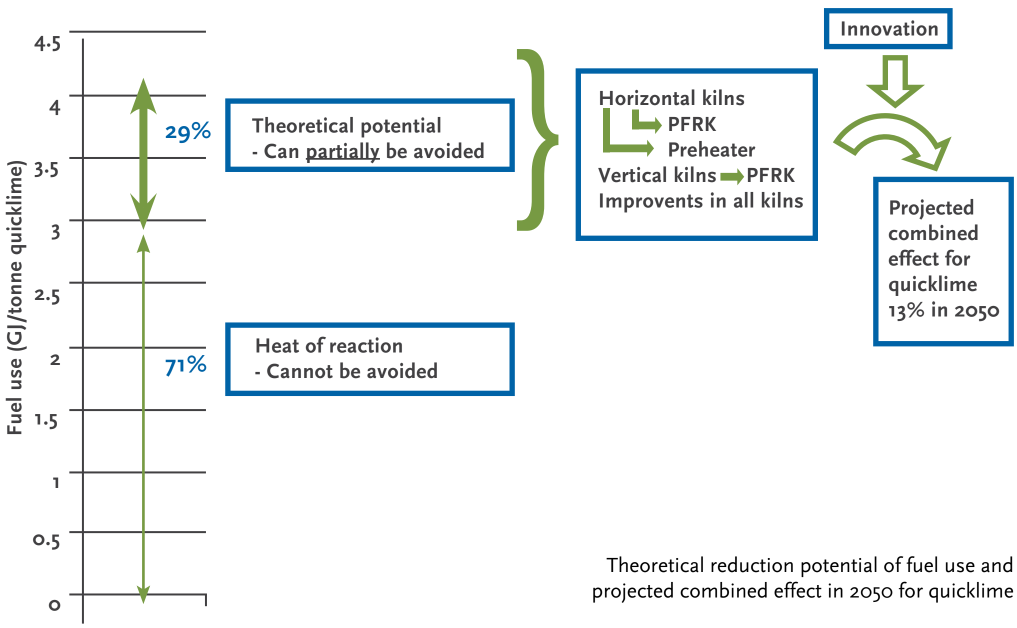
Reducing our emissions

FUEL SAVINGS

Over the past decades, the European lime industry has invested heavily in energy savings technology and continuously improved plants to reduce their energy consumption.

While the heat of reaction, the energy required for the chemical reaction to take place – for a typical quicklime quality – is 3.03 GJ/tonne. Theoretically, the potential for energy efficiency improvement is, therefore, limited to 29%; the rest of the fuel is needed to provide the energy for the chemical reaction. Limestone always contains impurities and a driving force is always required to get the reaction going.

We estimate that implementing existing technology and future innovation could lead to a reduction of 16% in fuel intensity by 2050. This would be achieved mainly by building new – highly efficient – kilns, and retrofitting existing kilns. By 2030, the projected total decrease of fuel intensity is estimated to be 8%.



Theoretical reduction potential of fuel use and projected combined effect in 2050 for quicklime

The main methods of this increased fuel efficiency would be

Switching from horizontal to vertical kilns

Lime can be produced in different kinds of kilns. Over the past decades, new kiln types have been developed and existing kilns have been improved. Newer vertical kilns are considerably more energy efficient than horizontal kilns. In Europe, 80% of lime is produced in vertical kilns. Some existing horizontal kilns have been refurbished, but they cannot achieve the same energy efficiency as a new vertical kiln. In the coming years, old kilns are likely to be replaced by new, more efficient ones.

Installing heat exchangers in horizontal kilns

In horizontal kilns heat exchangers can be used to recover some of the heat from the flue gases produced in the kiln and use this heat to preheat the feed limestone. This could generate – on average – a fuel saving of around 25%. However, this potential reduction is only applicable to horizontal kilns.

> “Optimizing cooling and grinding for instance could lead to further energy efficiency gains.”

Switching from vertical kilns to vertical kilns Parallel flow regenerative kilns

There are several types of vertical kilns. The Parallel Flow Regenerative (PFRK) type is the most efficient one. However, they cannot always produce all types of products to fully satisfy market needs and sometimes cannot process the smallest particles; therefore, they are not always the best solution from a resource efficiency point of view.

Further innovation could increase the applicability of PFRKs enabling them to handle smaller particles and, thus, making them more resource efficient.

Improved use of Waste Heat

Waste heat from the kiln can be used to dry limestone or in the milling process. In addition, the waste heat can be used in other industrial processes, in other sectors with a heat demand or they can be used to heat buildings and generate electricity. However, many lime plants are located in remote rural areas, which makes distributing the excess heat to other industries or as a residential heating source difficult at times.

Energy recovery in hydration

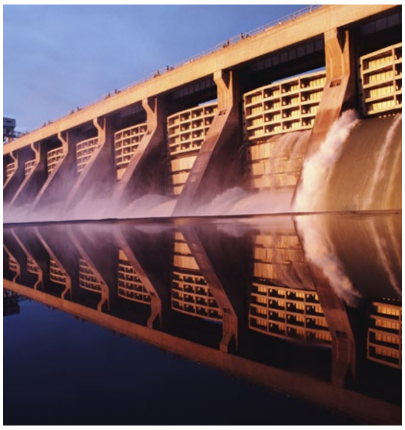
The production of hydrated lime and dolime is an exothermal reaction, i.e. it generates heat. The heat resulting from the production of hydrated lime amounts to about 1.2 GJ/tonne of CaO. This heat could be used in industrial processes or heating buildings if there is such a demand in the remote areas where the plants operate. This option will require further R&D to work out how to extract the heat without affecting the production process and quality of the product.

Other Measures

A range of other measures could also lead to increased fuel efficiency. These include efficient kiln insulation lining, optimised combustion processes improved process and input control, optimal change-over and further improved maintenance procedures.

Electricity Savings

Significant steps have been taken over the years to reduce our electricity consumption. Increasingly efficient engines and other technological progress have made a real difference but more stringent environmental legislation and increased controls in modern plants have offset some of these gains. Nerveless, we remain committed to finding ways to reduce our power consumption. The efficiency of motor systems is – conservatively - assumed to have a saving potential of 10%. Optimizing cooling and grinding for instance could lead to further energy efficiency gains.


Changing the Fuel Mix

One of the possible ways to reduce our emissions is switching to less carbon intensive fuels sources, such as natural gas or increase the use of biomass or waste materials.

However, many factors have to be taken into account when selecting the right fuel source.

SEVERAL CHANGES IN THE FUELS MIX COULD LEAD TO A REDUCTION OF CARBON EMISSIONS

Factor:	Fossil solid fuels:	Gas:	Biomass:
Price of energy source	Low - Moderate	High	Various
Ease of use / Maintenance	Moderate	Easiest	Requires most handling (transport, drying, processing)
CO_2 emissions	Highest	Moderate	None
Other emissions	Highest (particles, sulphur)	Lowest	Moderate (particles, other)
Effect of carbon price	Highest	Moderate	Not impacted
Required investment	High	Low (piping + burners only)	Highest (adapt injection and burners, and pre-treatment)
Impact on quality		Best	
Availability	High	High, not available for a couple of kilns due to their locations. Concerns over security of supply	Depending on other uses of biomass; sustainable sourcing important
Applicability	All	All	Not for MSFK A wide variety of biomass can be used.

“The European lime industry is committed to remaining an important part of the value chain contributing to the circular economy.”

Use of gas instead of solid fossil fuels

The European lime industry currently uses natural gas for about one third of its energy needs. Switching from solid fossil fuels to natural gas would reduce the CO_2 intensity of lime production although the gas network may be a concern, given the location of our plants.

Within the framework of this exercise, we assumed that all solid fuels used today would be replaced by natural gas. This can potentially reduce the average emission factor of the fuel mix by 30%.

This switch is dependent on a steady, secure and affordable supply of natural gas and will be affected by on a series of external factors such as potential price hikes caused by a switch to natural gas by the power sector or, inversely, lower gas prices, as European unconventional gas becomes available.

Use of waste as a fuel

Certain types of lime kilns are suited for the use of waste as a fuel source. The European lime industry is committed to remaining an important factor in the circular economy. The use of waste as a fuel source will continue but is conditional upon the availability of the right kind of waste and a regulatory environment that permits the use of waste as a fuel.

Use of biomass as fuel

Different forms of biomass can be used as a fuel in kilns. There are some technical restrictions, especially in the fuel efficient vertical kilns, as to the type of biomass that can be used, but ongoing innovation could ensure biomass will remain a fuel source of the European lime industry.

One of the ways to overcome the difficulties using biomass would be to convert it to syngas first. Using similar technology kilns could even be fuelled by biogas, sewage gas or landfill gas.

Use of electricity to heat kilns

Electricity could theoretically be used in the future to heat kilns. The European Commission’s Energy Roadmap plans a total decarbonisation of power, so this would result in a substantial reduction of our emissions. However, with current and foreseen power prices, this option is not economically viable. Moreover, this option is not yet technically feasible for the moment and will require further R&D.

However, the situation would be different in times of oversupply of electricity, resulting in cheap or even free electricity. Using electricity to heat the kilns might then be feasible and could help to bring supply and demand in equilibrium.

Solar heat

Solar heat could potentially be used, in some countries, to heat the kilns but they have to be heated to at least 900°C. In the future, high-temperature Central Receiver Systems (CRS) with pressurised air could reach temperatures up to 1000°C. However, this technology is still in an experimental phase, would require further research, and is only suitable for Southern Europe.

CARBON CAPTURE AND STORAGE/UTILIZATION

Two thirds of our emissions are process emissions linked to a reaction which happens when limestone is heated. Even if all kilns were optimised and the fuels mix perfect, emissions would still be substantial.

Carbon Capture & Storage or Carbon Capture & Utilization represent the measures with the biggest abatement potential of all, and are, in fact, the only ones tackling process emissions during the manufacture of lime products.

Its costs are high in comparison with the production costs of lime. Given the right technological development, economic situation and infrastructural requirements, and with an incentive to not harm the EU lime industries competitive position, the industry would embrace this technology.

Carbon Capture

If capturing carbon is the key to substantially lower emissions, it does represent a real challenge in terms of cost.

In 2012, TNO (Netherlands Organisation for Applied Scientific Research) performed a techno-economic evaluation of post combustion CO_2 capture in lime production plants. Using the lowest electricity price assumed in the report, costs to capture CO_2 were evaluated at €94/tonne of avoided CO_2.

Future innovation could provide the potential to reduce the cost associated with capturing CO_2 and quick uptake would accelerate innovation. Nevertheless, at current price levels, it is not economically viable since it would be more than double the production cost.

"If capturing carbon is the key to substantially lower emissions, it does represent a real challenge in terms of cost."

Storage or Utilization?

Assuming that the barriers of technical and economic feasibility as well as social acceptance have been overcome, the other big question is what to do with captured CO_2. Two options are available: storage or utilisation:

Storage

Storage involves transporting the CO_2 to a geographically suitable location and storing it underground. Currently, lime plants are typically located right next to the limestone quarry, not clustered in large industrial agglomerations. Transport costs – to overcome the distance between the lime plant where it is captured and the location where it is stored – as well as any additional piping infrastructure can add significantly to the capture costs.
Storage locations would need to be developed and maintained and public and regulatory acceptance of CO_2 storage still needs to be overcome.

Utilization

The business case for capturing carbon, could be improved in case the captured CO_2 could be used, rather than stored. Storage costs could be saved, and it might get a financial value. The lime industry itself will not be able to use the it, but the business case to capture the CO_2 could benefit from others using it. A lot of research is currently devoted to developing new uses of CO_2, including:

- Using it to produce fuels/hydrocarbons.
- Transforming CO_2 into inert carbonates, to be used, for example, as construction material.
- Using it as a feedstock for the production of polymers.
- Applying CO_2 to enhance recovery of fossil fuels (oil, gas).

Many of these applications are, however, only at research stage for the moment.

BIOFUEL PRODUCTION FROM CO2 EMISSIONS FROM LIME PRODUCTION

A lime producer partnered in the Agical+ research project (financed under the European Commission LIFE+) that aimed at making use of the lime and glass sectors CO2 emissions. This project looked into an innovative solution, based on algae culture and biomass production, which would allow for the CO2 capture of lime or glass furnace fumes and the production of biofuel that could be used within the furnaces during the production process.

If applied at full-scale, such technology might significantly reduce CO2 emissions and consumption of fossil fuels related to lime and glass production industries. However, the economic analysis done in the project revealed that the cost of the biofuel produced would be around €650/GJ, or around 100-times more expensive than commercially traditional energy resources (natural gas, heavy fuel).

CARBONATION

Although not a traditional abatement measure, and not within the scope of our analysis, it is important to note that during the lifetime of products in which lime is applied, CO_2 from the atmosphere is captured (basically reversing the reaction in which lime is produced from limestone).

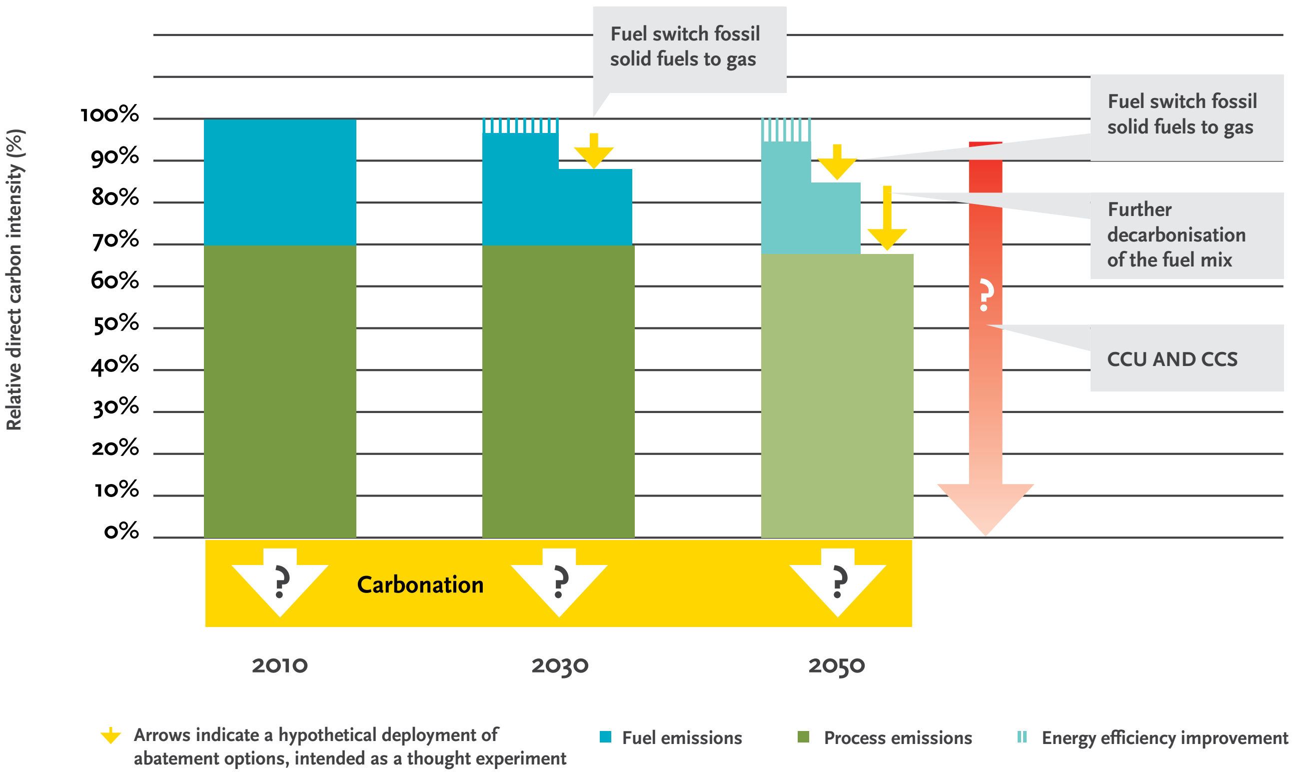
If atmospheric CO_2 has good access to the material, as is the case for example in some building materials, the lime, or the new material can reabsorb CO_2. This so-called "carbonation" partly closes the loop starting with CO_2 process emissions during lime production.

Carbonation is highly dependent on the application; in some applications the main carbonation takes place within five years, in other applications it takes longer. For example, for lime mortars, it is estimated that within 100 years, 80-92% carbonation will take place.

Pathway to 2050

Taking into account the unique emission profile of the lime industry, the type of plants in operation today and the possible savings, we have mapped a possible carbon reduction roadmap from 2010 to 2030 and 2050.

DECARBONISATION TOWARDS 2050: RELATIVE DIRECT CARBON INTENSITY (99% OF TOTAL EMISSIONS)



Possible development of the carbon intensities of lime production for 2030 and 2050, compared to 2010. Direct emissions only, which form about 99% of total emissions. Green bars reflect process emissions, blue bars reflect fuel emissions and the striped blue block indicates energy efficiency abatement. The orange bar reflects the – unknown – effect of natural carbonation. The arrows (apart from the arrows in the carbonation part) indicate the technical potential of emission reduction options.

A reduction of emissions related to the heat production in kilns can be achieved through a reduction in fuel intensity and switching to lower carbon fuels whilst a reduction in process emissions can only be achieved using CCS/CCU.
The technical potential of these options is shown by arrows with a colour gradient, representing the huge uncertainty in the potential that could be realized in 2030 and 2050. It should be kept in mind that this technical potential is intended as a theoretical thought experiment, and does not necessarily reflect a possible reality nor economical potential.

The figure shows two options for switching to lower carbon fuels:

- A fuel switch from fossil solid fuels to gas in 2030 and 2050;
- A full decarbonisation of the fuel mix, for example by using biomass (in 2050).

These options are shown as the yellow arrows. The last (red) arrow represents the technical potential of Carbon Capture and Storage/ Utilization. This technique could bring about the biggest reduction in emissions. However, it is important to understand the barriers related to CCS/CCU.

When assessing the effect of the remaining carbon emissions, the mechanism of natural carbonation could be taken into consideration.

> “The EU lime industry is at the beginning of the value chain, supplying to various other industrial sectors.”

Challenges and Risks

The lime industry has a long history in Europe and wants to continue to play its role, providing a unique material to industry, agriculture and consumers whilst taking care of reducing our environmental footprint in terms of emissions.

Yet this has to be done whilst remaining competitive as a European industry. Transport costs may be high but imports to regions near ports or waterway can be cost effective and if production costs in Europe rise much faster than other regions.

CAPITAL EXPENDITURE COSTS & COMPETITIVENESS

Wide scale implementation of several measures could be inhibited by high investment costs, leading to long payback periods.

CARBON COST AND COMPETITIVENESS

The EU lime industry is at the beginning of the value chain, supplying to various other industrial sectors. Unilateral European carbon costs would, therefore, have two impacts:

- The EU industrial client sectors could relocate their production site, reducing EU demand for lime products. To prevent this, the EU lime industry needs a stable EU industrial platform to prosper;
- The share of the EU demand for lime that is produced in the EU could decrease:

  - Due to the high carbon intensity of lime production processes, carbon pricing directly causes higher costs for lime production, e.g., an increase in carbon prices equivalent to €1/tonne of CO_2 translates into a lime production average cost increase by €1,1/tonne of quicklime.
  - This high sensitivity to energy and carbon prices has a large impact on competitiveness. Combined cost of an EU unilateral carbon price of €5/tonne CO_2 on top of the existing differences in energy prices, could exceed transport costs of import for some European kilns. When carbon costs increase even more, it is more economically viable to import lime from over further distances. Non-EU production costs are already lower than EU production costs, and adding a unilateral EU carbon price increases the difference.

In 2011, exports (~500 kton; ~2% of production) and imports (~300 kton; ~1% of production) of lime products in the EU are more or less balanced (Eurostat, 2013).

Despite the fact that transporting lime is costly, it is apparent that in the absence of free allocation of allowances – and with current differences in energy prices, some neighbouring countries have energy and transport cost that are low enough that they could pose a threat to EU producers.

COSTS ASSOCIATED WITH ABATEMENT MEASURES

Several abatement solutions are available and, although, some currently have technical limitations or are not feasible as yet, future innovations and technological progress might remediate some of these limitations over the following decades.

Even if theoretically possible, the wide scale implementation of some measures is currently inhibited by high investment costs.

However, in the future, innovation, increasing energy-cost and CO_2 prices, and investment support schemes might make these measures more financially attractive.

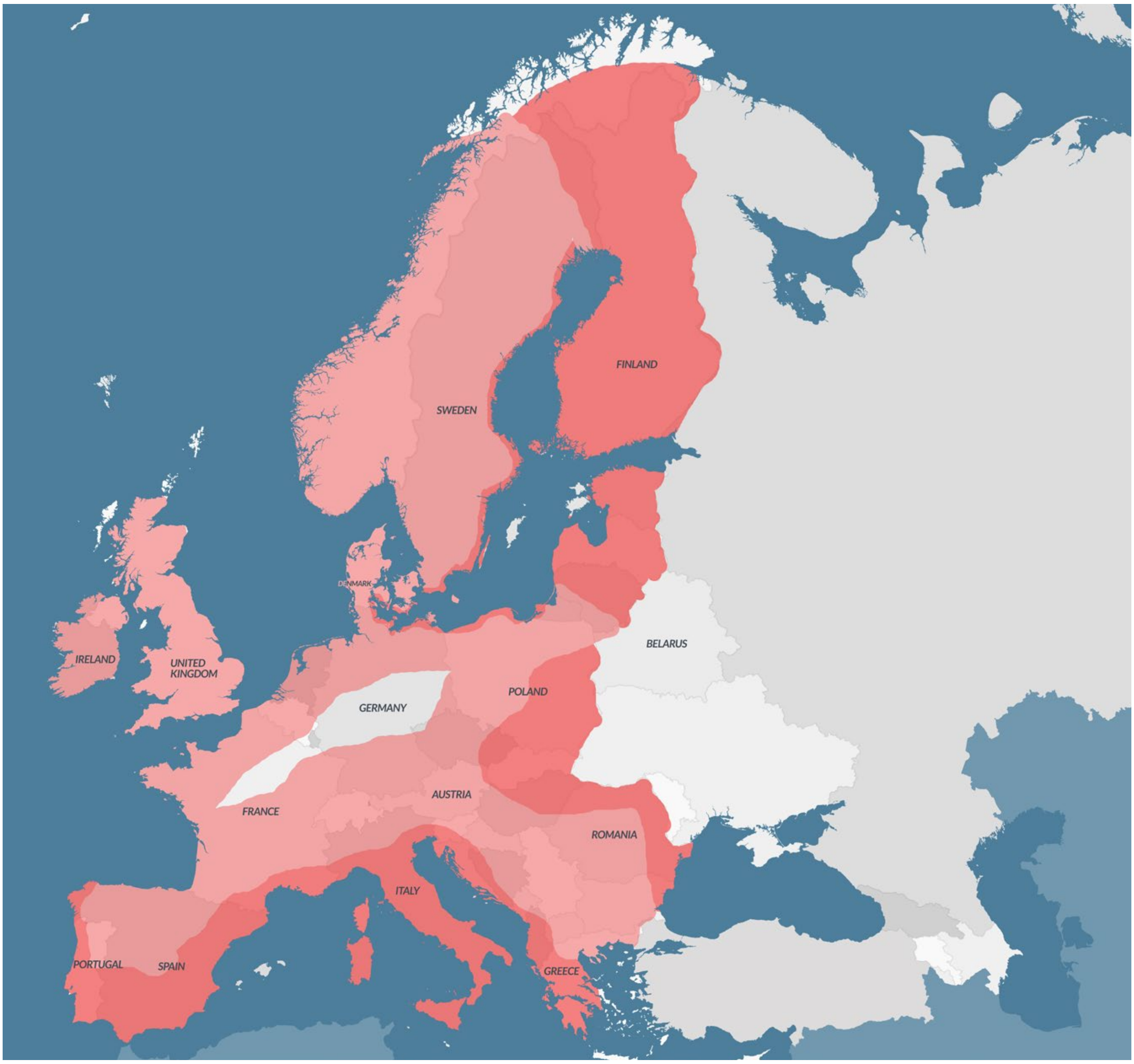
The numbers in the table below provide some guidance as to the investment costs associated with the uptake of the measures.

OVERVIEW OF ABATEMENT COSTS FOR KEY MEASURES TAKEN INTO ACCOUNT IN THIS ROADMAP

Measure:	Abatement costs (€/ton CO2):	Investment costs:	Savings (%):
Energy efficiency:			
Rotary kilns ➡ Shaft kilns	45	100 €/tpy	45%
LRK ➡ PRK	38	72.5 €/tpy	30
All shaft kilns ➡ PFRK	331	100 €/tpy	19%
Continuous improvements	Close to zero	Not assessed	3-7%
Fuel Switch:			
All solid fossil fuels ➡ Natural gas	91	No investment	28%
All Biomass	43	10.9 €/GJ	100%
CCS (Capture)	94	76 €/ton CO2 avoided	70%

Where possible, its starting points are aligned with the starting points for this Roadmap document. This is a simplified assessment, based on investment costs and changes to the fuel costs only. Neither changes in operation/maintenance costs, nor the possible advantage to increase capacity or potential impacts on the quality of produced lime products are taken into account.

LOCATIONS WITHIN THE EU TO WHICH IT MIGHT BE ECONOMICAL TO IMPORT LIME FROM OUTSIDE OF THE EU, MAKING INTO ACCOUNT THE DIFFERENCES IN ENERGY AND CARBON COSTS BETWEEN THE EXPORTING (NON-EU) COUNTRIES AND THE EU AND COMPARING THIS DIFFERENCE TO THE TRANSPORT COSTS FROM THE EU BORDER.



The darker red shaded zone represents the Central Case scenario; the lighter red shaded zone shows the additional area under the Increased Threat Scenario (NERA, 2013) assumptions have to be actually mentioned.

Policy Recommendations

OUR POLICY RECOMMENDATIONS FOR MAINTAINING A LONG TERM SUSTAINABLE EUROPEAN LIME INDUSTRY

- Our industry needs regulatory predictability and stability. A long-term industrial policy will create certainty and enable EU industries to make investment decisions, including investments in innovative technologies to reduce emissions.
- A global level playing field for climate policies is paramount and will prevent carbon leakage. In the absence of a global climate agreement, compensation for climate costs is needed for the lime industry as energy intensive one to maintain competitiveness.
- As the most important abatement option for the lime industry, CCS/CCU needs to be developed and deployed. This includes solving liability issues, designing and building an efficient piping network and providing connection to every active lime facility in the EU. This would enable the EU lime industry to take CCS/CCU on board once economically viable.
- Technology neutrality is needed to permit to other technologies to get developed in this field.
  Allowing carbonation to be accounted as a CO_2 abatement technique.
- The industry needs access to innovative investment models to attract finance for measures that do not meet the industry financial thresholds, or direct support for low-carbon investments.
- European energy policy should strive to build a fully integrated and well-functioning electricity and natural gas market. This energy policy should further:
  - Consider integrating energy requirements in international negotiations;
  - Guarantee a diverse and more competitive energy supply in Europe;
  - Eliminate differences of energy prices within Europe as a consequence of national differences in energy taxation.
- Future targets should not take the feasibility of large scale implementation of CCS/CCU for granted, take differences between sectors into account, and provide long term certainty.

About EuLA

The European Lime Association (EuLA) gathers the non-captive lime producers organised in national associations that market lime products.

As the voice of the European lime sector, its activities and mission focus on:

- Promoting the interests of the European lime industry on all non-commercial issues of common concern, such as sustainable development, product legislation, energy and climate environmental protection, health and safety, communication and image enhancement.
- Providing the members with a single voice and competent assistance to address the complex legislative framework on scientifically and technically-sound dossiers.
- Ensuring that the lime industry, at large, benefits from the sharing of non-sensitive information and playing a supporting role in the promotion of best practices.

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