Derbyshire Climate Coalition

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Position paper on Carbon Capture and Storage (CCS) for cement and lime
July 2024

Summary

Cement and lime production is one of the single biggest point sources of carbon dioxide (CO_2) emissions in Derbyshire, responsible for over a third of the County's emissions. The bulk of these come from a large cluster of cement and lime plants (known as the 'Peak Cluster') in and around Buxton in the High Peak.

The production of CO_2 is inherent in the process of cement and lime manufacture and therefore difficult to abate through resource and energy efficiencies alone. To address the residual process emissions, the Peak Cluster plan to develop Carbon Capture and Storage (CCS), including a pipeline to Ellesmere Port (Cheshire) and storage of CO_2 at depth below the Irish Sea.

However, the cement and lime industry's roadmap to net zero does not include the role of demand reduction (i.e. reducing the amount of cement needed in the first place) or the use of cement-free concrete or recycled concrete, both of which could reduce CO_2 emissions significantly and potentially avoid the need for CCS.

Demand reduction includes using less concrete by reusing existing buildings rather than demolishing them, better design and substituting less CO_2 intensive materials – especially timber for construction. It has been suggested that up to 90% of concrete used in building construction could be replaced with timber. Given that over four-fifths of cement in the UK is used in building, a move towards timber in construction of buildings has significant potential to reduce CO_2 emissions.

Low/zero CO_2 concretes are based on cementitious materials from waste streams or naturally occurring substrates, which can reduce CO_2 emissions significantly. Recycling concrete from demolished buildings, which has recently been done at scale, could also help to reduce the use of new cement/concrete.

The increasing use of cement substitutes and development of novel cements that don't rely on limestone breaks the link to large scale extraction of virgin limestone and makes the cement industry of the future more mobile. The obvious new locations would be coastal hubs for energy intensive industries, particularly sites proposed for the new hydrogen industry and where offshore wind energy will be landed.

While many hopes in the cement and lime industry are pinned on CCS, and the technology for use at scale exists in Norway, there are significant impacts associated with building and operating the plant, pipeline and storage facilities including a large footprint (in areas of valued landscape and a national park) and heavy energy use. It also comes with high risks such as the need to store CO_2 on a geological timescale. It will also be extremely costly, possibly doubling the cost of cement, and there will need to be a robust tariff regime to ensure locally produced cement with CCS would not be undercut by high CO_2 cement imports.

Any planning application for CCS in Derbyshire is likely to be determined nationally rather than by local planning authorities. While CCS feasibility studies for the Peak Cluster are well advanced, the local and cumulative impacts will be considerable and the planning application process challenging.

These challenges are recognised by the government for sites which are distant from coastal areas, which raises the option of a 'managed retreat' and early retirement of older plant.

Recommendations for government

- Develop and implement accredited embodied carbon rating certificates for concrete (and lime) products.
- Safeguard waste streams, that can be used instead of cement based on limestone, for future use.
- Quantify the carbon savings from substitution of cement with timber in buildings.
- Implement ambitious and robust standards for net zero/carbon negative homes, which include a requirement for all new homes to have low embodied energy materials, as soon as possible.
- Set national standards for the reuse and refurbishment of existing buildings and the recycling of concrete, especially in relation to embodied carbon.
- If permission for CCS is given, this must be predicated on (a) a robust tariff regime to prevent the market for carbon-mitigated cement from being undercut by imports of non-mitigated cement; (b) clear responsibility for ongoing monitoring and maintenance of the CO_2 storage reservoirs over an indefinite and constant period, including replacement of wellheads when necessary, with minimal CO_2 leakage; (c) proper account of the total CO_2 budget of CCS including the energy used to build and operate the plants and pipeline and (d) effective mitigation of the cumulative environmental impacts.

Recommendation for Derbyshire County Council

- Make policies in mineral plan less permissive of cement making to facilitate timely adherence to meeting carbon targets and budgets.

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1. Background

Cement and lime production is one of the single biggest point sources of carbon dioxide (CO_2) emissions in Derbyshire. Unlike power generation from fossil fuels where there are good alternative ways to avoid carbon emissions (i.e. renewable energy), this is not necessarily the case for cement and lime production. Although resource and energy efficiency can reduce emissions to some extent, the production of CO_2 is inherent in the process, i.e. even if a zero carbon (i.e. renewable) energy source was used, the calcination process would still produce CO_2 (see Box 1 below). Therefore, there are proposals to reduce the residual emissions from cement/lime production in Derbyshire using carbon capture and storage (CCS) or carbon capture utilisation and storage (CCUS).[1]

Derbyshire County Council's (DCC) Climate Change Strategy (2021-25) sets a county-wide target to '(r)educe manufacturing and construction emissions by 70% by 2035 (against 1990 levels) through energy efficiency improvements and expansion of CCUS technologies, and promotion of fuel switching'.[2] This will be extremely challenging to meet. There is also a near term target of a 47% reduction by 2025.

The aim of this position paper is therefore to assess the opportunities for radical decarbonisation of the county's cement and lime industries (to meet or exceed the DCC targets) and to examine the case for CCS in the production of cement/lime.

2. Production and uses of concrete, lime and cement

Cement is a key binding material in concrete, a composite material made of cement and aggregates. While cement is only around 10-15% of concrete by mass it is responsible for over 80% of its carbon emissions.[3] Cement contains lime (calcium oxide) and lime is made by heating limestone. CO_2 is given off both by the combustion of the fuel which provides the heat, and by the chemical reaction which forms the lime. Box 1 below describes the cement and lime production process.

Box 1: The cement and lime production process

Traditional (Portland) cement is made by heating limestone and clay at 1400-1500°C ('calcination') to produce clinker which is then ground and mixed with gypsum to produce cement. The chemical process releases large quantities of CO_2 (c.70% of total) with the heat energy (depending on the combustion fuel) contributing the other c.30%. The energy used in quarrying and transporting raw materials and finished products is negligible by comparison. Cement is then used as the key binding component (typically 10-20% by volume) in concrete, now the most ubiquitous construction material globally.

[1] CCS just stores the captured carbon, but CCUS uses it in products such as carbonates and beverages (where it can find its way back to the atmosphere) or products such as cement and plasterboard blocks, or to displace hard to extract fossil fuels from wells which otherwise be regarded as unviable.

[2] See Policy T1, p60. Derbyshire County Council (2021) Climate Change Strategy: Achieving Net Zero. 2021-2025.

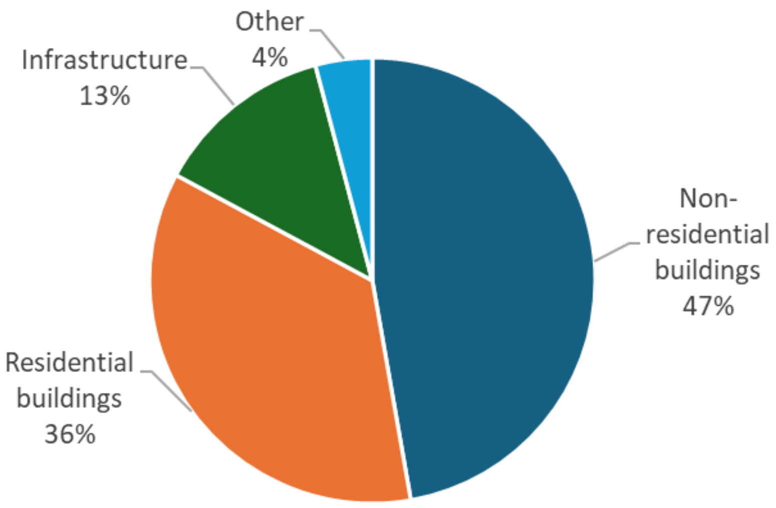
[3] Shanks W et al (2019) How much cement can we do without? Lessons from cement material flows in the UK. *Resources, Conservation and Recycling*, Volume 141, pp 441-454, ISSN 0921-3449. https://doi.org/10.1016/j.resconrec.2018.11.002.

Lime production also involves heating of limestone, albeit to slightly lesser temperatures (c.900°C). Again the chemical reaction (calcination) results in two-thirds of the emissions; most of the rest arise from fuel combustion. The main products in the UK are high calcium lime (in various forms: quicklime, hydrated or slaked lime) and dolomitic lime ('dolime'). Lime is used widely across manufacturing, food and drink and sanitation sectors, as well as its use in construction, especially in mortars, renders and plasters.

Many different materials can be used as aggregates in concrete, including waste materials. Concrete markets (and associated building standards) are dominated by cements based on Portland cement clinker, albeit with new standards allowing for some substitution by fly ashes and blast slag (see Section 4.3).

The UK produces around 85% of cement used in the UK (i.e. 15% is imported). Of this the majority (83%) is used in buildings (residential and non-residential), 13% in infrastructure (railways, pipes, paving slabs, roads) and 4% for other uses (see Figure 1 below).[4]

Figure 1: Uses of cement in the UK



According to the Climate Change Committee, in 2018 the cement and lime industry in the UK was responsible for emissions of 8 million tonnes (8,000 kilotonnes, kt) of greenhouse gas emissions.[5]

3. The cement and lime sector in Derbyshire

In 2021, government statistics show 'large industrial installations' (mainly cement and lime plants) were responsible for 34% of Derbyshire's greenhouse gas emissions (or 38% of CO_2) and 73% of greenhouse gas emissions (77% of CO_2) in High Peak.[6] In the Peak District National Park, they represented 65% of total greenhouse gas (and CO_2) emissions. Between 2005 and 2021 emissions from Derbyshire large industrial installations overall have reduced by only 2%.[7]

[4] Shanks et al 2019, see footnote 3.

[5] Climate Change Committee (2020) Sixth carbon budget charts and data. Manufacturing and Construction.

[6] In 2021 (latest figures available) industrial installations in Derbyshire emitted 2,815 ktCO2e. Department for Energy Security and Net Zero (2023) UK local authority and regional greenhouse gas emissions national statistics, 2005 to 2021.

[7] In 2005 they were 2885.9kt, and in 2021 they were 2815.4kt. Source as for footnote 6.

The wider county (including the Derbyshire part of the Peak District National Pak) is unique in having a large inland cluster of cement and lime plants, comprising roughly half of UK cement production. This is centred near and around Buxton. The five plants (in four locations), part of what is known as the 'Peak Cluster', are shown in Table 1. Collectively they are responsible for around 2,300 kt/y of CO_2 emissions.

Table 1: 'Peak Cluster' cement and lime plants and annual CO_2 emissions (see DBEIS, 2020[8])

Location	Operator	Product	Annual CO_2 emissions
Hope	Breedon	Cement	1,200 kt (a)
Tunstead	Tarmac/CRH	Cement Lime	644 kt 257 kt
Hindlow	Buxton Lime/SigmaRoc	Lime	199 kt
Hindlow (Brierlow)	Lhoist	Lime	142 kt
Total		Cement Lime Cement & lime	1,844 kt 598 kt 2,300 kt

(a) Estimates for 2023, up from 975 kt in 2016.

There are also outlying plants at Whitwell, Derbyshire (Lhoist – dolomitic lime or 'dolime') and Cauldon Low, Staffordshire (Aggregate Industries – cement).

All the plants have plans for significant carbon emission reductions by 2030 using CCS, fuel switching/lower carbon options (trial hydrogen kiln at Tunstead; natural gas CHP with heat recovery by Lhoist; alternative fuels/biomass at Hope) plus process efficiencies and operational measures (e.g. trialling a zero carbon delivery fleet at Hope).

The most significant initiative revolves around the Peak Cluster plants installing carbon capture equipment and having a common pipeline to the Hynet NorthWest project, based around Ellesmere Port (Cheshire), with CO_2 sequestration at depth below the Irish Sea. The pipeline may also serve Cauldon Low cement works. Breedon, Lhoist and Tarmac have been in receipt of government seed funds[9] and Buxton Lime have also received government support.[10] These monies have gone towards feasibility studies of CCS plant options and scoping the environmental and planning constraints of the pipeline routing.[11] Planning applications and permissions are expected in 2025-2026, with plant and pipeline operational by 2030.

4. Reducing CO_2 emissions from cement and lime

4.1 Current industry trajectory to net zero (UK mainstream)

Both the UK cement and lime sectors have produced 'roadmaps' to net zero, with upbeat estimates of CO_2 emission reductions to date and in prospect.[12] Both the lime sector[13] and the Minerals Product Association (MPA) have claimed that they have reduced emissions significantly over the last 20 years, though the House of Commons Environmental Audit Committee observe in their report 'Building to

[8] Department for Business Energy & Industrial Strategy (BEIS) (2020) *CCS deployment at dispersed industrial sites*. See Table 6, p.22.
[9] Department for Business Energy & Industrial Strategy and Department for Energy & Net Zero (2024) IETF Phase 2, Spring 2022: competition winners.
[10] Department for Business Energy & Industrial Strategy and Department for Energy & Net Zero (2023) Cluster sequencing Phase-2: Track-1 project negotiation list, March 2023.
[11] *pers.comm*: Powerpoint presentation by Ed Cavanagh (Breedon) to HVCA, 21 December 2023.
[12] Minerals Product Association (MPA) (2020) Net Zero Carbon webpage.
[13] The lime sector claims a 25% reduction since 2005. Minerals Product Association (MPA) (2020) MPA Lime Net Negative 2040 Roadmap.

Net Zero' that emissions reductions have slowed with only a 10% reduction in emissions between 2008-2019.[14] This reflects the view that – in relation to cement – resource and energy efficiency (sometimes termed 'REEE') interventions can only address around 50% of CO_2 emissions. Further expert evidence to the EAC suggested that future improvements in the energy efficiency of cement production were likely to be limited (only up to 13%).[15]

Box 2 below shows the main levers of change to reduce CO_2 emissions from cement and lime. Note that the industry's roadmap does not consider the role of demand reduction, i.e. by reducing the amount of cement needed or by using cement-free concrete or recycled concrete.

Box 2: Main ways to reduce CO_2 emissions associated with the production and use of cement

Reduce CO_2 in the production process

- Decarbonise electricity used in production
- Low carbon transport of cement
- Low carbon cement products
- Fuel switching (i.e. use of renewable energy) in production

Demand reduction

- Reduce the amount of building work done (e.g. by reuse of existing buildings)
- Reducing the amount of cement used in construction by the substitution of other materials, e.g.timber.

Low or no cement concretes

- Cement-free concretes
- Recycling of concrete

Carbon capture and storage

- CCS or CCUS

The UK Cement (UKC)/MPA Roadmap, although ambitious, does reveal the limitations of their four main levers of change (decarbonised electricity; low carbon transport; low carbon products and fuel switching) which deliver up to 39% CO_2 reduction by 2050, leaving the residual emissions (61%) to the optimistic (default) solution of CCS deployment at scale (see Section 4.4).

The UKC/MPA Roadmap also shows how two further levers (not included in the box above), carbonation (the slow, natural sequestration of carbon by concrete and other lime products) and thermal mass can contribute to further CO_2 reductions (the roadmap claims up to -56%), potentially taking the industry into negative emissions (assuming that CCS can be implemented at scale). Whilst carbonation (across all cementitious materials, including lime products) is significant in global carbon balances (700 million tonnes, Mt, pa - equivalent to half of all cement process emissions), the Green Construction Board's Low Carbon Concrete Roadmap states that carbonation solutions should not drive decision-making, due to the long timescales for sequestration and the short-term need for urgent action to reduce CO_2 emissions.[16]

[14] see para.99: House of Commons Environmental Audit Committee (2022) Building to net zero: costing carbon in construction. May 2022.
[15] *ibid.*, see p.32, para.100 of the Building to Net Zero report.
[16] See p.60, Green Construction Board's Low Carbon Concrete Group Low Carbon Concrete Routemap. Briefing Paper 07/12/23.

Thermal mass arguments should also be viewed with extreme caution. Firstly, concrete is quite thermally conductive, so the thermal mass is only useful if it's inside the insulating envelope of the building.. Secondly, any savings would have to be judged in relation to the embodied whole life carbon figures of heavyweight concrete buildings, and also in the light of comparative energy performance of a range of building types, before firm conclusions could be reached.

In summary, the UK cement industry approach – as exemplified by the UKC/MPA Roadmap − appears to be predicated on a continuing role for quarried limestone for clinker, thus tying the sector to extraction of virgin (Derbyshire) limestone, despite the development of many clinker substitutes in recent years. Whilst pulverised fuel ash (PFA) and ground granulated blast-furnace slag (GGBS) are commonly substituted into Portland cement[17], there is a developing market in cement free/low carbon concretes that is not considered in the MPA/UK Concrete Roadmap to Beyond Net Zero. The potential for clinker substitution is therefore explored in Section 4.3.

Finally, it should be noted in relation to the MPA LIME's 'Net Negative' 2040 Roadmap (see footnote 13), that broadly the same levers (carbonation; fuel switching; decarbonised electricity; low carbon transport) are deployed (reducing emissions by c.28-41% from 2018 levels) before CCS is utilised to achieve net zero. No mention is made of substitution of lime by alternative substrates.

4.2 Demand reduction and alternatives

There are two main focuses here: i) reduced use of concrete (and other high embodied energy materials such as steel) through reuse of existing buildings, better design and use (smarter deployment) and ii) substitution by less CO_2 intensive materials, especially timber.[18]

As the Green Construction Board's Routemap makes clear, '*once it has been established that it is not possible to 'do nothing' or to re-use an existing structure or element, and that an alternative material would not provide a lower-carbon solution*' then how you use concrete in terms of design and specification (what type of concrete) can become the focus. In the Low Carbon Concrete Roadmap this sits within a helpful hierarchy of actions on the route to net zero comprising: 1) Benchmarking (CO_2e) 2) Knowledge transfer 3) Design and specification 4) Supply and construction 5) Optimising existing technology 6) Adopting new technology 7) Carbon sequestration.

More widely, there appears to be a lack of detailed quantum on the kinds of carbon saving offered by improved concrete design, specification and use. However, the Green Construction Board's initial focus on concrete benchmarking (providing an accredited embodied carbon rating certificate, akin to the energy efficiency marque for consumer products) emphasises the pivotal role of a requirement for 'embodied whole carbon assessments' of all building products within policy and planning. This was a key recommendation of the Environmental Audit Committee's 'Building to Net Zero' report and embodied carbon regulation is now strongly endorsed as an industry-wide manifesto ask for a new government.[19]

In evidence to the Environmental Audit Committee, a joint submission by three government departments[20] stated that greater use of timber construction could reduce emissions from new

[17] the relative cement/PFA/GGBS composition determining the BS EN 197 sub-categories of CEM I to CEM III.

[18] Timber frame buildings include the walls, floors and roofs, which are designed as one coherent engineered structure. Most timber frame constructions in the UK use prefabricated panels for external and internal stud walls, floor joists and roof trusses that can then be clad with wood or other materials.

[19] UKGBC (2024) UKGBC joins industry leaders calling for Government to regulate embodied carbon. News release, 31/01/24.

[20] Written evidence submitted by the Department for Levelling Up, Housing and Communities, with the Department for Business, Energy, and Industrial Strategy and Department for Environment, Food and Rural Affairs.

builds by 20-60%. Other sources[21] suggest that over 90% of concrete used in construction could be replaced with timber, with obvious exceptions of major infrastructure (motorways, tunnels etc). Evidence from the three government departments identify a key opportunity for growth in low-rise buildings, using traditional and modern methods of construction (including off site construction), and in a wide variety of commercial and non-residential settings. Given that over 80% of cement is used in buildings, a move towards timber in building construction has the potential to reduce the use of cement and carbon emissions significantly.

4.3 Low/zero carbon concretes

There are an increasing number of low/zero carbon concretes on the market which are based on secondary cementitious materials (SCMs) from waste streams or naturally occurring substrates, or alkali-activated cementitious materials (AACM) for example.[22]

- Some SCMs, such as the olivine-based Seratech, may also have carbon sequestering properties that can offset Portland cement content, to make a net zero cement.[23]
- There are already a number of AACM-based (see footnote 22) ultra low carbon (cement-free) concretes on the market (Earth Friendly Concrete; Greenbloc; Ecocrete), which contain no Portland cement.

Manufacturing cement free concretes still gives rise to carbon emissions, but they are much reduced.[24] There are also options for injecting CO_2 into concretes or incorporating sequestered carbon (e.g. in biochar or novel aggregates[25]) in concrete.

In the short term, the Chatham House 'Making Concrete Change' report recommends increasing clinker substitution as a key focus for scaling up, especially as deployment is cheap (materials are available and manufacturing plant needs little adaptation), prior to the development and market acceptance of more novel/carbon-free cements.[26] A key issue however is the long-term sustainability and availability of such alternative substrates.

The Green Construction Board's Routemap report makes clear that wider concrete sustainability is a balance between performance and carbon credentials; also in the mix is the need for 'a sustainable, responsibly sourced supply chain with ethical treatment of people and the environment'.[27]

Some waste streams, notably for fly ash and furnace slag, will decline strongly by 2050 (especially in the US and Europe due to the decline in the coal and steel sectors) and will need replacing with other SCM/AACMs.[28] However, exploiting older waste sites and positive policies to conserve waste, both in Europe/US plus large waste streams in China and India could still supply much of the market, and clinker substitutes are now globally traded to a much greater degree. Beyond ash and slag alternatives, volcanic (siliceous) ash/rocks and calcined clays are already increasing in use, and many are globally ubiquitous.[29]

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[21] Williams F (2023) 'Over 90% of concrete used in construction could be replaced with timber'. Architects Journal, 20/07/23.
[22] Examples include pozzolans, calcined kaolinite clays, fly ash, volcanic ash and silica fume. Some are also known as AACMs: alkali-activated cementitious materials.
[23] Seratech website
[24] Emissions are 80-85% lower compared to CEM I Portland cement.
[25] For example, see O.C.O Technology
[26] See Executive Summary, p.viii. Chatham House (2018) Making Concrete Change: Innovation in Low-carbon Cement and Concrete. 13/06/18.
[27] see p.54, Low Carbon Concrete Routemap, *ibid.*, fn.16.
[28] see p.43, section 3.1. Chatham House (2018) Making Concrete Change: Innovation in Low-carbon Cement and Concrete. 13/06/18.
[29] Olivine for example See Seratech website

Coming back to the UK context, the implications are two-fold. Firstly, as the Environmental Audit Committee has recommended (based on experience in the Netherlands), policies need to be put into place to safeguard (rather than dispose of) waste streams that could be used as clinker substitutes.[30] Secondly, and more importantly, increasing clinker substitution and the move to entirely novel cements breaks the link to large scale extraction of virgin limestone and makes the cement industry of the future more mobile. The obvious new locations would be coastal hubs for energy intensive industry, largely the sites proposed for the new hydrogen (H_2) industry and where offshore wind energy (and, possibly, imported clinker substitutes) will be landing. This fits with the current strategic planning of new locational (high energy) demand so as to reduce further build out of the electricity transmission grid.[31]

Lastly, scientists have recently found ways to recycle concrete from demolished buildings which could reduce carbon emissions, particularly if they switched to electric-powered furnaces, and used renewable energy.[32] While this has been done at scale in cement kilns, the breakthrough has been to piggyback on the heat generated by steel recycling. This could make a further contribution to reducing the demand for cement/concrete.

4.4 CCS

The industry's routemap for decarbonisation relies heavily on CCS to reduce over 60% of cement emissions. There are certainly optimistic estimates for the potential of CCS. Modelling performed for the Climate Change Committee's (CCC) sixth carbon budget suggests that fuel switching to biomass energy combined with carbon capture (BECCS) could provide up to around 3 million tonnes (Mt) of negative emissions, initially in the cement sector.[33]

However, the respected policy thinktank Chatham House have noted how '*in practice hopes are currently pinned on CCS*' but that '*(m)any experts are understandably sceptical about the potential to rapidly scale up CCS*'.[34] One robust peer-reviewed study noted that there was no industrial-scale demonstration of CCS on a cement plant anywhere in the world and stated "pathways to decarbonisation cannot confidently rely on CCS technology".[35] More forcefully, the Green Construction Board, in their Low Carbon Concrete Routemap, recommends '*CCUS should not be considered a certainty as a means to achieve net-zero concrete and there needs to be a focus on activities that can avoid emissions more quickly and with less risk*'.[36] Thus if CCS deployment predictions prove overly optimistic, other solutions, such as reduced demand for cement and concrete, may have to work harder to help achieve net zero.

Others have argued that the technology for CCS for cement already exists at scale. The world's first CCS facility for cement is now being installed in Norway, with completion expected at the end of this

[30] See para.108/recommendation 16, EAC report (2022), *ibid.*, fn.14. The Government, in its response, made no specific commitment so to do:

[31] See p.44 addressing placement of large-scale (energy) demand sources behind current grid 'bottlenecks': National Grid (2024) Beyond 2030. A national blueprint for a decarbonised electricity system in Great Britain. March 2024.

[32] Rowlatt J (2024) UK breakthrough could slash emissions from cement. Article on BBC news, 22/05/24.

[33] see page v in Element Energy (2020) Deep-Decarbonisation Pathways for UK Industry. Report for Climate Change Committee, November 2020.

[34] see p.ix: Chatham House (2018) Making Concrete Change: Innovation in Low-carbon Cement and Concrete. 13/06/18.

[35] Shanks et al (2019). How much cement can we do without? Lessons from cement material flows in the UK. Resources, Conservation and Recycling Volume 141, February 2019, Pages 441-454.

[36] See p.61: Green Construction Board's Low Carbon Concrete Group (2023) Low Carbon Concrete Routemap. Briefing paper, 07/12/23.

year.[37] This is part of the Norwegian Government's 'Longship' programme to demonstrate CCS for industrial sources. The facility aims to capture around 400 kt CO_2/y, around 50% of the cement plant's emissions and inject it into underground rock formations on the Norwegian continental shelf. This has been done in other locations with 1,000 kt CO_2/y stored since 1996 at the Sleipner field and 700 kt CO_2/y since 2007 at the Snohvit (Snow White) field. Surveillance programs show that there is no CO_2 leakage from the storing.[38]

A study by the Institute for Energy Economics and Financial Analysis (IEEFA) concluded that while the technology and regulatory framework for CCS around the world was generally wanting, "*(s)ome applications of CCS in industries where emissions are hard to abate (such as cement) could be studied as an interim partial solution with careful consideration*."[39]

Nonetheless, it is clear that there are significant impacts associated with building and operating CCS plant, pipelines and storage facilities. An overview of the feasibility studies for a CCS plant at Hope shows key impacts including water use and discharge, waste generation, stack emissions, and noise. A large footprint, additional power demand (c.50-150MW) and integration with already highly complex industrial processes also add planning challenges.

The risk remains of the possibility that the captured CO_2 will escape as it needs to be stored on a geological time scale (at least 1,000 years, but possibly longer). This means that the stored CO_2 needs to be sealed and monitored and, if any CO_2 does leak out, the leak needs to be fixed immediately. Some may argue that even temporary CO_2 storage (e.g. for 100 years) is preferable to emitting CO_2 into the atmosphere now if it buys time to find more permanent, less risky solutions.

While CCS may be part of a broad strategy for the decarbonisation of cement and lime, this should only be done when other less damaging and costly measures have been implemented including ambitious targets for demand reduction, reuse of buildings and recycling of concrete, that apply to the whole construction sector.

Lastly CCS is very expensive. It is estimated that it would double the cost of cement. This would require a robust tariff regime to prevent the market for carbon-mitigated cement from being undercut by imports of non-mitigated cement.

5. The policy and planning framework for CCS

DCC is the mineral planning authority for most of the county's lime and cement operations, overseeing the existing quarry and plant permissions for Tunstead (Tarmac/CRH), Hindlow (Buxton Lime), Hindlow/Brierlow and Whitwell (both Lhoist). The Peak District National Park Authority is the mineral planning authority for the area of the national park, including Hope (Breedon).

However, it is likely that any planning applications for CCS plant and associated infrastructure (pipeline) would be considered under the Nationally Significant Infrastructure Projects (NSIP) planning regime, where consents are determined nationally by the relevant Secretary of State after examination by the Planning Inspectorate. Affected local authorities and third parties can feed into the consenting/examination process but their influence is limited.

Although it is noted that CCS feasibility studies, some government funded, for the 'Peak Cluster' are well advanced, the Government's Industrial Decarbonisation Strategy (2021), already foresees

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[37] Heidelberg materials. Welcome to Brevik CCS. Webpage.
[38] As above.
[39] Robertson B (2022) Carbon capture remains a risky investment for achieving decarbonisation. Article for IIEFA, 02/09/22.

locational issues with 'dispersed sites' (away from coastal CCS/H_2 hubs): '*some are in or close to areas of natural beauty. This poses a significant challenge and increases costs for deployment of carbon dioxide transportation pipelines*'.[40]

The Strategy also underlines (p.54) *'(t)he role for CCUS in dispersed sites is less certain*' and, where retrofit 'windows' are difficult to align (e.g. with asset/investment cycles' then *'(t)his may require flexibility regarding decisions to retire assets – for example, potentially retiring higher carbon equipment early*'.

Thus, there is a choice for the cement and lime industry whether to maintain or invest further in what might become 'stranded assets'.[41] The option of a 'managed retreat' from dispersed sites is reinforced in policy terms by the fact new low carbon cement substrates have a different resource geography. Finally, in terms of job markets, the Climate Change Committee envisage, in a future net zero workforce[42] that cement jobs will transition by being re-directed, though clearly there will be locational impacts. This would be within an overall economic environment of growth in high quality jobs and addressing regional economic disparities.

5.1 Local (county) planning

Both DCC and the PDNPA are local planning authorities for cement plants in Derbyshire. DCC see mineral development as central to the county's future, as the submission draft Mineral Plan makes clear: '*Derbyshire is one of the Country's leading producers of minerals and the exploitation of Derbyshire's mineral resources bring significant benefits to both the local and national economy*'.

Current and new DCC mineral policies are strongly facilitative of the continued presence and extension of cement making[43] and do not specify constraining policy criteria for carbon or climate change, bar a requirement (Policy SP2) to demonstrate a progressive reduction in greenhouse gases towards net zero, against local and national targets. This would help support applications for CCS in the mid-term but near-term industry planning proposals could founder against the current DCC target of a 47% reduction in county-wide CO_2 emissions by 2025. Clearly any applications would also be judged on their overall merits and demerits (in terms of wider sustainable development, see Policy SP1, and a raft of the usual development management policies, such as impacts on landscape, traffic etc), including any proposed improvements by way of resource or energy efficiency, most likely by fuel switching.

There is little basis in current or proposed DCC policy for arguing against cement- and lime-related development on (lack of) need grounds, except indirectly by arguing that the only certain route to meeting county emission trajectories would be to refuse permission for continued production of high carbon products when it was clear that alternative lower carbon materials and methods could meet construction market needs.

5.2 NSIP planning

Planning decisions within the NSIP regime are determined by National Policy Statements (NPS) and, for CCS and allied infrastructure (pipelines, storage facilities), this is governed by EN-1 Overarching

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[40] See p.55, Department for Energy Security and Net Zero and Department for Business, Energy & Industrial Strategy (2021) Industrial Decarbonisation Strategy. 17/03/21.

[41] In this context, stranded assets refer to significant energy/carbon intensive infrastructure that once built, is no longer needed or performs less optimally/provides less value due to changes in circumstances. See here https://www.lse.ac.uk/granthaminstitute/explainers/what-are-stranded-assets/

[42] Climate Change Committee (2023) A Net Zero workforce. Report, May 2023.

[43] see draft policies SP10 and SP12 (Supply of Cement Making Materials) in the Minerals Local Plan (under revision). Derbyshire County Council (2023) Derbyshire and Derby Pre-submission Draft Minerals Local Plan Regulation 19 consultation - spring 2023.

NPS for Energy, which states an urgent need for CCS.[44] The new suite of energy NPS (which came into force early in 2024) also define a new category of 'critical national priority' low carbon infrastructure, which acts as a trump card within the NSIP planning system. Although CCS is not explicitly defined as 'critical national priority', it is very likely to be considered as such, as it would '*fall within the normal definition of "low carbon"*' (see EN-1, para.4.2.5). This makes constructing a needs case against CCS an uphill task.

Consents will also be required from other regulators in addition (EA, HSE etc) and any NSIP application would also need to cover transport of CO_2 and its storage. Ancillary matters may also need consent from DCC or the PDNPA.

It is presumed that a 'bundled' application would likely be made for the Peak Cluster CCS network, so that cumulative impacts could be properly assessed. Local impacts would be judged both against the NPS policy suite and also relevant local policies. It is almost certain that almost all aspects of a multi-CCS application, plus pipeline, would be subject to EIA requirements.

Either way (a bundled or multiple NSIP applications), this would be a very challenging process for all concerned: developers, decision-makers and third parties. Based on previous experience of NSIP applications, local non-statutory third parties (such as Derbyshire Climate Coalition), with few resources, would find it almost impossible to participate meaningfully, let alone influence the outcome. The amount of energy-related NSIP applications that have been refused can (literally) be counted on one hand.

6. Conclusions and recommendations

The CO_2 emissions from cement and lime plants in Derbyshire are significant and need radical reduction to meet net zero targets. While local operators from the Peak Cluster are taking steps to reduce process emissions by resource and energy efficiency, they are proposing CCS to deal with the considerable residual emissions. This is likely to result in significant environmental impacts locally and cumulatively, poses significant risks from the long-term leakage of stored CO_2 and will likely double the cost of cement.

The industry's roadmap to net zero does not consider the options of demand reduction or use of novel concretes made without cement or from recycled concrete. These have significant potential to reduce the demand for cement and associated CO_2 emissions. However, these options are outside the cement and lime industry's control and will need ambitious and robustly enforced national targets and action across the whole construction sector.

There is also the option of a 'managed retreat' for cement and lime plants to new locations such as coastal hubs for energy intensive industries. Thus, there is a choice for the cement and lime industry in Derbyshire as to whether to invest further in what may become stranded assets.

If a planning application for CCS for the Peak Cluster does come forward, which is likely to be determined nationally, there must be strong evidence that alternatives such as demand reduction and low/zero CO_2 cement have been considered, and there must be robust conditions set on the environmental impacts and long-term risks of CCS.

[44] See section 3.5, p.45ff: Department for Energy Security & Net Zero (2023) Overarching National Policy Statement for Energy (EN-1). November, 2023.

Recommendations for government

- Develop and implement accredited embodied carbon rating certificates for concrete (and lime) products.
- Safeguard waste streams, that can be used instead of cement based on limestone, for future use.
- Quantify the carbon savings from substitution of cement with timber in buildings.
- Implement ambitious and robust standards for net zero/carbon negative homes, which include a requirement for all new homes to have low embodied energy materials, as soon as possible.
- Set national standards for the reuse and refurbishment of existing buildings and the recycling of concrete, especially in relation to embodied carbon.
- If permission for CCS is given, this must be predicated on (a) a robust tariff regime to prevent the market for carbon-mitigated cement from being undercut by imports of non-mitigated cement; (b) clear responsibility for ongoing monitoring and maintenance of the CO_2 storage reservoirs over an indefinite and constant period, including replacement of wellheads when necessary, with minimal CO_2 leakage; (c) proper account of the total CO_2 budget of CCS including the energy used to build and operate the plants and pipeline and (d) effective mitigation of the cumulative environmental impacts.

Recommendation for Derbyshire County Council

- Make policies in mineral plan less permissive of cement making to facilitate timely adherence to meeting carbon targets and budgets.

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