

 **CONCRETENE™**  
decarbonising concrete



# Contents

## Section #1 Concretene explained

- 3. What is Concretene?
- 4. What is graphene?
- 5. How does Concretene work?
- 6. Why do we need Concretene?

## Section #2 Product development

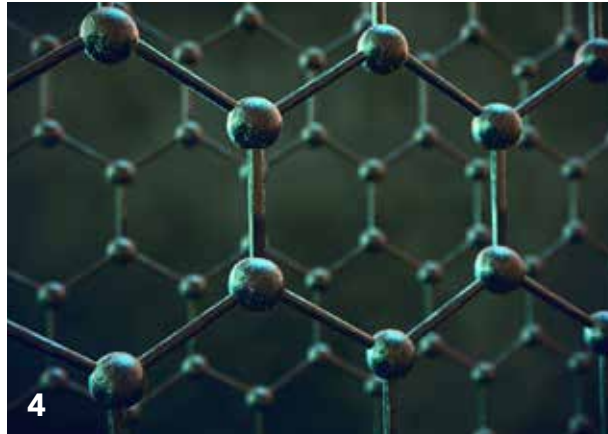
- 8. Concretene: the inventors
- 10. Scale trials
- 12. NERD: commercialisation ecosystem
- 14. Chemistry and specification team
- 16. Testing and verification team
- 18. Operations team

## Section #3 Strategic partners

- 20. Arup
- 22. Black Swan Graphene
- 24. The University of Manchester
- 26. Graphene Engineering  
Innovation Centre
- 28. LocalGlobe

## Section #4 Market analysis

- 30. UK market overview
- 32. Concretene market opportunity  
and timeline
- 34. Market opportunity: further  
applications
- 35. UK carbon budgets/Net-zero trajectory
- 36. Media and awards
- 38. Key engagements and summary



# What is Concretene?



**C**oncretene is a graphene-enhanced admixture for concrete, engineered to enhance performance and sustainability. Developed by Nationwide Engineering Research & Development (NERD) and The University of Manchester's Graphene Engineering Innovation Centre (GEIC), the formulation reduces embodied carbon and supports the drive to net-zero, creating a game-changing potential for industry.

Concrete is the most widely used man-made material on Earth. Each year, 24 billion tonnes of concrete are produced, delivering 2.9bn tonnes of associated carbon dioxide emissions. Consequently, the global cement industry

already accounts for more than 7% of worldwide CO<sub>2</sub> emissions.

The UN's Intergovernmental Panel on Climate Change (IPCC) report states 75% of infrastructure to support population growth in 2050 remains to be built, while cement production is expected to double by 2030. Hence, embodied carbon in concrete is one of the world's biggest environmental challenges, with no established, sustainable solution.

Imminent global legislation regarding Whole-Life Carbon (WLC) assessments and Upfront Embodied Carbon Limits (UECL) and associated taxation will drive adoption of CO<sub>2</sub> reduction

technologies by asset owners and the construction industry. Concretene has been developed to enhance the properties of concrete, aiming at a 30% reduction in cement content and proportionally decreased embodied carbon on construction projects.

The technology incorporates graphene, an atomically thin form of carbon, which improves the microstructure of concrete, significantly increasing compressive, tensile and flexural strength, reducing curing periods, microcracking and permeability.

The technology has been developed for use in existing batching plants, requiring no extra training or equipment, and can be scaled at a viable cost.



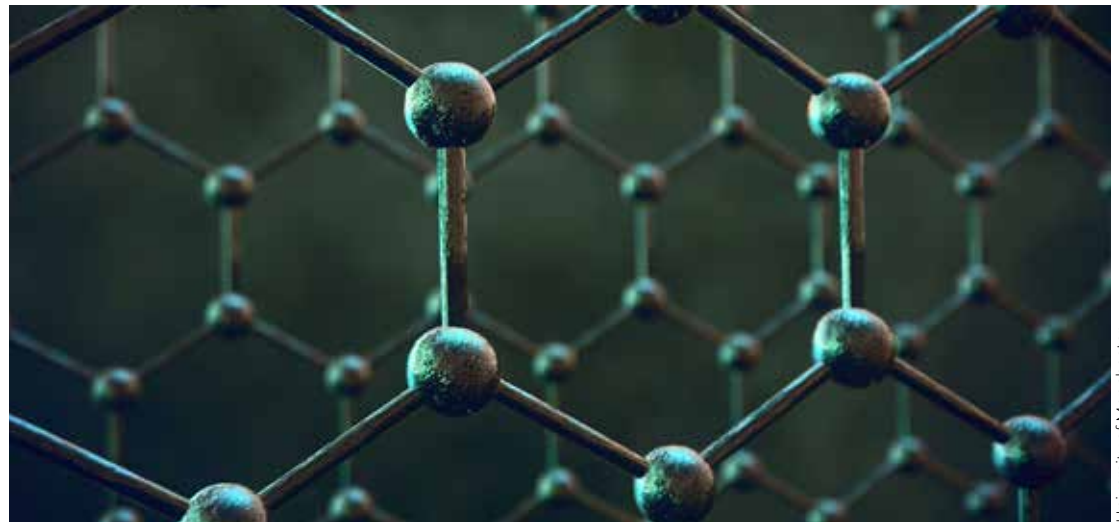
# What is graphene?

**G**raphene was first isolated at The University of Manchester in 2004 by two scientists – Professor Andre Geim and Konstantin Novoselov – who subsequently received the Nobel Prize for Physics for their work in the field of atomically thin materials. It has been recognised as one of the most significant material discoveries of recent years because graphene's 2D nature exhibits unique properties. It is exceedingly strong, light and flexible and is the most conductive material of both electricity and heat yet discovered.

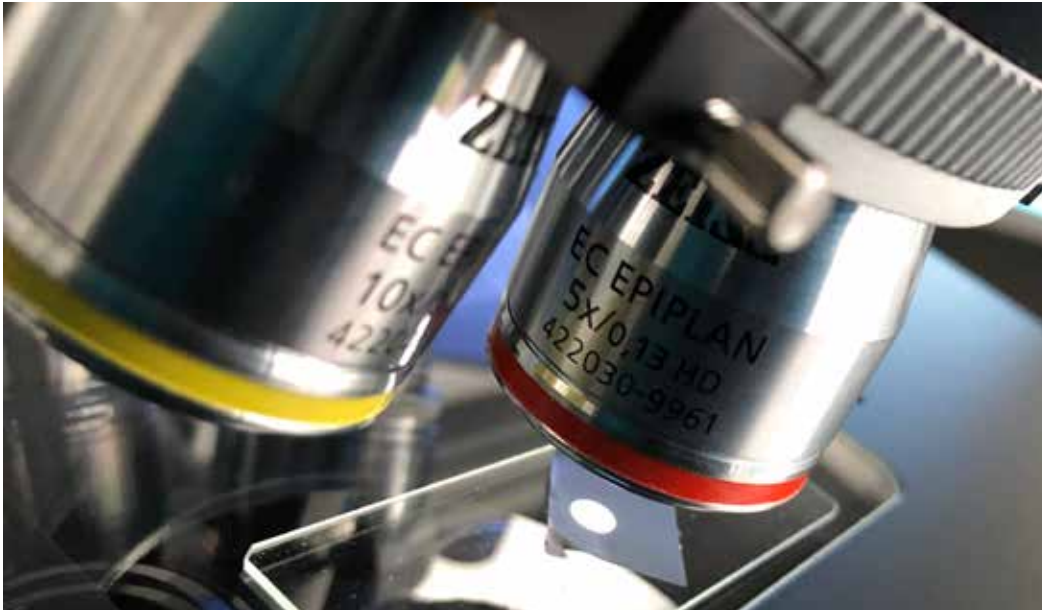
Methods of graphene production have developed rapidly in recent years, with manufacturing processes developing to produce this material not only from raw graphite but also from plastic waste, hydrogen production, battery production, wood char and other forms of industrial carbon waste.

The application drives the form and origin of the graphene used and high-volume production has created a viable, real-world application in concrete. Crucially, only very low dosages of the material, in some cases less than 0.01%, are required to deliver significant performance gains in mortars and cements.

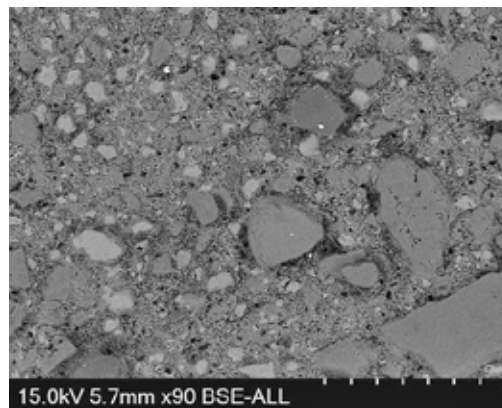
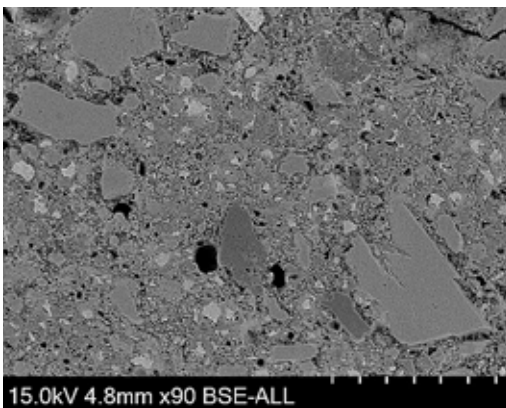
Graphene is hydrophobic by nature, which means getting it to mix, interact and disperse in a water-based material such as concrete is highly complex. Numerous companies have conducted trials of graphene-enhanced concrete, but to date only NERD has proven the performance at meaningful scale and patented its dispersal technology.



# How does Concretene work?



University of Manchester



Magnification shows a comparison between the structure of standard concrete (left) and graphene-enhanced concrete (right). The right-hand image shows a more refined pore structure (smaller holes) and improved interfacial properties between the aggregate and the cement, plus less crack propagation.

The history of concrete stretches back thousands of years, yet the precise chemistry of the curing phase is still not fully understood and the range of mineral microstructures resulting from the hydration reaction is difficult to predict.

The introduction of nanomaterials further increases the complexity of the chemistry; however, observations indicate that graphene affects crystal formation, producing a more uniform overall structure.

Current thinking suggests that when graphene is properly dispersed in concrete, it acts to fill voids and provides nucleation sites for the formation of a stronger cement microstructure upon curing.

Microscope imaging of the final graphene-modified concrete materials exhibits a smaller, more evenly distributed pore network (see left). This change in pore structure can prevent several concrete degradation mechanisms from occurring, including reduced moisture ingress, resistance to carbonation and a greater resistance to corrosive chemicals.

However, making effective graphene-enhanced concrete is technically challenging as, if uncontrolled, graphene agglomerates, reducing its effectiveness. Concretene's patented technology allows graphene to disperse evenly in large volumes of concrete and also demonstrates stability in solution for storage and transport. Several years of optimisation work have been necessary to achieve these characteristics.



# Why do we need Concretene?

**G**lobal annual CO<sub>2</sub> emissions from cement production are forecast to reach 4.3bn tonnes by 2050 which, by volume, would fill London's O2 Arena every 23 seconds. The challenges are an increase in cement use and the need to decarbonise the energy for its manufacture. The 'carbon intensity' of global cement production, CO<sub>2</sub> emitted per tonne, continues to rise.

Environmental legislation to mitigate construction emissions is imminent or active across the globe. The US, Canadian and European governments have made recent moves which will drive adoption in developed economies and influence others.

In the UK, the 2008 Climate Change Act has been bolstered by 'Part Z' of Building Regulations, in effect from January 2023. The changes drive carbon reduction, requiring a Whole Life Carbon (WLC) assessment be submitted for all new buildings which includes 'dwellings' from January 2025. Stipulations for carbon intensity, Upfront Embodied Carbon Limits (UECL), will come into force on 1 January 2027.

New environmental measures pose a robust challenge but also offer a significant opportunity to those willing to think differently about innovation in construction and take advantage of environmental social governance (ESG) focused asset investments.

Traditional solutions for cement reduction in concrete are rapidly becoming unsustainable. Cement replacements such as ground granulated blast-furnace slag (GGBS) and pulverised fly ash (PFA) are byproducts from thermal steel-production and coal-fired power stations, which are in terminal decline.

Currently, the embodied carbon of GGBS and PFA is not measured in lifecycle assessments. Limited supplies are increasing in cost as industry struggles to secure alternative low-carbon solutions. Concretene development is progressing to support cement replacement technologies such as calcined clays and crushed limestone that the industry is exploring.

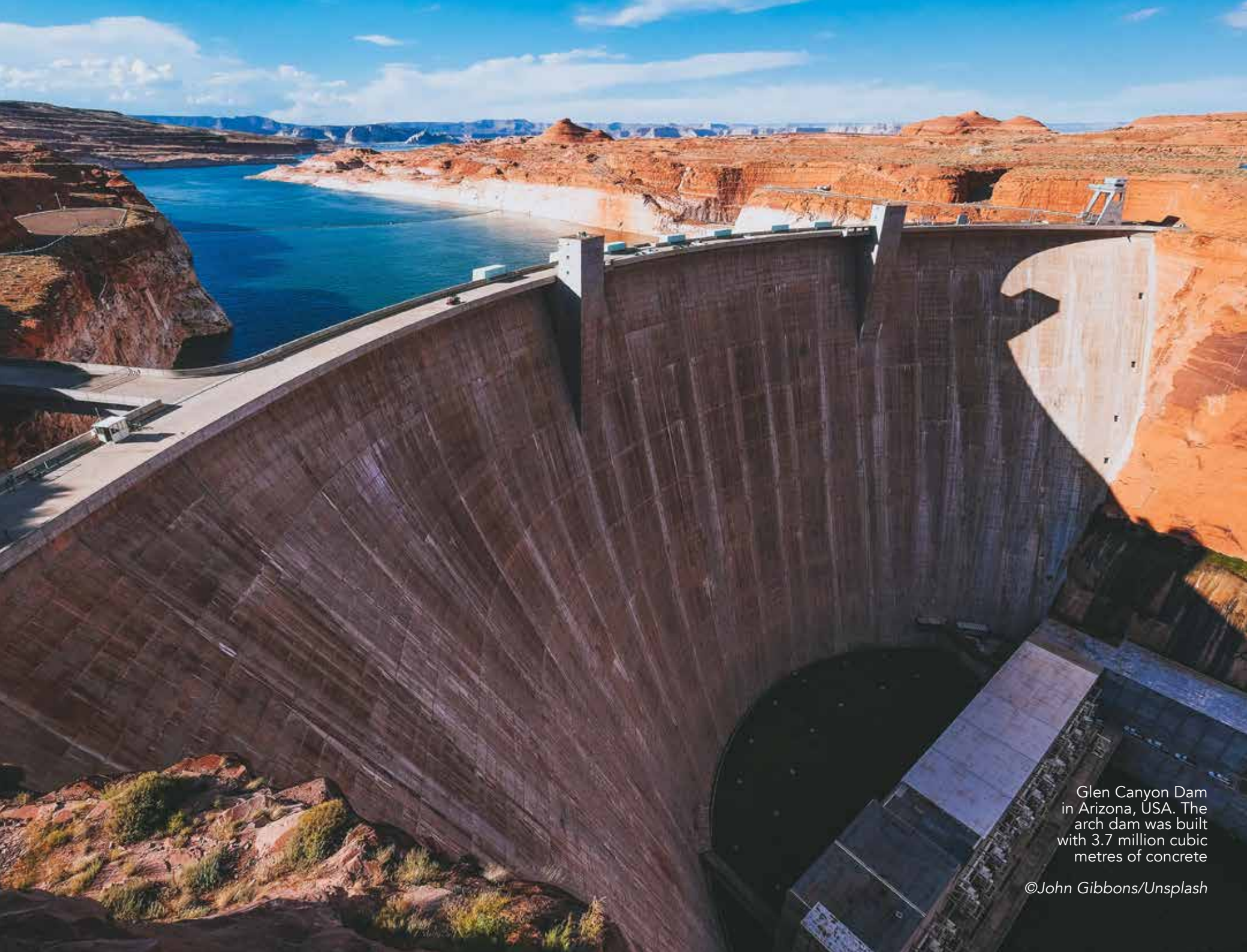
Concretene enables decarbonisation in construction, as follows:



- Construction codes do not need to change. Enhanced concrete properties avoid the additional cement volumes traditionally added to achieve construction timelines
- Concretene is an additive, compatible with existing mix design standards
- Non-disruptive – suppliers use existing batching plants
- and technologies with no additional equipment or training required
- Compatible with cement replacement technology
- Does not change the method of construction, therefore tech is contractor-friendly
- Uses the simplest form of graphene manufacture







Glen Canyon Dam  
in Arizona, USA. The  
arch dam was built  
with 3.7 million cubic  
metres of concrete

©John Gibbons/Unsplash

# Concretene: the inventors

In January 2019, Alex McDermott attended a seminar at The University of Manchester (UoM), the institution from which he graduated in 2000 as a civil engineer and went on to co-found Nationwide Engineering, a UK construction group, with business partner Rob Hibberd.

The venue for the seminar was the University's new institute for advanced materials, the Graphene Engineering Innovation Centre (GEIC), a £60m facility dedicated to the prototyping and commercialisation of products and applications using graphene and others in the family of nanomaterials.

CEO of the GEIC James Baker explained how laboratory tests introducing small amounts of graphene to concrete had shown promising results, with significant improvements demonstrated in compressive and tensile strength. He added that the construction industry had shown little interest in investing in this early-stage research and development.

Alex and Rob, however, understood the implications these results might have for reduction of the carbon footprint of concrete and its increasing importance in the face of net-zero ambitions and upcoming legislation for the industry.

Nationwide Engineering entered into a partnership with the GEIC to examine the potential for a graphene-enhanced additive to improve the performance of concrete with reduced cement content. Concretene was born.



**Rob Hibberd**  
**Chief Executive, NERD**

Rob is a chartered civil engineer with 24 years' experience in the construction industry.

In 2009, he co-founded Nationwide Engineering (NEG), a UK principal civil and building construction group.

In 2022, he co-founded NERD, a standalone spin-out to bring Concretene, and ultimately a further suite of sustainable building technologies, to market.



**Alex McDermott**  
**Chief Development Officer, NERD**

Alex is a chartered civil engineer and an alumnus of The University of Manchester. He had spells at VINCI and Spencer Group before co-founding NEG.

Alex has 23 years' industry experience and as Chief Development Officer is responsible for managing the complex network of partnerships, projects and funding opportunities presented by Concretene.



**Dr Lisa Scullion**  
**Application Manager, GEIC**

Lisa is a nanotechnology expert with more than a decade's experience in working with industry to scale up new materials from laboratory to full production.

After a PhD in molecular electronics from Liverpool, Lisa worked for Unilever and Itaconix before joining the GEIC to leading the coatings and formulations lab. She has co-led the University's team on the Concretene project since day one.





**Dr Craig Dawson**  
Chief Scientific Officer,  
NERD

Craig is a nanomaterials expert with 28 years' experience in industrial chemistry.

He has worked with graphene across numerous applications, including fuel cells and battery technologies.

For the past five years, Craig was Application Manager at the Graphene Engineering Innovation Centre and a lead engineer in R&D on Concretene.



**Dr Happiness Ijje**  
Senior Application  
Specialist, GEIC

Happiness is a Chemical Engineer with over nine years' experience of developing novel systems and processes.

After a PhD and post-doc work at Nottingham on molten salts, she came to The University of Manchester to work on graphene applications such as coatings, membranes and electrochemical technologies and has been instrumental in the development of Concretene.





# Concretene: the scale trials

After successful university lab testing in 2019-20, Concretene took a more scaled-up form in April 2021 with the first industrial-sized pour; a gym floor at Southern Quarter in Amesbury, Wiltshire. An 800m<sup>2</sup> floor slab was laid, demonstrating carbon savings with 30% less material overall and no steel reinforcement grid.

Subsequent pours followed, with a parking bay outside the Graphene Engineering Innovation Centre at The University of Manchester and a suspended floor slab at the nearby Mayfield Depot, forming part of the Escape to Freight Island leisure complex.

Concretene was also deployed on a housing redevelopment at Netherhampton Farm in Wiltshire, where an 1150m<sup>2</sup> concrete raft was poured as the structural foundation.

These live trials allowed the engineering team to understand the challenges and benefits of using graphene-enhanced concrete in real-world scenarios and gather data on performance. The trials act as 'living labs' for onward development of Concretene towards our targets of reducing cement content by 30%, commercialisation of the technology and global industry roll-out.



## **Southern Quarter Gym Amesbury, Wiltshire**

- Innovate UK-funded trial
- 800m<sup>2</sup> floor slab (47 x 17 x 0.15m)
- 30% overall material reduction
- Two weeks saved on site programme
- Est. CO<sub>2</sub> saving = 20.7 tonnes



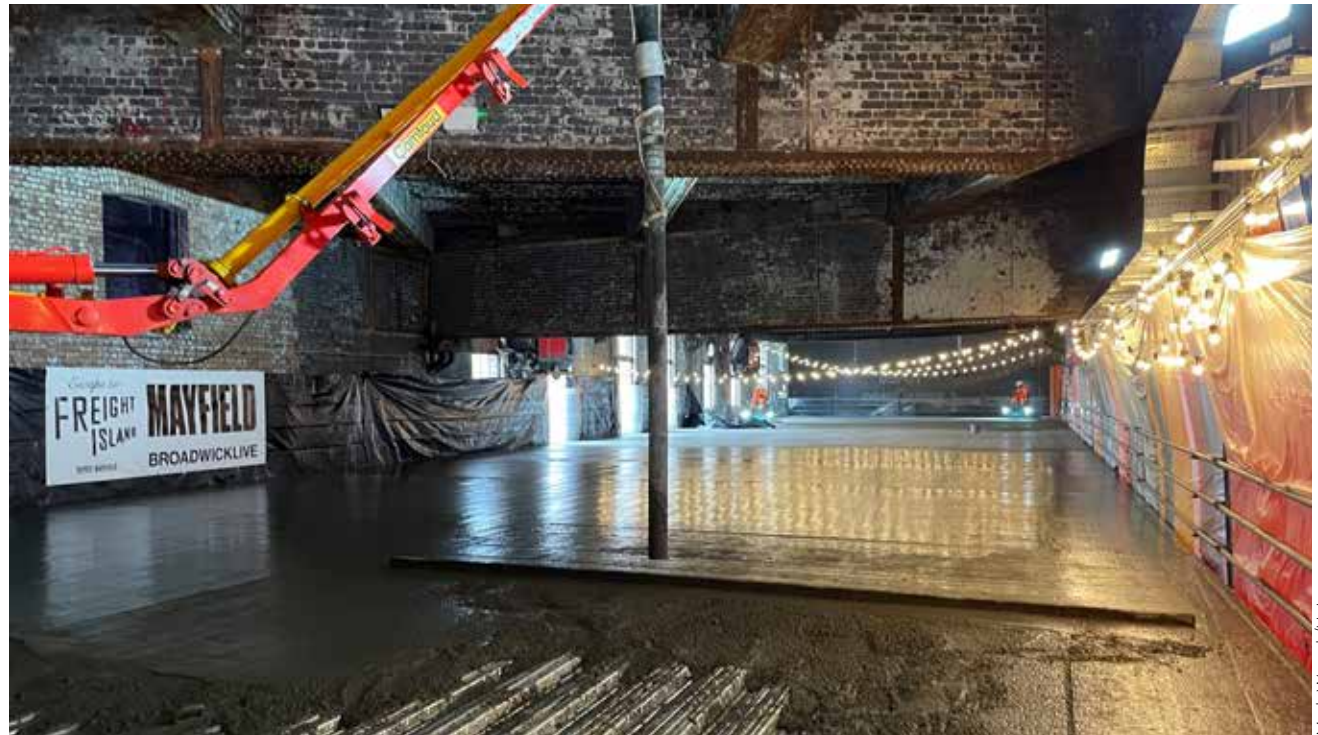




### GEIC Parking Bays

#### The University of Manchester

- First outdoor trial, funded by NEG
- Heavy-goods parking bay slab
- 37% reduction in slab thickness
- No shrinkage or cracking
- 24hr strength = 107% over control
- 4-day strength = 50% over control
- Est. CO<sub>2</sub> saving = 3.8 tonnes



Mark Waugh/U+I



### Mayfield Depot Central Manchester

- Redevelopment of former railway station for leisure complex
- First commercial client
- First use of Concretene on metal deck
- 785m<sup>2</sup> suspended slab (54 x 14.5 x 0.14m)
- Est. CO<sub>2</sub> saving = 4.3 tonnes









## Further applications

Our IP has application beyond carbon reduction for concrete, in technologies for resilience of the built environment and transport infrastructure, including anti-corrosion coatings, passive fire protection, polymers and composites. Our agreement with The University of Manchester and the GEIC means that any future inventions or patents will remain wholly owned by NERD.

### Coatings

- Global anti-corrosion coatings market (2020) = >\$25bn
- Graphene bonding structure provides impermeability to environmental reactants such as salt and oxygen
- Additional strength from graphene prevents chipping and defects (eg. when rebar is bent)

### Passive fire protection

- Global fire protection market (2020) = >\$60bn
- Nanomaterials improve fire protection resistance in carbon fibre composites/polyurethane foams
- Graphene improves strength, robustness and long-term durability in aggressive fires

### Composite materials

- Worldwide composites market (2020) = >\$110bn
- Graphene improves strength and flexibility of composites, eg. pipelines, turbine blades, bitumens and asphalt, films and packaging
- Extends lifespan of products



# Chemistry and specification team

**A**s part of NERD's partnership with the GEIC, we have a private laboratory in the facility for wet chemistry and formulation development. We also have access to state-of-the-art equipment for analysis and characterisation of nanomaterials and application-specific engineering knowhow from the GEIC's own team of 2D material science specialists.

This is where the vital work is done to assess the precise chemistry of the Concretene formulation. In conjunction with the testing lab, we determine the performance parameters to meet the needs of different applications and their associated mix designs.



**Dr Craig Dawson**  
**Chief Scientific Officer**

Craig heads up the chemistry and materials specification team, based in NERD's dedicated lab in the GEIC at UoM.

Prior to joining as CSO, Craig was Energy Lab Manager at the GEIC and one of the original inventors of Concretene, having worked on the project since its inception.



**Camille Wright**  
**Research Scientist**

Camille is a graduate of Colorado State University, USA in Environmental Engineering, with a Masters in Chemistry from Reading University in the UK.

After a spell back in the US, working for Boston-based battery tech firm Lionano, Camille has been working further in nanomaterials, exploring the use of graphene dispersion in cementitious systems.



**Dawit Sium**  
**Research Technician**

Dawit is a Chemical Engineering graduate from UoM, originally from Eritrea in east Africa.

Dawit worked as a technician in a cement factory in the port of Massawa - making and analysing cement - before coming to the UK in 2014. Since graduating he has been a lab technician for Hampshire County Council and an electrical calibration engineer for Trescal in Bredbury, Stockport.







Will Pryce/University of Manchester

# Testing and verification team

**A**djacent to the GEIC, our dedicated concrete testing and verification laboratory uses industry leading equipment to assess the performance of Concretene.

These facilities enable our team of concrete and nanotechnology specialists the perfect environment to conduct rigorous repeat testing on beams, cubes and mortar prisms to establish the performance parameters of Concretene.

This allows direct collaboration between chemical and materials engineering development.



**Dr Aldo F. Sosa Gallardo**  
**Research Scientist**

Aldo is a nanotechnology and concrete specialist, with 12 years of research experience across various industries.

Originally from Mexico and formerly part of the academic team in the Department of Mechanical, Aerospace and Civil Engineering (MACE) at UoM, he was instrumental in the early experimentation and application of Concretene in lab tests and live trials to prove the technology at meaningful scale.



**Oliver Gordon**  
**Laboratory Technician**

Manchester born and bred, Oliver studied civil engineering at the University of Nottingham, specialising in sustainability in construction and low-carbon materials, including concrete.

Oliver joined NERD in January 2023 and has helped to streamline processes in the testing lab for greater throughput and consistency of data collection.



**Abayomi Adebari**  
**Laboratory Technician**

Born in Lagos, Nigeria and raised in south-east London, Abayomi graduated from Manchester Christ the King College with an extended diploma in engineering.

Before joining NERD, Abayomi worked at James Fisher Testing Services (now CMTL) in the structures department, assessing concrete cores for strength, corrosion and wear to establish the health and estimated lifecycle of buildings.



**Brendon Geddes**  
**Laboratory Technician**

Born in Devon and well-travelled in his youth as part of a military family - living in Cyprus and Germany - Brendon studied media and sports science at Priestly College in Warrington.

Before joining NERD, like Abayomi, Brendon worked at James Fisher as a lab technician, testing concrete cubes for strength and also working on particle distribution for asphalt.





# Operations team

**H**eadquartered in Manchester Technology Centre, in the heart of the city's tech district, the NERD operations team boasts a wealth of experience in construction, project management, finance, media and communications.

Mike Harrison and Dave Evans have extensive experience within the built environment, leading building and civil projects that delivered complex infrastructure across the UK. Most recently, Mike led Mayfield Manchester, a new mixed-use regeneration area, clearing the dereliction to create the first new park in more than 100 years.

Alan Beck joined NERD in January 2023, his previous role as comms lead for the GEIC providing an ideal foundation as our Head of Communications.



**Mike Harrison**  
**Chief Operating Officer**

Mike has expertise in the technically challenging areas of the construction industry, developed through delivery of complex, multidisciplinary projects in specialist sectors including: marine, energy, waste, buildings and infrastructure.

Prior to joining NERD, Mike was delivery director for regeneration developer U+I plc, then held the same role for real estate investment and management firm Landsec.



**Dave Evans**  
**Chief Financial Officer**

Dave is a commercial director with 34 years' experience in the construction sector and a proven track record of improving financial performance in the UK civil engineering industry.

With companies including BAM Nutttall and J Murphy & Sons, Dave has specialised in business management, training and development, strategy, contract negotiation, project risk management and assurance, and sub-contracting.



**Alan Beck**  
**Head of Communications**

Alan has more than 25 years' experience in communications, marketing, editorial and design.

Alan has worked in London for newspapers including The Times and Observer, and publishers Emap, Dennis, IPC and Haymarket.

Moving to Manchester in 2012, he was managing editor of the media team at Manchester United and spent three years at BBC Sport (top right) before joining The University of Manchester's Faculty of Science and Engineering.







Will Pryce/University of Manchester



# Strategic partners

**D**edicated to sustainable development, Arup provides design, engineering, architecture, planning and advisory services across all aspects of the built environment. Its extensive global portfolio of engineering achievements includes (clockwise from below left) Manchester's Etihad Stadium and Bridgewater Hall, New York's 2nd Avenue Subway, Raffles City, Chongqing, China and Samuel De Champlain Bridge in Montreal, Canada.

Arup's international reach, reputation and expertise from its world-leading designers will be invaluable in the formulation, prototyping and assurance case required in the lead-up to roll-out of Concretene to the construction industry.

The firm's unparalleled depth of understanding of the construction market is providing critical insight into, for example, the addressable market for concrete admixtures and strategies for market penetration (see Analysis, p30).

Alignment with industry, application deployment and product development will be the drivers behind Arup's journey with NERD and Concretene towards effective carbon reduction in construction.



Dennis Gilbert





David Millington



Charles Aydtlett/AECOM



Arup



CapitalLand

*“Innovation in the production and design of concrete is needed to support the construction industry’s journey towards net-zero carbon emissions.*”

*“Arup is extremely interested in Concretene’s potential to support transformative change in the built environment.*”

*“Imagine what concrete with both enhanced engineering performance and substantially reduced carbon impact could contribute to our industry.”*



**Matt Lovell**  
Director,  
Arup

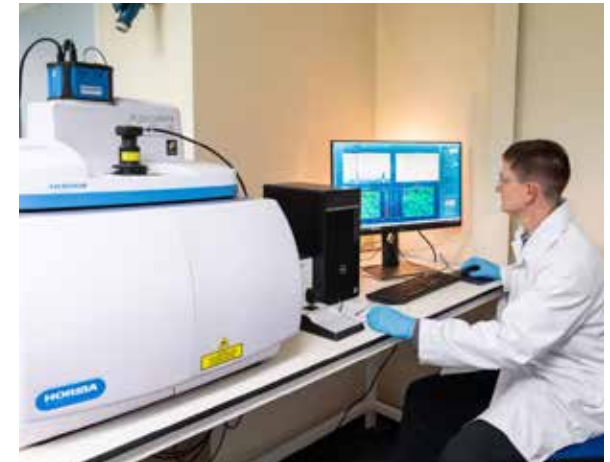
# Strategic partners

**B**lack Swan Graphene (TSX-V: SWAN, OTCQB: BSWGFE, XETRA: R96) is a producer of low-cost and high-performance graphene powders, derived from graphite, ideally suited for the concrete industry. Black Swan's graphene technology was originally developed and advanced by Consett-based Thomas Swan & Co. until the launch of Black Swan in 2021.

Reliable and sustainable graphene supply is the key driver in the partnership between Black Swan and NERD, an equity swap where each company owns approximately 5% of the outstanding shares of the other, securing this supportive commercial relationship.

Black Swan intends to increase its graphene production volume significantly with a new plant based at the graphite facility of Nouveau Monde Graphite Inc. in Quebec, Canada. The entire facility will operate fully on renewable hydro-electric power.

Sustainable sources of graphene are critical to commercialisation of Concretene and Black Swan will trial anode production waste as a raw material for graphene production, forming part of further product development trials in Q3 2023.







*"Our partnership with NERD could have serious ramifications for the concrete industry around the world."*

*"The performance achieved with the process of Concretene, combined with the leadership of Arup, could trigger a transformation of the concrete industry globally."*

*"With concrete being the second-most-used substance on Earth after water, it is hard to imagine a more exciting opportunity."*



**Simon Marcotte**  
President and CEO,  
Black Swan  
Graphene

# Strategic partners

The University of Manchester (UoM) is one of the world's leading institutions for science and engineering and renowned as the 'Home of Graphene', with an unmatched capability for research into advanced materials.

In 2021, UoM was the leading UK higher education institution by value of funding received from UK Research and Innovation (UKRI) and placed first in the world for action on sustainable development by the Times Higher Education rankings (2nd in 2023).

NERD is sponsoring a new professorial position – Chair in Construction Materials – which creates a construction material specialism for nanotechnology within the Faculty of Science and Engineering. The position will be advertised globally, bringing a truly world-class individual into the UoM collaboration with NERD.

This five-year commitment ensures further development of patentable technology aligned with Concretene and IP ownership for all collaborative projects.

In addition, the Chair will secure additional research funding for complimentary projects that interact with NERD technologies, supporting our efforts to develop innovative



nanotech for the decarbonisation of the construction and property industries.

The new Chair's research group will work on the fundamental chemistry of Concretene, providing the scientific understanding to underpin the observed engineering performance, which together will provide the route to product assurance and certification.

Collaborative projects will explore graphene enhanced materials for other construction applications. Early work in coatings, asphalt and fire protection has shown potential and will provide the foundation for numerous, parallel workstreams.







The University of Manchester's new 76,000m<sup>2</sup> engineering building, which opened in 2022

*"NERD's investment in the Chair in Construction Materials provides a gateway for the informed development of next-generation graphene-enhanced cementitious materials, underpinned by deep scientific understanding, allowing system properties to be engineered for specific environments."*

*"We look forward to seeing this applied, yet fundamental, research collaboration thrive."*



**Professor Bill Sampson**  
Chief Scientific Officer, GEIC

# Strategic partners

The Graphene Engineering Innovation Centre (GEIC) is a £60m institute dedicated to the commercialisation of graphene and associated ‘two-dimensional’ materials. Alongside the National Graphene Institute and the Henry Royce Institute for Advanced Materials, the GEIC forms part of an unparalleled ecosystem for materials R&D at The University of Manchester.

The GEIC and NERD have also forged relationships with leading international universities, through which formal research agreements will evolve, the Chair position providing the scientific leadership and focus to develop these opportunities.

Work on the development of Concretene began at the institute in 2019, leading to live trials in 2021, following which the GEIC team focused its work on characterisation of materials and dosage refinement to understand formulations and performance.

NERD was created in 2022 to manage Concretene development and commercialisation, and has taken Tier 1 membership of the GEIC. This provides dedicated laboratories and resources

for the transition and industrialisation of our patented technologies. Our chemistry and materials labs have been resourced with skilled personnel and industry professionals to optimise the material composition of Concretene.

Consistent and sustainable material suppliers have been secured during 2022, these supply partnerships supporting detailed Environmental Product Declaration (EPD) and Lifecycle Assessment (LCA) characterisation of our product and the concrete in which the embodied carbon is reduced. Our laboratories are fully engaged in modifying Concretene composition to optimise the properties of the materials sourced reliably through our new supply chain partnerships.

NERD continues to innovate and collaborate with the GEIC, most recently engaging in the further development research of graphene enhanced coatings, and with further work on fire protection and asphalt.

Our long-term commitment to partnership with the GEIC ensures further development of patentable technology and IP ownership for all collaborative projects remains wholly owned by NERD.







Will Pryce/University of Manchester

*“Concretene is a great example of what Graphene@Manchester is seeking to achieve: using our expertise in the GEIC and broader UoM capabilities to develop innovative ideas around graphene and 2D materials with industrial partners, attracting investment and ultimately accelerating the bringing of products and applications to market.”*

*“Graphene-enhanced concrete is a potential game-changer for sustainability in the construction sector.”*



**James Baker**  
CEO,  
Graphene@  
Manchester

# Strategic partners

LocalGlobe is a tech investor, backing the most ambitious founders on their journey from seed through to the public markets and beyond over the last two decades. The fund, part of the Phoenix Court Group (pictured), is Europe, Middle East and Africa's (EMEA) most successful investor in unicorns at seed stage.

According to dealroom.co, LocalGlobe topped both the seed and overall rankings for EMEA in 2021, with 14 unicorn seed investments and 11 future unicorn seed investments. That was the second year running that LocalGlobe attained the top spot for the EMEA seed ranking. Notable companies receiving funding from LocalGlobe include Improbable, Wise, Zego, Tide, Monzo and Oxford Nanopore.

Funding to NERD has enabled the company to spin-out from Nationwide Engineering Group, to assemble the core management and research functions, and to co-sponsor a new Chair in Construction Materials position at The University of Manchester's Faculty of Science and Engineering (see previous spread).







*"Graphene offers huge potential across industry and with Concretene, the teams at NERD and GEIC have unlocked this potential in a way that could transform construction and physical infrastructure."*

*"Finding new technology to create a more sustainable world is just the kind of impact investment that matters so much to LocalGlobe and we're delighted to be joining Alex, Rob and the wider team in bringing Concretene to the world."*



**Robin Klein**  
Co-founder,  
LocalGlobe





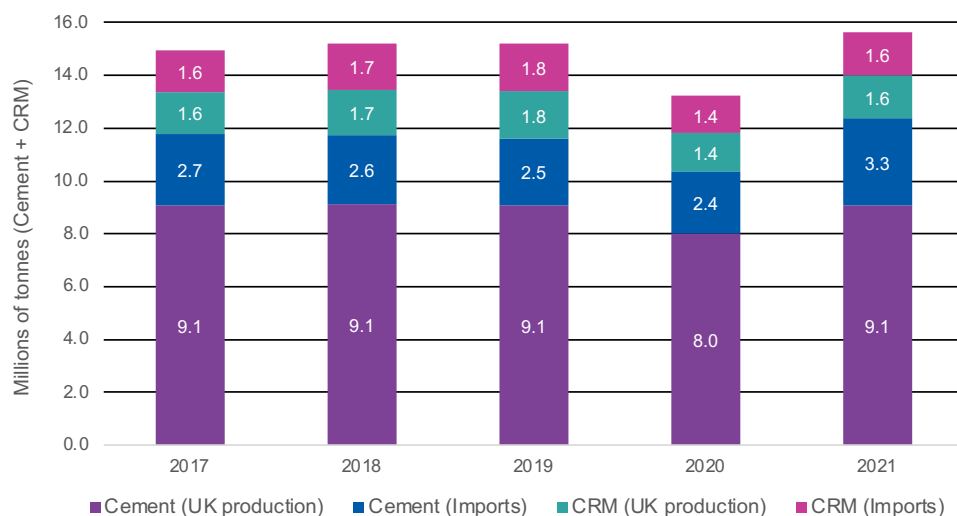
## UK cement/CRM consumption

The concrete market remains stable in the UK with consumption of cement and cement replacement materials (CRM) recovering quickly post-pandemic.

The UK's total annual consumption of cement is 11.6 to 12.4m tonnes. These figures imply an average cement content of ~250-325kg/m<sup>3</sup>.

Annual consumption of cement replacement materials (CRM) in the UK – mainly ground granulated blast furnace slag (GGBS), fly ashes (FA) and other concrete additions - is between 2.8 and 3.6m tonnes.

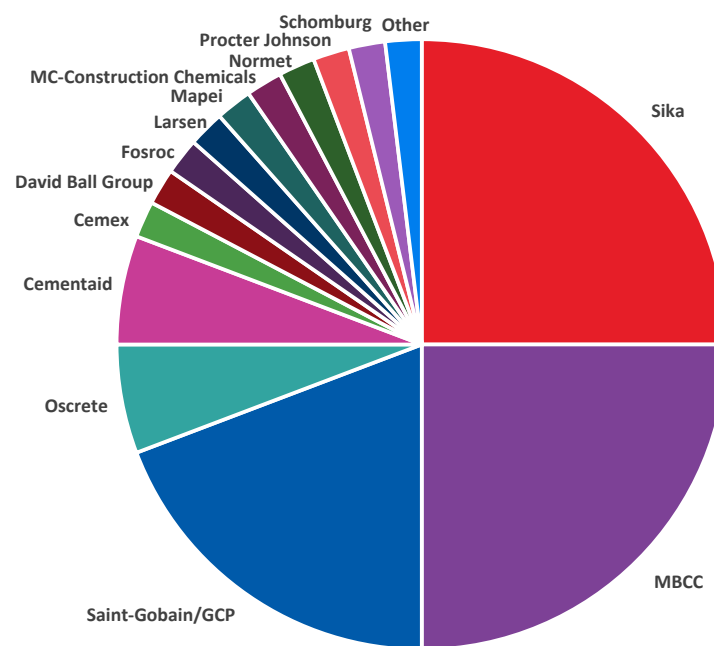
Arup estimates that around 50% of the CRM used in the production of concrete in the United Kingdom comes from imports. Typically, CRM amount to ~20% of the overall binder used in the concrete mix.



Annual consumption of cementitious material in the UK (2017-2021)

## UK concrete admixture market

The market for chemical admixtures in concrete has a high competitor concentration, with three companies - Sika, MBCC and Saint-Gobain/GCP accounting for approximately 70% of the UK's supply\*.



Shares of supply in cement, concrete and mortar admixtures in the UK (2021)

Source: Competition & Markets Authority (\*NB. CMA figures for this graph date from 2021, since when Sika acquired MBCC but subsequently sold its concrete admixture arm to Ineos in Jan 2023).

# Concretene market opportunity

## UK market

ARUP research establishes concrete production in the UK consistently exceeds 40 million cubic metres per annum, a market value in excess of \$11bn. We anticipate Concretene will represent between 15-20% of concrete costs, equating to a whole market opportunity of circa \$1.9bn for the UK.

Asset owners in all sectors, constructors and concrete suppliers are committed to reducing embedded carbon in construction and view the carbon reducing properties of Concretene as a major step forward for the industry. We anticipate uptake will be swift, the annual market value growing progressively as addressable sector assurance processes achieve compliance.

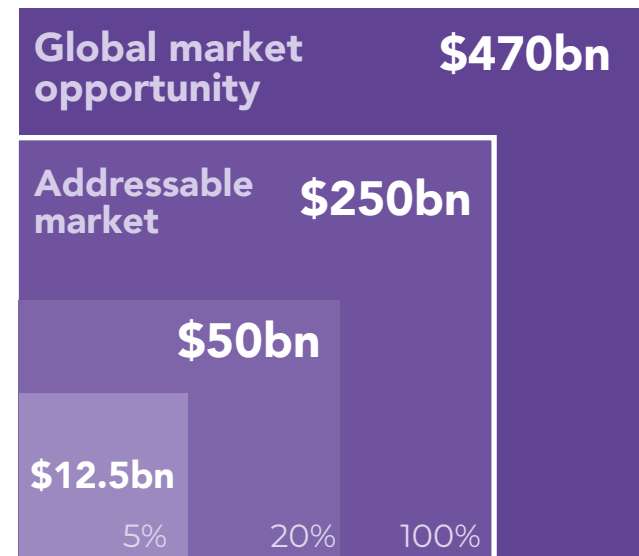
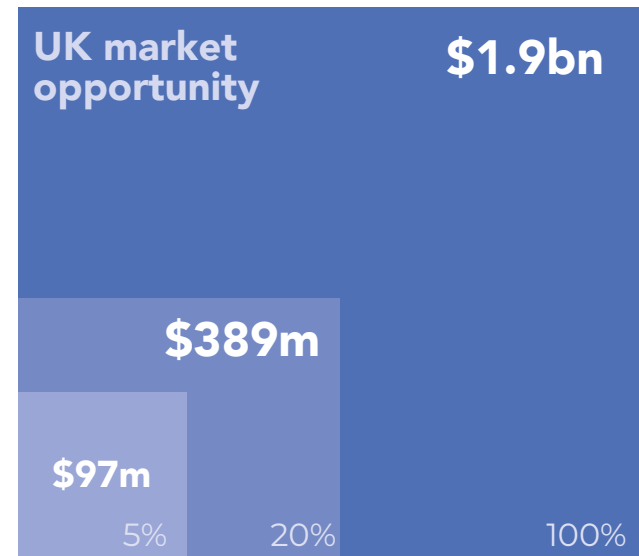
The readily addressable market in sectors that have the lowest barrier to entry represents 20% of the total market, growing to a potential 75% as the market matures.

## Global market

Market research by ARUP, supported by Statista cement production data, states that annual global concrete production exceeds 10.1bn m<sup>3</sup>, projected to rise by 4.7% per annum. This equates to a market in excess of \$2tn by 2030, delivering a worldwide market opportunity of ~\$470bn.

The global market value has been evaluated to take account of growth opportunities where adoption of our technology can be scaled within 10 years, meaning the addressable market is roughly 53% of that globally, at ~\$250bn.

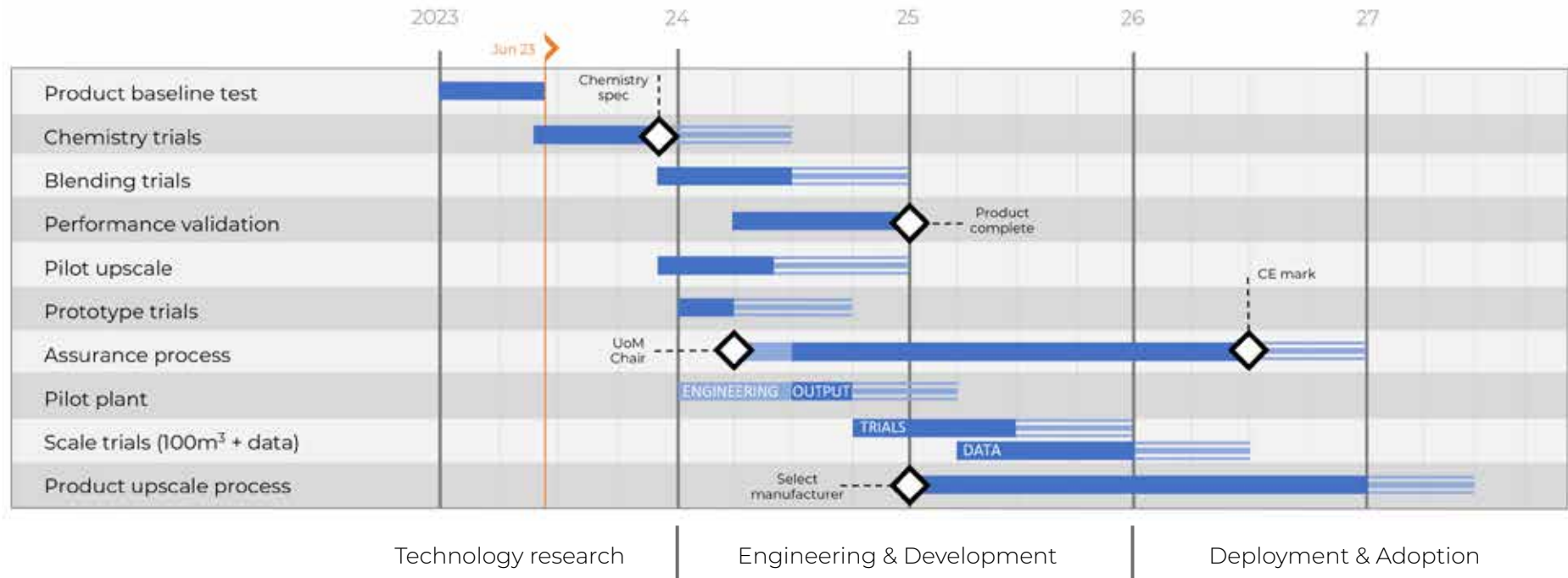
Net-zero obligations driven by legislation will be the quickest to adopt carbon-reduction technologies, which has been assessed at 20% of the global opportunity and representing \$50bn revenue opportunity.



Potential annual revenue of Concretene by UK and global market shares in 2030



# Concretene timeline 2023-27



## 2023

Raw material supply security, compositional variability and assurance around environmental performance has led NERD to fully revisit the raw material supply chain for Concretene. New supply agreements have been secured with organisations capable of upscaling production at viable levels of cost and carbon footprint.

Establishing a performance-reliable composition of Concretene with the updated supply chain materials will be the key deliverable in our R&D process.

## 2024-25

Pilot plant development alongside at-scale delivery of demonstration projects will support the assurance and certification of Concretene for industry-wide adoption of the technology. The UoM chair sponsorship will deliver the science that underpins the observed enhancement of concrete performance.

Detailed engagement with potential manufacturers will be undertaken during the pilot plant development, allowing for adjustments of composition and associated performance validation.

## 2026+

We envisage Concretene production will be delivered by licensed manufacturers in each global region, detailed engagement and partnership arrangements functionalised to deliver the key metrics for each market.

Initial assessment of the global market opportunity and the manufacturing upscale required to service the market supports a partnering approach and global launch of the technology.

# Market opportunity – further applications

## Anti-corrosion coatings

NERD's patented technology for dispersal of graphene in aqueous solution creates a unique opportunity to exploit the global anti-corrosion coatings market.

NERD has secured funding from the European Regional Development Fund (ERDF) to progress this opportunity, which will be collaboratively delivered with the GEIC, beginning Q3 2023.

Early indicators are positive for graphene-enhanced coatings, showing improved performance and durability.

## Fire protection

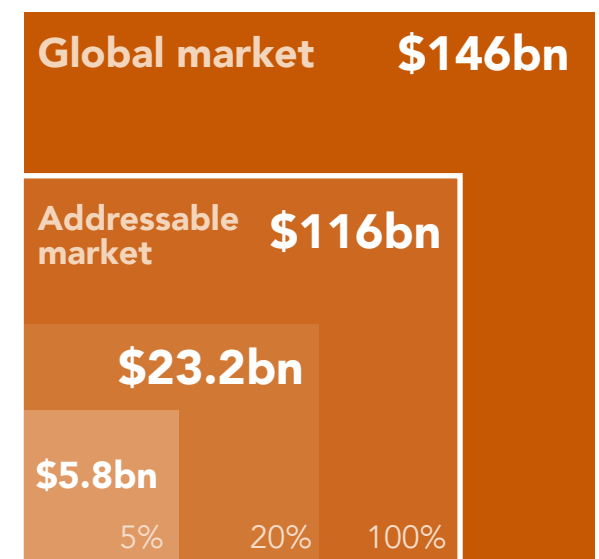
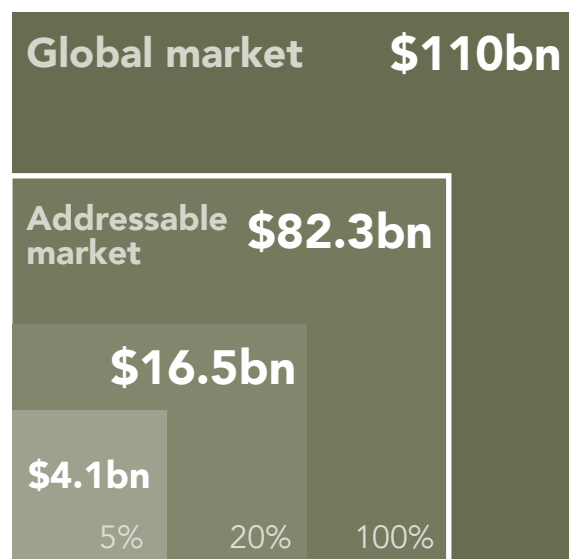
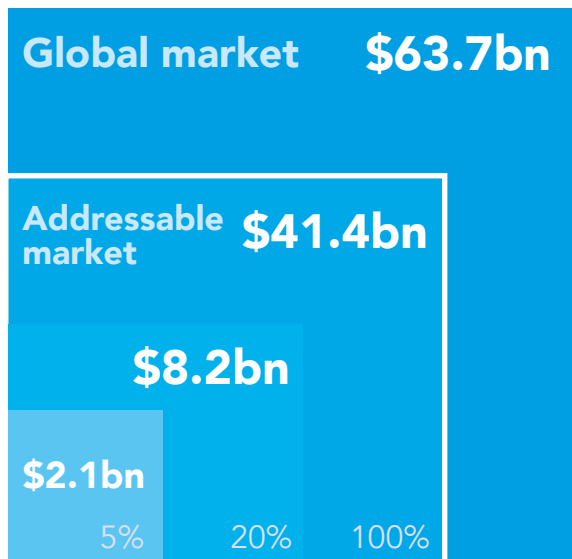
Aqueous polymer fire protection applications are an area where the addition of graphene could improve the thermal performance, potentially reducing the volume of product required and the effective embodied carbon.

NERD, using the University Chair and extensive research capability, will initiate the next tranche of nanotechnology research. Complex building product applications form a key element of a series of planned technology development.

## Composites

The circular economy in construction provides an opportunity for nanotechnology to create new composite products that utilise waste streams from other processes and industries as a raw material.

Initial research opportunities have been undertaken in asphalts and NERD, with support from UoM, will develop a wider programme of composite nanotech opportunities. These will be a key driver for the UoM Chair in Construction Materials, anticipated to commence Q2 2024.



Est. global market size in 2030; sources - Anti-corrosion: Statista, Fire protection: Grandview research, Composites: markets and markets



# UK carbon budgets

In the 2008 Climate Change Act, the UK set out a long-term climate objective of cutting overall greenhouse gas emissions by at least 80% (relative to 1990) by 2050.

In 2019, this was replaced with a target of achieving net-zero emissions by

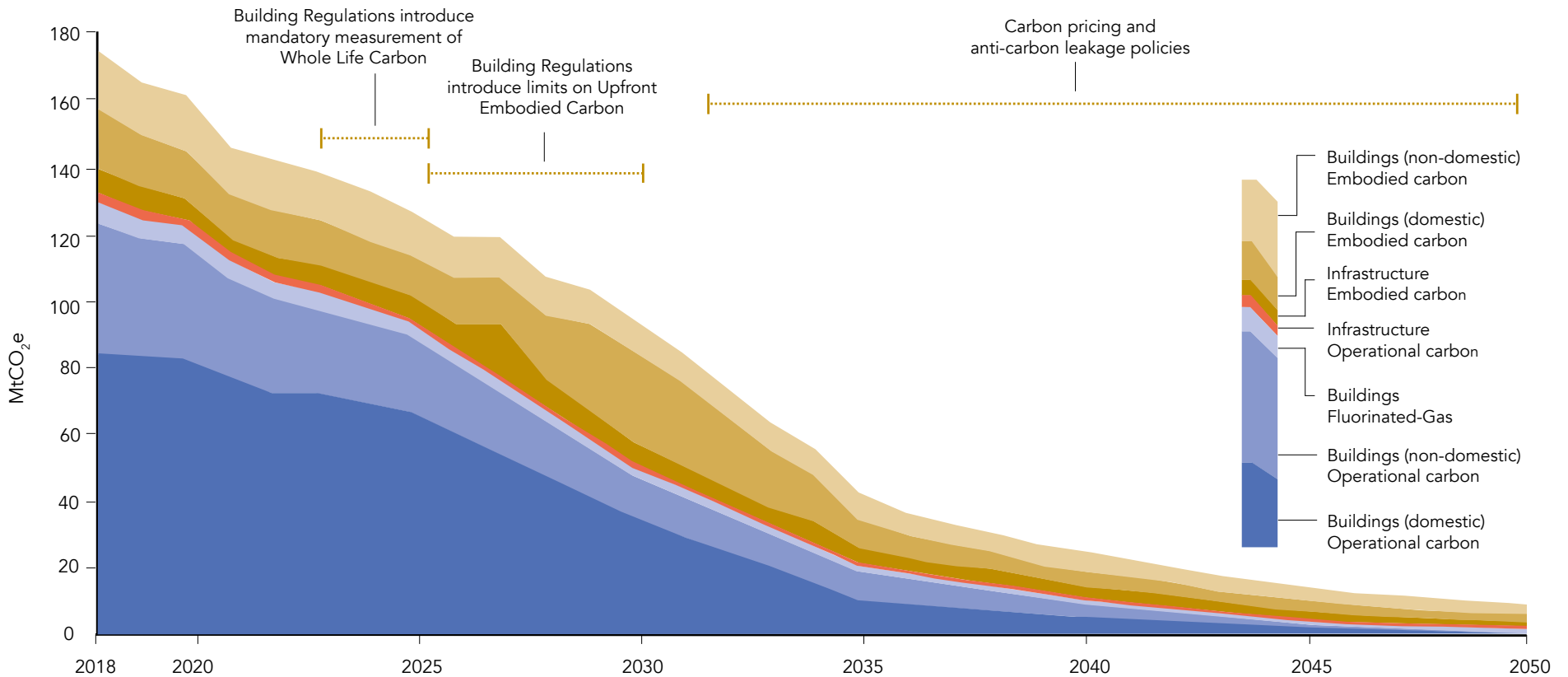
2050 (100% reduction compared to 1990 levels).

The Climate Change Committee (CCC) draws up 'carbon budgets' to provide a five-year statutory cap on total greenhouse gas emissions which should

not be exceeded, in order to meet the UK's emission reduction commitments.

Carbon budgets define a cost-effective path towards Britain's long-term climate objective. Each budget is set 12 years ahead to provide sufficient guidance to investors.

## UK Net-zero trajectory 2018-2050 (UK Green Building Council, Nov 2021)



# Media and awards

Concretene has received a wealth of media coverage and numerous awards since 2021. Follow the links to read more about how our innovation has been covered in both specialist and mainstream media outlets.

## Press



**THE TIMES** Today's sections ▾ Past six days Explore ▾ Times Radio Times+ My account

## Concretene cements its future with £8m funding

Tracey Boles

Thursday December 29 2022, 12:01am, The Times

> **VIEW** (paywall)

Concretene used on real-world construction projects is up to 50 per cent stronger than concrete alone

TWITTER

**NEWS**

### The super material reinforcing rinks, cars and buildings

28 Aug 2022

**> VIEW**

**FINANCIAL TIMES**

### Company Announcements

**> VIEW**

#### Black Swan Graphene and Nationwide Engineering Announce Strategic Partnership, Part of an Integrated Supply Chain, to Accelerate the Adoption of Graphene-enhanced Concrete Globally

TORONTO, March 27, 2023 (CNW) - Mason Graphite Inc. ("Mason") (TSXV: LGG) (OTCQX: MGPHF) is excited to report the following announcement from Black Swan Graphene Inc. ("Black Swan"). Mason currently owns approximately 41% of the total shares issued and outstanding of Black Swan.

Black Swan Graphene Inc. (TSXV: SWAN) (OTCQX: BSWGF) (Frankfurt: R96) and Nationwide Engineering Research and Development Ltd. ("NERD") are pleased to announce a strategic partnership being embedded in a fully integrated supply chain which will include Arup Group Limited ("Arup"), a multinational engineering consultancy headquartered in London.

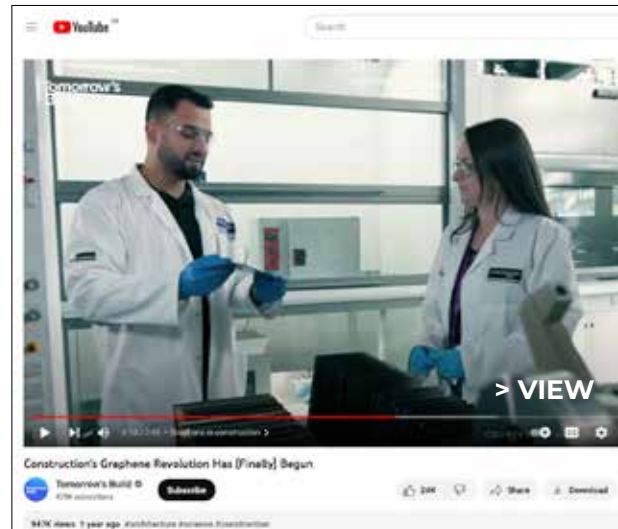
**The Economist** Menu Weekly edition Search

### The wonder material graphene may have found its killer app

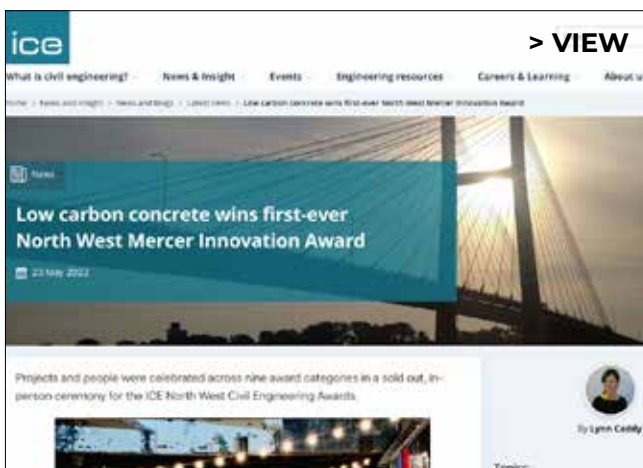
It will help decarbonise industry, produce greener concrete and make hydrogen

**> VIEW** (paywall)





## Awards



**Institution of Civil Engineers North West**  
Mercer Innovation Award 2022

**CogX Awards 2022**  
Best Climate Innovation

**University of Manchester**  
Making a Difference Awards & Better World Showcase 2022 - Outstanding Contribution to Environmental Sustainability

# Concretene engagement: key organisations

The logos displayed on this page are a selection from NERD's growing community of partners and stakeholders.



Brochure Images courtesy of: unsplash.com, pexels.com, iStock, University of Manchester, Will Pryce, Mark Waugh/U+I, Arup, Black Swan Graphene, Phoenix Court, Southern Quarter



# Join the industrial evolution

Since the start of this journey in 2019, when Alex and I committed to a research project with the GEIC, there has been significant progress and milestones achieved to the present day, culminating in the creation of NERD and our first product Concretene.

NERD provides an ecosystem whereby our strategic partnerships provide a community for rapid research and routes to market. With this combined experience, NERD provides a turnkey solution for clients who want to explore nanomaterials.

Nanomaterial technology is infinite in the number of markets and the scale of application. Our mission is to help lead the nanomaterial evolution, working with global partners to deploy technologies that significantly reduce CO<sub>2</sub> emissions on the journey to net-zero targets.

If you share our vision, please get in touch, and support our journey.



**Rob Hibberd**  
Co-founder and CEO, NERD



**Change, before you have to**  
Jack Welch, former Chairman, GE





Watch a video  
on Concretene

# CONCRETENE™

