Centre of Excellence
for Decarbonising Roads

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South Campus

Department for Transport
ADEPT LIVELABS2 Decarbonising Local Roads
North Lanarkshire Council
Transport for West Midlands
Amey
COLAS WE OPEN THE WAY

What is CEDR?

Centre of Excellence for Decarbonising Roads

The Centre of Excellence for Decarbonising Roads (CEDR)?

2
Campuses

8
Local Highway Authorities

1
Shared Objective

Decarbonise local road materials and processes through information discovery and sharing.



NORTH CAMPUS

North Lanarkshire Council



SOUTH CAMPUS

West Midlands Combined Authority

Birmingham, Coventry, Dudley, Sandwell, Solihull, Walsall and Wolverhampton

Why does CEDR exist?

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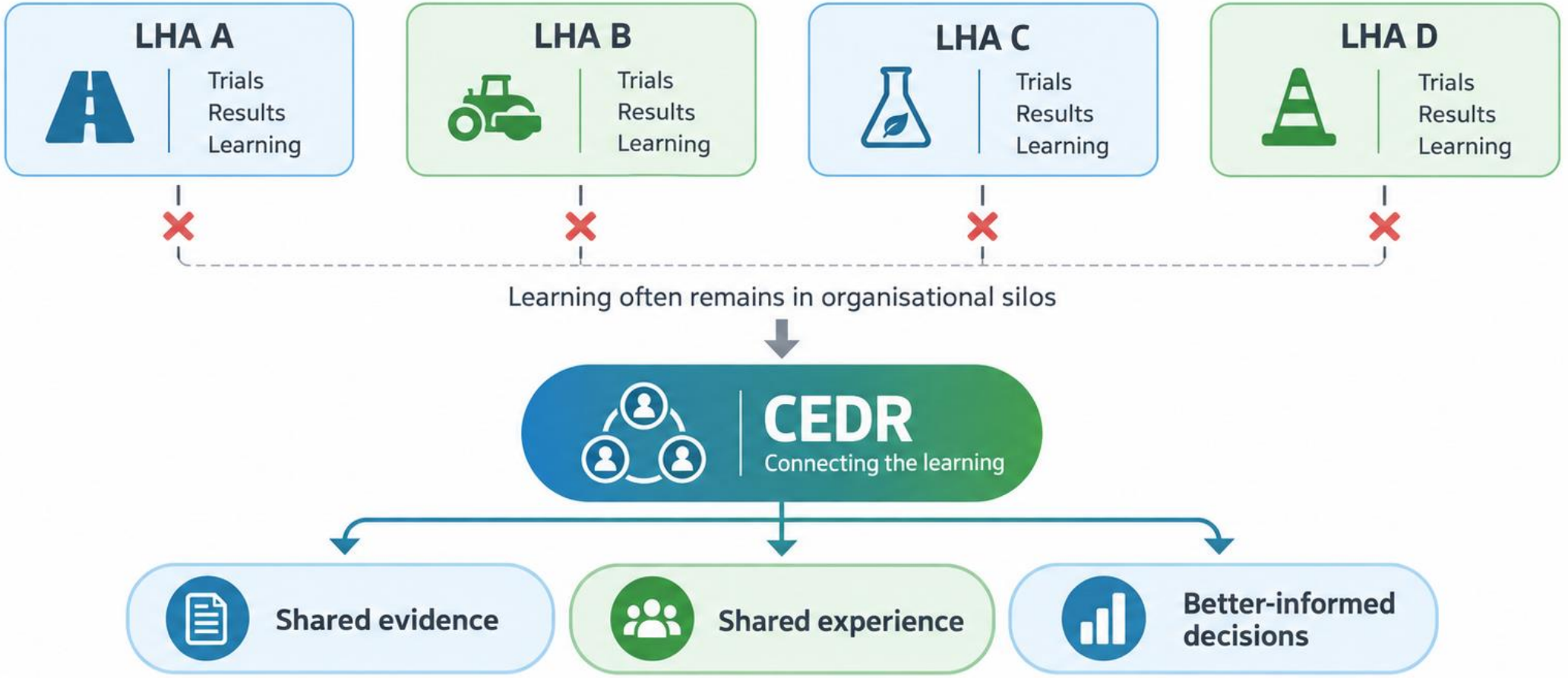
Innovation is happening. The challenge is sharing what we learn!



CEDR is an attempt to turn isolated innovation into shared knowledge

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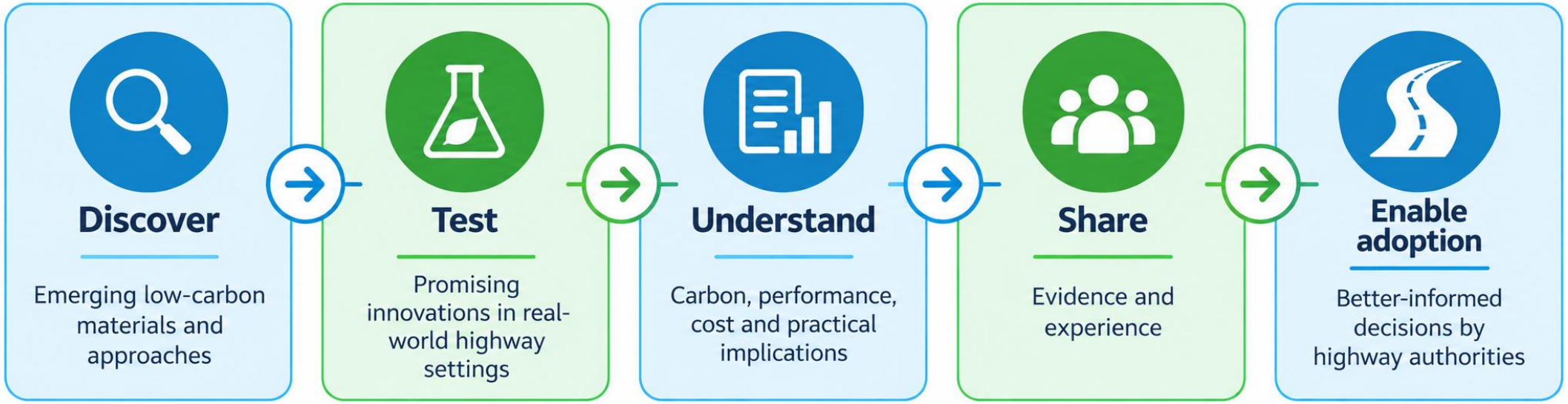
So, what did we set out to do?

CEDR was designed to take innovation from discovery through to informed adoption.



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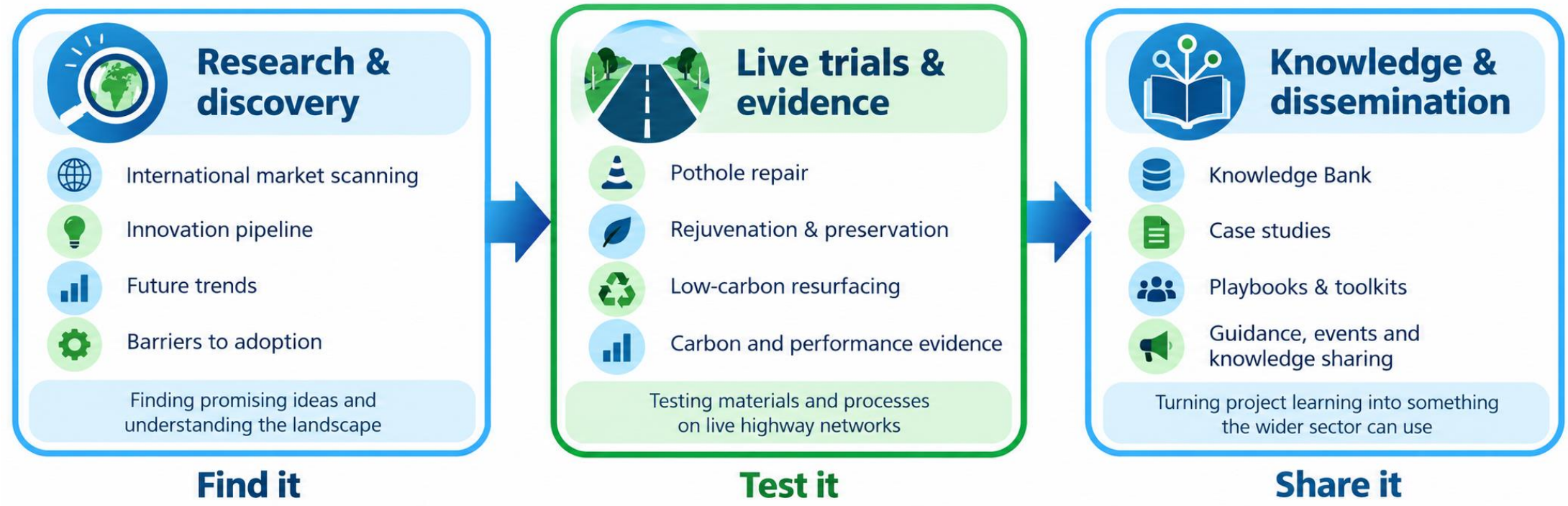
What did we actually do?

CEDR brought together research, real-world trials and knowledge sharing across the highways sector.



South Campus Trials Overview

Centre of Excellence for Decarbonising Roads

We tested lower carbon materials and processes on live roads through three south campus trial programmes.

Pothole repair

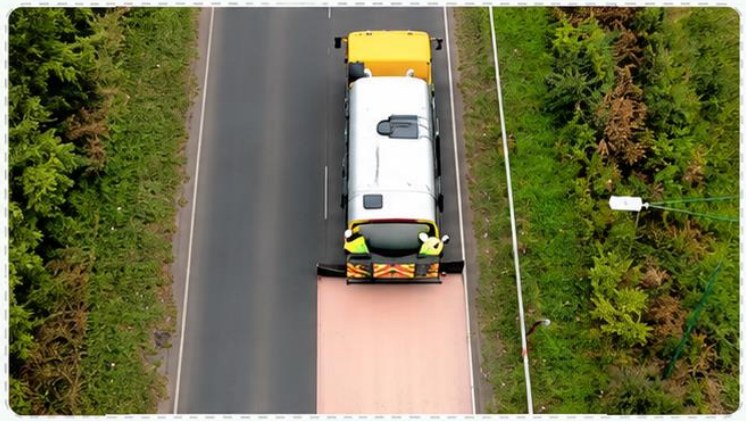
Trialling innovative materials and approaches for reactive repairs.



Phase 1 | Phase 2

Rejuvenation & preservation

Extending the life of existing assets with spray-applied treatments.



Phase 1 | Phase 2

Resurfacing

Testing lower-carbon materials and construction approaches.



Phase 1 | Phase 2 | Phase 3 | Phase 4

Different interventions. One question.

Can we reduce whole-life carbon without compromising highway performance?

Potholes Phase 1 - What did we learn?

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We tested innovative repair solutions in real-world conditions across five highway authorities.

Phase 1

71 pothole repairs on real defects.

9 different products.

Real-world defects.

Real-world operations.



But no two defects were the same.

So, we modified our methodology for Phase 2

Potholes Phase 2 - What did we change?

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Phase 2 redesigned the trial to create a fairer and more comparable test of pothole repair materials.

What Phase 1 told us

- Real-world conditions
- Useful operational insight
- Limited comparability

So, we changed the methodology

One road	Standardised defects	Side-by-side comparison	Consistent data capture	BAU comparator
Thimblemill Road, Sandwell	28 artificial repairs of consistent size and depth	All products in the same road environment	Fuel, materials, time and site data recorded	HRA 45/10 included as a baseline

Transportation distance matters

A1-A5 changes when A4 is standardised

Carbon rankings change substantially when A4 transport emissions are standardised.

In real-world decision-making, transport distance still matters.

Lowest carbon in both

Bio-based cold-lay asphalt repair material

Lowest in A1-A3 and A1-A5.

14-month performance

Most repairs remained in service.

1 repair failed and was replaced.

2 removals were due to speed-calming works, not failure.

Transport distances matter. Longevity is currently comparable for most products (14 months on)

Asphalt Rejuvenation
What did we learn?

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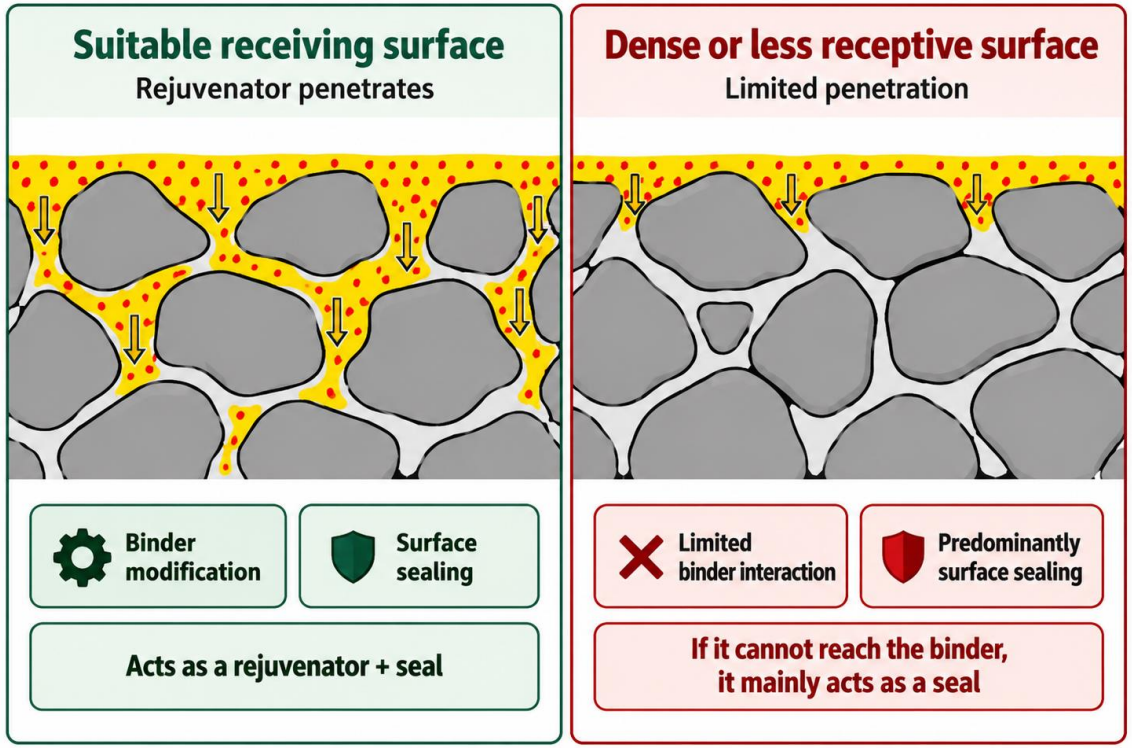
RSTA identified asphalt rejuvenation as one of the lowest-carbon maintenance interventions, so we tested whether it could modify ageing binder and support earlier preventative maintenance.



Low installation carbon

Laboratory response is measurable

Life extension is not yet proven

Early results and wider local authority experience are promising.

When should a spray-applied asphalt rejuvenator be applied?

Condition-led, not age-led.

UK practice often considers treatment after 4-5 years in service, while some US approaches intervene earlier.

Our evidence does not support a universal age rule; receiving surface condition and intended outcome matter more.

A rejuvenator only works as a rejuvenator if it can reach and modify the binder.

Asphalt preservation – what did we learn?

Preservation and rejuvenation are **different early-life** preventative treatments with different functions and use cases.

Different mechanism

University of Nottingham testing identified different chemical mechanisms for preservation and rejuvenation products.

Different function

Preservation products primarily stabilise the existing binder, while rejuvenators have a greater softening and flexibility-restoring effect.

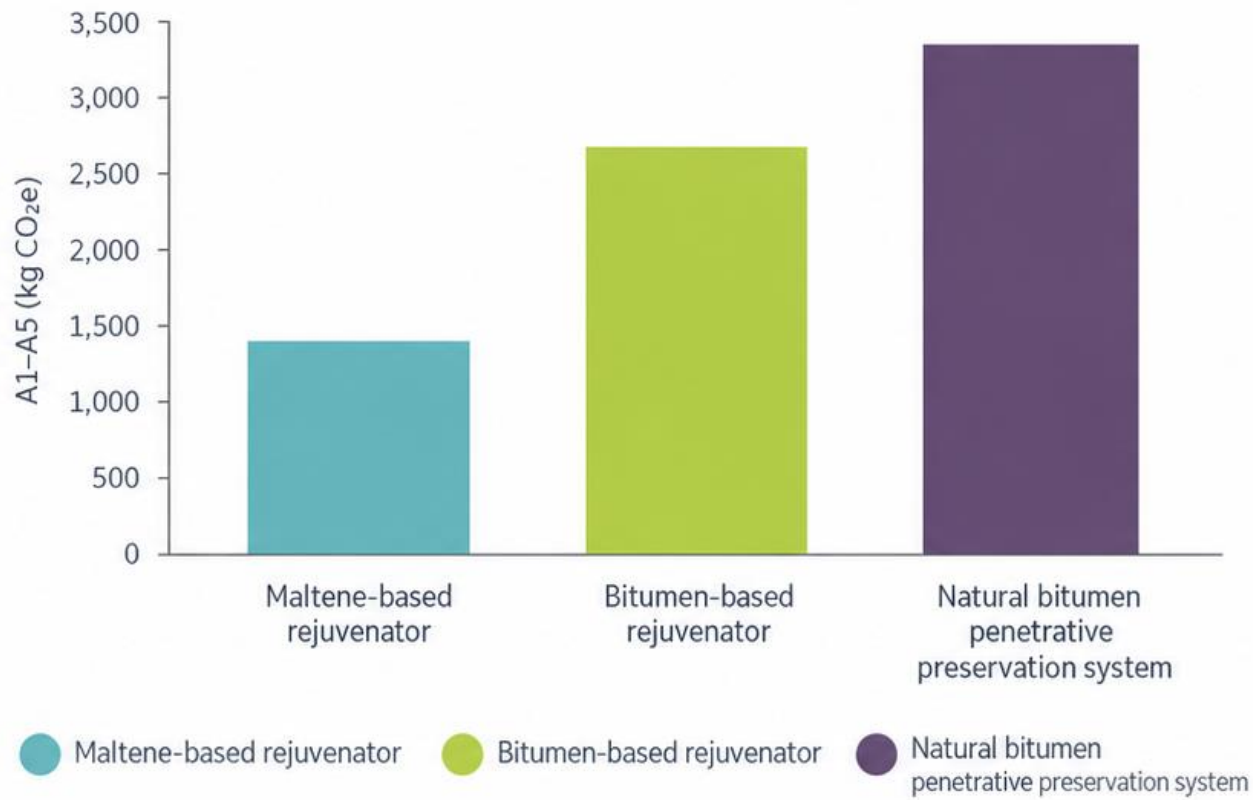
Different use case

Both are early-life preventative treatments with similar application windows, but selection should be based on the intended outcome and the condition of the existing binder.

Carbon takeaway

Preservation was more carbon intensive than the two **rejuvenators tested, but still lower carbon than waiting** to surface dress or resurface.

Spray-applied rejuvenator and preservation systems
A1–A5 carbon comparison



Define the outcome first, then choose the treatment.
Preservation and rejuvenation are different tools for different maintenance objectives.

Choosing the right treatment

Start with the intended outcome: does the surface need to be softened, or mainly preserved?

Use a rejuvenator

PenTack / Reclamite type

- Aged, hard or brittle binder
- Early fretting or fine cracking
- Goal: restore flexibility
- Best used as an early preventative treatment when binder modification is needed



Aged and stiff → More flexible

Main effect: softening and flexibility

Practical guidance

Need to soften and restore flexibility?
→ **Rejuvenate**

Need to preserve a sound but ageing surface?
→ **Preserve**

Earlier intervention may help, but timing should be condition-led — not a fixed age rule.

Use a preservative / stabiliser

Rhinophalt / Everphalt / Finaphalt type

- Surface still in reasonable condition
- Goal: slow deterioration
- Avoid unnecessary softening
- Best used when preservation and sealing are the intended outcome



Sound but ageing → Protected and stable

Main effect: stability and preservation

Not for structural failure, deep cracking, rutting or major defects — consider heavier maintenance.

Based on laboratory findings: rejuvenators produced greater softening; penetrative preservatives showed a more stabilising response. US evidence suggests earlier rejuvenation may be beneficial, but application timing should still be condition-led.

Resurfacing – Phase 1: Pauls Coppice, Walsall

Residential-road resurfacing showed clear installation-stage carbon savings. Long-term performance remains under monitoring.

What we tested

- Residential-road trial at Pauls Coppice, Walsall
- Warm-mix controls vs biogenic binder and surface-course alternatives
- Same Birmingham asphalt plant to minimise plant-location variability

Trial area: 1,378 m² | Control section: 280 m²

What we found

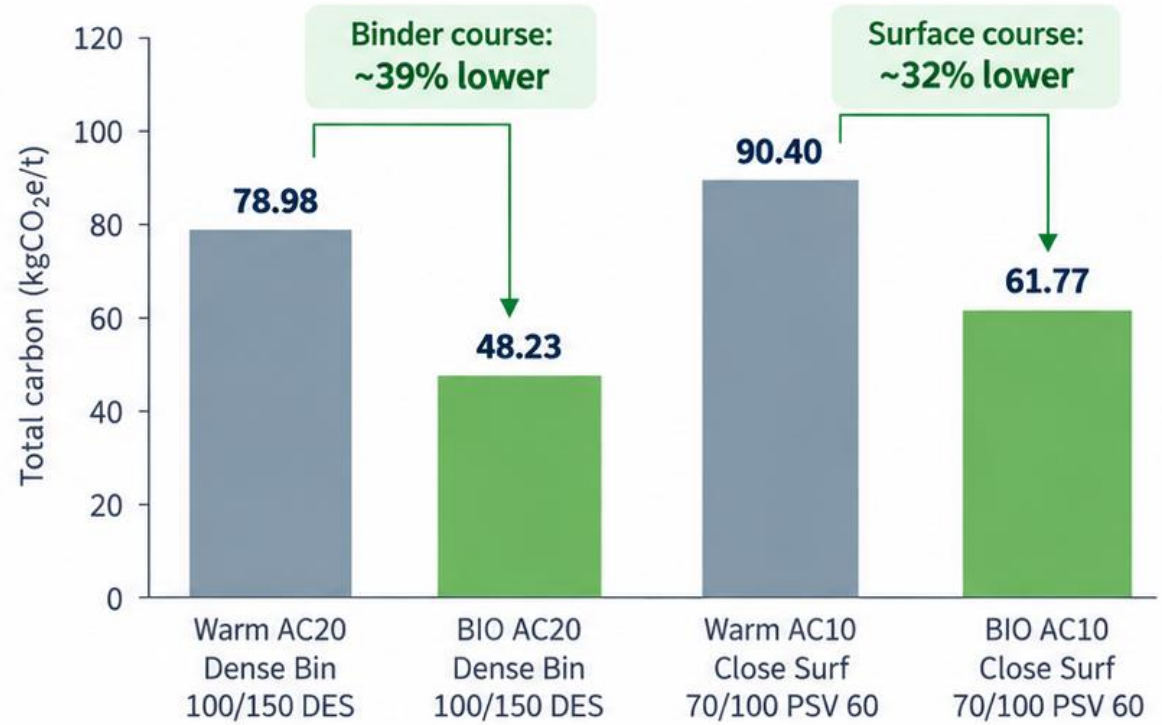
- Lower installation carbon in both binder and surface course
- Binder course: **78.98** → **48.23** $kgCO_2e/t$ **(~39% lower)**
- Surface course: **90.40** → **61.77** $kgCO_2e/t$ **(~32% lower)**
- Additional site-wide cost: **~£2,000**

What remains unknown

- Longevity and whole-life performance are still under monitoring
- Whole-life carbon benefit depends on long-term durability

Installation carbon results (A1–A5)

Total carbon per tonne ($kgCO_2e/t$)



Takeaway: **Carbon savings can be achieved on residential-road resurfacing for a modest additional cost — longevity will determine the whole-life case.**

Resurfacing – Phase 2: Croxstalls Road, Walsall

A graphene-modified surface course was tested against PMB to explore lower installation carbon and potential longevity benefits on a more heavily trafficked road.

What we tested

- Type 3 industrial estate road in Walsall
- Graphene-modified surface course vs PMB control
- G*enable™ Pavement (Universal Matter)
- Binder course held constant
- Trial area: 2,631 m²

What we found

- Graphene-modified surface course: 79.40 $kgCO_2e/t$
- PMB controls: 102.66 and 96.52 $kgCO_2e/t$
- Average PMB control: 99.59 $kgCO_2e/t$
- Around 20% lower installation carbon
- Binder course average: 69.71 $kgCO_2e/t$

Plant location can materially influence A1–A3 carbon data.

What remains unknown

- Whether the graphene-modified surface course matches or exceeds PMB longevity
- Whether lower installation carbon translates into a whole-life benefit
- Monitoring is ongoing

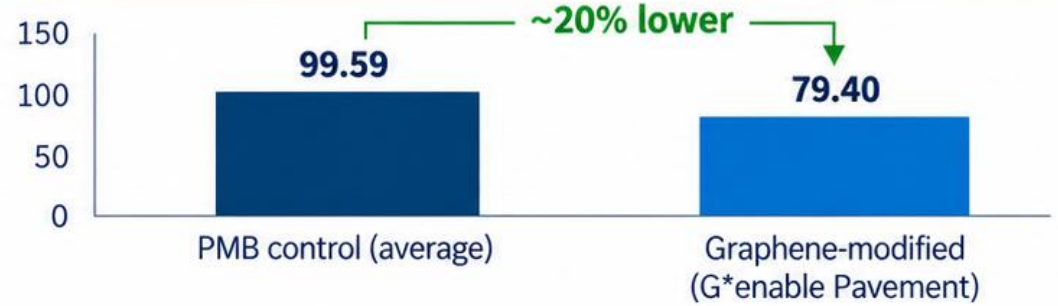
Installation carbon results (A1–A5)

Total carbon per tonne ($kgCO_2e/t$)

Binder course (held constant)



Surface course comparison



PMB control sections = 102.66 and 96.52 $kgCO_2e/t$

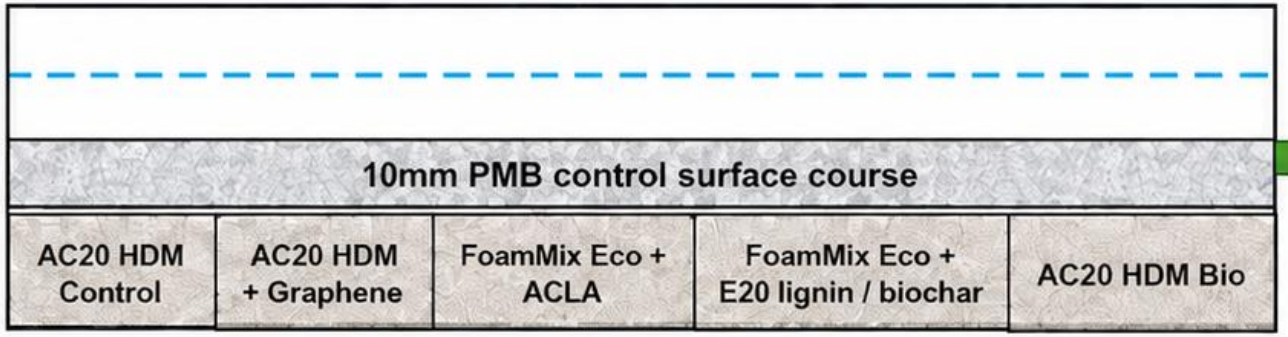
Takeaway: Lower installation carbon was achieved, but longevity will determine the whole-life case.

Resurfacing Trials - Phase 3

Controlled trial design allowed lower-carbon materials to be compared while minimising other pavement variables.

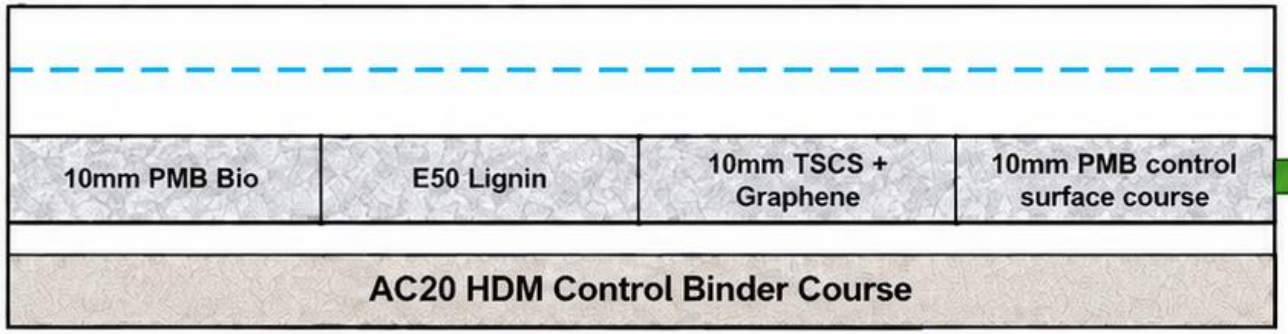
Broad Lane – binder course trial

Surface course held constant to minimise variables.



Willenhall Lane – surface course trial

Binder course held constant to minimise variables.



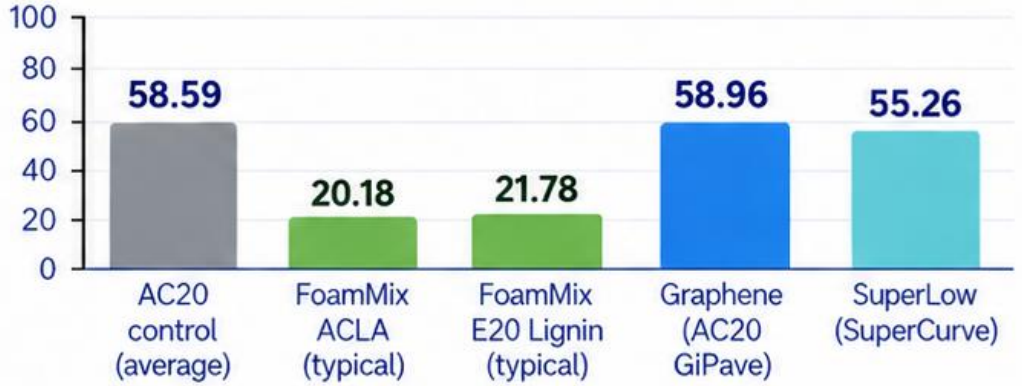
Installation carbon is only part of the story.

The whole-life carbon benefit will depend on how long each material performs in service, as well as other factors such as initial cost.

Installation carbon results (A1–A5)

Total carbon per tonne ($kgCO_2e/t$)

Broad Lane – binder course



FoamMix note: A1–A3 was recorded as zero at the time of the trial, so the A1–A5 result came from transport and installation. More recent EPDs now report negative A1–A3 values.

Willenhall Lane – surface course



Resurfacing – Phase 4: Walsgrave Road, Coventry

A heavily trafficked electric-bus corridor was used to test supplier-led lower-carbon, longer-life resurfacing proposals.

Why this site?

- Heavy electric bus route
- Good testbed for deformation-resistant materials
- Whole-life carbon strategy focused on fewer future interventions

Section 1 – Control (Holcim)

HOLCIM



Conventional specification

Section 2 – Holcim proposal

HOLCIM



Long-life / deformation-resistant proposal

Section 3 – Tarmac proposal

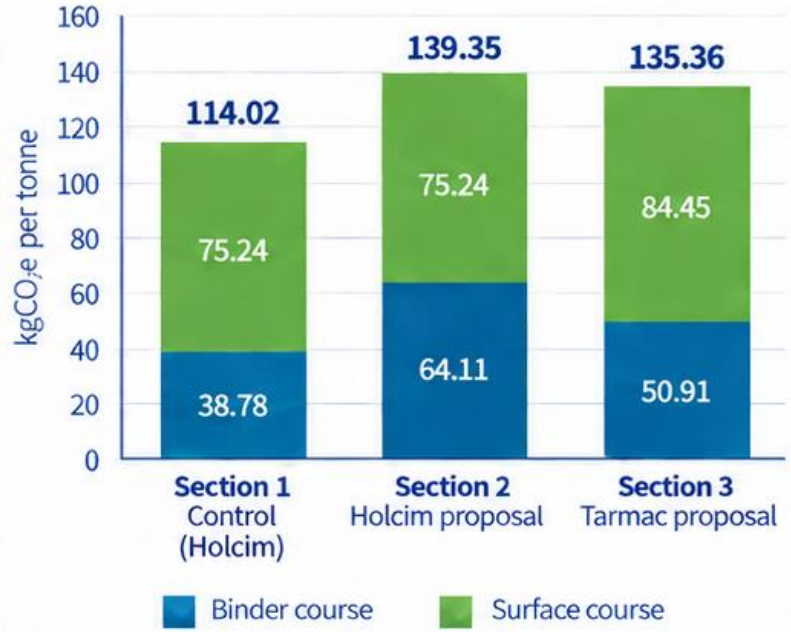
TARMAC
A CRH COMPANY



Lower-carbon / long-life proposal

Installation carbon results (A1–A5)

Total carbon per tonne ($kgCO_2e/t$)



Key observations

1. The conventional control had the lowest installation carbon.
2. Both supplier proposals increased installation carbon at the point of installation.
3. The whole-life case depends on whether greater durability reduces future interventions

Lower-carbon resurfacing is not only about installation carbon — on Walsgrave Road, the key question is whether higher-carbon long-life materials reduce maintenance over time.



What don’t we know yet?

Across all of our trials, one question remains: how long will the benefit last?



Installation
Carbon

Laboratory evidence
Material properties

Early monitoring
Early condition

Long-term performance?
Durability • service-life extension • deferred maintenance • whole-life carbon

We can predict — but not prove

Laboratory testing and residual-life modelling can indicate likely performance, but they cannot replace years of in-service evidence.

Lower carbon can involve calculated risk

A material may have lower installation carbon, but the whole-life case depends on it performing for long enough.

Long-term evidence needs long-term monitoring

Our project period does not provide funded monitoring over the full service life of these treatments.

We can measure carbon today. Longevity takes years to prove.

Good innovation evidence reduces uncertainty — it does not pretend uncertainty has disappeared.

Testing innovation was only half the job

The challenge was not only testing new materials — it was making sure the learning travelled.

Trial → Evidence → Knowledge → Other authorities



How do we get the learning off the trial site and into other highway authorities?

Trial → Evidence → Knowledge → Adoption

Building the infrastructure for sharing

The **Knowledge Bank** was built to turn individual project learning into a resource the whole highways sector can use.

75
materials listed

19
case studies published

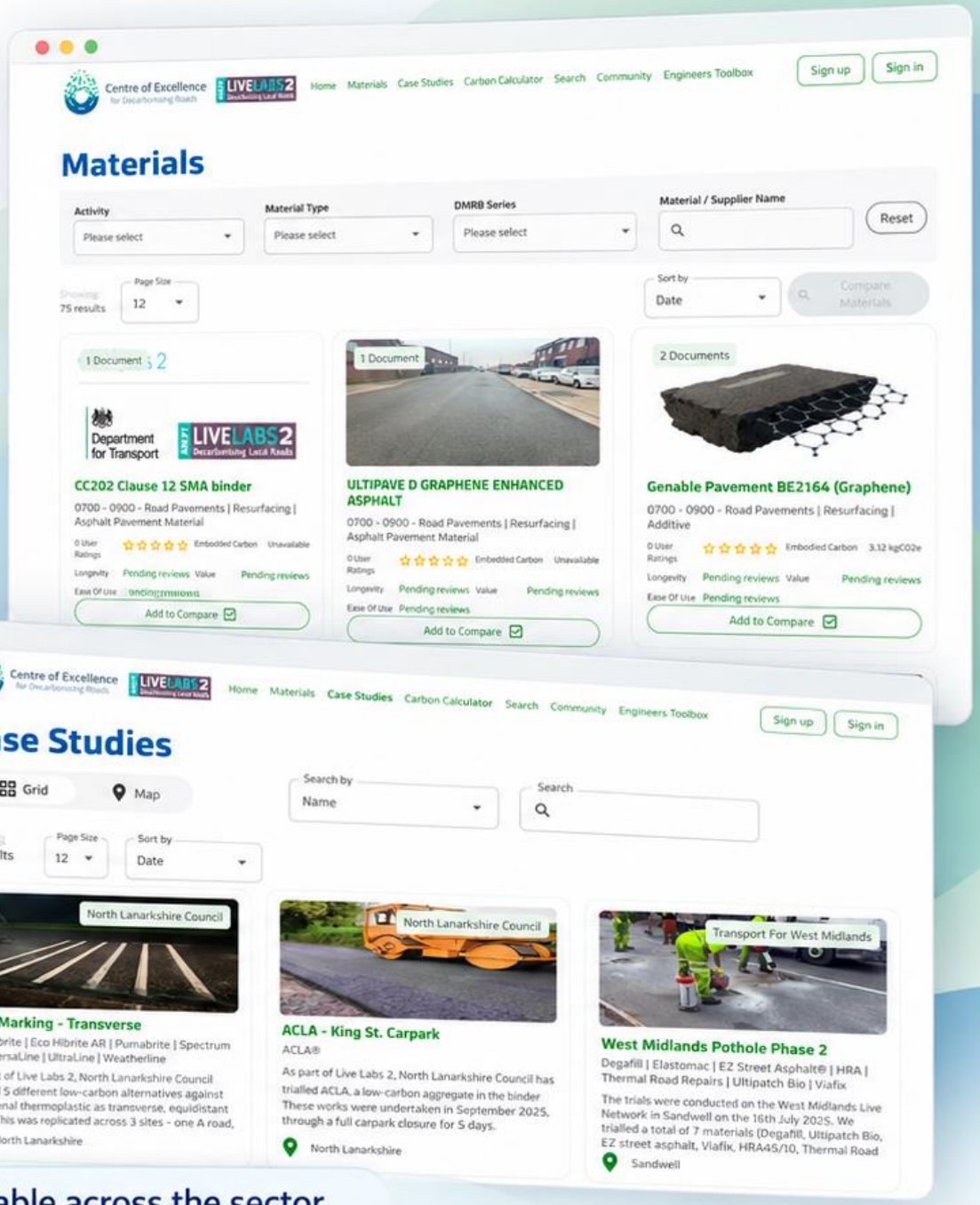
25+
additional case studies identified

Case Studies
What was tried, where and what was learned

Materials Directory
A searchable view of lower-carbon materials and solutions

Engineers' Toolkit
Practical guidance, tools and resources

Community & sharing
Connecting engineers, evidence and experience



The aim: move learning out of individual projects and make it reusable across the sector.

More than a Knowledge Bank

CEDR also produced practical tools, research and guidance to help innovation move from idea to adoption.

Understand the market

International market scan
Innovation log
Future trends & external factors

Finding what is emerging and where the sector is heading.

Support highway authorities

Local Authority Playbook
Trial protocols
Carbon emission factor work

Helping authorities assess, trial and compare solutions.

Understand adoption

Barriers to decarbonisation
Behavioural opportunities

Understanding why good ideas do — or do not — become normal practice.

Support innovators

Innovator toolkit for the roads sector

Helping new products and suppliers navigate the highways market.

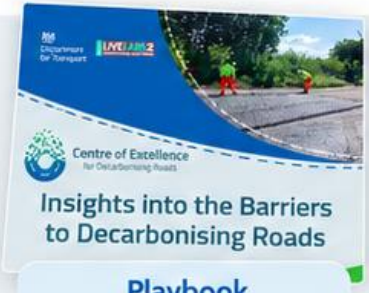
Programme evidence base



North Campus report



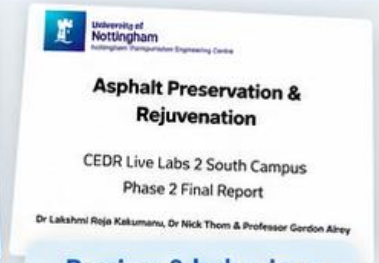
South Campus report



Playbook



Market scan



Barriers & behaviour

The aim was not just to generate evidence — but **to make innovation easier to find, test, understand and adopt.**

Carbon assessment – different tools for different questions

CEDR used different carbon tools depending on whether the question was about materials, construction activity or wider programme decisions.



Materials & design

asPECT

Best suited to:
Product and asphalt-mixture carbon assessment

What it gives us:
A1–A5 embodied carbon estimates using established sector data



Construction & maintenance

Asphalt IQ / manual data collection

Best suited to:
Capturing what actually happened on site

What it gives us:
Material quantities, transport, plant, fuel and installation activity



Strategic / programme level

FHRG carbon tools & standards

Best suited to:
Whole-life and network-level decision-making

What it gives us:
A broader view for option appraisal, organisational reporting and net-zero pathways

What did we assess?



A1–A5

Product + transport + construction

Installation carbon is not the whole-life answer.
Service life, durability and future interventions also matter.

A1–A5 ≠ whole-life carbon

No single tool answers every carbon question — choose the tool to match the decision.
The stronger the whole-life decision, the more important performance and service-life evidence become.

Decarbonisation isn't only in the material

CEDR also assessed the enabling plant used around pothole repairs — and electric alternatives consistently reduced operational carbon.

Electric vs petrol equivalent



Circular saw

~77%

lower

operational carbon per minute

Up to **2.74** tCO_2e/year saved



Road breaker

~56%

lower

operational carbon per minute

Up to **1.05** tCO_2e/year saved



Handheld blower

~62%

lower

operational carbon per minute

Up to **0.39** tCO_2e/year saved



Plate compactor

~14%

lower

operational carbon per minute

Up to **0.31** tCO_2e/year saved

More than carbon

- Lower noise
- Less vibration
- No exhaust at point of use
- Lower idle losses

The electric saw and breaker also provided smoother handling and reduced vibration during the trials.



How was it assessed?

Petrol tools: physically tested under controlled conditions
Electric tools: normalised from audited whole-life carbon data

Electric equipment is not carbon-free — batteries, manufacture and electricity generation still matter.

Lower-carbon maintenance is about the whole operation — not just the material in the road.

Indicative annual savings assume 150 working days per year and 6 operating hours per day.

So what difference did it make?

269 tCO_2e

estimated carbon saved across the North and South Campuses

Delivered through a relatively small number of live demonstrations.



Illustrative equivalent:
≈12,000 trees absorbing CO_2 for one year

The demonstrations show the opportunity. **The bigger prize is replication at scale.**

Did we do what we set out to do?

We demonstrated the concept — but we haven't finished the job.

1 DISCOVERED

We found and understood innovation.



- Market intelligence
- Emerging materials and approaches
- Barriers and opportunities

2 TESTED

We generated real-world evidence.



- Live highway trials
- Carbon and performance data
- Lessons on trial design and implementation

3 SHARED

We built the mechanisms for knowledge sharing.



- Knowledge Bank
- Case studies and materials directory
- Reports, guidance, tools and events

4 THE UNFINISHED PART: ADOPTION

The learning exists — but it is not yet travelling as widely as we hoped.

Lower use and contribution

Use and contribution to the Knowledge Bank have been lower than expected.

Stronger dissemination needed

People need to know the resource exists and return to it.

More practical value

The content must provide enough practical value to justify an engineer's time.

Building the resource was achievable. Building the habit of sharing is harder.

Building it doesn't mean they'll come

A useful platform is only valuable if people know about it, trust it and make time to use it.

THE ASSUMPTION

Valuable knowledge + online platform + sector need = adoption.

Good evidence + Online platform + Sector need = Adoption

THE REALITY

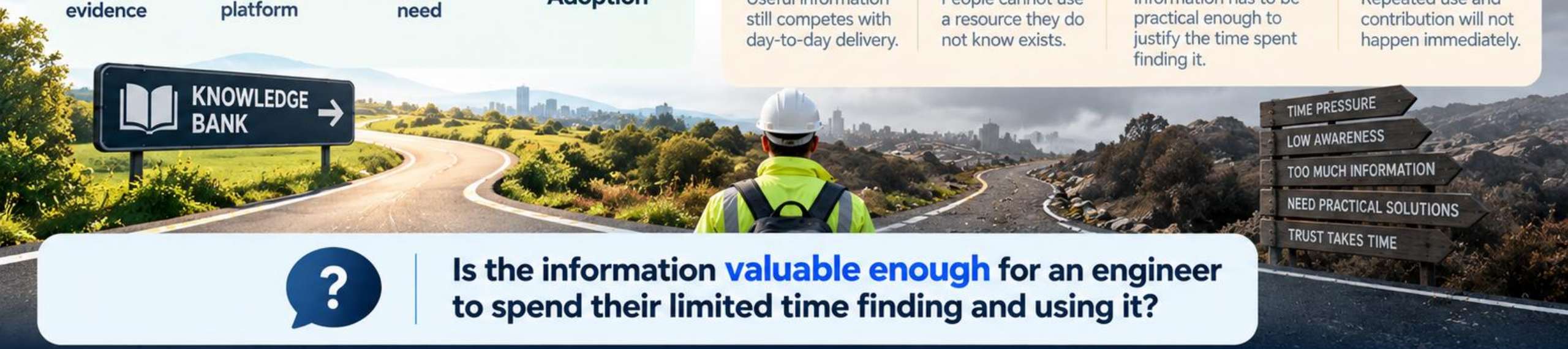
Adoption is more complex. Engineers face real barriers to finding and using the Knowledge Bank.

Engineers are time-poor
Useful information still competes with day-to-day delivery.

Distribution matters
People cannot use a resource they do not know exists.

Content must solve a real problem
Information has to be practical enough to justify the time spent finding it.

Trust and habit take time
Repeated use and contribution will not happen immediately.



Is the information valuable enough for an engineer to spend their limited time finding and using it?

VALUE Solves real problems

VISIBILITY People know it exists

HABIT Trusted and used over time

Adoption depends on value, visibility and habit — not simply availability.

What would we do differently?

We learned as much about how to run innovation as we did about the materials themselves.

> **If we ran parts of the rejuvenation trials again tomorrow, we would design them differently.**
>
> That is one of the most useful outcomes of experimentation.



01

Bring expertise in earlier

Specialist input from the outset

02

Design trials around the questions you need to answer

Start with the decision the evidence needs to support, then work backwards to the data, controls, monitoring and trial design required.

03

Plan for the long term

Monitoring beyond project delivery

04

Allow time to mobilise

Procurement, approvals and setup

05

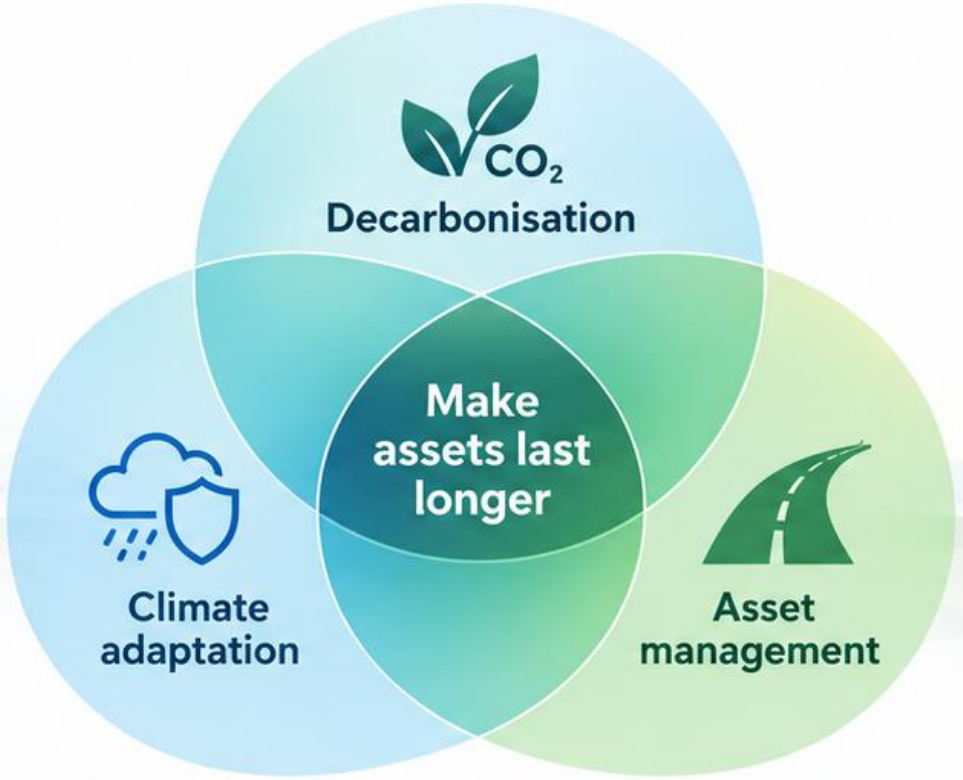
Share from day one

Dissemination built into delivery

The next programme should start with the lessons this one had to learn.

Decarbonisation is becoming a bigger conversation

CEDR began with decarbonisation, but the same principles increasingly support climate adaptation, resilience and better asset management.



- Fewer interventions
- Less disruption
- Lower cost
- Greater resilience
- Lower whole-life carbon

Longer-lasting assets can mean fewer interventions, less disruption, lower cost, greater resilience and lower whole-life carbon.

Decarbonisation, resilience and asset management increasingly point in the same direction.

Where should CEDR go next?

The opportunity is to evolve from a decarbonisation resource into a broader national platform for better, longer-lasting highway assets.

Today

Decarbonisation Knowledge Bank

Materials, trials, case studies and carbon evidence.

EVOLVE

Future

A national platform for better, longer-lasting highway assets

Decarbonisation
Lower whole-life carbon

Durability
Longer-lasting materials and interventions

Climate resilience
Assets better able to withstand future conditions

Innovation
A route for testing and sharing emerging solutions

Best practice
Making proven learning easier to find and reuse

For this to work nationally...

CEDR needs a sustainable long-term home within a national organisation.

- Ongoing ownership and curation
- National reach and credibility
- Long-term funding and stewardship



The next step is not simply a bigger Knowledge Bank — **it is a trusted national home for shared highways evidence and practice.**

One final question...

You've heard our story.

Would you keep going?

We've built the foundations.
We've learned what works — and what doesn't.
Now the question is whether the sector sees enough value to take it forward.

Show of hands

LET IT END HERE

The project closes and the learning remains available.

BUILD ON IT

Develop the platform, broaden its scope and create a sustainable national home.

Knowledge Bank: **https://decarbonisingroads.co.uk/**