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Digitalisation and Sustainability in Road Construction: A Case Study on Pavement Design Optimisation for the UK Major Road Network

Laura Traseira

Project Engineer, ORIS

irf2024.irfofficial.org

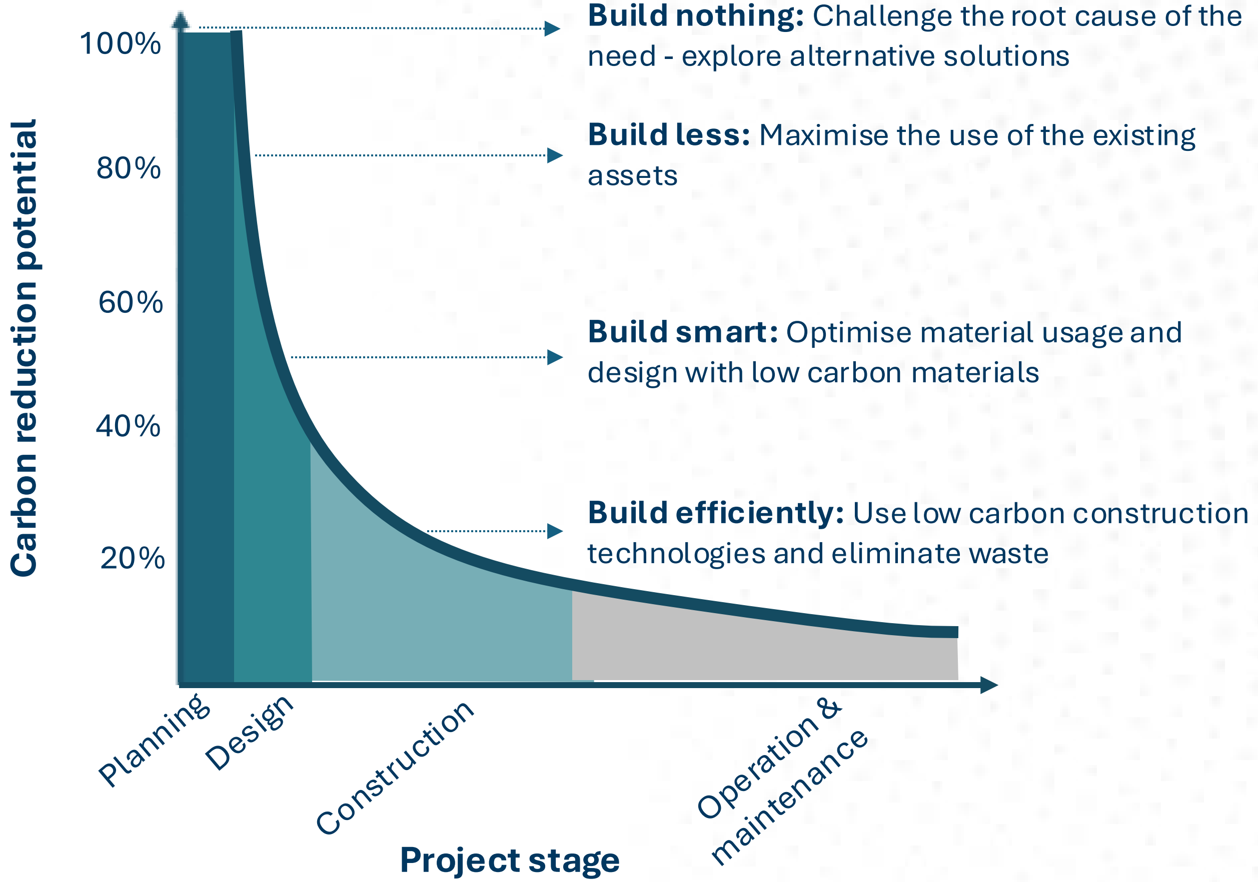
Principles of Pavement Sustainability in Road Construction

Importance of due diligence at an early stage of the project

25% of the global GHG emissions come from the **transportation sector**

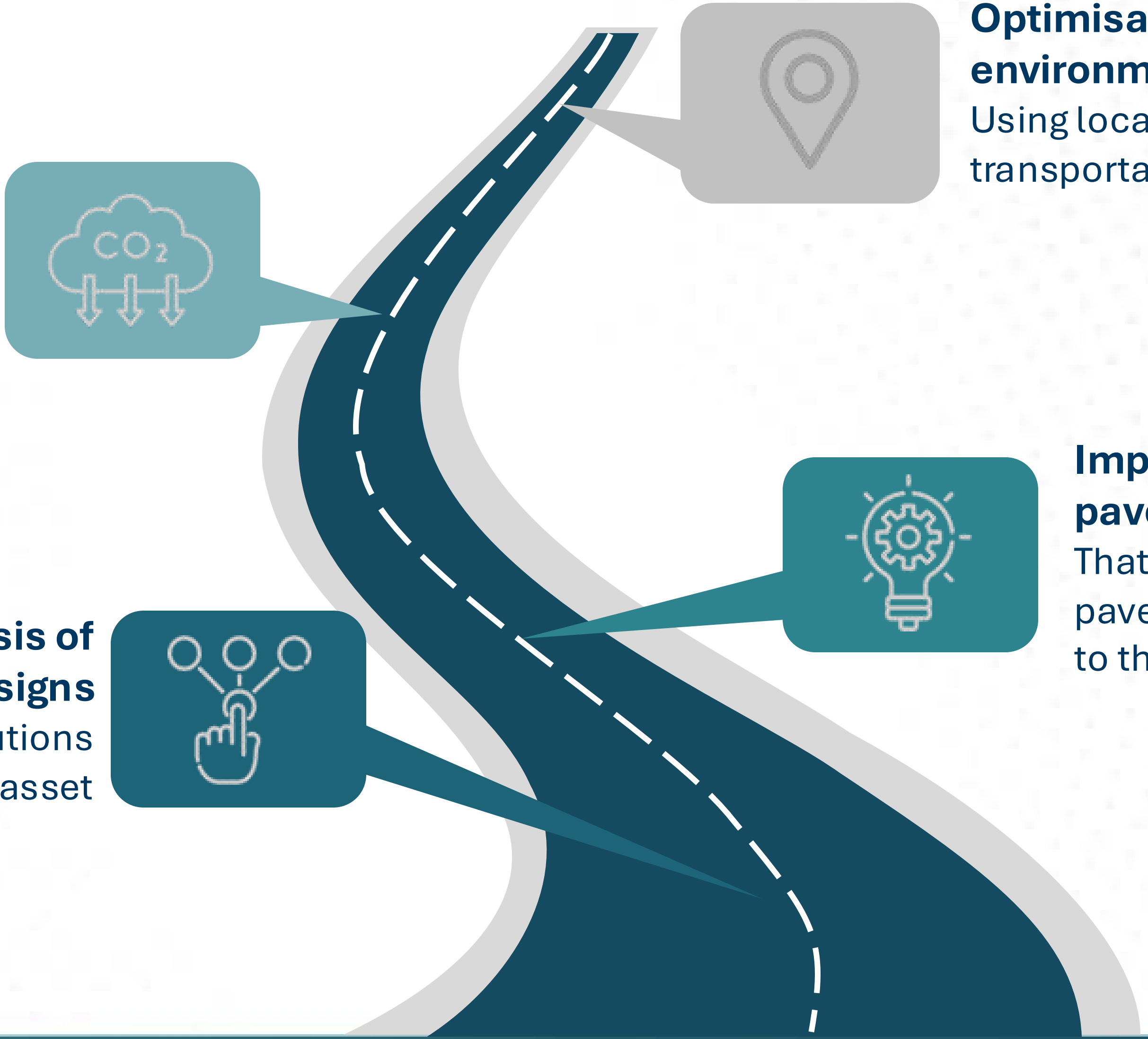
The predominant sector is **road transportation,** accounting for **75%**

Up to **25%** of those GHG emissions correspond the **road infrastructure** construction and maintenance



Principles of Pavement Sustainability in Road Construction

Pathway for carbon reduction in road infrastructures



Optimisation of the sourcing environment
Using local sources to reduce transportation distances

Selection of low-carbon materials
Such as the use of recycled materials or industrial by-products

Implementation of innovative pavement solutions
That can extend the lifespan of the pavement and improve its resilience to the climate change

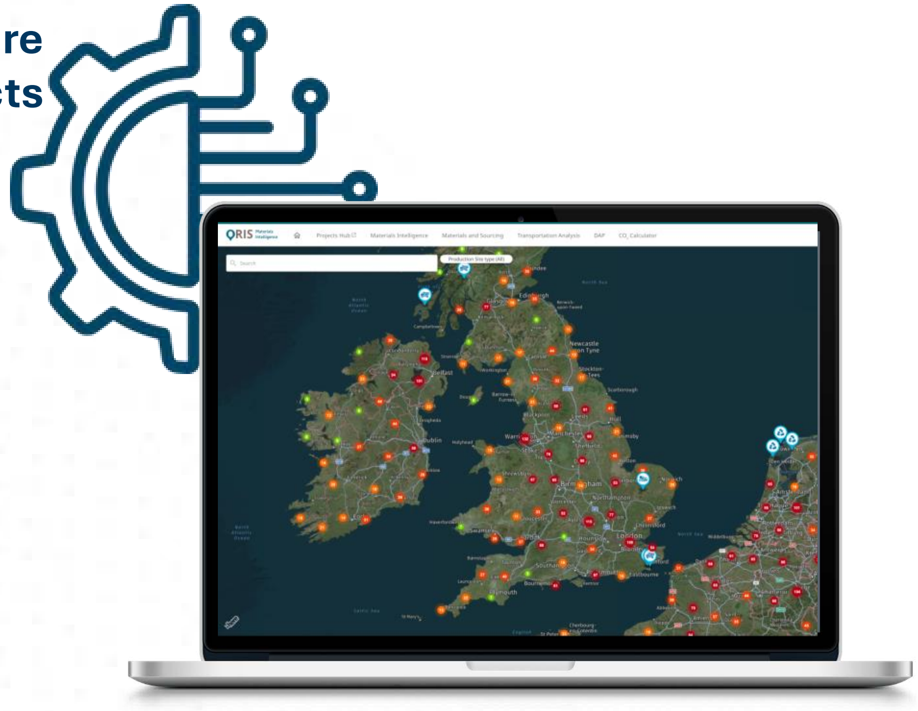
Comparative analysis of pavement designs
Assessing multiple solutions considering the lifecycle of the asset

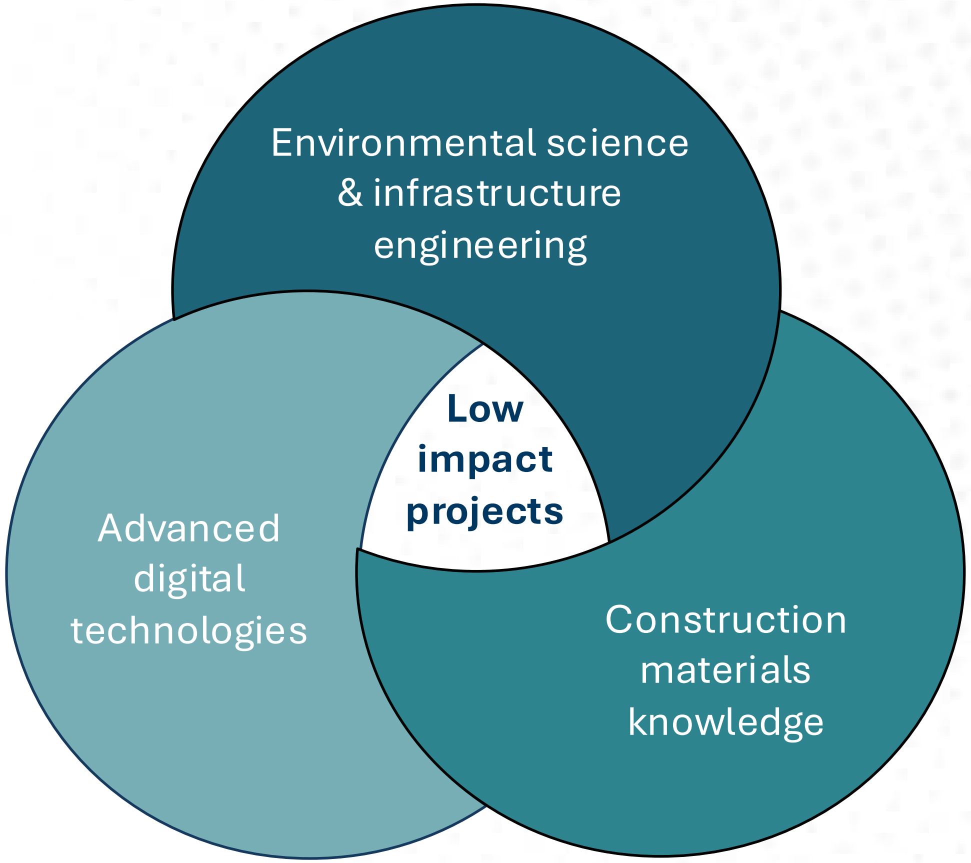
Digital Solutions Driving Sustainability in Road Construction

Leveraging digitalization for an informed decision making

...driven by the collaboration across three key expertise

Road infrastructure projects

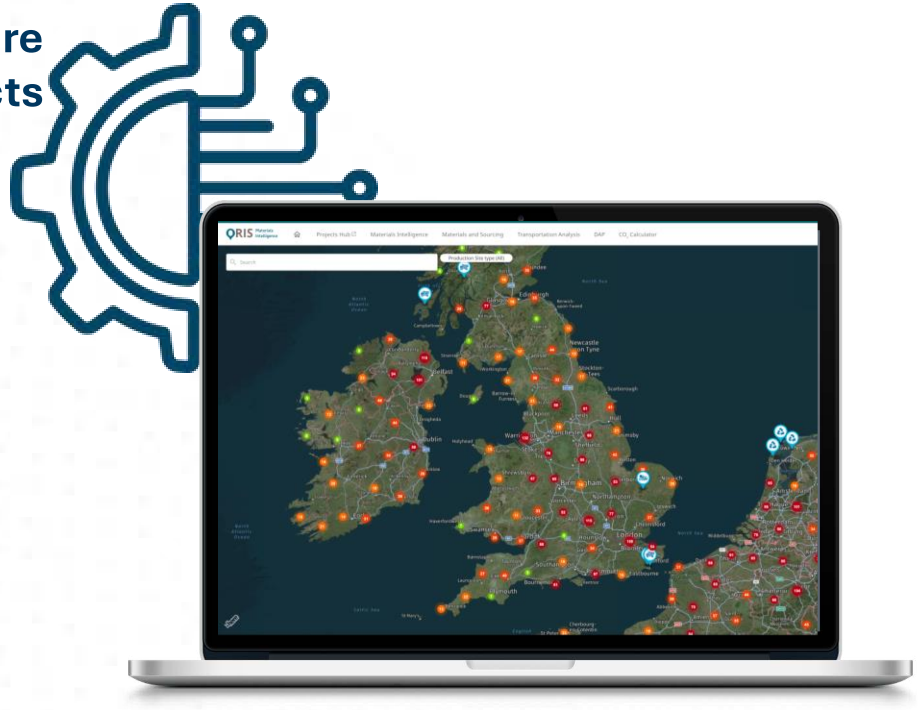




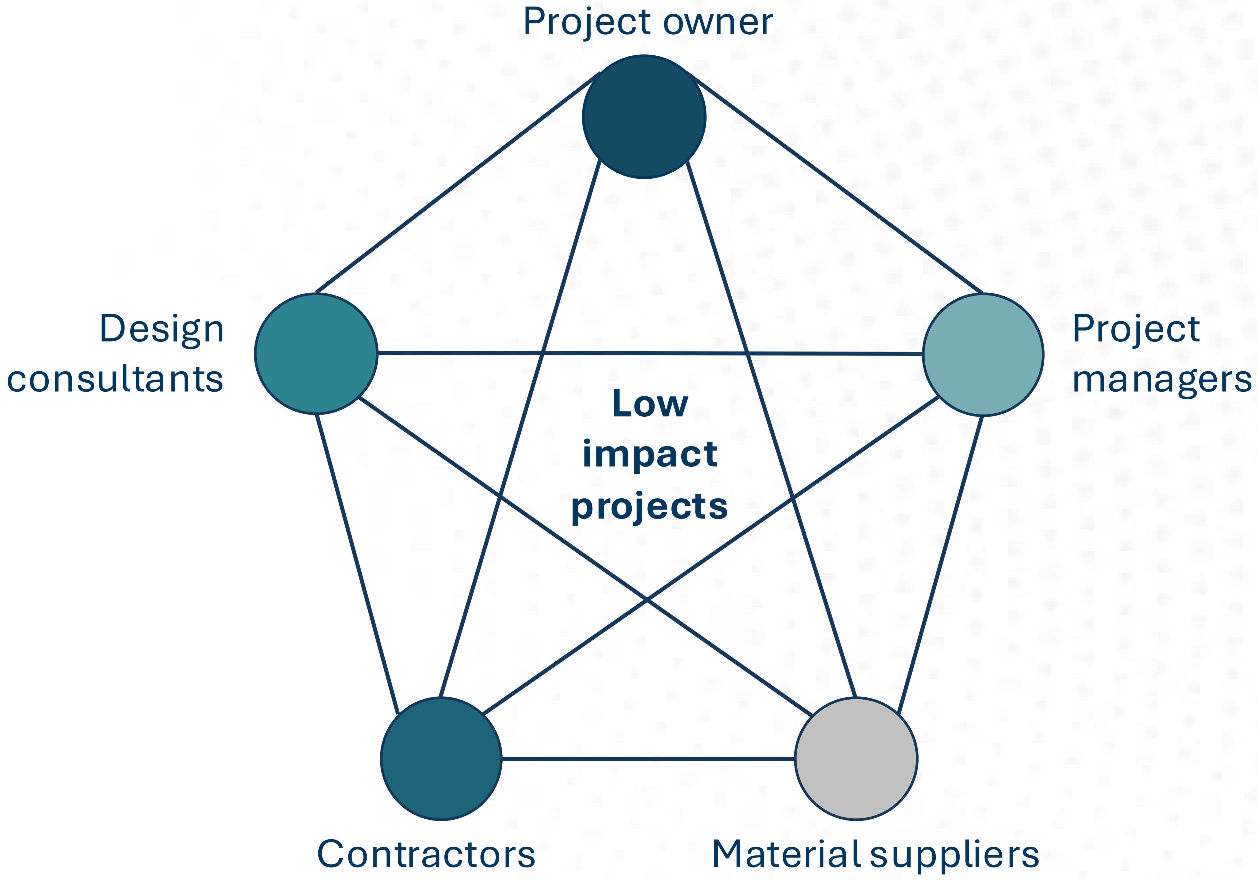
Digital Solutions Driving Sustainability in Road Construction

Leveraging digitalization for an informed decision making

Road infrastructure projects

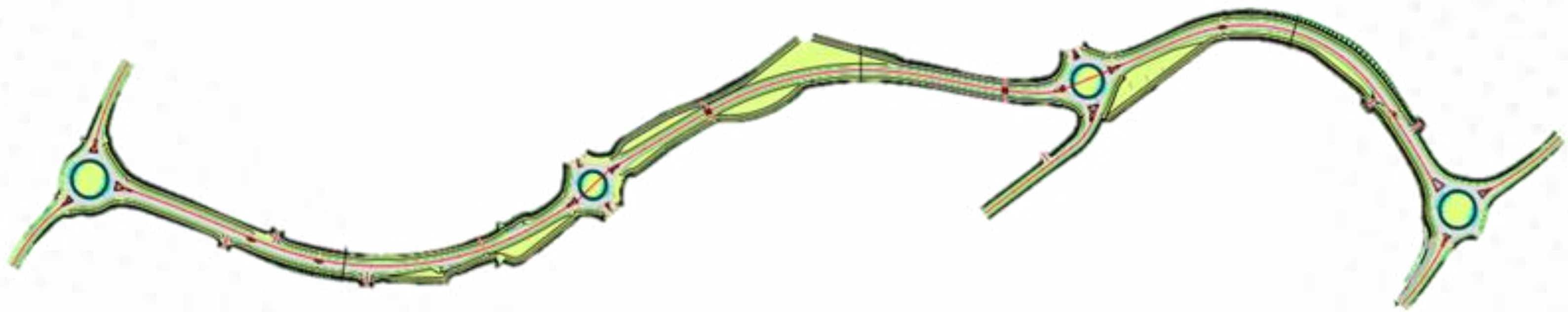


....strengthening the connection between project stakeholders



Objectives and Case Study Overview

Project overview



- Construction of 1.6 km link road for the Major Road Network (UK)
- Design traffic of 12 msa
- Preliminary pavement design not compliant with standards

Pavement optimisation at an early design stage

Minimise environmental impact

Promote an efficient use of resources

Optimise project cost estimates

Evaluation over a 60-year analysis period

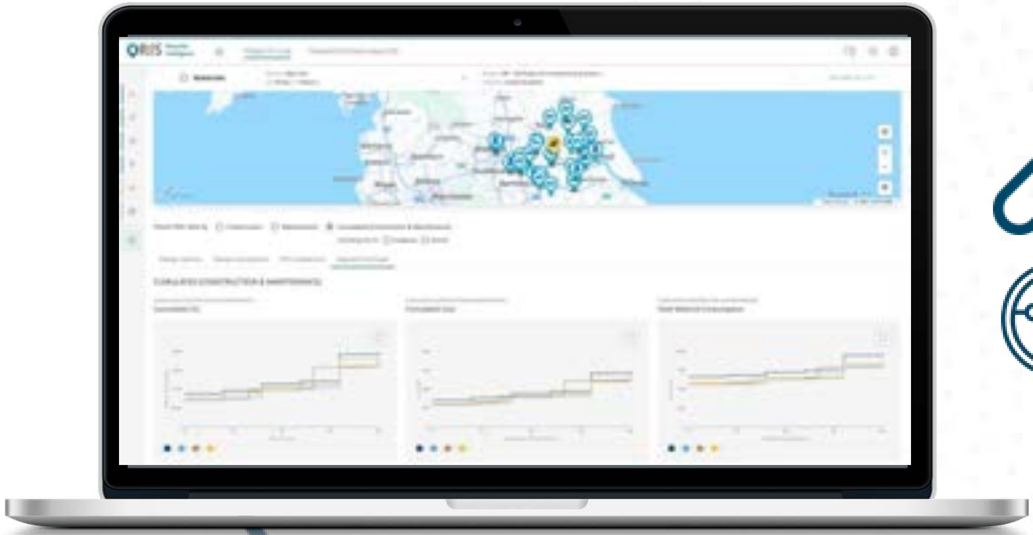
Methodology

Using a collaborative digital platform to streamline the Life Cycle Assessment (LCA) and Whole Life Costing (WLC) evaluations

- **A**ssess the base design
- **B**enchmark alternative solutions
- **C**ompare designs based on the KPIs
- **D**ecide after identifying the optimum solution

Project scheme

ORIS Materials Intelligence



Local sourcing environment

Advanced analysis tools

Cost, CO_2, material consumption

Pavement design options

Base design against proposed alternatives in compliance with UK standards

Base design

TSCS	30 mm
AC 20 40/60 pen bin	50 mm
AC 32 40/60 pen base	280 mm
Type 1 subbase	150 mm
Capping	600 mm
	1,110 mm

Fully flexible TSCS

TSCS	30 mm
AC 20 40/60 pen bin	60 mm
AC 32 40/60 pen base	190 mm
Type 1 subbase	250 mm
Capping	430 mm
	960 mm

Fully flexible HRA

HRA 35/14 F surf PMB	50 mm
AC 20 40/60 pen bin	60 mm
AC 32 40/60 pen base	170 mm
Type 1 subbase	250 mm
Capping	430 mm
	960 mm

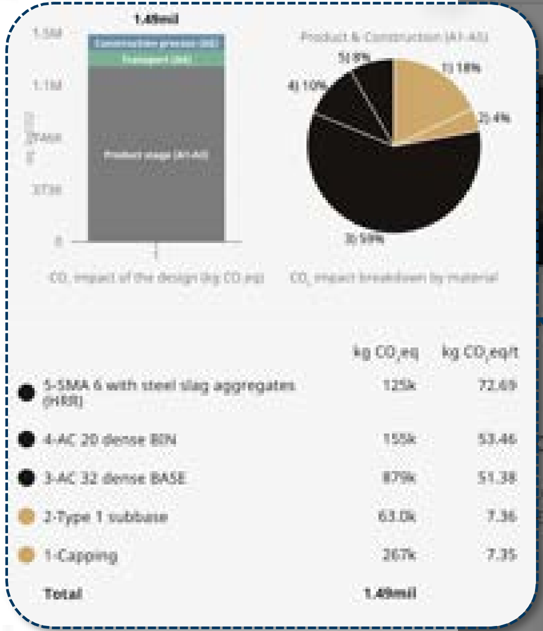
Flexible on HBGM

TSCS	30 mm
AC 20 40/60 pen bin	50 mm
AC 20 40/60 pen bin	60 mm
CBGM (C8/10) base	170 mm
Type 1 subbase	250 mm
Capping	430 mm
	990 mm

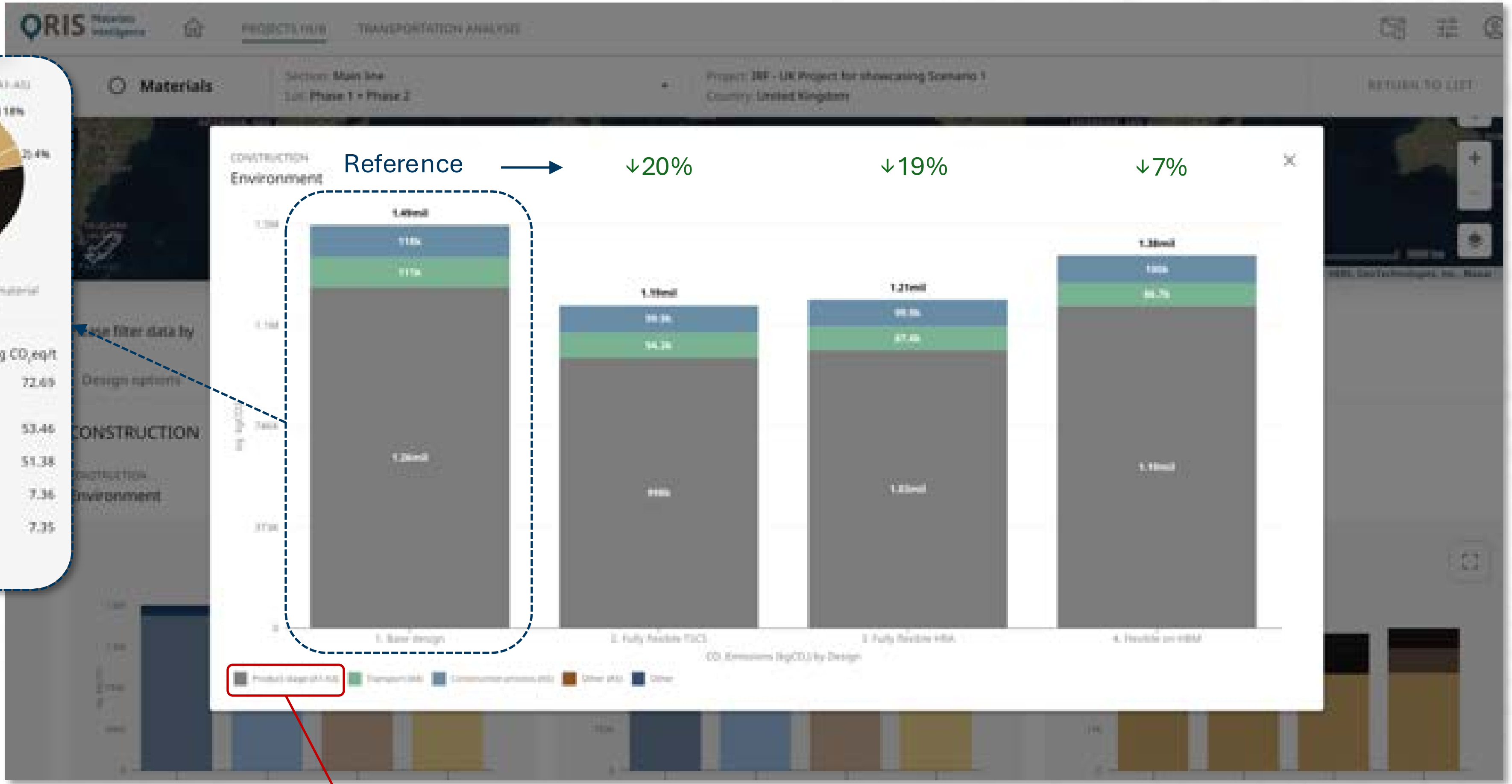
- **Rigid pavements** already discarded in preliminary assessment
- Project owner preference: Reuse **locally sourced steel slag** aggregates on surfacing materials

Results

GWP (in eq. kgCO_2) from the product (A1-A3) and construction stages (A4-A5)



Detailed results of the base design

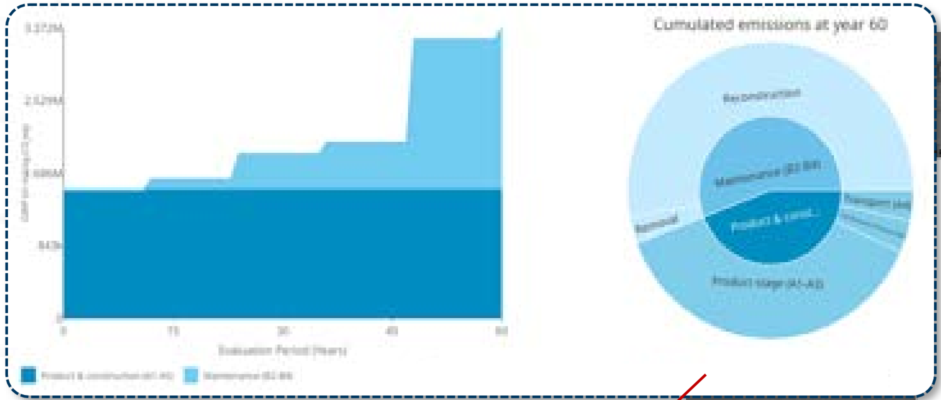


The **material selection** accounted for up to **85% of the carbon footprint** associated with the construction of the link road (A1-A5)

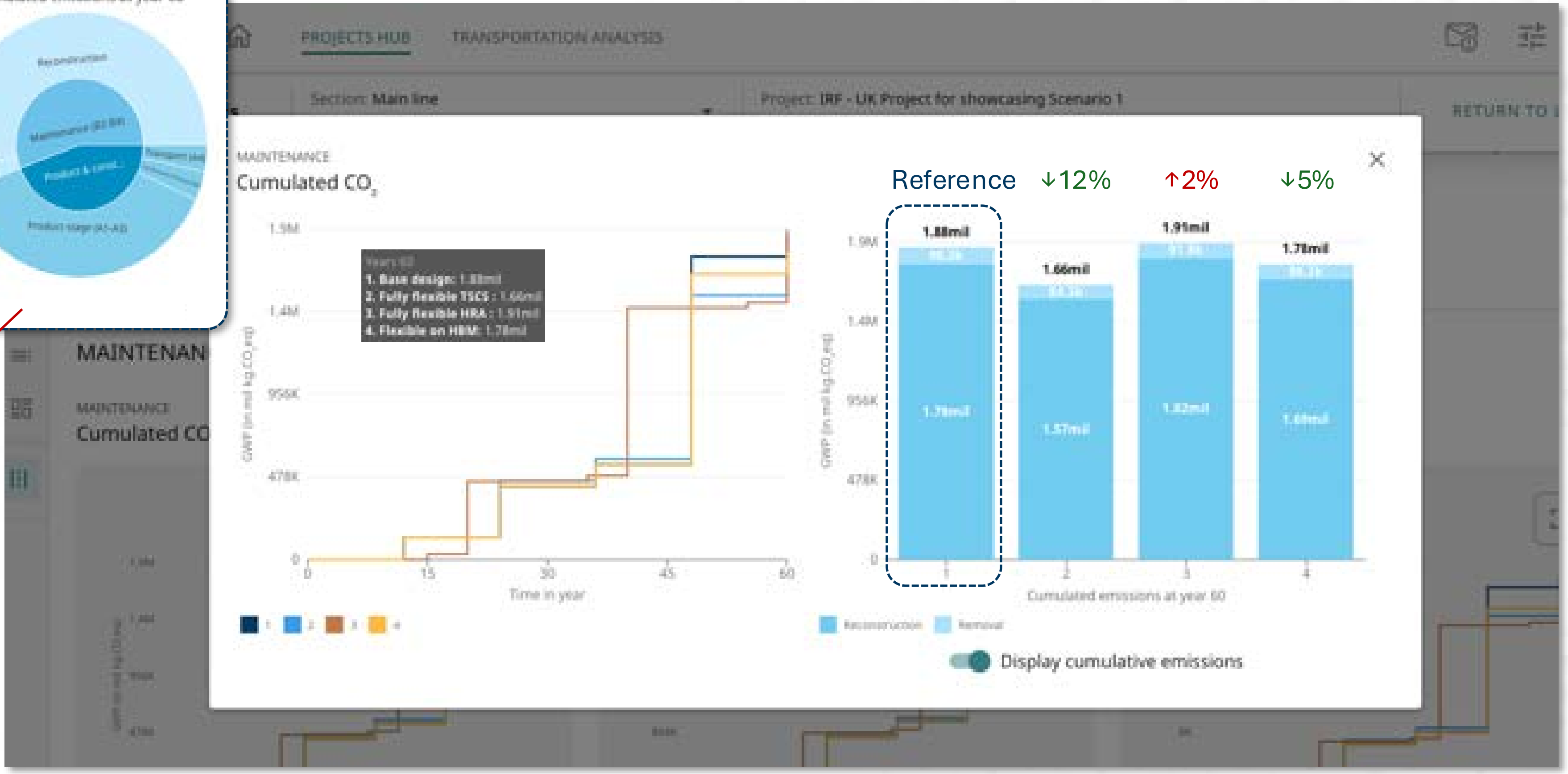
Results

GWP (in eq. kgCO_2) from the maintenance over a 60-year analysis period (B2-B4)

Base design: CO_2 construction & maintenance



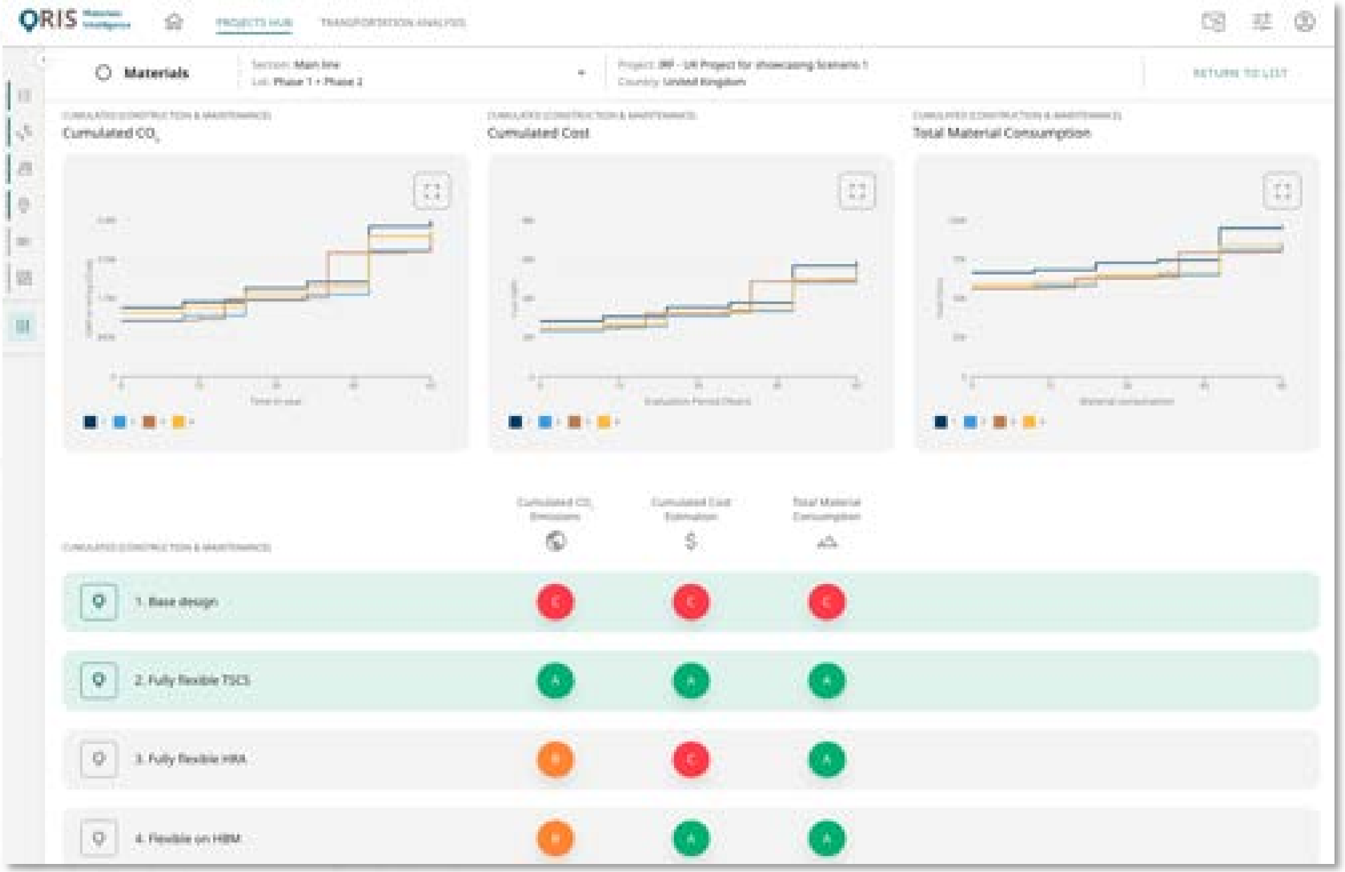
The **predicted maintenance** accounted for roughly **60% of the total carbon footprint** over the analysis period



Comparison: CO_2 predicted maintenance

Results

Evaluation of the project KPIs integrating results from both construction and maintenance phases



Design option	CO_2 (kg.CO_2eq)	Cost (GBP)	Mat. consumption (tonnes)
1. Base	3.4M	5.9M	96.7k
2. FF TSCS	2.8M (-15.4%)	5.0M (-14.3%)	82.5k (-14.7%)
3. FF HRA	3.1M (-7.3%)	5.7M (-4.0%)	86.1k (-11.0%)
3. F ON HBM	3.2M (-6.2%)	5.2M (-11.5%)	85.6 K(-11.5%)

Results extracted from the platform

Conclusions

Digital platforms are revolutionizing the infrastructure sector....

With a **data-driven** decision making based on data science

Connecting the key players of the infrastructure sector

To promote a **smart use of resources** in low-impact infrastructure projects

Key insights from the case study

Early-stage design optimization, enabled by **digital solutions**, resulted in improved environmental sustainability and cost-efficiency

Key role of:

✓ Evaluating the entire **life cycle of the asset**

✓ Factoring in the **local material sourcing** available & the **reuse** of industrial by-products

Laura Traseira

Project Engineer, ORIS

laura.traseira@oris-connect.com