CASE STUDY

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The Challenge

While rail is commonly viewed as a low-carbon mode of transport, the operations of train stations themselves contribute significantly to overall emissions through energy use, supply chain activities, and passenger behaviour.

One of the biggest gaps in current sustainability strategies is the underrepresentation of Scope 3 emissions, such as those arising from passenger commuting patterns, waste generation, and upstream supply chains. These indirect emissions frequently make up the largest share of a station's carbon footprint, yet they are rarely factored into decarbonisation efforts.

Adding to the complexity, many UK train stations are heritage-listed buildings, limiting the feasibility of traditional retrofitting methods like insulation upgrades or modern glazing. This creates a need for alternative, cost-effective decarbonisation pathways that respect architectural constraints while supporting national Net Zero goals.

This project set out to address that need by developing a holistic, data-driven approach to station decarbonisation - one that considers all emission sources, including Scope 3, and identifies realistic, economically viable strategies for cutting carbon across the full operational footprint.

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To tackle the decarbonisation challenge, the project developed a comprehensive carbon footprint model for train stations — one that accounts for emissions across Scope 1 (direct energy use), Scope 2 (purchased electricity), and Scope 3 (supply chains and passenger travel). The model was built using real-world carbon and energy data from Network Rail, enriched by behavioural insights gathered through surveys of station passengers and employees. The travel survey uncovered key opportunities for targeted intervention: 75% of respondents were unaware of their personal carbon footprint, highlighting the need for improved carbon literacy. Notably, 65% expressed a preference for behavioural change over carbon offsetting, indicating that encouraging sustainable travel choices may be more effective than traditional offset-based strategies. Rather than focusing solely on infrastructure upgrades, the research explored a broader set of decarbonisation solutions — including heat pump technology, renewable energy procurement, demand-side energy management, and emerging carbon removal techniques such as direct air capture. By combining carbon modelling with financial analysis, the team was able to compare the cost-effectiveness of different sustainability options, helping decision-makers prioritise high-impact investments. The collaboration between the RiR programme and the Connected Places Catapult enabled close engagement with Network Rail and other industry experts. This direct knowledge exchange ensured the findings were practical, scalable, and ready for real-world implementation — with strong potential for adaptation beyond the rail sector, including in airports, logistics hubs, and other commercial infrastructure.

Result

The research produced several key findings that challenge conventional approaches to decarbonisation of buildings. One of the most significant insights was the dominance of Scope 3 emissions, particularly from passenger commuting patterns and waste generation, demonstrating the need for a broader, system-wide approach to sustainability. This finding shifts the focus from station-level energy efficiency upgrades to strategies that consider the entire ecosystem of station-related emissions.

Additionally, the passenger survey results highlighted the critical role of passenger awareness and behaviour in emissions reduction. The fact that 75% of passengers were unaware of their carbon footprint suggests that targeted interventions, such as real-time carbon tracking in ticketing systems or incentives for sustainable commuting, could drive meaningful change.

The financial analysis component of the carbon footprint model further revealed that traditional retrofits may not always be the most cost-effective solution, particularly in heritage-listed stations. Instead, investment in energy-efficient heating, external engineered offsets, and behavioural interventions provided higher impact per unit cost, allowing for more effective long-term emissions reductions.

Furthermore, the scalability of the carbon footprint model will be further established through its application to other infrastructure sectors. While originally designed for train stations, the model can be adapted for airports, logistics hubs, and commercial real estate, offering a versatile tool for decision-makers seeking to reduce emissions across a variety of transport and infrastructure settings.

Impact

This research has the potential to reshape the way train stations and other transport hubs approach decarbonisation, moving from a narrow focus on infrastructure upgrades to a more comprehensive, data-driven strategy. Incorporation of the passenger travel choices and supply chain factors into emissions assessments provides new insights for policymakers and industry leaders striving to achieve Net Zero goals.

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The development of the carbon footprint model represents a critical step toward evidence-based sustainability planning, giving rail operators and policymakers a practical tool to assess and forecast emissions, prioritise investments, and track progress over time. The ability to compare different decarbonisation strategies based on both carbon reduction potential and financial feasibility ensures that sustainability measures can be implemented efficiently and at scale.

Beyond the rail sector, this model is being prepared for commercialisation, with a focus on adaptation to other transport infrastructure. Discussions are underway with CPC to explore licensing, subscription-based access, and consulting services, making the model accessible to airports, logistics centres, and commercial real estate developers. This commercialisation pathway ensures that the project's findings will have a long-lasting impact beyond academia, influencing industry practice on a much wider scale.

Moreover, the research has helped shape sustainability discussions within Network Rail and Connected Places Catapult, reinforcing the importance of Scope 3 emissions in transport infrastructure planning. As train stations increasingly become focal points for urban mobility and sustainable travel, the tools and insights developed in this project provide a foundation for long-term industry transformation.

In conclusion, this project has demonstrated the value of integrating emissions modelling, behavioural insights, and financial analysis into a single decision-support framework. In the short- to mid-term this research will enable train stations and other infrastructure hubs to adopt a holistic, cost-effective approach to decarbonisation, making a meaningful contribution to the broader effort to reduce transport emissions and achieve a Net Zero future.

Dawid Hanak

"Through this project, we have redefined how train station emissions are understood and managed, highlighting the crucial role of Scope 3 emissions and passenger behavior in achieving net zero goals. We have provided industry with a data-driven tool that enables informed decision-making and cost-effective decarbonisation strategies. This collaboration between NZIIC and CPC demonstrates the power of integrating cutting-edge research with real-world application, delivering a more sustainable and resilient transport infrastructure."

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