

Net Zero Rail

The U.K.'s network
of the future

2021



Jacobs

Decarbonisation and the role of infrastructure

The U.K.'s rail industry faces an intensive period of significant infrastructure upgrade and delivery throughout Europe.

This opportunity must be leveraged to transform how infrastructure is designed, constructed and operated.

We must not deliver infrastructure solely for today's needs. Instead, we must visualise how society will operate in the future, its changing needs and how the needs of our day-to-day lives will evolve.

Decarbonising is an imperative for all sectors of the economy ahead of the U.K.'s 2050 net zero target, and as a result of the climate emergency.

This requires the rail industry and infrastructure associated with it to adapt and respond quickly and with innovation to deliver a smart, integrated, and net zero ready transport system.

Decarbonisation presents challenges that could be transformative for the industry:

- How can we decarbonise the railway without compromising passenger experience?
- How can we minimise disruption to services?
- How can we link rail into existing and new modes of transport as part of a system-wide approach to transport decarbonisation?
- How do we make decisions in the short term that will produce the best outcomes for a net zero world?
- How do we use rail to improve air quality, especially in stations that are within air quality management zones?
- How do we reduce noise pollution from rail?
- How do we create railway infrastructure that is ready for the climate of the future and can operate safely and comfortably?



Decarbonising our rail networks

In 2018 the U.K. Government challenged the rail industry to produce a vision for the removal of all diesel-only trains from the network by 2040.

As well as ensuring rail continues to be an attractive option for users, government investment seeks to reduce the railway's carbon emissions by improving infrastructure and rolling stock, and supporting the deployment of lower carbon technologies.

The Government is working to evaluate the whole network, and build an evidence base to inform decisions about which technology option will be best where.

A decarbonisation programme for the rail network is already in development, to inform the deployment of electrification and new technologies over the next 30 years.

Rail Industry Decarbonisation Taskforce Report to the Minister for Rail:

"the removal of diesel only passenger trains from the national rail network by 2040 and the whole industry contributing to the Government's net zero carbon target by 2050, is achievable. We note that the most cost-effective way to achieve net zero carbon may be to net off some residual rail emissions within the wider U.K. carbon reduction effort. However, a number of key decisions have to be taken from this point on, with the clear target of net zero carbon by 2050 or before."

Great British Railways: Williams-Shapps plan for Rail:

"A modern rail network requires an ambitious approach to decarbonisation, climate change adaptation and data driven transformation. This can only be achieved by becoming more outcome focused and forward thinking and by balancing competing priorities carefully."

The railways need to better understand their customers, speed up delivery of projects, and set out clear long-term plans to unlock success and innovation."

Department for Transport's Decarbonising Transport: Setting the Challenge report:

"to deliver the reduction in transport emissions needed for our interim carbon budgets and net zero, we will need to go further than the existing plans set out in this document. This is not optional; there is no plausible path to net zero without major transport emissions reductions, reductions that need to start being delivered soon."

UK Parliament - Trains fit for the future? report:

"Decarbonising rail, and making our trains cleaner and greener, will be a considerable challenge for us all."



Seizing the opportunity

Rail is a low carbon travel option. In 2018 greenhouse gas emissions from rail (passenger and freight) made up just 1.4% of the U.K.'s domestic transport emissions, while 10% of passenger miles travelled in the U.K. were by rail.

As higher carbon transport modes decarbonise, work is needed to maintain rail's position as the low carbon transport mode of choice. Decisions made about infrastructure today will either enable or restrict the future of low carbon rolling stock, which has a 35-year lifespan.

In March 2020, a new challenge emerged from COVID-19. The U.K. rail industry saw up to [95% reductions](#) in passenger numbers during lockdowns, and longer-term impacts of home working.

This will necessitate a shift in rail tariffs and service away from the commuter-centric model of previous years, with more flexibility in pricing.

Chief Executive of Network Rail, Andrew Haines:

"If we fail to improve our environmental performance while cars, lorries and planes clean up their act, then we stop being a leader... rail does not have a right to exist and grow regardless of our performance."

What is happening?

- **Department for Transport - Transport Decarbonisation Plan (TDP):**
 - Accelerating the modal shift to public and active transport (to counter the reduction in passenger numbers).
 - Decarbonising how we get our goods. This is an opportunity for expanded rail freight.
- **Network Rail Traction Decarbonisation Strategy:**
 - Government challenged the rail industry to produce a vision for the removal of all diesel-only trains from the network by 2040.
 - The strategy considers where overhead electrification, battery or hydrogen trains might be most effectively deployed.
- **Network Rail Environmental Sustainability Strategy:**
 - The vision is to serve the nation with the cleanest, greenest mass transport. It puts passengers first, and helps users to make green choices, support local communities and be a good neighbour.

The key areas that need to be addressed for a net zero railway:

- **Putting passengers first** - Putting passengers first must be considered in all decisions.
- **Ticketing** - Changes to peak demand and season tickets will change the way tickets are priced and more flexibility will be required for passengers.
- **Timetabling** - Increased demand for reliable and regular services, with more trains to meet demand.
- **Diesel rolling stock** - This must be phased out ahead of 2040.
- **Technology** - For net zero in rail to exist today, managing and encouraging transition is key.
- **Skills** - The industry must diversify and upskill to meet the challenge.
- **Industry** - Will need to be given time and funding to respond to the challenge.
- **Safety** - No changes can compromise safety.
- **Power supply** - Electrification and the integration of renewables must be managed.
- **Competition** - Other modes of transport are also decarbonising. This is the single biggest opportunity, where rail can take a modal share, particularly from domestic aviation routes.



Net zero rail - challenging today

Jacobs' vision for the zero carbon railway of the future, and our road map for delivering that vision.

The net zero railway of the future will be powered by locally supplied renewable energy from the grid to the rolling stock or stored in batteries.

Whole life carbon assessments will be carried out with traction power options, and for the enabling infrastructure, genuine and long-term carbon assessments should be part of the decision-making process.

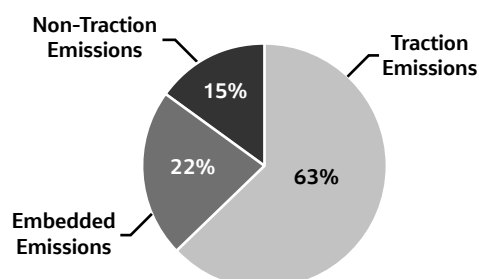
Passengers will have a comfortable and reliable service that can be configured based on carbon footprint per journey. Rail will be the lowest carbon choice available to them, especially when coupled with last mile low carbon transport options (e.g. active travel).

Increased freight services will be scheduled to fit in with passenger services. They will also run off low carbon energy, and HGV's will be replaced with a low carbon and reliable option.

Net zero rail – what the numbers say

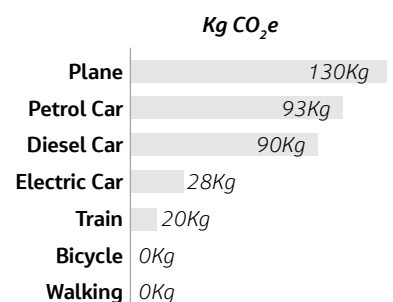
Typical emissions split for a rail project

The chart below shows a typical emissions split for a rail project. Although traction emissions are a priority area, emissions from infrastructure (embedded emissions) and non-traction emissions (lineside power) must be considered for any net zero railway of the future.

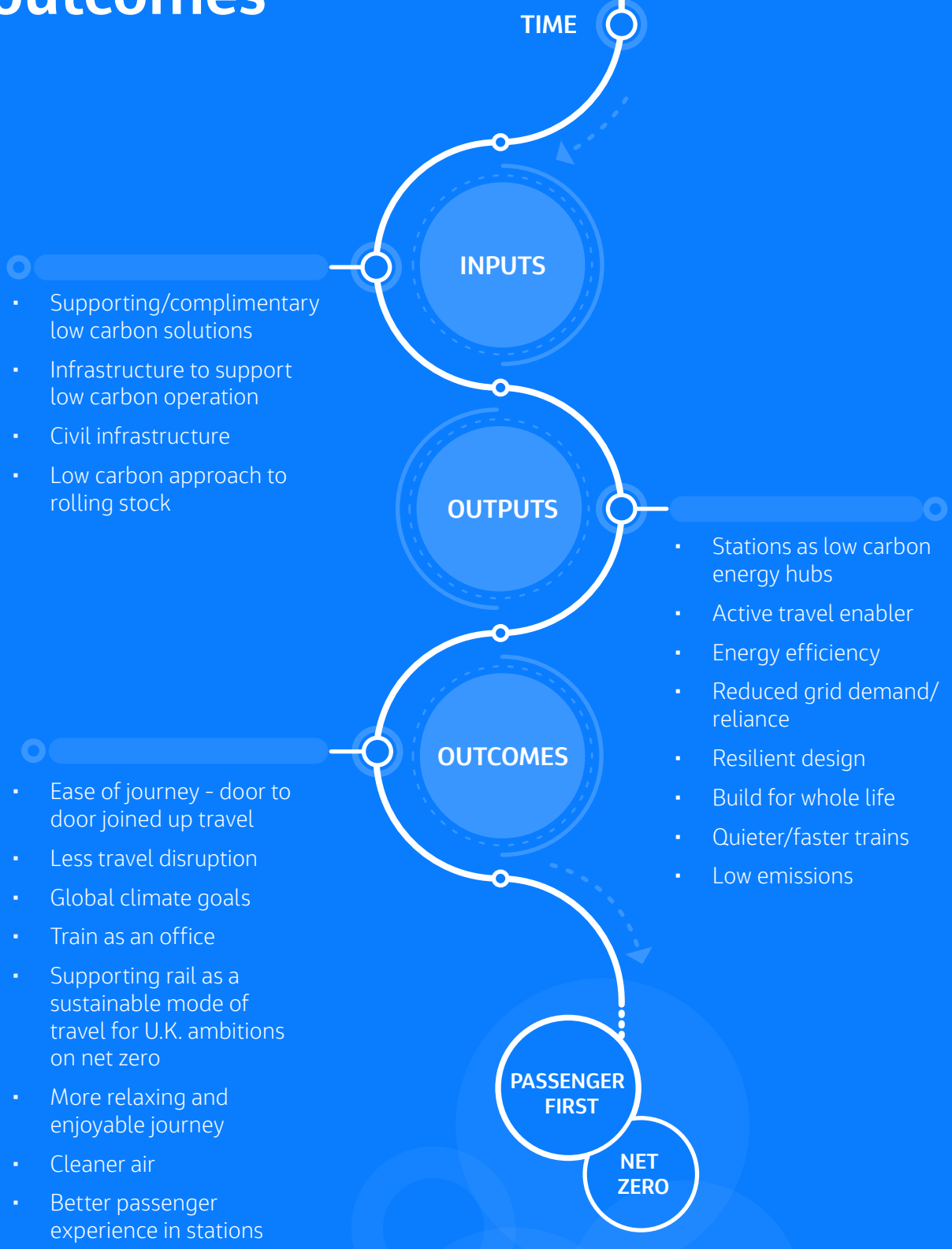


Indicative GHG emissions for a passenger travelling from London to Edinburgh (2020)

The chart below shows that train is rightly considered a low carbon option, but the challenge from electric cars will increase as adoption increases.



Achieving net zero outcomes



Net zero rail - reinventing tomorrow

Low carbon infrastructure

- The wider rail industry needs to collaborate to create a consistent demand for low carbon products. By setting out clear ambitions for carbon reduction when procuring infrastructure, the supply chain is given signals for low carbon alternatives and a consistent and clear direction to encourage investment.
- This in turn will produce more case studies for the use of low carbon materials (e.g. low carbon concrete and recycled steel) and encourage their use as a tried and tested product, while also minimising unnecessary over-design and specification.
- The focus for this process should be around the carbon hot spots within railway infrastructure, namely stations, bridges/tunnels and the track itself. Track especially could be a key driver for low carbon innovation as it is a more consistent product with room for standardisation to be applied universally.
- The industry must work together to make product acceptance, and the ability to challenge standard design processes for new products, shorter and easier.

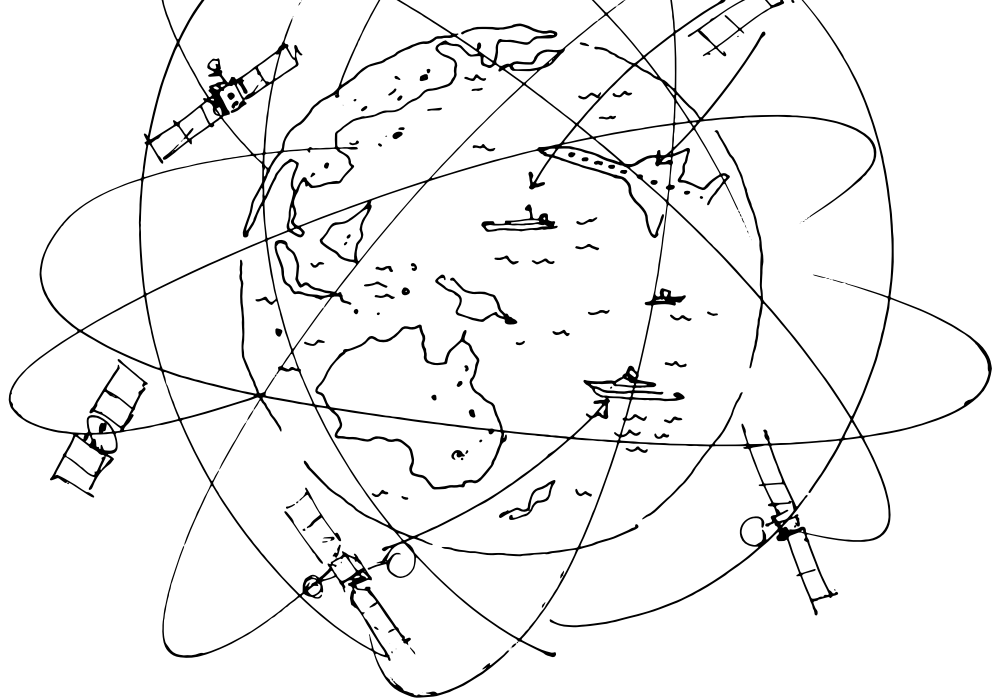
- Infrastructure offers a chance to realise carbon reductions via the circular economy principles, leading to lower carbon materials in the market.
- Focus on infrastructure that is low carbon enabling for example, overhead line equipment in electrification.
- 'Invest to save' mentality for carbon. Make carbon "investment" in the short term to bring whole life carbon reductions.

Rolling stock considerations

- Make the optimum choice of power supply type to decarbonise on a route-specific basis, considering the whole railway system, including vehicles, infrastructure, power supply and operations – noting that rolling stock has a typical life of 35 years so vehicles specified and procured in the next year will be expected to remain in service beyond the net zero target year 2050.
- Take a holistic approach on the choice between buying new vehicles and retaining existing ones, accounting for factors such as the potential improved energy efficiency of new rolling stock and the

avoidance of greenhouse gas emissions from manufacturing by keeping existing vehicles in service.

- Minimise the energy consumption of operations, through the use of energy storage to recover braking energy that would otherwise be lost, driver advisory systems and intelligent control of systems such as heating, ventilation, air conditioning and lighting.
- Adopt lighter weight vehicles and components and apply the principles of the circular economy.
- Using the predictable requirement for traction energy to create consistent baseload demand in the market for renewable electricity and hydrogen.
- Develop and refine the process for accepting and introducing new technologies such as battery-electric and hydrogen to the railway.



Biodiversity net gain

- Significant opportunities exist across the rail industry to manage the extensive landholding for the conservation and benefit of biodiversity. These would support the industry's requirements around biodiversity and development which will be set out in the U.K.'s Environment Bill, and could contribute towards the net zero rail approach.
- In line with the aspirations of the Williams-Shapps Plan For Rail, the planting and management of green infrastructure alongside rail infrastructure would provide an increase in the extent of valuable habitat for wildlife, increasing biodiversity value and locking up atmospheric carbon, contributing to decarbonisation goals.
- Through careful planting and correct management, the rail industry not only joins people and communities, but forges strong green links between existing areas of biodiverse habitats such as woodlands, wetlands and grasslands, and builds resilience into these green networks both in terms of developmental and climate pressures.

- The approach to habitat creation and enhancement across the rail industry's estate could also unlock biodiversity value, measured through tools such as Defra's 2.0 biodiversity metric. Realising and managing this value could ensure the industry can meet its biodiversity net gain targets and could even support other agencies and developers in meeting theirs.

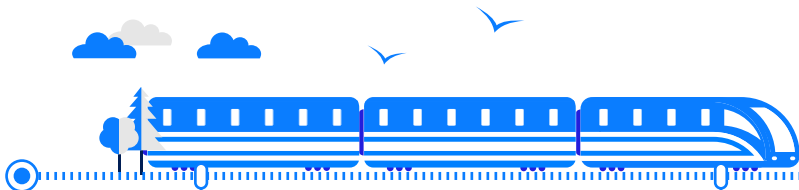
Supporting technology and connections

- Utilise lineside land and depots/stations potential for renewables. This must be balanced against visual impact and biodiversity considerations.
- Enable connections with electric vehicle (EV) charge points at stations, as this is a good fit with commuter's patterns of car use.
- Ensure good connections with active travel infrastructure to allow for end-to-end low carbon journeys.
- Create space to trial new technology for rail, and link to green job apprentices.

Putting passengers first in a net zero world

- Increase passenger numbers via enhanced passenger experience and low carbon journey planning apps.
- Roll out Mobility as a Service (MaaS) electronic ticketing.
- Facilitate last mile journeys, with rail to partner with cycle hire/scooter/taxi schemes. Increased cycle storage on trains and easier booking options.
- Focus on electrification brings schedule benefits and results in more trains, of better quality.
- Improve timetabling through enhanced collaboration between different areas of the rail network, i.e. building on current cross industry work to better join up Train Operating Companies and Network Rail, aligning the Williams-Shapps Review outcomes.

Our solutions for net zero rail



LIGHT RAIL AND UNDERGROUND METRO SCHEMES

Details

Project development, preliminary appraisal and feasibility studies through to the detailed design.

Net zero fit

We achieve early stage carbon reductions by applying the carbon hierarchy. Light rail will be key in shifting away from cars in urban areas.

PERMANENT WAY DESIGN SERVICES

Details

From initial feasibility studies through to construction and commissioning, and for track asset management.

Net zero fit

Adopting a low carbon approach to reduce material use and over-specification.

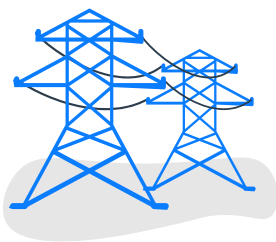
ROLLING STOCK

Details

New train procurement. Input to development of vehicle maintenance depots. Vehicle modification and upgrades.

Net zero fit

Making the optimum choice of power supply type to decarbonise on a route-specific basis, considering the whole railway system.



OVERHEAD LINE ELECTRIFICATION (OLE)

Details

Design modifications to existing OLE, and technical support for OLE.

Net zero fit

OLE is a key element of decarbonising rail and enabling low carbon rail of the future. The existing over-design of OLE structures has too much embedded carbon.



SYSTEMS ENGINEERING

Details

Develop, enhance, maintain and protect critical assets, infrastructure, processes and policies.

Net zero fit

Minimise large scale repairs and extend asset life to reduce whole life carbon impact. Keep services running by making them more resilient.



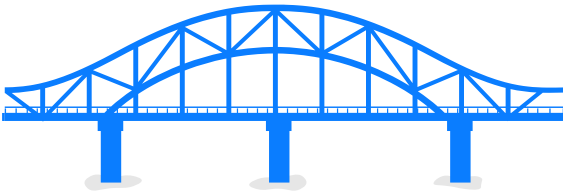
CIVILS DESIGNS

Details

Act as a critical point of coordination and provide a key interface with all other disciplines to enable them to achieve project aims.

Net zero fit

Application of the carbon hierarchy and specification of low carbon options for materials such as concrete and steel.



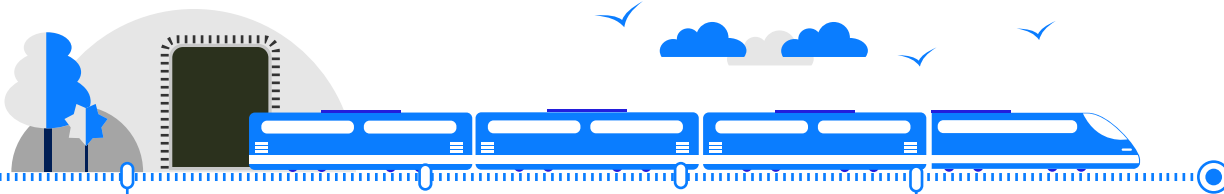
FULL DESIGN CYCLE EXPERIENCE ON A RANGE OF LIGHT AND HEAVY RAIL SCHEMES

Details

We develop and produce design deliverables at all project stages from case studies of sustainable options to construction support.

Net zero fit

Able to achieve early stage carbon reductions by applying carbon hierarchy. Real life case studies of low carbon design.



ENGINEERING MANAGERS

Details

Bring together a range of inputs, interfaces and disciplines in a timely, safe, sustainable and economically efficient manner.

Net zero fit

Sustainability leadership and programme integration. Engineering Managers have promoted innovation, value and sustainability across all our projects.

HIGH-SPEED RAIL INITIATIVES

Details

High-Speed Rail and Programme Management experience.

Net zero fit

High-Speed Rail releases capacity on conventional lines for more local passenger services and freight utilisation, reducing road congestion and associated vehicle carbon emissions.

To understand more about the carbon hierarchy click [here](#).

Decarbonisation case studies

We are always challenging to find a better way

We undertook a 'Putting passengers first' review for the Ely Area Capacity Enhancement scheme

As part of our review on the Ely Scheme Strategic Outline Business Case Programme, we discovered that it had been used for the potential size of freight trains and the annual days of freight operations.

We determined that adjusting the assumption to match forecast demand could lead to an additional 100,000 lorries equivalent of freight being transported by rail each year. We found that additional project benefits of £300 million could be taken based on the available days per year for freight traffic now proposed.

Our work identified an additional yearly net carbon saving based on rail freight versus road freight of 22,612 tonnes per year, equating to an additional 42,432 lorries taken off the road per year.

These savings multiplied over a 5-year period, created a client agreed saving of 113,000 tonnes of carbon from 212,000 lorries being taken off the road, along with the community benefits that reduction in traffic would bring.

For Phase 1 of HS2, we are the Life Cycle Analysis (LCA) Practitioner for the ALIGN main works civils contract.

Navigating multiple requirements to create a low-carbon design is a challenge that Jacobs is helping HS2 to reach their 50% carbon reduction target for civil assets.

Using LCA, which includes carbon, we have set a baseline using a standard design approach. We then assessed the updated designs at each project gateway to record savings against the target, and monitored progress to ensure compliance with PAS2080 Carbon Management.

We work with HS2 and Main Works Civil Contractors through the carbon collaboration and materials management group, discussing technical requirements and solutions. Currently, the programme has saved more than 200,000 tCO₂e in capital carbon through material volume optimisation and specification, with smaller assets yielding up to 73% embodied carbon savings.

Sustainability at Jacobs

Climate Action Plan

- Jacobs Climate Action Plan was published on 22 April 2020.
- It details how we will make a positive environmental, societal and economic difference for business, governments and communities around the world.
- The plan details our long-term commitments on emissions reduction and climate risk.

Delivering on our climate commitments

- We achieved net zero carbon and 100% renewable energy in FY20.
- Our carbon reduction targets were approved by the Science Based Target Initiative.
- We're engaging with COP26 to raise awareness, inspire and motivate collective action.

Read our climate action plan [here](#)

PlanBeyond

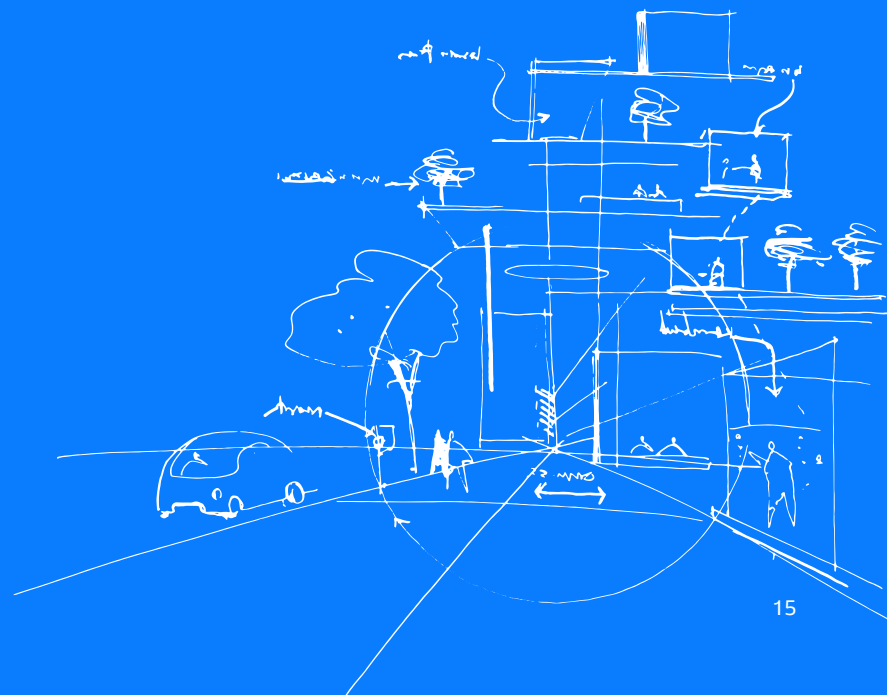
- PlanBeyond is Jacobs' Global Sustainability Strategy. Planning beyond today for a sustainable future for everyone.
- Our Global Sustainability Commitment Statement sets out our intent to integrate sustainability throughout our business by making it part of our culture.
- Jacobs is a values-driven company that was founded on the premise of safety, ethics and integrity. This, along with our strong Culture of Caring, create the foundation of our PlanBeyond Strategy.

Read about our global approach to sustainability [here](#)

Value Plus

Value Plus is our process for generating and quantifying ideas that provide improved execution and delivery of our projects and a return on investment to our clients.

We challenge conventional thinking and approaches; suggesting new and different technologies; or streamlining processes, materials or labour.



Contact:

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Our Jacobs

At Jacobs, we're challenging today to reinvent tomorrow by solving the world's most critical problems for thriving cities, resilient environments, mission-critical outcomes, operational advancement, scientific discovery and cutting-edge manufacturing, turning abstract ideas into realities that transform the world for good. With \$14 billion in revenue and a talent force of approximately 55,000, Jacobs provides a full spectrum of professional services including consulting, technical, scientific and project delivery for the government and private sector.

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