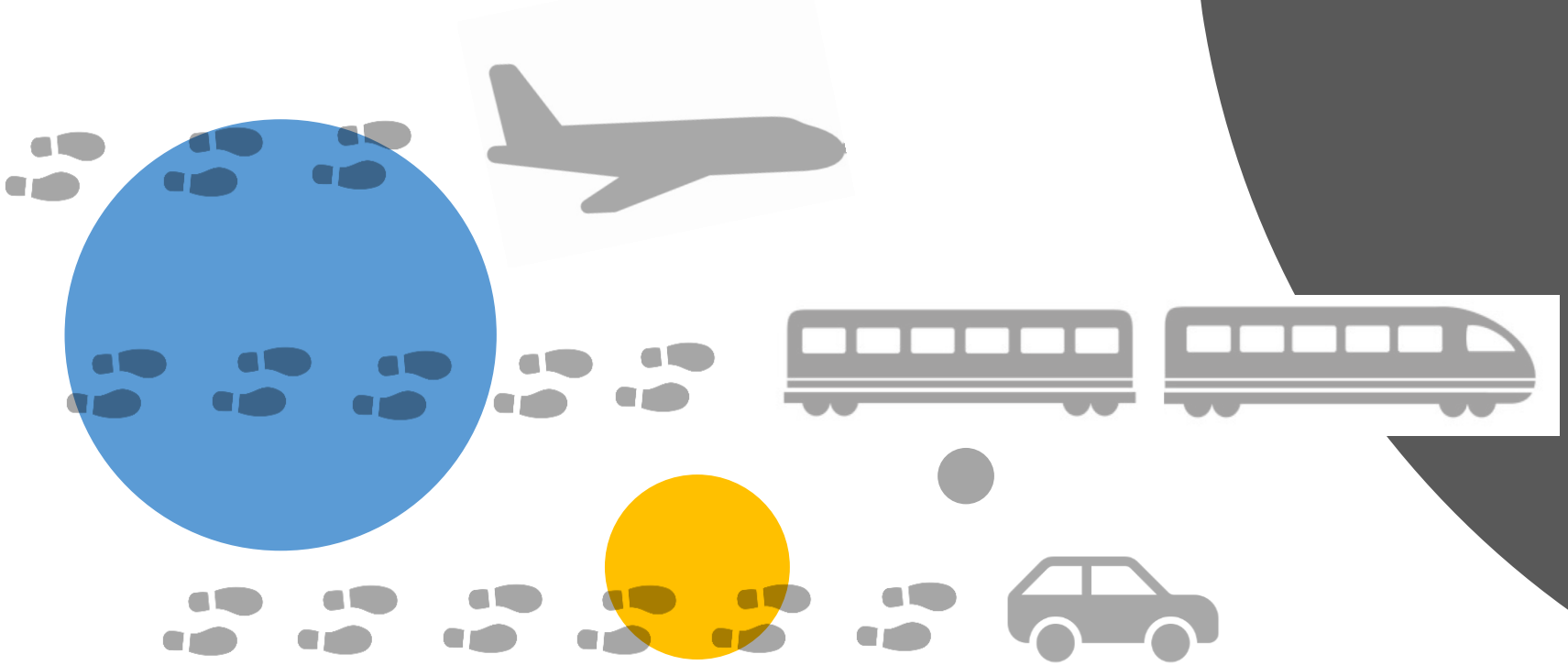


Modal Comparison Carbon Footprint (MCCF) Model

Paper to Member Steering Group – Oct 2019

Regional & Business Airports Group

What does it do?

- Working with an external third party provider, the RABA Secretariat have been evaluating a new model that is capable of providing more accurate ‘route specific’ assessments of carbon footprints for UK domestic journeys by different modes of Transport.
- The current version of the model evaluates the use of aircraft against train and car travel; additional functionality to cover ferries and coach are in development.
- User input data is required in a pre-specified format to enable the model to calculate the carbon dioxide per passenger (or per passenger/Km) emitted on a defined journey using alternative modes of transport.
- This version of the model calculates emission of the vehicle on one journey between two defined points only; the evaluation of multi-modal and multi-leg journeys will be made simpler in future versions of the model, but currently can be assessed by segmenting the overall journey into a series of distinct stages or sectors

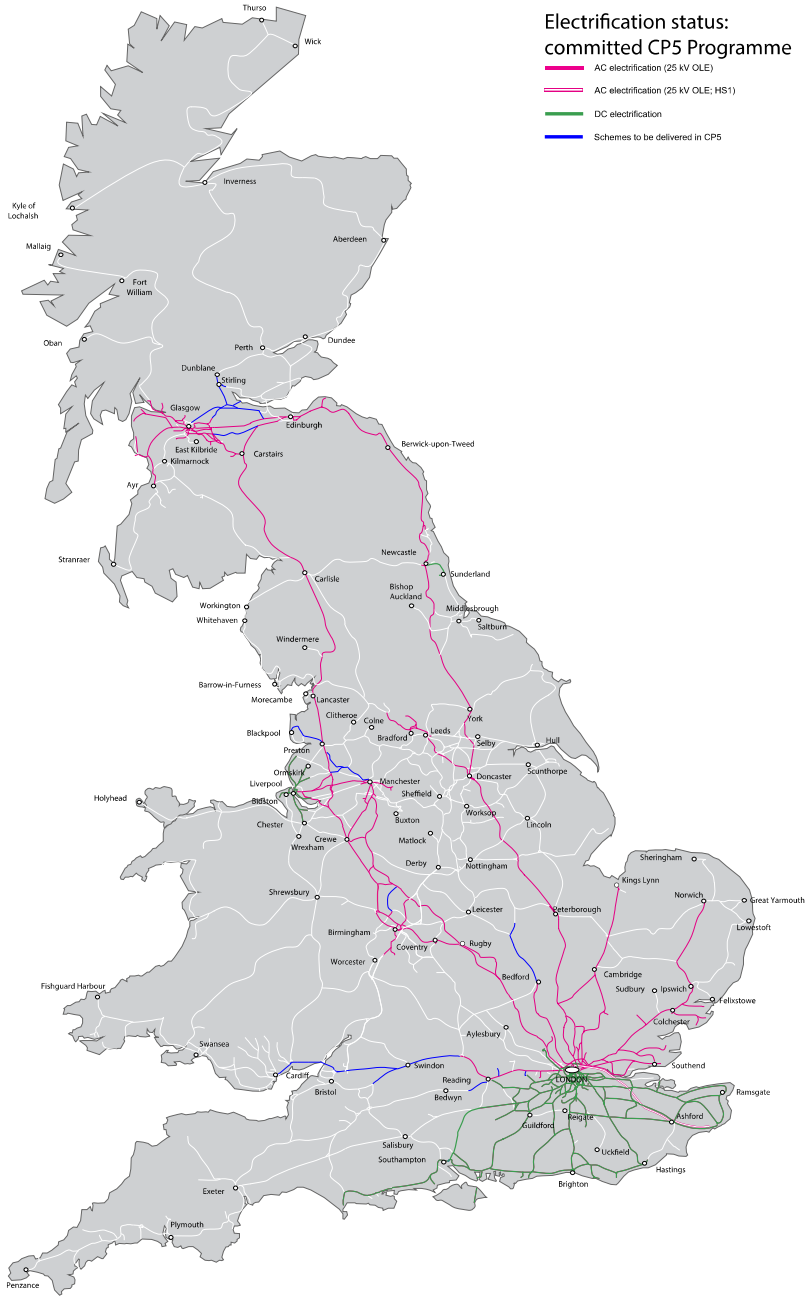
What is the need for the model?

- The UK Government has declared a Carbon Crisis and committing to the UK achieving zero carbon status by 2050.
- Like many other economic and transport sectors, aviation industry needs to be able to accurately calculate its carbon footprint in order to beginning to identify how it can reduce, manage or mitigate its impacts as it continues to grow.
- In doing so it will be valuable to be able to compare the carbon footprint of alternative modes, alongside the cost, time, reliability and economic value of making the same journey by different modes.
- Existing models use aggregated and averaged data to calculate carbon emissions on individual journeys, some of which may bear no resemblance to the journey's from which the data is sourced. If this is then used and quoted in the wrong context and without appropriate caveats it is potentially both inaccurate and misleading.
- There is concern that aviation, particularly on shorter domestic routes may be being presented in an unfair light as a result. The model is designed to bring clarity and accuracy to such modal assessments

Current Rail Electrification Map

What the map shows:

1. Extensive existing rail electrification around London and on 2 mainline routes north.
2. There is not a electrified route connecting these mainline routes apart other than at the final destinations of these routes.
3. Scotland (North of Edinburgh and Glasgow), Wales and South West has little to no electrification built nor planned.



Current Rail Calculators

There are significant issues with rail methodologies in existing calculators:

1. They assume diesel and electric trains produce the same emissions when their carbon footprint is very different, as it is between different Power Units and train sets.
2. They ignore the limited extent of the electrified network in the UK (see previous slide) and that for cross country routes and more peripheral parts of the UK deisel train still predominate.
3. They assumes a blanket load factor across the entire UK rail network, ignoring the fact they very between commuter, inter city, cross country and remote routes and between rural and urban components of the journey.
4. A stopping train is assumed to have the same emissions as a limited stop High Speed or Semi-Fast Express train.
5. Mileage of rail journey is assumed to be the same as for a car journey, when the train may take a vey different routing
6. Makes no allowance for the significant life cycle emissions associated with building and maintaining a large rail network.

Extract from 2019 GOVERNMENT GREENHOUSE GAS CONVERSION FACTORS FOR COMPANY REPORTING:

5.68. The national rail factor refers to an average emission per passenger kilometre for diesel and electric trains in 2017-18. The factor is sourced from information from the Office of the Rail Regulator's National rail trends for 2017-18 (ORR, 2019). This has been calculated based on total electricity and diesel consumed by the railways for the year sourced from the Association of Train Operating Companies (ATOC), and the total number of passenger kilometres (from National Rail Trends).

Current Flight Calculators

All existing online calculators (see opposite) seem to have the same associated issues:

1. Use distance rather than time-based methodology.
2. Do not calculate emissions associated with different aircraft, their specific routings and sector length (e.g. aircraft fly more directly which can reduce the actual distance travelled and consequent flight times materially).
3. Do not take account of taxi time (e.g at congested or uncongested airports), the flight at which they operate and the variation in the length of the climb-out, cruise and descend phases in each specific sector.
4. If following the DEFRA approach, they give fixed conversions based on sector length for a limited number of aircraft types, which is very inaccurate). Turboprops are for example more fuel efficient than jet engine aircraft.
5. DEFRA based Calculators include Radiative Forcing ignoring the fact EU Guidance indicates it should not be included for flights with sector lengths of less that 500 miles of flight levels below 9000m.

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How does the MCCF Model fix these issues?

1

It is a calculator which uses time-based methodology. Which makes rail and air calculations much more accurate.

2

It is a carbon calculator which uses data specific to the individual journey.

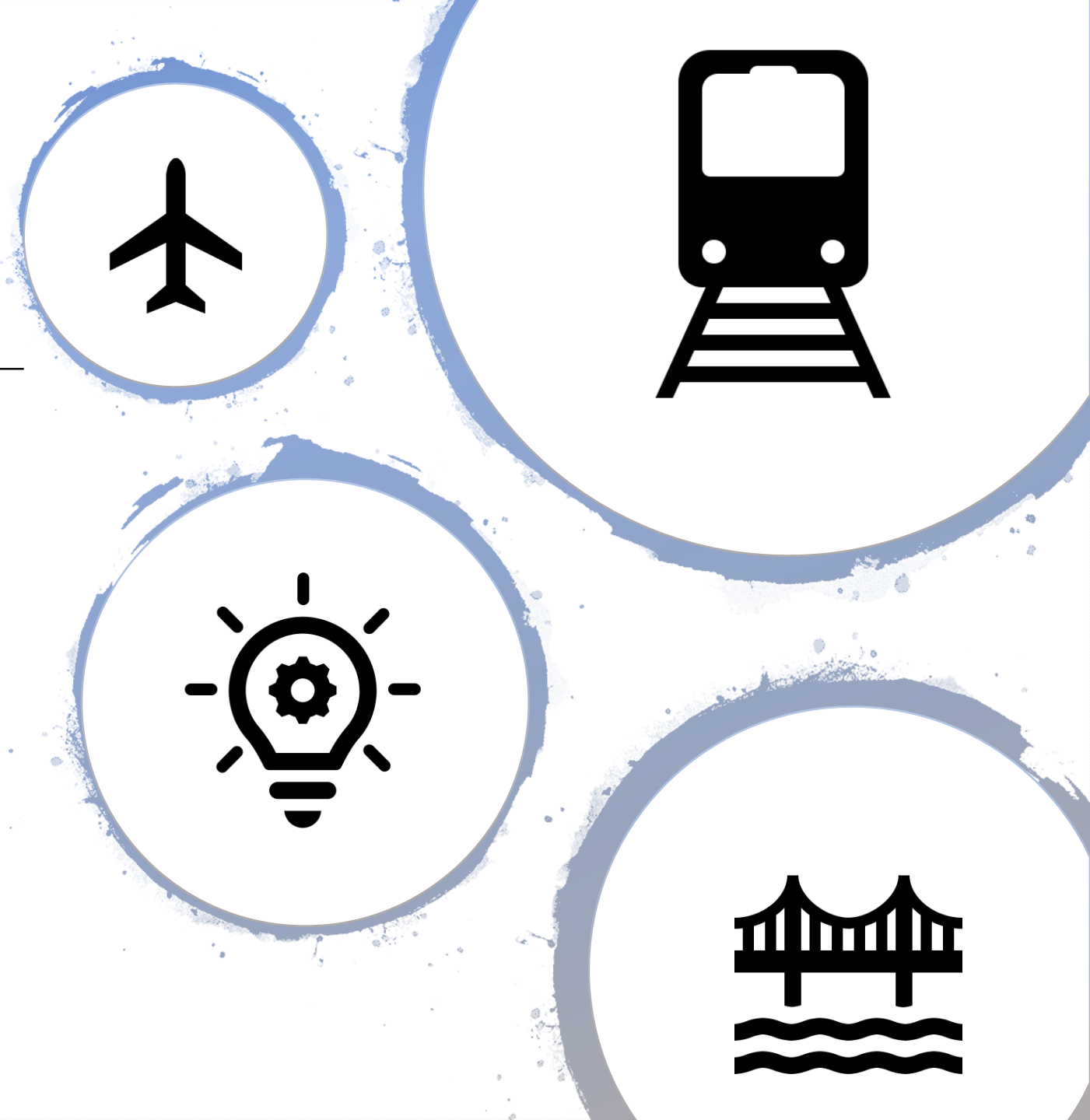
3

It acknowledges and accounts for the differences between specific aircraft and rail locomotives.

It continues to adopt a conservative approach by not making allowance for the significantly higher ‘life cycle’ carbon footprint of road and rail vs aviation infrastructure.

What are the model's capabilities?

- It has the ability to calculate $C0_2$ emissions of any rail and road journey between any two land-connected, destinations.
- It can calculate air travel emissions between any predetermined airports (Currently only UK airports).
- It has the ability for user to choose specific aircraft and trains specific to the individual journey.
- It can predict carbon emissions should the journey not already exist.



Case Study 1: Cardiff - Manchester

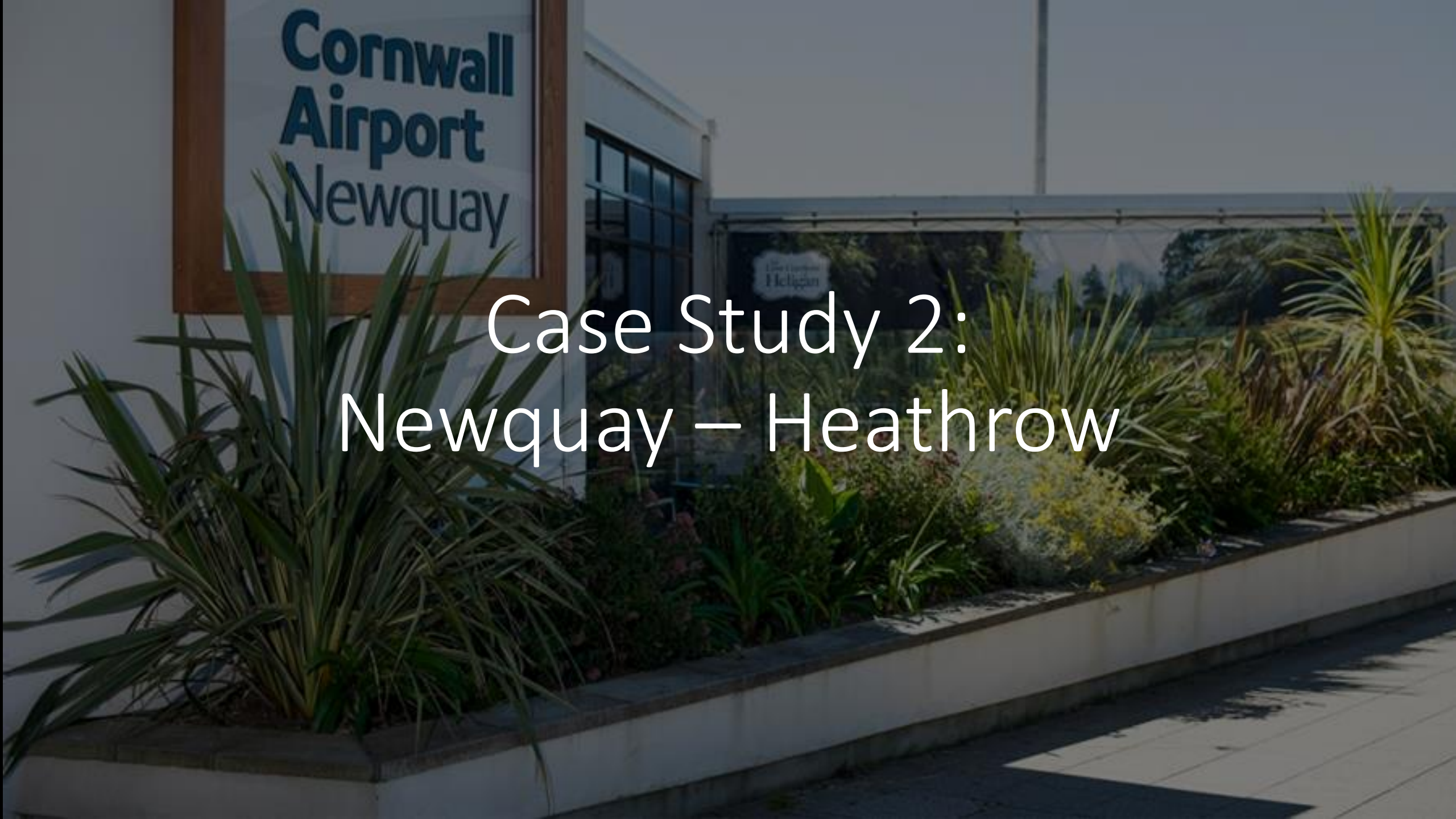
Case Study 1: Cardiff - Manchester

- The results are provided on the right.

- Explaining the results:
  - The Rail journey is 81% diesel powered and 19% electric. The route uses the Transport for Wales operated route to Crewe. Load factors varied between 20-35%.
  - Road journey travels via M5 &M6.
  - Air travel uses a Bombardier Q400 with 82% load factor.

Mode of Transport	Amount of CO_2 emitted per passenger (kg/pp)	Amount of CO_2 emitted per passenger per km (kg/pp/km)
Road	40.72	0.13
Rail	55.05	0.14
Air	36.05	0.16

Road: 3h50m, Rail: 4h40m, Air: 40m



Case Study 2: Newquay – Heathrow

Case Study 2: Newquay - Heathrow

- The results are provided on the right.

- Explaining the results?
  - The rail journey is 83% diesel powered and only 17% electric, with estimated load factors between 15-60% for various parts of the journey.
  - Road is using the most direct route (A303).
  - Air is using a Bombardier Q400 (what Flybe uses) with 82% load factor.

Mode of Transport	Amount of CO_2 emitted per passenger (kg/pp)	Amount of CO_2 emitted per passenger per km (kg/pp/km)
Road	48.86	0.13
Rail	88.53	0.19
Air	44.03	0.13

Road: 4h20m, Rail: 6h50m, Air:1h10m

Case Study 3:
Southampton - Edinburgh

Case Study 3: Southampton - Edinburgh

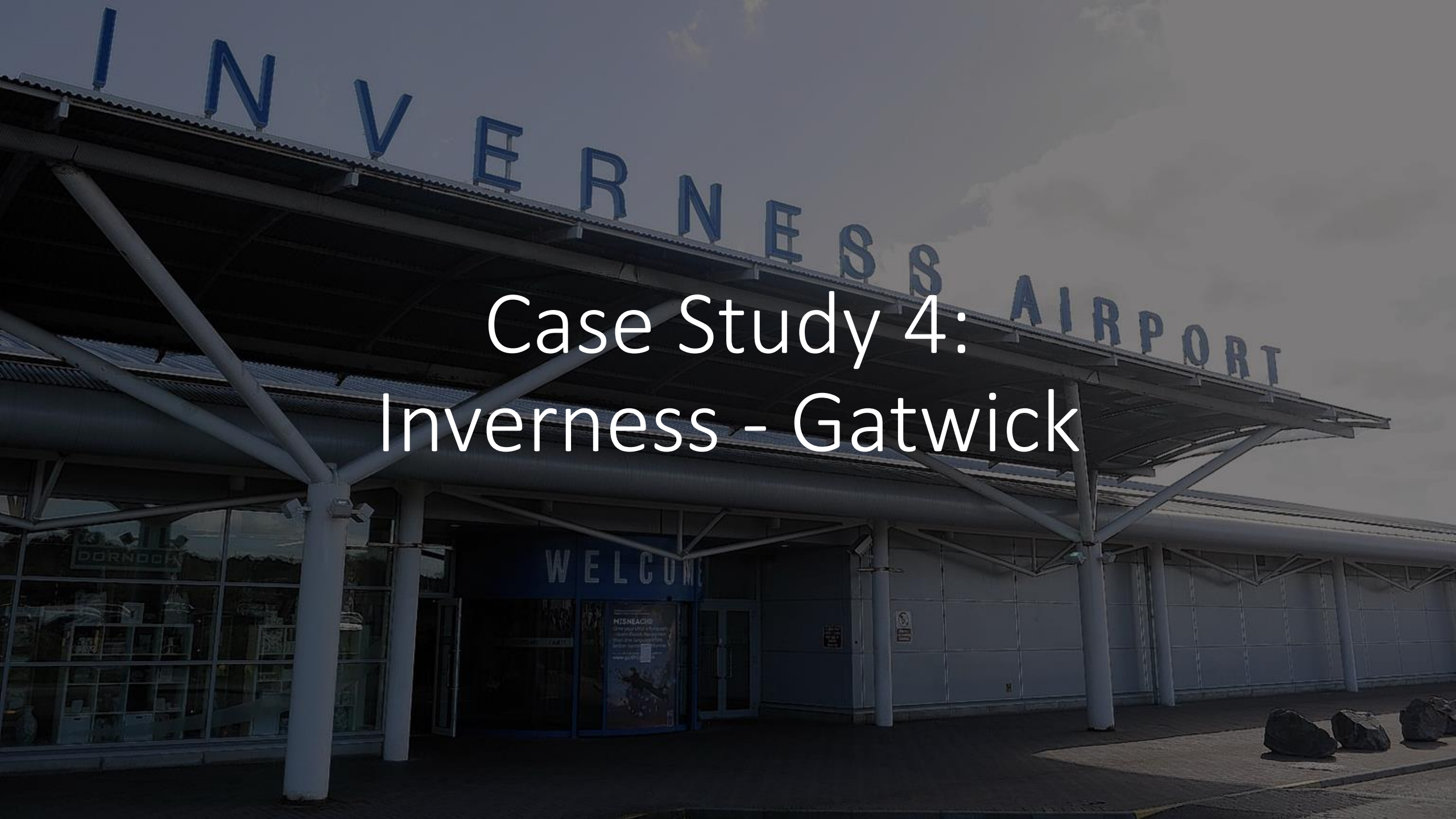
- The results are provided on the right.

- Explaining the results:
  - The rail journey is 100% electric and assumed load factors between 45-50%
  - The road journey travels via the M6.
  - Air travel uses a Bombardier Q400 with an 80% load factor.

To note: the rail emissions will be cut in half when new electric locomotives become the rolling stock for the large part of the journey.

Mode of Transport	Amount of CO_2 emitted per passenger (kg/pp)	Amount of CO_2 emitted per passenger per km (kg/pp/km)
Road	90.59	0.13
Rail	39.46	0.04
Air	63.29	0.11

Road: 7h15m, Rail: 7h, Air: 1h35m



Case Study 4: Inverness - Gatwick

Case Study 4: Inverness - Gatwick

- The results are provided on the right.

- Explaining the results:
  - The rail journey is 29% diesel power and 71% electric. Assuming LNER using Intercity 225 train. Load factors assumed to vary between 30-50% on different sections of the route.
  - Road journey is via M6
  - Air travel uses an A320-200 with 85% load factor

To note: the rail emissions will reduce to closer to 50kg when LNER introduces it's new electric fleet.

Mode of Transport	Amount of CO_2 emitted per passenger (kg/pp)	Amount of CO_2 emitted per passenger per km (kg/pp/km)
Road	122.15	0.13
Rail	68.00	0.07
Air	65.96	0.09

Road: 9h50m, Rail:9h45m, Air: 1h25m