HIGH SPEED RAIL IN BRITAIN

The Heathrow Opportunity

02/2010

GREENGAUGE21

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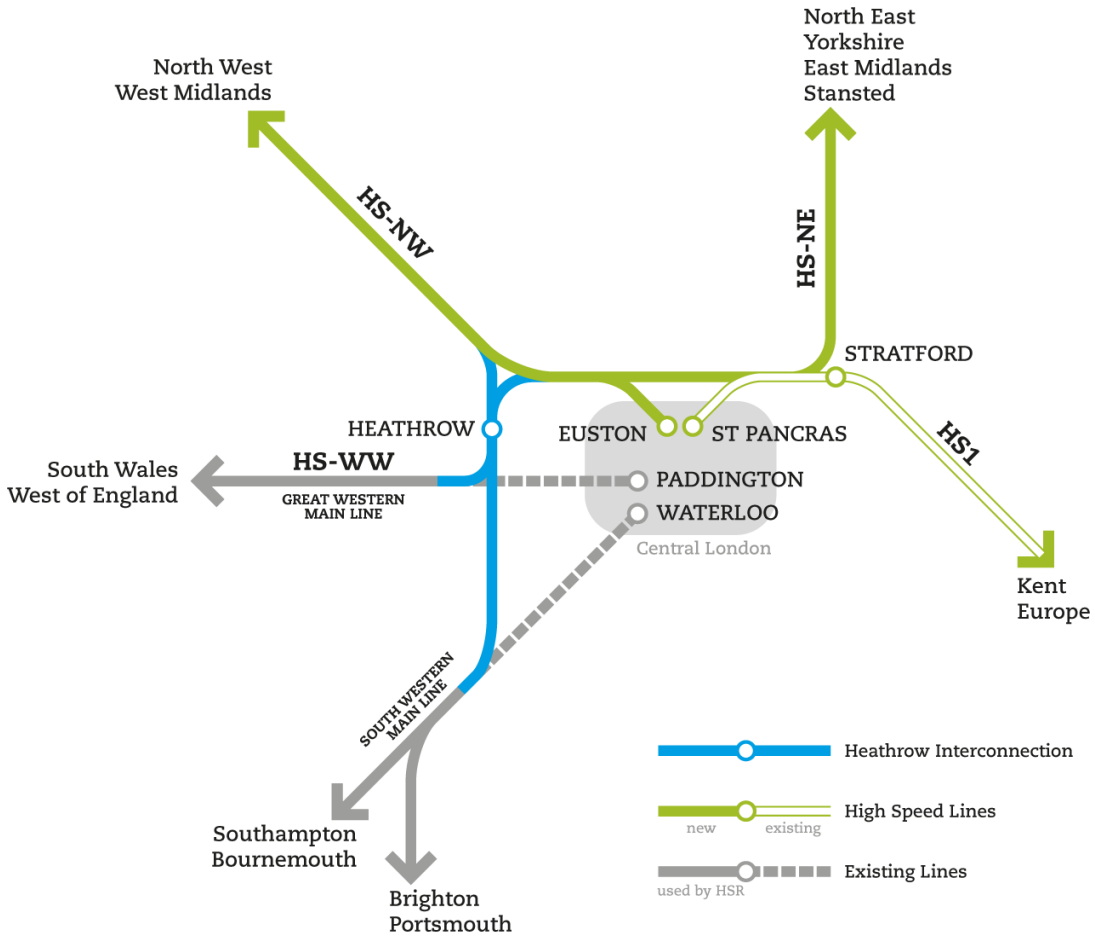
Executive Summary

With Ministers shortly to announce their conclusions from the work that has developed the case for the nation's second high-speed line, from London to the West Midlands, now is the time to get the right strategy for high-speed rail and Heathrow.

There is clear evidence that what is needed is for high-speed rail services to operate directly to the airport. The *Fast Forward* report published by Greengauge 21 in September last year shows how this can be done, with a through station for high-speed rail at the airport offering direct services to locations north, south, east and west.



High-speed rail at Heathrow adds capacity and value to Heathrow and will allow it to act as the international travel hub for the whole nation.

This is not a 'predict and provide' proposition. By achieving a dramatic switch in travel modes, carbon can be reduced and air quality enhanced. The new rail services will improve access to the airport from across Britain and offer new choices for many journeys in the broad M25 corridor for which, at present, there is no realistic alternative to car use.

The Heathrow Interconnection Network, a combined rail and high-speed rail hub, is the key to achieving a new vision for Heathrow, broadening its national catchment while allowing the airport to better target its medium and long haul flight network.

There may be apparently more cost-effective ways of providing access to Heathrow for HSR passengers in the interim, but these neither have the extensive strategic benefits that we have identified for the Heathrow Interconnection Network, nor do they avoid the need for passengers to negotiate interchanges *en route* for the airport

We have identified three candidate sites for the location of a high-speed rail station at Heathrow Airport. These now need to be the subject of a study by government to develop the best option to achieve the aims of the 'Heathrow Opportunity'.

To ensure that the benefits of this vision are not squandered, we identify a need to pull back from maximum runway use so that airline service punctuality and air journey times can be improved. The stacking of incoming flights and routine aircraft taxi queues on departure can and should be cut out, both enhancing the quality of service for Heathrow users and improving air quality for local residents.

The business case for the set of new rail links in the vicinity of Heathrow is very strong. Benefits exceed costs by a ratio of 4.8:1. The interconnections, which form part of the wider national network for high-speed rail (including the plan being developed by Government for a new line between London and the West Midlands) can be developed in stages.

The key point is to ensure that Heathrow and the high-speed rail network are brought together in a way that ensures that rail services to the airport are well-used and viable, and that the wider objectives surrounding both high-speed rail and Heathrow are met.

1. *The Challenge*

High-Speed Rail at Heathrow

The next high-speed railway (HSR) line in Britain, building on the success of HS1, the link between St Pancras and the Channel Tunnel, is most likely to be a route from London towards the north, starting with a scheme reaching the West Midlands.

The Eddington Transport Report identified improved transport connections with the nation's 'global gateways' as being critical to economic development and growth.[1] Heathrow Airport is the UK's leading international airport, competing against Paris, Frankfurt and Amsterdam, especially for business travel.

The airport could potentially be connected to the new north-south high-speed line, resulting in substantial and widespread benefits. While there appears to be general support for this proposition, difficulties and differences arise when specific solutions are advanced. This report is concerned with getting the strategy right before deciding on specific schemes.

On the face of it, there are three ways to add Heathrow to the high-speed network:

(i) HSR spur – adding a branch from Heathrow to the new north-south high-speed line

(ii) Interchange on HSR – providing an interchange station in West London on the new high-speed line at which north-south trains could call and connect with local train services running into the airport;

(iii) New remote hub – diverting the north-south high-speed line to serve Heathrow *en route* to London at a hub station reasonably near the airport.

In practice, each approach has at least one significant disadvantage:

(i) offering only low frequency and hence unappealing (or alternatively, uneconomic) high-speed rail services to the airport;

(ii) requiring high-speed rail users to interchange to reach the airport;

(iii) extending the journey times and/or reducing service frequencies for users of the new north-south high-speed line.

Greengauge 21 has developed a solution that puts Heathrow on a through HSR route and which overcomes these problems. Moreover, it has a strong business case, and this is our recommended way forward.

We described this solution in our report on a national network for high-speed rail, *Fast Forward,* published in September 2009,[2] but we have found since that there has been some misunderstanding of our conclusions and little consideration of the specific requirements for HSR at Heathrow. But there is a broad consensus that high-speed rail should serve Heathrow.

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[1] *The Eddington Transport Study*, DfT and HM Treasury, December 2006.

[2] *Fast forward: a high-speed rail strategy for Britain*, Greengauge 21, September 2009.

The Transport Select Committee addressed the subject very positively when it reported on aviation recently.[3] Having noted the small (and diminishing) number of UK cities currently with flight connections to Heathrow, the Committee said it is unlikely that Heathrow would become a hub airport for UK domestic flights even with a third runway at Heathrow.[4] According to its report, "in order to maximise the economic benefits of an enlarged Heathrow, it is essential that *direct access* from the national rail network to Heathrow be provided" (our italics). The report goes on to say that connecting the UK's major airports, particularly Heathrow, to a future high speed rail network "is essential".[5]

The recent report of the Bow Group[6] is also clear in its support for a strategic rail hub for high-speed rail at Heathrow. Its conclusions read as follows:

> "Continental Europe has a growing network of high speed rail services. These networks have helped regenerate post industrial and neglected regions as well as providing true integrated transport strategies. The principal European examples of airports served by high speed rail demonstrate that:
>
> - high speed rail lines are being routed as close as possible to the terminal facilities of national hub airports to provide "on-airport" stations;
> - airport stations are being located on 'through' high speed rail lines, rather than being built as dead end terminal stations;
> - additional local and regional train connectivity is provided, allowing the high speed stations to serve the airport and allow connections from high speed rail into conventional services for non-airport related domestic and international rail-rail journeys."

Creating a new vision for Heathrow

The future of Heathrow Airport is contentious and uncertain in respect of the Runway Three question. This is not the subject of this report.

In our view, the key to a successful and sustainable future for Heathrow is enhanced surface access, and specifically the creation of new national and regional rail links, with a hub station for high-speed rail. This creates the *opportunity* of this report's title, transforming Heathrow into a genuine national airport, rather than becoming a facility just for London, an airport that can increasingly be reached without reliance on the motorway/road network.

Heathrow already has good public transport on offer, with a choice of connections to London in particular: what's missing is its connectivity to the national rail network including to the emerging new high-speed routes. Providing high-speed rail at a surface hub that already provides Underground, bus, coach, taxi and car access gives Heathrow an advantage over other candidate locations in the wider South East that might be considered for HSR stations.

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[3] *The Future of Aviation*, HC125-I, House of Commons Transport Committee, 7 December 2009.

[4] The Select Committee supported the Government's case for expanding Heathrow with a third runway, and did not regard high-speed rail as an alternative

[5] *Ibid*.

[6] *The Right Track: Delivering the Conservatives' Vision for High Speed Rail* Tony Lodge, The Bow Group, January 2010.

But attention also has to be given to the use of the road network in the vicinity of the airport, because road traffic is a key contributor to the difficulties faced in meeting *air quality standards* in this area. At present, growth of Heathrow is likely to be limited because the locality is at air quality limits. This concern has already led to the proposed creation of new regulatory mechanisms should the third runway proceed.

Any measure to increase capacity requires consideration of demand management and this applies to high-speed rail as well as to runways. It has been suggested that adding HSR to Heathrow places additional demand and pressure on the airport[7]. As we show in Chapter 3 below, with the right strategy for HSR at the airport, on balance there should be a reduction in demand for runway capacity and a substantial relief for the surrounding road network.

Greengauge 21's proposed new rail connections – which are comprehensive and which accommodate conventional as well as high-speed services – provide the solution by providing an alternative to car and other road-based travel, and not only for travel to and from the airport itself. The new rail connectivity described in this report centres on Heathrow but offers a transformation of travel opportunity across the western arc of the M25 and the M4, M3 and M40 corridors. But these wider benefits could count for little if the current practice of maximum runway utilisation is allowed to continue.

As we show in Chapter 2 – and as is well known – Heathrow Airport is operating at capacity and flight times are extended significantly as a consequence. It would be possible to add passenger capacity with high-speed rail and for this situation to continue. But this would:

(i) reduce the value of the investment in HSR at Heathrow, because the airport would not be as popular a choice as it should be for international/long haul flights, with a poor customer service offer because of the delays associated with relentless operation at the limit of runway capacity limits;

(ii) risk breaching air quality standards, despite the opportunities for greater rail use and less car use in the wider vicinity of Heathrow.

So we see the vision for Heathrow simply like this:

- An airport focussed on the efficient delivery of long haul flights but which serves the whole of Britain and the near continent through HSR connections
- A high quality customer service attuned to the needs of the passenger and with a reduction in the intensity of runway use delivering an end to endemic flight delays.

Achieving the second aim requires runway utilisation to be reduced below the maximum-use levels of today to a level such that un-padded schedules can be delivered dependably. This means, ideally, an end to planned aircraft taxi queues for departing flights and scheduled stacking for those incoming. Both of these offer important greenhouse gas savings. The reliability of journey times can be transformed for passengers, journeys would become quicker and the extent of air pollution and carbon emissions would be significantly reduced.

[7] Bow Group *op. cit.* p73

2. *Heathrow: the Key Issues*

There are three key issues that have to be faced at Heathrow to capitalise on the proposed investment in high-speed rail. These are:

- Decongesting the airport, with less intensive use of the runways
- Meeting the European air quality standards in the Heathrow area
- Getting the best use out of high-speed rail, and exploiting its potential to replace short-haul flights and provide national connectivity.

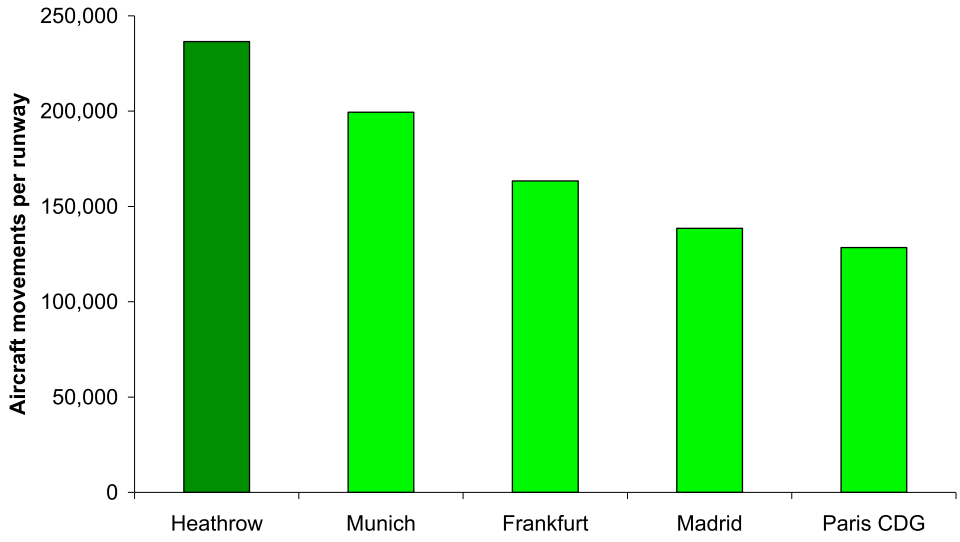
De-congesting the Airport

At present, demand for runway use at Heathrow generally exceeds capacity hour by hour. According to analysis conducted on February 15th 2009, for example, there were only three hours between 05h00 and 22h00 during which there was sufficient capacity available for all arriving flights and only one hour, over the same period when demand did not exceed capacity availability at all for departing flights.[8]

This pattern of intensity of use is not replicated at other major European hub airports, at which there are peaks and troughs in runway utilisation through the day. Typically this will mean four 'waves' occurring each day, with the waves arising to facilitate plane to plane transfers. This creates the opportunity to use the intervening quieter periods to recover from any delays that may have built up in the peaks and recover normal schedules.

Heathrow is the busiest two runway airport in the world, with many more aircraft movements/runway than other large airports in Europe, as shown in Figure 2.1

Figure 2.1 – Runway use at major European airports (Air Traffic Movements per runway, 2005)



Source: ATRS Benchmarking Report 2007

[8] *BAA airports market investigation, Final Report,* Competition Commission, March 2009, Figures 3, 4 in Appendix 4.2

Heathrow's runway use is near-uniform throughout the day, and the resulting capacity constraint is likely to be having an adverse affect on airline economics, with airlines unable to operate on a timed hub basis or at times customers prefer. It also means that residents under the flight-path get little or no respite during operating hours.

The flight delays at Heathrow are substantial, as is shown in Table 2.1: a third of flights are delayed and the overall average delay per passenger using the airport is close to 20 minutes.

Table 2.1 – Passenger Delays at Heathrow 2008

	Departures	Arrivals
Percentage of flights delayed	37%	33%
Average passenger delay	19.3 mins	18.5 mins

Source: Transport Minister Paul Clark, Parliamentary Answer, 30 November 2009.

Whether this high level of delay is directly attributable solely to the very intensive use of the runways is difficult to establish. The average aircraft delay per delayed flight, for example, seems to be fairly similar across the main European airports. Last year, with a modest reduction in air traffic movements (ATMs), however, BAA reported a significant reduction in flight delays, which would tend to support the thesis that a fairly modest cut in runway intensity could bring significant benefits.[9] Of course, the availability of Terminal Five will also have contributed to this improvement.

Part of the analytical complexity is that delays are measured against scheduled flight times, and over the years, services at the busiest airports have had their schedules extended. London – Edinburgh/Glasgow, for example is now generally shown with a 1h 25/1h 30 flight time, compared with perhaps 1h 05 of 25 years ago.

In fact, delay is built into the planned operation of the airport, in order to maximise throughput. It is set at 10 minutes per flight and this is increased during peak periods to 20 minutes for arrivals and 25 minutes for departures. There are no regular 'firebreaks' during the daily schedule to insure against the inevitable knock-on consequences of early delays.

The impact of changing the delay standard on runway capacity varies from airport to airport. A modelling study[10] showed that decreasing the average delay at Heathrow from the current standard of 10 minutes to 5 minutes would require a six per cent capacity decrease from 82 to 77 ATMs per hour.

We cannot be definitive about the level of reduction in runway use intensity here. There are important interactions with Air Traffic Control to consider, for example. But it is evident that a decrease in movements per runway in the range of 5 – 10% should have a very significant impact in bringing down delays and bringing Heathrow's performance up to the standards achieved in competitor airports with more runway capacity and associated facilities.

[9] BAA told us that delays had fallen last year to around 10 minutes from the figures quoted in Table 2.1.

[10] *SERAS Runway Throughput/Delay Modelling—Final Report for DETR Airports Policy Division*, National Air Traffic Services Limited 2001, quoted in Competition Commission *op. cit.*

This is significant because while the scale of demand that could be attracted to high-speed rail is not as high as the increase in capacity that would be afforded by a third runway, it is certainly sufficient – all other things being unchanged – to bring sufficient demand relief from the current pattern and level of usage to transform the airport's punctuality performance.

How a reduction in intensity of use would be brought about will need careful consideration, under two and three runway scenarios and with or without high-speed rail. There will be financial implications, even if only in terms of opportunity costs through foregone revenue growth: runway slots have a commercial value. But the key to developing Heathrow sustainably is to address this challenge with clarity of purpose, making a distinction between actual and declared airport capacity.

This approach fits with the conclusions of the recent Transport Select Committee report which suggested that there is a case for expanding Heathrow, not to meet the demand forecasts of the Aviation White Paper of 2003, but to improve the "resilience of an airport that is already operating at full capacity".[11]

In a study undertaken for the British Chambers of Commerce,[12] it was pointed out that the lack of capacity had meant that over the last twenty years, rather than having flight connections to 21 UK cities, only six now had Heathrow flights. Moreover, in a European league table, Heathrow, which used to have the greatest number of international flight destinations, has now fallen to fifth place. The study argued that a lack of runway capacity was driving out connectivity across the UK and reducing international connectivity too.

There are therefore two further important policy points related to the over-use of Heathrow's runways:

(i) It is recognised that this leads to poor resilience – the word used by both the Transport Select Committee and the Competition Commission – as well as poor performance in terms of delays.

(ii) Important destinations, including regional airports across the UK, are being crowded out, reducing the overall effectiveness of Heathrow as a global gateway.

Air Quality Constraints

Air quality in the area of Heathrow is poor.[13] A reduction in runway use as identified above would bring some modest relief on this score, at least in the two-runway case.

The Government has determined as a condition of proceeding with a third runway that the increase in flights is restricted to the level that would comply with the obligations on air quality in the Heathrow area.[14] In practice, poor air quality in the vicinity of Heathrow is partly caused by aircraft movements and partly by road traffic (there are other factors but these are by far the two most important). And there is an inter-relationship between the two: an extra runway will generate more demand for road travel by air passengers, employees and others in the Heathrow area.

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[11] House of Commons Transport Committee *op. cit.* The Transport Select Committee's reluctance to see the airport expanded to meet demand increase reflects its appreciation that DfT downgraded its aviation demand forecasts for 2030 by 7% last year.

[12] *Economic Impacts of Hub Airports*, Colin Buchanan & Partners for British Chambers of Commerce, July 2009

[13] There are even worse air quality problems in central London, but Heathrow is the second problem area for the capital. Last year the worst measured exceedence was 54 micrograms against a target of 40.

[14] Secretary of State for Transport Statement, January 26th 2009.

This suggests that if the third runway is to proceed then emphasis would need to be placed on achieving a move away from the use of private car and other road-based transport in the vicinity of Heathrow towards the use of lower carbon public transport systems. Indeed, the Aviation White Paper[15] contained a joint submission by BAA plc and the Strategic Rail Authority setting out the several rail projects that in 2003 were believed to be necessary to support a third runway at Heathrow.

High-Speed Rail

Whether or not high-speed rail would attract significant numbers of air passengers from flights at Heathrow has been the subject of various studies. Most recently, work for the Committee for Climate Change examined this specific issue and concluded that a high-speed rail network would attract about 10% of air passenger movements if a full network was provided serving Heathrow.[16] Earlier work by Greengauge 21 on this question came to the conclusion that as much as 19% of Heathrow's air passenger demand was addressable by high-speed rail (domestic and near-continent), but some shorter haul flights (including those from Leeds/Bradford and Durham Tees Valley) have since been lost, and in any event, as this earlier report suggested, not all of the demand would transfer to high-speed rail.[17]

The forecasts suggest, therefore, that the market share that high-speed rail would win from the airlines would broadly match the reduction in air passenger carrying capacity needed to lower the level of runway utilisation to get decent levels of punctuality. This is a potentially valuable balance.

Over time, the prospect for air to high-speed rail diversion may diminish, if the current trend of larger-aircraft long-haul flights continues to squeeze out short-haul feeder air services, both from near-Europe and domestic destinations. But that would not undermine the case for creating HSR at Heathrow, because to a very large degree, the flights displaced, in the absence of HSR, would re-appear as short-haul flights from the UK regions to the competing European airport hubs and to other secondary airports in Europe. This weakens Heathrow's competitive position and its contribution to the economy whilst doing nothing to abate the high carbon impact of short haul feeder flights.

In practice, of course, much would depend on the detail of the high-speed rail offer at the airport and its suitability for interlining traffic[18] in particular. We turn to this subject in chapter 4 below.

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[15] *The Future of Air Transport,* Cm 6046, Department for Transport, December 2003.

[16] *Potential for modal shift from air to rail for UK aviation,* Steer Davies Gleave for the Committee for Climate Change, November 2009. This figure is given in the report's Executive Summary, but the full report suggests a figure of 8%.

[17] *The Impact of High-Speed Rail on Heathrow Airport,* Greengauge 21, March 2006.

[18] Interlining being a significant proportion of the reason for using domestic and other short-haul flights to Heathrow, i.e. in order to catch another flight from the airport.

Conclusions

On these three issues, the conclusions we can draw are these:

(i) Runway over-use is damaging the functional purpose of Heathrow, limiting its appeal to customers, causing unnecessary environmental damage and business productivity losses. The capacity constraint is also causing a narrowing of the range of destinations served. An initiative is needed that brings a reduction in runway intensity to minimise delays and these wider adverse consequences. We suggest that the reduction in runway intensity should be of the order of 5-10%.[19]

(ii) Air quality standards are poor in the vicinity of Heathrow and under a do-nothing scenario there is the likelihood of a breach of statutory levels now in force. There is likely to be a significant period when air pollution from road traffic will increase[20]. A strategic shift towards public transport, not just for access to the airport, but also more generally in the wider sub-region, is needed.

(iii) The evidence available suggests that a full high-speed rail network could attract about 10% of air passenger demand at Heathrow, potentially fitting well with the need to reduce runway utilisation.

More generally, according to the Committee for Climate Change, the country faces a choice with its aviation policy if it is to achieve its adopted carbon emission totals. It is not possible to plan on the same basis of air demand growth as was assumed in the Aviation White Paper of 2003. There will have to be active measures to contain demand growth, and the Committee identifies the measures that could be applied:

- Pricing/taxation increases
- Changed air traffic management practices
- Adoption of high-speed rail
- Capacity expansion policies or slot allocation at specific airports[21].

Irrespective of the conclusion ultimately reached on Heathrow Runway Three, it is clear that Heathrow will offer the greatest number of international flight connections of the UK airports for a very considerable period of time. Drawing on the Eddington Transport Report conclusion on the economic significance of global gateway connections, it follows that this is the airport where there would be most economic value to be derived from providing high-speed rail connections.

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[19] At New York's, La Guardia Airport, where excessive peak runway use was causing knock-on problems for the management of US airspace, the FAA has imposed a limit on departures and in effect capacity controls on runway use.

[20] The beneficial effects of technology change on road vehicle emissions are expected to take several decades to materialise, as the vehicle fleet is renewed and a move away from petrol/diesel takes place. In the meantime, motorway widening schemes such as that for the M25 between junctions 17 and 21 will lead to an increase in traffic volumes in the wider Heathrow area.

[21] The London airports and Manchester already have slot allocation arrangements but these do not take into account wider social or economic policy goals.

3. *The High-Speed Rail Options*

Heathrow was a key feature of the thinking behind Greengauge 21's report on *High Speed Two,* published in June 2007.[22] In this proposition, Heathrow would have a direct HSR connection to the north-south high-speed line, allowing HSR services to reach the airport directly from the north and from mainland Europe. Heathrow would have a terminus HSR station. But our thinking has evolved since then.

For Government, serving Heathrow was an option to be explored by its HS2 company, with an explicit reference to the possibility of doing so by means of an interchange in West London on the new HSR line. This is a distinctly different proposition, so we can expect HS2 to have engaged in some comparative assessments.

These would include, no doubt a third idea which has been promoted by consultants Arup, in which Heathrow would be served by HSR services at a new station built on the Great Western Main Line where it is crossed by the M25 motorway. This has been dubbed the 'Heathrow Hub'. It implies:

(i) creating links from the new GWML/M25 station into the airport; and

(ii) diverting the route of HS2 so that it serves the new station.

So, in short there would appear to be three concepts under consideration:

1. **HSR spur:** building a new rail spur into the airport to accommodate HSR services
2. **Interchange on HSR:** building an interchange in West London on the planned new north-south HSR line so that HSR passengers can transfer easily to another railway line such as that used by Heathrow Express (or in future, Crossrail) that goes to the airport
3. **New remote hub:** creating new connections into the airport from a site reasonably nearby that could accommodate HSR services on a diverted north-south route[23].

However, each has some significant draw-backs as well as virtues, as shown in Table 3.1.

[22] *High Speed Two: A Greengauge 21 Proposition*, Greengauge 21, June 2007.

[23] A variant of this third option can also be distinguished. If it is objected that the concept of diverting north-south HSR to serve Heathrow will inevitably extend journey times unnecessarily, a variant would entail siting the Heathrow HSR station on a loop from the north-south HSR line. But this would add further cost as well as operational complexity.

Table 3.1 – The Relative Merits of the Three Strategic Options identified for Heathrow's HSR connections

Concept	Advantages	Disadvantages
1. HSR spur into the airport *Source: Greengauge 21 Report June 2007*	• Relieves pressure on central London HSR terminal • Adds to the accessibility of the HSR network via all the access modes available at Heathrow • Widens the function of the HSR network • Connects major provincial cities directly with Heathrow	• High capital cost • Requires separate airport HSR services, which will attract less demand than services operating to/from central London and therefore have low service frequencies • Adds to the pressure on the motorway network around Heathrow (although only if increased car parking is allowed) • Disruption at Heathrow during HSR construction
2. Interchange on HSR in West London *Source: remit for the HS2 company, January 2009*	• Relieves pressure on central London HSR terminal • Relatively cost effective way of providing LHR access in the short term (assuming the interchange station has a stand-alone business case) • Potentially adds to the accessibility to the HSR network by rail to/from inner London • Creates interchange possibility with GWML services, improving network connectivity • Provides better access to some London destinations via Crossrail (e.g. Canary Wharf) for HSR passengers • No disruption at Heathrow • Construction is independent of the Runway 3 outcome	• Airport passengers' aversion to *en route* interchange reduces ability to attract demand and to replace short-haul flights • Slows down all HSR services because of the need for an extra station call** • Slows down GWML services at their peak load point • Adds pressure on capacity constrained section of the GWML • Difficult to access by road, so local regeneration benefit may be difficult to secure • Introduces a project inter-dependency (with Crossrail) • Requires changes to inner London rail and possibly LU networks to achieve wider connectivity
3. Remote hub: new HSR station on GWML/M25 ('Heathrow Hub') on diverted north-south HSR route *Source: Arup, September 2008*	• Relieves pressure on central London HSR terminal • Widens the function of the HSR network • Adds connectivity to a wide range of destinations to the west of Heathrow as well as Kent/ Europe • Flexibility with respect to Runway 3 outcome	• Capital cost: HS2 route longer than otherwise needed • Requires costly new airport connections and extends journey times for passengers to reach the airport • Therefore construction will also be disruptive at Heathrow • Requires 'double interchanges' for cross-airport travel • Extends journey time on HS2 • Restricts frequency for north-south HSR services to/from London, damaging the value of north-south HSR • Green belt/flood plain construction • Requires new connections to the motorway network near critical M25/M4 junction,

** If only some services were to call at this station, there would be a significant loss of line capacity, so an assumption that all HSR services would stop is appropriately cautious.

The fundamental objections to option 1 are that it is expensive, will be disruptive to build and has a questionable impact on the overall economics of running HSR services, since less well-loaded Heathrow trains would take the place of better-loaded London trains. However, each of the two alternatives to option 1 brings their own disadvantages.

A critical and poorly understood issue that affects the second and (to a lesser extent) the third option is the question of *en route* interchange for airport passengers. Some of the best evidence on this subject comes from Manchester Airport, where there has been a mix of long distance and local direct services, as well as those that would require an interchange, for some time. Research by the Institute for Transport Studies at Leeds University shows us that the need for an intermediate *en route* interchange dissuades many people from using rail as an access mode to the airport, with a loss of 37-40% of rail demand.[24] This is much greater than the deterrent effect that is normally observed as a result of the need to transfer and led to their conclusion that "providing though services is particularly important for airport users". For interlining passengers, the position is even more dramatic. Evidence for the Committee for Climate Change, which included separate modelling of the potential for interlining passengers at Heathrow to switch to rail, found that 38% of existing interlining passengers would transfer from air to HSR for the domestic leg of their journey if there was a direct HSR service to the airport, but only 1% would do so if there was a need to make an interchange *en route*[25].

This problem – those accessing air services by rail much prefer direct services – would clearly affect option 2, where passengers for the airport would need to transfer to trains that would be already well-loaded. It might also be a problem for option 3, the hub station on the Great Western Main Line, depending on whether the transfer to the connection system to reach the airport is regarded as requiring an interchange. A purpose-built and free transit to each terminal might well help to overcome this problem, but clearly at some expense, and with some extension of real and perceived access times.

So we would say that the critical factors for option 2, an interchange in West London, centre on its potential ineffectiveness at capturing much of the air market because of the need to interchange, the need to extend HSR journey times to/from central London and the apparent inter-dependency with Crossrail.

Option 3 has rather different problems: it creates a bottleneck at the southern end of the north-south HSR line, reducing available capacity[26] as well as extending HSR journey times. Whether it can fully serve as a surface rail interchange at Heathrow with connections, for example to Airtrack or the Piccadilly Line, would depend either on passengers being prepared to make double interchanges or on extensions of the Airtrack and Piccadilly lines to the new station on the Great Western Main Line being built. Either way, there is a gap of 4km (the straight line distance between the proposed hub site and the nearest terminal, T5) to be overcome.

Greengauge 21, in its 2008/9 HSR Development Programme, was keen to find further evidence on what has worked well in terms of HSR/air interfaces, and what has not, to try to develop the best solution available for HSR to serve Heathrow which could then be subject to value for money assessments.

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[24] Lythgoe, W F and Wardman, M (2002) Demand for Rail Travel to and from Airports *Transportation 29* 125-143

[25] Steer Davies Gleave, CCC *op. cit.*

[26] The extent of the reduction depends on the mix of services that would operate over the common section of line from central London to Heathrow, but earlier suggestions were that there may be eight train paths/hour (tph) left available for north-south HSR trains, out of a total of (say) 15 tph.

The Paris Charles de Gaulle Airport model

Each of the main continental rivals to Heathrow, Paris Charles de Gaulle, Amsterdam Schiphol and Frankfurt, has a HSR station at the airport itself. So it would hardly be a great innovation or untried step to develop HSR at Heathrow. However, HSR services are only just now starting up at Schiphol, and Paris is more similar than Frankfurt to London in terms of its potential relationship to a national HSR network. So it was to Paris Charles de Gaulle that Greengauge 21 turned to develop its thinking on HSR and Heathrow.

The thinking in SNCF when planning the TGV network was that it was important to serve the main national airport, Paris CDG, but not at the expense of the faster journey times achieved on the new TGV routes. It also believed there would be a market for some interconnecting TGV services running 'around' Paris, linking two provincial route sectors together. Services of this type could have a station call at Charles de Gaulle if the circumferential route around Paris was designed to serve the airport.

So this is how the TGV 'Interconnexion' network was developed. In practice, the level of demand for inter-provincial services has surprised the planners at SNCF who find that, with careful planning, they can maintain the high load factors of the overall TGV network.

The TGV network that serves Paris CDG in this way is illustrated in Figure 3.1. A very large number of major towns and cities (not all of them shown on the diagram) across France enjoy a direct TGV service to the national airport at CDG.

Figure 3.1 – TGV Services to Paris Charles de Gaulle Airport

Evidence provided to us by SNCF shows that in 2008 there were 3.4 million passengers per annum (mppa) using the TGV station, and of these, 2.3 mppa were transferring to/from air.

At this stage, provision for through ticketing is limited[27]. As the overall TGV network is developed,[28] many more services will operate to and from CDG airport.

The advantage of the arrangement developed in France is that the national airport is served without detracting from the efficiency and appeal of the TGV services to/from central Paris, and the airport station call has become just one of a limited number of stops on a range of inter-regional TGV services. As the Bow Group report says, having examined the approach taken at Paris-CDG, Brussels, Amsterdam, Zurich and Frankfurt:

> "The unmistakable lesson from Europe is that a through station on the principal network is essential, and some airports are carrying out major investment to achieve this, in some cases correcting earlier planning mistakes."[29]

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[27] Paris CDG – Lille Lyon by TGV is marketed as an air route in Global Distribution Systems.

[28] Work on the southern section of the orbital route around Paris is in hand, but currently TGV trains have to leave the high-speed network for a service between Bordeaux and CDG, for example.

[29] Bow Group *op. cit.* p59

The question is: could the same approach be adopted in Britain for Heathrow?

The Fast Forward HSR solution for Heathrow

Detailed arrangements for HSR at Heathrow depend on two (current) unknowns:

(i) the route of the new HSR line(s) – and indeed, on longer term national HSR network development; and

(ii) the decision on whether or not to proceed with Heathrow's Runway Three.

The focus for Greengauge 21 and our consultants was on a strategic network concept, but clearly, to be confident in the results of business case appraisals, we need also to be confident on the specific feasibility and costs entailed.

The essential network concept is illustrated in Figure 3.2 below. The question of suitable locations for HSR stations at Heathrow has been discussed with BAA and their engineering consultants. There are physical constraints, and there is a strong desire to avoid a further period of reconstruction at the main terminal sites. Fortunately, there are three sites available very close to existing terminals, and are located such that disruption to ongoing airport operations could be minimised.

A choice of three suitable HSR Station sites at Heathrow Airport

The Heathrow HSR station could be located on the west side of Terminal 5, where a site was identified in the 2003 Aviation White Paper for possible airport development. Another possibility is on the north side, between the runway operational area perimeter and the A4 Bath Road, where surface car parks and potentially some office facilities would need to be displaced.

The advantage of the first site is that for 40% of airport users, there would be no need for a transit system because access to T5 would be on a walk-in/travelator basis, and this means that inter-connectivity to Airtrack, the Piccadilly Line and Heathrow Express would be similarly straightforward. Access to the other terminals would be achieved over existing rail links with a free transit, as now. The second site would require short new transit links into the terminals.

If Runway Three proceeds, the HSR terminal could be integrated with Terminal 6, which would be built astride a diverted Heathrow Express line into the airport. There would be excellent connectivity across the airport terminals and onward connectivity to the other surface transport modes available.

Figure 3.2 – HSR Interconnection Network at Heathrow

The Heathrow Interconnection Network shown in Figure 3.2 allows for a European or TGV-style mix of inter-connected corridors with Heathrow as one of the HSR station calls. The route towards central London would be connected to HS1 for services to Stratford, Kent and Europe; this route might also be connected with High-Speed North East. The connection to the west is a new line that provides a direct west-facing connection to the Great Western Main Line which might form the basis of a high-speed route to the west and South Wales in Greengauge 21's national strategy; the new route to the south connects into the South Western Main line for services to the south and south west.

These short interconnections in the 'M25 corridor' at Heathrow combine with the national HSR network developed by Greengauge 21 to provide a rich set of service opportunities and transformed connectivity, linking British cities and large towns north, south, east and west to Heathrow and to each other directly, without the need to interchange or in central London. This is illustrated in Figure 3.3.

Figure 3.3 – HSR services direct to Heathrow

Note: The routes shown also include services running over the new links into and across Heathrow at conventional line speeds.

In effect, a very large HSR network is being created through the addition of some short new rail links (total length 28 km) in the Heathrow area. These new links are relatively expensive on a *per-km* basis, since, in the area of Heathrow itself at least, the routes will have to be tunnelled and the HSR station itself would be probably be sub-surface.

The HSR services that could be operated have an essential characteristic. They place Heathrow as a station in the centre of a longer 'cross country' trip. Examples would be services, for instance, from Manchester *via* Heathrow to Southampton or from Cardiff/Bristol *via* Heathrow to Gatwick/Brighton.[30] These services will have high load factors because they are connecting a number of different markets. Their usage is not dependent on the single market at Heathrow, and their load factors and overall economics will be attractive. They will justify their place on the highly valuable capacity offered by the national HSR network, in a way that far fewer services would do if they were just to serve Heathrow on a spur.

One of the very valuable functions that a HSR station at Heathrow can serve is in the operational management of through services using a combination of the new national HSR routes and the existing network (which may itself be subject to some upgrades). In operational terms, these needs are two-fold:

(i) to be able to split long (400m) trainsets operating over the HSR network into two 200m sets (or vice versa). This allows onward direct services to a wider range of destinations using half-length trains and obviates the need for a huge programme of platform/station extension on the existing network

(ii) to provide a facility where headway regulation can take place, so that services joining the HSR lines can be timed to ensure a smooth integration with preceding and succeeding trains, keeping punctuality levels on the HSR network up to the highest standards.

The HSR links to the west and south west from Heathrow shown in Figure 3.2 would not be fully used if only HSR services were to run over them. Instead these interconnections (which would not be suitable for high-speed running in any event due to the proximity to junctions and to the station at Heathrow) would be used for new conventional-speed regional services as well as through HSR services. This would allow for direct Heathrow connectivity for places across the wider southeast beyond the ambit of the Airtrack scheme,[31] including Coventry, Oxford, Bicester, Milton Keynes, Banbury, Newbury, Portsmouth, Basingstoke and Reigate, as shown in Figure 3.4. In addition, these places would be cross-connected with one another either directly, or with interchange at Heathrow, where there would also be access to the Airtrack destinations, the HSR services, Heathrow Express, Piccadilly Line and Crossrail.

[30] Some upgrades may be needed to rail networks in the south to facilitate these services.

[31] This scheme, which is now the subject of a Transport & Works Act order application is complementary to the Greengauge 21 proposals. It serves places between Heathrow and Reading (via the Bracknell route), Waterloo (via Richmond) and Guildford (via Woking).

Figure 3.4 - Extending Heathrow's catchment by rail and high-speed rail

In summary, the infrastructure that is needed at Heathrow inescapably provides the spare capacity to support a completely new mix of services that will offer, for the first time, a realistic alternative to motorway use across much of the Thames Valley and beyond.

The Heathrow Interconnection Network described here forms part of a wider national network as described in the *Fast Forward* report.[32] It overcomes the problems of each of the three options described earlier. It is possible that other configurations could be devised that would serve the overall aims, but these are likely to be costlier and take longer to implement.[33]

[32] *Fast Forward, op. cit.* The Heathrow element of the national network is described on page 32.

[33] An approach that combines options 2 and 3 might be considered for example, in which a separate east-west high-speed line is built between central London and Heathrow and connected onwards to the west, with an interchange with a separate 'HS2' route built in West London. This could avoid some of the problems identified with options 2 and 3. Services from Heathrow to the Midlands and the North West would need to operate over existing lines *via* Oxford before regaining the use of new high-speed lines from London, extending journey times, but improving HSR catchments in the Thames Valley/South Midlands.

Extending HSR services over existing main lines is a key means to ensure that the benefits of HSR investment is maximised. It would mean that some upgrading of existing lines may be appropriate. Examples would include junction improvements at Woking and Redhill. Some lines will require electrification, and the case for conversion from the southern region 3rd rail electrification to standard overhead systems will also become worth considering.

One possible service development is worth mentioning. With a fast connection southwards from the new station at Heathrow to Woking and Guildford as shown in Figures 3.3 and 3.4, the same route that would be followed by Gatwick trains could be used to reach the line from Redhill to Ashford and so connect with HS1. This might prove a better means of connecting the national HSR network from the north to HS1: that is *via* Heathrow but avoiding a traverse of central London. It could in any event provide a very helpful back-up route and address the problem that may arise of HS1 reaching capacity in due course.

In the next chapter, we describe the business case for the Heathrow Interconnection Network. We have made no attempt at this stage to estimate the wider benefits that would flow across the south east region from this new south-east regional cross-connectivity.

4. *The Case for the High-Speed Rail Interconnection at Heathrow*

The change in the pattern of travel demand in the vicinity of Heathrow resulting from the Heathrow Interconnection Network would be far-ranging. Thus far we have some evidence from modelling work on the aviation and airport related impacts but little evidence on the wider impacts. Fortunately, these as yet unquantified effects are likely to be hugely positive.

We have estimates on the one hand, of the diversion of short-haul air to high-speed rail (estimated at about 6 mppa)[34] and on the other, the possible additional air travel demand that the improved accessibility that HSR would bring (estimated at 4 mppa).[35] The latter is derived substantially from winning back travel from provincial centres in Britain, from people who would otherwise use continental airport hubs. The combined effect is likely to be a reduction in demand for air travel from Heathrow, but the overall effect is relatively modest: potentially 2 mppa, about 3% of current demand levels.

The locations that HSR could serve according to the research carried out for the Committee for Climate Change are set out in Table 4.1.

Table 4.1 – Candidate short-haul aviation routes significantly susceptible to HSR
(shows routes from Heathrow only)

Domestic	**Near-continent**
Glasgow	Paris
Edinburgh	Frankfurt
Manchester	Dusseldorf
Newcastle	Brussels
	Bordeaux
	Amsterdam

Source: Steer Davies Gleave for Committee for Climate Change September 2009; Tables 8.4 and 8.5

With the full HSR network for Britain identified by Greengauge 21, we believe that Aberdeen would also become a significant source of mode transfer from Heathrow and that there is significant potential in further destinations in Europe such as Geneva and Milan as the HSR infrastructure and associated services expand.

The new rail interconnections would bring beneficial reductions in car dependency for access to the airport, the effect of which would be enhanced by the new regional rail services that could be provided. Against this, there would be the new attraction of driving to the airport and using its (capacity-capped) parking provision for journeys by high-speed rail. However, the cost of parking at Heathrow Airport is high, and this factor would militate against large-scale take-up. Overall, we would judge that road use in the vicinity of Heathrow would fall, with significant transfers to the new set of conventional and high-speed rail services. This would add further towards the objective of improving air quality in the area, provided road-space freed up was not allowed to 'back-fill' with further traffic growth.

[34] Source: Systra/MVA for Greengauge 21 *Fast Forward* development programme. This estimate includes potentially some trips originating at Heathrow that have not involved air travel.

[35] See Bow Group *op cit* page 73, quoting section 3.1.5 in a submission by BAA and Arup to HS2 Ltd.

It is also worth noting that both Gatwick and Stansted could be provided with direct Heathrow rail services using the new interconnections.

It is possible in future that there could be somewhat greater role for Manchester, Edinburgh and Birmingham airports for long haul flights. Each of these airports has been identified as being suitable for having HSR stations in Greengauge 21's national strategy. Birmingham International Airport has recently been put forward as an airport suitable for handling demand from the London area once High Speed North West is built, since this line could have a station at Birmingham's airport and offer journey times of (say) 40 minutes from London. It is notable, however, that Stansted Airport has offered this level of accessibility to London for some years but the network carriers have been reluctant to relocate there.

On balance, it would seem unlikely that Heathrow's position as the leading international hub will change, even looking into the longer term.

The business case benefit assessment shown below is based on aviation demand projections consistent with the 2003 Aviation White Paper, and is therefore more accurate in relation to a three runway case. This assumption is not intended to reflect anything other than a need to keep the analysis simple. In a two-runway case, similar benefits – perhaps even greater – would arise, but with a different pattern of air travel. As the combination of runway constraints and poor airport access come to bite at Heathrow, air travellers would shift towards other European airport hubs.

The HSR business case

The infrastructure costs of the HSR connections at Heathrow have been estimated at £3.2bn. These costs were developed by SYSTRA-MVA, with the assistance of BAA for the airport-related costs, and are broken down in Table 4.2

Table 4.2 – Heathrow connection capital costs

Item	Capital cost (£million, 2008 prices, including optimism bias)
Heathrow sub-surface station	£750m
Connections to HS-NW (London direction)	£157m
Connection to HS-NW (Birmingham direction)	£166m
Link from Northolt Junction to LHR	£615m
Connection to GWR/HS-WW	£528m
Connection to SW main lines	£620m
Increased depot costs (from larger fleet requirement)	£324m
Total	£3,159m

Source: Systra/MVA for Greengauge 21, 2009

The business case for the Heathrow part of the HSR network is very strong, with an incremental benefit cost ratio of 4.8:1[36].

[36] *Fast Forward, op. cit.* This provides a good overview of the appraisal techniques and full details are available on the Greengauge 21 web-site at www.greengauge21.net/hsr-development-programme.html.

In terms of demand forecasts, the modelling results suggest that approximately 15 million passengers per annum would use the HSR services at Heathrow, and of those, about six million would be generated from Heathrow itself, another six million from the surrounding catchment area and three million would be connecting to HSR services from rail services to the south of Heathrow.[37]

The demand forecasts and appraisal results are conservative because they take no account of either:

(i) the potential for HSR to HSR transfer at Heathrow (which could be considerable: a land-side hub would be created alongside the airside hub), or

(ii) the additional demand that would arise from the conventional speed services that would be added to the service mix at Heathrow.

[37] Source: SYSTRA-MVA for Greengauge 21. These figures are 2055 forecasts but are based on modest HSR service frequency levels so may be taken as being conservative estimates.

5. *Conclusions*

There are various ways that Heathrow can be served by high-speed rail. Unless care is taken to develop an approach that responds to the needs of longer distance travellers and that is forthright in its aims, the result may be an ineffective compromise. The Transport Select Committee has recently made its views known: it is *essential,* in their view that Heathrow is directly connected to the high-speed rail network.

We have described here an approach that achieves this. It addresses the key problems and the shortcomings of solutions that rely on interchange, whether nearby the airport or in West London. It forms a key part of Greengauge 21's thinking on a national HSR network.

The proposed solution is to create a surface rail hub *at* Heathrow, not merely near to the airport. New links will connect with both the HSR network and with existing main lines and offer the opportunity to operate cross-country services on a combination of the new HSR lines and existing main lines, serving Heathrow *en route*. Heathrow gets interconnected by new rail links and the HSR network gets a hub station located at the airport itself.

The infrastructure needed to create the new rail capacity at the airport has to be new: the facilities for Heathrow Express, Airtrack and Crossrail cannot accommodate either the type or frequency of service needed. There are options for the location of the new station needed for the new HSR and conventional rail services at Heathrow. The choice is affected by the decision on whether or not to proceed with Runway Three, but the business case and planning rationale we believe is strong under either scenario. In any event, what is needed next is a Government-led study of which of the Heathrow station options identified in Chapter 3 works best for the HSR Interconnection Network and for the overall development of the 'Heathrow Opportunity'.

The capital cost of the rail links to serve Heathrow is £3.2bn. The benefits are substantial, and the investment has a benefit cost ratio of 4.8:1.

The advantages of the Heathrow Interconnection Network can be summarised as follows:

- it provides **direct** service connectivity and very attractive journey times from the Midlands, the North and Scotland to Heathrow without compromising journey times to central London and/or Europe by HSR;
- there will be high levels of demand on HSR services which connect the regions to Heathrow and with one another, meaning that the new rail services will be financially viable;
- this relieves pressure on the central London HSR terminal: travellers from south and west of London in particular may find access by rail to Heathrow a better prospect than crossing central London;
- the function and value of the HSR network is widened;
- the major provincial cities are connected with Heathrow;
- an alternative to car use is provided across the M25/M4/M40/M3 corridors; and
- the scope for carbon reduction from displaced short-haul flights and from reduced car use is maximised.

The analysis contained here shows that while other solutions have their merits and could be made to work, each suffers from some significant drawbacks, not shared by the proposed HSR/rail hub at Heathrow.

Given the additional HSR infrastructure (and capital cost) required to deliver the Heathrow Interconnection Network, it may need to form a subsequent phase of HSR strategy after the core London to West Midlands route. If this is the case, proper provision should be made in HS2's plans so that the necessary connections can be added to the high-speed network without undue disruption in due course.

If it is judged desirable, interim arrangements could be established for connections between HS2 and Heathrow Airport, with a purpose-built interchange in West London. Given the evidence of this report, it would seem necessary that the business case for such a project would be based on benefits other than airport access.

It would be inappropriate to propose a strategy that adds capacity – however good the carbon credentials of the transport modes concerned – without considering the question of demand management. In this case, we have identified runway utilisation as the critical variable. We have shown that a reduction of perhaps 5 - 10% in runway utilisation would bring wide benefits from reduced delays at the airport. Currently, flight times may be extended by nearly an hour in peak periods because of planned stacking and aircraft taxi queues and through an extension to advertised schedules.

We therefore propose that along with high-speed rail at the airport, steps are taken to reduce the intensity of runway utilisation. This will be a policy reversal, and does not come cost-free: runway slots have a commercial value. But it is an essential part of the vision for Heathrow identified in this report. It will ensure that the benefits of investment in HSR are not dissipated through poor punctuality and reliability from the aviation side.

This is a vision in which Heathrow, with its predominant position in the UK's global inter-connectivity, is able to serve the whole country and not just London.

The significant environmental challenge at Heathrow concerns air quality, with the looming concern of a significant breach of EU-mandated standards. The problem arises from a combination of aircraft movements and road traffic. The proposed new set of complementary regional rail links, combined with HSR and the existing surface access transport at Heathrow, offer a substantive alternative to car use across a wide geography of the M25 and the motorway corridors leading to it. This can contribute significantly to the improvement needed in local air quality.

Given the completion of the work of Government company, HS2, charged with developing a HSR line between London and the West Midlands and considering how to serve Heathrow, a clear long-term vision for HSR access to Heathrow is now imperative.