

High Speed Rail Group response to Call for Evidence on the Sixth Carbon Budget

Representing companies with relevant experience and an interest in high speed rail, the High Speed Rail Group (HSRG) is committed to supporting the successful delivery of a world-class high speed rail network in Britain. Our members have helped deliver major infrastructure projects in the UK and around the world, ranging from creating entirely new high speed networks through to maintaining and improving the UK's existing rail network. This gives us a unique insight into both the shortcomings in the current network, and the transformative capacity, connectivity and carbon benefits that high speed rail (HSR) can bring.

We are delighted to have this opportunity to inform the Committee on Climate Change's ('the Committee') important analysis regarding how to deliver radical reductions in greenhouse gases to deliver the 2050 net zero target.

A. Climate science and international circumstances

Question 1: The climate science considered in the CCC's 2019 Net Zero report, based on the IPCC Special Report on Global Warming of 1.5°C, will form the basis of this advice. What additional evidence on climate science, aside from the most recent IPCC Special Reports on Land and the Oceans and Cryosphere, should the CCC consider in setting the level of the sixth carbon budget?

ANSWER:

Question 2: How relevant are estimates of the remaining global cumulative CO₂ budgets (consistent with the Paris Agreement long-term temperature goal) for constraining UK cumulative emissions on the pathway to reaching net-zero GHGs by 2050?

ANSWER:

Question 3: How should emerging updated international commitments to reduce emissions by 2030 impact on the level of the sixth carbon budget for the UK? Are there other actions the UK should be taking alongside setting the sixth carbon budget, and taking the actions necessary to meet it, to support the global effort to implement the Paris Agreement?

ANSWER:

As the Committee has set out, the net zero target will require emission reduction on a steeper trajectory in turn necessitating a smaller Sixth Carbon Budget.

Being one of the first countries to adopt climate change legislation and a binding net zero target, the UK has a head start. So in terms of other actions, it is important that the UK now shares successes and learnings - from industry as well as government - to inspire and help other countries to decarbonise faster.

HSRG members are acutely aware of the challenges to industry that the net zero carbon target brings. Our recent report¹ set out examples how new techniques such Building Information Modelling (BIM) and offsite construction are being used to decarbonise the construction of High Speed 2 (HS2), Europe's largest infrastructure project. With the main civils works contracts starting soon, we expect to share more case studies and data as they become available.

Question 4: What is the international signalling value of a revised and strengthened UK NDC (for the period around 2030) as part of a package of action which includes setting the level of the sixth carbon budget?

ANSWER:

In order to deliver the Prime Minister's desire to show global leadership when the UK hosts COP26 later this year, it is critical that the UK's Nationally-Determined Contribution (NDC) is ambitious. This is all the more important in regarding surface transport emissions, which have risen to become the largest single sector.

The first NDCs produced in 2016 were produced to a compressed timetable and lacked detail as to cost effective pathways to deliver the ambition of the Paris Agreement². Adaptation has received even less attention than mitigation (ibid.). Nonetheless NDCs from Japan to Nigeria committed to a modal shift to rail. With the European Union having produced a high level NDC on behalf of its member state, Brexit now provides the opportunity for the UK to set out its own ambitions in detail.

The UK has the third highest aviation emissions globally, behind only the USA and China³. The potential of HS2 to deliver modal shift to mitigate this should be recognised in the UK's NDC. As the Oakervee Review recommended, this will need to form part of a wider package:

"To achieve significant modal shift from both road and air to rail, HS2 should be part of an integrated government strategy to induce this behaviour change, implemented alongside other measures to dissuade passengers from carbon-producing transport modes."⁴

Despite its substantial contribution to emissions, freight was mentioned in just 29% of NDCs identifying transport modes, already a small subset of those submitted⁵. HS2 both frees up capacity for freight to shift from road to rail and itself has potential to shift high

¹ [HS2 – towards a zero carbon future](#) (HSRIL, 2019)

² [Transport in Nationally Determined Contributions \(NDCs\)](#) (International Climate Initiative, 2017)

³ [CO2 emissions from commercial aviation](#) (The ICCT, 2018)

⁴ Paragraph 5.36 in [Oakervee Review of HS2](#) (DfT, 2020)

⁵ [Nationally-Determined Contributions \(NDCs\) Offer Opportunities for Ambitious Action on Transport and Climate Change](#) (PPMC, 2016)

value freight from air, such freight making up about a fifth of aviation emissions⁶. The UK NDC should mention freight, with detail on a credible decarbonisation pathway in the forthcoming Transport Decarbonisation Plan.

B. The path to the 2050 target

Question 5: How big a role can consumer, individual or household behaviour play in delivering emissions reductions? How can this be credibly assessed and incentivised?

ANSWER:

In the short term smarter choices measures have great potential to secure modal shift for shorter distance travel, though these benefits will decay without locking them in⁷. Evidence on strategic transport networks is more limited but the Highways Agency Influencing Travel Behaviour programme around Birmingham produced a BCR of over 13:1 and significant modal shift before funding was ended in 2010⁸. Most recently, many European train operators have reported strong growth at the cost of aviation due to consumer *flygskam*.

In the medium term, infrastructure constraints pose a challenge to simply relying on behaviour change. The West Midlands has experienced the fastest rail growth and key lines such as Coventry-Birmingham are full, likewise the West Coast Mainline between Wigan and Scotland is close to capacity, despite rail only having a modal share of around a third for passenger travel between London and Scotland. Research suggests the likelihood of synergies between the provision of sustainable transport and increasing public acceptance of demand management measures⁹ though there is limited data to confirm this.

Assessing behaviour change is complicated by the potential for modal shift to be combined with destination shifting, for instance the transformation offered by HS2 - in terms of speed, comfort and capacity enabling lower fares - could increase the relative attractiveness of domestic breaks compared to short-haul flights abroad.

In the longer term there is greater scope to influence spatial patterns of development and, through this, incentivise behavior change. The potential to influence these through integrating policies and funding across sectors needs to be considered.

⁶ [CO2 emissions from commercial aviation, 2018](#) (The ICCT, 2018)

⁷ [The effects of Smarter Choice programmes in the Sustainable Travel Towns](#) (DfT, 2010)

⁸ 7.29 in [Creating growth, cutting carbon - making sustainable local transport happen - White Paper](#) (DfT, 2010)

⁹ Åkerman, J. (2011). [‘The Role of High-Speed Rail in Mitigating Climate Change – The Swedish Case Europabanan from a Life Cycle Perspective’](#). Transportation Research Part D: Transport and Environment 16:3

Question 6: What are the most important uncertainties that policy needs to take into account in thinking about achieving Net Zero? How can government develop a strategy that helps to retain robustness to those uncertainties, for example low-regrets options and approaches that maintain optionality?

ANSWER:

The transport sector has had more than its fair share of breakthroughs promised to be just around the corner that have failed to materialise in scale. To deliver net zero by 2050, the focus should, according to new research¹⁰, be on today's technologies rather than placing undue hope on breakthrough technologies to be scalable by then. In practice therefore the key uncertainties are likely to be social or socio-technical. For transport, the biggest uncertainty relates to the replacement of fuel duty and the resulting implications for travel demand.

Small scale incremental improvements, whether solar panels or cycle tracks certainly have their place as low-regret options but megaprojects are important too so as to enable system restructuring, which studies have suggested is needed alongside demand management and technological improvements¹¹. By freeing up existing mainlines through removing non-stopping services, HS2 restructures the rail network and unlocks much more capacity and connectivity than a new largely two-track railway would otherwise be expected to. As the debate about HS2 has shown, this systems level argument has been difficult for some to grasp.

Finally it is critical to consider adaptation in the context of what options are low-regrets. The resilience of new high speed rail lines, compared to existing railways that are almost 200 years old, is an increasingly important element of the case for HS2, for instance¹².

Question 7: The fourth and fifth carbon budgets (covering the periods of 2023-27 and 2028-32 respectively) have been set on the basis of the previous long-term target (at least 80% reduction in GHGs by 2050, relative to 1990 levels). Should the CCC revisit the level of these budgets in light of the net-zero target?

ANSWER:

Question 8: What evidence do you have of the co-benefits of acting on climate change compatible with achieving Net Zero by 2050? What do these co-benefits mean for which emissions abatement should be prioritised and why?

ANSWER:

¹⁰ Allwood, J., et al. (2019) [Absolute Zero](#). Apollo - University of Cambridge Repository

¹¹ Hall, J., ed. (2016) *The Future of National Infrastructure: A System-of-Systems Approach*. Cambridge, UK ; New York: Cambridge University Press

¹² Page 22 in HSRIL, 2019 (ibid)

Prioritising modal shift from road to rail through rail investment has multiple benefits. Although Electric Vehicles reduce NOx emissions and, at low speeds, noise, they still lead to costs of congestion, particulates, road danger and above all lead to very inefficient patterns of land use. With net zero requiring major changes to land use to provide for food, bioenergy and carbon sequestration¹³, in addition to ambitions to secure a net gain for nature, this advantage of rail oriented development will prove ever more important in the decades ahead.

Especially in areas of major housing growth, a step change in rail capacity will be required to ensure no net increase in motor traffic, even more so if a reduction in traffic is sought.

C. Delivering carbon budgets

Question 9: Carbon targets are only credible if they are accompanied by policy action. We set out a range of delivery challenges/priorities for the 2050 net-zero target in our Net Zero advice. What else is important for the period out to 2030/2035?

ANSWER:

As the Committee and indeed National Infrastructure Commission have set out, measures to reduce road traffic demand are needed in the 2020s to address the increase in surface transport emissions. This can in turn be expected to increase demand above existing growth rates on our busiest railways, on which capacity is already constrained, between our biggest cities. Delivering HS2 phases 1 and 2a by 2030 or as soon as possible afterwards is therefore critical.

Further planning is needed for how best to use the capacity freed up by HS2, as there are choices between passenger and freight and between creating new intra and inter regional services, enabling greater modal shift, or maintaining links to London on existing lines¹⁴. Suggestions that HS2 might not deliver for freight, have a significant impact on the road network or lead to fewer services for existing stations are really criticisms of the delays in planning and agreeing future services on the three mainlines that HS2 would transform by freeing up. With the uncertainty over HS2 from Oakervee Review now lifted and the Williams Review expected shortly, the rail sector can and should move forward with this.

The completion of phases 1 and 2A will reduce journey times by 35 minutes to destinations that HS2 will serve further afield. This will increase passenger demand beyond existing high rates of growth, making swift improvement of the rail network between the north and Scotland essential. With HS2 unlocking freight bottlenecks on existing lines, there will be increased pressure for more rail freight paths there too. Work here should not wait for completion of phase 2A¹⁵.

The study into Euston recommended by the Oakervee Review offers the opportunity to reconsider connectivity from HS1, such as for easier interchange or passive provision for a

¹³ [Zero Carbon Britain: Rising to the Climate Emergency](#) (CAT, 2019)

¹⁴ [Better Connections: Options for the Integration of High Speed 2](#) (Network Rail, 2013)

¹⁵ See for instance [Linking north to south](#) (Greengauge 21, 2016)

full connection. St Pancras has limited capacity for a major increase in international passengers shifting from air, so providing additional capacity for passengers accessing international services from HS1 should be considered too.

It is too early following the Oakervee Review to comment on the integration of Northern Powerhouse Rail (NPR) and HS2 into what is now being termed High Speed North beyond to say the aim should be to deliver these in full by 2040, with significant sections delivered before then. The use of sections of HS2 by NPR will significantly improve the Benefit Cost Ratio and carbon case for phase 2B compared to current estimates.

At a more strategic level, given the difficulty in decarbonising materials such as concrete, there should be better integration of carbon modelling in the transport and industry sectors, as the infrastructure footprint (i.e. road construction and maintenance needs) of electric vehicles are as great as petrol and diesel ones, indeed with their extra weight may be greater. Although the division of the Committee's advice into different sectors has served well so far, the challenge of net zero requires making the most of synergies between sectors, particularly for a project the size of HS2. This is covered further in our answers to questions 22 and 28.

Question 10: How should the Committee take into account targets/ambitions of UK local areas, cities, etc. in its advice on the sixth carbon budget?

ANSWER:

As the UK's biggest infrastructure project, HS2 is catalysing wider investment into local transport and greater ambition for modal shift from the car. Birmingham, for instance, is moving forward on a major expansion of its tram network and now with plans to remove private cars from driving through its centre.

The Williams Review is expected to recommend changing the current rail franchising system to enable city regions to run concessions with simplified ticketing, like that which has driven major growth of the London Overground. Combined with infrastructure changes proposed in the Northern Powerhouse Rail and the Midlands Engine Rail, the National Infrastructure Commission's recommendation for investing more in intra-urban public transport, this should create a golden age of rail. The Committee should therefore give full weight to local and regional aspirations to secure modal shift that do not currently appear in DfT forecasts based on past policies and trends or its modelling for the benefits of HS2. One important example is Midlands Connect's work on the potential wider transport benefits that HS2 could unlock far beyond its own stations and services¹⁶.

Question 11: Can impacts on competitiveness, the fiscal balance, fuel poverty and security of supply be managed regardless of the level of a budget, depending on how policy is designed and funded? What are the critical elements of policy design (including funding and delivery) which can help to manage these impacts?

¹⁶ [The True Benefits of HS2 Revealed](#) (Midlands Connect, 2019)

ANSWER:

Unlike other modes, rail provides a funding stream from its users. Because other modes do not pay the cost of their externalities, this disadvantages rail for passenger and freight travel. Ensuring that the polluter pays, such as updating the HGV road user levy to a distance based model, will help readdress the balance as well as improving national competitiveness. Care will needed, such as by considering impacts on transport poverty as well as local impacts of existing transport such as from severance and pollution.

Question 12: How can a just transition to Net Zero be delivered that fairly shares the costs and benefits between different income groups, industries and parts of the UK, and protects vulnerable workers and consumers?

ANSWER:

With HS2 becoming the net zero spine of the UK's transport network, improving access to it across parts of the UK is crucial. Upgrading and electrifying railways from Birmingham to the south west and Crewe to north Wales, plus new sections of line to Scotland and better integration with HS1 (for access to East Anglia via Stratford International and to Kent) should be prioritised.

The capacity offered by HS2 will enable fares to be lowered, particularly off peak. HSR operators elsewhere - whether state run or independent - in Europe have innovated by offering special low fare services but their ticketing and timetabling is often not well integrated. By contrast the UK approach has been to offer low fares, so long as booked in advance, on trains that also offer much higher fares. As noted above, to maximise modal shift HS2 needs to be part of a wider strategy containing demand management policies as well as infrastructure. The fares strategy for HS2 will therefore need to consider the cost of using alternatives and how to incentivise different market segments to shift to rail from less environmentally friendly modes.

Industry as well as government should promote training and enable new opportunities. HS2 at peak construction will employ 30,000 workers and, to help encourage people into this workforce and leave a lasting skills legacy, HSRG has just launched an apprentice network¹⁷.

D. Scotland, Wales and Northern Ireland

Question 13: What specific circumstances need to be considered when recommending an emissions pathway or emissions reduction targets for Scotland, Wales and/or Northern Ireland, and how could these be reflected in our advice on the UK-wide sixth carbon budget?

ANSWER:

¹⁷ <https://www.rail-leaders.com/events/launch-of-hsr-group-apprentice-network/>

Question 14: The Environment (Wales) Act 2016 includes a requirement that its targets and carbon budgets are set with regard to:

- The most recent report under section 8 on the State of Natural Resources in relation to Wales;
 - The most recent Future Trends report under section 11 of the Well-Being of Future Generations (Wales) Act 2015;
 - The most recent report (if any) under section 23 of that Act (Future Generations report).
- a) What evidence should the Committee draw on in assessing impacts on sustainable management of natural resources, as assessed in the state of natural resources report?
 - b) What evidence do you have of the impact of acting on climate change on well-being? What are the opportunities to improve people's well-being, or potential risks, associated with activities to reduce emissions in Wales?
 - c) What evidence regarding future trends as identified and analysed in the future trends report should the Committee draw on in assessing the impacts of the targets?
 - d) Question 12 asks how a just transition to Net Zero can be achieved across the UK. Do you have any evidence on how delivery mechanisms to help meet the UK and Welsh targets may affect workers and consumers in Wales, and how to ensure the costs and benefits of this transition are fairly distributed?

ANSWER:

Question 15: Do you have any further evidence on the appropriate level of Wales' third carbon budget (2026-30) and interim targets for 2030 and 2040, on the path to a reduction of at least 95% by 2050?

ANSWER:

Question 16: Do you have any evidence on the appropriate level of Scotland's interim emissions reduction targets in 2030 and 2040?

ANSWER:

Scotland's recently published draft National Transport Strategy includes many welcome goals, such as decarbonising the rail network by 2035 and decarbonising flights within Scotland by 2040. With aviation being a reserved matter, the potential to reduce or even design out flights between the central belt and London has not been considered there but elsewhere the Scottish Government has been supportive on the potential of an extension of HSR (whether a new line or a mixture of new sections and upgrades) to Scotland, which would also enable rail freight to continue to grow. The strategy does note the £10 billion

contribution of tourism to Scotland's economy and more modelling is needed to assess the carbon benefits of rail upgrades, not least in light of likely changes to consumer preferences and aviation demand management policies in the UK and beyond.

Question 17: In what particular respects do devolved and UK decision making need to be coordinated? How can devolved and UK decision making be coordinated effectively to achieve the best outcomes for the UK as a whole?

ANSWER:

E. Sector-specific questions

Question 18 (Surface transport): As laid out in Chapter 5 of the Net Zero Technical Report (see page 149), the CCC's Further Ambition scenario for transport assumed 10% of car miles could be shifted to walking, cycling and public transport by 2050 (corresponding to over 30% of trips in total):

- a) What percentage of trips nationwide could be avoided (e.g. through car sharing, working from home etc.) or shifted to walking, cycling (including e-bikes) and public transport by 2030/35 and by 2050? What proportion of total UK car mileage does this correspond to?
- b) What policies, measures or investment could incentivise this transition?

ANSWER:

A challenge for national forecasts of potential for modal shift is that there may be local or regional constraints, for instance parts of the rail network between our biggest cities where there are few remaining free train paths and on which net zero policies shift would put the greatest pressure. Although most *journeys* are local, the majority of car *mileage* is longer distance. Without delivery of HS2 phases 1 and 2A by about 2030, creating much needed capacity between the UK's biggest cities, national policies to reduce car miles could be harder to implement. Arguments about the benefits of packages of small interventions over HS2 sidestep this major challenge¹⁸ and it is notable how none of the reports published, other than that we published last November, consider the impact on rail passenger demand from the policies needed to achieve net zero.

Modelling of HS2's benefits assumed a demand cap of zero passenger growth after 2035¹⁹, which should be reconsidered as part of the forthcoming refresh of its strategic case. As noted in the answer to question 9, modelling of future services on railways freed up by HS2 is needed to assess the potential for further modal shift. Again only very conservative assumptions have been used up to now (e.g. compared to the aspirations of Midlands

¹⁸ The claim in [Behaviour change, public engagement and Net Zero - A report for the Committee on Climate Change](#) (Imperial College London, 2019) that rail; electrification would deliver greater carbon reduction than HS2 misses the fact that rail is already expected to decarbonise (see footnote 24) as well as this capacity challenge and the need to reduce Scotland - London rail travel time to address aviation emissions.

¹⁹ E.g. Figures 5.10-5.12 in [The strategic case for HS2](#) (DfT, 2013)

Connect, see footnote 16), and these do not seem realistic given the requirement for more public transport capacity to achieve net zero.

Recent research suggests a greater reduction in car miles than 10% is needed for a trajectory compliant with net zero, even with rapid fleet electrification²⁰. The potential requirements of a greater, more ambitious shift, such as through a combination of road demand management, infrastructure investment and land use changes, should now be modelled.

By 2050, many trips are likely to be different, due to new housing or social patterns, as illustrated by the influence of the internet on shopping, dining and commuting travel over the last few decades. While new services such as ride-hailing and food delivery have reduced car use, they may have created other trips by vans and private hire vehicles. This is another reason why policies, such as rail investment, that enable compact, higher density development are important.

Question 19 (Surface transport): What could the potential impact of autonomous vehicles be on transport demand?

ANSWER:

The starting point is that there is a wide range of scenarios for the potential impact of AVs on transport demand and indeed for electricity and land use²¹. With the challenges of meeting net zero, not least in the transport sector where trends have overall gone in the wrong direction, such novel technology poses major risks to achieving net zero compared to incremental technologies such as rail and e-bikes.

If AVs are introduced without a major reform of vehicle taxation, road traffic would be likely to increase significantly between the UK's biggest cities, leading to increased congestion even allowing for AVs running closer together. If interurban road charging is introduced, then rail gains a cost advantage for users. So for travel between the UK's biggest cities, the market targeted by HS2, it is effectively a case of heads rail wins, tails cars lose.

Question 20 (Surface transport): The CCC recommended in our Net Zero advice that the phase out of conventional car sales should occur by 2035 at the latest. What are the barriers to phasing out sales of conventional vehicles by 2030? How could these be addressed? Are the supply chains well placed to scale up? What might be the adverse consequences of a phase-out of conventional vehicles by 2030 and how could these be mitigated?

²⁰ Hopkinson L. and Sloman L. (2019). Planning for less car use. <https://policy.friendsoftheearth.uk/insight/planning-less-car-use>

²¹ Wadud, Z., MacKenzie, D. and Leiby, P. (2016). 'Help or Hindrance? The Travel, Energy and Carbon Impacts of Highly Automated Vehicles'. Transportation Research Part A: Policy and Practice 86

ANSWER:

Recent progress has shown that major barriers include the supply chain's ability to deliver enough batteries, including sustainability challenges around rare earth metals²², and roll out of charging points, particularly those offering rapid charging.

Longer journeys are the hardest to decarbonise. Though cars are rarely used for long journeys, range anxiety leads to consumer demand for batteries with ever greater capacity. Demand for charging is likely to be highest when longer journeys are made such as around holiday periods and this may also provide a barrier to the phase out. With an average car being unused about 95% of the time and when in use the average car journey being 8-10 miles, the resource efficiency of each private car having a large battery to cater for the possibility of a 150+ mile journey a few times a year will be very low indeed. The combination of pressure to decarbonise transport faster with the battery supply challenges mean that smarter policy is urgently required.

National policy, such as the forthcoming Transport Decarbonisation Plan, should therefore recognise rail as the mode of choice for longer journeys, as it indeed did in 2010. Prioritising and integrating electric car sharing with rail stations in areas would encourage behaviour change and maximise the decarbonisation potential of battery capacity.

Question 21 (Surface transport): In our Net Zero advice, the CCC identified three potential options to switch to zero emission HGVs – hydrogen, electrification with very fast chargers and electrification with overhead wires on motorways. What evidence and steps would be required to enable an operator to switch their fleets to one of these options? How could this transition be facilitated?

ANSWER:

The full environmental costs of rolling out these technologies should be assessed so that they can be compared with greater use of electrified rail freight, such as enabled by HS2. Although recent electrification projects in England have suffered from cost increases, there is scope to reduce the cost by 33-50% in future²³.

While the carbon footprint of constructing HS2 has been carefully assessed, there has been no similar assessment of all the changes needed to electrify freight for instance. Such a comparison is needed to help prioritise investment. The ambition to decarbonise passenger travel on the rail network by 2040²⁴ assists the case for electrifying rail freight.

Changes to agriculture, diets and bioenergy required for net zero are likely to change freight demand, in some areas and corridors more than others. Potential impacts should be considered fully when analysing the best options to decarbonise freight.

²² [We need more scarce metals and elements reach the UK's greenhouse gas goals](#), Natural History Museum, 2019)

²³ [RIA Electrification Cost Challenge Report](#) (Rail Industry Association, 2019)

²⁴ [Decarbonisation – Our Final Report to the Rail Minister](#) (RSSB, 2019)

Question 22 (Industry): What policy mechanisms should be implemented to support decarbonisation of the sectors below? Please provide evidence to support this over alternative mechanisms.

- a. Manufacturing sectors at risk of carbon leakage
- b. Manufacturing sectors not at risk of carbon leakage
- c. Fossil fuel production sectors
- d. Off-road mobile machinery

ANSWER:

A major reviews of transport megaprojects suggested a failure by decision-makers to recognise their potential as agents of change that can stimulate wider sectoral change²⁵.

Reflecting on the recommendation by the Committee's Expert Advisory Group on Reaching Net-zero Emissions in the UK to move beyond a piecemeal sectoral approach, the potential for megaprojects like HS2 to catalyse wider changes should be recognised, such as transforming the construction supply chain²⁶ and enabling more compact housing. This could be through adding an emergent goal to the forthcoming refresh of HS2's strategic case and, separately, as a case study in the advice on the Sixth Carbon Budget.

Question 23 (Industry): What would you highlight as international examples of good policy/practice on decarbonisation of manufacturing and fossil fuel supply emissions? Is there evidence to suggest that these policies or practices created economic opportunities (e.g. increased market shares, job creation) for the manufacturing and fossil fuel supply sectors?

ANSWER:

Question 24 (Industry): How can the UK achieve a just transition in the fossil fuel supply sectors?

ANSWER:

Question 25 (Industry): In our Net Zero advice, the CCC identified a range of resource efficiency measures that can reduce emissions (see Chapter 4 of the Net Zero Technical Report, page 115), but found little evidence relating to the costs/savings of these measures. What evidence is there on the costs/savings of these and other resource efficiency measures (ideally on a £/tCO₂e basis)?

ANSWER:

²⁵ Agents of Change (UCL)

<http://www.omegacentre.bartlett.ucl.ac.uk/mega-transport-projects-as-%e2%80%a8agents-of-change/>

²⁶ See for instance HSRIL, 2019 (ibid)

Question 26 (Buildings): For the majority of the housing stock in the CCC's Net Zero Further Ambition scenario, 2050 is assumed to be a realistic timeframe for full roll-out of energy efficiency and low-carbon heating.

- a) What evidence can you point to about the potential for decarbonising heat in buildings more quickly?
- b) What evidence do you have about the role behaviour change could play in driving forward more extensive decarbonisation of the building stock more quickly? What are the costs/levels of abatement that might be associated with a behaviour-led transition?

ANSWER:

When addressing the challenge of decarbonising heat, the potential to reduce emissions by encouraging higher density new housing through rail oriented development - compared to the prevailing model of road based lower density - should not be overlooked.

Compact homes can require a quarter of the energy needed to construct and heat them compared to detached homes, as there are fewer external walls per dwelling²⁷. In addition, as density increases, so does the viability of district heating. There is however no explicit planning policy connecting density and heat decarbonisation, for instance it is not highlighted in the National Planning Policy Framework in paragraphs 150-151.

Question 27 (Buildings): Do we currently have the right skills in place to enable widespread retrofit and build of low-carbon buildings? If not, where are skills lacking and what are the gaps in the current training framework? To what extent are existing skill sets readily transferable to low-carbon skills requirements?

ANSWER:

Question 28 (Buildings): How can local/regional and national decision making be coordinated effectively to achieve the best outcomes for the UK as a whole? Can you point to any case studies which illustrate successful local or regional governance models for decision making in heat decarbonisation?

ANSWER:

Highlighting how only 1,500 of the 15,000 homes planned around the HS1 station at Ebbsfleet, where district heating had been proposed, the Oakervee Review (ibid.) recommended joining up housing and transport plans better. Planning for energy and heat should be integrated too, indeed there may be scope to secure efficiencies in power

²⁷ Rode, P., et al. (2014) '[Cities and Energy: Urban Morphology and Residential Heat-Energy Demand](#)': *Environment and Planning B: Planning and Design*

transmission and emerging storage technologies by considering rail electrification requirements at the same as planning for electrification of heat.

Question 29 (Power): Think of a possible future power system without Government backed Contracts-for-Difference. What business models and/or policy instruments could be used to continue to decarbonise UK power emissions to close to zero by 2050, whilst minimising costs?

ANSWER:

Question 30 (Power): In Chapter 2 of the Net Zero Technical Report we presented an illustrative power scenario for 2050 (see pages 40-41 in particular):

- a) Which low-carbon technologies could play a greater/lesser role in the 2050 generation mix? What about in a generation mix in 2030/35?
- b) Power from weather-dependent renewables is highly variable on both daily and seasonal scales. Modelling by Imperial College which informed the illustrative 2050 scenario suggested an important role for interconnection, battery storage and flexible demand in a future low-carbon power system:
 - i. What other technologies could play a role here?
 - ii. What evidence do you have for how much demand side flexibility might be realised?

ANSWER:

Question 31 (Hydrogen): The Committee has recommended the Government support the delivery of at least one large-scale low-carbon hydrogen production facility in the 2020s. Beyond this initial facility, what mechanisms can be used to efficiently incentivise the production and use of low-carbon hydrogen? What are the most likely early applications for hydrogen?

ANSWER:

Question 32 (Aviation and Shipping): In September 2019 the Committee published advice to Government on international aviation and shipping and Net Zero. The Committee recognises that the primary policy approach for reducing emissions in these sectors should be set at the international level (e.g. through the International Civil Aviation Organisation and International Maritime Organisation). However, there is still a role for supplementary domestic policies to complement the international approach, provided these do not lead to concerns about competitiveness or carbon leakage. What are the

domestic measures the UK could take to reduce aviation and shipping emissions over the period to 2030/35 and longer-term to 2050, which would not create significant competitiveness or carbon leakage risks? How much could these reduce emissions?

ANSWER:

International experience, not least Eurostar, shows that HSR can be very effective at shifting shorter distance flights to rail. With growing public concern about the climate and greater demand management of aviation, the three to four hour journey time thresholds for which HSR is most competitive may increase, enabling HSR to take a larger market.

With the challenge of decarbonising aviation by 2050 increasingly appreciated, the benefits of securing a rail journey time beneath three hours between London and Scotland's central belt are increasingly clear. Although there are fewer flights to the south west, the importance of services running from there onto HS2 should not be ignored.

Through better integration with hub airports and airlines, HSR can reduce more substitutable short haul connecting flights for long haul passengers²⁸. As noted in the answer to question 9, it is important to consider the potential of HSR to offer an alternative to air freight too.

Aviation demand management in nearby countries and behaviour change is also likely to lead to higher demand for UK rail services from visiting tourists. This should not be overlooked when assessing the case for extending HS2 to Scotland or upgrading the railway between HS2 at Crewe and Holyhead port.

Question 33 (Agriculture and Land use): In Chapter 7 of the Net Zero Technical Report we presented our Further Ambition scenario for agriculture and land use (see page 199). The scenario requires measures to release land currently used for food production for other uses, whilst maintaining current per-capita food production. This is achieved through:

- A 20% reduction in consumption of red meat and dairy
- A 20% reduction in food waste by 2025
- Moving 10% of horticulture indoors
- An increase in agriculture productivity:
 - Crop yields rising from the current average of 8 tonnes/hectare for wheat (and equivalent rates for other crops) to 10 tonnes/hectare
 - Livestock stocking density increasing from just over 1 livestock unit (LU)/hectare to 1.5 LU/hectare

Can this increase in productivity be delivered in a sustainable manner?

Do you agree that these are the right measures and with the broad level of ambition indicated? Are there additional measures you would suggest?

²⁸ Albalade, D. et al. (2015). '[Competition and Cooperation between High-Speed Rail and Air Transportation Services in Europe](#)'. Journal of Transport Geography 42

ANSWER:

Question 34 (Agriculture and Land use): Land spared through the measures set out in question 33 is used in our Further Ambition scenario for: afforestation (30,000 hectares/year), bioenergy crops (23,000 hectares/year), agro-forestry and hedgerows (~10% of agricultural land) and peatland restoration (50% of upland peat, 25% lowland peat). We also assume the take-up of low-carbon farming practices for soils and livestock. Do you agree that these are the key measures and with the broad level of ambition of each? Are there additional measures you would suggest?

ANSWER:

Question 35 (Greenhouse gas removals): What relevant evidence exists regarding constraints on the rate at which the deployment of engineered GHG removals in the UK (such as bioenergy with carbon capture and storage or direct air capture) could scale-up by 2035?

ANSWER:

Question 36 (Greenhouse gas removals): Is there evidence regarding near-term expected learning curves for the cost of engineered GHG removal through technologies such as bioenergy with carbon capture and storage or direct air capture of CO₂?

ANSWER:

Question 37 (Infrastructure): What will be the key factors that will determine whether decarbonisation of heat in a particular area will require investment in the electricity distribution network, the gas distribution network or a heat network?

ANSWER:

Question 38 (Infrastructure): What scale of carbon capture and storage development is needed and what does that mean for development of CO₂ transport and storage infrastructure over the period to 2030?

ANSWER: