Accelerating Investment for Decarbonising UK Freight Transport

Executive summary

Decarbonising
UK Freight Transport

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Decarbonising UK Freight Transport Network is one of the five Decarbonising Transport Networks programme funded by the Engineering and Physical Sciences Research Council (EPSRC), part of the UK Research and Innovation (UKRI). The Network consists of eleven universities and thirty industry partners, that prioritises rigorous and co-created research (academia and industry) to unleash significant investment into the freight sector's decarbonisation and guide enabling policy.

For more information and latest news visit: www.decarbonisingfreight.co.uk

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Decarbonising UK Freight Transport is hosted by University College London. We are partnered with a further ten universities where our academic and research staff are based.

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The decarbonisation of UK freight transport represents both opportunity and risk to UK stakeholders. Shipping, road freight, air freight and rail transport make up approximately 7% of UK's CO_2 emissions. The report will focus on shipping and road freight (particularly HGV's) which have some of the largest shares of UK freight activity and GHG emissions.

Operating over three years, the UKRI funded 'Decarbonising UK Freight Transport' (DUKFT) project has undertaken a series of research projects and stakeholder discussions on how to accelerate investment that can enable UK freight decarbonisation whilst managing risk and maximising opportunity. Three inter-related key findings from the projects are (for more detail see section 'How – can investment be accelerated'):

- UK freight decarbonisation pathways can be most efficiently informed by a whole freight system, whole UK analysis capability. This needs to couple detail on both infrastructure[1] and vehicle/vessel fleets with operational and technology specifics, resolved at granular space and time detail. Agent Based Modelling was evidenced to provide a viable and valuable platform for this objective.
- Co-creation processes are key for future research on UK freight decarbonisation, not only to maximise the relevance and quality of research, but also for the co-benefits of creating and enabling shared visions within stakeholder communities, framing of the challenge ahead and helping to enable a dialogue between industry and government stakeholders.
- Ports are key nodes in the UK freight sector's decarbonisation. They are both interfaces between the modes (road, rail and shipping), but also represent locations where infrastructure and decarbonisation solution synergies are most likely exploited. They are also likely to be hubs for wider offtake of electrification and RFNBO, for example for decarbonising collocated industry. Port's role in the UK's transition needs to be considered broadly to help reframe them as centres for green opportunity.

Why is investment needed?

Freight transport modes have common challenges to decarbonise. They can all further reduce GHG emissions through further efficiency improvements. However, efficiency improvements cannot create the scale and speed of GHG reduction to enable a proportionate response to UK Climate Change Act (2008) objectives. Road freight transport and shipping will rapidly need to transition away from reliance on fossil fuels to new energy commodities and energy supply chains. Sustainable biofuels that could be dropped-in and used with existing fleet and infrastructure, may be used in the sector but are not considered scalable and able to achieve the decarbonisation objectives. Furthermore, drop-in biofuels may increase reliance on carbon fuels and delay transition to net zero. The road freight and shipping sectors both require significant fleet and infrastructure investment.

Evidence compiled through DUKFT indicates the pathways for these modes as follows:

- Maritime freight – predominantly substitution to RFNBOs, but also electrification (in ports, when at berth, and battery electrification for shorter voyages), and wherever possible direct use of wind propulsion.
- Road freight – predominantly electrification, which could be through battery vehicles, road electrification (e.g. through catenaries and catenary enabled HGVs), or hybrid solutions which combine these two technologies. RFNBOs may have a limited role to play in the UK for a subset of routes that cannot make an investment case for electrification infrastructure and are a significantly lower efficiency use of renewable electricity.
- Rail freight - Despite an increasing proportion of the UK rail network being electrified, rail freight still travels predominantly on diesel trains. The transition pathway is similar to road freight, and therefore requires investments in electrification, and isolated use of RFNBO if/where electrification cannot be enabled.

1 e.g. charging, production and supply of Renewable Fuels of Non-Biological Origin (RFNBO) i.e. green hydrogen derived fuels, such as methanol and ammonia, as well as logistics infrastructure such as ports and distribution centres.

What is the gap between investment deployed and what is needed in these pathways?

At the conclusion of the DUKFT project in 2022, there remains a large gap between the investment deployed to decarbonise UK freight, and what is needed for these sectors to reach zero emissions. Public spending aligned with deep decarbonisation of UK freight has been minimal (e.g. a total of £40m in 2021-22), and by association so has private sector investment. This is of significant concern given the longevity of asset lives (fleet and infrastructure), and the timescales that are needed for renewal. Whilst road freight fleet may be able to be replaced through technologies applied to new vehicles alone, for maritime freight, the existing fleet is likely to need either early replacement or retrofit to RFNBO compatibility (which DUKFT found evidence could be achieved).

The report finds that the majority of investment needed to enable decarbonisation of maritime freight is on land, and in the energy supply chain rather than on the vessels. This includes port electrification investment – particularly connections to grid and provision of electricity at berth for cold ironing, as well as investment in the production of RFNBO. Hydrogen investment activity is starting, driven by UK wider hydrogen strategy, and could count towards maritime and road freight decarbonisation investment. But there are limited examples of RFNBO production investment specifically for supply to freight transport. RFNBO production investment could be co-located in or near the port (such as H2H Humber, aiming to develop a 600MW hydrogen production facility), in which case there can be synergy with electrification investment. It could also be located elsewhere in UK with other industry off-takers, or for export overseas. Uncertainty on the relative role and value of UK produced or overseas produced hydrogen may be affecting investment confidence, however this should be countered by recent strengthening of the UK's hydrogen strategy to production of 10GW of low carbon hydrogen by 2030.

For HGV and road freight electrification, there is only activity towards pilot and trials. The nature and extent of investment that will be needed on land or on vehicles will significantly depend on whether the dominant solution is electrified – via Electric Road Systems (ERS) and/or battery electrification of vehicles – or hydrogen-based solutions. An electrification pathway is gaining more traction due to expected costs involved, but the solution for charging road vehicles, and whether this needs to be bespoke for freight vehicles or can be integrated with charging of other vehicles, will also influence the decision-making and investment needs. The urgency of decarbonisation and uncertainty of timelines for delivering energy and transport infrastructure on which freight decarbonisation is dependent implies that there is little time for real-world demonstration projects. This highlights the importance of the role of modelling and simulation, for complementing and minimising

How can investment be accelerated?

DUKFT combined a series of studies commissioned over the three-year period and stakeholder events to help identify actions that could address the evidenced and urgent need for accelerated investment. There were three overarching findings, which resulted in associated recommendations for future research:

1 The need for a whole system, whole UK approach to identify technology pathways

DUKFT found that there was broad understanding in the stakeholder community of the technologies that will be needed to decarbonise freight. Although not widely deployed in the freight sector as yet, components required for deep decarbonisation e.g. batteries, electrolysers, motors, fuel cells and low emission combustion machinery solutions were broadly understood and recognised. Whilst further research into the components could be appreciated (e.g. for performance optimisation and cost reduction), this was not holding back the ability to identify a clear technology pathway for investment. Instead, DUKFT found that clarifying the technology pathway for UK freight is critically dependent on integrating understanding of vehicle and infrastructure technology options, with a detailed representation of UK logistics. The parameters for logistics of cost, time and reliability need to be brought together in the review of any solution.

To date, most efforts to understand technology pathways have focused on techno-economic approaches, that focus only on cost and efficiency. One of the DUKFT studies evidenced how the state of the art could be extended through development of a pilot multimodal agent-based freight system model. Although only at pilot scale, this modelling showed the viability and value of bringing together the specifics of infrastructure constraints alongside vehicle technology options, within a model that could consider both space and time dimensions at the scale of individual journeys.

Furthermore, the modelling showed the value when different freight modes are represented within a single model, for understanding the synergies between modes' decarbonisation solution (for example the potential for leveraging shared infrastructure investment associated with electrification). Multi-modal modelling showed that it is necessary to consider freight modes as a whole system; failure to do so runs the risk of unexpected consequences. The pilot nature of the study meant a broader geographical perspective than a subset of UK freight was not considered, but the pilot showed how larger geographical scales, including those that recognise that maritime and road freight systems have both national and international connections, could help further identify synergies beyond those that take just a technology perspective.

Recommendation: There remains a clear need for identifying and articulating the least-cost technology pathways for UK freight decarbonisation. Mature existing modelling techniques are limited in providing further clarification and this sector would significantly benefit from modelling capability that can integrate operations and technology, space and time characterisation of multi-modal fleet and infrastructure at fine granular scales.

2 The importance of co-creation in freight research

Both stakeholder events, and several of the studies, revealed the fragmented nature of the freight stakeholder space and the challenge ahead for creating a shared vision on how to decarbonise these sectors. Signals had been received by industry stakeholders that major change was expected, including from key strategies such as Transport Decarbonisation Plan, Clean Maritime Plan, however the specifics of policies that will incentivise change are not clear.

In early consultation and studies, DUKFT found little evidence that business-to-business engagements are incentivising freight decarbonisation investment at the speed needed, and clear evidence that stakeholders are waiting on regulation to create certainty for investment to be deployed.

It was a key finding that when effort was invested to bring stakeholders from different parts of freight value chains together (industry, academia, NGO and government stakeholders), there was good potential to identify a shared vision and co-create ideas for both public and private actions aligned with unlocking investment in decarbonisation. DUKFT primarily had the resources to explore co-creation regionally, which showed that even within the UK, freight decarbonisation can require place-based specialisation.

Recommendation: Research funding should deploy a sustained multidisciplinary research effort alongside stakeholder community engagement and ensure a broad spectrum of the freight sector's value chain in co-creating solutions. This can unlock multiple benefits:

- **Academia, acting as an evidence-led information broker can help articulate the scale of investment and change needed, and enable a constructive discussion between industry and government about how decarbonisation can most efficiently be incentivised. Assembling a common view of the challenge ahead and building trust is a key first step.**
- **Enabling a shared vision, underpinned by discussions of specific technology pathways, and potential barriers to solutions, can start to align mindsets and strategies, smoothing the path for regulation and commercial action.**
- **Social science researchers working closely with stakeholders across policy and commercial roles have a key role to play in testing the results from engineering and techno-economic analysis and quantitative modelling, and identifying gaps between theory and solutions that might have more practical benefits**

3 Ports as decarbonisation hubs

DUKFT studies found UK ports can combine multiple roles including being energy consumers, energy suppliers (including to freight vehicles calling to them), and also act as energy nexuses e.g. for interconnecting energy networks, creating charging opportunities and for throughput of offshore or imported liquid energy commodities. This contrasted with views in the stakeholder community that were often focused on narrower nearer term issues such as cold ironing, constraints on accessing grid electricity supply and maximising port throughput.

In particular, ports were identified as having a key role in the development of new energy supply chains associated with RFNBOs. The opportunity could vary depending on the specifics of the port, some may be used as major import terminals for RFNBO produced offshore or overseas. Some may need significant RFNBO storage infrastructure in order to meet the demands of shipping (e.g. bunkering). Others may be suited to local production of blue hydrogen, taking advantage of their proximity to gas and CCS infrastructure or local production of green hydrogen interconnected to large offshore wind generation. The existing collocation of ports with UK heavy industry, and increasingly distribution logistics infrastructure, mean that there are even wider opportunities than looking at their synergies with freight decarbonisation alone.

Recommendation: Further research should continue to explore how ports' opportunities in the transition can be characterised and assessed. This can not only help with the identification of synergies that occur across electrification and hydrogen investment related to the decarbonisation of the port and the UK freight modes connected to it, but also help identify their potential roles in wider UK transition, electrification and use of hydrogen. This should be part of ensuring balance of freight decarbonisation to consider infrastructure investments equally and alongside technology and investment at the vehicle/vessel level.

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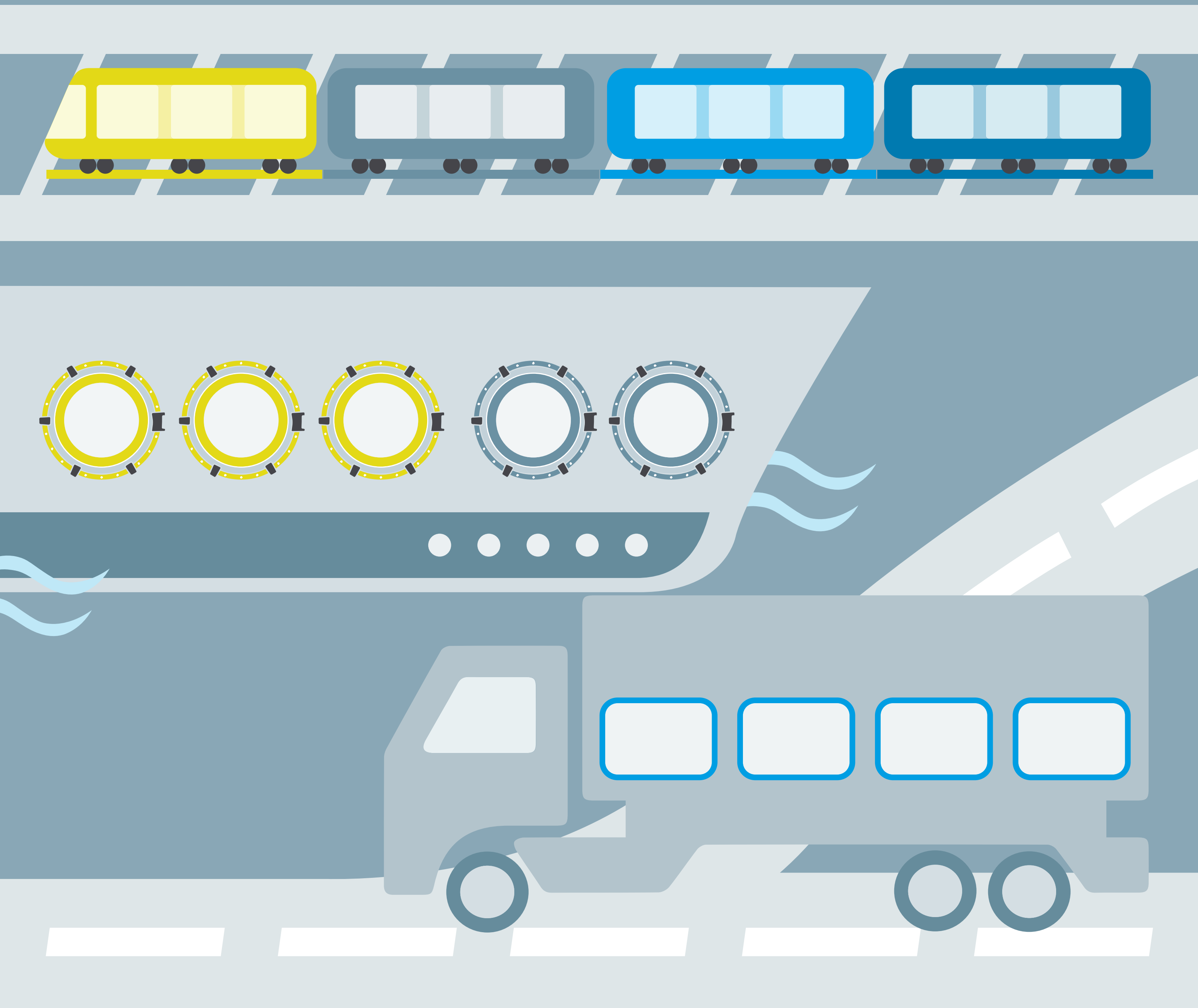

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