Mapping Synergies in the Freight Sector to Enhance the Success of Future Low Carbon Energy Systems

Molly J. Haugen[a], David Flynn[b], Philipp Greening[b], Philip Blythe[c], Adam M. Boies[a]

[a]University of Cambridge, Cambridge, UK
[b]Heriot Watt University, Edinburgh, UK
[c]Newcastle University, Newcastle, UK

Success of the future freight operations in the UK is dependent on the energy system as a whole, and requires a strategic redesigned to amplify key synergies with other sectors and transport modes as the infrastructure is upgraded and adheres to emission and climate commitments. Low carbon initiatives are driving an infrastructure transformation in the UK and there is potential to unlock additional benefits by integrating previously independent well-to-tank energy pathways. Not only is the multimodal overlap in freight distribution important, but the coordination with passenger operations must also be considered in designing the future of freight infrastructure. A low carbon transport future relies on both freight and passenger operations to use zero emission vehicles and fuel generated by a low carbon source (Department for Transport, 2018). By deliberately intertwining the path forward for both low carbon energy generation and passenger and freight operations, optimal greenhouse gas and cost reductions can be achieved.

The advancement of battery electric vehicles is on the rise and is changing the way our energy is distributed and used (Department for Transport, 2018). There is an increase in localised charging collocated with energy generation, which reforms infrastructure requirements compared to vehicles using a centralised refuelling or recharging station. The degree of centralisation, and type of fuel (hydrogen or electricity), has a direct impact on the primary energy demand, fuel or electricity cost for the consumer, and how quickly these changes can be implemented. For example, larger, more centralised energy generation systems have a higher production efficiency but lower distribution efficiency, whereas a localised energy generation processes are less efficient and have higher distribution efficiency. Centralised systems also require more energy and investments for fuel deliveries or transmission/distribution infrastructure than a decentralised system. This analysis will include the difference in energy efficiency, cost of fuel, and the implementation timeline for a more decentralised/localised energy systems compared to persevering with a highly centralised system.

The flexibility and resilience of the analysed infrastructure distribution and therefore overall energy systems, including freight operations, is reliant on the ability to store energy (Energy Research Partnership, 2018). A successful storage system must be integrated into a future infrastructure design and allow energy to be stored for a useful amount of time, with minimal energy loss, and a monetary gain. Here, different utility-scale energy storage systems were compared using a lifecycle cost analysis. These systems were compared assuming a lifespan of 30 years, power converter rating of 100 MW and storage capacity of 500 MWh. The estimated levelised cost of electricity (LCOE) for the energy storage systems considered ranged from 0.17 £/kWh for pumped hydro storage to 1.02 £/kWh with storage via lithium-ion batteries. Liquid air (0.27 £/kWh) and hydrogen stored above ground via electrolysis (0.69 £/kWh) were also included in the analysis.

Relevant literature relating to the degree of which energy systems are decentralised, diversifying energy sources, fuel types, and storage mechanisms will be included in the long-term analysis, but here I will present on how on-road freight operations are an integral component in the energy system as a whole and how optimising synergies between other on-road transport and multimodal operations can expose previously inaccessible energy and cost savings. This will serve as a platform to compile research, literature, reports, and datasets to help guide future decisions in planning the infrastructure for freight operations.

References

Department for Transport. (2018). *The Road to Zero.*

Energy Research Partnership. (2018). *Resilience of the UK Electricity System.*