Demonstrating the GHG reduction potential of asset sharing, asset optimization and other measures

ROAD FREIGTH LAB

A report by Route Monkey,
on behalf of WBCSD members in the
Low Carbon Technology Partnership initiative (LCTPi)

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Executive Summary

Transport accounts for 20% of global final energy consumption, and road-freight is a rapidly growing component of that, especially in developing countries. The WBCSD's Road Freight Lab initiative aims to investigate and select measures that companies can adopt to reduce GHG emissions from road freight transport. This report represents a mature stage in that process, discussing six high potential measures and attempting to quantify their benefits via data collection, modelling, and other evidence. The key outcomes are:

- Use of top-tier asset optimization tools could reduce energy use and emissions by on average 12.5%, and are still to be taken up by approximately 85% of fleet operators;
- The increasing prevalence of tight delivery windows, especially in the 'last mile' context, is set to increase transport energy use and emissions if left unchecked; but relaxing delivery windows from 1hr to 5hrs could lead to savings of 25%;
- Modest asset sharing models that can save 15% of cost are only being used by 20% of operators, while highly integrated vehicle and depot sharing can lead to a 20% savings and is yet to be taken up in the case of at least 85% of commercial vehicle miles;
- Accelerated adoption of immediately available alternative fuels such as biogas and electric vehicles would lead to a 58% reduction in GHG emissions;
- Widespread adoption of vehicle-centric efficiency measures would lead to a 32% reduction in fuel consumption;
- Eco-driver training has been widely adopted in many markets and can save on average 7% GHG emissions by better fuel efficiency.

These findings show that fleet operators have significant opportunities to reduce emissions from freight transport. The solutions relating to alternative fuels and drivetrains, vehicle efficiency and driver training are well known and many local initiatives are in pace to help deploy these across fleets. On the other hand, solutions relating to optimization, relaxing delivery time windows and asset sharing are either not known or the market does not yet offer ready commercial solutions to fleets. Another feature of these latter three solution areas, is that companies will be required to collaborate to reap the GHG reduction benefits that are possible.

The WBCSD will continue to facilitate collaboration between member companies and partners to better understand how these solutions can be developed into viable business models and deployed at scale across road freight transport providers. Given the scale of the necessary challenge to decarbonize transport, the WBCSD and its members recognize the need to develop all solutions. Those described within this report will all be key elements in the fight against climate change in the road freight sector.

Introduction

Transportation alone accounts for 20% of final global energy consumption [IEA Energy Technology Perspectives, 2015][1]. In the EU, transport produces a quarter of the greenhouse gas emissions, of which road transport, passenger, and freight, contributes to over 70% [European Commission White Paper, 2011], consequently, accounting for 15%-20% of emissions.

The freight transport sector will significantly evolve by 2050. The global demand for road freight, measured in ton-kilometers, will almost triple between 2015 and 2050 (ITF, 2017), with the growth concentrating in developing economies. In 2050, non-OECD countries will represent more than 80% of the demand for road freight transport, up from 60% in 2015. Demand will grow particularly strongly in countries where rail infrastructure is not well developed, such as African or South-East Asian countries. It is also expected that road will remain the primary mode of transport for short distances (EC White Paper, 2011).

[1] Note this is a summary of the Road Freight Lab report, see www.wbcsd.org for the full report including list of references

Given the potential to create a meaningful impact the WBCSD is exploring several practical measures that could be promoted for global carbon footprint reduction in the freight sector.

The practical measures suggested can be achieved by majority of operators at low or reasonable cost. Operators fall into two groups: (i) those relating to logistical arrangements, both in the contexts of individual operators, and the sharing of data and other assets between pairs or groups of operators; (ii) those relating to materials and human factors, such as fuels, vehicle modification, and driver training.

For the first group, focus is given to the potential benefits that would arise because of the following three measures:

1. Use of top-tier tools for optimizing routing and resource-allocation;
2. Changing the business context to avoid narrow delivery windows;
3. Promoting the sharing of assets (vehicles and/or depots) between suitable groups of operators.

Regarding materials and human factors the report considers the following measures:

1. 'eco'-oriented driver training;
2. alternative fuels;
3. vehicle-centric efficiencies, via modifications to on-board components or systems.

Benefits of High-Quality Routing and resource/allocation

Road transport routing and scheduling involves meeting conflicting objects such as minimizing vehicle driver's time, maximizing the vehicles' carrying capacity (weight and/or cube), minimizing the distance travelled, minimizing the fleet size, while satisfying cost and service parameters. The granular capability for organizations to be able to select their priorities will ensure efficient utilization of available transport capacity. Computerised Vehicle Routing and Scheduling (CVRS) can bring significant benefits, with typical cost savings of between 5%-30% in comparison to manual processes [Hosny, 2014].

The UK Freight Transport Association (FTA) published a best practice guide that was formulated based on a 2004 survey of 700 FTA members, whom operated 10 or more vehicles with similar fleet profiles. CVRS was reported to be used by 15% of the members of which 75% experienced improved efficiency, 58% reduced operating costs, 38% decreased fuel costs, 29% reduced their fleet size and 29% reduced total mileage.

Former research has focused on comparing different optimization methods with each other, but has neglected to account for the benefits between using machine optimized versus manual optimization route planning methods. For this report Route Monkey Ltd (RM), a member of the WBCSD Road Freight Lab Working Group, has contributed the necessary data from 35 fleets (having 5-52 vehicles). Data for each fleet (spanning the recycling, furniture, foods, removals, waste collection, fuel transport, parcel delivery, pharmaceutical supplies, healthcare, and commercial cleaning sectors) includes both a benchmark plan – reflecting what would have been done without high-quality optimization in use – and an optimized plan.

After analysis of the data WBCSD were unable to determine a correlation between fleet size and percentage mileage savings. Results signified that the more complex the route plan (involving large volumes of data) under short time restrictions results in customers reaping the largest benefits in terms of time, cost, and emissions savings. The broad average of 12.5% emerged as the cost saved due to routing and resource allocation. If all commercial vehicles across the UK all used CVRS 6.4 billion vehicle miles could be saved per year.

The research thus far implies a typical transport cost saving of 10-20%, supporting the business case for this complex integration of software. Nevertheless, WBCSD can tentatively conclude that 85% of the transport market is still yet to transition to use of high-quality route optimization.

Case study

1. The power of optimized route planning and navigation

US Example: UPS integrated technologies for efficient last mile delivery

UPS aims to optimise over 55,000 U.S. daily routes in both efficiency and emissions released. Their latest technology advancement is ORION (On-Road Integrated Optimisation & Navigation), a UPS proprietary routing software that uses package-level detail, customized online map data, fleet telematics, and advanced algorithms.

ORION enhances customer service and reduces miles driven by determining the most efficient delivery route each day. Used in conjunction with other technologies and service offerings at UPS, provides for the most efficient delivery and pickup allocation.

- Package routing technology – Enables real time route adjustments.
- Telematics – Data is captured on more than 200 elements such as speed and engine idling.
- Service offerings – Decreases unsuccessful delivery attempts (UPS My Choice and UPS Access Point).

In 2015, UPS completed deployment of ORION to 70 percent of U.S. routes. When fully deployed to all U.S. routes by the end of 2016, UPS expects to reduce the distance driven by their drivers by 100 million miles annually and achieve a 100,000-metric ton reduction in CO_2 emissions.

Using ORION and other technologies UPS has seen benefits such as;

- Increase in stops per mile since 2011 from 1.44 to 1.51, resulting in the avoidance of 70 million miles travelled, 7.6 million gallons of fuel and 74,000 metric tonnes of CO_2.

Benefits of widened delivery windows

The consideration of time windows in this report stems from two facts. First, scenarios of the 'hard/narrow' type are becoming increasingly prevalent, fueled by growth in e-commerce and associated shifts in customer expectations. Second, the 'hard/narrow' scenario has significant negative implications for mileage and GHG emissions. The results provide potential evidence for legislative action or other mechanisms to dissuade operators and clients from the 'hard/narrow' scenario.

Data was captured from 20 fleets, where 100 separate route optimizations were performed. After modelling, the WBCSD discovered relaxing the delivery window from 1 hour to half a working day **saves up to 25%** of the mileage that would have been covered. Comparisons of findings to literature can be seen in Table 1.

Time window relaxation	% millage saved	Source
2-3hours	7	(Boyer, 2009)
3-9 hours	15	(Boyer, 2009)
1-2 hours	35	(Punakivi 2001)
1-2 hours	6	WBCSD
1-5 hours	25	WBCSD

Table 1: Summary of percentage impact of mileage travelled when relaxing time windows for commercial transport

Boyer (2009) found that there could be up to a 10% variance in mileage/ cost savings when dealing with a dense urban area or sparse setting. The 35% savings stated by Punakivi (2001) seems extreme, however their simulation settings were consistent with high-density urban customers.

Narrow time windows have been found to be valued by 86% of customers followed by 80% prioritizing time slots, of which 49% paid additional fees for their preferred option. Further, 66% of customers had chosen one retailer over another based on their delivery options while half had abandoned an online order because of unsatisfactory delivery options.

The report also indicates that 92% of logistics companies see e-commerce as the biggest growth area. With the e-commerce logistics market expected to grow at almost 10% annually from 2016 to 2020 [Technavio, 2016]. The customer behavior of expecting narrow delivery windows challenges logistics operators who wish to avoid the need to offer narrow/hard delivery windows. Logistics operators require legislative frameworks or other mechanisms to help change the direction of this trend. However, the 2015 Accenture report suggests that absent customers is an even bigger issue than cost management. Thus, minimizing this factor through narrow delivery windows may equally be advantageous. Overall narrow delivery windows have a significant effect on mileage for freight and goods operators.

Benefits of asset sharing

While CVRS can lead to improved operational efficiency, there are limitations to what can be achieved for a single organization. In 2003 around 130,000 lorries travelled empty between Scotland and England, as 31% more tonnage of freight was moved in the opposite direction [McKinnon and Edwards in Green Logistics 2010]. Higher levels of vehicle load utilization have been found to be achieved through collaboration with other companies [McKinnon in Global Logistics 2010].

There are several asset sharing approaches, for the scope of this report three kinds have been characterized. The first approach, backhaul refers to the return trip, where the same truck would normally be travelling empty from B to A. The second sharing approach involves urban consolidation centers' (UCCs); these are facilities – perhaps located at an airport or near a major shopping center – that can be used by multiple operators to deposit all deliveries for (typically) the surrounding urban region. These centers have resulted in reduced mileage of between 60% and 80%, and reductions in GHG emissions of between 20% and 80% (Allen 2012). The third approach, joint optimization of vehicles and depots, essentially involves two (or more) fleets working closely together, sharing a large portion of their joint resources to optimize the service of their current delivery tasks. The third approach is much less evident in practice, and it is consequently difficult to obtain estimates of its impact. We therefore focused on this third approach for the modelling in this report.

Four scenarios of modelling experiments were performed and the results can be seen in Figure 1. Each scenario involved either being set UK wide or London based and either used a diesel or a hybrid diesel/EV truck.

As can be seen there is a significant cost benefit (20% or higher) when fleets operate collaboratively and an additional benefit with regards CO_2 emissions if hybrid trucks are used.

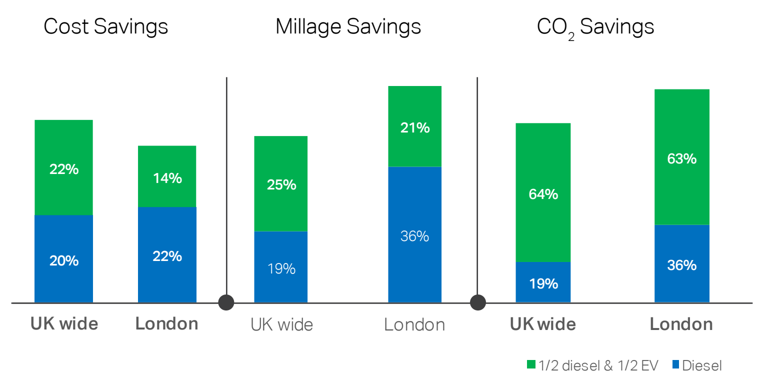

Figure 1: Highlights the percentage potential benefits with regards to cost, mileage and CO_2 emissions when collaborating assets for both diesel and hybrid trucks

In the second set of asset sharing experiments, a set of five simulated long-haul continent-wide fleets were optimized to identify the benefits of multi-national co-operation, and the full range of potential combinations was tested, ranging from all pairwise combinations, through to the combination of all five fleets. Acknowledging model limitations two key findings emerged. The first, the range of benefits, though always significant, is highly sensitive to geographic context and the second independent of geographical context, rapidly diminishing returns are seen when collaboration goes beyond two fleets.

Asset sharing will result in saving 7-70% of GHG emissions depending on the degree to which operations (seen in approaches above) are jointly optimized, the number of independent operators involved in the alliance, and the geographic context. Backhaul-centered asset sharing can lead to emission benefits around 8%, while more extensive sharing of assets between two operators can lead to 15-30% emission and mileage saving, with higher benefits achievable in some cases. Based on the modelling, WBCSD would propose a tentative average of 20%, varying significantly with details, recognizing that pairwise collaborations are likely to be more numerous and achievable in the short to medium term. Meanwhile, a cautious extrapolation, suggests that 85% of current commercial vehicle miles are yet to benefit from such measures. Given the potential for positive impact and current low uptake, we recommend national regulators facilitate collaborative solutions reaching the market.

Case study

2. The benefits of cross collaboration between truck fleets

UK Example – Collaboration Between Nestle and United Biscuit

Two major competitors, Nestlé, and United Biscuit, joined forces to eliminate empty trailer journeys.

This strategic move resulted in many benefits such as the elimination of 28,000 kms of empty trailer journeys, a fuel saving of 95,000 litres, reduce CO_2 released by 250 tonnes, a cost savings of GBP 300,000, and a place to protect both parties' interest.

Nestlé and United Biscuit learnt that their competition is on the shelf, and not in transport logistics. Clear boundaries were put into place to protect both parties' interests. Greater cost and emissions can be saved with a collaborative approach.

Benefits of alternative fuels

While technology and policy may well advance in the future to boost the economic viability of hydrogen fuel cells or biofuels, short and medium term pragmatics seem to favor the recommendation of fuel additives, R-CNG / R-LNG and electric vehicles (EVs) to businesses seeking to meaningfully reduce their carbon footprint quickly at feasible levels of investment.

The use of additive fuels can also provide benefits especially due to the ease with which to implement this solution across the existing fuel distribution infrastructure and vehicle pool. Additive fuels have been enriched with detergents, which clean and keep the main components of engines (injectors and inlet valves) clean, thus improving performance compared to fuels without additives, by up to 4.4% [Total, 2016].

Over the longer term, a mix of advanced biofuels, EVs and FCEVs (both with decarbonized production pathways) will achieve the best GHG emissions reduction results, but these pathways require time for the technologies to reach scale and become more viable. The conversion and infrastructure costs of R-CNG and EV are favorable compared to those for hydrogen, while their emissions benefits profile and fuel costs are favorable in comparison to biofuels; however, it must always be recognized that this is assessed against a constantly changing landscape.

The potential impact of full take-up of R-C/LNG (for the sake of argument) is quantified by first estimating 80:20 (averaged from several sources) for the ratio of 'heavy duty' vs 'light-duty' commercial vehicle miles. It should be noted that CNG tends to be more suitable for light duty vehicles, and LNG for heavy duty [Westport, 2013]. Using lifecycle average estimates for R-C/LNG, we can estimate that full take-up of R-C/LNG for commercial vehicle miles would lead to an 83% reduction in well-to-wheel GHG emissions in comparison with diesel [LFCS, 2009]. Of the 12.6 million commercial vehicles, currently on the road in the US [IHS, 2016], we expect approximately 2.5 million (20%) of these to be using alternative fuels by now or in the near future [AFDCc, 2016]. The potentially addressable commercial vehicle miles can be estimated at 80%. Similar quantification for the addressable miles from an aspirational full take-up of EVs would follow the same argument, and consequently yields the same figure of 80%. Averaging over the R-C/LNG and EV savings (84% and 63% respectively), and considering the addressable miles, we settle on a figure of 58%, representing the 'high-take-up' potential impact of alternative fuels in reduced CO_2 emissions from freight transport. While these numbers are considered possible, it should be noted that both the use of RNG and EVs in road freight operations would need to overcome supply and infrastructure barriers. For instance, there is a significant shortfall in supply of RNG and the cost/performance of batteries would need to decrease significantly for heavier truck applications.

Benefits of vehicle efficiencies

Vehicle-centric efficiency measures tend to be additive and widely applicable, and could lead to an indicative **fuel consumption savings of 32% on average**, if multiple such measures are used and the vehicle is updated regularly. Considering average fleet age, it seems that these measures could be applicable to at least 80% of commercial vehicles.

The efficiency measures in this theme broadly fall into five categories. The first, 'Intelligent vehicle', refers to the exploitation of telematics, GPS, vehicle state and environmental information via intelligent software. The second measure, 'aerodynamics' refers to modifications that can be installed to reduce air-resistance. This measure can produce savings between 3% and 15% [TRB, 2010]. The third, 'rolling resistance', relates to improved tires (in terms of weight reduction and/or tread), along with specifics of their arrangement in multi-axle vehicles, and the maintenance of tire pressure. Fourthly, 'weight reduction', refers to the replacement of components with lower-mass alternatives (e.g. replacing standard panels with aluminum composite versions). The final measure in this theme is, 'auxiliary loads', which concerns minimizing the power demands for systems other than driving the wheels, such as power steering, braking, alternators and fans.

Benefits of driver training

Finally, eco-driver training is widely acknowledged to be one of the most cost-effective means of reducing fuel consumption and GHG emissions in the road freight sector. Greening (2015) cites average improvements that vary from 9% on long haul journeys to 5% on urban journeys, consistent with this 7% fuel efficiency improvement average found by this analysis.

The UK Centre for Sustainable Road Freight concludes that sustained take-up of driver training programs will account for 2.5 Mt CO_2 reduction in the UK by 2035, placing it on a par with a range of 'logistics measures' such as a backhaul, urban consolidation, and acceptance of night-time deliveries, and telematics (Greening, 2015). However, they did not include route optimization among these measures.

Case study

3. How tires can affect the fuel consumption of your truck

USA Example – XOne Truck Tire Deployment by Michelin North America

To reduce consumption and improve the operating efficiency of Heavy Duty trucks, Michelin North America launched the XOne Product Line of Trick Tires in 2001. Introducing products that could be integrated into the existing infrastructure maximized the benefits and the deployment of the technology.

Michelin designed the XOne Product Line such that one tire carries the load that would normally be carried by two. This design configuration resulted in improved fuel efficiency by 3-10% and increased payload by up to 700kg per vehicle. Additionally, the reduced mass of the tire/wheel assembly reduced the environmental footprint at all stages in the products lifecycle.

Michelin found that introduction of innovative products into a mature market is possible as long as they deliver clear understandable benefits to the customer.

Conclusion and policy recommendations

It is clear from the findings within this report that there is large potential to decrease carbon emissions in the road freight sector through a combination of solutions.

While many previous studies and efforts have focused on alternative energies and vehicle efficiency, we cannot ignore the emissions and energy savings possible through novel approaches including optimization and sharing assets. It is important to highlight the complementarity of different approaches. The measures of optimization, sharing assets and relaxing delivery time windows are additive and together offer the potential for over 50% energy and emissions savings. While some may argue that a priority should be to transition to alternative energies to tackle emissions, we believe that all the measures available need to be implemented in parallel. It will be imperative to reduce energy consumption in addition to emissions from road freight transport as this will support energy security and the ability of the clean energy system to cope with expected demand from different end-uses.

Another consideration in designing markets, policies and incentives is the phasing of solutions. There are readily available solutions to implement immediately and with speed. On the energy side of these include fuel additives, so called “drop-in” biofuels and electric (hybrid) vehicles for urban delivery. For efficiency, we can already ramp up solutions such as low roll-resistance tires, driver training and route optimization. These and other early “quick-wins” can and should be implemented widely without delay.

At the same time, more systemic changes that require coordination among several actors and infrastructure investments should start now, recognizing that their full implementation will take longer, but that they must be available in the medium and longer term. These solutions include asset sharing platforms and hydrogen fuel cell vehicles to name but a few.

In each case, the solutions implemented will be chosen by the market and these choices will differ to some extent depending on the local circumstances (such as available resources). Policy-makers should take care to design frameworks that are technologically neutral but serve an environmental/climate outcome. Such an approach will stimulate the market and provide diversity in the solutions available for each end-use case. For the solutions that are pre-commercial and require significant coordination or infrastructure investment, governments can provide targeted incentives to kick-start deployment and market creation.

The findings presented in this report will be taken to the next stage by the companies convened by the WBCSD. This next stage will focus on demonstration of a dynamic data and asset sharing platform to enable route and load optimization across multiple fleets of road freight vehicles. This focus has been chosen given the high emission reduction potential identified and the first-of-a-kind nature of collaboration for applying this concept in road freight.

While we will focus on this solution, it will be important to continue efforts on other complementary efforts. To tackle climate change and the expected growth in demand for road freight transport, all solutions will be required.

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About the WBCSD

The World Business Council for Sustainable Development (WBCSD), a CEO-led organization of some 200 forward-thinking global companies, is committed to galvanizing the global business community to create a sustainable future for business, society and the environment. Together with its members, the council applies its respected thought leadership and effective advocacy to generate constructive solutions and take shared action. Leveraging its strong relationships with stakeholders as the leading advocate for business, the council helps drive debate and policy change in favor of sustainable development solutions.

The WBCSD provides a forum for its member companies - who represent all business sectors, all continents and a combined revenue of more than $8.5 trillion, 19 million employees - to share best practices on sustainable development issues and to develop innovative tools that change the status quo. The council also benefits from a network of 70 national and regional business councils and partner organizations, a majority of which are based in developing countries.

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