

THE DECARBONISATION OF TRANSPORT LOGISTICS: A SOUTH AFRICAN CASE STUDY¹

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1. Introduction

South Africa ranks 13th globally on carbon dioxide (CO₂) emissions contributions and is one of the top 10 carbon-intensive major economies in the world (GDP larger than \$200 billion), with a carbon intensity of 0.972 metric tons of CO₂ per \$1000 of GDP in 2011 (compared to leading countries such as Germany at 0.290 tCO₂ per \$1000 of GDP) (U.S. Energy Information Administration, 2013). During the 2009 Copenhagen climate change negotiations, South Africa pledged to reduce domestic greenhouse gas (GHG) emissions by 34% by 2020 and 42% by 2025 (National Treasury, 2010).

The transport sector (freight and passenger) was responsible for 9.3% of South Africa's total cumulative GHG emissions between 2000 and 2010, with road transport (freight and passenger) contributing 92% of transport sector emissions (Department of Environmental Affairs, 2013). Transport decarbonisation will therefore be an important contributor to national decarbonisation efforts. McKinnon et al. (2014) identified external factors that will impact on company-level efforts to cut freight logistics-related carbon emissions, and classified these into 6 categories using the acronym TIMBER - technology, infrastructure, market changes, behaviour, energy and regulation. This paper applies the TIMBER framework to assess transport decarbonisation activities in South Africa.

2. Methodology

Data, except where otherwise indicated, are outputs from the following models:

¹ This paper is based on research done in association with the Kuehne Logistics University's project on the impact of external factors on the decarbonisation of logistics

- Logistics cost model - bottom-up aggregation of logistics related costs for commodity-level tonnage produced and imported, comprising transport; storage and port-handling costs; management and administration costs; and inventory carrying costs (Havenga, 2010). The model was recently expanded to include detailed externality cost modelling per mode pertaining to accidents, congestion, emissions, noise, policing and land use value (Havenga, in press).
- Freight Demand Model (FDM) - a demand-side model based on the national input-output table to model supply and demand of commodities according to geographical areas, and translating this into modal share through gravity modelling, currently for 83 commodity groupings in 372 geographical areas with a 30 year forecast at 5 year intervals for three scenarios (Havenga, 2013).

Aggregate data for the TIMBER factors are not available and examples of decarbonisation activities, based on secondary research and limited face-to-face interviews, create impressionistic data for future expansion.

To provide context for the decarbonisation initiatives, the macro structure of South Africa's competitive (road and rail) freight transport market is summarised below.

3. Freight transport market in South Africa

Logistics costs as a percentage of GDP plateaued at 12.5% between 2011 and 2013. However, logistics costs as a percentage of transportable GDP (primary and secondary sectoral GDP) steadily increased since 2010, peaking at 46.7% in 2013. Transport costs contributed 62% of logistics costs (Havenga and Simpson, 2013), compared to the global average of 39% (Rodrigue et al., 2009). Transport externalities of R40bn added an additional 15% to already high transport costs, of which almost 40% are due to accidents and 30% to emissions. In 2013, 88% of the country's total freight tonnage, or 70% of tonne-kilometres (tonne-km), was on road. More disconcerting, however, is that 86% of corridor (long-distance) tonne-kilometres were on road. As a result, almost 40% of South Africa's freight transport

costs were attributable to diesel costs, a volatile exogenous cost driver (Havenga and Simpson, 2013).

4. Review of external factors

4.1 Technology

4.1.1 Road freight

South Africa's national road network consists of 19 704 km of which 16% are tolled (SANRAL, 2013). Potential benefits of open-road tolling are a reduction in carbon emissions due to less time spent on the road, and differentiated tolling based on the environmental performance of vehicles (the latter is not applied yet in South Africa).

EU-level estimates point to a 3.2% increase in average fuel efficiency of new vehicles between 2010 and 2020 (McKinnon et al., 2014). Road freight vehicles comprise 27% of total registered vehicles in South Africa, with an exponential rise in the truck fleet from 20 000 vehicles in 1950 to 340 000 in 2012, a compound annual growth rate of 5% (eNatis, 2012). Sixteen percent of the fleet were found to be unroadworthy in 2009 (Barry, 2011). Emissions contribute approximately 30% of road externality costs. Some efficiency initiatives are described below.

Barloworld introduced a "Green Trailer", an aerodynamic trailer, consisting of a superlink taut liner-trailer combination. In a test, the Green Trailer, travelling at a constant speed of between 70 and 80 km/h, resulted in an 11% fuel saving or a reduction of 66.8 tons of CO₂ emissions over a ten-month period (Henderson, 2014).

Smart trucks, extra heavy vehicles currently mainly used off-road in, for example, the timber and forestry industry, provide improved stability, reduced trips, increased productivity, reduced carbon emissions and significantly reduced road wear. Smart trucks are generally longer and have the ability to carry heavier loads than other trucks and are therefore limited to travelling on certain roads. There are currently 60 smart trucks in operation in South Africa, with 30 more in the process of being designed and approved (Henderson, 2014).

Imperial Logistics introduced the “extra distance” campaign, i.e. the difference between the number of kilometres vehicles actually run, and the kilometres required under optimal planning conditions. Initial indications are that eliminating extra distance in their Gauteng and Cape Town fleet could lead to cost reductions of R29 million (De Swardt, 2014).

ECO2Fleet is a web-based fleet management data collection and reporting service that measures carbon emissions and provides emissions reporting data to internationally accepted standards. Almost 500 companies (40 000 vehicles) currently subscribe to this product. One customer reports that, by using this data, average fuel consumption per vehicle across the group’s 900 vehicles fell to below the 10 litres/100km average for the first time, an improvement of up to 30% for some vehicle classes (Arrive Alive, 2014).

4.1.2 Rail freight

The introduction of new-generation locomotives with regenerative braking capabilities on the ring-fenced coal and iron ore export lines (Transnet, 2012) culminated in a reduction of total energy consumption by 3.4% in 2012-2013 (Munshi, 2014). These export “machines” constitute 13% of the network, but about 64% of tons shipped and two thirds of tonne-km of the railways’ current freight task. The objective is to deploy these new technologies in the general freight business.

4.2 Infrastructure

4.2.1 Congestion

Freight vehicle fuel consumption rises quickly when speeds drop below 40 km/hour, with the optimum range between 40 and 70 km/hour. Fuel consumption approximately doubles with an average of one stop per km and trebles when the vehicle stops twice per km (Kuehne Logistics University, 2014). Consequently, fuel consumption and resulting emissions rise quickly under conditions of congestion. In South Africa, congestion adds R4bn (or 10%) to total externality costs. Across 6 major metros, South Africa had a congestion level of 21% in

2013, i.e. a 21% increase in overall travel times when compared to a free flow situation (TomTom, 2014).

4.2.2 Overloading and road quality

Fifteen to twenty percent of heavy vehicles on South Africa's roads are overloaded, accounting for 60% of damage to road surfaces (CSIR, 2009). Almost a third of provincial roads in South Africa are in a poor to very poor condition (SAPA, 2012), and almost 40% of national roads (Kannemeyer, 2013). The quality of the roads *inter alia* impacts the speeds at which vehicles can travel, cause accidents, and damages goods and vehicles. A 2010 wheat transport case study calculated an incremental revenue loss of R1.34 per tonne per trip, or R2.5 million annually for South Africa, due to vibrations when wheat is transported on bad roads (Steyn et al., 2011).

4.2.3 Promoting a shift from road to rail

Given South Africa's freight transport market structure described earlier, the main avenue to address congestion and overloading challenges, is modal shift. Eighty six percent of corridor tonne-kilometres are on road, of which 48% are on the two main corridors Johannesburg-Durban and Johannesburg-Cape Town. Road corridor freight contributes 45% of freight emissions (WWF South Africa, 2013). Dense, long-distance corridors are ideal intermodal candidates. Havenga et al. (2012) estimate that building three intermodal terminals to connect the three major industrial hubs – Gauteng, Durban and Cape Town – through an intermodal solution could reduce transport costs for the identified 22.9 million tons of intermodal freight flows on the two main corridors by 64% (including externalities), resulting in 1.2 million tons CO₂ savings. Initially, targetable freight is identified as palletisable fast moving consumer goods.

The delivery of domestic intermodal solutions has been included in the annual shareholder compact between the national Department of Public Enterprises (the shareholder) and the national rail operator. The recent memorandums of understanding between two of South Africa's largest logistics service providers – Imperial Logistics and Barloworld Logistics – and Transnet support this goal (Diza, 2013; Finweek,

2013). The railway recently signed agreements with two local private firms to test swap body technology within this year (Ash, 2015). There are, however, currently no incentives from government to shift from road to rail.

4.3 Market

A higher degree of concentration will result in greater opportunities for rationalising freight movement, raising load factors and reducing empty running (Kuehne Logistics University, 2014). Competition within the road freight transport industry in South Africa is high. There is an estimated 4 000 operators in the transport for reward market (which is estimated at 60% of total road freight, the balance provided by in-house transport), with the “big 7” handling 40% of this outsourced freight (Department of Transport, 2005). This is negated through collaboration between service providers and freight owners to exploit *inter alia* backhaul or cyclical opportunities.

4.4 Behaviour

The Road Transport Management System (RTMS) was initiated in 2003 in an attempt to self-regulate South Africa’s road freight transport sector after failure to implement the regulated Road Transport Quality System (Collings, 2009; Furter, 2014). The successes, listed below, brought about through RTMS adherence, point to the inter-relation of the six TIMBER factors. RTMS certified organisations reported a reduction in the number crashes of between 40% and 66% over a 5-year period, translating into a decrease in the cost of crashes from 5% of revenue to 1.3% of revenue over a 5 year period for one road haulier. Overloading in the forestry sector was reduced from 18% to 6% in the decade leading up to December 2010, while the sugar industry reduced overloading from more than 30% prior to 2007 to approximately 7% in 2011. The City of Cape Town Electricity Support Services improved fuel consumption from 5.9 km/litre in 2007/08 to 8.3 km/litre in 2010/11. These results are indicative of what can be achieved; substantial efforts are however required to raise awareness to increase certification and compliance (Nordengen and Naidoo, 2014).

Drive Report was launched in 2001 using South Africa's national cell phone network to monitor and mitigate on-road risks and support improved road safety more effectively by targeted driver coaching. It operates through a combination of a 'Report my Driving' hotline bumper sticker, a 24/7 call centre and sophisticated driver-profiling software. In 2006, Drive Report formed a partnership with DriveCam USA. Future goals include integrating the DriveCam smart video technology with Drive Report to provide South Africa's first fully comprehensive Integrated Driver Management system (IDM) with the ability to provide the following functions (Drive Report, 2012).

4.5 Energy

Approximately 88% of South Africa's total energy is supplied by fossil fuels (Department of Energy, 2010). The three largest consumers of primary energy in South Africa is industry (40.8%), transport (27.2%) and residential (20%) (Department of Energy, 2010). Given the structure of South Africa's freight transport market, the consumption of diesel is paramount. The use of biofuels in South Africa has so far been limited. The mandatory blending of biofuels with petroleum and diesel will be introduced from 1 October 2015. The biggest impact will, however, be through modal shift to less carbon-intensive rail. According to the Association of American Railroads (2011), railroads are on average four times more fuel efficient than trucks.

4.6 Regulation

4.6.1 Carbon tax

A new carbon tax, set to be implemented in 2016, is one of the South African Government's initiatives to transition the country towards a low-carbon economy. During Phase 1, Scope 1 emissions (activities under the ownership or control of an entity) above the 60% threshold will be taxed at R120 per tCO₂ increasing by 10% a year during the first 5 years (National Treasury, 2013). Potential benefits of the carbon tax is that it could fast-track a shift to a more efficient, well-maintained truck fleet, but more importantly that it could support a modal shift.

4.6.2 Road freight regulation

Road transport regulation allows for one of the highest permissible gross vehicle mass combinations in the world (changed to 56 tons in 1989 (Parliamentary Monitoring Group, 2000), compared to, for example, the maximum weight of trucks in the majority of EU countries of 40 tons (International Transport Forum, 2011)). Given the important role road freight plays in the South African economy, reduction in GVM will remain contentious and the potential impact should be transparently quantified by a neutral entity with inputs from all stakeholders.

4.6.3 Externalities

Freight transport externalities for South Africa across all modes are estimated to be approximately R40 billion (compared to the total freight bill of R260 billion), almost exclusively attributable to road transport (Havenga and Simpson, 2013). In a market economy, with price the most important decision-making criterion, neglecting to account for the full ecological and social impact of economic activity causes the price signal to fail (Lewis and Conaty, 2012: 34). To allow full cost decisions between modes, it is important to measure and regulate the internalisation of these costs.

5. Concluding remarks

The application of the TIMBER framework to assess transport decarbonisation activities in South Africa indicates that the external (or macro) freight transport environment still poses significant challenges to transport decarbonisation in South Africa. Decarbonisation of South Africa's freight transport industry will be facilitated by:

- Technology: adopting and implementing formal fuel efficiency and economy standards for freight vehicles; deploying rail's export line success in the general freight business.
- Infrastructure: timely road surface maintenance; promoting road-to-rail shift.
- Market: encourage collaboration between service providers and freight owners.

- Behaviour: training and retaining skilled drivers; increasing RMTS certification and compliance.
- Energy: reducing carbon intensity of energy; road-to-rail shift.
- Regulation: implementing carbon emissions reduction policies; internalising externalities.

In addition, aggregate data of industry-wide initiatives such as the DriveReport and ECO2Fleet should be made available to facilitate national measurement and planning, and to prioritise and expand high-impact interventions.

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