SOME THOUGHTS ON REQUIREMENTS FOR CAPACITYBUILDING

MARIANNE VANDERSCHUREN and **TANYA LANE-VISSER***

University of Cape Town, Private Bag X3, Rondebosch, 7701Tel: 021 650 4756; E-mail: marianne.vanderschuren@uct.ac.za*University of Stellenbosch, Private Bag X1, Matieland, 7602Tel: 021 808 4236; E-mail: tanyav@sun.ac.za

ABSTRACT

Oil depletion, global warming and rising fuel prices have made the South African Government realise that it has to move to a low carbon economy. Government realises that there are knowledge and skills shortages that need to be addressed to be able to make the transition to a low carbon transportation system.

This paper explores low carbon transportation and the knowledge and skills needed to enhance existing systems. It makes some detailed suggestions in this regard. However, as the paper draws to its conclusions it becomes clear that a holistic vision of the future transportation system is needed, before knowledge and skills training can be upgraded in a meaningful way. It is recommended that South Africa 'piggy backs' on international research/experience and identifies the transferability of findings. This will guarantee that South African investments will have the maximum impact with minimal risk.

Keywords: *Transport, Low Carbon Economy, capacity building, South Africa*

1 INTRODUCTION

Energy consumption in the global transport sector, from both passenger and freight systems, is growing at an alarming rate (UNEP, 2011). The South African transport system is highly exposed to the risks associated with peak oil and fuel price spikes, given the extent to which petrol-driven private cars, Mini-Bus Taxis (MBTs), and diesel-powered trucks provide transportation for the vast majority of commuters and businesses, respectively. In total, 78% of all petroleum fuels used in South Africa are used in the transportation sector and, within the sector, only 2% of the energy required is not petroleum based (DME, 2006). It is, therefore, of utmost importance to start planning and implementing energy savings measures in the South African transport sector.

Sustainable economic growth will only occur if growth is balanced with social and environmental requirements. In South Africa this implies the inclusion of poverty alleviation and a reduction of the environmental burden (in this context, pollution) as part of the development strategy.

Given South Africa's crude oil dependency and the oil security risk associated with oil depletion, as well as the awareness of global warming and other transport externalities, South Africa is exploring whether to move to a low carbon transport economy. Low carbon transport can be achieved by improving the transport system and/or providing 'green energy' (Vanderschuren et al, 2010b). Although both are important, this paper focuses on the improvements of the transportation system only. Within the transportation field, it has been established that a low carbon economy can be achieved through combinations of interventions from two distinct categories:

1. Pollution reduction interventions
2. Energy efficiency improvement measures.

2 POLLUTION REDUCTION INTERVENTIONS

The European Union (EU) has set standards regarding the fuel quality in its member states, for environmental purposes. The legal framework consists of a series of directives, all amendments to the 1970 Directive 70/220/EEC (EU, 1970). A summary of the standards, when they come into force, what they apply to, and which EU directives provide the definition of the standard, is:

- Euro 1 (1993) for passenger cars (91/441/EEC) (EU, 1991), for passenger cars and light trucks (93/59/EEC) (EU, 1993),
- Euro 2 (1996) for passenger cars (94/12/EC) (EU, 1994) and (96/69/EC) (EU, 1996),
- Euro 3 (2000) for any vehicle (98/69/EC) (EU, 1998),
- Euro 4 (2005) for any vehicle (98/69/EC) (EU, 1998) and (2002/80/EC) (EU, 2002), and
- Euro 5 (2008/9) and Euro 6 (2014) for light passenger and commercial vehicles (2007/715/EC) (EU, 2007).

These limits all supersede the original directive on emission limits (70/220/EEC) and have resulted in a gradual improvement in vehicular fuel consumption and emissions over the years. New cars consumed approximately 10% less fuel in 2002 than they did in 1990 (EEA, 2005). While greenhouse gases from transport were clearly on the rise, emissions of more harmful substances from transport - acidifying substances, particulate matter and ozone precursors - decreased. For example: emissions of ozone precursors (CO, NO_x, NMVOC, CH_4), which accounted for close to 45% of total ozone precursor emissions because of NO_x emissions, dropped by 46% over the period, particularly as a result of a 52% decrease in emissions from road transport (EC, 2007). Catalytic converters are mainly responsible for this decrease, together with the clean fuel directives (Euro 1 to 5) and vehicle pollution verification during the annual vehicle test (Vanderschuren et al, 2010a). If South Africa wants to move to a low carbon economy, the European fuel standards, catalyst converter legislation and annual vehicle test requirements, should be closely followed.

3 ENERGY EFFICIENCY IMPROVEMENT MEASURES

In 2008, the Association for the Study of Peak Oil South Africa (ASPO-SA) and the Centre for Transport Studies at the University of Cape Town were approached by the South African Department of Transport, to investigate energy related risks in the transportation sector as part of the development of their National Master Plan 2050. One of the major focus areas in their study was to identify potential energy efficiency improvement measures. All modes of transport, including passenger and freight transport, were considered in the study.

The analysis was primarily based on a comparison with international literature. Improvements and changes to the propulsion technology used in individual transport modes, the energy technology employed by the behaviour of drivers and transport users, as well as other management measures, were explored as possible solution options. Appendix 1 provides an overview of the measures considered feasible in South Africa (based on Vanderschuren et al, 2010b).The indicated potential saving will only materialise over time (given that the planning period was until 2030). Moreover, the reader needs to realise that potential percentage gains are not mutually exclusive and, therefore, cannot be summed. During the study (ASPO-SA et al, 2008) it became clear that only the implementation of a basket of measures will be able to adequately meet future challenges.

4 CAPACITY BUILDING REQUIREMENTS

Given its importance to the South African economy, it is of utmost importance to understand all facets of the current and potential future transport sector; from the infrastructure, vehicle maintenance and sustainability requirements, to the operational and policy aspects. Table 1 provides a summary of the facets that need to be included to be able to move to a low carbon transport economy.

Table1: Facets of the South African Transport System

Infrastructure	Vehicle	Operations	Policies
Modes Network design Hubs/interchanges Modal integration	Vehicle design Propulsion systems Lightweight materials Maintenance	Public transport services Fleet management Traffic management Travel Demand Management Driver behaviour	Energy security Land use Taxes and rebates Subsidies Standards Behaviour push

4.1 Infrastructure based training requirements

Infrastructure includes the following modes: air, water, rail and road transport (pipelines are excluded from this paper). In general, South African infrastructure is under threat. Various parts of the infrastructure need maintenance and the capacity for sections of the infrastructure is only sufficient for the near future. The infrastructure section is, mostly, based on the SAICE Infrastructure Report Card (2011). This report summarises hundreds of pages of research by the CSIR and other reputable institutions and individuals. Being the most recent elaborated research on the state of South Africa’s infrastructure, the authors assume it most accurate.

Airports (ACSA owned) are, currently, in very good condition, as they have recently been upgraded to serve tourists during the Soccer World Cup in 2010 (and leaving a legacy behind). Capacities and maintenance will be sufficient for the next five to ten years (SAICE, 2011). South Africa, clearly, has access to the knowledge and skills needed to upgrade and maintain airports.
Expenditure on upgrading and providing new port infrastructure, owned and operated by Transnet, has continued at a steady pace since 2006, with a number of large projects already completed, including the new port, Ngqura. Other ports are ageing, but well maintained. The South African commercial ports are scored at ‘fit for the (near) future’ (SAICE, 2011). Human resource capacity is, therefore, assumed to be sufficient at this moment in time; although there might be human capacity shortages in the medium to long term.

Regarding rail infrastructure, the system can be separated into a freight system and a passenger system. According to the SAICE Infrastructure Report Card 2011 (SAICE 2011), only the two main heavy haul freight rail lines are, currently, in a good condition. However, the demand on the heavy haul lines is near capacity, providing a risk regarding infrastructure maintenance. All other lines, including passenger lines, score between satisfactory to poor (at risk) for branch lines. Furthermore, many railway engineers in Transnet (currently responsible for the infrastructure maintenance and operations) are nearing retirement, providing a further threat to the rail system. This, also, provides a risk when shifting road freight to rail (see also the section on behaviour push policies). Although the maintenance of rail infrastructure can be outsourced, the total railway engineering capacity in the country will need to be supported by enough human resources. South Africa has some training capacity, although a detailed analysis would need to be established as to whether the training capacity is sufficient.

The ever increasing tonnage on the South African road network provides a threat to the current infrastructure. According to the SAICE Infrastructure Report Card 2011 (SAICE 2011), national roads are in good to excellent condition, due to recent investments, maintenance and upgrades. Metropolitan roads are, generally, also in a satisfactory condition with less than 10% in a poor to very poor condition. Paved provincial and district roads and all gravel roads, however, are fair to very poor. Nonetheless, South Africa has a long history in road engineering. The 'padmakers' have built impressive passes, highways and the like. Various tertiary institutions in this country, specifically the Universities of Pretoria and Stellenbosch, have a strong focus on road engineering. Furthermore, the number of Civil Engineering graduates from these universities has been growing over the past couple of years; the University of Pretoria has doubled its graduates over the past five years, while the final year student numbers at the University of Stellenbosch has grown by 500% in the same period. It is, therefore, unlikely that human capacity on road engineering becomes a threat. Having said that, if capital expenditure does not meet investment requirements, well trained engineers might leave for overseas work opportunities. The age profile of SAICE membership, clearly, shows that South Africa has suffered from engineers leaving the profession and or the country, in the past.

A further important infrastructure element is hubs and interchanges. South Africa does not have a lot of experience with hubs and interchanges. There are only a few public transport interchanges and rail freight hubs. Furthermore, some privately owned companies (retail chains and the like) own distribution centres. The lack of appropriate hubs and interchanges jeopardises current operation and potential modal integration. Investment in research and development (R&D) will be needed to make sure that the appropriate knowledge and skills are identified to improve hub and interchange operation improvement and advance modal integration.

4.2 Vehicle based training requirements

Around the world, Research & Development (R&D) institutions are investigating more sustainable vehicle design, propulsion systems and using lightweight materials to make planes, ships, trains and road based vehicles for low carbon systems (Vanderschuren et al, 2010b). The investments required to become among the world's best, regarding this type of R&D, would be tremendous. It is not recommended that South Africa makes an investment of this kind. However, R&D regarding the transferability of overseas findings to the South African context is recommended. Moreover, an investigation regarding speedy policy amendments, once R&D results become available, is also needed.

Besides improvements to the vehicles, it is also of utmost importance that planes, ships, trains and road based vehicles are maintained properly. South Africa only requires proof of maintenance for specific vehicles, such as aircraft and public transport vehicles. Changing policies and legislation, together with providing the knowledge and skills to enforce better maintenance (most probably through vehicle testing) is required. This would provide an immediate benefit.

4.3 Operational training requirements

The supply of public transport is of utmost importance in countries such as South Africa, where 75% of people have no access to private cars (NDoT, 2005). Operational skills regarding the supply of public transport are, therefore, needed. Focussing on formal public transport, South Africa has experience with the supply of rail services and traditional bus services. However, the recent investments in Bus Rapid Transit (BRT) systems require skills development. BRT systems incorporate various complex components that all need to be understood and optimised. The implementation challenges for the first phase of the IRT, in Cape Town, suggests that the current South African knowledge and skills base is not enough to guarantee the growth of BRT systems that is needed to supply sufficient, low carbon transport in the future.

Fleet management systems are based on navigation technology with feedback links to the operators. Operators are able to follow the vehicle, analyse driver behaviour and take steps if behaviour is unsatisfactory. Fleet vehicle tracking systems are introduced by companies to get a better idea about the whereabouts of their vehicles and to optimise goods flows. One of the benefits of these systems is a reduction in fuel consumption by between 15% and 25% (Baas and Latto, 2005; Vanderschuren, 2006).

Intelligent Traffic Systems represent a cost effective way to improve traffic flows, for all modes of transport. It has been demonstrated that techniques which improve road traffic management, adopted internationally, reduce fuel consumption by between 5% and 20% (Willekens et al, 2008; Vanderschuren and Jobanputra, 2005; Immers et al, 1994). Two systems have been identified as having the largest impact, namely: (1) optimising traffic controllers; and (2) variable speed limits, which can be implemented through government investment in highway systems with Variable Message Signs (VMS). A severe human capacity gap has been identified regarding traffic management, especially for the road system. In the South African context, energy waste could be twice as high as the international studies reviewed.

Travel Demand Management (TDM, also called Mobility Management) is a general term for strategies that result in more efficient use of transportation resources. Most individual TDM strategies have modest impacts, affecting a small portion of total vehicle travel, but their impacts are cumulative and synergistic. An integrated TDM program can often reduce 20-30% of private vehicle travel where it is applied. Some studies suggest that comprehensive implementation of TDM strategies, to the degree that they are economically justified, could reduce total vehicle kilometres travelled by more than a third (www.vtpi.org). TDM measures include measures such as: border control streamlining, improved air control, car/ride sharing, adaptive work schedules, tele-working, tele-learning or tele-shopping and shifts to more sustainable modes. Before investing in capacity building, it is recommended to choose the TDM measures that South Africa is focusing on first.

Aggression and a lack of driver education (as can also be seen in the high fatality rates), have proven to be important reasons for energy inefficiencies in South Africa. International studies show that improved driver behaviour (with or without technology assistance), can reduce fuel use by up to 35%. Investment in improved driver training, including economical driving, is required.

4.4.1 Policy based training requirements

According to the DME's (2007) Energy Security Master Plan – Liquid Fuels, indications are that oil will run out sooner rather than later and a transport strategy that is over 90% dependent on oil is guaranteed to land South Africa in serious trouble in a few years time. The *Master Plan* recommends that the national petroleum company, PetroSA, procure 30% of all crude oil imports in order to reduce the risks associated with reliance on private oil companies, which currently source more than 80% of South Africa's imported crude oil from the Middle East. The *Master Plan* further recommends that at least 30% of refined petroleum fuels continue to be manufactured from domestic raw materials, as is presently the case (DME, 2007). Unfortunately, it has to be concluded that neither of these two suggestions will move South Africa to be a low carbon economy. Only renewable energy is low carbon and knowledge and skills levels, regarding renewable energy sources, is scarce in this country. Human resource investment is urgently needed.

Land use management has the greatest potential to reduce vulnerability of oil depletion and rising oil prices in the medium to long term (Vanderschuren et al, 2010b). Land use measures will, therefore, promote a low carbon transport system. Travel demand is, in large, a function of land use patterns and access to a variety of destinations, markets and services. Changes in land use development that improve accessibility by alternative modes or reduce the travel distance required will, therefore, reduce the need to travel by private vehicle and thus improve resilience to sustained high oil prices. During the first decade after the first democratic elections in South Africa, land use planning did not really change. In Cape Town and Gauteng, poor settlements were located at the outskirts, following the previous apartheid trends (Harrison et al, 2003). This indicates that land use planning, knowledge and skills, still need further development in South Africa. Moreover, human resource development is also needed, regarding auditing processes for new developments, as they currently are not in line with policies.

There are various ways of taxing road users. Most commonly, localised taxation is used around the world. Road Pricing is the term commonly used, which means that motorists pay directly for using a particular roadway or driving in a particular area. Road Pricing can be implemented as a demand management strategy, to fund roadway improvements or for a combination of these objectives. Economists have long advocated road pricing as an efficient and equitable way to pay roadway costs and encourage more efficient transportation. Although the Gauteng road tolling system is facing a lot of opposition, Road Pricing should also be considered as a way of prompting car users to make greater use of public transportation, moving South Africa to a low carbon economy. South Africa has some experience with tolling, so it is unlikely that a human resource bottleneck will occur. However, it is unclear how further implementation of taxes should be implemented. R&D is needed to identify the most promising tax (and/or rebate) initiatives, such as taxing Single Occupancy Vehicles (SOV's) and Sport Utility Vehicles (SUV's).

Subsidies are the other financial policy with the potential to promote a low carbon transport economy. Besides public transport subsidies, other countries subsidise small carbon friendly cars. Furthermore, investments in renewable energy systems are subsidised, even in this country. Further, R&D needs to establish which other subsidies can speed up the move towards a low carbon transport system.

The most promising and direct policy to promote the move to a low carbon economy is setting standards. Section Two of this paper explains the European fuel standards. It is recommended that South Africa follows European standards promptly, which is already the case. Furthermore, South Africa should set other standards, such as vehicle pollution standards. Investigating standards that will promote the move to low carbon systems will need to be an ongoing process.

Pushing humans to change their behaviour is a complex process. Understanding human behaviour, as well as marketing strategies, is needed. The South African transport sector does not have a lot of experience influencing human behaviour to move to low carbon behaviour. Experts should be consulted to establish suitable behavioural push strategies. It is not expected that skills shortages will occur in this field.

4.5 Résumé

The authors realise that the South African transport system, in its current form, and the possibility of moving to a low carbon system, is a complex but critical issue. This paper, therefore, does not attempt to give a full overview of the skills development needed to generate this complex move. The paper attempts, however, to prompt the discussion (and identify required research) needed to kick-start the transport system transition. To conclude the review, a SWOT (Strength, Weaknesses, Opportunities and Threats) analysis was conducted. The results of the SWOT analysis are provided in Table 2.

From the SWOT analysis it is clear that the weakness is the lack of R&D, mainly into the transferability of international research into the South African context, a lack of knowledge on low carbon transport measures, and a lack of vision on how to transfer the current system into a sustainable system. An important opportunity is the possibility to utilise international research findings. This means that South Africa does not need to make excessive investments into R&D, but investment into R&D is needed to identify transferable measures and establish a vision regarding the transition into a low carbon transport economy.

Table2: SWOT analysis of South Africa's transition to a low carbon transport system

Infrastructure	**Strengths** • Airport provision and maintenance • Ports fit for the near future • Heavy haul rail (export lines) • National road network (with some exceptions)	**Weaknesses** • Non-export rail lines • Passenger rail lines • Road provision in rural areas • Road maintenance in various municipalities and rural areas • Freight hub and public transport interchanges
	Opportunities • Boost rail engineering • Investment in roads • Investment and R&D in hubs/interchanges	**Threats** • Long term risk regarding ports • Maintenance of rail; even heavy haul • Freight on road network • Lack of R&D in energy infrastructure needs
Vehicle	**Strengths** • Global market forces	**Weaknesses** • Local R&D is too expensive • Slow adoption of international trends • Lack of maintenance requirements
	Opportunities • Piggy back on international research • Annual vehicle testing schemes	**Threats** • Lack of R&D into transferability • Weak policy implementation
Operational	**Strengths** • Investment in public transport • High-tech fleet management systems are available • Short term potential improvement through traffic management	**Weaknesses** • Current public transport operation • Current driver training • Knowledge on TDM implementation
	Opportunities • Public transport investment • Public transport operation standards • Economic drivers promoting fleet management	**Threats** • Lack of training in public transport and fleet management operations • Lack of driver training • Lack of R&D into TDM • Border control procedure improvements
Policy	**Strengths** • Fuel standards	**Weaknesses** • Focus on traditional fuels • Lack of policy and strategy implementation • Lack of enforcement • Tax benefits for guzzlers
	Opportunities • Subsidies for low carbon transport (small vehicles, NMT, use of public transport) • Emissions standards • Efficiency standards • Import policies (no guzzlers)	**Threats** • Lack of R&D into preferred policies • Human behaviour

5 CONCLUSIONS AND RECOMMENDATIONS

The South African Government is exploring ways to move to a low carbon future. Capacity building is one of the areas that needs to be addressed, to make sure that the transport system is able to support a low carbon economy, in the future. However, capacity building has no future if South African policies, and overall leadership, are not in place to change the current system so that the newly created capacity will be utilised properly. Training and skills development are not enough to address capacity issues. If no employment possibilities are available, it is very likely that skilled people will leave the country to find employment elsewhere.

This paper explores the different areas within the transportation field where human capacity gaps have been identified. Although these capacity gaps need to be addressed, capacity management of the entire transport system is needed to address the short comings, in the long run. Transport is a complex system and integration between various role-players is required. However, the capacity of the people currently in charge is often limited to a specific part of the transport system. Holistic decision making, based on system thinking, does, therefore, not happen. The first step to address this shortcoming is assessing the need for data collection, processing, storing and analysis in the transportation field to assist good decision making. A related knowledge area that needs to be secured is in the Information and Tele-communication (IT) field, which includes data mining and data manipulation skills.

South Africa suffers from a lack of R&D and skills training, as identified in the SWOT analysis. However, it is not recommended to invest in R&D to re-invent the wheel, by investigating systems that are already under investigation overseas. R&D, in South Africa, should focus on identifying the transition steps to a low carbon transport system. A lack of knowledge on low carbon transport measures, and a lack of vision on how to transfer the current system into a sustainable system, further delays progress in this regard.

In conclusion – capacity building needs to follow a top-down approach: the decision makers need to clearly identify the goals and objectives of the capacity development initiative, after which the key capacity shortages can be identified and the most appropriate capacity building initiatives to fill these gaps can be launched.

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Appendix 1 Transport efficiency measures and their potential impact

Measure	Description	Source
Mode improvements • Smaller vehicles (10%-20% (P); 7%-15% (F)) • Tyres (2%-8%) • Aerodynamic fittings (4%-19%) • Lightweight materials (1.8%-30%) • Regenerated breaking (up to 10%) • Rolling resistance (0.1%-17%) • Aircraft improvement (20%-70%) • Ship improvements (5%-30%)	Mode design and the use of alternative (light weight) materials can improve energy efficiency, in the transportation system, substantially. In the past, propulsion improvements were counter balanced by increases in (private) vehicle size (Jansen, 1995). Recently, smaller and lighter vehicles have become accepted in the market. Large campaigns and financial incentives have started to change the consumers' behaviour, mainly in Europe. In South Africa, the trend towards large vehicles still continues. Between 2000 and 2006 sales in sedan vehicles decreased by an average of 1.76%, whilst sales of SUVs and hatchbacks have increased by 21% and 4.2% on average, respectively (based on Naamsa sales database). Nonetheless, in the period under investigation in this paper, this is expected to change.	Ang-Olson & Schroeer, 2002; Baas & Latto, 2005; Bendtsen, 2004; IAC, 2007; Immers et al, 1994; Markstaller et al, 2000; Ogburn & Ramroth, 2007; RMI, 2007; TMC, 1998; Vanderschuren & Jobanputra, 2005; www.enviro.aero; www.iata.org
Energy improvements • Hybrid-electric vehicles (3%-106% (P); 55%-140% (F); 75% (B)) • Electric vehicles (up to 100%) • Hydrogen (20%-43%) • Biofuels (6%) • LPG (5%)	Vehicle manufacturers are investigating the use of alternative energy sources, such as the use of (hybrid) electric or hydrogen vehicles. The efficiency of these sources depends on the production techniques and production capacity (South Africa has electricity production capacity problems). Furthermore, hydrogen is not a source but an energy carrier and there are severe energy losses during the formation process. The implementation of new energy sources will require distribution infrastructure implementation. Biofuels can replace some of the oil based products, but food security is an issue. Biofuel production is, therefore, capped in South Africa. LPG (a by product of the traditional refinery process) is currently wasted in South Africa.	An et al., 2000; Deffeyes, 2005; EPA, 2007; Eskom, 2008; Gilbert & Perl, 2008; IAC, 2007; Lovins et al, 2005; Science Daily, 2008; Stodolsky, 2002; Strahan, 2007; USDEEE & ER and EPA, 2008; USDEEE & RE, 2008; Vanderschuren et al, 2008; Wurster, 2003
Behavioural improvements • Driver behaviour (15%-25%) • (up to 33% (P); 5%-35% (F)) • Driver assistance systems (up to 23%) • Carpooling (5%-15%)	Driver behaviour can have a severe negative effect on fuel efficiency. Aggression and a lack of driver education have proven to be one of the reasons for energy inefficiencies in South Africa. International studies show that improved driver behaviour (with or without technology assistance), can reduce fuel use by up to 35%. Car pooling and reduced idling also	Ang-Olson & Schroeer, 2002; Baas & Latto, 2005; Ogburn & Ramroth, 2007; Stodolsky, 2002; USDEEE & RE and EPA, 2008; Vanderschuren, 2006; Van der Voort, 2001;

• Idle reduction (10%-27%)	decreases fuel use. Idling is a major problem in the South African rail industry. An interview with one of the employees of the South African rail company revealed that 5% of diesel is wasted by locomotives idling in the yard.	www.carsharing.net; www.iata.org; www.vtpi.org;
Management improvements • Integrated TDM (5%-30%) • Public Transport (PT) priority (10%) • Road efficiency measures (4%-20%) • Vehicle maintenance (1%-50%) • Company cars and travel allowance (up to 20%) • Fleet tracking systems (15%-25%) • Consist management (5%) • Redesigning auxiliary load (2%) • Air infrastructure and operations (up to 18%) • Air traffic management (up to 12%)	The road manager, vehicle owners, as well as professional (public) transport companies, can reduce the demand for oil based energy sources by reducing the inefficiency in the system. Travel Demand Management (TDM) encourages people to avoid, shift or replace trips. This can be accommodated through the improvement of public transport, the provision of e-services, and the like. One way of improving public transport services is giving priority at intersections. In general, better maintained traffic controllers (traffic lights) will improve energy efficiency. Another road efficiency measure included in this study is flexible speed limits. In rail-based freight operations, consist management is the manipulation of train length, car placement, and locomotive placement based on operating speed, tonnage, and terrain. Finally, the improvement of fleet (and air) management provides substantial energy efficiency potential. Included in these measures are route optimisation and the reduction of empty trips.	Ang-Olson & Schroeer, 2002; Baas & Latto, 2005; CSIR, 2007; DME et al, 2002; Handy & Mokhtarian, 1996; IEA, 1996; Immers et al, 1994; Lovins et al, 2005; Martens & Korver, 1999; Taylor, 1999; Tichauer & Watters, 2008; USDEEE & RE and EPA, 2008; Vanderschuren et al, 1993; Vanderschuren & Jobanputra, 2005; Vanderschuren, 2006; Willekens et al, 2008; www.enviro.aero; www.flightsciences.com; www.freight-village.com; www.iata.org; www.vtpi.org; www.4Freight.net;
() = potential energy efficiency benefit margins according to international literature; P = Passenger cars; F = Freight vehicles; B = Buses		

Note, a full list of sources, used in this appendix, can be requested from the authors.