9.1 Introduction

Given the interlinked relationship between energy and the environment, and the transport sector’s 34% contribution to energy use in South Africa, it is crucial that there be an integrated approach to transport decision-making processes that incorporates and takes both sectors into account.

Discussed in this chapter are the implications of energy and environmental considerations for transport planning, as well as proposed strategies for the incorporation of these important macro-aspects into an integrated national master plan for transport in South Africa.

9.2 Energy Implications for Transport

In South Africa, most of the current needs for transportation require access to petroleum-based energy sources, as available in and as dictated by the market. It is, therefore, imperative that there be synergy between the planning of national transportation and national energy and that the possibility of using emerging alternatives such as new fuels should be explored. Transportation objectives must be aligned with the country’s energy supply–demand conditions. In this regard, South Africa’s Integrated Energy Plan (IEP) and Integrated Resource Plan (IRP) are important strategies to which the NATMAP 2050 needs to be linked. This chapter ties in with the information and objectives in these strategies.

9.2.1 Energy use in the transport sector

In 2006, the transport sector used an estimated 27% of the energy that was consumed in South Africa during that period. This increased to an estimated 34% in 2010 and is projected to increase to approximately 44% of the total energy demand by 2050 (Department of Energy, 2012) (see Table 9-1 and Figure 9-1). Ninety-eight per cent of the transport sector’s energy is derived from petroleum liquids. Figure 9-2 demonstrates that only 2% of the transport sector’s energy requirements are met by electricity (primarily electric trains).

<table>
<thead>
<tr>
<th>SECTOR</th>
<th>2010</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>37%</td>
<td>34%</td>
</tr>
<tr>
<td>Mining</td>
<td>8%</td>
<td>4%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Commerce</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>Residential</td>
<td>11%</td>
<td>8%</td>
</tr>
<tr>
<td>Transport</td>
<td>34%</td>
<td>44%</td>
</tr>
</tbody>
</table>

Table 9-1: ENERGY DEMAND PER SECTOR IN 2010 AND PROJECTED DEMAND BY 2050 (Source: DoE, 2012)

![Projected increase in final energy demand to 2050](Source: DoE, 2012)
The heavy reliance on fossil fuels in the transport sector is mirrored in the rest of the economy. By 2012, South Africa’s primary energy production remained largely dependent on fossil fuels, with coal accounting for 72% (see Figure 9-3) and oil, which is used primarily by the transport sector, for 22% of the energy demand.

Transportation energy demand today remains totally dependent on petroleum liquids and there is very little scope for improving the availability of petroleum liquids for transportation with savings from other user sectors. Over the long-term, the sector will have to lower its greenhouse gas (GHG) footprint by reducing its reliance on petroleum products, and start using alternative fuels such as Compressed Natural Gas (CNG), and others.

Figure 9-4 reflects transportation’s extreme vulnerability to the availability of petroleum liquids, most of which (70%) is derived from imported oil, although a significant portion (approximately 23%) is derived from Sasol (coal-to-liquid production) and PetroSA (gas-to-liquid production).

South Africa is expected to remain a net importer of liquid fuels for the foreseeable future, as shown in Figure 9-6 (US Energy Information Administration 2014).

An analysis of the transport sector’s usage of energy reveals that 89% of the petroleum liquids are used in road transportation sector this includes both passenger and freight transport. The second largest consumer of transport energy is air transport, which uses 11% of the available liquid petroleum. Road transport accounts for 85.8% of the total CO₂ emissions by the transport sector (according to the GHG

“Transport in South Africa will also promote a low-carbon economy by offering transport alternatives that minimise environmental harm.”

National Development Plan 2030
Emission Reduction Strategy for the Transport Sector). The reliance on fossil fuels for transport also means that the sector (combined domestic aviation, road transport and railways) was responsible for 11.1% of South Africa’s GHG emissions in 2010 (according to South Africa’s GHG Inventory released in 2014) as shown by Figure 9-5.

9.2.2 Challenges

Discoveries of oil reserves worldwide reached a peak in 1965 and have since declined steadily. Remaining reserves being discovered are relatively small.

As shown by Figure 9-7, oil production has steadily increased but, as it is from a finite source, it is predicted to decline with the depletion of resources. Estimates of when production will peak differ. One estimate predicts that by 2030 the production of oil will have declined to 50% of the peak in 2012. Once the peak is reached, the available oil will be used by nations who have access to oil and nations who have the ability to pay for it. Once oil production has peaked, the competition for oil will be fierce and the oil price will rise dramatically. Since the transport sector greatly relies on fossil fuel, it is faced with significant challenges with respect to the availability of liquid fuels, with the most adversely affected sector being the road transportation sector.

South Africa’s best-case scenario is that it will be able to retain its market share of the available oil at whatever cost. This means that the availability of oil in South Africa will decline to about 70% (or less) of what it was in 2008 while the ‘business as usual’ demand will be 2.5 times in excess of the availability. The most likely scenario regarding the availability of petroleum liquids is shown in Table 9-2 and Figure 9-8.
### Strategy

As the predicted decline in the availability of oil places a limit on the supply of fuel, bridging the gap between demand and supply lies in reducing the demand in one of the following ways:

- Implement fuel efficiency measures where less oil-derived fuel is used to shift the same quantity of freight or transport the same number of passengers
- Reduce the quantity of freight and the number of passengers
- Change the way (mode) in which freight and passengers are transported
- Encourage, through appropriate policy interventions, the increased use of cleaner fuels and transport systems that are less dependent on fossil fuel such as electric vehicles, hybrid vehicles and or solar-powered electric vehicles
- Review legislation that prevent innovation and prevent the introduction of cleaner technologies. For instance, interact with relevant government stakeholders to create a level legal playing field (e.g. in terms of taxation) for the introduction of electric and alternative fuel vehicles
- Encourage the increased use of public transportation through public transport policy interventions to reduce the use of single occupancy vehicles with a view to reducing GHG emissions

A plausible strategy would be to initially focus on creating fuel-efficient usage and, later on, modal shifts and new transportation infrastructure technology. Long-term transport planning needs to be aligned with land use and spatial planning in terms of a reconstructed space economy.

To this end, the NATMAP 2050 supports the following IEP goals that relate to the transport sector:

- Diversify the supply of energy sources and primary energy carriers. This is necessary to improve the security of supply and, at the same time, to reduce environmental impacts from the use of carbon-intensive fuel sources and modes of transport.
- Improve the energy efficiency (reduce the energy intensity) of the transport sector, achieving the same quality of transport with a lower level of energy input.
9.3 The Biophysical Environment and its Implications for Transport

9.3.1 Context

The major drivers of environmental change in South Africa are population growth, economic activities and associated infrastructure development, urbanisation, governance, technology, research and development (R&D) and innovation. The planning of economic activities must provide for assessments of the impact on the environment. This is required by the National Environmental Management Act, 1998 (Act No. 107 of 1998) and the environmental impact assessment regulations thereunder (Government Notices R.982 to 985 of 2014). The right to access to the environment, that is not detrimental to health and well-being, is further enshrined in the Constitution.

The potential environmental impact of transport infrastructure depends greatly on the characteristics of the affected environment (e.g. whether it includes ecosystems such as wetlands or intact ecosystems that are sensitive to disturbance) or transformed or altered land. Almost all transport infrastructure (e.g. pipelines, roads and railway lines) is linear, which, by its nature, can affect the landscape visually and create barriers to the movement of people, plants and animals. Other typical impacts of transport infrastructure include noise (in the case of airports, roads and railways), biophysical impacts (e.g. vegetation and faunal disturbance and/or habitat destruction) and, in the case of buried infrastructure such as pipelines, temporary habitat disturbance, which can be successfully rehabilitated if properly managed.

The main objective of the NDP 2030 is the improvement of South Africans’ standard of living, an objective shared by the NATMAP 2050. The NDP 2030 recognises nine factors that influence standard of living, transport being one of them (see Figure 2-1). The efficiency of transport has a critical influence on socio-economic development and standard of living, as it determines ease of access to work and the proportion of earnings spent on transport.

9.3.2 Challenges

International and national trends, reflected in legislation, require that sustainable development principles are applied to a transportation strategy. Sustainable development has environmental, economic and social dimensions; accordingly, environmentally sustainable transport can be defined as transport that functions within the limits set by nature and society. Within this context the following challenges are relevant in the South African context:

- Biophysical priority areas
- Energy intensity of different modes of transport

BIOPHYSICAL PRIORITY AREAS

Nine broad areas for conservation action in South Africa have been identified according to Rouget et al (2004). At a more detailed level, several centres of endemism1 are located across South Africa. Although only centres of plant endemism have been formally defined, they serve as useful proxies for other categories of biota too at broad planning level. Many of the areas of conservation action and endemism are bisected by transportation corridors or planned corridors. Obtaining authorisation for new transportation corridors in these areas may be difficult, time-consuming and costly in terms of environmental assessment and public participation if these corridors are not planned with consideration of sensitive environmental resources.

However, with proactive planning (e.g. considering the environmental opportunities and constraints from early planning phases, potentially significant environmental impacts can often be very successfully avoided or mitigated through prudent project design. This can be achieved by taking into account environmental constraints from a FEL 1 planning phase study.

ENERGY INTENSITY OF DIFFERENT MODES OF TRANSPORT

The environmental issue that will most probably have the most significant impact on transportation has to do with energy consumption. Reducing the reliance on energy sources that produce high levels of greenhouse gas emissions has been the focus of a number of international conferences. Examples are the World Summit on Sustainable Development 2002, and various Conferences of the Parties (CoPs) held under the United Nations Framework Convention on Climate Change (UNFCCC). Furthermore, South Africa’s Climate Change Response White Paper (CCRWP) also emphasises transport as one of the flagships for combatting climate change, because of this sector’s high energy intensity.

Within this context, South Africa is committed to reducing carbon emissions by 34% by 2020 in terms of the Copenhagen Accord and by 42% by 2025. This will require adherence to South Africa’s currently applicable Nationally Determined Contributions (NDCs) agreed to through the COP process.

Reducing the transport sector’s generation of greenhouse gases can be achieved through a number of different strategies, including reducing the total energy demand (unlikely, given population growth, and economic growth) or shifting behaviour from the use of greater energy and carbon-intensive modes of transport to other modes that are less energy- and carbon-intensive. This means reducing the

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1 A centre of endemism is an area in which the ranges of restricted-range species overlap or a localised area that has a high occurrence of endemic species. An endemic species is one that is unique to (occurs only in) a defined geographical area.
amount of energy used to move a given number of people or a given weight of freight. Although the energy intensity of all modes of transport has improved worldwide between 1990 and 2007 (International Transport Forum 2008), the overall rise in transport use offsets this gain in efficiency. Therefore, a shift in use to less energy-intensive modes of transport is required. Figures 9-8 and 9-9 provide indications of the relative energy and carbon (CO$_2$) intensities of different modes of passenger and freight transport, respectively.

For passenger transport, passenger vehicles and short-haul air transport have some of the highest energy intensities of all modes of passenger transport, whilst well-used buses and rail modes have some of the lowest energy intensities.

For freight transport, it is similarly evident that, of the available transport modes in South Africa, rail transport alternatives (whether diesel or electric) are some of the least energy- and CO$_2$-intensive, whilst road transport has substantially higher energy intensity and air transport has the highest energy intensity (with short-haul air transport having the absolute highest energy intensity). Although sources differ on the exact quantification of energy and CO$_2$ intensity, it is clear that all sources agree that short-haul flight is the least efficient, followed by road and, finally, rail as the most efficient.

Thus, for both passenger transport and freight transport, a modal shift from road to rail transport will bring about substantial improvements in energy intensity.

Replacing oil with biofuels has also been identified as a possible solution to reducing the need for oil, and its rising cost. However, this will have an impact on food security and food prices and will in all probability not replace more than a single-digit percentage of South Africa’s liquid fuel needs.

Other energy alternatives include renewable technologies such as solar power (photovoltaic and concentrated solar and wind power) and biogas. The Integrated Resource Plan (IRP) proposes that a much greater proportion of renewable energy technologies form part of South Africa’s electrical energy mix by 2030. However, these technologies have little potential to have an impact on the transport sector’s energy use, as only around 2% of the transport sector currently uses electricity as an energy carrier. Should there be a substantial mode shift from road to rail transport in the future and should there be substantial market penetration by electric passenger vehicles, this may change.

While the development of hydrogen fuel cells also offers a possible solution to the problem, it is currently too expensive. Should the change from a hydrocarbon-based energy technology to a hydrogen-based energy technology be successful, then the nature of transportation in South Africa will probably not change drastically. Road transportation will stay as it is, as will the use of private cars.

9.3.3 Strategy

Achieving sustainable transport will require a policy shift. Transport policy cannot be “business as usual” or maintain its current path. Sustainability requires a new set of policies and guidelines that includes a policy pathway that will be an evolutionary, not revolutionary, move towards environmentally sustainable transport (EST) policies.

The following long-term national transportation planning principles should be adhered to:

- Existing transportation corridors must be maintained as a priority. Existing right of way is a valuable commodity that should be protected at all cost.
- South Africa already possesses an extensive road network. Existing roads should be improved and its efficient use should be increased rather than adding new capacity. The same applies to other infrastructure such as railways, harbours, and airports, where appropriate.
- The current transportation model in South Africa is carbon-intensive and highly inefficient and unsustainable. Resource efficiency and clean technologies are critical to foster this low-carbon economy and are an essential component of climate change mitigation.
9.4 Proposed Interventions

The following interventions are proposed.

- **Short-term (one to three years)**
  - Create and implement a sustained energy awareness programme to raise public awareness of the true financial and environmental costs of transport modes with a high carbon intensity and high energy intensity.
  - Promote non-motorised transport through the development of infrastructure that facilitates its use.
  - Promote fuel efficiency measures and the adoption of fuel-efficient modes of transport, including BRT systems and trains (where practical) in urban areas. (Also see Chapter 8 in this regard.)
  - Plan for new long-distance transportation infrastructure (e.g., long-distance trains) with lower energy intensity than road transport, provided that the proposed interventions meet the minimum distance threshold for the proposed transport infrastructure to be cost-effective and to compete with other forms of transport.
  - Actively implement:
    - the DoT’s transport energy consumption reduction strategy
    - The Nationally Appropriate Mitigation Actions (NAMAs) identified in the DoT’s Greenhouse Gas Emission Reduction Strategy for the Transport Sector (GHGERS)
  - Develop and implement transport-sector specific programmes and projects that support (where appropriate) and align with South Africa’s Nationally Determined Contributions (NDCs) as agreed at COP 21

- **Medium-term (three to seven years)**
  - Continue public education and awareness.
  - Finalise long-distance infrastructure investment and planning.
  - Implement transport mode shifts.

- **Long-term (seven to ten years)**
  - Implement long-distance transportation infrastructure.
  - Expand the quantity of goods and number of people affected by transport mode shifts.
  - Review earlier medium-term measures.

- **Medium-term (three to seven years)**
  - Implement the measures identified in the transportation energy reduction strategy and in the green transport strategy.
  - Implement appropriate measures identified in the feasibility study for CBG, CNG and other alternative and renewable fuels for road transport.
  - Implement the Transport Flagship Programme of the National Climate Change Change Reduction White Paper (2011). This includes:
    - development of an enhanced public transport programme to promote lower-carbon mobility in five metros and in ten smaller cities; and
    - the creation of an Efficient Vehicles Programme, with interventions that result in measurable improvements in the average efficiency of the South African vehicle fleet by 2020.
  - Implementation of the following NAMAs identified in the GHGERS:
    - Road transport: develop standards for increased efficiency
    - Road transport: switching of fuels to natural gas
    - Road transport: switching of fuels to electricity
    - Road transport: effect a modal shift from cars to public transport
    - Effect a modal shift from road transport to freight rail
    - Effect a switch in fuel through biofuel blending
  - DoT to provide planning support to the Department of Public Enterprises to assist in the recapitalisation of rail rolling stock
  - Review earlier short-term measures and adjust to and ensure they are achieved over the short term.

- **Long-term (seven to ten years)**
  - Give effect to the DoT’s implementation plan for transport energy consumption reduction for selected transport corridors.

**Adherence to the following principles is required to develop a sustainable transport system:**

- **Travel demand management**
  - Reduce the need for travel while protecting social and economic needs for access by changing urban form and promoting new communications technologies.
  - Improve access by diversifying transportation options, giving people more choices as to how they meet their needs.
  - Concentrate urban growth, limit sprawl, and provide for more mixed land use through urban structure and land policies.

- **Modal shifts**
  - Prioritise less polluting and lower-impact modes of transportation in the design of transportation systems and urban areas.
  - Establish partnerships with local authorities to:
    - establish local travel policies that promote public transport. This includes the establishment of BRT systems and the provision of pedestrian and cycling paths as an attractive and safe alternative to private vehicles;
    - Create pilot low emission zones in certain highly densified urban areas (e.g., Gauteng, Durban and Cape Town) that prevent certain type of vehicles entering such zones during certain times of the day.
  - Integrate transport modes, whether for passengers or goods, in order to provide more efficient goods movement, and to increase the availability of lower-impact transportation options such as public transit.
Decision-making processes
- Integrate transportation decisions with environment, health, energy, and urban land use decisions.
- The decision-making processes should be open and inclusive.
- Anticipate the environmental and/or social impact of transportation-related decisions. Require all state-owned enterprises and organs of state that develop transport infrastructure to undertake proactive planning of this infrastructure to minimise or avoid environmental impacts before the commencement of environmental impact assessment.
- Consider global and local social, economic, and environmental effects of decisions.

Land use
- Ensure that land use planning processes emphasise compact urban form (reduce urban sprawl) to reduce habitat destruction and the loss of agricultural and recreational lands around urban areas.
- Ensure that the land use planning processes encourage the development of mixed use developments to provide places of work close to home and that the designation of high-density development areas along transport corridors makes public transport feasible.
- Reduce the impact on wildlife, their natural habitats and people when designing the construction operation of intercity transportation systems and infrastructure, including highways, pipelines, and railways.

Paramount to the sustainability of the proposed interventions are careful planning, prioritisation and the allocation of funding, where appropriate. Doing so will ensure that the appropriate resources are directed to appropriate focus areas, with the public gaining maximum benefit at moderate cost.