Climate and Sustainable Investment

INVESTMENT AND FINANCE OPPORTUNITIES IN THE SOUTH AFRICAN TRANSPORT SECTOR: A FOCUS ON LOW-CARBON TECHNOLOGIES

October 2022

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This report aims to present information for the financial sector that is useful for capital allocation, by supporting financial institutions' risk assessment methodologies with overviews of technology options and associated environmental, social and governance (ESG) risks in the transport sector.

At the same time, where known, the scale of the opportunities is described, together with associated uncertainties.

This is aimed at supporting the financial sector to consider two primary questions:

- Will the local financial sector be able to meet the scale of the financing opportunities required in the move to a low-carbon transport sector, or will significant Foreign Direct Investment (FDI) be required?
- What are the appropriate financing instruments for each opportunity?

The report brings together viewpoints from various studies and transport sector experts on the pathways for South Africa's transport sector to decarbonise by the year 2050, placing the country on a new, low-emissions development path.

ACKNOWLEDGEMENTS

The analysis benefited from interaction and close dialogue with several individuals active in areas relevant for this study. The authors gratefully acknowledge:

- Comments on financial aspects by David Goldsworthy (Standard Bank) and Christelle van Vuuren (Carbon Trust)
- Comments and insights on technical matters by:
    - Kevin Baart (South African Petroleum Industry Association (SAPIA))
    - Farai Chireshe (World Wide Fund for Nature (WWF))
    - Liesl de Wet (Road Freight Association)
    - Winstone Jordaan (GridCars)
    - Gordon Laing
    - Louise Naudé (WWF)
    - Hiten Parmar (uYilo Electric Mobility Programme)
    - Lauren Rota (Imperial Logistics)
    - Dave Wright

This publication has been made possible with the financial support of the Lewis Foundation.

ABBREVIATIONS AND ACRONYMS

Abbreviations and acronyms		
BEV	Battery electric vehicle	
CO_2e	Carbon dioxide equivalent	Standard approach to quantify all greenhouse gases (GHG)
EV	Electric vehicle	Two categories: BEV and fuel cell EV (FCEV)
FCEV	Fuel cell electric vehicle	
GHG	Greenhouse gas	Globally 76% carbon dioxide, 16% methane, 6% nitrous oxide, 2% other
Gt	Gigatonne	1 000 000 000 tonnes (1-billion)
GW	Gigawatt	1 000 000 000 watts (1-billion)
GWh	Gigawatt hour	
HCV	Heavy commercial vehicle	Greater than 15 tonnes
ICE	Internal combustion engine	Energy source is fossil – oil (refined to petrol and diesel), natural gas, jet fuel
LCV	Light commercial vehicle	Less than 6 tonnes
MCV	Medium commercial vehicle	Between 6 and 15 tonnes
Mt	Megatonne	1 000 000 tonnes (1-million)
MW	Megawatt	1 000 000 watts (1-million)
MWh	Megawatt hour	
TW	Terawatt	1 000 000 000 000 watts (1-trillion)
TWh	Terawatt hour	
SAF	Sustainable aviation fuel	
Solar PV	Solar photovoltaic	

CONTENTS

KEY MESSAGES

The imperatives for the world and South Africa to transition to a net-zero carbon economy are clear. Harmful biophysical damage is already occurring. The urgency to address climate change is increasingly embedded in policy, regulation and markets. Countries representing almost 90% of global carbon dioxide emissions, including South Africa, have committed to net-zero carbon emissions targets, mostly by 2050.

South Africa will have to play its role. Current trade exposure to carbon-related risks will reduce, and access to international financial support will increase, if the country sets more ambitious decarbonisation targets. There is now recognition across government, business and labour that South Africa must achieve the transition to a low-carbon economy in a manner that is just and well managed. A just transition for South Africa includes support for workers and communities affected by the transition away from income and livelihoods supported by traditional value chains, and which enables the creation of decent green jobs. These changes will impact South Africa, whether or not it chooses to proactively drive decarbonisation and embrace the opportunities inherent in the transition.

Global trends are already driving changes in the transport sector. The transport sector accounts for 16% of global emissions and 11% of South Africa's emissions, and **is seen to be a prime sector for decarbonisation in the country**. This is partly because of lower alternative technology costs, but also because the solutions envisaged go some way to redress related imbalances in South Africa, such as over-utilisation of roads and under-utilisation of public transport and rail for freight.

Ninety-one percent of South Africa's transport emissions are from road and rail, 8% from aviation, and 1% from shipping.

There have been several policy and regulatory developments in South Africa that can collectively mitigate the risks for transport powered by renewable electricity, and exacerbate the risks for fossil liquid fuels.

These include the Department of Transport's Green Transport Strategy (2018) and the Department of Trade, Industry and Competition's Green Paper on the Advancement of New Energy Vehicles (2021). The Carbon Tax Act (No. 15 of 2019) provides for annual increases of the tax rate, and the February 2022 South African budget proposals and July 2022 proposed amendments to the Carbon Tax Act indicate a clear intention to raise carbon pricing levels significantly into the future. Cabinet has adopted the Climate Change Bill, which provides for company-level emissions allowances (carbon budgets), and sector emissions targets, one of which will be for the transport sector.

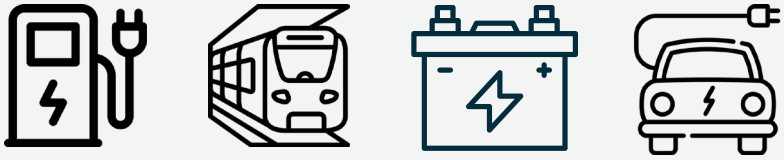
The USA, UK, Germany, France and the EU have undertaken to award a $8.5-billion financial support package to support South Africa's energy transition.

Avoid-Shift-Improve

Decarbonisation in the transport sector is generally considered in terms of the *Avoid-Shift-Improve* framework, which calls for:

- *Avoiding* unnecessary motorised trips based on proximity and accessibility. This can include the creation of compact, walkable, pedestrian-oriented, mixed-use communities centred around high-quality train systems – it encompasses a combination of regional planning, city revitalisation, suburban renewal, sustainable transportation and walkable neighbourhoods.
- *Shifting* to less carbon-intensive modes – including from private vehicles to public transport (rail, bus, minibus, bus rapid transit (BRT)), shared mobility, walking and cycling, from road freight to electrified rail freight, and use of cargo bikes for last-mile deliveries.
- *Improving* vehicle design, energy efficiency and clean energy sources for different types of freight and passenger vehicles.

This report focuses mainly on *Shift* and *Improve* measures, and draws upon several published studies and papers to produce a summary of these, with quantification where possible. ***Avoid*** measures are beyond the scope of this report.



The sector can be fully decarbonised by 2050, and will contribute around 15% of South Africa's estimated carbon budget (the cumulative amount of greenhouse gas (GHG) that SA is allocated through international negotiations) for the period 2021-2050.

For land-based transport, the key decarbonisation levers are:

- **Shift freight from road to rail**
- **Shift passengers away from private motorised vehicles to public transport**
- **Electrify transport, ultimately with decarbonised electricity**
- **Adopt battery electric vehicles (EVs or BEVs) for passenger cars and for light commercial transport**
- **Adopt fuel cell EVs (FCEVs) for heavier commercial transport**

Together, these levers will allow road transport to be fully decarbonised by 2050.

Aviation and shipping cannot be directly electrified: the key decarbonisation levers here are alternative fuels, including sustainable aviation fuel (SAF). **Several options are being explored at present for aviation**, including SAF (biomass-based and powerfuels), batteries (for short haul), hydrogen turbines and fuel cells.

Some implications of these statements are that:

- **Significant further renewable electricity capacity will be required to decarbonise the transport sector**
- **The volume of liquid fossil fuel required will drop to zero by 2050**
- **No new liquid fossil fuel refining capacity is likely to be required**

Shipping emissions comprise less than 1% of the South African transport sector's emissions and need not be prioritised.

Implications for the finance sector

The risks and opportunities for the financial sector in the global and domestic transitions to low-carbon and climate-resilient economies are significant. This report focuses primarily on providing assessments of technology risk for the transport sector transition.

Key considerations for the financial sector include **what type of financial instruments or products** would need to be used (or developed) to facilitate an affordable clean electricity dominated transition pathway, and **how the sector would responsibly divest from liquid fossil fuel intensive assets**. A just transition for South Africa further includes support for the full spectrum of workers and communities affected by the transition away from income and livelihoods supported by liquid fuels and internal combustion engine (ICE) vehicle and component manufacture, and enables the creation of quality green jobs.

Financing opportunities

Financing opportunities have been identified but, except for the endeavour to produce decarbonised electricity for the transport sector, there are various uncertainties. These will be clarified to some degree with the forthcoming publication of a study led by the National Business Initiative (NBI) and Business Unity South Africa (BUSA), in association with the Boston Consulting Group (BCG), but others will only clarify with further study and experience, or with release of additional information into the public domain.

Manufacturing of battery passenger cars and light commercial vehicles merits special attention. There is no doubt that EVs are no longer merely a possibility, but an inevitability. South Africa manufactures a broad range of vehicles, 60% of which are exported, with passenger cars and light commercial vehicles comprising the great majority. Seventy-seven percent of South Africa's vehicle exports in 2022 went to Europe. At present almost all cars manufactured in South Africa are ICE vehicles.

The EU and the UK have set aggressive targets for the phase-out of ICE vehicles and the introduction of EVs. This presents South Africa with an opportunity if it shifts from manufacturing oil-fuelled ICEs to EVs, and a threat of loss of business if it does not.

1. Introduction

The global pathway to net-zero carbon emissions

There is global acceptance that the temperature increase from climate change needs to be stabilised to no more than 1.5˚C above pre-industrial times.

Harmful physical damage is already occurring, and the science says that even the impacts of 1.5˚C will be severe. The consequences of existing warming (currently at about 1.2˚C) are already being seen in more extreme weather, rising sea levels and diminishing Arctic sea-ice.

A maximum temperature increase of 1.5˚C requires global carbon dioxide (CO_2) emissions to reach net zero by 2050. This includes a 50% reduction from current emissions by 2030. Achieving this will require unprecedented and rapid decarbonisation in energy, industry, buildings, transport, cities and land use.

One hundred and thirty seven countries, including South Africa, representing 83% of global carbon dioxide emissions, have adopted net-zero targets, mainly for 2050.[1]

The impact of climate change on the global financial system

Given the urgency that is increasingly embedded globally in policy, regulation and markets, biophysical climate change and the transitions to low-carbon and climate-resilient economic activity will have almost unprecedented impacts on every industrial sector, energy use, consumption patterns, technological innovation and global trade. This process has ramped up considerably even in the past three years. Climate change as a global exogenous risk will continue to drive change and impact all economies.

The risks and opportunities for the financial sector are significant. The need for the commercial dimensions of climate risk to be integrated into mainstream investment processes and portfolios has never been greater.[2] New profit opportunities (and new financial risks) are emerging every day, as the trend towards decarbonisation intensifies.

South Africa will have to play its role

As the shift in the global economy escalates, so the extent (both the rate and degree) to which South Africa will need to decarbonise will become clearer.

What is known is that the country's current trade exposure to carbon-related risks will reduce, and access to international financial support increase, by setting more ambitious targets. Detailed work is already under way, led by the National Business Initiative (NBI) and Business Unity South Africa (BUSA), in association with the Boston Consulting Group (BCG), to assess what achieving net-zero carbon looks like for each sector of the economy. Government has formed a high-level Presidential Climate Commission (PCC) and is brokering South Africa's first major financial deal on climate change with the developed world.

Financing South Africa's next phase of industrial development

Significant opportunities are emerging from this global shift. Market-related developments in renewable energy and electric vehicles (EVs) are harbingers of what is to follow. At the same time, the costs of inaction are likely to be stark, resulting in vulnerable exports, outdated technologies and sluggish growth.

There is now recognition across government, business and labour that South Africa must achieve a transition to a low-carbon economy in a manner that is just and well managed. The finance sector is at the heart of enabling the next phase of economic development.

[1] https://zerotracker.net/
[2] Recommendations of the Task Force on Climate-Related Financial Disclosures. Financial Stability Board, June 2017.

2. EMISSIONS FROM THE **TRANSPORT SECTOR**

Global

Transport accounted for 16% of global greenhouse gas (GHG) emissions of 49.6-billion tonnes CO_2e in 2016 (the latest year available).[3]

Of the sector's 8-billion tonnes of CO_2e in 2018 (the latest year available), 74% was from road transport.[4]

Source of emissions	% of total
Road passenger	45%
Road freight	29%
Aviation	12%
Shipping	11%
Rail	1%
Pipeline	2%
Total	**100%**

Figure 1: Breakdown of global transport emissions

South Africa

Transport accounted for 11% of country GHG emissions of 500-million tonnes CO_2e (gross before forestry and land use adjustment) in 2017. Of the sector's 55-million tonnes CO_2e, 91% was from road and rail transport.[5]

Road transport presents the greatest decarbonisation challenge for the sector, although aviation must also be addressed.

Shipping emissions comprise less than 1% of the sector's emissions and need not be prioritised.

Source of emissions	% of total
Cars	**27%**
LCVs	**22%**
HCVs	**16%**
MCVs, buses, motorcycles	**26%**
Aviation	**8%**
Shipping	**<1%**
Rail	**1%**
Pipeline	**<1%**
Total	**100%**

Commercial vehicles		Gross loaded weight, t
LCV	**Light**	**< 6**
MCV	**Medium**	**6-15**
HCV	**Heavy**	**> 15**

Figure 2: Breakdown of South African transport emissions

[3] https://ourworldindata.org/emissions-by-sector
[4] https://ourworldindata.org/transport#co2-emissions-from-transport
[5] NBI/BUSA/BCG analyses based on South African GHG Inventory, 2017.

3. THE PURPOSE AND SCOPE **OF THIS REPORT**

Purpose

This report aims to support financial institutions' risk assessment methodologies with overviews of technology options and associated ESG risks in the transport sector.

At the same time, where known, the scale of the opportunities is described, together with associated uncertainties.

All of this will allow the financial sector to consider two primary questions:

- Will the local financial sector be able to meet the scale of the financing opportunities, or will significant Foreign Direct Investment (FDI) be required?
- What are the appropriate financing instruments for each opportunity?

Figure 3 illustrates the broad risk categories that need to be assessed in a project lending or investment decision-making processes (for debt or equity). This categorisation was synthesised after several discussions with financial sector experts. It became clear that there was a particular need for the sector to understand the technology risks, as well as the associated environmental, regulatory and social risks.

Transport is a complex sector, with several sub-sectors, each with different decarbonisation solutions at different stages of maturity. For example, battery EVs (BEVs) are being commercialised today, but fuel cell EVs (FCEVs) and green hydrogen are still in development. Despite over a decade of work on low-carbon transport by a number of parties in South Africa, the sector is only now beginning to receive serious attention.

The transport sector is quite unlike the electricity sector, which has one big solution – that is essentially to decarbonise the generation of electricity using solar photovoltaic (PV) and wind coupled with energy storage. All these technologies have been commercialised, and significant investment now seems imminent.

Broad risk categories need to be assessed in a project credit decision-making process:

1. **Technical and financial**: is the technology used new to SA? Is it adopted offshore? How has the technology performed and how is it expected to perform in future?
2. **Environmental**: does the project present benefits or drawbacks e.g. BEVs replacing diesel with internal combustion engines (ICEs) reduces emissions (GHGs, SOx, NOx, particulates)?
3. **Regulatory**, for example carbon pricing.
4. **Social**: does the project have social impacts such as, for example, creating or destroying jobs?
5. **Legal and contractual**: where or with whom does ultimate recourse for repayment lie, for example with parent guarantee or a surety?
6. **Government**, including country risk.
7. **Governance and operations**: for example, who is managing the project, who is on the board, have they done it before? Consider longer-term operations (to distinguish from shorter-term project construction and implementation management).

Figure 3: Generic framework to assess financial risk

Scope

Climate change mitigation in the transport sector is generally considered in terms of the widely adopted *Avoid-Shift*-Improve framework, [6,7] illustrated in Figure 4.

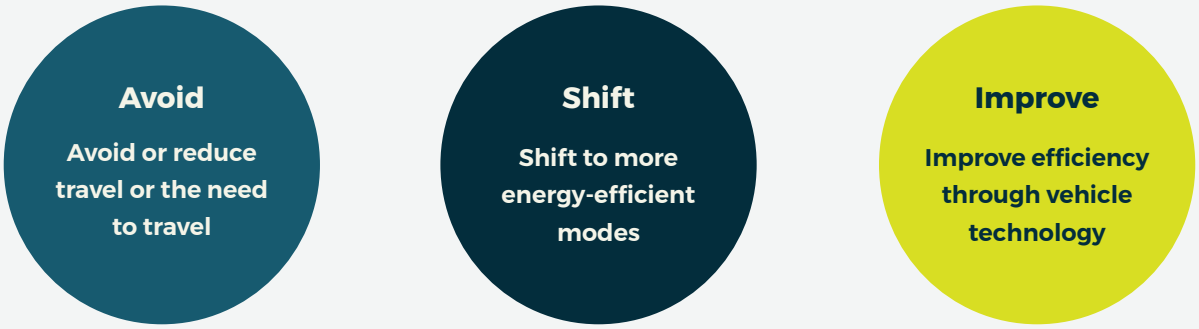


Figure 4: The Avoid-Shift-Improve framework

The framework calls for:

- *Avoiding* unnecessary motorised trips based on proximity and accessibility. This can include the creation of compact, walkable, pedestrian-oriented, mixed-use communities centred around high-quality train systems. This of course requires a vastly more coordinated government approach to regional planning, city revitalisation, suburban renewal, sustainable transportation and walkable neighbourhoods.
- *Shifting* to less carbon-intensive modes – including from private vehicles to public transport (rail, bus, minibus, bus rapid transport (BRT)), shared mobility, walking and cycling, from road freight to electrified rail freight, and cargo bikes for last-mile deliveries.
- *Improving* vehicle design, energy efficiency and clean energy sources for different types of freight and passenger vehicles.

This report focuses mainly on *Shift* and *Improve* measures, and draws upon several published studies and papers to produce a summary of these, with some quantification where possible. There is particular emphasis on energy carriers and technologies, with some consideration of modal shifts of road freight to rail and private to public passenger transport.

The report does not consider opportunities for finance in ensuring the sector is climate resilient. An example of this would be hardening of existing rail infrastructure to prevent damage by floods. In other situations new infrastructure will be required. *Avoid* measures are beyond the scope of this report.

[6] https://mobilityinstitute.medium.com/til-for-blue-skies-avoid-shift-improve-fe96ba369dbb
[7] https://www.researchgate.net/publication/273259318_GIZ_Sourcebook_5e_Transport_and_Climate_Change

4. THE TRANSPORT **ENERGY TRANSITION**

The global transport sector currently runs almost entirely on fossil fuels – in internal combustion engines (ICE) using petrol and diesel produced from oil. In South Africa around 20% of petrol and diesel used is made from the liquefaction of coal and gas by Sasol, at its Secunda and Sasolburg plants. [8]

Global

Decarbonisation of the transport sector

The International Energy Agency (IEA) produced a report in 2021 titled *Net Zero by 2050: A Roadmap for the Global Energy Sector* (the "IEA Net Zero report") on the transformation of the energy system (including transport energy carriers) required to achieve net-zero carbon emissions by 2050. [9]

It shows pathways for decarbonisation of each transport sub-sector (Figure 5). This is achieved with a range of technologies, all of which are described in this report. The residual total emissions of ±0.7 Gt emissions in 2050 must be captured or removed, although economically viable technology to do so is not yet available.

The major shift is one away from the use of fossil fuels – that is petrol and diesel for road transportation, kerosene ("jet fuel") for aviation, and fuel oil for shipping. These fuels are derived mainly from oil, but also from natural gas.

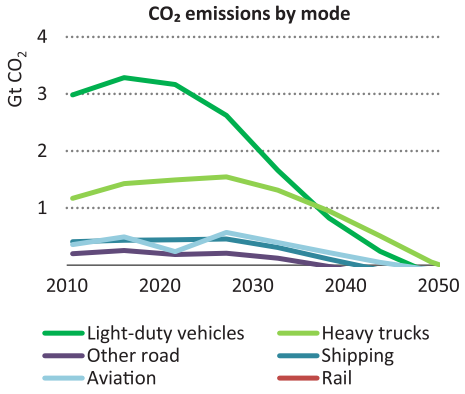


Figure 5: CO_2 emissions for transport sub-sectors

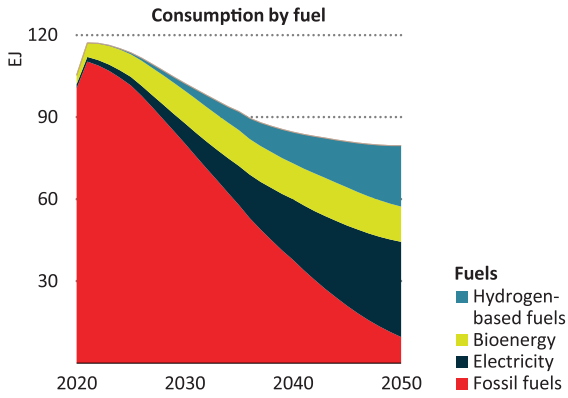


Figure 6: Consumption by fuel type

In the IEA Net Zero report, by 2050 clean electricity is the dominant fuel in the transport sector worldwide, accounting for nearly 45% of total final energy consumption, followed by hydrogen-based fuels (28%) and bioenergy (16%). Oil accounts for 10%, compared to more than 90% today. [10]

The hydrogen-based fuels are themselves produced from clean electricity.

The electricity is produced mostly by solar PV and wind, with some hydro, and is used either directly as in the case of trains with overhead lines, or indirectly by making hydrogen and other synthetic clean fuels for use in heavy trucks and shipping.

Electricity storage plays a major role, especially batteries for powering passenger vehicles.

Together these developments signify the demise of the liquid fossil fuels sector.

These global trends will lead to unavoidable changes in the transport sector, even in a scenario where South Africa does not proactively drive decarbonisation.

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[8] https://www.businessinsider.co.za/sasol-coal-to-fuel-production-south-africa-fuel-price-2019-10
[9] Net Zero by 2050: A Roadmap for the Global Energy Sector. International Energy Agency, May 2021
[10] Ibid

Decarbonisation of the electricity sector

The decarbonisation and electrification of the transport sector requires major changes in the electricity sector. The IEA Net Zero report notes that getting to net-zero emissions calls for a massive expansion of the electricity sector to power the needs of a growing global economy, the electrification of end-uses that previously used fossil fuels, and the production of hydrogen from electrolysis using renewable electricity. Total electricity generation increases from ~27 000 TWh in 2020 (20% of global energy demand) to ~71 000 TWh in 2050 (49%), a compound annual growth rate of 3.3%.

The IEA Net Zero report sets out a cost-effective pathway, in which electricity generation is increasingly dominated by solar and wind renewable sources. Combined, these increase from ~2 400 TWh in 2020 (9% of global electricity generated) to ~48 000 TWh in 2050 (68%), a compound annual growth rate of ~11%.

South African context

The South African transport sector will be subject to the same dynamics as the global sector.

Furthermore, a just transition for South Africa must include support for transport workers and their dependants affected by the transition away from fossil liquid fuels and ICE vehicle and component manufacture, and enable the creation of quality green jobs in a new, clean electricity-driven transport sector. For the transition to be just, decarbonisation must be implemented in a way that contributes to addressing present and historical inequality, reducing poverty and restoring natural systems to build resilience.

Sector energy integration

Today, there are two quite separate energy systems – **mobility** (transport) and **electricity**. There are only relatively small overlaps between these systems, such as in the use of electric trains and trams.

In the future, as electrification proceeds apace, these two systems will become increasingly integrated (Figure 7).[11] For example, batteries in electric cars sitting idle during the day will be able to store energy particularly from solar PV and wind, and then discharge what is not required back into the grid at night. And solar farms will be able to produce excess electricity during the day to make hydrogen by electrolysis of water – hydrogen that can then be used as a fuel in transport and for production of chemicals (which will no longer be petrochemicals derived from oil and gas).

The system will be facilitated by digital control, dynamic time-of-use pricing and other demand side management interventions, e.g. remote control of hot water geysers that can be heated during the day, when energy is abundant.

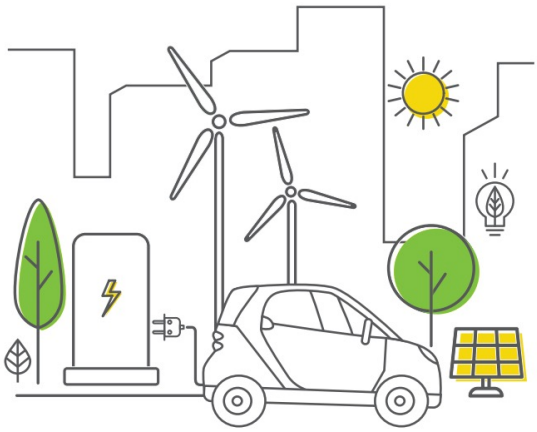


Figure 7: Schematic sector integration

Transport will increasingly become electricity plus smart communications.

These developments constitute a global paradigm shift – away from a fossil fuel-based system with two separate energy sub-systems, to a situation that uses variable solar and wind sources, with balancing technologies such as batteries.

Opportunities from the transition

Taken together, these developments create a financing gap for investments in areas such as EV manufacture and charging infrastructure, an upgrading of passenger and freight rail systems, and production facilities for sustainable aviation fuel (SAF).

5. SOURCES OF INFORMATION FOR **SOUTH AFRICA**

National Transport Master Plan

The National Transport Master Plan 2050 (NATMAP 2050) was commissioned in 2005, developed from 2007 and finalised in 2010/11, and approved by Cabinet in October 2016.[12] NATMAP 2050 is intended to be South Africa's cornerstone policy instrument which outlines key transport planning themes. It emphasises the preservation of the environment in tandem with accessible, cost-reflective, and affordable transportation services.

Green Transport Strategy

In accordance with NATMAP 2050 and in response to the National Climate Change Response Policy White Paper 2011, which includes ideas for a transport flagship programme, the Green Transport Strategy for South Africa (2018-2050)[13] was issued in 2018. The purpose of the strategy is to serve as an implementation plan, tabling interventions that would contribute equitably to meet the national objective of a low-carbon transport sector.

The strategy is the current policy roadmap for informing decarbonisation of the South African transport sector. This has the unambitious stated strategic vision "to substantially reduce GHG emissions and other environmental impacts from the transport sector by 5% by 2050". There is anecdotal comment that this is supposed to be "to 5% (of current) by 2050" or "to 5% (of overall emissions) by 2050", but this has never been officially corrected.

A June 2022 communication from the Department of Transport stated that the vision was to reduce the sector contribution of 10.8% of South Africa's emissions at the time of the finalisation of the strategy to 5.8% by 2050. However, the following statement appears on p44, under Adaptation: "... the transport sector supports moving to a competitive low-carbon economy in 2050 that foresees a reduction of at least 80% of GHGs by 2050 compared to 1990". Thus, the actual vision is quite unclear.

The strategy has a set of implementation themes and strategic pillars.

A study commissioned by Climate Compatible Growth[14] assessed the strategy for its efficacy in decarbonising road transport. This included quantitative modelling up to 2050. The study concluded that the strategy "could achieve substantial GHG mitigation in transport and the national inventory if the interventions are implemented as tabled. Furthermore, in light of continued technological innovation, the '5% by 2050' mitigation goal appears conservative and should be reviewed for a more ambitious target."

Climate Transparency

Climate Transparency[15] commissioned a report published in 2020 on a low-carbon transport future for South Africa,[16] which made recommendations for requirements to achieve a low-carbon transport system by 2050. This included quantitative modelling up to 2050, with ambitious emission reductions. The results of the Ecomobility scenario were considered in this current report: this scenario incorporated development of a local EV industry, migration of freight from road to rail, development of public transport and a reduction in demand for motorised transport.

Energy Research Centre, University of Cape Town

The then Energy Research Centre (now the Energy Systems Research Group) explored scenarios of transport technology choices and demand in a future of uncertain fuel and technology costs, and the consequences for energy

[12] https://www.transport.gov.za/natmap-2050
[13] https://www.transport.gov.za/documents/11623/89294/Green_Transport_Strategy_2018_2050_onlineversion.pdf
[14] https://climatecompatiblegrowth.com/wp-content/uploads/2021/07/4B-COP26-Policy-Brief.pdf
[15] https://www.climate-transparency.org
[16] https://www.climate-transparency.org/a-low-carbon-transport-future-for-south-africa

supply and GHG emissions.[17] Its 2018 report included quantitative modelling up to 2045 with reasonably ambitious emission reductions.

World Wide Fund for Nature

In addition to other publications, the World Wide Fund for Nature (WWF) produced two reports that can be considered as taxonomies of decarbonisation opportunities in the sub-sectors of:

- Passenger transport[18]
- Freight transport[19]

The WWF has also recently produced an assessment of the production of SAF from sustainable biomass (coupled with green hydrogen in some scenarios).[20]

Department of Forestry, Fisheries and the Environment

In 2014 the Department of Forestry, Fisheries and the Environment produced the *Mitigation Report: South Africa's Greenhouse Gas Mitigation Potential Analysis, Technical Appendix E – Transport Sector*, with a technical appendix for the transport sector. A predominance of mitigation measures from the road sector is clear, including modal shifts from passenger vehicles to public transport and freight from road to rail.

However, the overall mitigation achieved by all the measures is that net-zero emissions in 2050 are projected to be similar to the levels of 2017. The reason for this is that the reductions are negated by growth in transport volumes.

National Business Initiative/Business Unity South Africa/Boston Consulting Group

The National Business Initiative (NBI), together with industry association Business Unity South Africa (BUSA) and consulting firm Boston Consulting Group (BCG), have modelled the decarbonisation of the transport sector as part of an economy-wide study to decarbonise South Africa by 2050.

At the time of writing, the final report had not been published, but the authors of this report have had access to the main conclusions being drawn and to some detailed cost information, for example in the cost of charging infrastructure, and for that reason, and because it is the most recent analysis of the sector, this work is quoted most often in this report.

A conclusion of this work so far is that demand management is the most impactful lever for a just net-zero transition of South Africa's transport sector.[21] The analysis assesses the high-level impact of demand management on the total demand for transport in South Africa through Shift measures such as shifting freight from road to rail and passengers to public transport (see section 3), but does not assess in detail the need for innovative smart city and infrastructure planning (which would be an *Avoid* measure). Addressing South Africa's spatial planning will be essential for a just transition and will be unpacked in future modules of the NBI/BUSA/BCG economy-wide study (*Integration and Buildings & Construction*).

GreenCape

GreenCape has produced an annual market intelligence report on EVs in South Africa since 2019. The reports are written for investors and businesses who are currently active or interested in the sector, and provide an overview of the market, including key developments and achievements, the key players, legislation and regulation, market opportunities and challenges, funding opportunities and an overview of general green economy investment opportunities. The 2022 report[22] is referenced in the current analysis.

[17] http://www.scielo.org.za/pdf/jesa/v29n3/04.pdf
[18] https://wwfafrica.awsassets.panda.org/downloads/wwf_2016_ghg_mitigation_opportunities_and_measures_in_passenger_transport.pdf?31802/greenhouse-gas-emissions-mitigation-opportunities-and-measurement-in-passenger-transport
[19] https://www.wwf.org.za/our_research/publications/?10721/Unpacking-freight-emissions-and-mitigation-opportunities-in-the-South-African-context
[20] https://wwfafrica.awsassets.panda.org/downloads/fuel_for_the_future.pdf?39122/fuel-for-the-future
[21] https://www.dffe.gov.za/sites/default/files/docs/appendixE_transportsector.pdf

Experts

Further input was provided by several transport experts:

- Kevin Baart (South African Petroleum Industry Association (SAPIA))
- Farai Chireshe (WWF)
- Liesl de Wet (Road Freight Association)
- Winstone Jordaan (GridCars)
- Gordon Laing
- Louise Naudé (WWF)
- Hiten Parmar (uYilo Electric Mobility Programme)
- Lauren Rota (Imperial Logistics)
- Dave Wright

[22] https://www.greencape.co.za/assets/EV_MIR_6_4_22_FINAL_DIGITAL.pdf

6. OVERVIEW OF LOW-EMISSION **TRANSPORT ENERGY TECHNOLOGIES**

Transport can be decarbonised through four routes. Three use electricity, which ultimately must come from renewable energy: batteries, fuel cells and synthetic fuels. A fourth decarbonisation route is through the use of biomass and powerfuels (see following section)

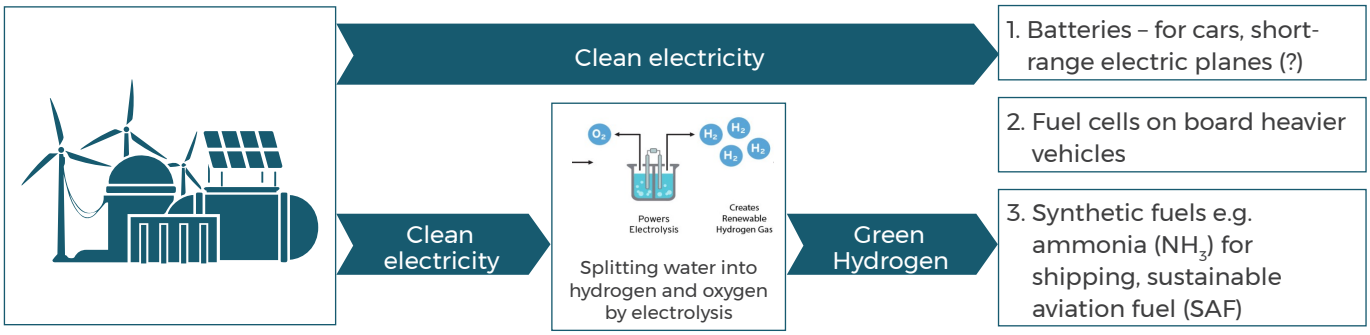


Figure 8: Three electricity-based routes for decarbonising transport energy carriers

Decarbonisation of the electricity sector is a precondition for decarbonisation of the transport sector. This will be achieved by shutting down the current coal-fired power stations, over time, and a mass build-out of renewable energy facilities – mainly solar PV and wind with attendant storage to manage variability. Storage will mostly be provided by batteries.

A separate report under this project, *Climate Change Investment & Finance Opportunities in the South African Electricity Sector*, makes recommendations for how this should be done and describes the scale of the financing opportunity.

As noted, transport is a complex sector, with several sub-sectors, each with different solutions at different stages of maturity and adoption globally, as shown in Figure 9. The more mature and widely adopted, the lower the technology risk.

While battery electric passenger vehicles are being commercialised today, FCEVs and green hydrogen are still in development.

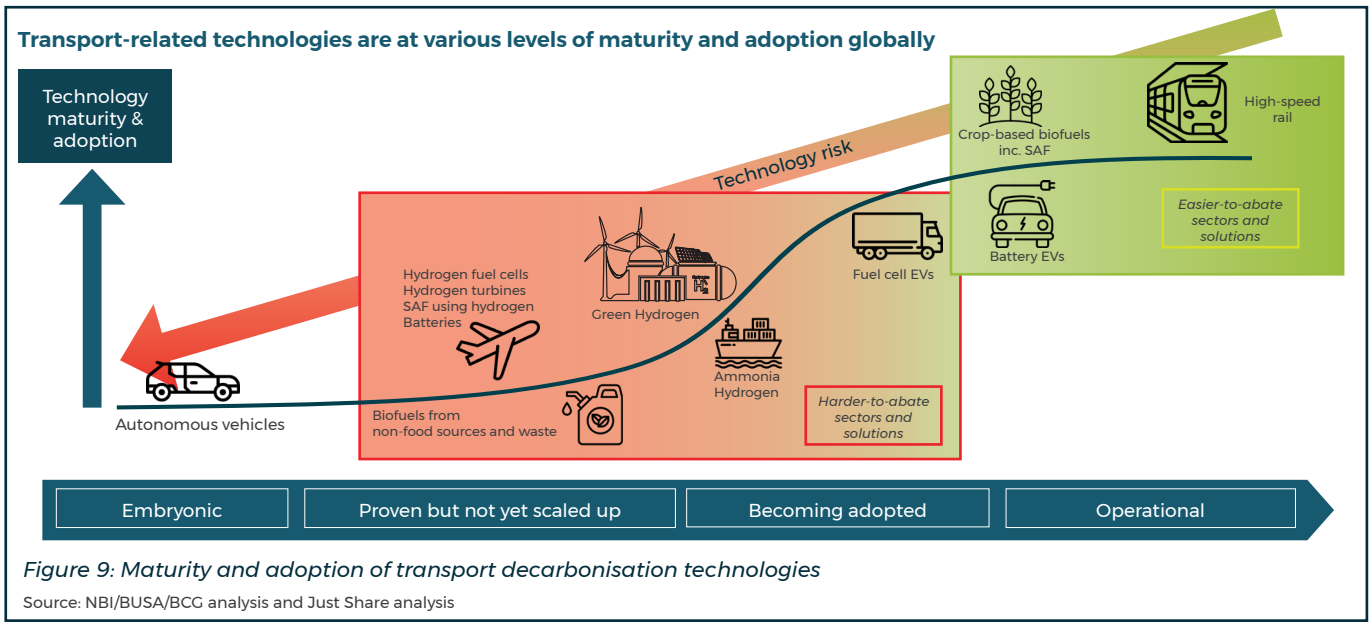


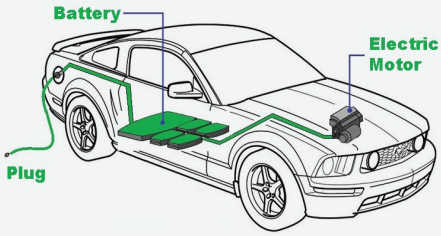
Figure 9: Maturity and adoption of transport decarbonisation technologies

Source: NBI/BUSA/BCG analysis and Just Share analysis

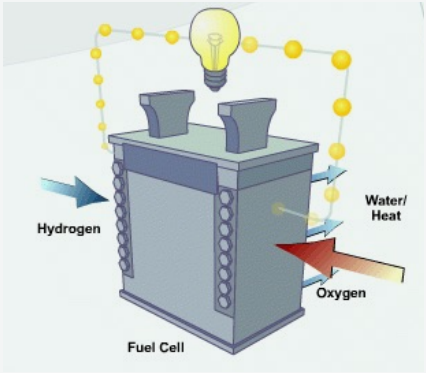
Road transport

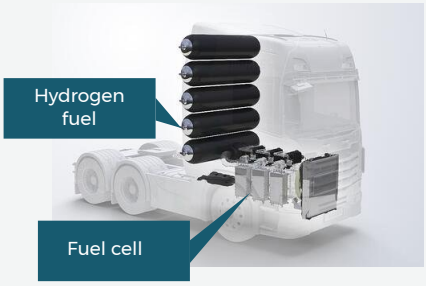
Batteries and fuel cells will be the dominant solution for decarbonising road transport. They may also play a role in decarbonising short-haul aviation.

Battery electric vehicles (BEVs): driven by electricity stored in batteries



Fuel cell: converts the chemical energy of a fuel (often hydrogen) and oxygen into electricity





Fuel cell electric vehicles (FCEVs): Driven by electricity produced in an on-board fuel cell

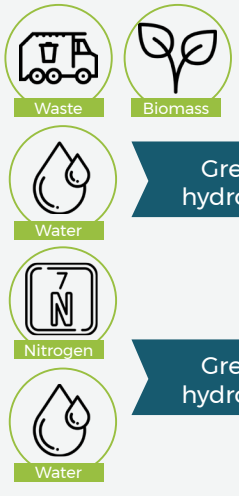
Figure 10: Technologies for decarbonising road transport

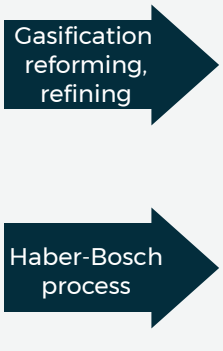
Shipping and aviation

Various synthetic liquid fuels, referred to as "powerfuels", are being mooted for decarbonisation of **shipping and aviation.** Powerfuels are synthetic gaseous or liquid fuels that draw their energy content from renewable electricity and use green hydrogen as an input. An advantage of some powerfuels such as SAF is that they can be used as so-called "drop-in" fuels in existing infrastructure, meaning that they can simply be substituted for fossil fuels.

Powerfuels may be hydrocarbons (which are chemically similar to fossil fuels used at present), ammonia (NH_3), and other hydrogen-rich compounds:

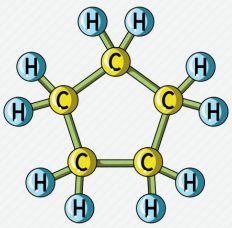
- Hydrogen will be sourced from water by electrolysis with clean electricity.
- Nitrogen will be sourced from the atmosphere.
- Carbon will be sourced from waste and biomass – the decarbonisation benefit is closely linked to the type of carbon used.





Sustainable aviation fuel (SAF) is a hydrocarbon produced from sustainable carbon resources such as waste and biomass, and green hydrogen.

SAF is a so-called drop-in fuel – it has the same characteristics and meets the same specifications as fossil jet fuel.



Green ammonia as fuel for shipping

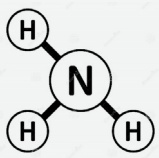


Figure 11: Decarbonising shipping and aviation with powerfuels

Several options are being explored at present for aviation, including powerfuels and SAF as noted above, batteries (for short haul), hydrogen turbines and fuel cells.

The WWF[23] notes that:

- South Africa has the immediate technical potential to produce 3.2-billion litres of SAF annually, following the strictest sustainability requirements.
- This is enough to replace the use of conventional jet fuel domestically up to a maximum blending threshold of 1.2-billion litres per annum,[24] while also providing 2-billion litres for export.
- These volumes could be extended to production of 4.5-billion litres of SAF annually, with 3.3-billion litres for export.
- A 10% SAF penetration is achievable by 2030 and 100% by 2050.
- Accessible biomass feedstock types such as sugarcane A-molasses and invasive alien plants, as well as industrial off-gases, are available to achieve this.

In a previous WWF study of growing crops in sub-Saharan Africa under different climate scenarios up to 2050,[25] Solaris tobacco was shown to have high potential in South African conditions and its yield was shown to increase as CO_2 concentration increased. This would be a good source for biomass.

[23] https://wwfafrica.awsassets.panda.org/downloads/fuel_for_the_future.pdf?39122/fuel-for-the-future
[24] Based on a maximum 50% blending ratio, and SA's 2019 aviation fuel consumption of 2.4-billion litres. https://www.mordorintelligence.com/industry-reports/middle-east-and-africa-aviation-fuel-market
[25] http://awsassets.wwf.org.za/downloads/sustainable_biofuel_potential_ssaf_fullreport_a4_v2_pages.pdf

Application and cost parity of technologies

Figure 12 summarises the current thinking of published sources on the application of batteries, fuel cells and synthetic fuels.

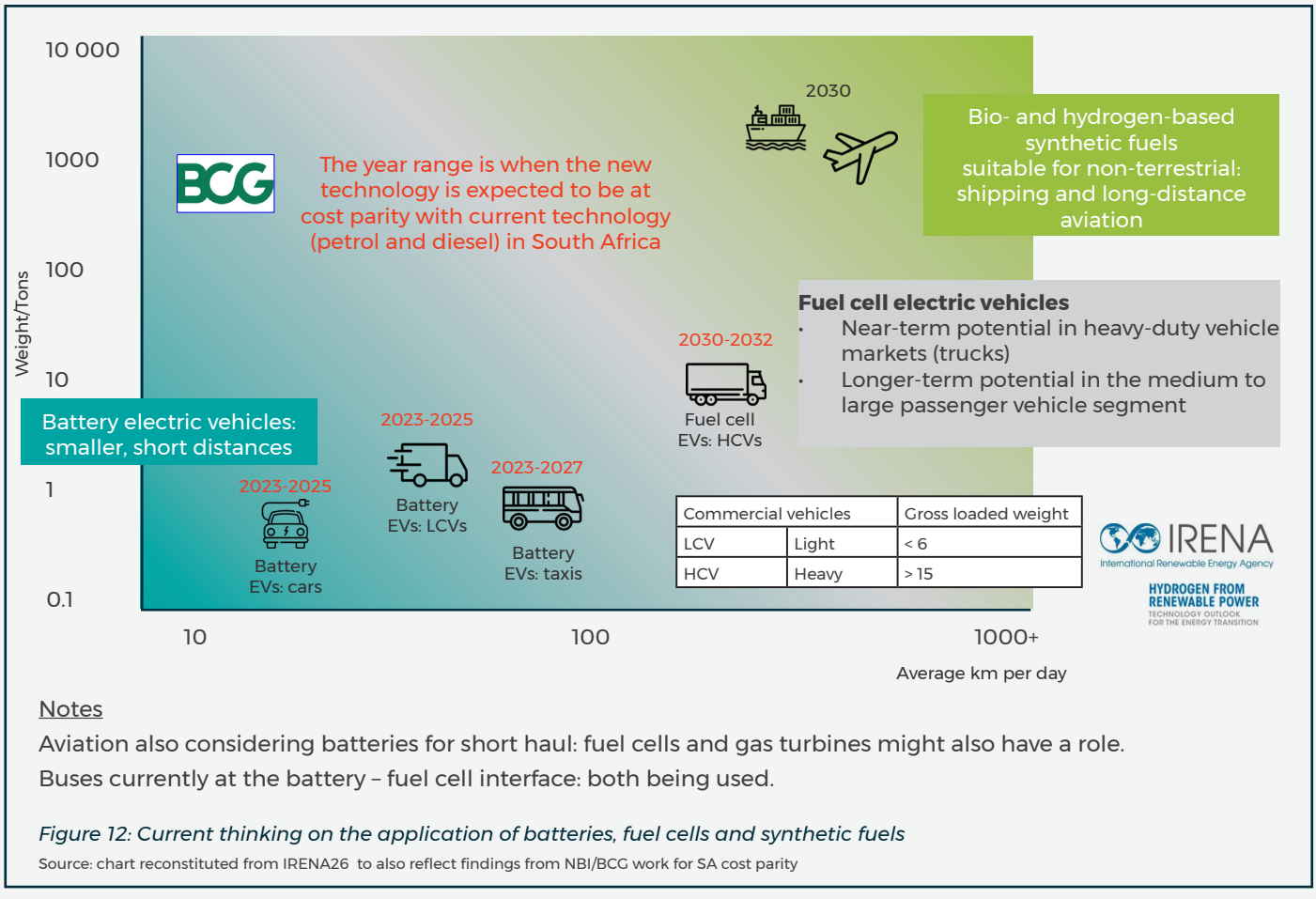
Batteries will dominate in the car, taxi and light vehicle markets.

Fuel cells will dominate in the heavy commercial vehicle (HCV) market and may encroach into the battery space later for passenger vehicles.

Synthetic ammonia (and potentially methanol) will likely dominate the shipping sector.

As noted earlier, several options are being explored at present for **aviation**. Decarbonisation is some years away.

The blue numbers in Figure 12 illustrate when the new technology is expected to reach cost parity with existing technology. Cost parity takes into account capital cost, which is usually higher for the new technology, and running costs, which are much lower for the new technology because of higher inherent energy efficiencies.



Notes

Aviation also considering batteries for short haul: fuel cells and gas turbines might also have a role.

Buses currently at the battery – fuel cell interface: both being used.

Figure 12: Current thinking on the application of batteries, fuel cells and synthetic fuels

Source: chart reconstituted from IRENA26 to also reflect findings from NBI/BCG work for SA cost parity

[26] https://www.irena.org/publications/2018/Sep/Hydrogen-from-renewable-power

7. SUMMARY OF CONCLUSIONS ON **DECARBONISATION OF THE TRANSPORT SECTOR**

The broad conclusion that can be drawn from the four sources that modelled energy and emissions from transport is that **the sector can be fully decarbonised by 2050**, and will contribute around 15% of South Africa's carbon budget for the period 2021-2050. This is apparent from the table below.

Study	Emissions from transport in 2050 (Mt CO_2e)	Estimated emissions from transport 2021 – 2050 (Gt CO_2e)	Proportion of total SA carbon budget 2021 – 2050	Comment
Climate Compatible Growth (2018)	24	1.5	19%	Constrained by the lack of ambition of the Green Transport Strategy.
ERC, UCT (2018)	29 (in 2045)	1.1	14%	
Climate Transparency (2021)	10 (from aviation)	1.2	15%	Did not consider decarbonisation of aviation.
NBI/BUSA/BCG (2022 draft)	0	1.2	15%	This is the only source that puts emissions at net zero in 2050.
*South Africa's carbon budget is the cumulative amount of GHGs that it is allocated through international negotiations. NBI estimates this to be 7-9 Gt CO_2e for the period 2021-2050, and the middle of this range (8) is used in the calculations in this table.				

In the latest finalised South African GHG assessment (2017),[27] emissions for the transport sector were 55 Mt CO_2e out of a total of ~500 Mt CO_2e in 2017 – that is around 11%.

[27] https://www.dffe.gov.za/sites/default/files/docs/nir-2017-report.pdf

8. NEW TRANSPORT OPPORTUNITIES AND **INVESTMENT REQUIREMENTS TO 2050**

A mix of qualitative and some quantitative conclusions can be drawn from the sources consulted.

Road decarbonisation

Qualitatively, there is agreement between the sources on the main levers on the need to:

- **Electrify transport, with decarbonised electricity**
  - **Adopt BEVs in passenger cars and for light commercial transport**
  - **Adopt FCEVs for heavier commercial transport**
- **Shift freight from road to rail**
- **Shift passengers to public transport**

Together, these levers will allow road transport to be fully decarbonised by 2050.

Some implications of these statements are that:

- **Significant further renewable electricity capacity will be required**
- **The volume of liquid fossil fuel required will drop to zero by 2050**
- **No new liquid fossil fuel refining capacity is likely be required**

Financing opportunities identified

Financing opportunities have been identified, but except for the endeavour to produce decarbonised electricity for the transport sector, there are various uncertainties as shown in the table below. These will clarify to some degree with the forthcoming publication of the NBI/BUSA/BCG study, but others will only clarify with further study and experience, or with release of additional information into the public domain.

Capital estimates are only available from:

- The NBI/BUSA/BCG study: these are still in draft form
- The WWF work on SAF

In the absence of comparisons with other sources, these should be regarded as indicative only, to help understand the scale of the financing required.

Qualitative need and financing opportunity		Rate and timing	Total capex estimated
Electrify transport with decarbonised electricity This will require an additional 30-40 GW solar PV + wind electricity generation by 2050 to that required for the electricity sector.		Build rate 1.5-2 GW/annum from ± 2030 to 2050, with rapid uptake of BEVs from 2030.	**Electricity generation:** R240-R310-billion (R12- to R15-billion per annum 2030-2050). **Grid capacity:** R90- to R120-billion (R5- to R6-billion per annum 2030-2050).
Adopt BEVs for passenger cars and light freight transport EVs have high capital costs but lower operating costs than ICEs (4-5 times as energy efficient).	**Manufacturing of passenger cars and LCVs**	Slow uptake pre-2030, rapid post-2030. Penetration by 2050 = 100%, with ~8-million BEVs.	Probably known but not in public domain.
	Assembly and possible future manufacturing of lithium-ion batteries	Not known or possibly known but not in public domain.	Not known or possibly known but not in public domain.
	Charging infrastructure	Identified, but several non-integrated ventures developing.	Wide range of estimates, from R1-billion for 5 000 public charging units to at least R100-billion for 1.4-million public charging units.
Adopt FCEVs for heavier freight transport	**Manufacturing of FCEVs**	Slow uptake pre-2030, rapid post-2030 (disagreement between sources).	Not known or possibly known but not in public domain.
	Manufacturing of green hydrogen	Still a matter of intense speculation.	Still very unclear.
	Hydrogen refuelling infrastructure	Not known or possibly known but not in public domain.	Not known or possibly known but not in public domain.
Shift freight from road to rail		Start immediately, linear progression to 2050. Rail as % of corridor freight in 2050: range of estimates from 35% (BCG) to 70% (CT).	Commercial rail expansion R40-billion (not confirmed).
Shift passengers to public transport		Start immediately, linear progression to 2050. Rail as % of passengers in 2050 = 15-20%.	Passenger rail expansion R300-billion (not confirmed). BRT R150-billion (not confirmed).
Produce SAF for aviation		Known with some confidence. 100% SAF penetration achievable in South Africa by 2050.	Known with reasonable confidence. R178-billion in capex to produce 3.2-billion litres of SAF annually in self-sustaining bio-refineries.

KEY AND NOTES

Rate and timing: this is projected, on a path to decarbonise the sector by 2050

Known with reasonable confidence

Known with some confidence

Identified but uncertain, either because not quantified, not confirmed or disagreement between sources

Not known or known but not in public domain

CT = Climate Transparency

BCG = NBI/BUSA/BCG

All capex estimates are from the draft NBI/BUSA/BCG study

Automobile sector EV manufacturing opportunity

The automotive sector is a very significant contributor to South Africa's economy. The National Association of Automobile Manufacturers of South Africa reports that for 2021:[28]

Automotive industry (manufacturing and retail) contribution to GDP	4.3%
Vehicle and component production as % of South Africa's manufacturing output	17.3%
Automotive sector employment (manufacturing and components)	109 571
Capital expenditure (manufacturing and components)	R14.3-billion
Total automotive export earnings	R208-billion
Automotive export value as % of total South African export value	12.5%
Total South African vehicle production	499 087 units
Export units as % of production	60%

South Africa manufactures a broad range of vehicles, including passenger cars, commercial vehicles and buses. Passenger cars and light commercial vehicles (LCVs) comprise the great majority of exports; 77% of these exports were to Europe in 2022. At present, almost all of the vehicles manufactured in South Africa are ICE vehicles.

The EU and the UK have set aggressive targets for the phase-out of ICE vehicles and the introduction of EVs. Norway, for instance, has announced its intention to ban the sales of new ICE vehicles from as early as 2025, while the UK, South Africa's top vehicle export destination (by volume), announced plans in late 2020 to bring forward the ban of sales of traditional petrol and diesel cars to 2030, five years earlier than planned. [29]

There is no doubt that EVs are no longer merely a possibility, but an inevitability. This presents South Africa with an opportunity if it shifts from manufacturing ICEs to EVs, and a threat of significant loss of business if it does not.

In anticipation of the rapid growth of transport electrification taking place globally, the South African government (through the Department of Trade, Industry and Competition (DTIC)) published a draft green paper in May 2021[30, 31] on the advancement of new energy vehicles in South Africa. A white paper was due late in 2021, but is now not expected until the second half of 2022; motor industry insiders say the delay could be due to the DTIC struggling to find ways to fund incentives. It is thought that government may find it hard to justify setting aside billions of rand to incentivise the purchase price of vehicles that, in the short term at least, would be bought by those who are better off.[32] This is not surprising, given South Africa's extreme inequality and high rates of poverty and unemployment. In addition to working on all elements on the Avoid-Shift-Improve framework to decarbonise the transport sector, a major challenge will thus also be to ensure that EVs are affordable for every owner.

EV prices are high in South Africa, largely due to their expensive batteries and punitive import duties, with EVs attracting a duty of up to 25% compared to 18% for ICE cars, depending on where they are imported from. Local manufacturing has the potential to eliminate or reduce the high import taxes. Economies of scale and battery developments will drive EV prices down, while carbon pricing will increase the cost of running ICE vehicles.

[28] https://naamsa.net/export-manual-2022-book/#flipbook-df_7004/1/
[29] https://www.dailymaverick.co.za/opinionista/2022-01-24-sa-is-not-leaving-itself-time-to-transition-to-evs-and-a-vitally-important-industry-could-die/
[30] http://www.thedtic.gov.za/government-releases-auto-green-paper-on-the-advancement-of-new-energy-vehicles-in-south-africa/
[31] http://www.thedtic.gov.za/wp-content/uploads/EV_Green_Paper.pdf
[32] https://www.businesslive.co.za/bd/national/2022-03-13-electrical-vehicles-the-poor-cannot-subsidise-the-rich-says-volvo-md-greg-maruszewski/

9. KEY POLICY AND REGULATORY **DEVELOPMENTS IN SOUTH AFRICA**

Just Energy Transition Partnership

A significant global development was the announcement at the United Nations Framework Convention on Climate Change (UNFCCC) COP26 in November 2021, of the Just Energy Transition Partnership, an $8.5-billion financial support package for South Africa over three to five years, to accelerate the energy transition. This is a first-of-its-kind partnership to turn financing commitments by the developed world (in this case France, Germany, the UK, the US and the EU) into reality, and hopes are that it will act as a model for similar forms of collaboration globally.

Presidential Climate Commission

The Presidential Climate Commission (PCC)[33] was established by President Ramaphosa in December 2020. This is an independent, multi-stakeholder body, the purpose of which is to facilitate a just transition towards a low-emission and climate-resilient economy. Its focus is to:

- Create a social partnership around a just transition
- Define a vision for a just transition, and means of achieving that vision, covering the necessary sectoral shifts, technological innovation, employment opportunities and climate finance
- Conduct independent analysis into climate change impacts on jobs, the economy and policy
- Monitor progress towards mitigation and adaptation goals, as well as the achievement of a just transition linked to broader development objectives
- Engage with a wide range of stakeholders, including all spheres of government, business, labour, academia, communities and civil society

In February 2022, the head of the Presidential Climate Finance Task Team was appointed.[34] This team is to negotiate and manage the Just Energy Transition Partnership monies and support South Africa's efforts to mobilise finance for climate change action.

Biofuels

In February 2020, the Department of Mineral Resources and Energy published the South African Biofuels Regulatory Framework and National Biofuels Feedstock Protocol (BRF),[35] meant to provide a policy and regulatory framework for the implementation of the Biofuels Industrial Strategy of 2007 (BIS). Together with the regulations regarding the Mandatory Blending of Biofuels with Petrol and Diesel of 2012, it aims to achieve the introduction of 4.5% of biofuels in the national liquid fuels mix, on a volume basis.

While the long-awaited regulatory framework for biofuels is a step in the right direction to introduce renewable resources at scale into the national transport fuel mix, after 14 years in the making, it still leaves a lot of uncertainty for this nascent sector and much room for unintended outcomes.

[33] https://www.climatecommission.org.za/
[34] https://www.news24.com/fin24/economy/former-absa-ceo-daniel-mminele-to-spearhead-plans-for-sas-cop-billions-20220208
[35] http://www.energy.gov.za/files/policies/petroleum/Biofuels-Regulatory-Framework-and-National-Biofuels-Feedstock-Protocol.pdf

Climate change policy in South Africa

The most significant recent climate change policy developments in South Africa are:

Carbon Tax Act (No.5 of 2019), amendments proposed for comment in July 2022.	This gives effect to the polluter-pays principle and helps to ensure that firms and consumers take negative adverse costs (externalities) of carbon emissions into account in their future production, consumption and investment decisions. Firms are incentivised towards adopting cleaner technologies over the next decade and beyond, and penalised for failing to do so. While the generous rebates to date – now extended until 2026 – have significantly watered down the overall effectiveness of the regime, this tax has the potential to be an important driver of emissions reduction. As of August 2022, proposed amendments to the Act are being considered by National Treasury.
Climate Change Bill, adopted by Cabinet in September 2019, formally introduced to the National Assembly in February 2022.	This provides for a coordinated and integrated economic response to climate change and its impacts. It provides for carbon budgets to be allocated to companies and for sector emissions targets. Public hearings on the Bill commenced in Parliament in September 2022.

Adequate carbon pricing

Recent research by the NBI[36] on carbon pricing concluded that the carbon price required in 2030 to meet the goals of the UNFCCC Paris Agreement is around $100/t CO_2e globally, and around $70/t in South Africa and other developing countries. These numbers were based on 10 published scenarios from organisations such as the International Energy Agency, the Carbon Pricing Leadership Coalition, BP, Shell and the World Bank. With the emissions intensity planned in the current IRP for 2030, this equates to about R600/MWh on top of the current industrial rate of around R1 200/MWh. The impact on the diesel price would be around R2.50/litre on top of the current R24/litre.

Carbon tax proposals in South Africa's February 2022 budget mean that the effective price will rise from an average of just over $2/t CO_2e today to "$20 by 2026", "at least $30 by 2030", and "up to $120 beyond 2050". This will apply to Scope 1 emissions within a company's allocated carbon budget, and the Budget Review stated that there would be an additional R640 ($40 at R16.00 = $1.00)/t CO_2e on emissions in excess of its carbon budget (note that this tax on budget exceedance is not mentioned in the proposed amendments to the Carbon Tax Act of July 2022). Amendments proposed are:

- An increase in the tax rate of $1/t CO_2e in 2023; $2/t CO_2e in 2024; and $3/t CO_2e in 2025
- A rate of $20/t CO_2e in 2026
- An increase in the tax rate of $2.50/t CO_2e in each year in the period 2027-2029
- A rate of $30/t CO_2e in 2030

The **Paris Agreement** of 2015 has the aims of holding the increase in the global average temperature to well below 2˚C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5˚C, recognising that this would significantly reduce the risks and impacts of climate change.

The aspirational view of the Paris Agreement, that is a maximum of 1.5˚C, is now seen as the global goal. It is not a "nice-to-have" goal, but one that has been scientifically demonstrated to be essential to limiting the worst impacts of climate change.

[36] Available upon request from the NBI.

Thereafter, it is proposed that the rate be increased by the amount proposed by the finance minister in the national annual budget. Not only will the carbon tax rate increase, but indications are that the current allowances will reduce significantly, starting in 2026, with the current basic allowance of 60% falling away by 2030.

While these numbers are currently lower than those established in the NBI research, they should be interpreted as steps on the way to even higher numbers. If the carbon price is inadequate to the task of driving mitigation that delivers on the Paris Agreement, South Africa's exports will become increasingly uncompetitive. The EU's Carbon Border Adjustment Mechanism will impose import duties equalling the difference between the carbon price in the country of origin and the EU's carbon price.[37]

The effective average price of just over \$2/t CO_2e today has arisen from application of generous deductions on the current headline rate of about \$9/t CO_2e. The delays to implementation of the carbon tax since 2010, the extension of Phase 1 to 2026, and the numerous allowances for deductions, mean that the tax remains relatively ineffective as a deterrent to emitting sectors. However, collectively, all these developments can be seen as drivers for change that mitigate the risks for renewable electricity and exacerbate those for fossil fuels.

[37] https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_3661

10. POTENTIAL FINANCING INSTRUMENTS **FOR THE TRANSPORT SECTOR**

Few overall reviews exist of finance instruments and products to achieve the transition needed for South Africa's transport sector.

Work was carried out by the Carbon Trust[38] in 2021 on linking financial instruments to activities in the real economy. The electricity sector technologies discussed in this report are mapped against the Carbon Trust's summary diagram below, to provide an overview of expected approaches to financial instruments in the transport sector.

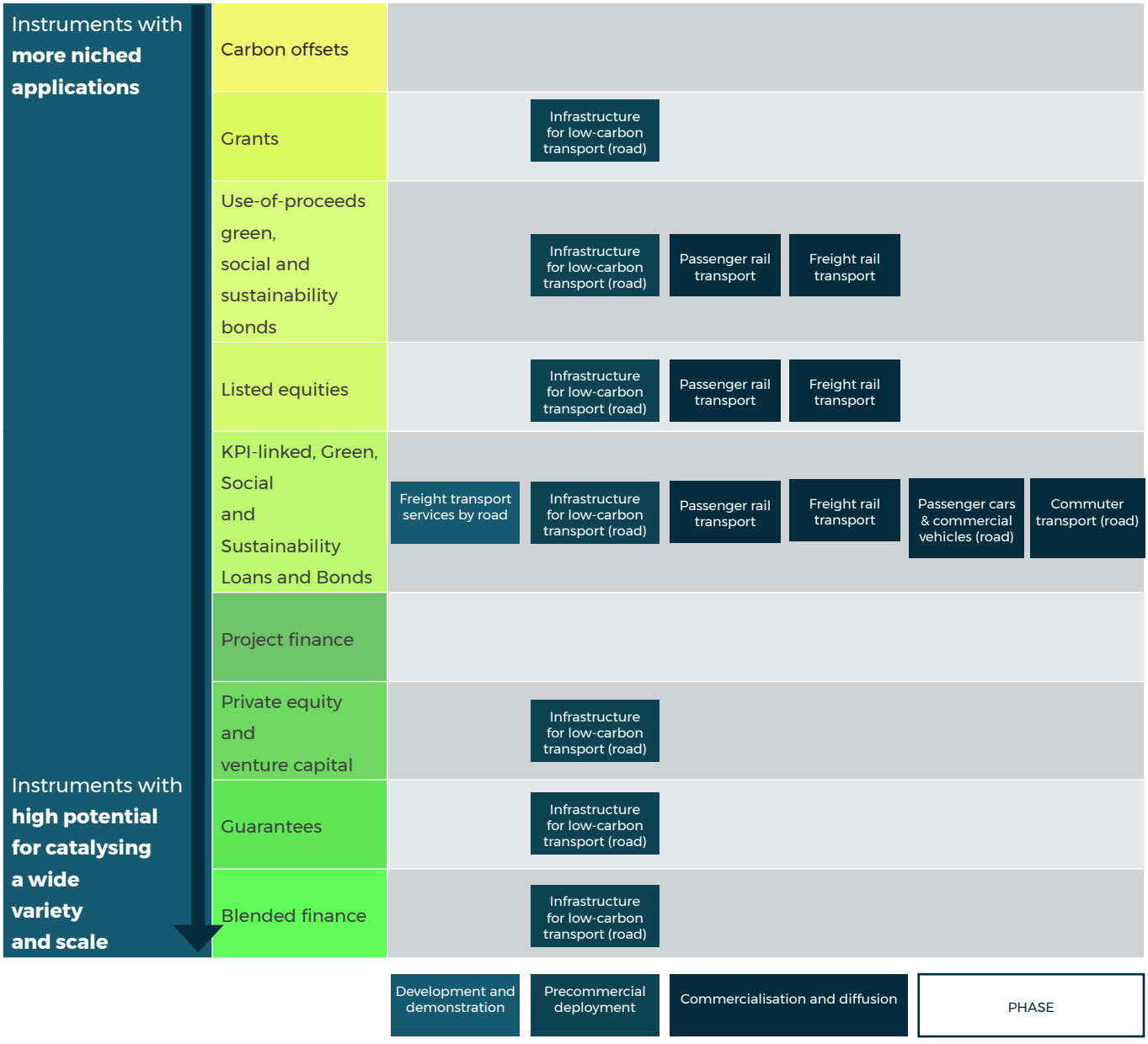


Figure 13: Matching financial instruments to electricity sector technologies

Source: Carbon Trust (2021) and Just Share analysis

A brief description of each of these financing instruments is provided in the table below:

Table 1: Overview of main financial instruments relevant to the transport sector

Carbon offsets*	Carbon offsets have a limited role in sustainable finance. They are currently poorly regulated, if at all, and offset projects have been criticised for failing to represent valid GHG reductions, and for causing human and environmental rights violations. Carbon offsets are not a substitute for climate action.
Grants	Grants continue to be relevant for technologies in demonstration and deployment phases, more often for concessional models and necessary ecosystem development. These could be government grants.
KPI-linked green, social and sustainability loans and bonds	• Use-of-proceeds models will continue to have relevance, but with a needed emphasis on new finance and new project pipelines • There may also be a greater focus on social and sustainable bonds in the future • These instruments may well have a place in blended finance arrangements
Listed equities	Listed equities and related products will provide a means to broaden the market and offer products in sustainable infrastructure and developing and transitioning economic activities.
KPI-linked green, social and sustainability loans and bonds	Performance-linked instruments will tie into transitioning sectors especially.
Project finance	Project finance offers opportunities to financial institutions to prepare and engage industrial clients accordingly.
Private equity and venture capital	Attracting equity players to this space will be vital, especially in "pre-commercial" and "demonstration" phase value chains.
Guarantees	Blended finance and guarantees are going to be especially important and will: • Require actor cooperation • Need to balance objectives and constraints of the cooperating capital providers
Blended finance	

***A note on carbon offsets**

Many countries and non-state actors, such as cities, regions and companies, are pledging to achieve net-zero emissions by 2050 or sooner. While some can feasibly eliminate all of their emissions to reach absolute zero, others will have residual emissions, e.g. biological processes in agriculture, some industrial processes such as cement manufacture, and oil combustion for aviation – these may be difficult to eliminate fully by 2050.

In such cases actors include **carbon offsets** in their climate strategies. These are purchased credits representing a certified unit of carbon dioxide or other GHG reduction, or removal, carried out by another actor elsewhere (because GHGs are distributed in Earth's atmosphere, the climate benefits from emission reductions regardless of where such cutbacks occur).

Most offsets available today are **emission reductions,** e.g. energy-efficiency improvements such as increasing insulation in buildings to reduce heat loss, or using more efficient vehicles for transportation. Reductions are necessary but not sufficient to achieve net zero in the long run.

Users of offsets should increase the portion of their offsets that come from **carbon removals,** rather than from emission reductions, ultimately reaching 100% carbon removals by 2050.

Source: Carbon Trust (2021)

11. SOCIAL CONSIDERATIONS IN **THE TRANSPORT TRANSITION**

One of the first tasks of the PCC was to develop a framework for a just transition. The framework builds on the existing body of knowledge in the country, as well as the vision set out by the National Development Plan (NDP). It will likely be the guide for ensuring social equity in the transition.

The PCC's recent report, *A Framework for a Just Transition in South Africa*,[39] highlights and reinforces the conclusions in this current report. The PCC Framework has been approved by Cabinet for implementation.

Research by NBI and BCG in partnership with BUSA led to the recommendation that 10 key factors should be addressed to tackle the localised challenges that will occur during the transition.

Job creation

Social and ecological welfare (public health and access to water are critical factors)

Managing geographic and cultural dislocation of communities

Education, capacitation and reskilling

Economic inclusion and participation (especially of youth and black women)

Ownership

Quality of work

Infrastructure planning and roll-out (linked to social acceptance and reputation)

Policy and governance

Funding (provision of social protection measures or retraining and reskilling programmes for workers negatively impacted by the transition)

Work is currently being completed under the NBI Transition Pathways programme to assess the economy-wide effects and opportunities of net-zero pathways. Impacts and opportunities are considered for several key socio-economic indicators, including employment (by sector and skill level), inequality, household income, sector growth and GDP. The NBI Just Transition Pathway body of work can be accessed via the NBI Just Transition web hub: https://jthub.nbi.org.za/.

[39] https://pccommissionflow.imgix.net/uploads/images/A-Just-Transition-Framework-for-South-Africa-2022.pdf

12. CONCLUSION

The imperatives for the world and South Africa to transition to a net-zero carbon economy are clear.

The transport sector is seen to be a prime sector for decarbonisation in South Africa. This is partly because of lower alternative technology costs, but also because the solutions envisaged can contribute to redressing imbalances in South Africa such as over-utilisation of roads and under-utilisation of public transport and of rail for freight.

Global trends will lead to unavoidable changes in the sector, even in a scenario where South Africa does not proactively drive decarbonisation.

The key decarbonisation levers are the electrification of transport with decarbonised electricity, a shift of freight from road to rail, a shift of passengers to public transport, and the development of SAF for aviation. While the understanding of these solutions is qualitatively quite good, quantification is generally not well developed.

The risks and opportunities for the financial sector are significant. Key considerations include what type of financial instruments or products would need to be used (or developed) to facilitate an affordable clean electricity dominated transition pathway, and how the sector would responsibly divest from liquid fossil fuel-intensive assets. A just transition for South Africa further includes support for workers and communities affected by the transition away from income and livelihoods supported by liquid fuels, and enables the creation of quality green jobs.

ANNEXURE: **FURTHER READING**

The following references will give greater insight into climate policy and legislation in South Africa, and the South African climate finance landscape.

Policy and regulatory developments

Climate policy and legislation in South Africa

Climate Laws of the World. Country Profile: South Africa, Grantham Research Institute at LSE and the Sabin Center at Columbia Law School

https://climate-laws.org/geographies/south-africa

Climate finance

***South African Climate Finance Landscape 2020* report**

The South African Climate Finance Landscape 2020 report presents a baseline of what is possible in catalysing the financing and investment required for a low-carbon and climate-resilient economy. It considers detailed project-level data, understanding the source, disbursement, instrument and use. The report aims to provide public and private role-players with information to shape sectoral strategies and selected policies, as well as improve coherence and coordination between public- and private-level spending in these sectors.

The sources of finance tracked included public finance (~R22-billion), private finance (R35.3-billion) and blended finance (R4.9-billion), for 2017 and 2018.

The report can be accessed here: https://www.greencape.co.za/assets/South-African-Climate-Finance-Landscape-2020-January-2021.pdf

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