National Business Initiative

CHAPTER

07

JUST TRANSITION AND CLIMATE PATHWAYS STUDY FOR SOUTH AFRICA

DECARBONISING SOUTH AFRICA'S HEAVY MANUFACTURING SECTOR

IN PARTNERSHIP WITH

BUSA BUSINESS UNITY SOUTH AFRICA

BCG BOSTON CONSULTING GROUP

ACKNOWLEDGEMENTS

RESEARCH SUPPORTED BY

UK PACT South Africa: UK PACT has partnered with South Africa to support action on Just Transition pathways and a low-carbon economic recovery. As the third largest economy in Africa, South Africa plays a critical role in economic and policy priority setting at a continental level and across the Southern Africa region. South Africa's long-standing participation in the United Nations Framework Convention on Climate Change (UNFCCC) processes creates a solid platform for an impactful and transformational UK PACT partnership. Moreover, UK PACT seeks to support climate action that will contribute to the realisation of other development imperatives in South Africa, such as job creation and poverty alleviation. Priority areas of focus for UK PACT in South Africa are aligned with key national priorities in the just energy transition, renewable energy, energy efficiency, sustainable transport, and sustainable finance. UK PACT projects can contribute to addressing industry-wide constraints, common metropolitan challenges, and bringing city, provincial and national level public and private partners together to address climate priorities.

We Mean Business: This is a global coalition of nonprofit organisations working with the world's most influential businesses to take action on climate change. The coalition brings together seven organisations: BSR, CDP, Ceres, The B Team, The Climate Group, The Prince of Wales's Corporate Leaders Group and the World Business Council for Sustainable Development. Together we catalyze business action to drive policy ambition and accelerate the transition to a zero-carbon economy. NBI has been a regional network partner to WMB since the beginning of 2015.

Strategic Partnerships for the Implementation of the Paris Agreement (SPIPA): Climate change is a global threat that requires a decisive and confident response from all communities, particularly from major economies that represent roughly 80% of global greenhouse gas emissions. The 2015 Paris Agreement complemented by the 2018 Katowice climate package, provides the essential framework governing global action to deal with climate change and steering the worldwide transition towards climate-neutrality and climate-resilience. In this context, policy practitioners are keen to use various platforms to learn from one another and accelerate the dissemination of good practices.

To improve a geopolitical landscape that has become more turbulent, the EU set out in 2017 to redouble its climate diplomacy efforts and policy collaborations with major emitters outside Europe in order to promote the implementation of the Paris Agreement. This resulted in the establishment of the SPIPA programme in order to mobilise European know-how to support peer-to-peer learning. The programme builds upon and complements climate policy dialogues and cooperation with major EU economies.

This publication was produced with the financial support of the European Union's Partnership Instrument and the German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU) in the context of the International Climate Initiative (IKI). The contents of this publication are the sole responsibility of National Business Initiative (NBI) and do not necessarily reflect the views of the funders.

Confederation of Danish Industry: DI is Denmark's largest, most representative and most influential business and employers' organisation, covering manufacturing as well as service industries. DI works with employer and business membership organisations all over the world to reach the UN's Sustainable Development Goals and make their vision of a world with economic opportunities for everyone come alive.

PARTNERS

National Business Initiative

At the National Business Initiative (NBI), we believe in collective action and collaboration to effect change; building a South African society and economy that is inclusive, resilient, sustainable and based on trust. We are an independent business movement of around 80 of South Africa's largest companies and institutions committed to the vision of a thriving country and society. The NBI works with our members to enhance their capacity for change, leverage the power of our collective, build trust in the role of business in society, enable action by business to transform society and create investment opportunities.

Business Unity South Africa

BUSA, formed in October 2003, is the first representative and unified organisation for business in South Africa. Through its extensive membership base, BUSA represents the private sector, being the largest federation of business organisations in terms of GDP and employment contribution. BUSA's work is largely focused around influencing policy and legislative development for an enabling environment for inclusive growth and employment.

Boston Consulting Group

BCG partners with leaders in business and society to tackle their most important challenges and capture their greatest opportunities. BCG, the pioneer in business strategy when it was founded in 1963, today works closely with clients to embrace a transformational approach aimed at benefitting all stakeholders – empowering organisations to grow, build sustainable competitive advantage, and drive positive societal impact. Their diverse global teams are passionate about unlocking potential and making change happen, and delivering integrated solutions.

TERMINOLOGIES

BAT	Best Available Techniques or Technology
BEV	Battery Electric Vehicle
BF-BOF	Blast Furnaces (BF) and Basic Oxygen Furnaces (BOF)
bn	Billion
BUSA	Business Unity South Africa
c	Cents (in South African currency)
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CCUS	Carbon Capture Utilisation and Storage
CHP	Combined Heat and Power
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
COP	UN Climate Change Conference of the Parties
DRI-EAF	Direct Reduced iron (DRI)-Electric Arc Furnaces
EAF	Electric Arc Furnaces
EU	European Union
EV	Electric Vehicle
FCEV	Fuel Cell Electric Vehicle
GDP	Gross Domestic Product
GHGI	Greenhouse Gas National Inventory
GJ	Gigajoule
Gt	Gigatonne (1 thousand million tonnes)
GW	Gigawatt
H_2	Hydrogen
HM	Heavy manufacturing
ICE	Internal Combustion Engine
IEA	International Energy Agency
k	Thousand
kg	Kilogram
kWh	Kilowatt-hour
LCOH	Levelised cost of hydrogen
mn	Million
Mt	Megatonne (1 million tonnes)
Mt p.a.	Megatonne per annum
MW	Megawatt
n/a	Not Applicable
NDC	Nationally Determined Contribution
OECD	Organisation for Economic Co-operation and Development

OEM	Original Equipment Manufacturer
OPEX	Operational Expenditure
p.a.	per annum
PFC	Perfluorocarbon
PGMs	Platinum Group Metals
PJ	Petajoule (10^15 Joule)
PPA	Power Purchase Agreement
R	South African Rand
R&D	Research and Development
RDF	Refuse-Derived Fuel
RDP	Reconstruction Development Programme
RE	Renewable Energy
SA	South Africa
SCM	Supplementary Cementitious Material
Scope 1 emissions	All direct emissions from activities of an organisation under their control, including on-site fuel combustion for fleet vehicles, stationary machinery and heating processes, and fugitive emissions from drilling or spontaneous combustion of coal
Scope 2 emissions	Indirect emissions from electricity purchased and used by the organisation
Scope 3 emissions	All indirect emissions (not included in Scope 2) that occur in the value chain of the respective organisation, including both upstream and downstream emissions (for example, emissions linked to the use of the organisation's products)
TWh	Terawatt-hour
UK	United Kingdom
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
US / USA	United States
US$	United States Dollar
WACC	Weighted Average Cost of Capital
WHR	Waste Heat Recovery
ZAR	South African Rand
ZEV	Zero Emission Vehicle

CONTENTS

JUST TRANSITION AND CLIMATE PATHWAYS STUDY FOR SOUTH AFRICA

SERIES INCLUDES:

01 Decarbonising South Africa's power system

02 Decarbonising the South African petrochemicals and chemicals sector

03 The role of gas in South Africa's path to net-zero

04 Decarbonising the South African mining sector

05 Decarbonising the AFOLU (Agriculture, Forestry and Other Land Use) sector in South Africa

06 Decarbonising the South African transport sector

07 Decarbonising the South African heavy manufacturing sector

08 Decarbonising the South African building and construction sector

09 Financing South Africa's Just Transition

10 South Africa's net-zero transition

Acknowledgements 2

Terminologies 4

Overview of CEO Champions 7

1. FOREWORD 10

2. INTRODUCTION 12

2.1 The purpose of this report 12

2.2 The case for change 12

2.3 Objectives and approach 16

3. TOWARDS A NET-ZERO, JOBS-RICH HEAVY MANUFACTURING SECTOR IN SOUTH AFRICA 20

3.1 Scope and approach of the heavy manufacturing sector analysis 22

3.2 South Africa's heavy manufacturing sector today 23

3.3 Decarbonising the heavy manufacturing sector will improve its global competitiveness and can support a Just Transition 29

3.4 Decarbonisation pathways for South Africa's heavy manufacturing sector 33

3.5 Just Transition and broader socio-economic implications 49

3.6 How to enable the decarbonisation of South Africa's heavy manufacturing sector 50

4. OUTLOOK 52


Photo: Shutterstock.com

OVERVIEW OF CEO CHAMPIONS

Onboarding of additional CEOs ongoing

Joanne Yawitch
NBI CEO

Cas Coovadia
BUSA CEO

Paul Hanratty
Sanlam CEO

Shirley Machaba
PwC CEO

Lungisa Fuzile
Standard Bank South Africa CEO

Leila Fourie
JSE Group CEO

André de Ruyter
Eskom CEO

Arrie Rautenbach
ABSA CEO

Ian Williamson
Old Mutual CEO

Alan Pullinger
First Rand CEO

Portia Derby
Transnet CEO

Stuart Kent
Aurex Constructors CEO

Mark Dytor
AECI CEO

Nolitha Fakude
Anglo American SA Chairperson

Taelo Mojapelo
BP Southern Africa CEO

Deidré Penfold
CAIA Exec Director

Theo Boschoff
AgBiz CEO

Seelan Naidoo
Engen MD and CEO

Mohammed Akoojee
Imperial Logistics CEO

Stuart Mckensie
Ethos CEO

Nombasa Tsengwa
Exxaro CEO

Gavin Hudson
Tongaat Hulett CEO

Nyimpini Mabunda
GE SA CEO

Bertina Engelbrecht
Clicks Group CEO

Tshokolo TP Nchocho
IDC CEO

Hloniphizwe Mtolo
Shell SA CEO

Vivien McMenamin
Mondi SA CEO

Andrew Robinson
Norton Rose Fulbright CEO

Roland van Wijnen
PPC Africa CEO

Njombo Lekula
PPC MD SA Cement and Materials

Alex Thiel
SAPPI CEO

Fleetwood Grobler
Sasol CEO

1.
FOREWORD

JUST TRANSITION AND CLIMATE PATHWAYS STUDY FOR SOUTH AFRICA

South Africa is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and to the Paris Agreement. As an energy and emissions intensive middle-income developing country, it recognises the need for it to contribute its fair share to the global effort to move towards net-zero carbon emissions by 2050, taking into account the principle of common but differentiated responsibilities and the need for recognition of its capabilities and national circumstances.

South Africa is highly vulnerable to the impacts of climate change and will need significant international support to transition its economy and to decarbonise. Furthermore, given the country's high rate of inequality, poverty and unemployment and the extent of dependence on a fossil fuel-based energy system and economy, this transition must take place in a way that is just, that leaves no-one behind and that sets the country onto a new, more equitable and sustainable development path; one which builds new local industries and value chains.

In response to the above imperatives, the National Business Initiative, together with Business Unity South Africa and the Boston Consulting Group has worked with corporate leaders to assess whether the pathways exist for the country's economic sectors to decarbonise by 2050, and whether this can be done in such a way as to build resilience to the impacts of climate change and to put the country onto a new, low emissions development path.

The work done by the business community has interrogated the energy, liquid fuels, mining, chemicals, AFOLU (Agriculture, Forestry and Other Land Use), transport and heavy industrial sectors. The results of the modelling and analytical work have been informed by numerous industry experts, academics and scientists. The results demonstrate that these pathways do exist and that even a country with an economy that is structurally embedded in an energy-intensive production system can shift.

The results of this work to date have shown that this shift can happen, and that to realise these pathways, efforts must begin now. Timing is of the essence and the business community is of the view that there is no time like the present to create the regulatory and policy environment that would support transitioning the economy

Accordingly, business can commit unequivocally to supporting South Africa's commitment to find ways to transition to a net-zero emissions economy by 2050.

In November 2022, South Africa tabled its revised Nationally Determined Contribution (NDC) to the UNFCCC. Business recognises the need for greater ambition to position the country as an attractive investment destination and increase the chances of accessing green economic stimulus and funding packages. Specifically, business would support a level of ambition that would see the country committing to a range of 420–350 Mt CO_2e by 2030. This is significantly more ambitious than the NDC put out for public comment and would require greater levels of support with regard to means of implementation from the international community than is currently the case. It is also consistent with international assessments of South Africa's fair share contribution to the global effort, and it would also ensure that the no-regret decisions, that would put South Africa onto a net-zero 2050 emissions trajectory, would be implemented sooner.

While South Africa has leveraged a degree of climate finance from the international community, the scale and depth of the transition envisaged will require substantial investments over an extended period of time. Critically, social costs and Just Transition costs must be factored in. Significant financial, technological, and capacity support will be required to support the decarbonisation of hard to abate sectors. Early interventions in these sectors will be critical.

Business sees the support of the international community as essential for the country to achieve its climate objectives. For this reason, business believes that a more ambitious NDC, and one that would place the country firmly on a net-zero emissions by 2050 trajectory, would

Upington, Northern Cape. Photo: scatec.com/locations/south-africa

have to be conditional on the provision of the requisite means of support by the international community. In this light the business community will play its part to develop a portfolio of fundable adaptation and mitigation projects that would build resilience and achieve deep decarbonisation.

Despite the depth of the challenge, South African business stands ready to play its part in this historical endeavour. Business is committed to work with government and other social partners, with our employees, our stakeholders, and the international community, to embark on a deep decarbonisation path towards net-zero and to build the resilience to the impacts of climate change that will ensure that our country contributes its fair share to the global climate effort.

2.
INTRODUCTION

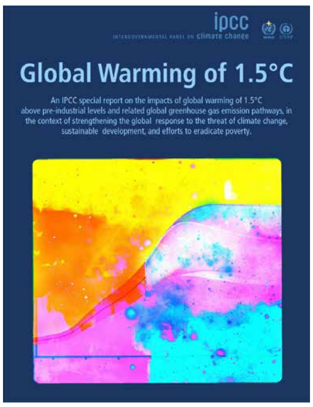
2.1 THE PURPOSE OF THIS REPORT

This report is part of the Just Transition and Climate Pathways study for South Africa. It focuses on the decarbonisation of South Africa's heavy manufacturing sector, and is part of a series of reports that are being released. These reports are intended to leverage further engagement with sector experts and key stakeholders, beyond the extensive stakeholder engagement that has been undertaken from August 2020 within the respective technical working groups of this project. We hope this will foster continued dialogue during the project as we work towards a final report that will collate the individual sector findings and provide collective insight.

2.2 THE CASE FOR CHANGE

2.2.1 CLIMATE CHANGE AND THE RACE TO GLOBAL NET-ZERO EMISSIONS BY 2050

Climate change is the defining challenge of our time. Anthropogenic climate change poses an existential threat to humanity. To avoid catastrophic climate change and irreversible 'tipping points', the Intergovernmental Panel on Climate Change (IPCC) stresses the need to stabilise global warming at 1.5 °C above pre-industrial levels. For a 66% chance of limiting warming by 2100 to 1.5 °C, this would require the world to stay within a total carbon budget estimated by the IPCC to be between 420 to 570 gigatonnes (Gt) of CO_2, to reduce net anthropogenic emission of CO_2 by ~45% of 2010 levels by 2030, and to then reach net-zero around 2050.[1]



Hence, mitigating the worst impacts of climate change requires all countries to decarbonise their economies. In the 2019 World Meteorological Organization report, 'Statement on the State of the Global Climate', the United Nations (UN) Secretary-General urged: "Time is fast running out for us to avert the worst impacts of climate disruption and protect our societies from the inevitable impacts to come."

South Africa, in order to contribute its fair share to the global decarbonisation drive, bearing in mind the principle of 'common but differentiated responsibilities and respective capabilities', should similarly set a target of reaching net-zero emissions by 2050, **and also keep it within a fair share of the global carbon budget allocated, estimated to be between 7 and 9 Gt CO_2e**.[2]

Even if global warming is limited to 1.5 °C, the world will face significantly increased risks to natural and human systems. For example, 2019 was already 1.1 °C warmer than pre-industrial temperatures, and with extreme weather events that have increased in frequency over the past decades, the consequences are already apparent.[3]

1 IPCC. 2018. *Special Report on Global Warming of 1.5°C*.

2 Extrapolation of the medians of various methodologies described by Climate Action Tracker. The full range is 4–11 Gt CO_2e.

3 World Meteorological Organization. 2019. 'Statement on the State of the Global Climate'.

"Time is fast running out for us to avert the worst impacts of climate disruption and protect our societies from the inevitable impacts to come."

Mr António Guterres,
United Nations Secretary-General

Photo: UN Climate Action Summit

More severe and frequent floods, droughts and tropical storms, dangerous heatwaves, runaway fires, and rising sea levels are already threatening lives and livelihoods across the planet.

South Africa will be among the countries at greatest physical risk from climate change. South Africa is already a semi-arid country and a global average temperature increase of 1.5 °C above pre-industrial levels translates to an average 3 °C increase for Southern Africa, with the central interior and north-eastern periphery regions of South Africa likely to experience some of the highest increases.[4] Research shows that a regional average temperature increase of over 1.5 °C for South Africa translates to a greater variability in rainfall patterns. Models show the central and western interiors of the country trending towards warmer and dryer conditions, and the eastern coastal and escarpment regions of the country experiencing greater variability in rainfall as well as an increased risk of extreme weather events.

Rising temperatures and increased aridity and rainfall variability may have severe consequences for South Africa's agricultural systems, particularly on the country's ability to irrigate, grow and ensure the quality of fruit and grain crops; and on the health of livestock, such as sheep and cattle, which will see decreased productivity and declining health at temperature thresholds. Parasites tend to flourish in warmer conditions, threatening people as well as livestock and crops. Increasing temperatures and rainfall variability threaten South Africa's status as a megabiodiverse country. Severe climate change and temperature increases could shift biome distribution, resulting in land degradation and erosion. The most notable risk is the impact on the grassland biome, essential for the health of South Africa's water catchments, combined with the risk of prolonged drought.

Finally, rising ambient temperatures due to climate change and the urban heat effect, threaten the health of people, particularly those living in cramped urban conditions and engaging in hard manual labour, as higher temperatures result in increased risk of heat stress and a reduction in

4 Department of Environmental Affairs, Republic of South Africa. 2018. *South Africa's Third National Communication Under the United Nations Framework Convention on Climate Change.*

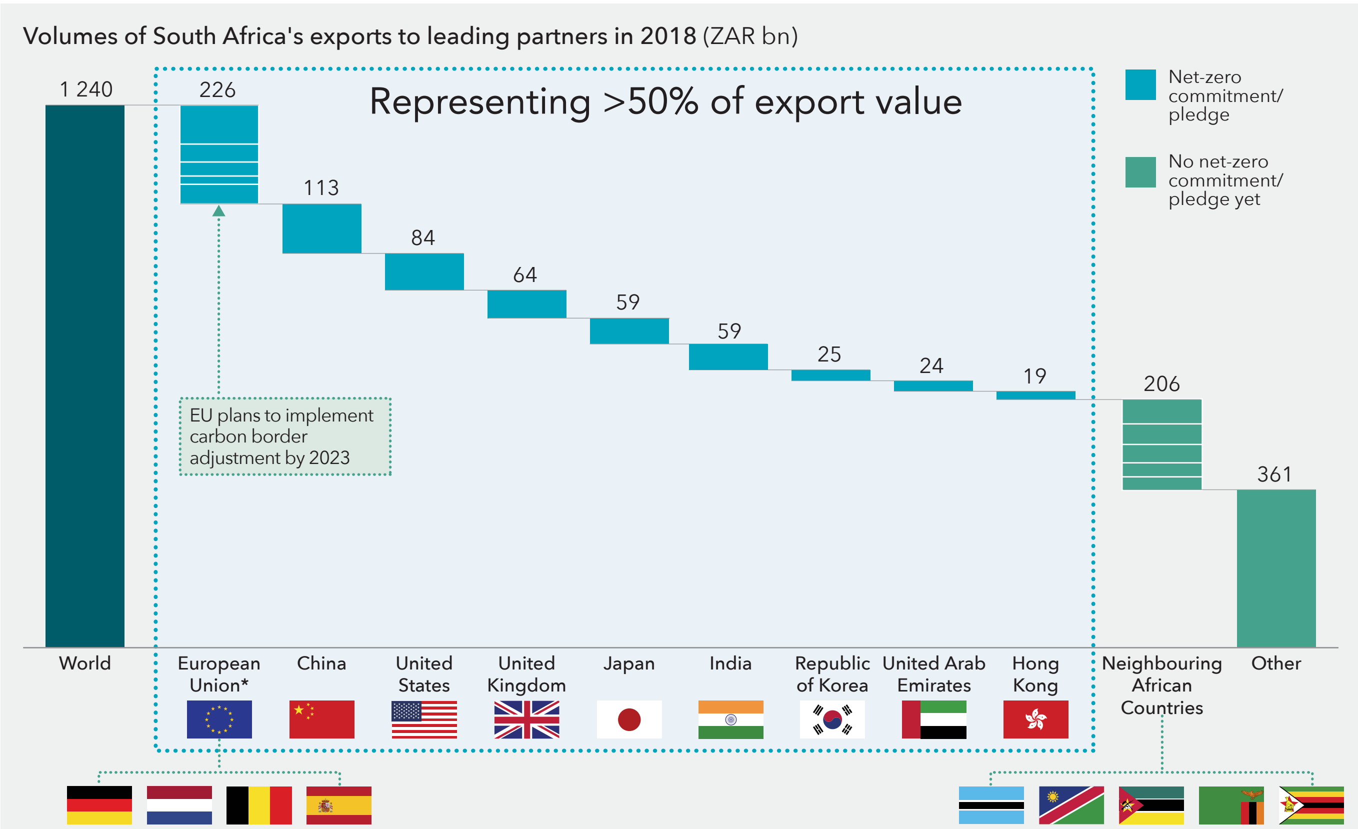
productivity. Therefore, limiting global climate change and adapting to inevitable changes in the local climate will be critical to limit the direct, physical risks to South Africa. Like many developing countries, South Africa has the task of balancing the urgent need for a just economic transition and growth, while ensuring environmental resources are sustainably used and consumed, and responding to the local physical impacts of climate change.[5] While South Africa is highly vulnerable to the physical impacts of climate change, its economy is also vulnerable to a range of transition risks posed by the global economic trend towards a low-carbon future, such as those from changing markets and technologies, and from regulations.

South Africa is also facing a significant trade risk. South Africa ranks in the top 20 most carbon-intensive global economies on an emissions per Gross Domestic Product (GDP) basis, and in the top five amongst countries with GDP in excess of US$100 billion (bn) per annum. The South African economy will face mounting trade pressure, as trade partners implement their low-carbon commitments. South Africa has predominantly coal-based power generation, the coal-to-liquid (CTL) process in the liquid fuels sector, and a coal-reliant industrial sector. In the mining sector, three of the four most significant minerals in South Africa's commodity footprint are at risk, given the global efforts to curb emissions: thermal coal, Platinum Group Metals (PGMs) with mainly palladium and iron ore. The fourth mineral is gold.

The bulk of South Africa's exports comprise carbon-intensive commodities from the mining, manufacturing, and agricultural sectors which will become less competitive in markets in a future decarbonised world. These sectors also provide the majority of employment of unskilled labour at a regional level.

The carbon-intensity of the South African economy, key sectors, and export commodities must be seen against the backdrop of the country's key trading partners committing to ambitious decarbonisation goals. By early 2021, countries representing more than 65% of global carbon dioxide emissions and more than 70% of the world's economy, have made ambitious commitments to carbon-neutrality. Seven of South Africa's key export markets have all set net-zero targets, including the European Union (EU),

Figure 1: Trade-related risks pose additional threats to South Africa's economy if it does not transition



Note: Exchange rate based on 2018 average = ZAR13:US$24.
* Top three trade partners within EU are Germany, Netherlands and Belgium, and among those with most aggressive targets.

Source: World Integrated Trade Solution 2018; Press research.

5 Department of Environmental Affairs, Republic of South Africa. 2016. *South Africa's Second Annual Climate Change Report*.

China, the United States (US), the United Kingdom (UK), Japan, and South Korea.[6]

At the UN Climate Change Conference of the Parties (COP26) in November 2021, all countries set out more ambitious goals, including setting concrete mid-term reduction targets. The COP26 Presidency's stated priorities included 'seizing the massive opportunities of cheaper renewables and storage', 'accelerating the move to zero-carbon road transport', and 'the need to unleash the finance which will make all of this possible and power the shift to a zero-carbon economy'.

Over and above this, select geographies like the EU are also considering carbon border taxes which could impact future trade. It is therefore essential to consider how South Africa's competitiveness in global markets, and therefore the viability of its industries, will be affected should key trading partners start taking steps to protect their net-zero commitments and enable their net-zero carbon growth trajectories. South Africa will need to address the risks and seize the opportunities presented by climate change.

South Africa will also have the chance to tap into new opportunities. Goldman Sachs estimate that around 35% of the decarbonisation of global anthropogenic greenhouse gas emissions is reliant on access to clean power generation, and that lower-carbon hydrogen and clean fuels will be required for hard-to-decarbonise sectors.[7] South Africa has key strategic advantages which can be leveraged to tap into such emerging opportunities. South Africa has a number of significant assets including plenty of sun and wind. Renewables-dominated energy systems and local manufacturing are key. South Africa's coal assets are aged, and decommissioning coal plants can be done within the carbon budget and with minimal stranded asset risk. South Africa's motor vehicle manufacturing expertise could be transitioned to electric vehicle (EV) production. The country's stable and well-regulated financial services sector, among the most competitive in the world, would make a strong base for green finance for the continent. The combination of wind and solar enables the right kind of conditions for green hydrogen (H_2), setting the stage for South Africa to be a net exporter. The role of PGMs in hydrogen and fuel cell technology and the increased demand for certain mined commodities, like copper for use in green technology, could bolster the minerals sector. South Africa's experience with the Fischer–Tropsch process positions it to be one of the world leaders in carbon-neutral fuels, and other innovations are thus waiting to be unlocked.

The imperative is clear: South Africa must decarbonise its economy in the next three decades and transform it into a low-carbon, climate-resilient, and innovative economy. This transition also needs to take place in a manner that is just and simultaneously addresses inequality, poverty and unemployment to ensure that no-one is left behind and that our future economy is also socially-resilient and inclusive.

6 United Nations News. 2020. *The race to zero emissions, and why the world depends on it.*

7 Goldman Sachs. 2020. *Carbonomics: Innovation, Deflation and Affordable De-carbonisation.*

2.2.2 THE NEED FOR A JUST TRANSITION

With a Gini coefficient of 0.63, South Africa is one of the most unequal societies in the world today.[8] A recent study shows that the top 10% of South Africa's population owns 86% of aggregate wealth and the top 0.1% close to one-third. Since the onset of the COVID-19 pandemic, levels of poverty have further increased and have likely shifted beyond 55% of the population living in poverty. In July 2020, a record 30.8% of the population was unemployed.[9] Exacerbating this are levels of youth unemployment that are amongst the highest in the world.[10]

As South Africa grapples with the economic recession accompanying the pandemic, and copes with the need to rebuild the capacity of the State and its institutions following a decade of state capture, it must start rebuilding and transforming its economy to make it resilient and relevant in a decarbonised world. However, while a transition towards a net-zero economy will create new economic opportunities for South Africa, it is also a transition away from coal, which without careful planning and new investments, will put many jobs and value chains at risk in the short-term, and exacerbate current socio-economic challenges.

Today, the coal mining sector provides almost 0.4 million jobs in the broader economy, with ~80 k direct jobs and ~200 k to 300 k indirect and induced jobs in the broader coal value chain and economy. The impact is even broader when it is taken into account that, on average, each mine worker supports 5–10 dependents. This implies a total of ~2 to 4 million livelihoods.[11] The low-carbon transition must do more than simply address what is directly at risk from decarbonisation. The transition must also address the broader economic concern of stalled GDP growth of ~1% for the last five years, rising unemployment with ~3% increase over the last five years,[12] deteriorating debt to GDP ratio, with growth of ~6% for the last 10 years, and the consistently negative balance of trade.[13]

These challenges are more severe given further deterioration during the COVID-19 pandemic. It is therefore critical that South Africa's transition is designed and pursued in a way that is just; meaning that it reduces inequality, maintains and strengthens social cohesion, eradicates poverty, ensures participation in a new economy for all, and creates a socio-economic and environmental context which builds resilience against the physical impacts of climate change.

This transition requires action, coordination, and collaboration at all levels. Within sectors, action will need to be taken on closures or the repurposing of single assets. Job losses must also be addressed with initiatives like early retirement and reskilling programmes, with the latter having the potential for integration with topics like skills inventories and shared infrastructure planning and development. A national, coordinated effort to enable the Just Transition will also be crucial to address the education system and conduct national workforce planning. In order to implement its Just Transition, South Africa will need to leverage global support in the form of preferential green funding, capacity-building, technology-sharing, skills development, and trade cooperation.

To move towards this net-zero vision for the economy by 2050, South Africa must mitigate rather than exacerbate existing socio-economic challenges and seize emerging economic opportunities to support its socio-economic development agenda. How to ensure a Just Transition towards net-zero and advancing South Africa's socio-economic context, is therefore the key guiding principle of this study.

2.3 OBJECTIVES AND APPROACH

Key objectives of this study. Achieving net-zero emissions in South Africa by 2050, whilst ensuring a Just Transition, is a complex and unique challenge. Extensive studies examining how a Just Transition towards a lower-carbon economy can be achieved in South Africa have already been conducted or are currently underway. There are many different views on what defines a Just Transition in South Africa, which decarbonisation ambitions South Africa is able to pursue and commit to, and how a transition towards a lower-carbon economy can be achieved.

This study is not advocating for a particular position. It is not setting ambitions around levels and timelines for South

8 The World Bank. 2021. 'South Africa Overview'.

9 StatsSA. 2017. *Poverty Trends in South Africa. An examination of absolute poverty between 2006 and 2015*.

10 Chatterjee, A., et al. 2020. *Estimating the Distribution of Household Wealth in South Africa*.

11 Minerals Council of South Africa. 2020. 'Facts and Figures'.

12 Department of Statistics, Republic of South Africa. 2021.

13 South African Reserve Bank. 2021.

Africa's emission reduction. Nor is this study prescribing sector- or company-specific emission reduction targets.

The study does aim to develop the necessary technical and socio-economic pathways research and analysis to support decision-making and bolster a coordinated and coherent effort among national and international stakeholders. This research is anchored around three key questions:

- What is the cost of inaction for South Africa should it fail to respond to critical global economic drivers stemming from global climate action?
- What would it take, from a technical perspective, to transition each of South Africa's economic sectors to net-zero emissions by 2050?
- What are the social and economic implications for South Africa in reaching net-zero emissions by 2050?

Approach of this study. To understand how a transition of the South African economy towards net-zero emissions can be achieved, this study assesses each sector and intersectoral interdependencies in detail (with this report detailing the initial findings of the heavy manufacturing sector analysis). Our analysis of the South African economy is structured along understanding what the decarbonisation pathways could be for key heavy emitting sectors, namely: electricity, petrochemicals and chemicals, mining, metals and minerals, manufacturing, transport and AFOLU (Agriculture, Forestry and Other Land Use) (Figure 2). Given this is a multi-year project, a preliminary report will be released as each sector is completed. Towards the end of the study, each sector analysis will be further refined on the basis of understanding interlinkages better. For example, insights gained from the transport sector analysis around the impact of EVs on electricity demand will be leveraged for further refinement of the electricity sector analysis.

The first phase of the study focuses on today's key drivers of South Africa's emissions: electricity and the petrochemicals and chemicals sectors which make up more than 60% of the country's total emissions. Given the socio-economic implications of decarbonising South Africa's energy landscape, particularly impacting coal mining regions and the mining workforce, the mining sector was assessed as part of the project's first phase. The second phase of the study focuses on the transport and AFOLU sectors. Eventually, the study will provide a comprehensive view of the South African economy, its potential future net-zero economy and the pathways that can lead to this future economy as informed by various key stakeholders (Figure 2).

The study is a collaborative effort, aiming to create a 'unified voice of South African business' on the country's needs, opportunities, and challenges in achieving a net-zero economy, involving multiple stakeholders from all sectors. The governance arrangement that has overseen this work is key to enabling this collaborative, multi-stakeholder approach: across multiple levels, key stakeholders are involved in the content development.

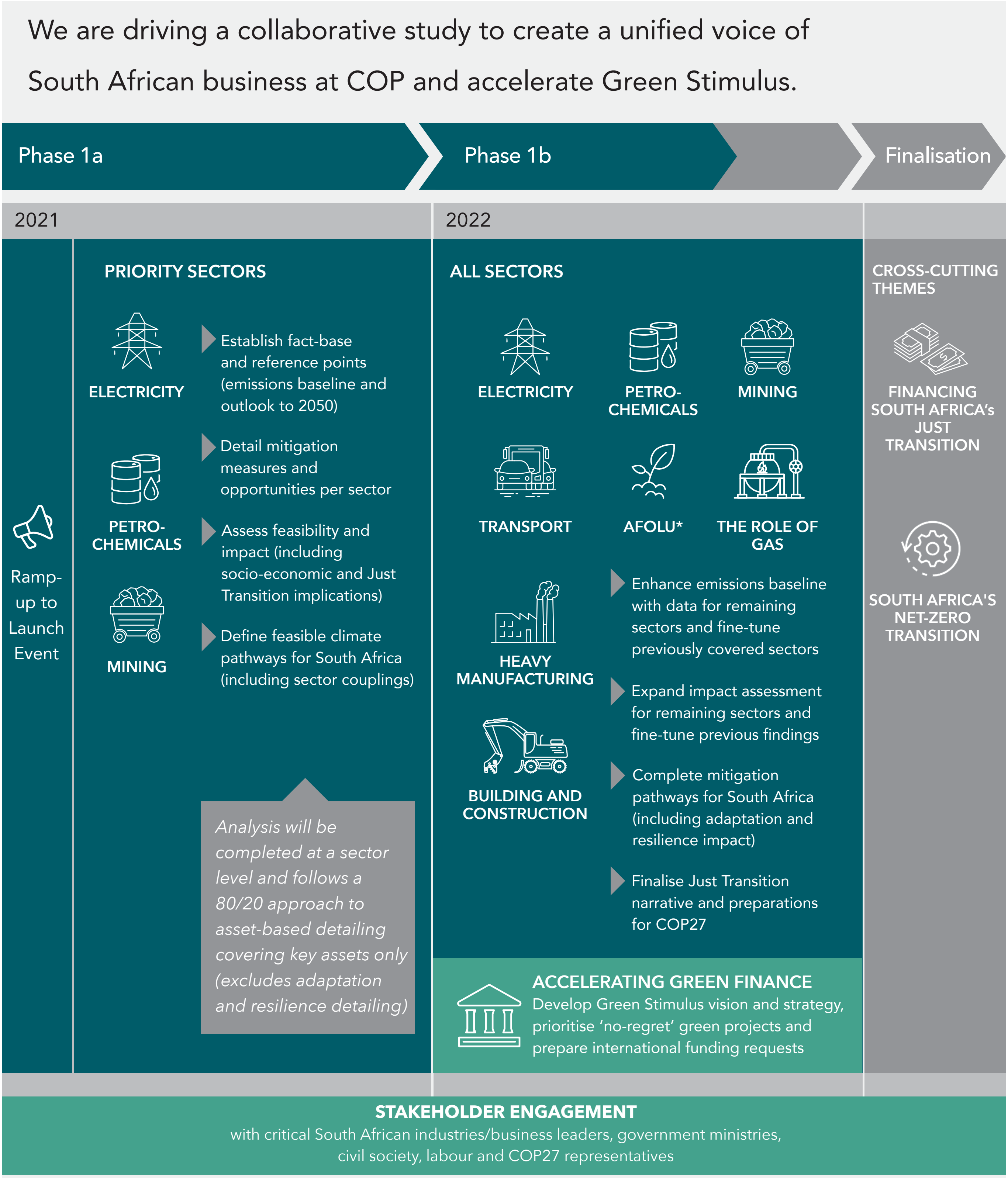
The sector assessments are conducted within technical committees which include South African and international experts and stakeholders from private and public sectors, as well as civil society and academia. An advisory board consisting of high-profile representatives from various sectors including industry, government, labour, civil society, and academia; and a steering committee consisting of selected private and public sector representatives provided continuous direction on content development. In addition, a group of 27 Chief Executive Officers (CEOs) from across the private sector endorsed and guided the study development (Figure 3).

This report is the sventh in a series being released to illustrate the findings of this study. Other reports focus on decarbonising the electricity sector in South Africa, the petrochemicals and chemicals sector, the mining sector, the AFOLU sector, the transport sector, and the building and construction sector. They also look at the role of gas in the path to net-zero and financing the Just Transition.

These reports are intended as consultation material to leverage further engagement with sector experts and key stakeholders, beyond the extensive stakeholder engagement that was already undertaken from August 2020 to June 2021 within the respective technical working groups of this project.

We hope this will foster continued dialogue during the project as we work towards a final report that will collate the individual sector findings and provide collective insight.

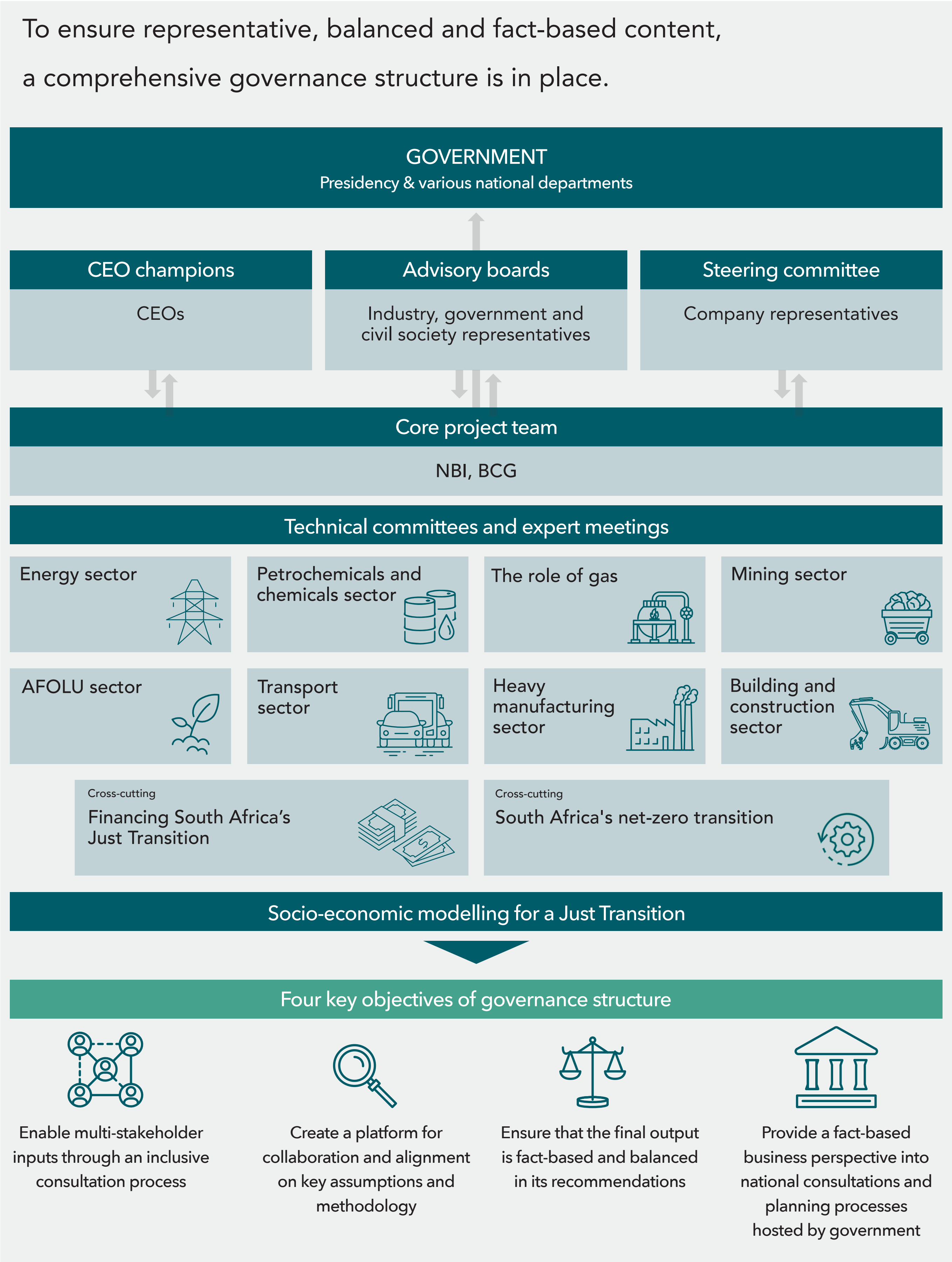
Figure 2: Approach of this study



* AFOLU: Agriculture, Forestry and Other Land Use

Source: NBI-BCG project team.

Figure 3: Governance set-up of the study



3.

TOWARDS A NET-ZERO, JOBS-RICH HEAVY MANUFACTURING SECTOR IN SOUTH AFRICA

10 key findings of the heavy manufacturing sector analysis

1. *South Africa is well-positioned to grow its heavy manufacturing sector to become a future global green manufacturing hub for energy-intensive goods, given its access to abundant, high-quality renewable energy resources; proximity to critical raw materials; existing relevant local capabilities; and a growing young population. To drive ambitious decarbonisation of the sector, it is critical to overcome the existing structural challenges, including the lack of a reliable power supply, inadequate transportation infrastructure, weak local demand, and challenging local labour market conditions (for example, skills shortages) that currently impair the sector's competitiveness.*

2. *If the heavy manufacturing sector does not decarbonise, South Africa risks losing ~50% or ~ZAR170 bn of its export value as its top export partners, the EU, USA, UK, China, and Japan, are all increasing their climate targets and regulations. This means 32% of iron and steel, 49% of non-ferrous metals, 22% of minerals, 64% of transport equipment, and 26% of machinery exports could disappear together with ~353 k jobs linked to exports.*

3. *Local demand for South African heavy manufacturing goods is expected to increase to enable South Africa's Just Transition to net-zero by 2050. This would result from growth in other sectors – such as the expansion and net-zero transition of the energy and transportation sectors – and overall national development, which drives increased activity in the construction of public infrastructure and residential housing. South African local steel, cement, and aluminium demand could increase by more than 270%, 70% and 240%, respectively by 2050.*

4. *By strategically decarbonising and diversifying the heavy manufacturing sector, South Africa can further grow the sector and create up to ~740 k net jobs, primarily linked to the production of metals, transport equipment, and machinery, and spearhead South Africa's industrial and socio-economic development – hence, supporting a Just Transition through sustainable job creation. However, workforce planning is required to ensure that the workforce is able take-up the jobs of the future.*

5. *Mature technologies, such as process and energy efficiency improvement, fuel and feedstock switching and material substitution, can reduce ~40% of the overall heavy manufacturing Scope 1 and Scope 2 emissions. The remaining ~60% requires disruptive technologies such as green H_2 for steel and yet to be proven carbon removals technology – Carbon Capture Utilisation and Storage (CCUS) – for cement.*

6 *Access to renewable power and green H_2 at scale is critical for decarbonising heavy manufacturing, reducing ~50% of the sector's emissions. By 2050, the sector could require ~80 TWh of renewable power p.a. (>33% of national demand) and ~0.3 Mt p.a. of green H_2 for steel decarbonisation.*

7 *Heavy manufacturing sectors (excluding steel and cement) can be fully decarbonised through the deployment of mature levers. Full decarbonisation of steel is possible but requires ~0.3 Mt p.a. of green H_2. However, the main uncertainty lies in the future feasibility of CCUS. Without CCUS, there could be ~15 Mt CO_2 p.a. annual unabated residual emissions from cement by 2050.*

8 *Growing and greening the South African heavy manufacturing sector enables socio-economic development. Failing to do this could result in systemic risk to the ability of other sectors to transition, such as power and transport, due to their dependence on heavy manufacturing outputs. Moving to green production can also improve the trade balance through the increased value of exported goods – a critical enabler to managing the financial risk of the transition.*

9 *Affordable green power and globally competitive local green H_2 production can be a source of competitive advantage for South Africa's heavy manufacturing sector – but it will require extensive investment (~ZAR150–160 bn) to upgrade heavy manufacturing plants to incorporate green processes and technology.*

10 *To enable the net-zero pathway, the heavy manufacturing sector requires a coordinated effort among public and private stakeholders. South Africa needs to ramp up renewable power production to enable sector decarbonisation, align a low-carbon market definition for heavy manufacturing goods, create local green lead markets, and ensure a trade support mechanism that protects local low-carbon production from cheap, carbon-intensive imports.*

3.1 SCOPE AND APPROACH OF THE HEAVY MANUFACTURING SECTOR ANALYSIS

South Africa's heavy manufacturing sector is facing complex challenges today. Its global competitiveness has been eroded by structural issues including the lack of reliable power supply, inadequate transportation infrastructure, weak local demand, challenging local labour market conditions (for example, lack of skills) and increasing global competition (especially in the steel market where China has been pushing the global prices down).

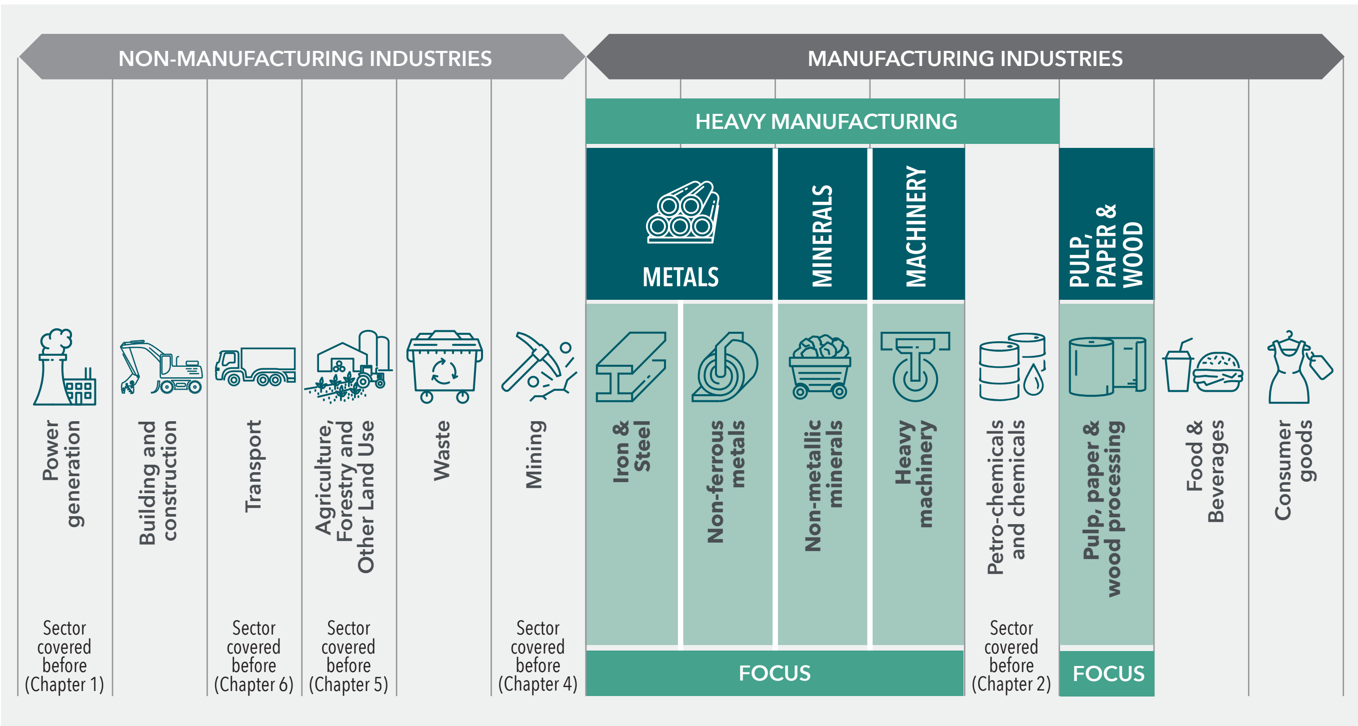
If, however, South Africa can overcome the existing structural challenges and leverage its natural resource endowments – such as high-quality renewable energy and proximity to key commodities, local manufacturing capabilities, and a young, growing population, it could develop a competitive, green manufacturing hub for energy-intensive goods (such as green steel) – for both local and global markets. This would support economic growth, job creation, enhance security of supply for critical heavy manufacturing goods, and contribute to a Just Transition.

To understand how South Africa can build a competitive, diversified, and decarbonised heavy manufacturing sector that can support a Just Transition to net-zero, this analysis addressed five key questions:

1. What is the sector's socio-economic contribution and emissions footprint today, and what are the structural challenges it faces at present?
2. What are the implications of decarbonisation trends on the South African heavy manufacturing sector, and what are the sector's growth opportunities to win in this context?
3. How can the South African heavy manufacturing sector transition towards net-zero and unlock new economic opportunities?
4. What risks and opportunities for a Just Transition are created if the sector decarbonises?
5. What are the key policies to enable the net-zero pathway, and what no-regret action should be taken immediately?

The most critical heavy manufacturing sub-sectors – based on their emissions and direct and indirect socio-economic impact (jobs and GDP contribution) – are iron and steel production, non-ferrous metals manufacturing (for example, aluminium, lead, and zinc), minerals production (for example, cement, glass, lime), machinery manufacturing (for example, transport equipment, parts and accessories, general-purpose machinery, and special-purpose machinery) and pulp, paper, and wood processing. The analysis focuses on those key sub-sectors. Other non-manufacturing sectors have been

Figure 4: The scope of the heavy manufacturing sector analysis



covered by the previous NBI Climate Pathways reports or will be covered on a high level in the coming NBI Climate Pathways Sector Integration report, for example, consumer-facing industries like food and beverages and consumer goods (Figure 4). Throughout the assessment, a range of stakeholders along the heavy manufacturing value chain were engaged, including stakeholders from primary and secondary steel, cement, aluminium and glass manufacturer companies, automotive Original Equipment Manufacturers (OEMs) and component manufacturers, industrial equipment processing and distributor companies, paper, and pulp producers as well as different sector associations, academia, and broader local and international heavy manufacturing experts.

3.2 SOUTH AFRICA'S HEAVY MANUFACTURING SECTOR TODAY

South Africa's heavy manufacturing sector is a critical socio-economic contributor to the country. Heavy manufacturing is integral to the broader South African economy by providing critical goods, like steel, cement, and heavy machinery, that are used across sectors – such as power, transportation, and building infrastructure (Figure 5). The heavy manufacturing sectors covered in this study drive ~792 k direct jobs in South Africa. The most significant job contributor is pulp, paper, and wood processing, driving ~269 k direct jobs (34% of the sectors'

Figure 5: The heavy manufacturing ecosystem

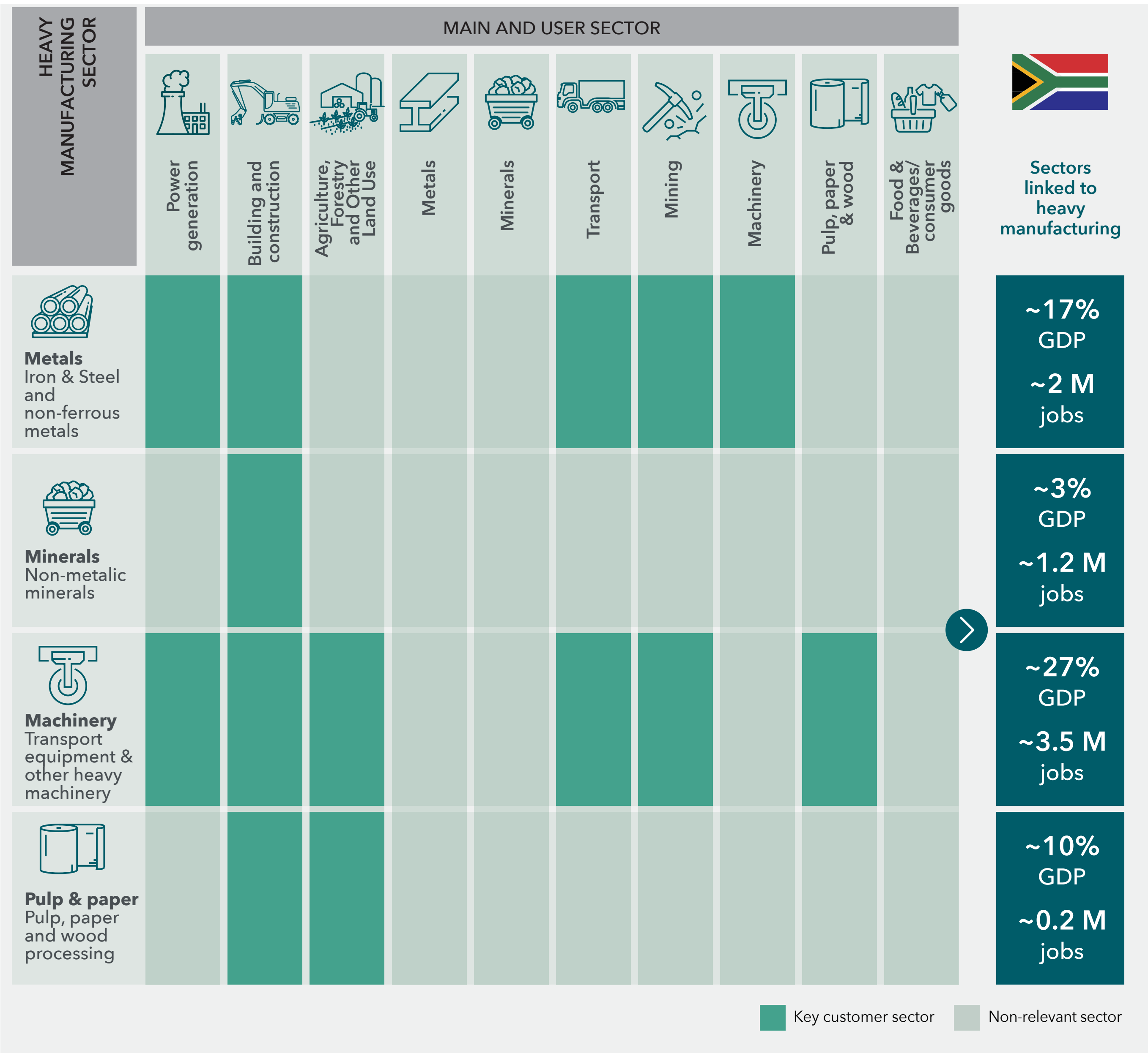
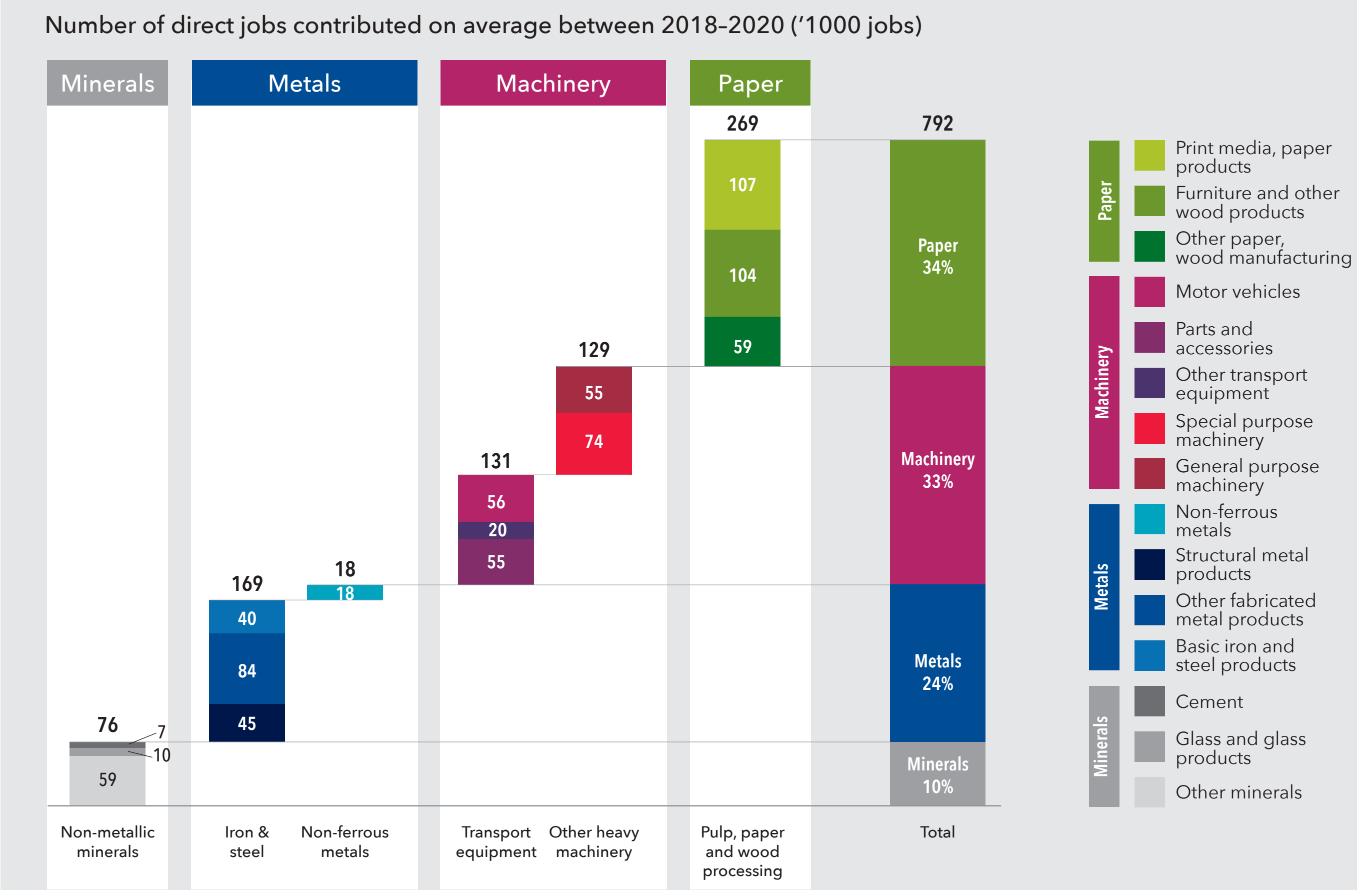


Figure 6: South African heavy manufacturing sector's direct job contribution



Note: This is prior to Covid-19 impacts. Therefore, the 2022/2023 job numbers may be lower.

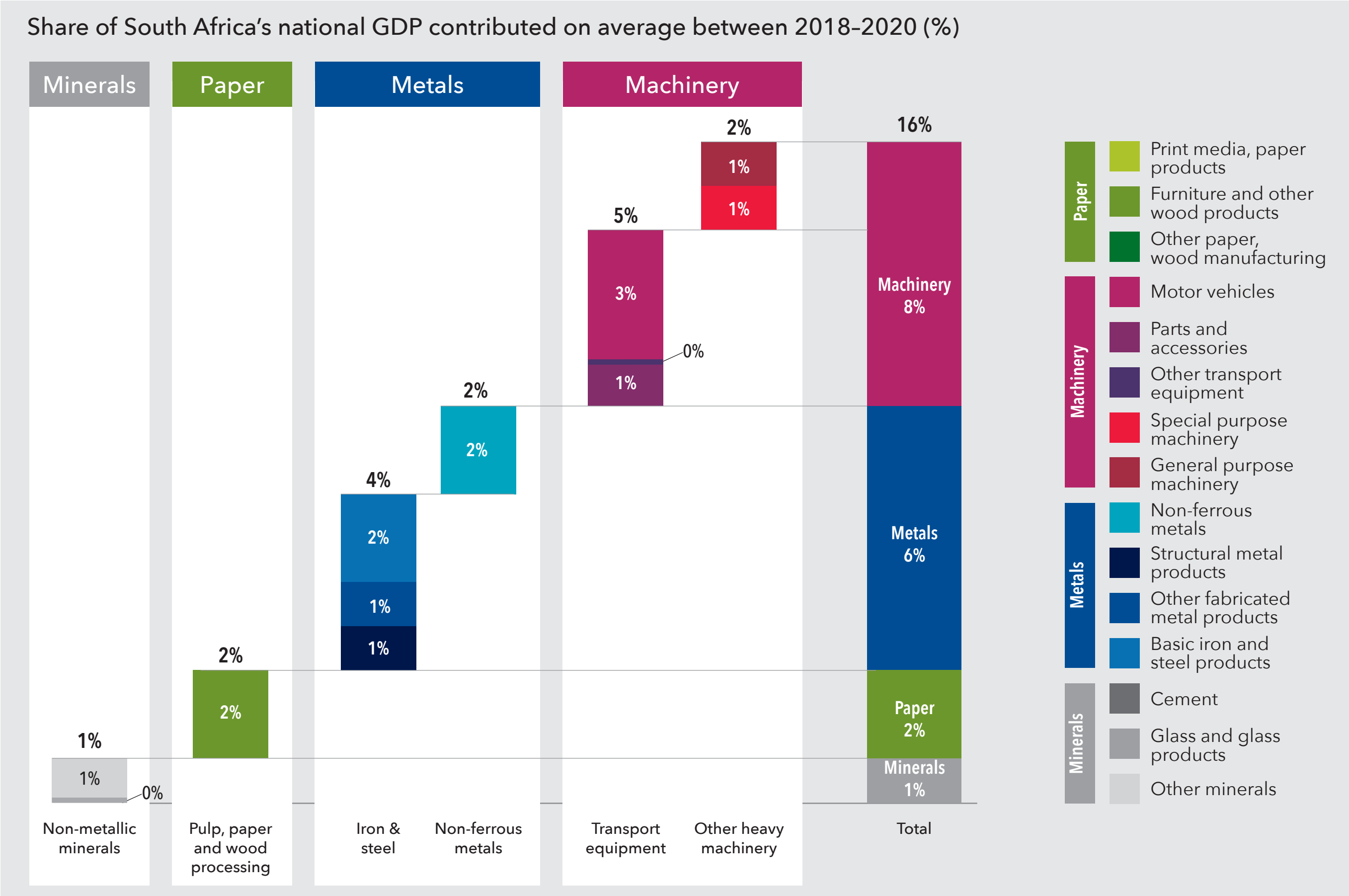
jobs), followed by machinery manufacturing ~260 k (33%), metals ~187 k (24%) and minerals ~76 k (10%) (Figure 6). Heavy manufacturing drives ~16% of South Africa's national GDP. The most significant GDP contributor is machinery with 8% – of which transport equipment manufacturing alone drives 5% of GDP, followed by metals with 6%, paper, pulp, and wood with 2%, and minerals with 1%[14] (Figure 7). It is important to highlight the overall heavy manufacturing ecosystem, which is defined as heavy manufacturing (0.79 M jobs; 16% GDP) and sectors linked to heavy manufacturing, i.e., power or utilities (0.1 M jobs; 3.6% GDP), construction (1.2 M jobs; 3.1% GDP), transportation (1 M jobs; 3.1% GDP) agriculture (0.8 M jobs; 2.8% GDP) and mining (0.4 M jobs; 3.6% GDP), which drive ~4.3 million direct jobs and ~43% of South Africa's GDP (Figure 5).[15]

While the domestic market is an important consumer for metals and cement production, where more than 60% and around 90% of production respectively is for local markets, the heavy manufacturing sector drives substantial value from international markets. On average more than 50% of transport equipment, almost 40% of non-ferrous metals, around 30% of iron and steel, and around 30% of heavy machinery production is for export markets.[16] Heavy manufacturing is one of the most important export sectors and a key contributor to the South African trade balance, driving ~30% of the nation's foreign trade value with key esport markets like the EU (more than 27% of the heavy manufacturing trade value), USA (7%), UK (6%), China (5%), and Japan (5%)[17 18] (Figure 8).

The heavy manufacturing sector is the fifth largest driver of direct emissions in South Africa. It drives ~10% (~49 Mt CO_2e) of South Africa's national direct emissions.

14 Direct jobs and GDP contributed on average '18–'20, based on Quantec Easydata.
15 StatsSA: Quarterly Labour Force Survey (Q2/2021).
16 Local market usage and export value '18–'20, based on Quantec Easydata.
17 OECD data, 2019.
18 UN ITC Trade Map, 2019.

Figure 7: South African heavy manufacturing sector's GDP contribution



Note: This is prior to Covid-19 impacts. Therefore, the 2022/2023 GDP distribution may be different.

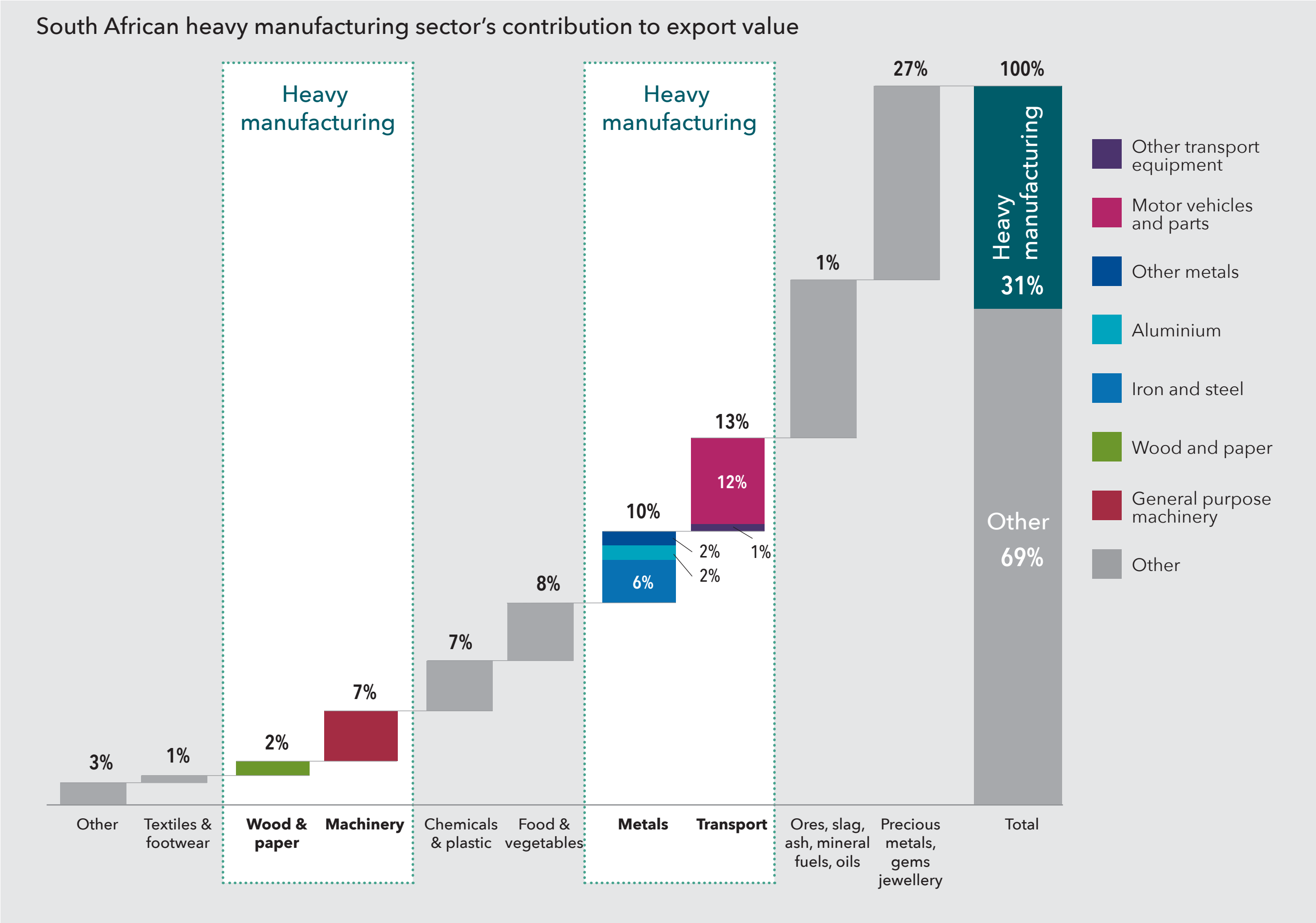
These are from 1) on-site fuel combustion (~21.9 Mt CO_2e) (mainly for heat generation) and 2) process emissions (~27.4 Mt CO_2e). Process emissions are mainly driven by iron and steel production and cement production, which drive ~71%[19] and ~16% of process emissions, respectively. Those emissions are hard-to-abate, meaning that they are directly related to the physical process itself. Thus, the decarbonisation cannot simply be done by, for example, increasing energy efficiency or switching fuels in the existing processes. To decarbonise, hard-to-abate sectors need to develop and shift process technologies themselves. If indirect emissions from the consumption of grid power are considered, the sector's emissions footprint grows to 77 Mt CO_2e (Table 1).

Figure 9 shows that iron and steel production is the biggest driver of emissions followed by aluminium, cement and pulp, paper, and wood processing – together driving ~95% of emissions. The remaining ~5% is divided between other non-ferrous metals, minerals, and machinery manufacturing.[20]

The South African heavy manufacturing sector is facing significant structural issues today, which are increasingly eroding its global competitiveness. Despite being an integral part of the economy, the heavy manufacturing sector, especially the metals and minerals sub-sectors, has been in structural decline for the past decade, with more than 50 k jobs lost overall between 2009 and 2019. The number of jobs in basic iron and steel, fabricated and structural metal products has dropped by 20%, non-ferrous metals by 53%, and minerals by 10% over these 10 years.[21] One of the most pressing issues is unreliable power and increasing electricity prices. Electricity prices were around 20 c/kWh in 2007, and around 110 c/kWh in 2020 – a 450% increase in nominal terms, or 160% in real terms, At the same time, the annual duration of power outages or loadshedding has increased ten-fold.[22] This has led to a loss in the production output and thus a

19 Includes 11 $MtCO_2$ of direct process emissions from ferroalloys production
20 GHGI, 2017; Department of Energy SA, 2018. Commodity Flow and Energy balance tables.
21 Job figures, based on Quantec Easydata.
22 CSIR, 2022; Eskom.

Figure 8: South African heavy manufacturing sector's contribution to export value



loss in revenue and profitability. Other challenges are a slow domestic market annual GDP growth on average of 1.0% p.a. (2010–2020),[23] and an inadequate local physical infrastructure (for example, lack of integrated transport networks, structural failures in railway infrastructure) resulting in the high cost of transport. In addition, local labour market conditions, especially the skills gap, cause challenges. Finally, there is increasing competition coming from the global markets, particularly around steel and machinery, with countries like China pushing into global markets with decreasing prices.

23 World Bank, 2022.

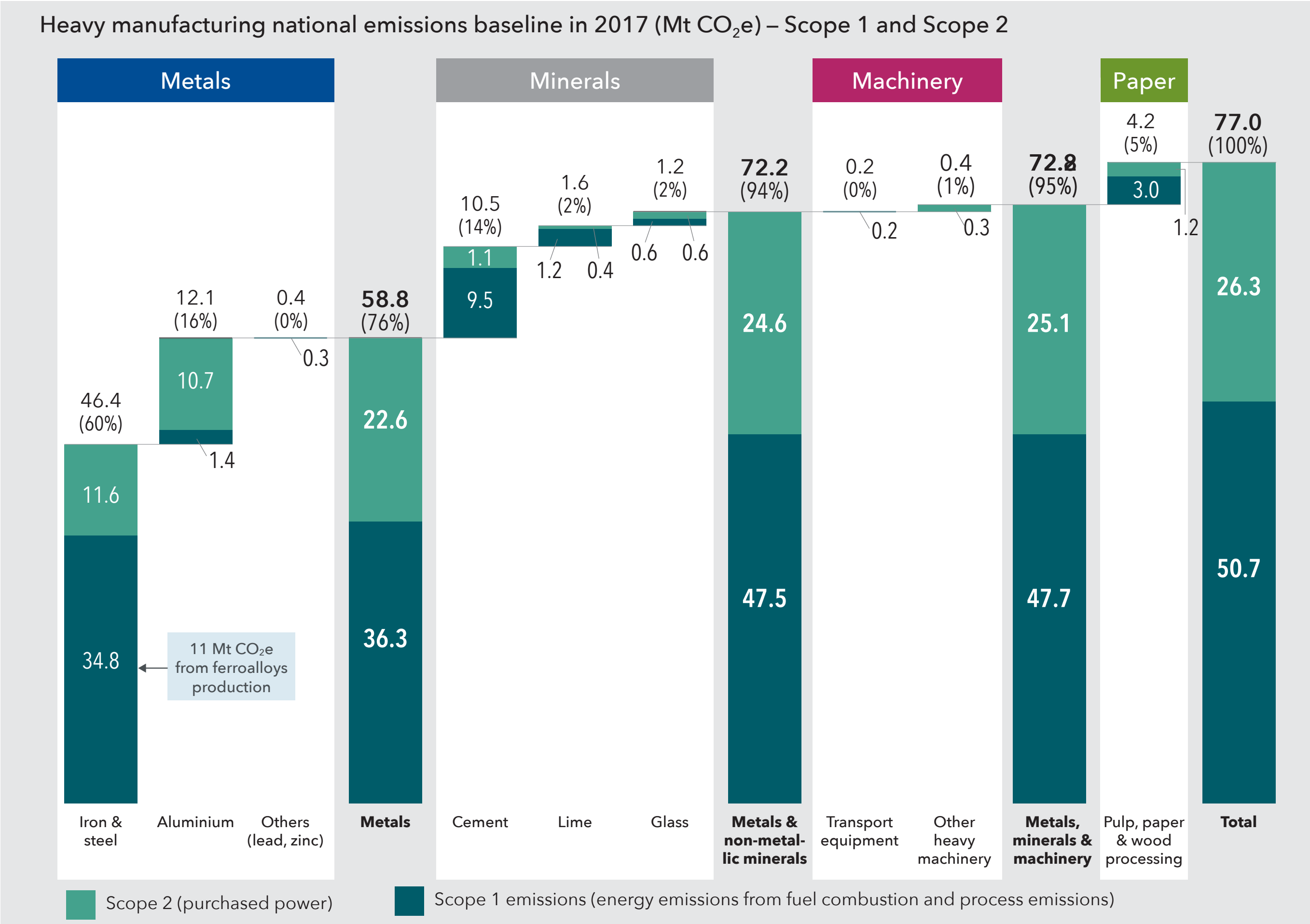
Table 1: Emission breakdown per heavy manufacturing sector

	Total Mt CO_2e (Scope 1 & 2)	Energy (Scope 1) %	Process (Scope 1) %	Scope 1 total %	Electricity (Scope 2) %
Iron and steel total	46.4	34%	41%	75%	25%
Aluminium	12.1	2%	10%	12%	88%
Other metals (lead, zinc)	0.4	5%	21%	26%	74%
Non-ferrous metals total	12.5	2%	10%	12%	88%
Cement	10.5	40%	50%	90%	10%
Lime	1.6	20%	57%	77%	23%
Glass	1.2	40%	10%	50%	50%
Non-metallic minerals total	13.2	38%	47%	85%	15%
Transport equipment	0.2	27%	0%	27%	73%
Other heavy machinery	0.4	27%	0%	27%	73%
Machinery total	0.6	27%	0%	27%	73%
Pulp, paper & wood total	4.2	71%	0%	71%	29%
Heavy manufacturing total	**77.0**	**31%**	**35%**	**66%**	**34%**

Source: 2017 Green House Gas Inventory (Department Forestry, Fisheries and Environment); 2018 commodity flow and energy balance table (Department of Energy).


Photo: Shutterstock.com

Figure 9: South African heavy manufacturing sector's emissions footprint



Source: GHGI (2017); Department of Energy SA - Commodity Flow and Energy balance tables (2018); NBI-BCG project team.

3.3 DECARBONISING THE HEAVY MANUFACTURING SECTOR WILL IMPROVE ITS GLOBAL COMPETITIVENESS AND CAN SUPPORT A JUST TRANSITION

South Africa is well-positioned to grow its heavy manufacturing sector to become a future global green manufacturing hub for energy-intensive goods, given its access to abundant, high-quality renewable energy resources; proximity to critical raw materials; existing relevant local capabilities; and a growing young population. To drive ambitious decarbonisation of the sector, it is critical to overcome the existing structural challenges, including the lack of a reliable power supply, inadequate transportation infrastructure, weak local demand, and challenging local labour market conditions (for example, skills shortages) that currently impair the sector's competitiveness.

South Africa has one of the most carbon-intensive economies in the world, with heavy reliance on coal for energy generation and as a feedstock for industrial processes. Because of this, South Africa faces a significant trade risk as countries are taking increasingly ambitious climate actions. The risk is particularly acute in export-oriented sectors like heavy manufacturing (particularly in transport equipment and non-ferrous metals). South Africa's top export markets for heavy manufacturing goods including the EU which accounts for more than 27% of the heavy manufacturing trade value), USA (7%), UK (6%), China (5%), and Japan (5%), all have net-zero emissions targets, and they are increasing their climate regulations (for example, the EU is considering implementing a carbon border tax by 2026 after a three-year transition which would make carbon-intense goods increasingly uncompetitive). Together these countries drive ~50% or ~ZAR170 bn of South Africa's heavy manufacturing export value, and thus these exports could disappear in the short- to medium-term due to increasing climate pressure. This means 32% of iron and steel, 49% of non-ferrous metals, 22% of minerals, 64% of transport equipment, and 26% of machinery exports are at risk. Jobs linked to these exports are similarly under pressure: ~18 k jobs in iron and steel, ~3 k jobs in non-ferrous metals production, ~2 k jobs in minerals production, and ~10 k jobs in machinery manufacturing could disappear if the exports disappear.

Figure 10: South African heavy manufacturing exports and linked jobs at risk

South Africa's heavy manufacturing exports at risk due to increasing climate regulation in Germany, USA, Belgium, UK, China and Japan markets (% of exports in 2019)

	Iron & steel	Non-ferrous metals	Non-metallic minerals	Transport equipment	Machinery	Total Heavy manufacturing
Export value at risk	32%	49%	22%	64%	26%	49%
Jobs linked to exports, at risk	~18 k	~3 k	~2 k	~320 k	~10 k	~353 k

If the heavy manufacturing sector does not decarbonise, South Africa risks losing ~50% or ~ZAR170 bn of its export value as its top export partners, the EU, USA, UK, China, and Japan, are all increasing their climate targets and regulations. This means 32% of iron and steel, 49% of non-ferrous metals, 22% of minerals, 64% of transport equipment, and 26% of machinery exports could disappear together with ~353 k jobs linked to exports.

The most prominent risk is in the automotive manufacturing sector, in which South Africa's top five automotive export partners (Germany, UK, Belgium, USA and Japan), representing 62% of the export value, plan to increase the conventional Internal Combustion Engine (ICE) vehicle regulation or even ban ICE vehicles by 2030–35.[24] Failing to adapt to the shift from ICEs to EVs could put ~320 k jobs[25] at risk – mainly from auto manufacturing and linked sectors, such as component and parts suppliers and manufacturers, auto retailers and aftermarkets (Figure 10).

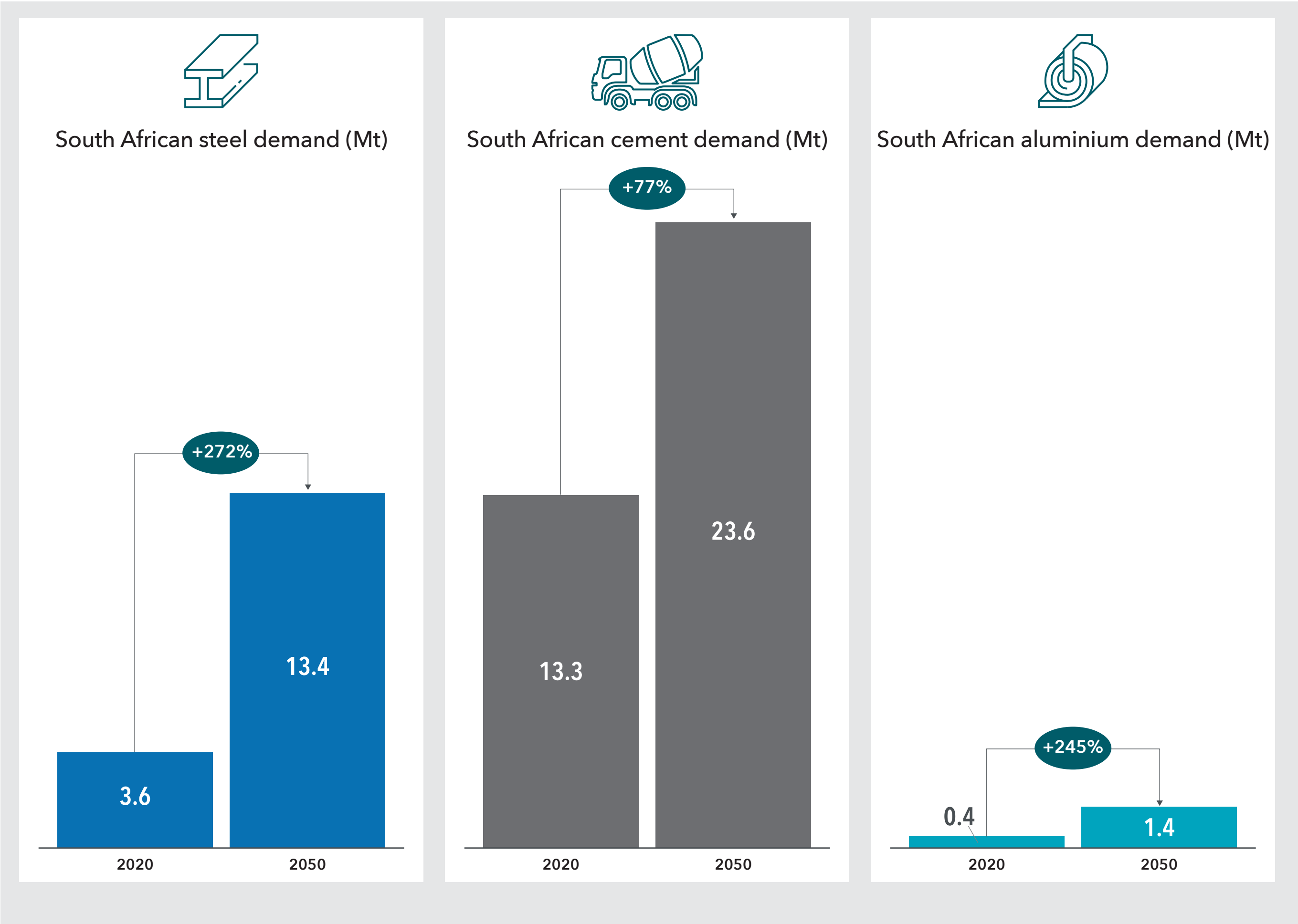
Local demand for South African heavy manufacturing goods is expected to increase to enable South Africa's Just Transition to net-zero by 2050. This would result from growth in other sectors – such as the expansion and net-zero transition of the energy and transportation sectors – and overall national development, which drives increased activity in the construction of public infrastructure and residential housing. South African local steel, cement, and aluminium demand could increase by more than 270%, 70% and 240%, respectively by 2050.

Local demand for South African heavy manufacturing goods is expected to increase to enable South Africa's Just Transition to net-zero by 2050. This would be the result of growth across other sectors and overall national development (driving, for example, modernisation and deployment of public infrastructures, such as the overhaul and expansion of the power system and transport infrastructure, and construction of social infrastructure, such as residential housing for all). In this context, demand for heavy manufacturing goods – particularly building materials – could grow significantly: By 2050, demand for locally produced steel, cement and aluminium could grow by more than 270%, 70% and 240%, respectively (Figure 11). Thus, growth in the heavy manufacturing sector is critical for South Africa to realise a Just Transition to net-zero by 2050.

24 UN ITC Trade Map, 2019; ICE sale bans: Germany by 2030, UK by 2030, Belgium by 2026, USA several cities and states but no nationwide ban, Japan by 2050.

25 Automotive manufacturing and linked sectors are responsible for ~320 000 jobs, according to South Africa's Automotive Sector Master Plan to 2035.

Figure 11: Future local demand for steel, cement and aluminium



Steel demand would be primarily driven by construction. Local steel demand is primarily driven by construction (54% of local steel demand) – followed by automotive manufacturing (8%), machinery manufacturing (6%) and a range of other sectors (32%), for example, packaging and consumer goods. Approximately 67% of demand today is met by local production – which has a capacity of 9.5 Mt p.a. Local steel demand could increase 272% by 2050, reaching 13.4 Mt p.a., driven by housing and public infrastructure developments, renewable energy capacity deployment and transportation infrastructure developments (for example, railway infrastructure build-up). Today, the local steel production capacity is underutilised, with on average less than 50% used in the past years. As a result, despite expected significant growth in local demand, it is estimated that demand will exceed the local installed supply capacity only by 2040. This means that local steel production capacity will not be constrained in the short- and mid-term. Globally, the demand for green steel is expected to increase as countries decarbonise their economies. This creates an economic opportunity for South Africa: with a strategic advantage to produce cost-competitive green H_2 at scale (see deep-dive 'South Africa's green H_2 opportunity', on page 33). South Africa could produce green steel at a competitive cost of ~ZAR8 k per tonne, which would be ~20% cheaper than green steel produced in the EU. In the mid-term, this could create an opportunity around leveraging the underutilised steel production capacity until 2040 for green steel production to international markets.

Cement demand could increase significantly because of growth in the buildings and construction sector. Today, local demand for cement is driven by construction of non-residential housing (50%), residential housing (40%), and public infrastructure (10%). Cement demand is met by more than 90% by local production, which has a capacity of 19–22 Mt p.a. Future local demand is expected to be driven by the construction of residential housing, primarily to close the existing housing gap and to provide housing to a growing population. Further drivers of future cement demand will be linked to national development and the transition to net-zero, which will drive the construction of public infrastructure, such as for transport (for example, the expansion of South Africa's rail network) or the expansion and modernisation of the power system (for example, including the large-scale roll-out of renewable energy capacity). Local cement demand could exceed local supply capacity by the mid-2030s already. However, with active management of demand – for example, via efficient building design and spatial planning and increased materials efficiency (for example, via reducing overengineering), the local supply capacity would not be exceeded before ~2050. However, this would still mean a +77% increase in demand by 2050 from today's 13.3 Mt p.a. to 23.6 Mt p.a.

Local aluminium demand is driven by construction (24%), automotive manufacturing (20%), packaging (18%) and various other sectors (38%). Demand is met by more than 60% via local production, which has a capacity of 1.0 Mt p.a. Local aluminium demand could exceed capacity around 2040 as demand for aluminium is expected to grow +245% from today's 0.4 Mt p.a. to 1.4 Mt p.a. by 2050, driven by growing usage across sectors, for example from construction and automotive, assuming South Africa is able to transform its automotive production to EVs.

> ***By strategically decarbonising and diversifying the heavy manufacturing sector, South Africa can further grow the sector and create up to ~740 k net jobs, primarily linked to the production of metals, transport equipment, and machinery, and spearhead South Africa's industrial and socio-economic development – hence, supporting a Just Transition through sustainable job creation. However, workforce planning is required to ensure that the workforce is able take-up the jobs of the future.***

In a decarbonised world, energy-intensive industries, such as heavy manufacturing, will be located in areas with access to abundant, affordable, and reliable clean energy supply and access to critical commodities needed for production. Diversifying South Africa's heavy manufacturing sector means that the heavy manufacturing sector of 2050 will be different to the heavy manufacturing sector of today. South Africa is well-positioned to become a green heavy manufacturing hub for both local and global demand: it is endowed with high-quality renewable energy sources which are among the best in the world, and it has proximity to critical commodities (for example, copper, nickel, lithium, cobalt, iron ore) and existing local capabilities and skills (for example, in the production of energy-intensive products, such as metals and minerals). South Africa could create up to ~740 k net jobs (assuming the jobs will grow in line with the estimated sector growths) and accounting for growth from new green industries and job losses from legacy grey industries. The job growth is primarily driven by growing the metals (Compound annual growth rate (CAGR) ~3%–4% 2020–2050), transport equipment (CAGR ~3% 2020–2050), and machinery sectors (CAGR ~2% 2020–2050).

This diversification and growth of South Africa's heavy manufacturing sector can spearhead South Africa's industrial and socio-economic development, and support a Just Transition. Even further opportunities in the medium and light manufacturing industries will exist to drive South Africa's industrial and socio-economic development. Finally, workforce planning and reskilling needs to begin to address the mismatch of the workforce's current skillset and future needed capabilities in manufacturing.

3.4 DECARBONISATION PATHWAYS FOR SOUTH AFRICA'S HEAVY MANUFACTURING SECTOR

> ***Mature technologies, such as process and energy efficiency improvement, fuel and feedstock switching and material substitution, can reduce ~40% of the overall heavy manufacturing Scope 1 and Scope 2 emissions. The remaining ~60% requires disruptive technologies such as green H_2 for steel and yet to be proven carbon removals technology – Carbon Capture Utilisation and Storage (CCUS) – for cement.***

Approximately 40% of combined direct emissions (Scope 1) and power-use related, indirect (Scope 2) emissions can be reduced by deploying mature, cost-competitive decarbonisation levers (Figure 12). Those levers include energy and process efficiency improvements, switching from conventional fossil fuels for energy generation to low-carbon fuels and renewable, clean electricity, and adopting alternative low-emissions materials (for example, recycled steel). Implementing those levers would allow full decarbonisation of machinery manufacturing, non-ferrous metals manufacturing and pulp, paper, and wood processing, given emissions in those sub-sectors are primarily energy-related and not process-related emissions.

The remaining heavy manufacturing sector emissions are primarily linked to the metals and non-metal minerals manufacturing sub-sectors, where process and energy emissions are significant. To achieve a further ~50% reduction in the heavy manufacturing sector, disruptive technologies – currently at early maturity stages or not yet cost-competitive – need to be deployed.[26] This would require the deployment of green H_2 in iron ore reduction and Carbon Capture Utilisation and Storage (CCUS) technology to address process emissions in cement. Full decarbonisation of cement production hinges on the feasibility of CCUS, while new, innovative cement production processes are not yet commercially viable. However, there is a risk in that South Africa does not yet have any confirmed, technically viable permanent CO_2 storage sites. Although CO_2 utilisation can form part of the future green fuels economy, and there are utilisation pilot sites under development, further technological and market advances are required for CCUS to become a commercially viable abatement lever.

By implementing both the proven and disruptive decarbonisation levers across the heavy manufacturing sub-sectors, the whole sector can reduce almost 90% of its combined Scope 1 and 2 emissions. The residual 10% are unavoidable (at this stage of technology development) and are linked to process emissions in cement and steel production.

> ***Access to renewable power and green H_2 at scale is critical for decarbonising heavy manufacturing, reducing ~50% of the sector's emissions. By 2050, the sector could require ~80 TWh of renewable power p.a. (>33% of national demand) and ~0.3 Mt p.a. of green H_2 for steel decarbonisation.***

Renewable energy has a critical role in enabling the sector's decarbonisation and enhancing its competitiveness. As the sector decarbonises, the electrification of machinery across sectors will rise, as electricity becomes the primary energy carrier for the sector. As a result, in 2050, electrification and sector growth could increase electricity demand by ~20% compared to 2019.

1. Firstly, ~10% (~7 Mt CO_2e) of the sector's combined direct and power-use related emissions can be reduced via a combination of electrification of machinery and clean, renewable power deployment.
2. Secondly, renewable energy is needed to produce green H_2. By 2050 green H_2 demand in heavy manufacturing could reach 0.3 Mt p.a.
3. Thirdly, the adoption of renewable energy will ensure a more affordable and reliable power source, thus enabling improved cost competitiveness of the sector while resolving the current unreliability of the power sector.

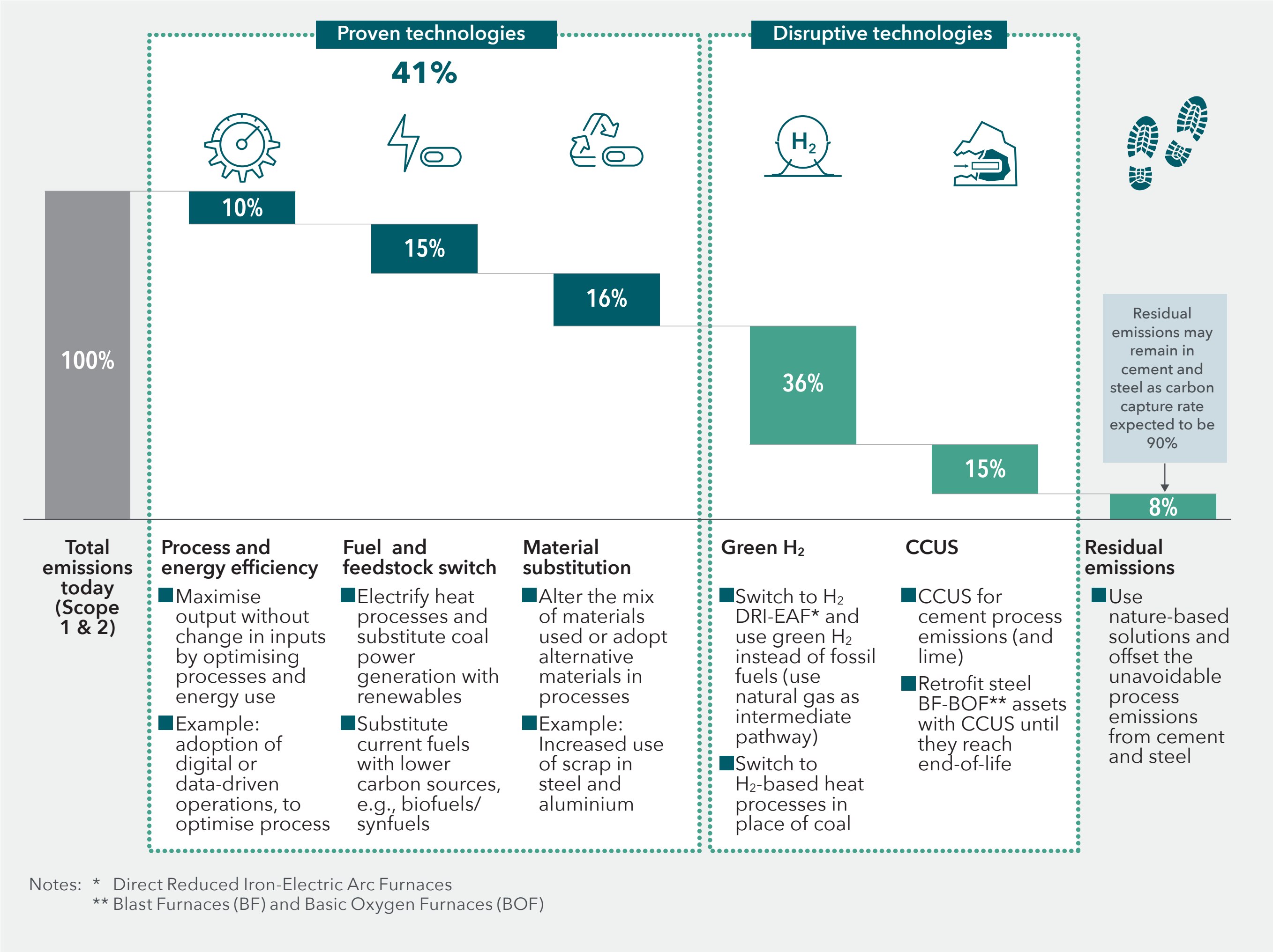
Although renewable energy installations can drive significant emissions savings, energy storage solutions (such as batteries for short-term peaking, and green H_2 for long term seasonal balancing) are required in addition to ancillary services, to realise the full abatement potential of renewables in the heavy manufacturing sector.

GREEN H_2 OPPORTUNITY

South Africa is well-positioned to manufacture up to 7–10 Mt p.a. of green H_2 at globally cost-competitive prices. This is driven by high solar and wind energy availability, the vast amounts of land available, and affordable access to crucial Platinum Group Metals (PGMs) required for H_2 production. South Africa can produce green H_2 at a levelised cost of hydrogen (LCOH) as low as US$2–3/kg of H_2 by 2030. For South Africa to capture this green H_2 opportunity, the country needs a coordinated approach, that includes consolidating both local and export demand, to catalyse the local industry.

26 IEA Iron and Steel Technology Roadmap, 2019.

Figure 12: Overview of the 2050 mitigation potential of the heavy manufacturing decarbonisation levers



3.4.1 DECARBONISING THE IRON AND STEEL SECTOR IN SOUTH AFRICA

IRON AND STEEL PRODUCTION IN A FUTURE, NET-ZERO SOUTH AFRICA

Global demand for green steel is expected to increase significantly. By 2030, 10% of global steel demand or ~0.2 Gt is for green steel compared to 0% today (Figure 13). Decarbonising the iron and steel sector thus creates an opportunity for South Africa to become a green steel manufacturing hub and to meet parts of this global and growing demand.

South Africa is well-positioned to produce green steel at a competitive cost. Using locally produced green H_2 and on-site generated renewable electricity can produce green steel at a ~20% discount compared to the EU (Figure 14).

DECARBONISATION LEVERS FOR IRON AND STEEL PRODUCTION

By 2050, up to 90% of combined direct and indirect (power-use related) emissions can be reduced; already 40% of reduction is achieved by mature levers. 50% of emissions reduction could be achieved by deploying green H_2 and carbon removal technology (CCUS). Potentially ~10% of residual emissions could remain linked to the production of iron ore pellets used in the direct reduction step of production (Figure 15).

Figure 13: Potential global demand for steel

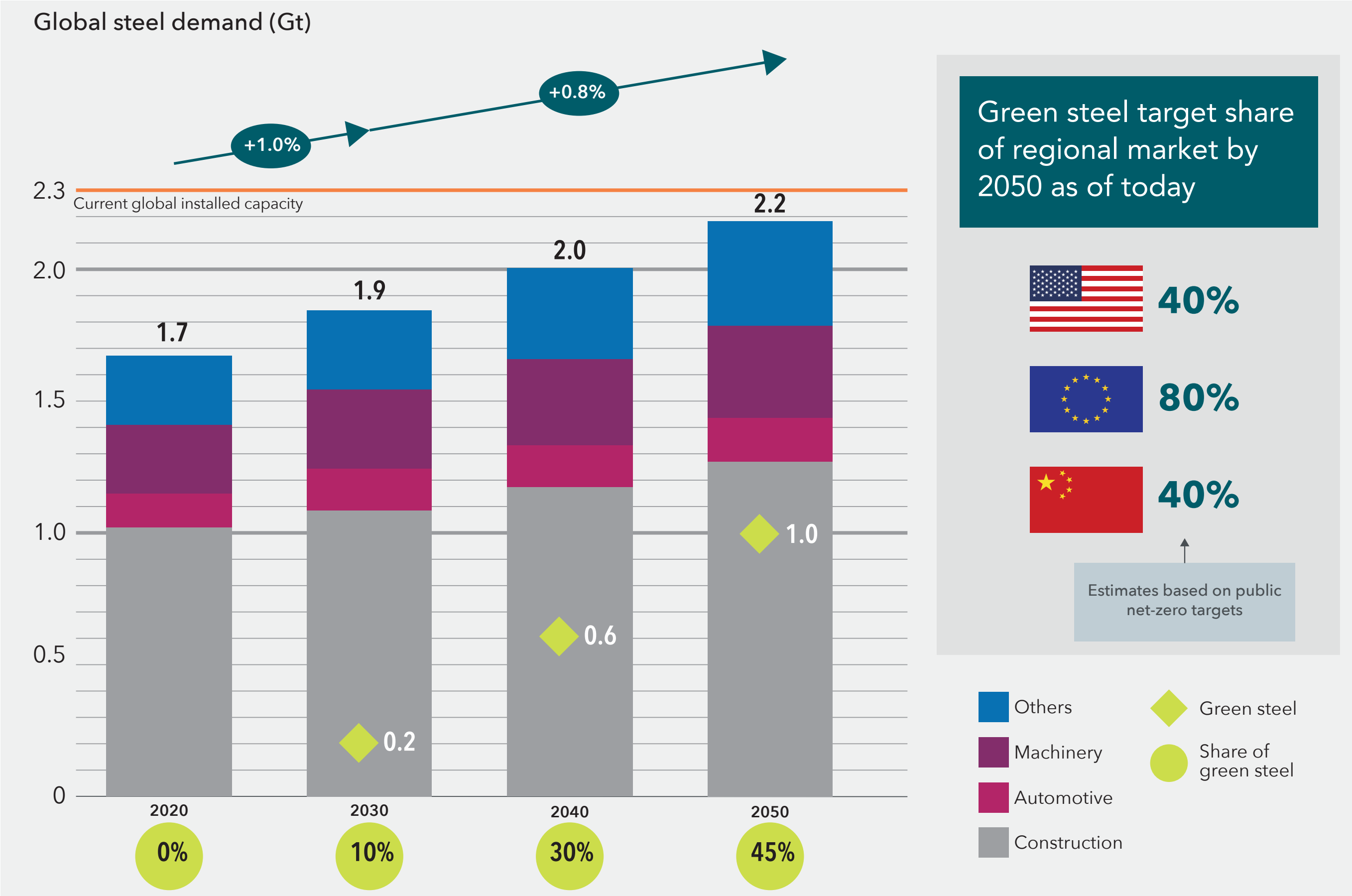
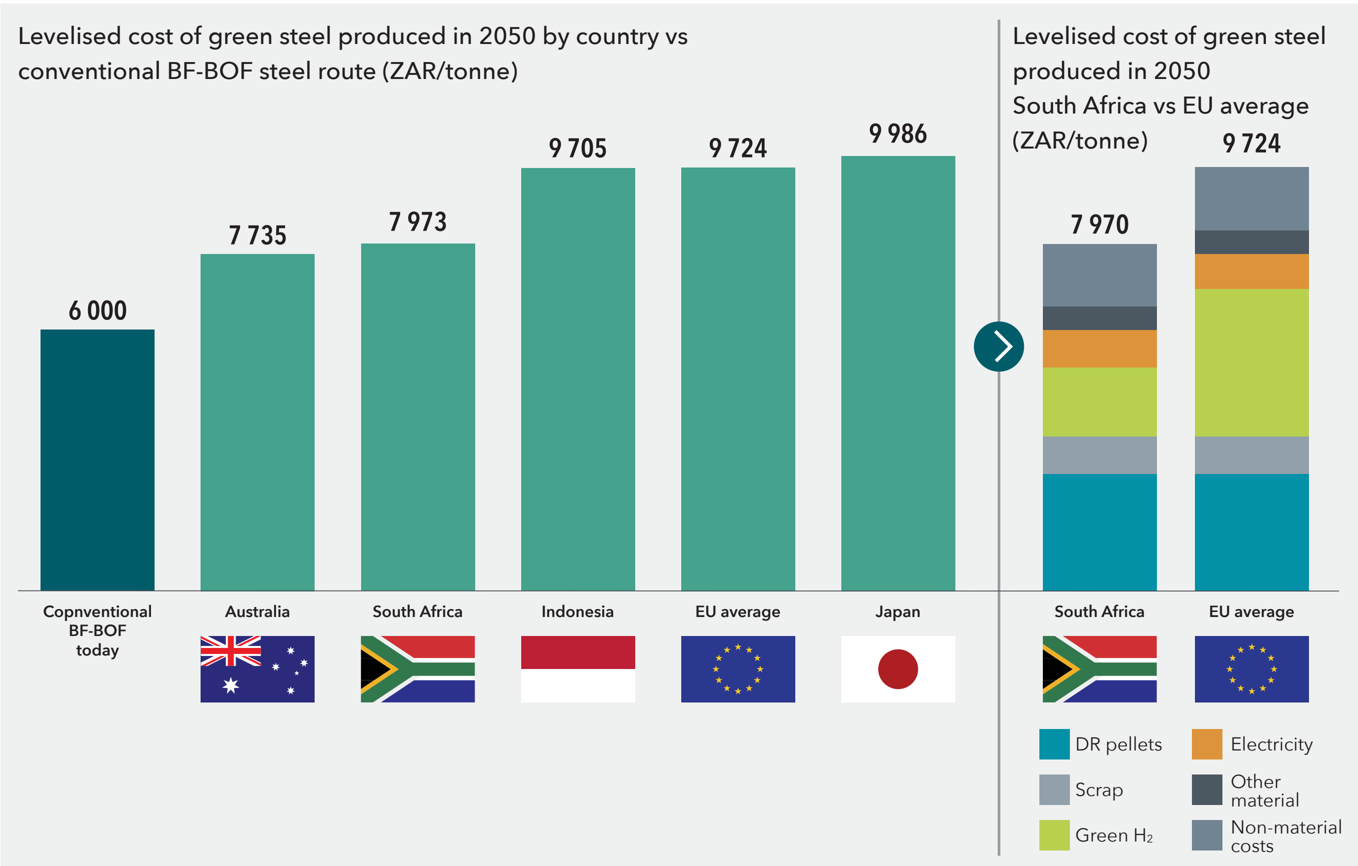


Figure 14: Potential cost of producing green steel



IRON AND STEEL DECARBONISATION LEVER DEPLOYMENT AND EMISSIONS REDUCTION OVER TIME

Figure 16 summarises the timeline for implementing the key decarbonisation levers aggregated by the short-, mid- and long-term.

In the short-term (by 2025): 10% emissions reduction can be unlocked by improving process and energy efficiency. However, unlocking the full mitigation potential will require replacing aged assets with the best available technology (BAT) to unlock best-in-class energy efficiency, investing in digital optimisation of plants, and deploying waste heat recovery and utilisation systems.

In the mid-term (2025–2030): Approximately 6% emissions reduction is possible through material substitution in steel. The recycling abatement potential is lower than global benchmarks for two main reasons. Firstly, South Africa has a relatively high share of scrap production already. Secondly, infrastructure construction requires primary steel as the scrap-Electric Arc Furnace (EAF) route produces a lower grade of steel that limits the possible end uses.

Adopting renewable electricity to substitute current coal-based electricity can reduce a further ~14% of current steel emissions. On-site or decentralised deployment of renewable power generation can unlock the total mitigation potential in the mid-term. Alternatively, grid decarbonisation can unlock the total mitigation potential in the long-term.

In the long-term (2030-2050): Additional emissions reduction of ~50% is possible by adopting structurally disruptive technology, either through switching to the Direct Reduced Iron-Electric Arc Furnace (DRI-EAF) route or retrofitting existing Blast Furnaces and Basic Oxygen Furnaces (BF-BOF) plants with CCUS technology. DRI-EAF with hydrogen has been proven to be technically feasible at scale. However, this production route is currently not cost-competitive compared to the BF-BOF route owing to higher upfront, electricity, and hydrogen costs and the low supply of hydrogen in the market today.

Figure 15: 2050 mitigation potential of steel decarbonisation levers

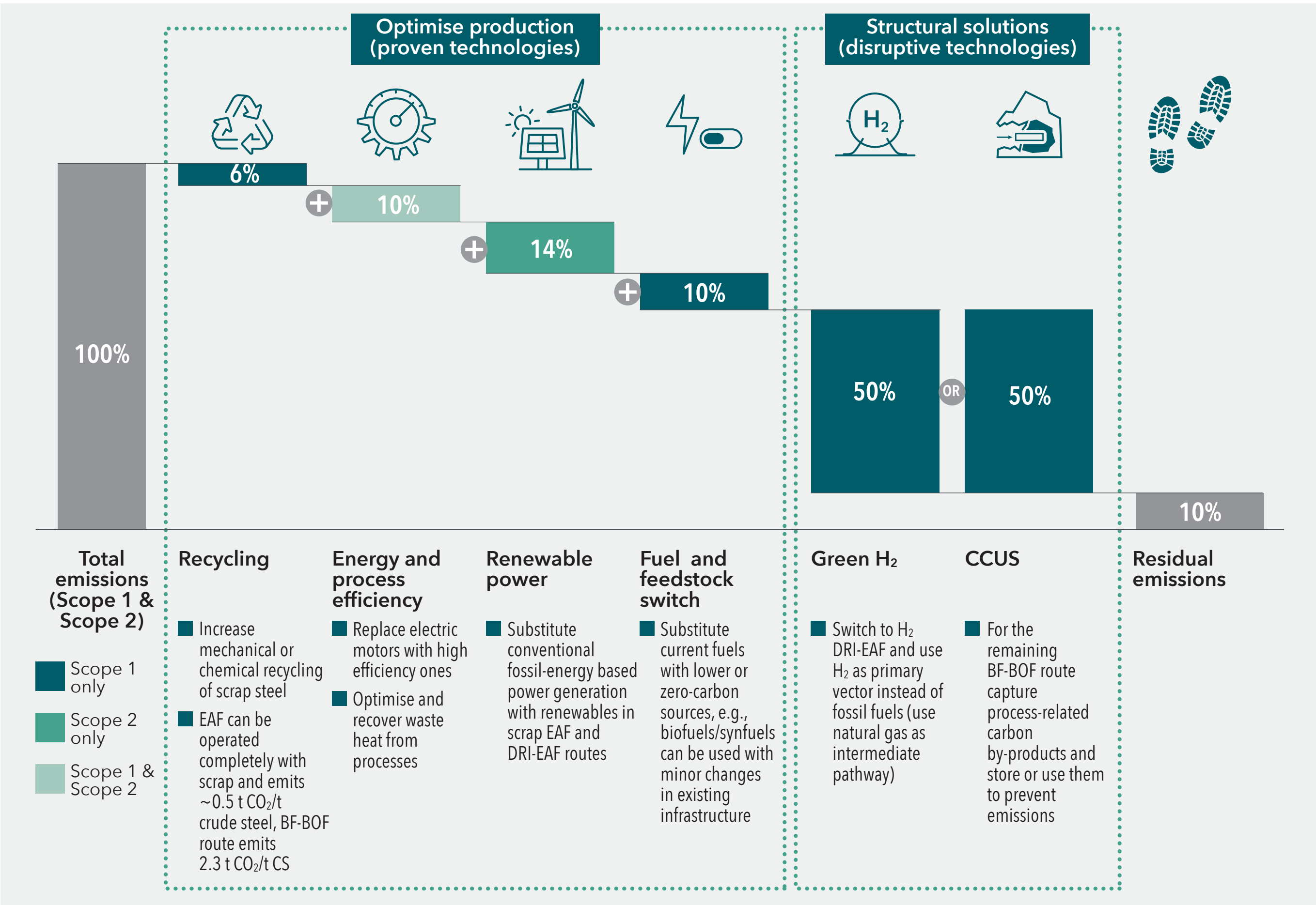
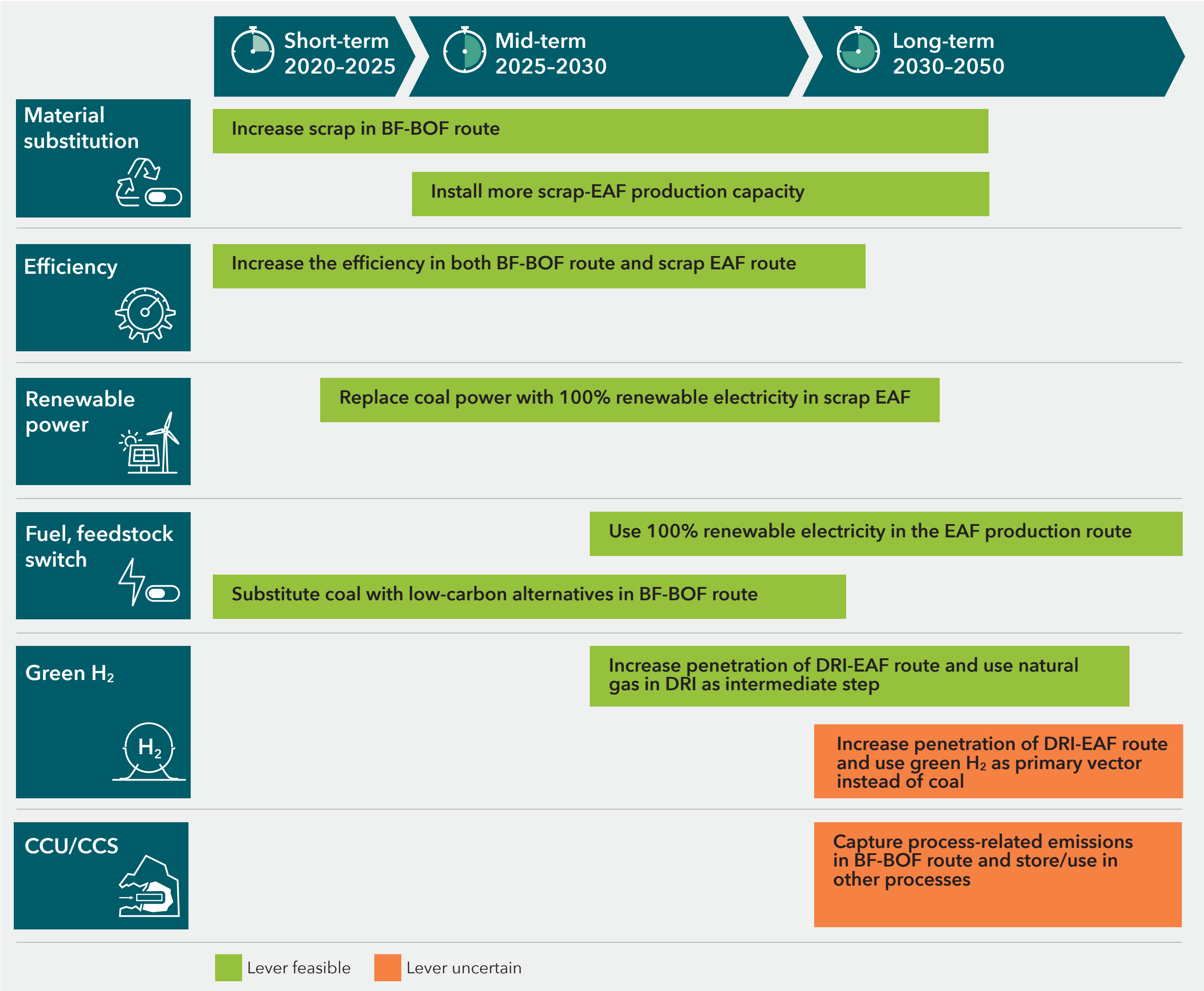


Figure 16: Steel sector decarbonisation lever deployment timeline



Additionally, due to the uncertainty around CCUS technology coupled with South Africa's competitive advantage in green H_2 production, the DRI-EAF route is preferred to decarbonise the iron and steel sector. With most South African BF-BOF assets expected to require relining by the 2030s, investing in DRI-EAF assets initially equipped with natural gas and eventually with green H_2, instead of extending the BF-BOF lifespan, will be pivotal to reaching net-zero.

Photo: Shutterstock.com

THE COST OF DECARBONISING IRON AND STEEL PRODUCTION IN SOUTH AFRICA

The wholesale technological transformation required to decarbonise the sector will need access to up to ZAR60 bn of transition finance dedicated to capital expenditure.

In the short-term (by 2025): Investment is required to procure the BAT and implement changes to improve process and energy efficiency. This lever may produce cost savings.

In the mid-to-long-term (2025–2050): The DRI-EAF production route could become competitive with the BF-BOF route assuming cost-competitive electricity and hydrogen ramp-up from 2030 onwards, reaching ~40% of production capacity by 2050 (Figure 17).

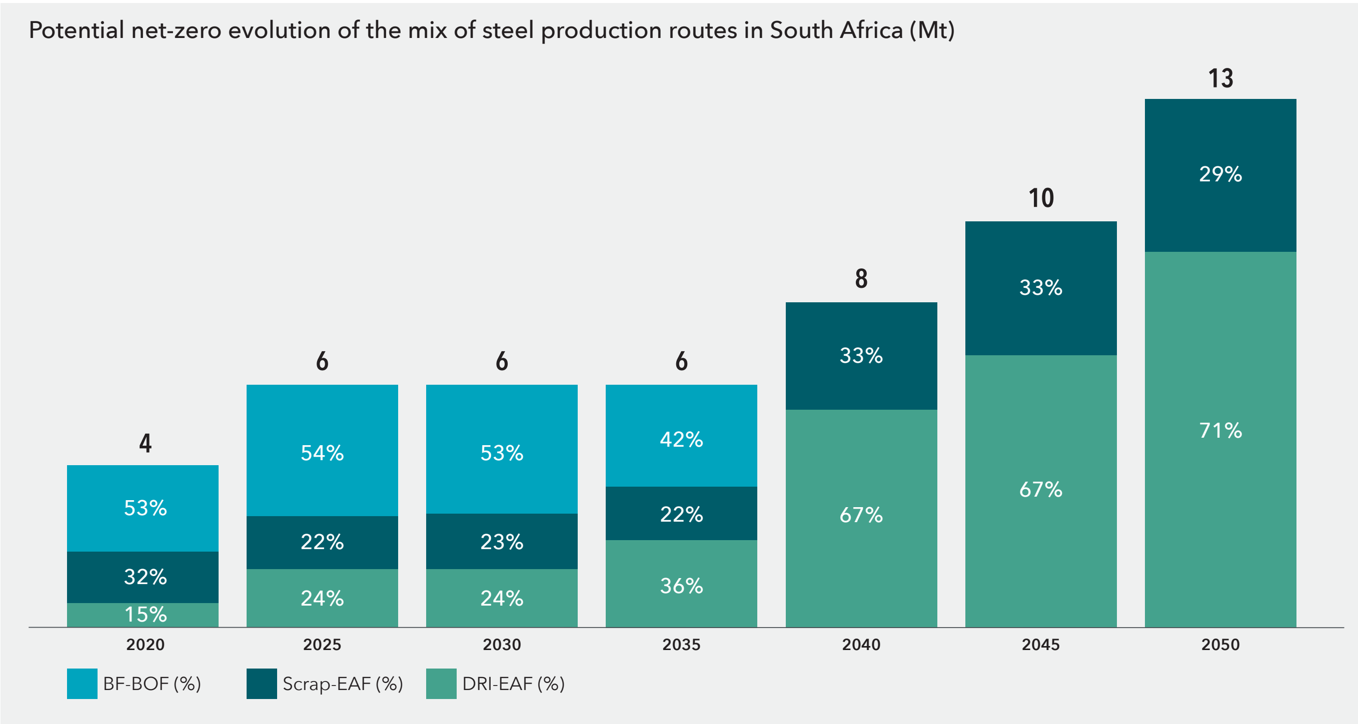
1 Mt p.a. of DRI-EAF capacity is required by 2030 to take advantage of the export market; this will come at an operational cost premium compared to the incumbent BF-BOF technology, driven by the high cost of high-quality iron ore pellets, grid or on-site electricity, and natural gas.

By 2040, the cost of operating DRI-EAF with green H_2 could decrease significantly. The availability of high-grade iron ore pellets in a local context is a crucial signpost to monitor, which may erode the cost reduction if a sustainable supply is not identified, or the ore grade requirements do not change to enable the production of lower quality iron ore. Previously presented Figure 14 compares steel production costs across the various routes by 2050. Low-carbon steel produced through the green H_2 DRI-EAF method can reach a simplified levelised cost of production of ZAR8 000/kg of steel. This is a 30% cost premium to the current BF-BOF method but ~20% lower than the similar production process in the EU, Japan, and Korea.

As carbon pricing levels inevitably increase into the future, the BF-BOF route will be progressively disadvantaged compared to the DRI-EAF route. Other factors such as reduced fly ash will also favour the DRI-EAF route.

South Africa can leverage this cost-competitive low-carbon steel production to access the EU, US, and Japan export markets commencing in the short-term. This can enable an early build-up of low-carbon steel production capacity that can be leveraged for growing local demand in the long-term.

Figure 17: Potential evolution of steel production routes in South Africa



3.4.2 DECARBONISING THE CEMENT SECTOR IN SOUTH AFRICA

CEMENT PRODUCTION IN A FUTURE, NET-ZERO SOUTH AFRICA

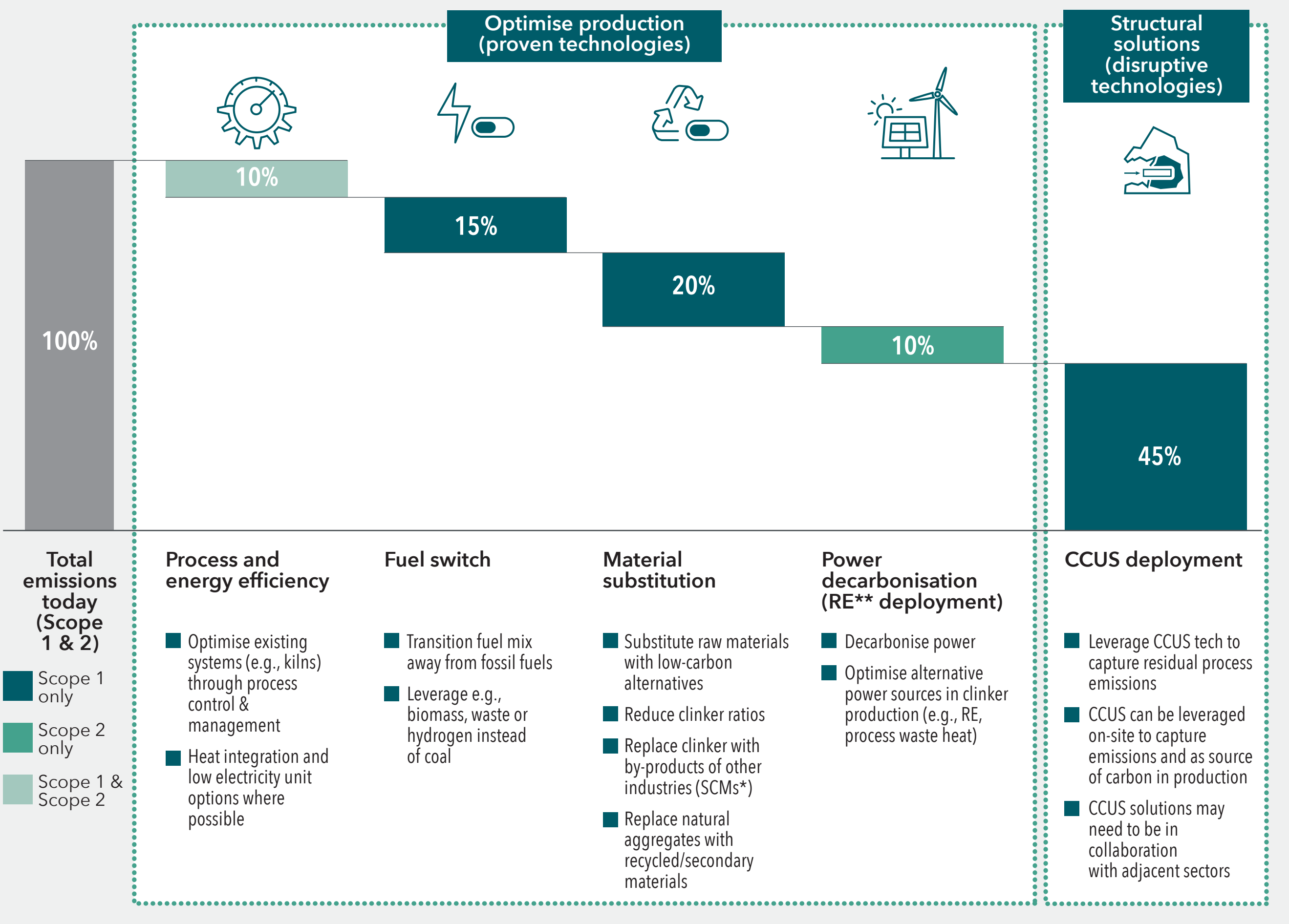
Cement production has 90% of its emissions due to direct emissions, and only 10% of emissions due to power consumption. For the full heavy manufacturing sector, cement production drives ~20% (~8 Mt CO_2e) of direct emissions and ~15% (~11 Mt CO_2e) of both direct and indirect (power-use related) emissions. The cement sector faces a unique decarbonisation challenge: 40–50% of its direct emissions are hard-to-abate process emissions generated in a chemical reaction of the production process. While more innovative production processes are not viable yet, only CCUS technology can address those emissions. However, CCUS is highly uncertain in the South African context, as it does not yet have any proven locations for permanent CO_2 storage, and CO_2 utlisation applications are not yet commercially viable at the required scale.

In the future, South Africa's cement sector will be critical for the local buildings and construction sector: for example, to close the current infrastructure and housing gap, cement demand is expected to increase. Meeting this increasing demand while avoiding a growing emissions footprint and enabling decarbonisation of cement production will be challenging but critical to enabling South Africa's Just Transition to net-zero.

CEMENT DECARBONISATION LEVER DEPLOYMENT AND EMISSION REDUCTION OVER TIME

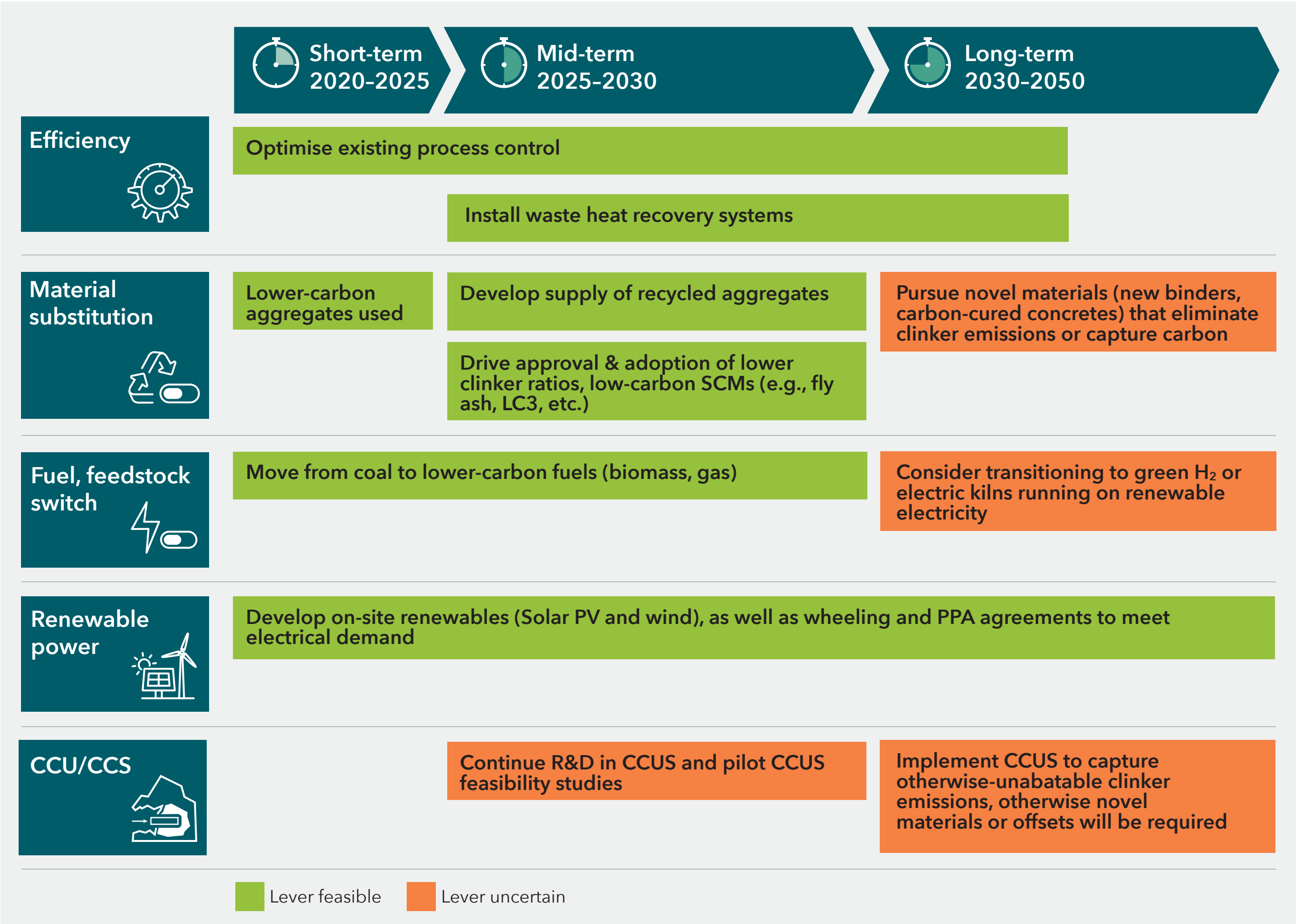
The cement sector can reduce approximately 55% of current emissions by adopting proven levers (Figure 18). Figure 19 summarises the timeline for the implementation of each decarbonisation lever. It is important to note that the precise contribution of each lever on policy choice such as green finance, carbon tax, etc.

Figure 18: 2050 mitigation potential of the cement sector decarbonisation levers



Notes: * Direct Reduced Iron-Electric Arc Furnaces
** Blast Furnaces (BF) and Basic Oxygen Furnaces (BOF)

Figure 19: Cement sector decarbonisation lever implementation timeline



In the short-term (by 2025): A 10% emissions reduction is possible by improving energy and process efficiency.

A further 15% reduction is possible by switching from fossil fuels as the primary energy carrier to low-carbon energy carriers (e.g., refuse derived fuels (RDFs), biomass, etc). In the short- to mid-term, switching to low-carbon energy will be the key decarbonisation lever for cement. In the long-term, switching to electric-based kilns or using low-carbon hydrogen in current kilns will be critical to eliminating all energy-based emissions.

In the mid-term (2025–2030): A 20% reduction is possible from material substitution, which predominantly includes replacing clinker substitution with supplementary cementitious material (SCMs) such as natural pozzolanas, calcined clays and by-products from other industries, such as slag and fly ash. On average, the clinker factor of cement produced in South Africa ranges between 70%–90%. Clinker factors as low as 50% can be achieved in the mid-term. However, slag and fly ash availability are expected to decline significantly, with the BF-BOF production route in iron and steel and coal power plants expected to be decommissioned by the 2040s.

Adopting renewable electricity can reduce up to 10% of current emissions and enable electrification by stabilising supply. This will entail either grid decarbonisation or on-site deployment of renewable electricity generation.

Although many of the levers are technically feasible, supporting legislation, and policies are required to enable their deployment at scale early, to allow South Africa's Just Transition to net-zero by 2050.

> ***Heavy manufacturing sectors (excluding steel and cement) can be fully decarbonised through the deployment of mature levers. Full decarbonisation of steel is possible but requires ~0.3 Mt p.a. of green H_2. However, the main uncertainty lies in the future feasibility of CCUS. Without CCUS, there could be ~15 Mt CO_2 p.a. annual unabated residual emissions from cement by 2050.***

In the long-term (2030–2050) Cement net-zero archetypes by 2050. Without CCUS or alternative chemistry cementitious material, the South African cement sector could produce ~15 Mt CO_2e annual residual emissions by 2050. Due to the uncertainty around CCUS and alternative chemistry cementitious material feasibility, different archetypes to decarbonise the cement sector emerge, namely:

- CCUS is feasible, and the cement sector can fully decarbonise
- CCUS is not feasible, and South Africa moves away from traditional cement using alternative chemistry, to for example, geopolymer cement, hempcrete or even timber for buildings
- CCUS is not feasible, and South Africa relies increasingly on green cement imports
- CCUS is not feasible, and residual emissions from cement are offset using nature-based sinks

THE COST OF DECARBONISING CEMENT PRODUCTION IN SOUTH AFRICA

In the short- to mid-term (by 2030): ~ZAR30 bn cumulative capital expenditure is required to implement proven decarbonisation levers at full mitigation potential in the cement sector by 2050. This is needed to upgrade technology and process control measures in plants to best-in-class to unlock energy and process efficiency. However, the efficiency improvements will also drive cost savings. Whether upgrading delivers enough cost savings to pay back the upfront investment will be a plant-by-plant decision.

Additionally, the infrastructure required to store, process and transport alternative material, fuel and feedstock will cost up to ZAR5 bn.

In the long-term (2030–2050): The cost of adopting disruptive technologies is highly uncertain. For example, the cost of CCUS infrastructure has been identified to range from ZAR2 500 – ZAR3 500/tonne of cement production capacity installed by 2040, equivalent to a further capital expenditure of ZAR25 bn – ZAR40 bn. In total, adopting CCUS would require ZAR60 bn – ZAR75 bn in capital expenditure by 2050.

It is important to note that there is significant uncertainty in the cumulative cost due to the impact of technology learning through to 2050, as well as the impact of disruptive levers.

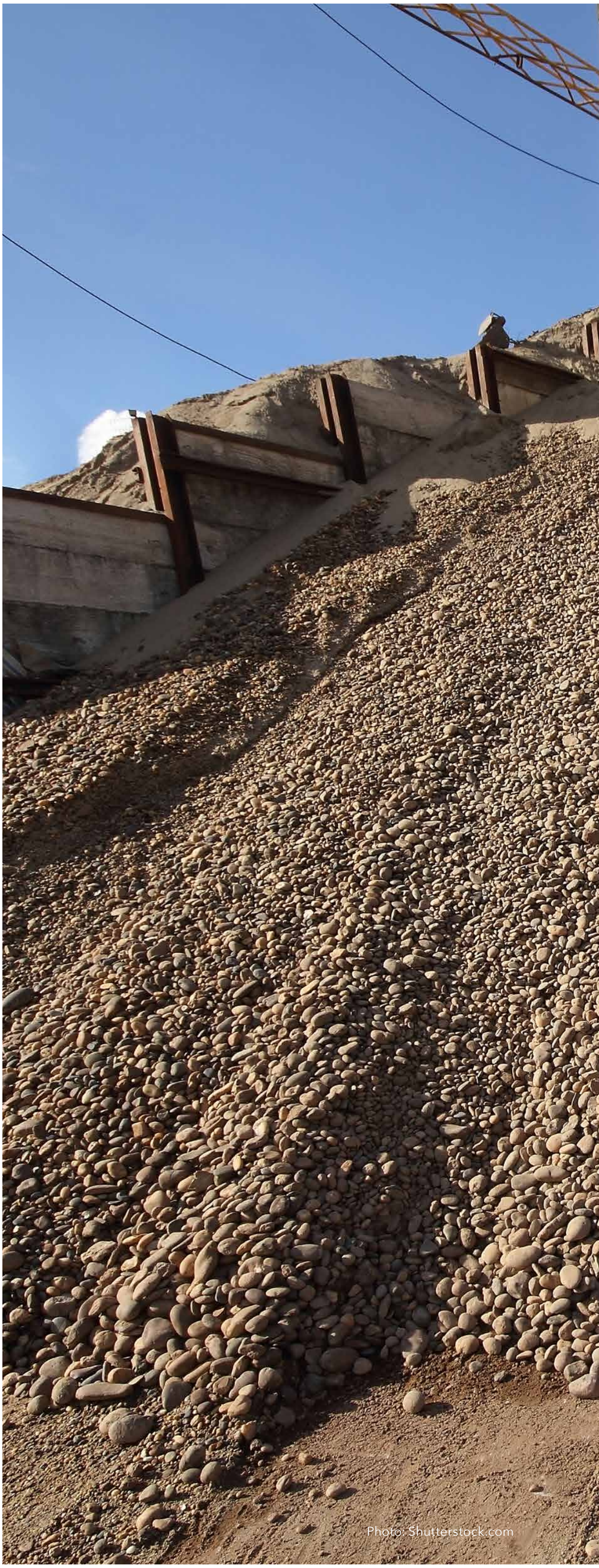


Photo: Shutterstock.com

3.4.3 DECARBONISING THE ALUMINIUM SECTOR IN SOUTH AFRICA

ALUMINIUM PRODUCTION IN A FUTURE, NET-ZERO SOUTH AFRICA

Decarbonising the aluminium sector is critical to enable South Africa to reach net-zero, secure national supply for a crucial input commodity, and maintain a strong presence in the export market for aluminium. This will reduce ~10 Mt CO_2e p.a.emissions and enable South Africa to produce low-carbon or green aluminium critical to decarbonise other sectors, such as the construction sector, and continue exporting in a future net-zero global aluminium market.

In South Africa, aluminium production involves smelting alumina into aluminium using electrolysis. Thus, the sector is a significant electricity user, driving ~10 TWh of electricity demand per annum. Coal-based power is the primary driver of aluminium emissions (~70%). Process emissions in aluminium are caused by carbon anode and pitch bath consumption during electrolysis and chemical imbalances (named anode effects), primarily driven by an unstable electricity supply. This causes carbon dioxide and perfluorocarbon (PFC) emissions – which have a greenhouse effect 10 000 times stronger than carbon dioxide. There have been crucial steps taken globally to reduce PFC emissions in the smelting process since the early 1990s, for example, capturing PFC emissions and scrubbing them using alumina before the smelting process – ensuring a closed loop where the emissions do not reach the atmosphere. However, PFC emissions are still seen in South Africa today due to load-shedding or rolling power supply cuts to the aluminium sector.

DECARBONISATION LEVERS FOR ALUMINIUM PRODUCTION

As the demand for aluminium is expected to triple by mid-century, coordinated efforts across the power and aluminium sectors are critical to limit and reduce emissions from the sector. Approximately 95% emissions reduction is possible using technically proven levers. Figure 20 summarises the critical aluminium production decarbonisation levers and their emissions mitigation potential from a 2019 baseline.

ALUMINIUM DECARBONISATION LEVER DEPLOYMENT AND EMISSION REDUCTION OVER TIME

In the short-term (by 2025): Improving energy and process efficiency can unlock a 5% emissions reduction. Optimising processes to reduce anode consumption and the occurrence of anode effects is critical to reducing carbon dioxide and PFC emissions. An additional 10% of emissions reduction can be achieved through adopting alternative low-carbon fuels and electricity for process machinery. Green H_2 may become a crucial alternative fuel in the long-term.

In the mid-term (2025–2030): Adopting renewable electricity is the most significant emissions reduction lever, with a ~70% emission reduction possible by 2050. An additional 10% emissions reduction can be achieved by material substitution. This involves increasing the share of secondary aluminium production, which uses 95% less energy than primary production. Scrap availability in South Africa limits how far this lever can be implemented; however, as aluminium usage increases across industries, this will become less of a barrier. A developed circular economy infrastructure and a behaviour change will be required to enable maximum scrap collection rates.

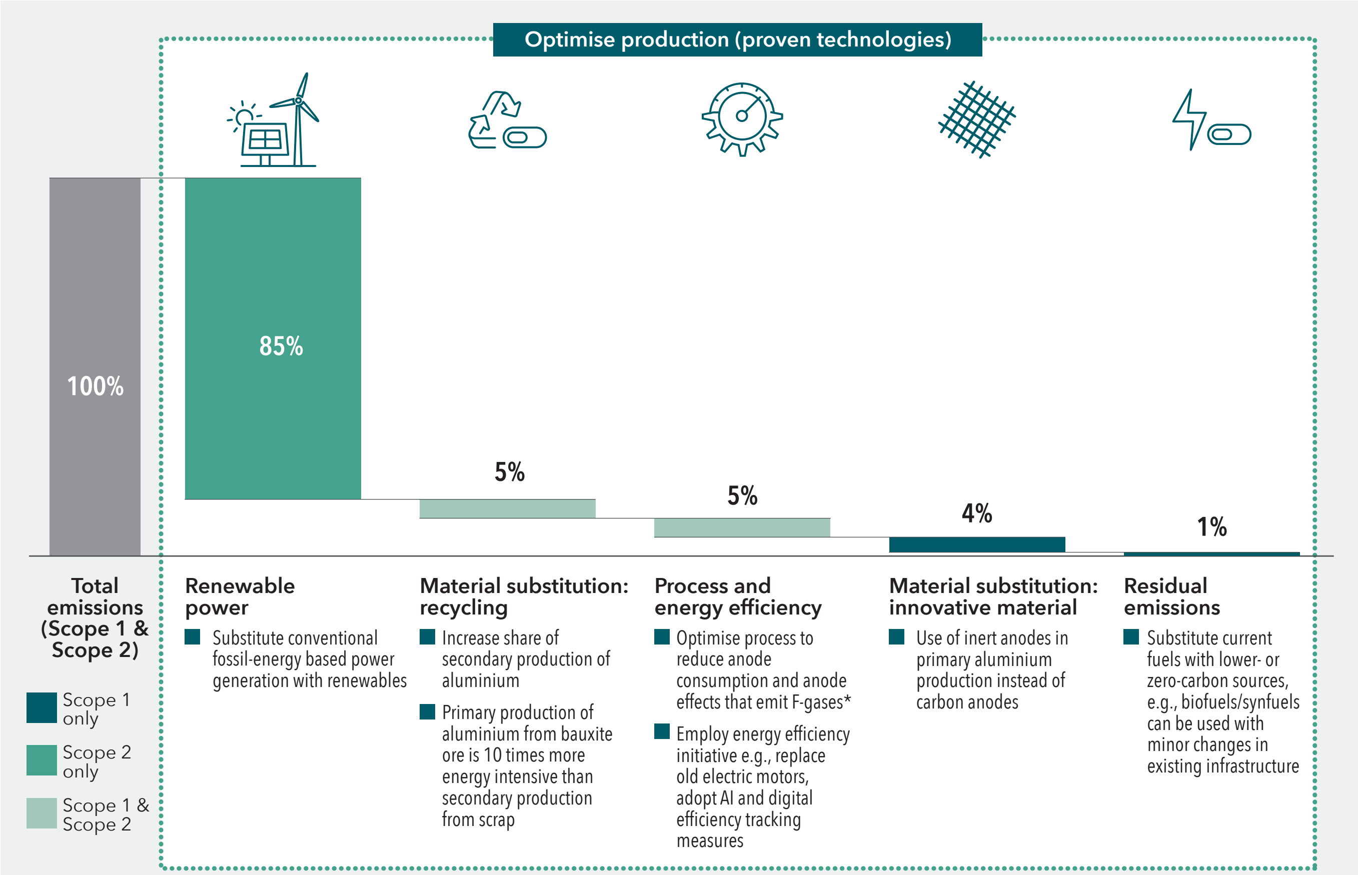
In the long-term (2030–2050): Inert anode adoption is the critical last-mile decarbonisation for primary aluminium smelters. This can eliminate the carbon and PFC emissions, thus reducing the remaining 5% of emissions. Inert anode technology is currently at a low maturity stage, mostly proven in R&D contexts. However, industrial-scale technical viability has been said to be possible as early as 2026 globally, while reaching cost competitiveness globally by the early 2030s.

THE COST OF DECARBONISING ALUMINIUM PRODUCTION IN SOUTH AFRICA

The cost of transitioning the aluminium sector will primarily sit in on-site renewable generation – if deployed – and upgrading plants to use and possibly produce inert anodes. Assuming ~2 Mt p.a. of installed production capacity split 70–30 between primary and secondary production, up to 9 GW of on-site generation capacity is required. Over 30 years, this would need at least ZAR20 bn in upfront investment. Following grid decarbonisation or using purchasing power agreements (PPAs) are a few examples of avenues to reduce the burden of the upfront cost. This will be critical, given the high cost of aluminium production. An inert anode baking facility requires at least ZAR0.8 bn – ZAR1 bn in capital expenditure.[27]

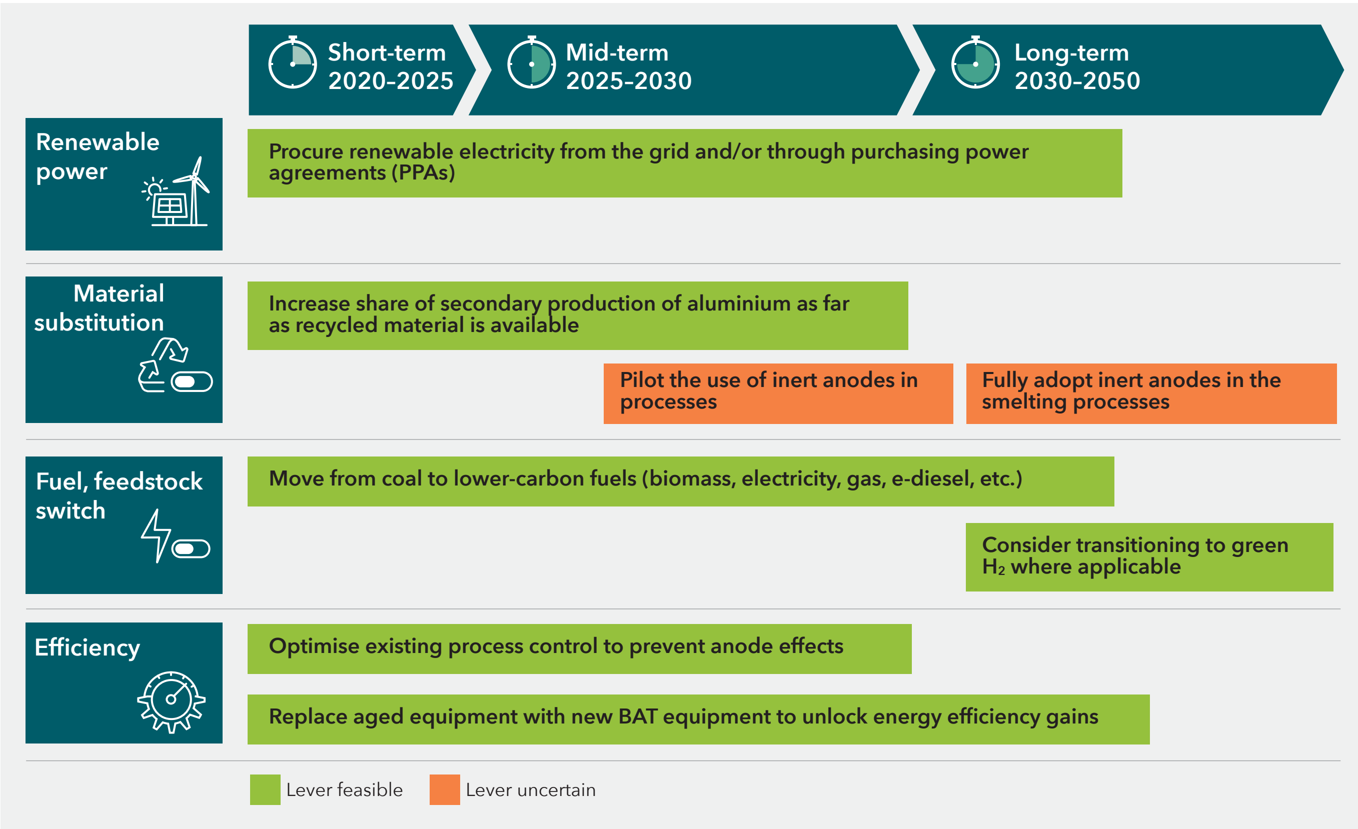
27 ELYSIS

Figure 20: 2050 mitigation potential of the aluminium sector decarbonisation levers



Note: * Fluorinated gases

Figure 21: Aluminium sector decarbonisation lever implementation timeline



3.4.4 DECARBONISING THE REMAINING OTHER ENERGY-INTENSIVE MANUFACTURING

Other energy-intensive manufacturing includes other ferrous and non-ferrous metals manufacturing (except aluminium and steel), minerals (for example, glass), machinery manufacturing, and pulp, paper, and wood processing. High energy intensity is standard across these sectors, and thus the bulk of greenhouse gases are emitted as a result of energy use. Electricity usage is high in the sector, driving significant Scope 2 emissions linked to the intensive local grid emissions factor. Therefore decarbonising the energy sector will be critical to reaching net-zero emissions in these industries.

South Africa's other energy-intensive manufacturing industries can reach net-zero emissions by 2050. Approximately 90% of this reduction can be achieved using already proven technology.

DECARBONISATION LEVERS FOR THE REMAINING HEAVY MANUFACTURING INDUSTRIES

Figure 22 summarises the sectors' key decarbonisation levers and their corresponding mitigation potential for emissions.

In the short-term (2020-2025): Approximately 10% of emissions reduction is possible by improving the process and energy efficiency. Implementation of this lever varies by sector, with initiatives including replacing aged assets with the BAT and deploying waste heat recovery or combined heat and power (CHP) plants.

A further 15% emissions reduction is possible through switching to alternative low-carbon fuels and electricity for on-site machinery. Implementing this lever at its full mitigation potential may require an overhaul of current technology and retrofitting to enable the usage of alternative fuels and electrification. In the long-term, disruptive low-carbon fuels, such as green H_2 should be considered for industries where full electrification is not feasible. Glass manufacturing is a key example, where electrification of kilns is expected for smaller kilns (less than 1 Mt p.a. capacity). In comparison, larger kilns will require more energy-dense carriers.

An additional 10% of emissions can be addressed by increasing the role of recycling and material substitution. The use of recycled material in the pulp, paper, and wood processing sector to divert waste from landfills is a key example. Increasing the circularity of the sectors will not only limit the use of the finite primary materials but also decrease energy usage and emissions from landfills.

In the mid-term (2025–2030): A 65% emissions reduction potential makes the adoption of renewable electricity the most significant decarbonisation lever. On-site electricity generation from renewable sources such as biomass has been rising in industries, such as pulp, paper, and wood processing. However, not all industries currently have the scale to deploy on-site generation. Therefore grid decarbonisation will be a key requirement to decarbonise the sector.

THE COST OF DECARBONISING THE REMAINING HEAVY MANUFACTURING IN SOUTH AFRICA

Investment to acquire the BAT in each sector is required to enable process and energy efficiency improvements. In some sectors, updating to BAT may require a wholesale change in the plant.

To unlock the mitigation potential of the fuel and feedstock switch, investment is required to either retrofit existing capacity to use alternative fuels or to acquire new technology that can utilise low-carbon alternatives. Material substitution requires a similar investment. Additionally, setting up processing, storage and transportation infrastructure for the alternative fuels, feedstocks, and materials is likely to require new investments.

Investment to build a combination of public renewable energy deployment and private PPAs will be critical to ensuring the remaining industries can decarbonise in a timeous manner, either due to grid decarbonisation or on-site renewable generation.

Figure 22: 2050 mitigation potential of other energy-intensive manufacturing decarbonisation levers

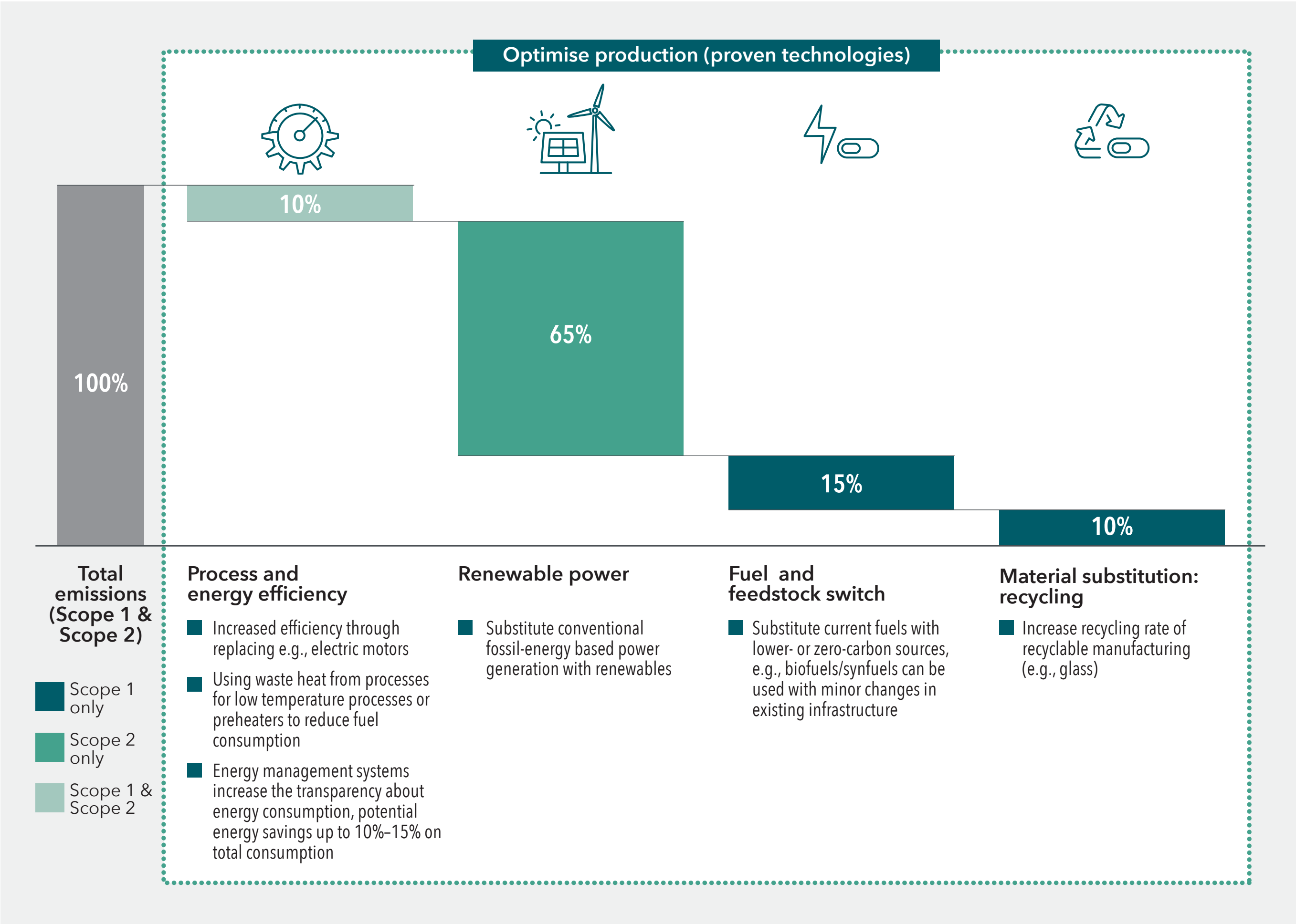



Photo: Shutterstock.com

3.5 JUST TRANSITION AND BROADER SOCIO-ECONOMIC IMPLICATIONS

Growing and greening the South African heavy manufacturing sector enables socio-economic development. Failing to do this could result in systemic risk to the ability of other sectors to transition, such as power and transport, due to their dependence on heavy manufacturing outputs. Moving to green production can also improve the trade balance through the increased value of exported goods – a critical enabler to managing the financial risk of the transition.

Strategically decarbonising, growing and diversifying the South African heavy manufacturing sector holds great potential for job creation. It is also a key enabler of greater supply chain security for critical goods, like steel and cement, and improved trade balance through increased export value, which is critical for financing the transition.

If South Africa can play a role in the emerging green heavy manufacturing markets and meet the increasing local and global demand, this could result in ~740 k net additional jobs by 2050 compared to today, assuming the jobs growth is linked to the estimated sector growth. Increased global and local demand for green metals, like steel and aluminium, could create ~280 k additional jobs (~240 k from steel, fabricated and structural metal products and ~40 k from non-ferrous metals, mainly from aluminium (assuming ~3%–4% CAGR 2020–2050). For minerals such ascement and glass, increased local demand could create ~62 k additional jobs (assuming CAGR ~2% 2020-2050). Increased global and local demand for forestry-based materials, such as usage of timber in construction and paper in packaging, could potentially create many additional jobs for the pulp, paper and wood processing sector. However, given the supply side constraints in terms of additional land available for forestation, combined with potential increasing temperatures and water scarcity, the job increase potential is estimated to be limited to ~10 k additional jobs.[28]

In addition to capturing the growing demand, it is important to consider diversification opportunities to grow a portfolio of climate-friendly manufacturing goods that also reduces the economy's exposure to transition risk. This is especially relevant for machinery and transport equipment manufacturing, where diversifying and growing the sector towards future green manufacturing goods could create even ~640 k additional jobs (assuming CAGR ~2%–3% 2020–2050). Given South African strong existing ICE vehicle manufacturing capabilities, the majority of the job increases would be linked to the automotive sector growing electric vehicles (EVs) manufacturing and linked sectors, like battery manufacturing. Additionally, current manufacturing capabilities and economic complexity would be well suited to support other sectors to transform by manufacturing future green goods (for example, producing railway infrastructure and buses for transport, renewable power technology, such as wind turbines and solar panels, and insulation materials and appliances, such as heat pumps for the housing market).

Failure to grow and decarbonise the heavy manufacturing sector could pose a significant risk for other sectors' transformation, as manufacturing commodities such as steel and cement are key enablers for the power and transportation sector transitioning to net-zero. Another systemic risk is the potential increased cost of heavy manufacturing goods, hindering the required infrastructure development needed to transition other sectors to net-zero and ensure socio-economic development. Ensuring affordability of key building materials is a key enabler, particularly in low-cost housing where cement contributes ~10% of the total cost per RDP (Reconstruction Development Programme) house. Decarbonisation of cement could double the cost of cement, increasing the cost of RDP houses by 10%. There are also sector specific risks, such as those related to the relocation of facilities and the need for reskilling due to new processes being adopted and products being made. Supportive policies, legislation, finance mechanisms, etc. are needed to manage these increased costs, and limit the additional costs passed on to the customer.

28 Assuming additional 100 000 hectares of land will be available for forestation, based on current South African government plans and expert interviews.

3.6 HOW TO ENABLE THE DECARBONISATION OF SOUTH AFRICA'S HEAVY MANUFACTURING SECTOR

3.6.1 UNLOCKING FINANCING FOR DECARBONISATION OF HEAVY MANUFACTURING

Affordable green power and globally competitive local green H_2 production can be a source of competitive advantage for South Africa's heavy manufacturing sector – but it will require extensive investment (~ZAR150 - 160 bn) to upgrade heavy manufacturing plants to incorporate green processes and technology.

The heavy manufacturing sector will require extensive investment – up to ZAR30 bn in the 2020s, ZAR40 bn in the 2030s and ZAR 90 bn during the 2040s – to unlock the full mitigation potential of all decarbonisation levers. Critically, funding is required to ensure the sector transitions timeously to reach net-zero by 2050 while securing the local supply of critical commodities during the transition – e.g., the iron and steel sector will need to invest in DRI-EAF assets in the 2020s and 2030s to ensure minimal disruption of local steel supply as the BF-BOF assets are retired.

3.6.2 RECOMMENDED POLICIES AND ACTIONS TO ENABLE THE NET-ZERO PATHWAY

To enable the net-zero pathway, the heavy manufacturing sector requires a coordinated effort among public and private stakeholders. South Africa needs to ramp-up renewable power production to enable sector decarbonisation, align a low-carbon market definition for the heavy manufacturing goods, create local green lead markets, and ensure a trade support mechanism that protects local low-carbon production from cheap, carbon-intensive imports.

A set of technical, policy and financial enablers is required to support a net-zero and Just Transition of the sector. To unlock these enablers requires collaborative and coordinated action across the private and public sectors.

South Africa needs to ramp-up green power and hydrogen to ensure the competitiveness and decarbonisation of the heavy manufacturing sector. By 2050, 80 TWh p.a. of electricity is needed across heavy manufacturing sectors and ~0.3 Mt p.a. of green H_2 for the DRI-EAF steel route. Without access to green electricity, the sector is unable to reach net-zero or produce green products. This creates the imperative to deploy renewable energy with speed today to ensure the sector is competitive in the net-zero future.

South Africa needs to implement both demand and supply-side policy measures to support heavy manufacturing decarbonisation. From the demand side, South Africa needs to align with a standard market definition for low-carbon commodities and goods and stimulate local demand by creating local green, lead markets. From the supply side, South Africa needs to enable a trade support mechanism that protects its local low-carbon production from cheap, carbon-intensive imports in the short-term. Moreover, South Africa needs to continue making fossil fuel usage less attractive with effective carbon pricing. Again, carbon pricing revenue could be allocated for low-carbon projects to accelerate the transition. Thus, South Africa needs to incentivise low-carbon alternatives and continue incentivising efficiency improvements across sectors (see Figure 23).

There are many actions that the private sector can take in the short-term to accelerate the change. Firstly, the private sector should take an active part in shaping the regulatory discussion around low-carbon alternatives and developing clear rationales and fact-based perspectives to argue a position on low-carbon alternatives. Secondly, private companies should secure access to critical resources as soon as possible, as prices of critical inputs, like recycled materials, are expected to increase as the net-zero transition progresses. Companies need to seek long-term contracts and partnerships to maintain a steady flow of future materials. From a Just Transition perspective, companies should start workforce planning and reskilling to address the potential mismatch of current skillset and future needed capabilities in manufacturing.

From a financing perspective, private sector actors need to plan and execute new large-scale investments on time and on a budget to avoid asset lock-in, plan diligently, and professionally execute the investments needed for new low-carbon processes and assets. Lastly, companies need to build new sales expertise and a sound value proposition for early low-carbon adopters, proactively target potential markets for low-carbon products, and persuade companies to pay a premium for a low-carbon alternative as demand grows; this will indirectly finance the transition.

South Africa will need international support to achieve this transition to improve the affordability and availability of key abatement levers, in particular, technology that is not yet mature – such as CCUS. The support South Africa requires is not only financial – South Africa requires support across financing, trade (such as cost competitive imports and risk mitigation of foreign currency fluctuations), technology (including IP sharing to enable green H_2 economy and early adoption), and skill and capacity development.

Figure 23: Key policy and financial enablers needed for net-zero heavy manufacturing

Selected key policies and financial enablers needed per sub-sector

Cross-sectoral	Metals (e.g., iron & steel, aluminium	Minerals (e.g., cement, glass)	Machinery (e.g., auto and machinery manufacturing	Pulp, paper and wood processing
Make fossil fuels less attractive (e.g., effective carbon pricing)	Standard definition of 'green steel' (threshold value for 'low-carbon' and accounting methods)	Standards on material efficiency & use of low-carbon alternatives (e.g., clinker substitution allowances)	Stimulate local EV (electric vehicle) demand through incentives (e.g., subsidies)	Ensure creditable and accessible sustainable forest certificates (with focus on small-scale farmers)
Increase transparency of emissions (e.g., CO_2 label)	Create local green lead markets (e.g., quotas, public procurement)	Stimulate use of low-carbon building material (e.g., LC3, in the construction value chain)	Actions to support EV value chain localisation	Investigate potential increase of land area for forestation to meet the future demand
	Trade support mechanism (e.g., protect own local production from emissions intensive imports)	Enable usage of waste as feedstock through supporting policies and waste management legislation	Negotiate favourable import terms for EV with major market (similar with ICE)	Incentivise towards energy and resource efficiency
Incentivise energy efficiency and usage of renewable power	R&D and pilot support to enable large-scale pilots to provide proof of concept (e.g., new steel routes)	Trade support mechanism (e.g., protect own local production from emissions intensive imports)	Partner with finance sector to provide financial products for EVs	
		R&D and pilot support to enable large-scale pilots to provide proof of concept (e.g., CCUS)	Recapitalisation programme for MBT and bus fleets to support financing of ZEV (zero emission vehicle)	

Regulatory policy enabler

Financial policy enabler

4. OUTLOOK

As was stated in the foreword of this report, South African business commits unequivocally to supporting South Africa's commitment to find ways to transition to a net-zero emission economy by 2050. Furthermore, business would support an enhanced level of ambition in the NDC that would see the country committing to a range of 420–350 Mt CO_2e by 2030. However, this enhanced ambition would have to be conditional on the provision of the requisite means of support by the international community. In this light the business community will play its part to work with international and local partners to develop a portfolio of fundable adaptation and mitigation projects that would build resilience and achieve deep decarbonisation.

A managed Just Transition is important, and such a transition is impossible without a broad multi-stakeholder effort. National Government, through the Presidential Climate Commission and the National Planning Commission and supported by key government ministries, are leading this effort.

In support of this national programme, the NBI membership together with BCG and BUSA are running a multi-year project to understand net-zero decarbonisation pathways, sector by sector. This will provide a solid input into national and local dialogues, as well as identify critical investment areas. Furthermore, this level of detail enables policy frameworks and engagement with providers of international support to maximise the potential to leverage concessional finance and trade support to attract local public and private finance.

This work is ongoing and is intended as a basis for further consultation and a foundation for future work. The work on each sector will be released in stages as it is completed and will form a basis on which others can build. Ultimately a final body of work of the combined sector content will be made up of reports on:

- An introduction to the project and to a managed Just Transition, including analysis from our economic modelling
- Electricity
- Petrochemicals and chemicals
- The role of gas
- The role of green H_2
- Mining
- Transport
- Agriculture, Forestry and Other Land Use
- Construction
- Heavy industry
- A concluding chapter highlighting key investment opportunities and no-regret decisions.

Each of these reports will be published via our Just Transitions Web Hub (http://jthub.nbi.org.za). Please monitor this website for the latest report versions, supporting data and presentation material, as well as news of other Just Transition initiatives and a wide range of current opinion and podcasts on a Just Transition for South Africa.

We invite you to engage with us and to provide comment and critique of any of our publications via info@nbi.org.za.

Kalkbult, Northern Cape. Photo: scatec.com/locations/south-africa

National Business Initiative

Photo: Shutterstock.com

5th Floor, 61 Katherine Street, Dennehof, 2196
PO Box 294, Auckland Park, Johannesburg 2006, South Africa
0861 123 624 (0861 123 NBI)
www.nbi.org.za
Reg. No. 1995/003141/08 Association Incorporated under Section 21 I Vat Number: 4070158433