National Business Initiative

CHAPTER 08

JUST TRANSITION AND CLIMATE PATHWAYS STUDY FOR SOUTH AFRICA

DECARBONISING SOUTH AFRICA'S BUILDINGS AND CONSTRUCTION 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.

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

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.

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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

AFOLU	Agriculture, Forestry and Other Land Use
BEV	Battery Electric Vehicle
bn	Billion
CAGR	Compound Annual Growth Rate
CCUS	Carbon Capture, Utilisation, and Storage
CDP	An international disclosure platform focusing investors, cities, companies and governments to measure and act on their environmental impacts
CLT	Cross-Laminated Timber
CO_2e	Carbon dioxide equivalent
EIA	Environmental Impact Assessment
EV	Electric Vehicle
FCEV	Fuel Cell Electric Vehicle
GDP	Gross Domestic Product
GHGI	Greenhouse Gas Inventory
Gt	Gigatonne (1 thousand million tonnes)
GW	Gigawatt
HVAC	Heating, Ventilation and Air Cooling
ICE	Internal Combustion Engine
IEA	International Energy Agency
IRP	Integrated Resource Plan
JT	Just Transition
k	Thousand
kg	Kilogram
km	Kilometre
KPI	Key Performance Indicator

LPG	Liquefied Petroleum Gas
M	Million
Mt	Megatonne (1 million tonnes)
NZ	Net-Zero
p.a.	Per Annum
PJ	Petajoule ((10^15 Joule)
PPP	Purchasing Power Parity
RDP	Reconstruction and Development Programme
RE	Renewable Energy
SA	South Africa
SANS	South African National Standards
SCM	Substitute Cementitious Material
Scope 1 emissions	All direct emissions from activities of an organisation under their control, including process emissions, fuel combustion on-site, such as gas boilers, fleet vehicles and air-conditioning leaks
Scope 2 emissions	Indirect emissions from electricity and steam purchased and used by the organisation. Emissions are created during the production of the electricity and steam that is used by the organisation
Scope 3 emissions	Indirect emissions along the sector's supply chain (emissions outside the reporting entity)
t	Tonne
TCO	Total Cost of Ownership
tn	Trillion
ZAR	South African Rand
ZEV	Zero Emissions Vehicle

CONTENTS

JUST TRANSITION AND CLIMATE PATHWAYS STUDY FOR SOUTH AFRICA

SERIES INCLUDES:


Image: firstmode.com

OVERVIEW OF CEO CHAMPIONS

Onboarding of additional CEOs ongoing

Shameela Soobramoney
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

Calib Cassim
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

Holger Riemensperger
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
Sub-Saharan Africa
CEO & MD

Stuart Mckensie
Ethos CEO

Nombasa Tsengwa
Exxaro CEO

Dan Marokane
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 building and construction 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 can be done, 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.**

Furthermore, 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,

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

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 further 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 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

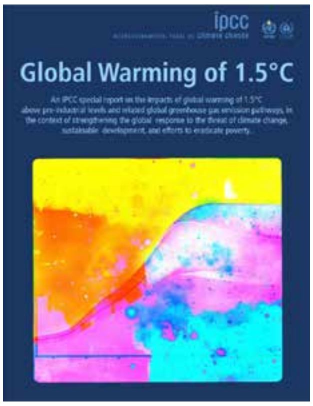
2.1 THE PURPOSE OF THIS REPORT

This report is part of the Just Transition and Climate Pathways study for South Africa. It focuses on the decarbonisation of South Africa's buildings and construction 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 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.

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.

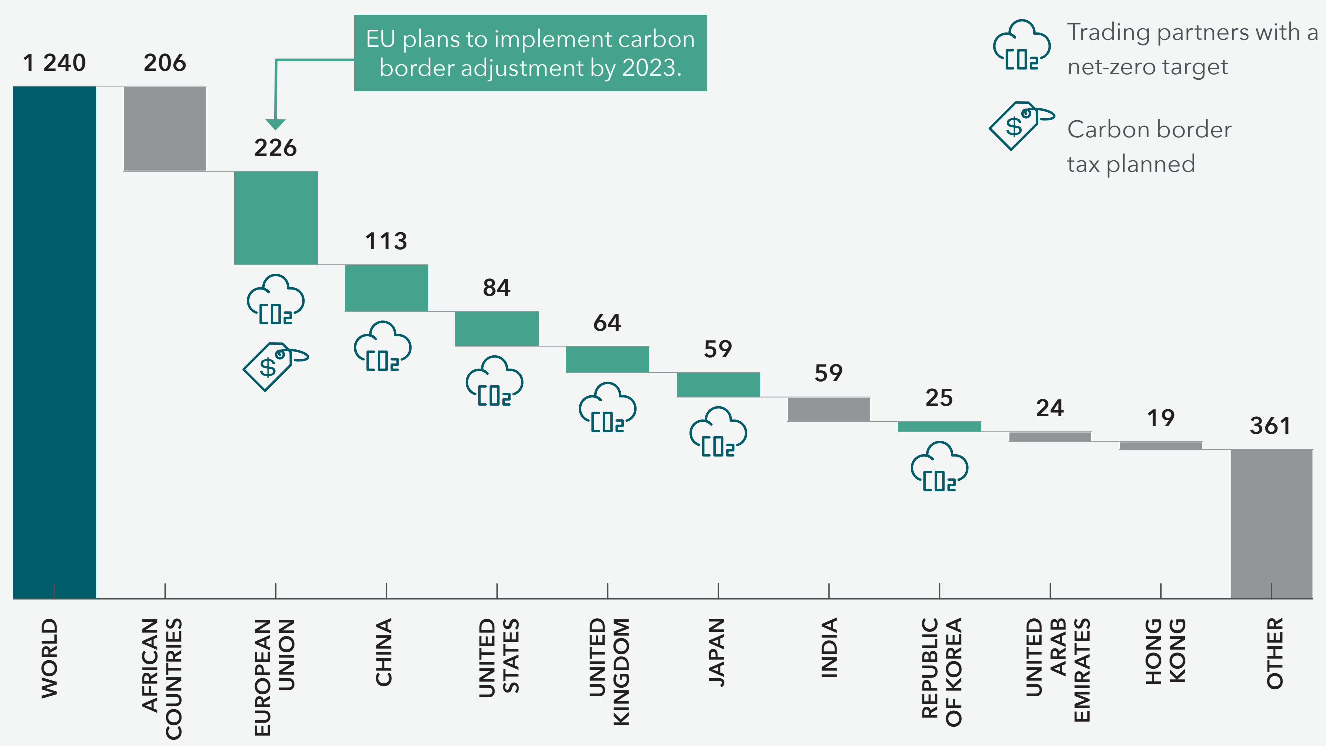
South Africa is also facing a significant trade risk. South Africa ranks in the top 20 most carbon-intensive global economies on an emissions per Gross Domestic Product (GDP) basis, and in the top five amongst countries with GDP in excess of US$100 billion (bn) per annum. The South African economy will 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), China, the United States, the United Kingdom, Japan, and South Korea.[6]

At the UN Climate Change Conference of the Parties (COP26) in November 2021, all countries are expected to

Figure 1: Volumes of South Africa's exports to leading partners in 2018 (ZAR billion)



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

set out more ambitious goals, including setting concrete mid-term reduction targets. The COP26 Presidency's stated priorities includes '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.[7]

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.[8] 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, 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.

7 At the time of writing, May 2023, the EU has announced that the Carbon Border Adjustment Mechanism (CBAM) will be implemented on certain carbon intensive goods imported to the EU and that, administratively, it will come into effect as early at October 2023. South Africa is unlikely to qualify for any leniency in the application of CBAM.

8 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.[9] 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.[10] Exacerbating this are levels of youth unemployment that are amongst the highest in the world.[11]

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.[12] 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,[13] deteriorating debt to GDP ratio, with growth of ~6% for the last 10 years, and the consistently negative balance of trade.[14]

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

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

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

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

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

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

14 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 buildings and construction 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 electric vehicles 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 eighth 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 heavy manufacturing 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

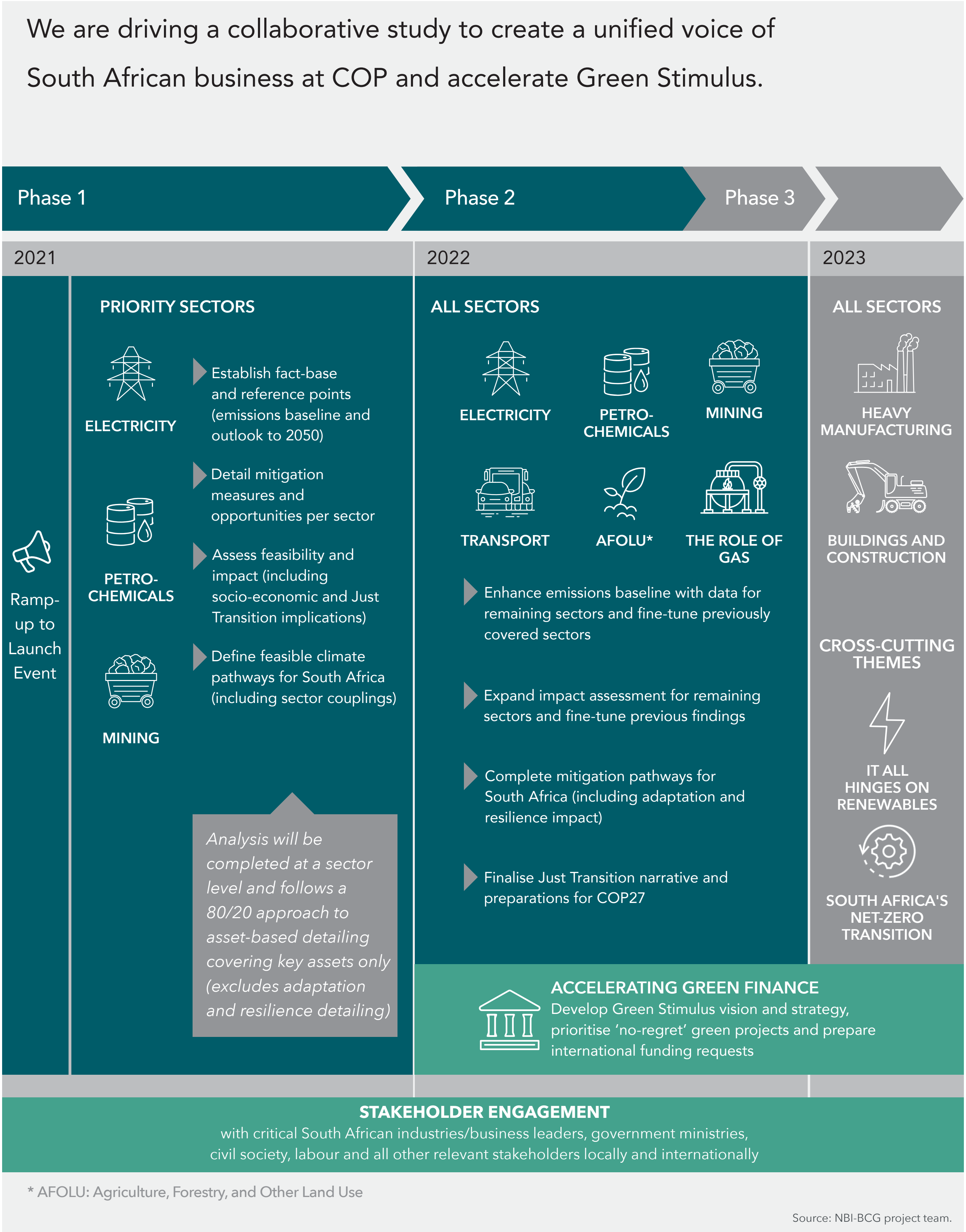


Figure 3: Governance set-up of the study

To ensure representative, balanced and fact-based content, a comprehensive governance structure is in place.

CEO champions	Advisory boards	Steering committee
CEOs	Industry, government and civil society representatives	Company representatives

Core project team

NBI, BCG

Technical committees and expert meetings

- Energy sector
- Chemicals and petrochemicals sector
- Mining sector
- Transport sector
- AFOLU sector
- Heavy manufacturing sector
- Buildings and construction sector
- Finance sector
- Integrated power analysis
- Integrated pathway analysis

Socio-economic modelling for a Just Transition

Four key objectives of governance structure

- Enable multi-stakeholder inputs through an inclusive consultation process
- Create a platform for collaboration and alignment on key assumptions and methodology
- Ensure that the final output is fact-based and balanced in its recommendations
- Provide a fact-based business perspective into national consultations and planning processes hosted by government

3. KEY FINDINGS OF THE BUILDINGS AND CONSTRUCTION SECTOR ANALYSIS

10 key findings of the buildings and construction analysis

1. *South Africa's buildings and construction sector needs to be decarbonised and adapted to withstand the physical impacts of climate change. The construction sector must also be decarbonised in a way that unlocks new job opportunities and provides affordable housing and infrastructure development for the growing population.*

2. *South Africa's buildings and construction sector could grow significantly, with building stock increasing by 74%–125% by 2050, driven by the growing population, socio-economic development (e.g., closing the housing and public infrastructure gap) and the needs of parallel sectors transitioning to net-zero (e.g., renewable power and public transportation infrastructure roll-out).*

3. *The increase in buildings and construction demand could significantly increase sector emissions. Today the sector drives ~7% (34 Mt CO_2e) of South Africa's direct emissions, and ~98% of those emissions are from building operations, such as water and space heating, cooling and cooking. Unabated, annual sector emissions could increase by 81%–127% by 2050. The direct emissions from construction are only 0.8 Mt CO_2e but could reach 1.9–3.5 Mt CO_2e by 2050, due to the increased infrastructure demand.*

4. *Decarbonising the buildings and construction sector, while avoiding a growing emissions footprint, requires both demand-side and supply-side levers. A ~10% emissions reduction can be achieved across the value chain through the use of demand-side levers such as spatial planning, building design and material re-use, as these measures can reduce the amount of emissions intensive materials, such as steel and cement, that are used. On the supply-side, ~90% emissions reduction across the value chain is possible through the use of low-carbon materials, efficiency improvements, fuel switching (largely electrification), and switching to renewable power on both buildings operations and construction, resulting in net-zero operational emissions.*

5. *By designing our buildings more efficiently, it is possible to reduce steel and cement demand by 13% and 28% respectively, without impacting what is built. Efficient spatial planning and building design, e.g., densifying and reducing the average home size, can further reduce material demand, proportionally to reductions in building unit size. Spatial planning is also a critical lever for national decarbonisation – densifying cities can help decarbonise the transport sector by reducing travel distances and enabling public transport.*

6 *Two supply-side levers to drive decarbonisation of building operations: are improving operational efficiency and moving to greater levels of electrification. These levers can help reduce emissions by 38% and 29% respectively. The two key levers for decarbonising construction are: improving on-site efficiencies and electrifying stationary machinery and transport equipment and powering them with renewable power. This has the potential to reduce emissions by ~42% and ~58% respectively on construction sites.*

7 *Retrofitting existing buildings is a key priority – existing building stock could contribute more than 40% of 2050 emissions if unaddressed and represents 60%–65% of the cost of decarbonising the sector. It is more challenging to systematically abate emissions from existing buildings than it is to abate emissions from new builds because new building efficiency standards cannot be applied post the building design phase. Retrofitting existing buildings is still a valuable and critical process to reduce emissions, to reduce building operating costs, and to create jobs. Retrofitting could, for example, reduce existing household energy spending by ~50% and is estimated to be twice as labour intensive as new construction.*

8 *Decarbonising the buildings and construction sector could cost ZAR 263–ZAR 285 bn by 2050. ZAR 50–ZAR 60 bn is needed to decarbonise construction sites, ~ZAR 170 bn to retrofit the existing buildings, and ZAR 43–ZAR 55 bn to decarbonise new buildings and infrastructure. Efficient building design is a crucial driver of the cost, as reducing the size of the average home by 33% halves the cost of greening the sector and frees up capital to accelerate the delivery of adequate housing and infrastructure for all South Africans.*

9 *The main socio-economic opportunity lies in job creation: the buildings and construction sector is a significant contributor to the South African economy, driving 1.1 M direct jobs today. The increase in construction demand could potentially create 0.8–1.4 M new jobs by 2050, and energy efficient RDP houses can limit energy demand for space heating and cooling. The extent to which the RDP model is the most feasible and sustainable model to provide low cost housing needs to be reassessed. The price of cement could double in a decarbonisation scenario and result in a 10% increase in cost for an RDP house. The RDP model is also not aligned with the concept of urban densification, and results in the development of less efficient transport systems. We must find better design solutions to address the low-cost housing gap in South Africa and support a Just Transition.*

10 *Decarbonising the operational emissions from both construction and buildings is technically feasible, and the necessary financial and regulatory enablers are in development. Building efficiency standards must be more stringent and extended to existing buildings to accelerate adoption. Building plans and material approval processes must be revised, driving efficiency and usage of low-carbon alternatives. New city planning and building design approaches are needed to achieve the necessary density and zoning for efficient cities. Construction companies need to develop carbon efficiency metrics and electrified equipment to enable on-site decarbonisation.*

3.1 SCOPE AND APPROACH OF THE BUILDINGS AND CONSTRUCTION SECTOR ANALYSIS

South Africa's buildings and construction sector needs to be decarbonised and adapted to withstand the physical impacts of climate change. The construction sector must also be decarbonised in a way that unlocks new job opportunities and provides affordable housing and infrastructure development for the growing population.

South Africa is faced with multiple and overlapping infrastructure challenges today. These challenges include: an inadequate, carbon intensive transportation network with poor road, rail and port infrastructure; aging and insufficient power infrastructure; and inadequate and insufficient housing for a large segment of the population. These deficits need to be overcome to enable and drive economic and social development.

South Africa is also challenged by the physical impacts of climate change. Increasingly frequent extreme weather events are expected to pose a considerable threat to physical infrastructure and people.

Therefore, going forward, the South African buildings and construction sector will need to meet the country's growing demand for adequate, affordable, climate-resilient infrastructure for a growing population and economy. However, this needs to be done in a way which does not further increase the sector's emissions, but rather goes together with the sector's decarbonisation.

This analysis aims to create a fact-based view of how decarbonisation of the buildings and construction sector can be achieved, the socio-economic risks managed, new economic opportunities unlocked, and a Just Transition supported.

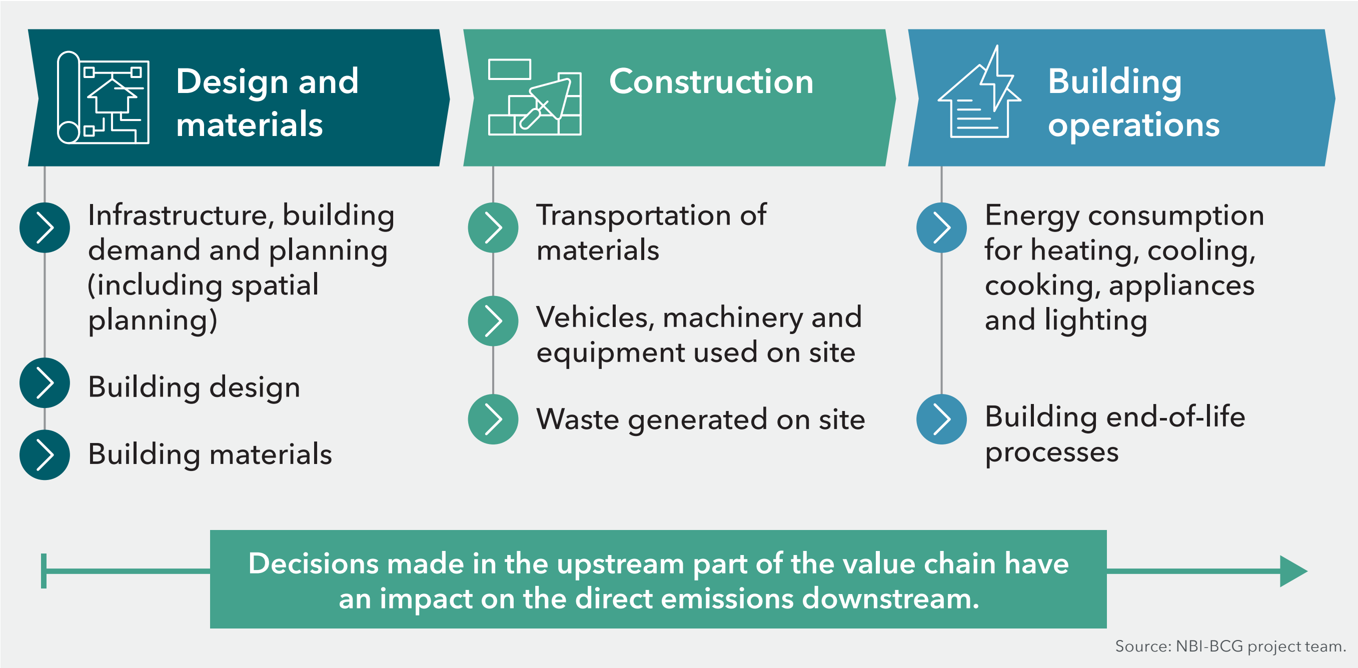
To address this, the buildings and construction analysis aims to answer six key questions:

1. What is the sector's present emissions footprint and socio-economic contribution in South Africa?
2. What challenges does the threat of climate change present to the sector in future?
3. What demand for local infrastructure developments will the sector need to meet?
4. What are the net-zero pathways for the buildings and construction sector, and how much will this cost?
5. What are the broader socio-economic and Just Transition risks and opportunities of decarbonising the buildings and construction sector?
6. What are the key enablers and no-regret actions to realise the net-zero pathway for the buildings and construction sector?

This analysis covers the full buildings and construction value chain: 1) Design and materials; 2) Construction; and 3) Buildings operations (Figure 4). Decarbonisation of building materials is covered in greater detail in the heavy manufacturing sector analysis. Throughout the assessment, a range of stakeholders along the value chain have been engaged, including construction companies, industry associations, civil society, academia, and broader local and international sector experts. These parties have been engaged in technical workshops and individual engagement sessions, with the opportunity to review, evaluate and discuss the assumptions and analysis.


Photo: Shutterstock.com

Figure 4: The sector analysis covers the entire buildings and construction value chain



3.2 TOWARDS A NET-ZERO BUILDINGS AND CONSTRUCTION SECTOR IN SOUTH AFRICA

3.2.1 SOUTH AFRICA'S BUILDINGS AND CONSTRUCTION SECTOR TODAY

The South African buildings and construction sector contributes significantly to both jobs and GDP, as well as to overall GHG emissions, and is therefore vulnerable to transition risk as the economy moves to decarbonise to net-zero by 2050. As with decarbonising the transport sector, the successful implementation of a decarbonisation pathway for the buildings and construction sector is closely linked to, and relies on the decarbonisation of, other sectors, such as power and heavy manufacturing (steel, cement and aluminium).

There are added needs to ensure that infrastructure and buildings are resilient to the impacts of climate change and that adaptation measures are undertaken alongside decarbonisation.

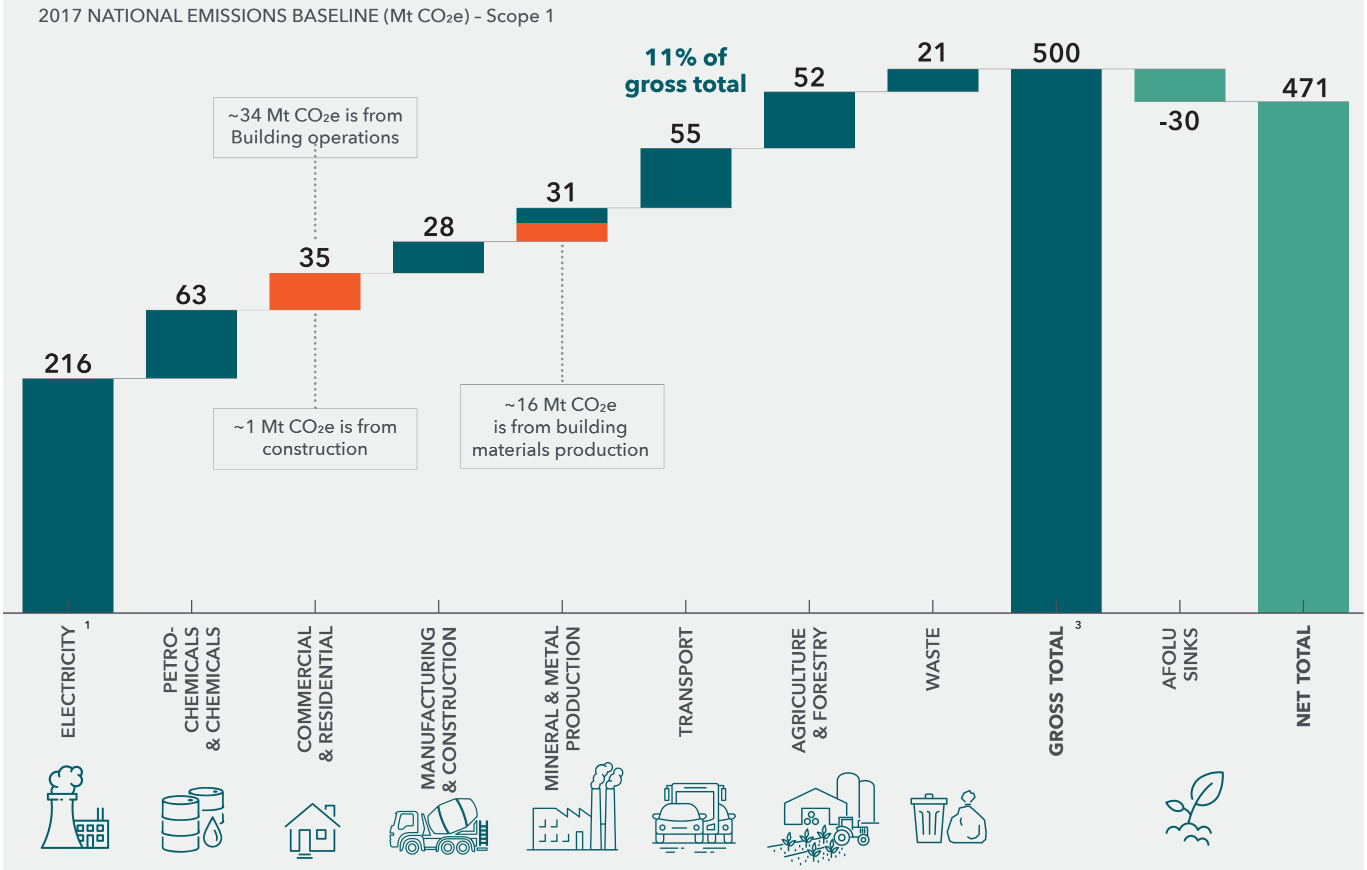
Finally, there is opportunity for the implementation of this pathway to contribute to job creation, in order to meet increasing demands for infrastructure and housing between now and 2050.

The following sections unpack the current sector context and starting point for the decarbonisation pathway proposed. We also highlight the various decarbonisation methods available and reflect on the need to consider adaptation measures for the sector going forward.

The sector's jobs and GDP contribution is mainly driven by construction. The buildings and construction sector directly employs ~1.2 M people. With ~1.1 M direct jobs (2021), the construction sector is the fifth largest direct employment sector, driving on average 2%–3% of national GDP (2014–2019). Around 63% of construction workers work in the formal construction sector, for example, as employees in construction companies. Around 37% of workers are employed in the informal construction sector. This typically refers to self-employment or micro-enterprises owned by individual household members. Challenges faced by individuals and SMMEs in the informal construction sector include that they may be relying on limited skill sets, have long working hours, have highly irregular incomes, have limited or no access to employee benefits, and have very limited access to finance for scale or development. People working in informal construction are often without any social protection, meaning that they do not have sources of extra income, for example, in case of an accident or a sudden end of their current project. A Just Transition in this sector would need to pay close attention to how workers in both the formal and informal sectors are considered if we are to realise the goal of achieving decent work for all and sustainable and inclusive development.

Construction drives the demand for locally produced building materials, such as steel, cement, aluminium, glass, brick mortar, wood, and insulation materials. For example,

Figure 5: Buildings and construction sector contributes 7% (35 Mt CO_2e) to South African direct emissions – with an additional 16 Mt CO_2e linked to building materials production



Note: 1 Emission figures based on view of Electricity & Heat Production of which electricity production contributes >97% of emissions.
2 National Greenhouse Gas Inventory (GHGI) Report does not explicitly state estimate for mining emissions, so this has been estimated. Assumed Scope 1 emissions share of top 12 companies is the same as their market share (80%) and used this to gross up to 100%. To be validated with CDP data.
3 Gross total excludes categories 1A5 as it is not linked to any sectors and 1B1 to avoid the double-counting of fugitive emissions from coal mining which are included in the mining sector emissions approximation. Agriculture emissions: Agriculture (~47 Mt, labelled as 'FOLU excl. AFOLU' in GHGI) + energy emissions in Agriculture/Forestry/Fishing (~4Mt). AFOLU sinks: FOLU (labelled as 'Land' in GHGI) + Other ('harvested wood products').

Source: GHGI (2017); IEA (2015); WEO (2019); CDP (2015); GHGI (2015); CAT.

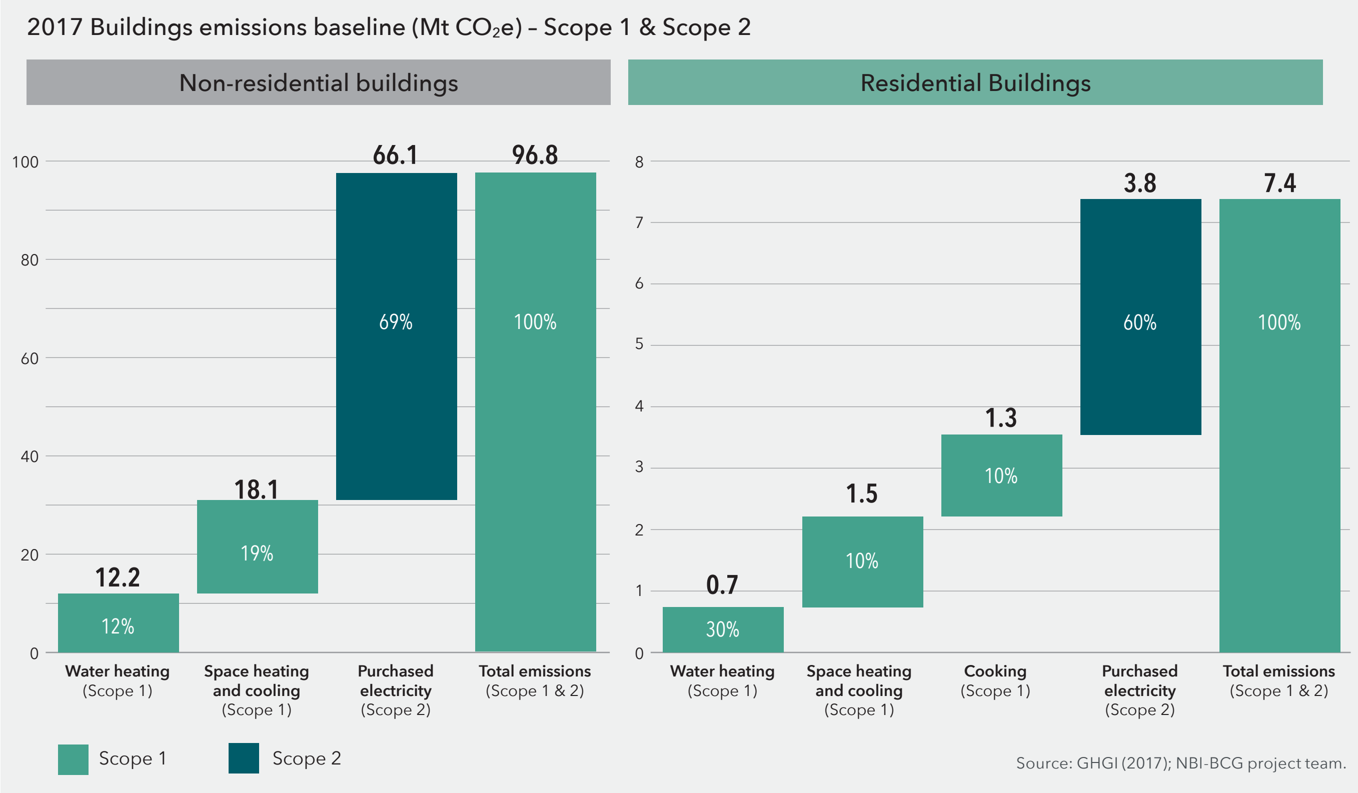
more than 90%, around 50%, and around 24% of locally produced cement, steel and aluminium respectively are used in the South African construction sector. Production of those materials drives an additional ~176 k jobs (2014–2019). The overall construction ecosystem, including the production of building materials, drives ~8% of the national GDP.[15]

The buildings sub-sector has a significantly smaller job and GDP contribution than construction – with significant shortfalls in the residential built environment. The buildings sector drives ~156 k direct jobs in building operations and maintenance, and on average drives less than 0.5% of national GDP (2014–2019).[16] Today, the residential built environment in South Africa is not meeting the demand for affordable and adequate housing for a large part of the population. As of 2017, 12.1%[17] of South Africa's population lives without adequate housing,[18] such as in informal settlements without proper access to utilities, such as water or sanitation.

The buildings and construction sector contributes 7% (35 Mt CO_2e) to South Africa's annual direct emissions. Buildings drive more than 97% (~34 Mt CO_2e) of the sector's direct emissions, with ~30 Mt CO_2e from non-residential buildings (commercial, public and institutional buildings) and only ~4 Mt CO_2e from residential households. In the non-residential sector, direct emissions come from the combustion of liquid fuels (mainly from sub-bituminous coal, followed by residual fuel oil and

15 Quantec. 2022.
16 Quantec. 2022.
17 Stats SA General Household Survey. 2021.
18 Stats SA General Household Survey. 2020.

Figure 6: The majority of the buildings' operational emissions are from purchased electricity followed by water heating, space heating and cooling, and cooking



Source: GHGI (2017); NBI-BCG project team.

gas/diesel oil) primarily for space and water heating and cooling purposes. Direct emissions in the residential sector result from the combustion, sub-bituminous coal, liquefied petroleum gas (LPG) and other kerosene, mainly for space and water heating and cooking[19] (Figure 6).

The buildings and construction sector is also a major power consumer. It drives ~34% of South Africa's power demand and is therefore indirectly responsible for around 70 Mt CO_2e per annum of power use. Emissions linked to the use of power, make up ~69% and ~52% of non-residential and residential building emissions, respectively, when considering both direct Scope 1 emissions from fuel combustion and indirect Scope 2 emissions from the purchased power. Hence, power use is today the largest driver of total Scope 1 and 2 emissions in the South African building and construction space. This carbon intensive use can be attributed to, for example, heating in the winter seasons and cooling in the summer season. Households in South Africa are not insulated in the same manner as those in the global north. This carbon intensive use can be attributed to, for example, heating in the winter seasons and cooling in the summer season. Thermally efficient housing is a key element to dwelling energy consumption and household income is strongly linked to the electricity emissions footprint of the household.

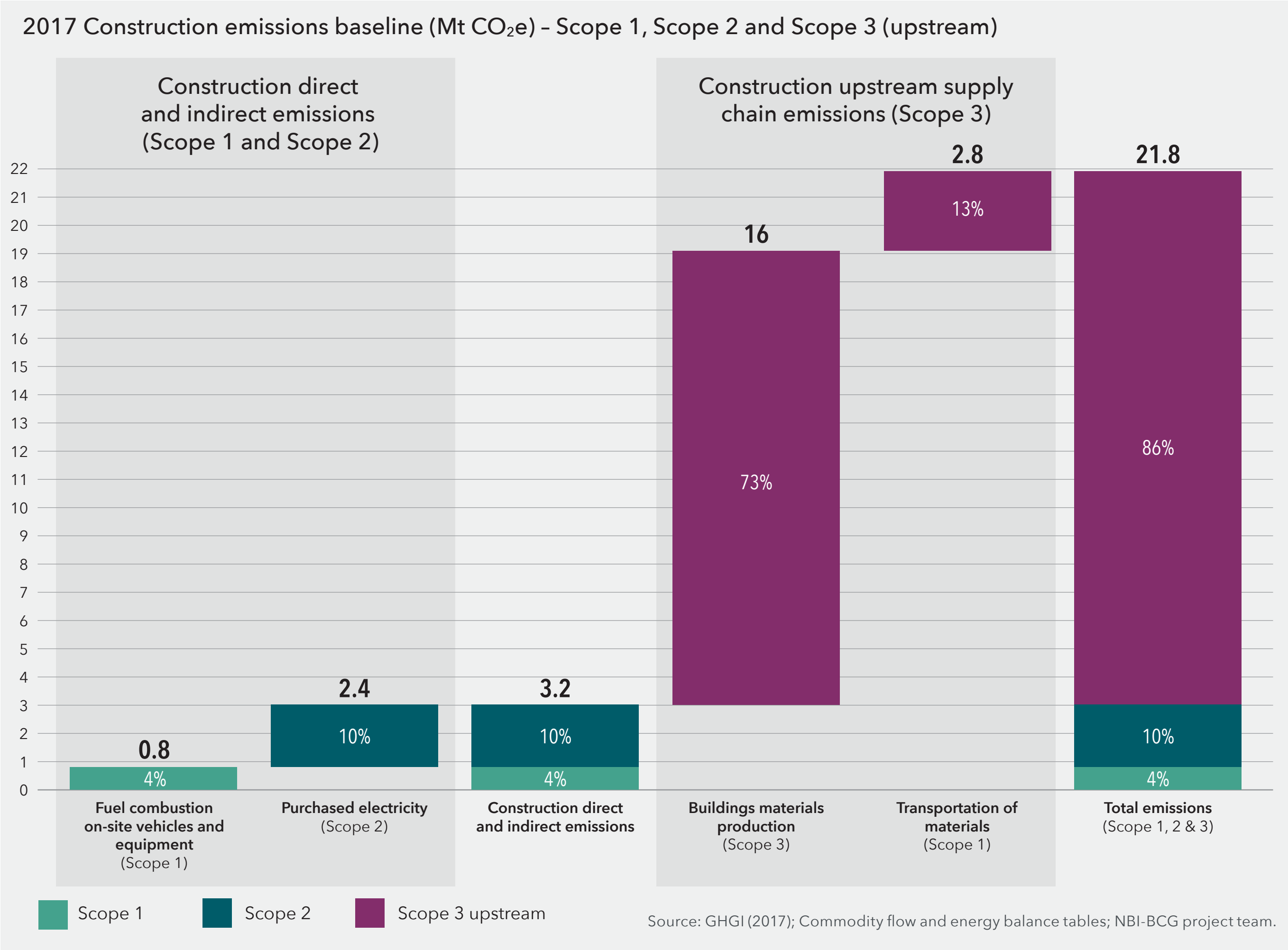
Compared to global averages, South Africa has high operational building emissions per capita (22% higher than global averages). The usage of more carbon-intensive electricity mainly drives this in the middle- and high-income households (which are responsible for ~98% of building operational emissions from electricity). However, whilst the global building emissions per capita have increased on average (+1.82% in the period 2014–2019), South African building emissions per capita have decreased by -1.4% (2014–2019).[20] This has also been partly driven by the effectiveness of new building sustainability standards, such as SANS 10400X/XA.[21]

19 Based on Department of Forestry, Fisheries and the Environment. 2021. *The South African 7th National Greenhouse Gas Inventory Report 2017.*
20 Based on South Africa Climate Transparency Report. 2020.
21 SANS10400 governs SA building standards, with recent updates to regulate environmental sustainability (X) and energy usage in buildings (XA).

In South Africa's residential sector, household income is strongly linked to the electricity emissions footprint of the household. Given the significant difference in electricity-consumption profiles across different income groups: middle-income household electricity emissions are approximately 10 times that of low-income household emissions; and high-income household electricity-use related emissions are 33 times that of low-income household emissions. Only 2% of the overall residential electricity emissions are from low-income households, whereas 34% are from high-income households, and 63% are from middle-income households.[22] This highlights the high levels of inequality in South Africa and suggests that energy efficiency measures need to be implemented in high- and middle-income households alongside measures to address these inequalities.

While Scope 1 and Scope 2 emissions are higher in the buildings sector, Scope 2 and 3 emissions make up the bulk of emissions in the construction sector. The current direct emissions from construction are only ~0.8 Mt CO_2e, driven by the usage of fossil fuel-powered vehicles and machinery. Emissions from purchased electricity are estimated at ~2.2 Mt CO_2e. However, construction has indirect emissions from the upstream supply chain: ~16 Mt CO_2e of indirect emissions from buildings material production (largely steel, cement and glass,[23] see Figure 7), representing ~73% of construction emissions, and the indirect emissions from transportation of materials (2.8 Mt CO_2e, or ~13% of construction emissions, see Figure 7).

Figure 7: 73% of the construction emissions are from carbon embedded in materials, followed by transportation and on-site fuel combustion



Source: GHGI (2017); Commodity flow and energy balance tables; NBI-BCG project team.

22 Based on 'Estimating greenhouse gas emissions associated with achieving universal access to electricity for all households in South Africa'. *Journal of Energy in Southern Africa*. 2021. The study categorises annual household income levels (adjusted for inflation to 2022 Rands) as low (<22 300), medium (22 300–89 200) and high (>89 200).

23 Scope 3 emissions estimated using the total local consumption (locally produced and imported) with a typical Scope 1 & Scope 2 ratio to Scope 3. This analysis is indicative and seeks to show that decisions in buildings and construction value chain have a significant impact on the total emissions, even though it may not directly impact its Scope 1 emissions.

3.2.2 IMPACT OF CLIMATE CHANGE ON THE BUILDINGS AND CONSTRUCTION SECTOR IN SOUTH AFRICA

The buildings and construction sector will need to adapt to the increasing physical risks of climate change. South Africa is amongst the countries at greatest physical risk from climate change (See side box). As a result of more extreme weather and climate events, infrastructure and livelihoods across the country will be at increasing risk. The recent devasting floods in KwaZulu-Natal in April 2022 serve as a harsh reminder of the potential risks of climate change and the need to build for resilience.[24] More than 400 people lost their lives as a result of the flooding, and thousands of people were left homeless, and an estimated R25 billion in infrastructure was damaged in the floods.[25] Climate change impacts may vary by location, but adaptation measures will likely be required across the country. (See side box *Physical risk of climate change* overleaf). The impacts of the Kwazulu-Natal floods were also exacerbated by the July 2021 riots. This further emphasises the need for a Just Transition that ensures socio-economic stability through increased employment, reduced poverty and inequality, with resilient infrastructure.

South Africa needs to adapt its existing buildings and infrastructure to withstand localised impacts of climate change, pre-emptively improve response mechanisms to natural disasters, and plan future urban expansions to minimise their vulnerability to climate change. These are expanded in Figure 8 below.

Figure 8: Three dimensions of climate adaptation needed for South Africa's buildings and construction sector

Improve infrastructure and building design

- Climate change will **increase the frequency of extreme weather events** e.g., storms, floods.
- **Construction methodologies must be adapted to increase climate resilience** of buildings and infrastructure.
- Necessary measures will include **improved structural integrity and drainage, new building materials and passive designs** to minimise energy demand.

Monitor and increase readiness to response

- Develop more **effective information, monitoring and assessment tools** to evaluate resilience of infrastructure to climate change.
- Educate rural, small-scale farmers about climate change risks and **empower local communities to design and action adaptation strategies**.
- Prioritise the **most vulnerable infrastructure and communities** when building climate resiliency.

Adopt a risk-based approach for future planning

- Potential **impacts of sea-level rise and extreme weather events** must be considered in infrastructure development.
- Provincial and municipal plans must account for the increasing number of people migrating to **high-risk coastal areas**.
- **Location selection** will be critical in avoiding the worst impacts of climate change.

Source: NBI-BCG project team.

24 Precisely quantifying the direct influence of climate change on the extreme rainfall is challenging due to a lack of comprehensive historical rainfall records.
25 'As KZN emerges from the devastation of recent floods, more adverse weather is on the way' (*News24*, May 29, 2022).

Photo: Shutterstock.com

The physical risk of climate change in South Africa

South Africa is already a semi-arid country, and because of its geographical positioning, the country is set to experience twice the global average rate of warming. This means that, for example, a global average temperature increase of 1.5 °C above pre-industrial levels will translates to an average 3 °C increase for South Africa. This will have an extreme effect on South Africa's rainfall variability, water availability, biodiversity, agriculture, sector processes, and human health and well-being.

Climate impacts on biodiversity, water availability, and agriculture

Climate science illustrates that the eastern half of South Africa is highly likely to experience a decrease in rainfall, resulting in more frequent droughts, while the western half of the country could see greater variability in rainfall patterns, resulting in the increased risk of more severe weather events and flooding in the medium-term, before also trending towards greater aridity in the long-term. This, together with average temperature increases, will shift biome distribution, resulting in land degradation and erosion. The two most notable risks are: (1) the likely degradation of the grassland biome, essential for the health of South Africa's water catchments, further reducing water availability; and (2) the impact of temperature increases and reduced rainfall on agriculture. These factors limit the ability of crops and livestock to survive and reproduce, and increase their exposure to a wider variety of pests that can thrive in warmer conditions.

The impacts of climate change on human health

Rising ambient temperatures due to climate change result in what is called 'the urban heat effect' – the phenomenon where urban areas have a higher ambient temperature than landscapes with greater volumes of vegetation. This is because buildings, paving and other surfaces, retain heat for longer periods of time. The urban heat effect compounds the temperature increases in densely populated areas and threatens the health of people, particularly those living in cramped urban conditions and engaging in hard manual labour (such as construction, for example).

Limiting global climate change and adapting to inevitable changes in the local climate will be critical to limiting the impact of direct, physical risks to South Africa.

The impact of climate change on settlements will vary by location. More than 67% of South Africa's population lives in urban areas, which are expanding rapidly. These urban areas face several climate change challenges. First, climate change can exacerbate the problems caused by poor management or urban sprawl, for example, storms made more destructive by poor water drainage systems. Second, as urbanisation has increased without adequate city planning or infrastructure expansion, so too has the number of people living in informal settlements. Informal settlements are particularly vulnerable to floods and fires, typically being poorly located and using inferior building materials, with inadequate support infrastructure, for example, emergency services access in the case of a natural disaster.

Around 33% of South Africans live in rural areas, ~80% of which are commercial farming areas with lower population densities, and 20% are former 'homelands'.[26] These 'homelands' are often densely populated, poorer regions with small-scale and homestead food production and reliance on social welfare for their livelihoods. Many rural communities are likely to experience more frequent flooding and water contamination, like in KwaZulu-Natal, or more droughts, like in like in the Western Cape and Eastern Cape. Municipalities here are typically under-resourced to adapt to changing conditions. Rural areas are also often under-represented in climate network monitoring, despite likely being most significantly impacted.

Three recent examples illustrating the risk of the loss and damage of lives, livelihoods, and property in urban areas as a result of weather-related natural disasters are:

1. The 2016–2018 drought in the Western Cape
2. The floods in KwaZulu-Natal in 2022
3. The floods in the rural areas of Port St. Johns in 2023.

Increasing sea levels are also a significant threat to around 40% of South African people, including several major metros and numerous towns located along the coastline. Increased flooding, coastal erosion and storms can severely impact the coastal infrastructure.

26 World Bank. 2022.

3.2.3 PRESENT AND FUTURE DRIVERS OF BUILDINGS AND CONSTRUCTION DEMAND IN SOUTH AFRICA

South Africa's buildings and construction sector could grow significantly, with building stock increasing by 74%–125% by 2050, driven by the growing population, socio-economic development (e.g., closing the housing and public infrastructure gap) and the needs of parallel sectors transitioning to net-zero (e.g., renewable power and public transportation infrastructure roll-out).

New construction is driven by demand for two types of infrastructure: residential and non-residential. Residential covers different kinds of housing, for example, apartment complexes and low-cost housing, while non-residential includes, for example, commercial and industrial sites, roads, bridges, power infrastructure, and public buildings and infrastructure. New construction is driven by the growing population, economic development, the economy-wide transitioning to net-zero, and the need to close the existing housing and infrastructure shortfalls (Figure 9).

Two book-end scenarios are considered with regards to the demand for buildings and construction: low demand and high demand.

The low demand scenario assumes that South Africa continues with its current growth trajectory without solving any of the historic shortfalls of the sector. Residential demand, in terms of number of dwellings, is predicted from current occupancy rates (people per dwelling) and population growth, and non-residential by extrapolating current economic development and construction output trends.

The high demand scenario assumes faster recovery post-2020 and moves towards a Just Transition by solving the housing shortfall of 2.1 million dwellings while meeting the additional demand for housing by a growing population. Residential demand, in terms of number of dwellings, is estimated based on assumptions around population growth, while the occupancy rate is projected from the relationship between GDP per capita and occupancy rate, and GDP per capita forecasts for South Africa. As individual wealth grows, occupancy rates typically reduce as more citizens can afford their own (or multiple) homes. The high demand scenario also assumes expansion of the non-residential sector as other key sectors like power and transportation are transformed towards net-zero.

This would translate into ZAR 2.8 tn,[27] and ZAR 300 bn[28] construction spending in renewable power and rail infrastructure, respectively, by 2050.

In this high-demand scenario, the non-residential growth would be double compared to the low demand scenario (Compound Annual Growth Rate [CAGR] 2.1% vs 4.3% 2022–2030; and 3.0% vs 6.0% 2030–2050 for the low and high demand scenarios, respectively). The realised trajectory will depend on economic recovery (funding the construction) and the implementation of key projects (such as filling the housing gap, the roll-out of renewables, and the expansion of rail infrastructure). A more detailed description of the modelling approach is presented in Figure 19 in the appendix.

The increase in buildings and construction demand could significantly increase sector emissions. Today the buildings and construction sector drives ~7% (34 Mt CO_2e) of South Africa's direct emissions, and~98% of those emissions are from building operations, such as water and space heating, cooling and cooking. Unabated, annual sector emissions could increase by 81%–127% by 2050. The direct emissions from construction are only 0.8 Mt CO_2e but could reach 1.9–3.5 Mt CO_2e by 2050, driven by the increased infrastructure demand.

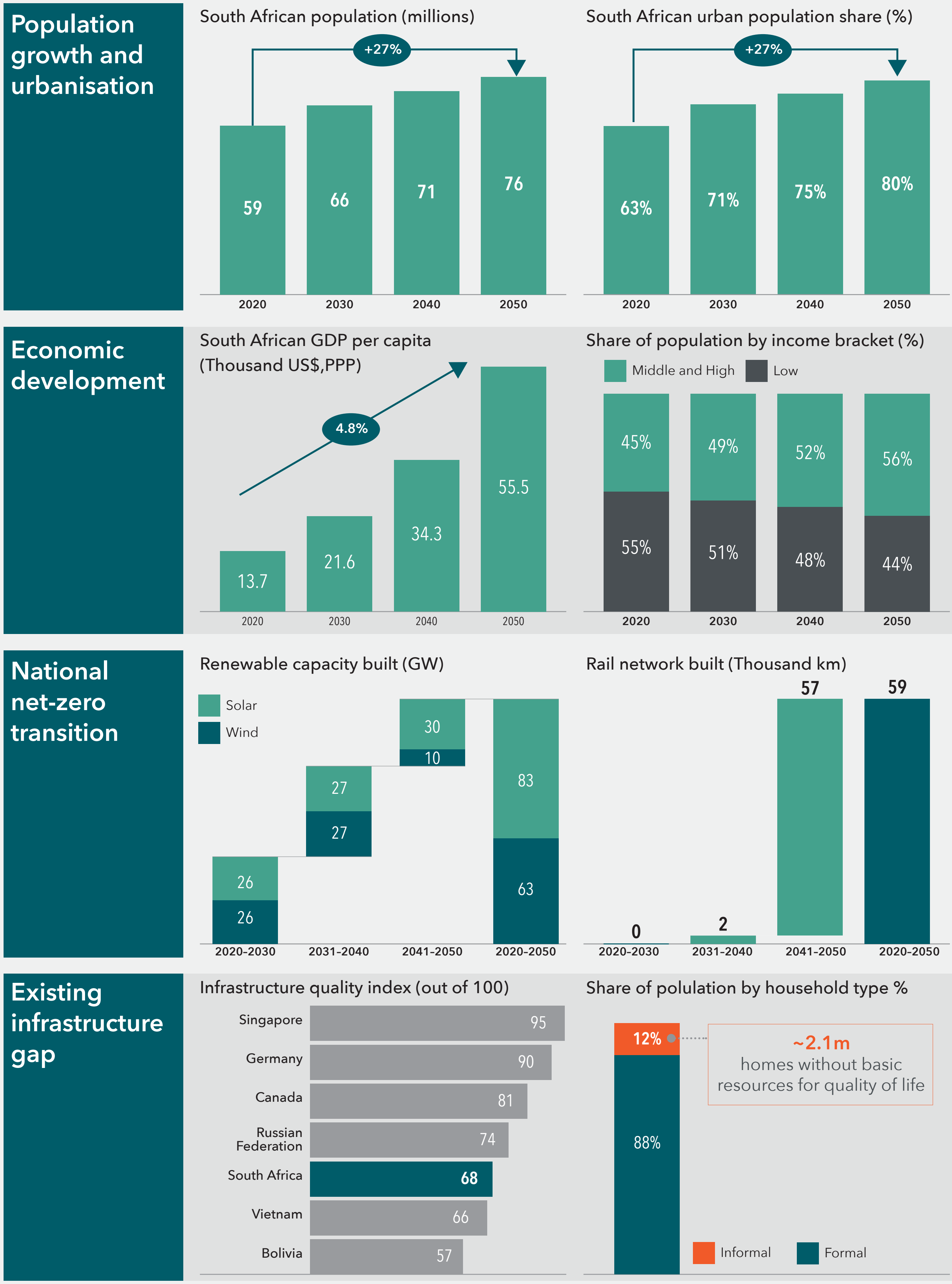
The future demand scenarios are used to determine the magnitude of mitigation required in the context of a growing sector. These demand projections assume business continues as usual in the sector, without any decarbonisation levers implemented, and provide a view of how the sector's emissions could grow by 2050, if the sector does not transition.

Overall, this would translate into 81%–127% growth in the building and infrastructure stock, resulting in 4.6–5.1 Gt CO_2e cumulative Scope 1 and Scope 2 emissions by 2050, if South Africa continues to build as it does today (Figure 10). This would mean a total 203–255 Mt CO_2e annual emissions from the sector by 2050, including construction emissions growing from 0.8 Mt CO_2e p.a. to 1.9–3.5 Mt CO_2e p.a. to meet the increasing construction demand. Approximately 68% of the emissions are Scope 2 from consumption of grid power. Even if decarbonised grid power becomes available, the slow grid decarbonisation pathway and residual Scope 1 emissions could result in 2.0–2.6 Gt CO_2e of cumulative buildings and construction emissions in 2050. Even if the grid were decarbonised, the Scope 1 emissions would be 66–82 Mt CO_2e by 2050 in a do-

27 NBI-BCG power analysis.

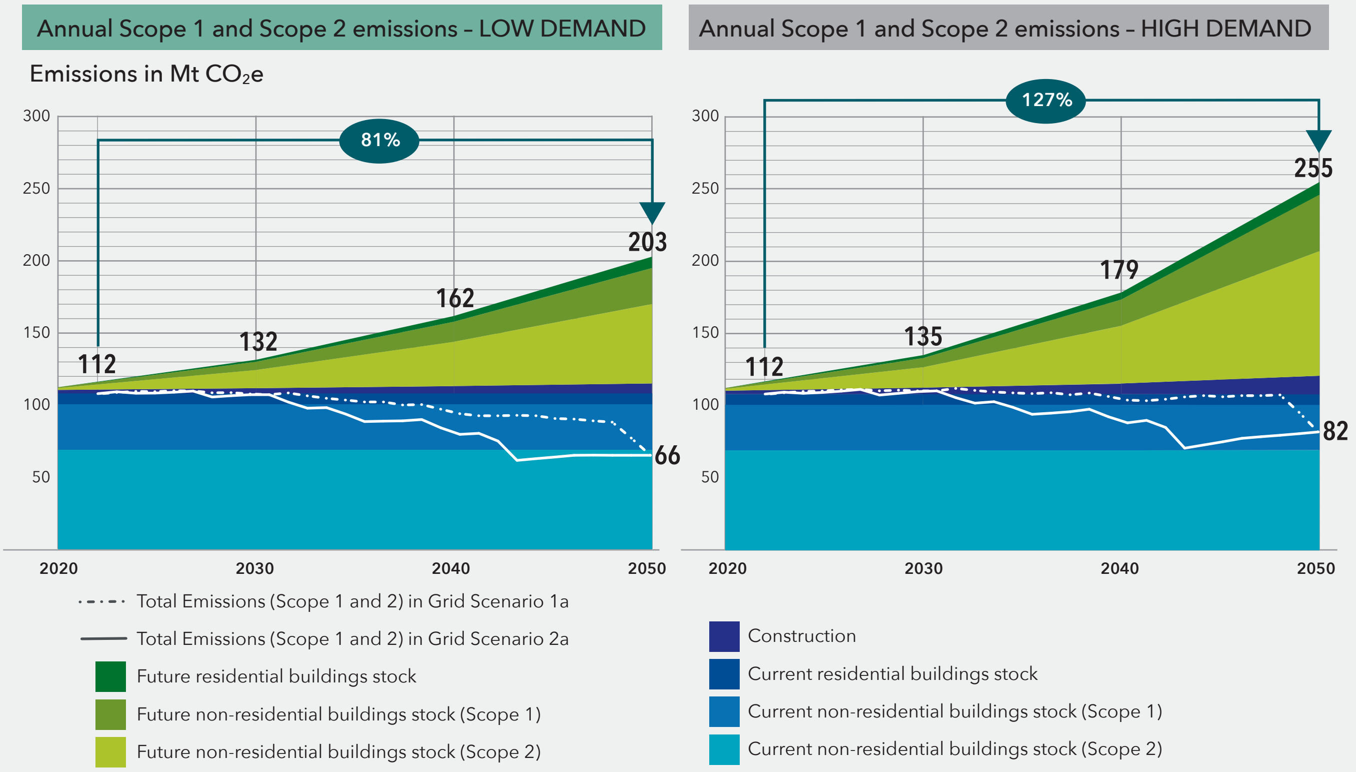
28 NBI-BCG transport analysis.

Figure 9: Key trends driving South African construction demand



Source: Parliamentary Monitoring Group; Economist Intelligence Unit (EIU); WEF Global Competitiveness Report; Stats SA General Household Survey (2020); NBI-BCG previous sector analyses (AFOLU, Power, Transport).

Figure 10: In a do-nothing scenario, annual buildings and construction emissions could increase by 81%–127% by 2050



Note: Future stock denotes built from 2023 onwards, current stock denotes buildings that exist in 2022.
Grid Scenario 1a – lower emission pathway, Grid Scenario 2a – Integrated Resource Plan (IRP) power pathway (both from power sector analysis).

Source: NBI-BCG project team.

nothing scenario. Approximately 96% of the emissions are driven by emissions from the building operations. Despite the growth in construction, ~44%–56% of the emissions by 2050 will be from operating the currently existing building stock. Thus, going forward, it is not only essential to build net-zero ready buildings but also to retrofit the existing building stock.

Whilst construction companies have limited control over embedded carbon in materials, the emissions footprint from the materials can be significant. Continuing to build with the current design, materials and techniques could add 2.2–3.1 Gt CO_2e to cumulative emissions by 2050 (20%–39% of South Africa's fair share carbon budget[29]). The bulk of these emissions are expected to come from steel and cement, as the most extensively used and highest-emitting materials used in construction (along with glass and plastic, but those have a significantly smaller emissions footprint).

Unabated emissions could be even higher due to economic development and a higher share of the middle-class population in a developing South Africa. Currently, the poorest 55% of the population contributes just 2% of sector emissions. Middle- and high-income homes are 10–33x more carbon-intensive than low-income homes.[30] If the growing affluent classes maintain their carbon-intensive lifestyles, emissions could increase significantly as South Africa develops towards a more equal future with a growing middle class.

The key takeaway from these do-nothing demand projections is that buildings and construction emissions could increase significantly (+81%–127% by 2050) if decarbonisation is not pursued. However, the drivers of this increase – building more and better homes, increasing access to and modernising infrastructure, and decarbonising the whole economy – which requires large-scale infrastructure projects – will be critical steps in the overall national development and in ensuring a Just Transition. Consequently, it will be critical to drive decarbonisation of the buildings and construction sector to avoid a significantly growing emissions footprint in this sector.

29 Assuming South Africa's 8–11 Gt CO_2e carbon budget to 2050.

30 Estimating greenhouse gas emissions associated with achieving universal access to electricity for all households in South Africa, *Journal of Energy in Southern Africa*. 2012.

3.2.4 A NET-ZERO PATHWAY FOR THE BUILDINGS AND CONSTRUCTION VALUE CHAIN

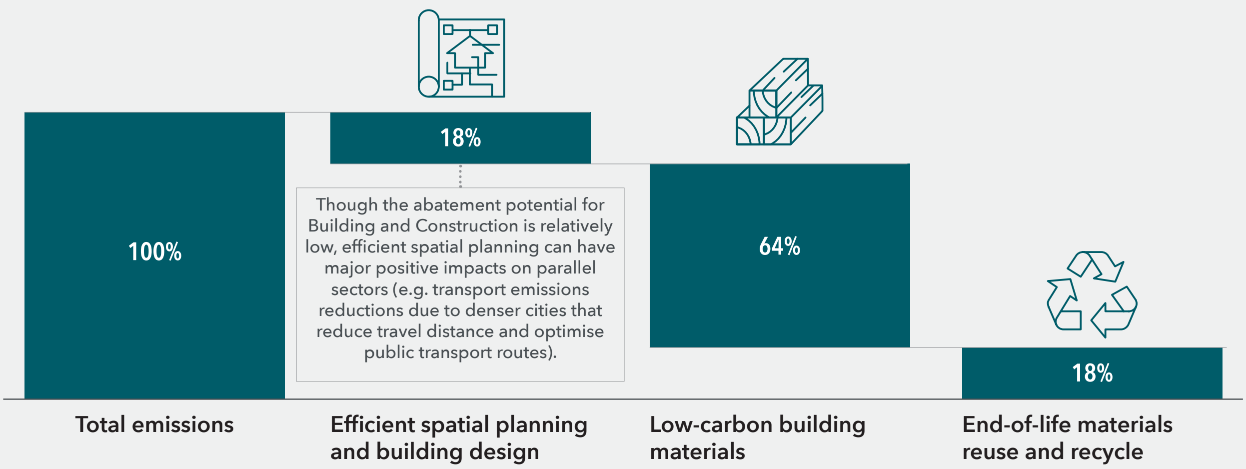
Decarbonising the buildings and construction sector, while avoiding a growing emissions footprint, requires both demand-side and supply-side levers. A ~10% emissions reduction can be achieved across the value chain through the use of demand-side levers such as spatial planning, building design and material re-use, as these measures can reduce the amount of emissions intensive materials, such as steel and cement, that are used. On the supply-side, ~90% emissions reduction across the value chain is possible through the use of low-carbon materials, efficiency improvements, fuel switching (largely electrification), and switching to renewable power on both buildings operations and construction, resulting in net-zero operational emissions.

To reach a net-zero buildings and construction sector, decarbonisation levers need to be deployed across the full value chain.

Decarbonising design and materials

Decarbonising building materials is the key lever for design and materials, and could reduce emissions in this building value chain by ~64%, or the total sector emissions by ~18% (Figure 11). Existing critical building materials, like steel and cement, are emissions-intensive and difficult to abate. If cement and steel cannot be decarbonised, novel materials will be needed to achieve fully net-zero buildings. However, there are alternative low-carbon materials currently at various stages of development, including cross-laminated timber (CLT) and alternative types of cement (geopolymer, hemp, lignin, and other substitute cementitious materials (SCMs). Moreover, promising new innovations are being discovered, for example, researchers have piloted a zero-emissions cement using today's technologies differently through virtuous recycling loops, that not only eliminates the emissions of cement production, but also saves raw materials, and even reduces the emissions required in making lime-flux.[31] Whether decarbonising or substituting the materials, maintaining affordability must be a priority for South Africa's development.

Figure 11: Breakdown of potential levers to decarbonise design and material



Efficient spatial planning and building design
- Minimise excessive material use due to overengineering.
- Provide opportunities for optimisation in other value chain stages (district heating/cooling).

Low-carbon building materials
- Replace emissions-intensive materials (cement, steel) with low- or zero-carbon options.
- Choose low-carbon versions of unavoidable materials where available.

End-of-life materials reuse and recycle
- Buildings designed for easy disassembly and maximum reuse of materials.
- Prioritise recycling of material that can't be reused.
- Minimise waste to landfill.

Source: NBI-BCG project team.

31 *Cambridge engineers invent world's first zero emissions cement*. University of Cambridge, 23 May 2022.

Challenges decarbonising steel and cement

Steel and cement can be decarbonised by ~50% and ~40%, respectively, using mature technologies. The remaining emissions depend on the development of more disruptive technologies, like green hydrogen for steel and CCUS[32] for cement. However, the feasibility of CCUS in South Africa is highly uncertain.[33] If cement cannot be decarbonised, it would need to be substituted (or the emissions offset) to achieve a fully net-zero buildings and construction value chain.

> ***By designing our buildings more efficiently, it is possible to reduce steel and cement demand by 13% and 28% respectively, without impacting what is built. Efficient spatial planning and building design, e.g., densifying and reducing the average home size, can further reduce material demand, proportionally to reductions in building unit size. Spatial planning is also a critical lever for national decarbonisation – densifying cities can help decarbonise the transport sector by reducing travel distances and enabling public transport.***

Given the difficulty and uncertainty in abating building materials, the demand-side levers like materials efficiency, spatial planning and efficient building design, are critical. Material efficiency could reduce the need for steel and cement by 13% and 28% respectively, without impacting what is built (e.g., via reducing over-engineering of structural elements). Efficient spatial planning and building design, e.g., densifying and reducing the average home size, can further reduce material demand, proportionally to reductions in building unit size. However, these levers face critical barriers making the implementation challenging, such as the scale of collaboration required (at a metro/city/national planning level), and the lack of social acceptance of living in smaller homes. This further highlights the need for a more complicated shift in consumer behaviour and preference that is embedded in many of the other these sector decarbonisation pathways as well, including in the Agriculture, forestry and land-use (AFOLU) sector analysis, as well as in the transport sector analysis. Finally, the end-of-life material recovery and reuse could be incorporated into building design and used as a demand-side lever, reducing the need for new materials, and thus reducing design and materials emissions by ~18%, or total sector emissions by ~5%. This recovery and reuse includes both steel as well as rubble. Enabling the building recovery and reuse would require major shifts in how buildings are designed, and how demolition sites operate. Increased use of recycled construction material could be unlocked through new innovative methods. This could for example include using rubble for the construction of new roads and pedestrian pathways. This recycling of materials in the buildings and constructions sector can also enable decarbonisation across other sectors.

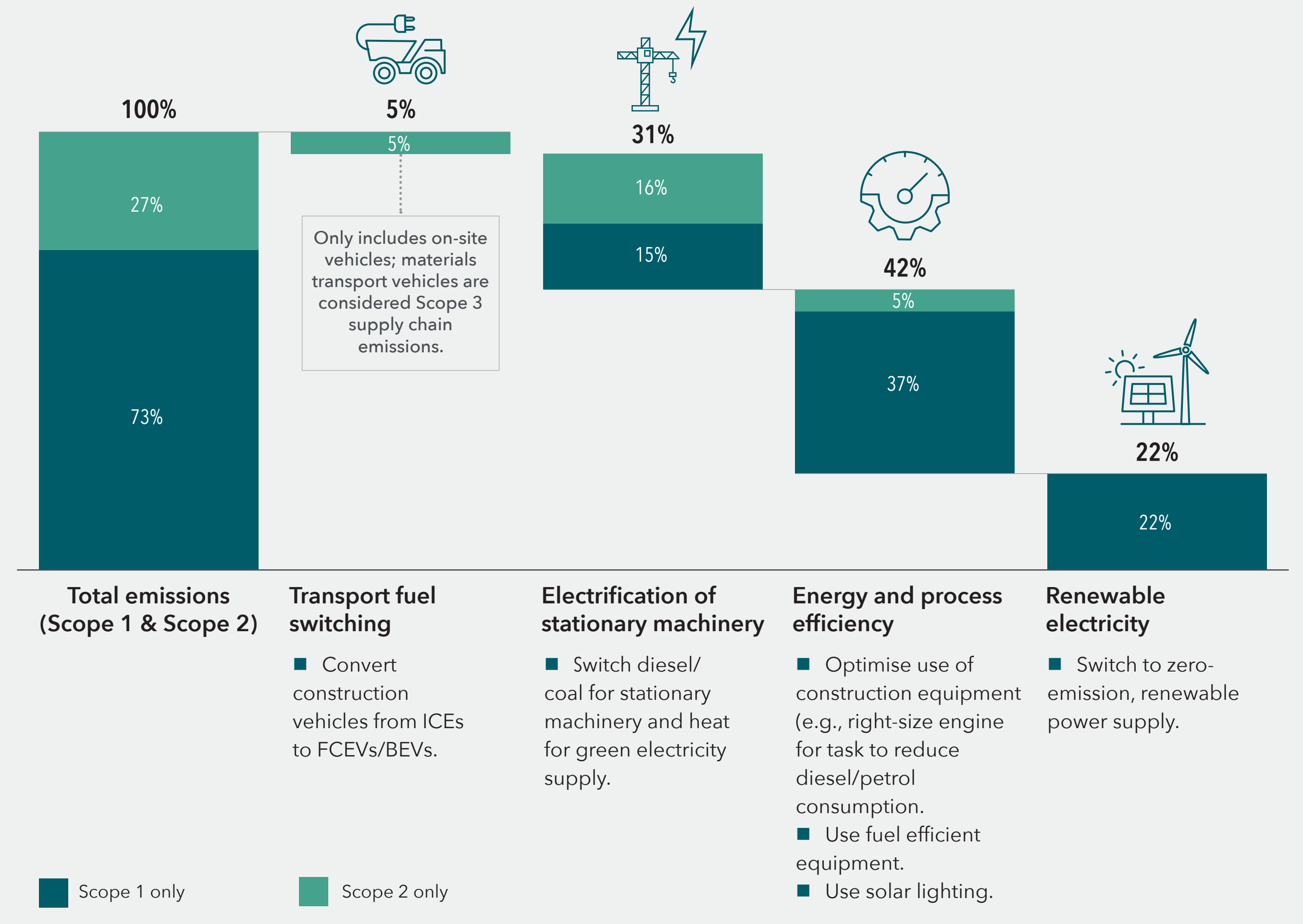
Decarbonising construction

Energy and process efficiency (~42% of construction emissions) and electrification of stationary machinery (~31% of construction emissions) are the key levers to decarbonise construction, with renewable electricity (~22% of construction emissions) as a key enabler (Figure 12). Energy and process efficiency wins come from process optimisation (using the right-sized vehicle or equipment for the job, prefabricating components off-site to avoid excess consumption/transportation). Decarbonising construction, though still prohibitively expensive, is abatable with existing technologies – the first zero-carbon options are currently being piloted globally. Fuel switching for on-site vehicles can abate the remaining ~5%, but electrification of vehicles and machinery present significant financial barriers in the short- to mid-term. Construction companies are hesitant to adopt green options – these options are currently expensive, and unless a proposal stipulates carbon-reduction measures, the added cost would result in contractors being unable to be competitive in tendering. Linked to this is a severe lack of previous performance data – without any examples at scale, the information needed to accurately cost proposals does not exist.

32 Carbon Capture, Utilisation and/or Storage.

33 NBI-BCG heavy manufacturing analysis.

Figure 12: Breakdown of potential levers to decarbonise construction



Source: NBI-BCG project team.

Critical contribution of spatial planning to national decarbonisation

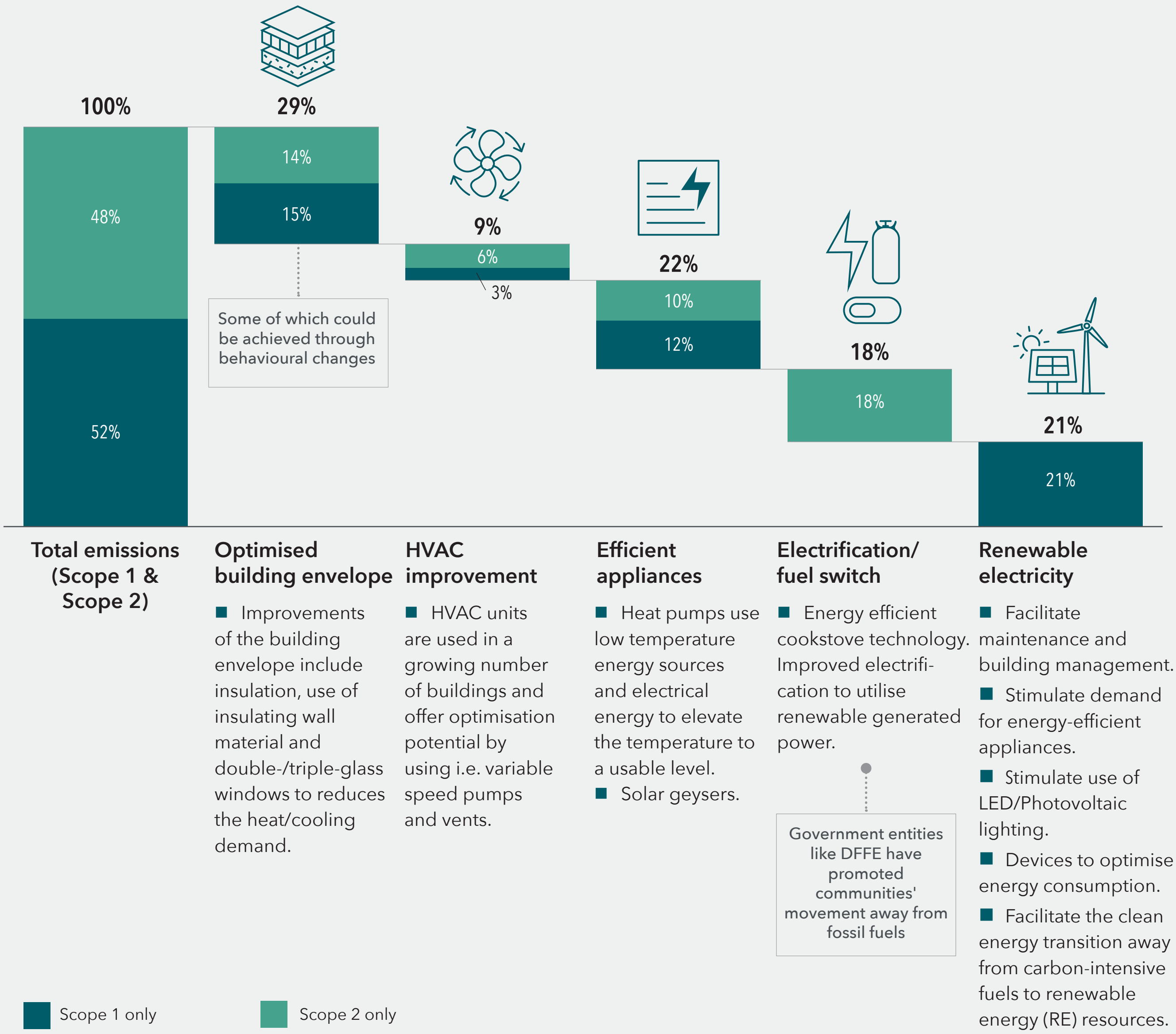
The questions of what is built and where will be key to unlocking efficient cities as South Africa develops. Efficient passive design can reduce the energy demand of a building and increase resilience, although this will have a relatively negligible impact on the quantity of building materials needed. Spatial planning could reduce building material demand, with smaller homes requiring proportionally less steel and cement, but the real value comes in the reduced cost to decarbonise and the parallel sector impacts. If the average dwelling size is reduced by 33% from the 2017 average of 120 m^2,[34] the cost to decarbonise buildings and construction by 2050 could be halved. These smaller homes could be less energy-intensive, hence cheaper to abate and more reflective of a sustainable quality of life improvement for the average South African. This saving could directly reflect as additional capital available to close the housing gap and extend public infrastructure. Densification will also be a critical enabler for transport, reducing travel distances, optimising public transport design, and saving South Africans commuting time and cost.

34 Stats SA. 2017. Building Market Assessment.


5

Photo: Shutterstock.com

Figure 13: Breakdown of potential levers to decarbonise residential building operations



Note: Split is indicated for a new building according to sustainable building codes, retrofits will be more dependent on RE.

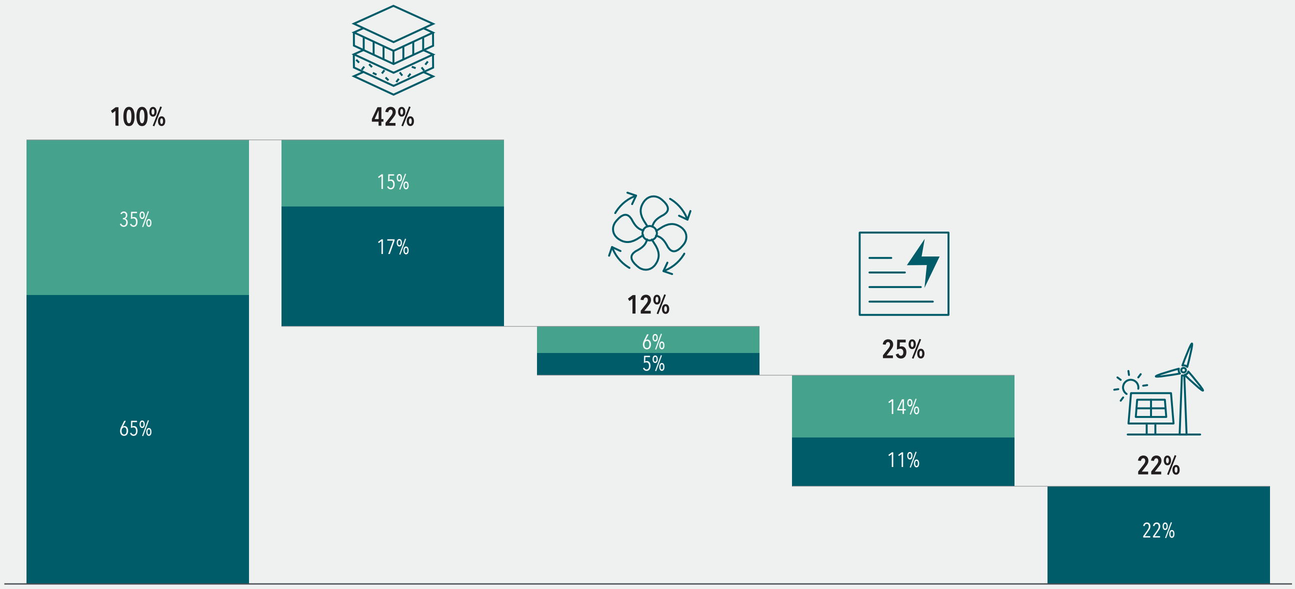
Source: NBI-BCG project team.

Decarbonising building operations

Two supply-side levers to drive decarbonisation of building operations: are improving operational efficiency and moving to greater levels of electrification. These levers can help reduce emissions by 38% and 29% respectively. The two key levers for decarbonising construction are: improving on-site efficiencies and electrifying stationary machinery and transport equipment and powering them with renewable power. This has the potential to reduce emissions by ~42% and ~58% respectively on construction sites.

Key levers to decarbonise building operations are efficiency measures (~38% of total sector emissions) and electrification and switching to renewable power (29% of total sector emissions, see Figure 15). The levers differ slightly between residential and non-residential buildings (Figure 13 and Figure 14). Residential buildings are for living in, for individuals or households, and non-residential buildings consist of commercial, industrial, and public buildings and infrastructure.

Figure 14: Breakdown of potential levers to decarbonise non-residential building operations



Total emissions (Scope 1 & Scope 2)

Optimised building envelope

- Improvements of the building envelope include insulation, use of insulating wall material and double-/triple-glass windows to reduces the heat/cooling demand.

HVAC improvement

- HVAC units are used in a growing number of buildings and offer optimisation potential by using variable speed pumps and vents.

Efficient appliances

- Heat pumps use low temperature energy sources and electrical energy to elevate the temperature to a usable level.
- Solar geysers.

Renewable electricity

- Facilitate maintenance and building management.
- Stimulate demand for energy-efficient appliances.
- Stimulate use of LED/Photovoltaic lighting.
- Stimulate demand for smart devices to optimise energy consumption.
- Facilitate the clean energy transition away from carbon-intensive fuels to renewable energy (RE) resources.

■ Scope 1 only ■ Scope 2 only

Note: Split is indicated for a new building according to sustainable building codes, retrofits will be more dependent on RE. Source: NBI-BCG project team.

Retrofitting existing buildings is a key priority – existing building stock could contribute more than 40% of 2050 emissions if unaddressed and represents 60%–65% of the cost of decarbonising the sector. It is more challenging to systematically abate emissions from existing buildings than it is to abate emissions from new builds because new building efficiency standards cannot be applied post the building design phase. Retrofitting existing buildings is still a valuable and critical process to reduce emissions, to reduce building operating costs, and to create jobs. Retrofitting could, for example, reduce existing household energy spending by ~50% and is estimated to be twice as labour intensive as new construction.

The critical steps in abating operating emissions are retrofitting of existing buildings, as the vast majority of current building stock is expected to still exist in 2050, and ensuring all new buildings are net-zero ready from 2030. These net-zero ready buildings are efficient,[35] electrified, and only require green power to be operationally net-zero. Some of these efficiency gains could be realised through behavioural shifts, though technological solutions represent more guaranteed solutions to reducing energy demand.

Retrofitting the existing built environment to electrify and improve energy efficiency will be a critical step in decarbonising the sector. This retrofitting is more difficult to implement in existing building stock than it is in new, net zero ready buildings, as monitoring and enforcing existing building efficiency standards would be a major logistical

35 Achievable reductions in operational energy intensity as a percentage of today's average are 50% and 70% for retrofits and new builds, respectively.

Figure 15: High-level decarbonisation levers across the buildings and construction value chain

Value chain	Total value chain emissions (2017 baseline)	Percentage of baseline emissions	Lever description
Construction	Electrification and low-carbon fuels on construction sites	~1-2%	Machinery electrification with self-generated and grid RE; fuel switch for vehicles; increased efficiency.
Building operations	Electrification, RE powered grid and decentralised RE for buildings	~29%	Electrify buildings and decarbonise using decentralised solar PV power, especially geysers, and grid RE.
	Increased energy efficiency in buildings	~38%	Enforce passive design and efficient building design standards (e.g., insulation), uptake of efficient alternatives (HVAC, heat pumps) and automation (occupancy sensors).
Design and materials	Efficient spatial planning and building design	~5%	Reduce materials need by minimising materials usage and optimising use of space.
	Low-carbon building materials	~18%	Switch to low- or zero-carbon materials (versions of existing materials or entirely novel buildings).*
	End-of-life building material recovery and reuse	~5%	Design buildings to be easily dismantled for maximum material reuse at end-of-life, and to reduce waste to landfill.
	Residual emissions	~4%	Hard-to-abate emissions from carbon-intensive materials e.g., cement and steel.**
	Natural carbon sinks	~4%	Offset, e.g., through increased forestation.

Note: * Assuming 70% of material decarbonisation is relatively achievable, remainder needs to be offset.
** All construction and operation emissions are abatable with current technology – only embedded materials emissions are likely to be residual.

Source: BCG-NBI project team; previous sector analyses.

challenge. No incentive regulatory scheme for existing building efficiency retrofits has yet been implemented. Market drivers could achieve this shift, given the cost-savings through reduced energy consumption, but this requires education of the individual owners, tenants and developers about the cost-savings, and mechanisms to provide capital for the upfront costs.

The new retrofitting market created could be a critical job creator, as initial pilots of low-energy retrofits are twice[36] as labour-intensive per Rand invested as traditional construction. There is also a parallel localisation opportunity, as the skills and inputs needed (e.g., insulation, heat pumps, efficient appliances) could be produced domestically.

36 European Climate Foundation. 2012. *Employment Impacts of a Large-Scale Deep Building Energy Retrofit Programme in Poland.*

Fuel switching, including in cooking, is a significant decarbonisation lever for residential buildings, with ~18% Scope 1 emissions reduction potential if fully electrified. This could be realised as a shift first from paraffin stoves and waste to natural gas or biomass, and finally from natural gas and biomass to renewable electricity via the electrification of appliances.

The combined pathway for the buildings and construction sector, and the case for energy efficiency

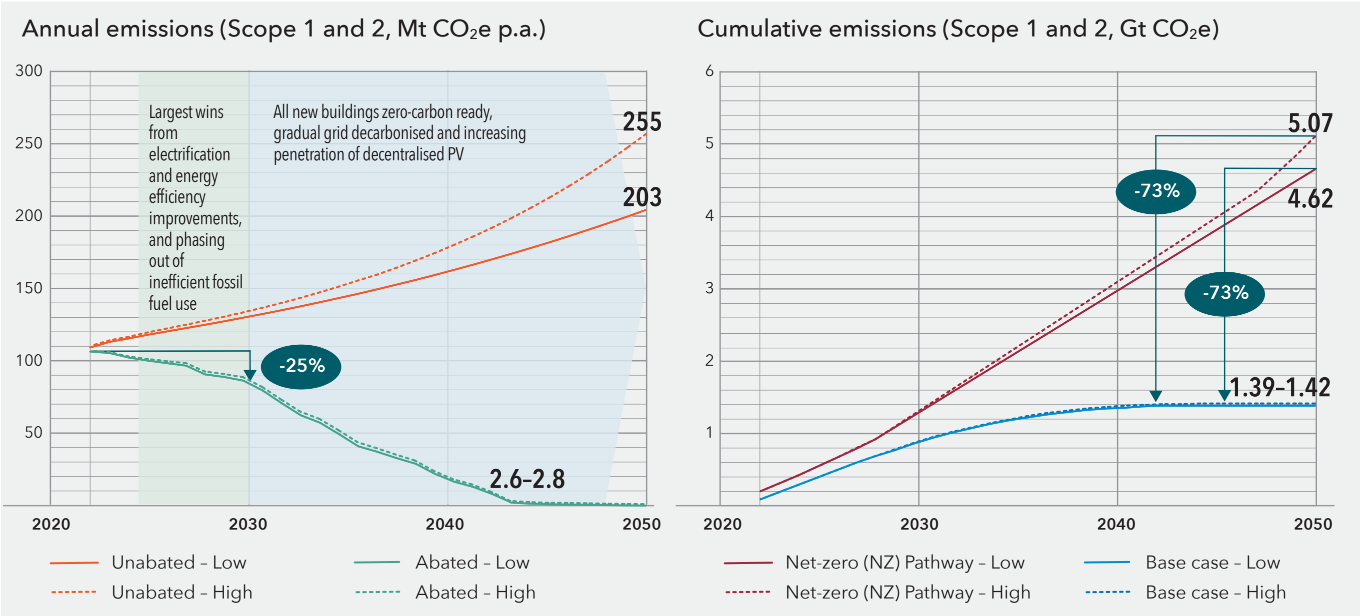
The modelled pathway can reach net-zero by 2050 (using the levers summarised in Figure 15) if renewable power becomes available, versus 203–255 Mt CO_2e p.a. (Scope 1 and 2) in 2050, if the country develops without the sector decarbonising (Figure 16). This could cut cumulative emissions (Scope 1 and 2, 2020–2050) from 4.62–5.07 Gt CO_2e to 1.39–1.42 Gt CO_2e, of which 0.50 Gt CO_2e is Scope 1 emissions. This would be below the sector's 'fair share' of 0.56–0.77 Gt CO_2e (the baseline's 7% Scope 1 share of South Africa's 8–11 Gt CO_2e carbon budget to 2050), freeing up the carbon budget for harder-to-abate sectors.

This sector trajectory is dependent on a having a decarbonised grid (renewable power dominant energy) by 2050, with the emissions reductions based on both sector-specific levers and the downward trajectory for carbon intensity of power.[37] The trajectory sees ~100% electrification by 2040, with the direct emissions coming from construction vehicles and machinery and the last unelectrified uses in homes. Given the dependence on decarbonised power, enabling the grid transition will be key for a net-zero buildings and construction sector.

The main barrier to energy efficiency is a social barrier, which is the lack of understanding of cost-saving through energy efficiency (this is closely tied to finance). Even if an individual has sufficient capital, convincing the individual to spend an upfront premium on a device or appliance that accomplishes the same function as cheaper alternatives, requires them to take a total cost of ownership (TCO) view in order to understand the benefits, and to accept – and be able to afford – the upfront impact on their cashflow.

Still, efficiency levers must be prioritised, as these could balance out future demand growth as the country urbanises and develops. Without efficiency improvements, the sector's energy demand could grow by 90%–124% by 2050. Since the sector will need to electrify, this would mean the pathway 2050 demand of 405–476 PJ of green electricity could increase to 847–1083 PJ, putting further strain on a grid that is already facing significant pressure to both expand and decarbonise. Efficiency measures are thus necessary enablers for the power sector transition, and consequently also critical to the buildings and construction sector transition.

Figure 16: Comparing the sector emissions trajectories for the pathway compared to business-as-usual



Source: NBI-BCG project team.

37 NBI-BCG power sector analysis.


Photo: Shutterstock.com

3.2.5 COST OF DECARBONISING THE BUILDINGS AND CONSTRUCTION VALUE CHAIN

Decarbonising buildings and construction could cost ZAR 263–ZAR 285 bn by 2050. ZAR 50–ZAR 60 bn will be needed to decarbonise construction sites, ~ZAR 170 bn to retrofit the existing buildings, and ZAR 43–ZAR 55 bn to decarbonise new buildings and infrastructure. Efficient building design is a crucial driver of the cost of decarbonising buildings, as reducing the size of the average home by 33% halves the cost of greening the sector and frees up capital to accelerate the delivery of adequate housing and infrastructure for all South Africans.

The decarbonisation cost to transition buildings and construction to net-zero could be ZAR 263–ZAR 285 bn by 2050. This cost accounts for the incremental cost for net-zero construction sites, electrification, and all building efficiency measures – rendering buildings and construction operationally net-zero (once decarbonised power becomes available). These buildings would incorporate all construction and operational levers – designed to be efficient, maximising passive design and insulation, with best-in-class heaters/geysers/ other appliances, and built on electrified, optimised construction sites.

Greening cost and net-zero (NZ)-ready buildings

Greening cost is the incremental cost associated with building in a NZ-ready pathway, expressed as a fraction of total project cost. For example, in building operations, it is the incremental cost incurred by improving insulation or installing more efficient appliances, such as a solar geyser, above what would have been paid for a standard, energy-intensive equivalent.

NZ-ready buildings are those that are fully electrified and up to target energy efficiency standards (50% reduction from today's intensity for retrofits, 70% for new buildings). Once decarbonised power is available, these buildings will be operationally net-zero.

The decarbonisation cost to transition buildings and construction to net-zero does not account for the cost to decarbonise building materials, end-of-life disposal, or the power grid. This cost is also highly dependent on what is built – if we continue to build the same large, energy-intensive homes as we have to date, the cost to reach operational net-zero could roughly double to ZAR 528–ZAR 565 bn by 2050.

3.2.6 JUST TRANSITION AND BROADER SOCIO-ECONOMIC IMPLICATIONS

The main socio-economic opportunity lies in job creation: the buildings and construction sector is a significant contributor to the South African economy, driving 1.1 M direct jobs today. The increase in construction demand could potentially create 0.8–1.4 M new jobs by 2050, and energy efficient RDP houses can limit energy demand for space heating and cooling. The extent to which the RDP model is the most feasible and sustainable model to provide low cost housing needs to be reassessed. The price of cement could double in a decarbonisation scenario and result in a 10% increase in cost for an RDP house. The RDP model is also not aligned with the concept of urban densification, and results in the development of less efficient transport systems. We must find better design solutions to address the low-cost housing gap in South Africa and support a Just Transition.

Given the current South African socio-economic context, with an existing shortfall of ~2.1 million homes and unequal access to public infrastructure, the Just Transition implications are imperative when considering the decarbonisation pathway.

Buildings and construction sector growth could be a key job creator. Assuming labour intensity of construction is maintained, construction jobs could increase proportionally to sector output growth – creating 0.8–1.4 M new jobs by 2050, above today's baseline of 1.1 M jobs. Despite the expected job impact being net-positive, reskilling and job transition support will be needed due to the use of new building materials and methodologies while increasing job inclusiveness. Retrofitting in particular could be localised, with individual communities best understanding how to optimise their built environment once they have been upskilled on the topic. There is an opportunity to develop small businesses along the supply chain, and to include previously under-represented groups in doing so.

People living in lower-income populations and in poor quality or informal housing are highly vulnerable to the most significant climate risks. Improving climate resilience is a key part of ensuring a Just Transition in this sector. In the event of droughts and heatwaves, residents of neighbourhoods without proper insulation or water and sanitation face significant health risks. Additionally, structurally unsound, poorly spaced homes are worst affected by extreme weather events and disasters, such as storms, floods and fires. With the frequency of such events increasing with climate change, it is imperative that resilient housing is developed for these most at-risk portions of the population. This could require the relocation of populations from high-risk areas as climate zones shift, which could present significant social, logistical and financial challenges.

Given the existing housing gap, the affordability of housing must also be maintained. Ensuring affordability of building materials is a key enabler, particularly in low-cost housing where cement contributes ~10% of the total cost per Reconstruction and Development Programme (RDP) house. For example, decarbonisation of cement could double its cost, increasing the total cost of an RDP house by 10%. The cost of greening should not be transferred to the low-income residents or end up constraining the number of homes built. Alternative housing design and material use can be considered to mitigate costs and provide low-cost, climate resilient housing of good quality.

Upfront capital cost should not be a barrier for materialising the buildings' energy efficiency gains and thus cost-savings. The achievable efficiency gains (and corresponding cost-savings) from these low-energy buildings represent both a risk and an opportunity. Lower-income residents likely will not be able to afford the upfront capital costs, preventing them accessing the monthly cost-savings. Conversely, if efficiency measures are unlocked for them, this could free up income without impacting their quality of life.

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

Decarbonising the operational emissions from both construction and buildings is technically feasible today, and the necessary financial and regulatory enablers are in development. Building efficiency standards must be more stringent and extended to existing buildings to accelerate adoption. Building plans and materials approval processes must be revised, driving efficiency and usage of low-carbon alternatives. New city planning and building design approaches are needed to achieve the necessary density and zoning for efficient cities. Construction companies need to develop carbon efficiency metrics and electrified equipment alternatives to enable on-site decarbonisation.

Realising the buildings and construction sector decarbonisation requires collaboration and actions across the full value chain (Figure 17). Asset owners, investors, developers, and tenants will drive demand for low-carbon buildings and construction. The demand will be met by contractors, designers and materials suppliers. Underpinning all of this is the need for the regulatory policies and measures supporting the net-zero transition, the upfront capital to implement the decarbonisation levers, the research and development of the necessary technologies, and the decarbonisation of the power grid.

Figure 17: Key policy changes and private sector actions needed to enable the Just Transition net-zero pathway

	Design and materials	Construction	Building operations
Authorities/build approval/regulators	■ **Encourage innovation** Approval process for new designs and materials made cheaper and quicker. ■ **Stimulate demand** Use green options for public projects. ■ **Leverage smart city planning** Directly for public projects, indirectly through land zoning/ plan approvals. ■ **Enforce efficiency** Develop and enforce building standards.	■ **Enforce efficiency** Develop and enforce on-site standards; update EIA to include carbon and waste to landfill. ■ **Facilitate fuel transition** Accelerate electrification and ZEV adoption with incentives, tax breaks. ■ **Stimulate demand** Use green contractors for public projects.	■ **Enforce efficiency** Monitor and enforce building standards. ■ **Drive power decarbonisation** Prioritise a net-zero grid, invest in and subsidise renewables.
Private sector stakeholders	■ **Stimulate demand** Choose green options when possible. ■ **Optimise designs** Reduce overengineering, maximise passive design impact. ■ **Supply the growing demand** Develop and bring to market new green options as demand grows.	■ **Drive innovation** Develop new processes and KPIs for sustainable, efficient construction. ■ **Avoid lock-in** Take a longer-term, TCO view when replacing equipment/ vehicles.	■ **Finance transition** Invest in efficiency wins, knowing the cost-saving payback. ■ **Shift consumer behaviour** Consider impact of energy demand, reduce wasteful consumption. ■ **Drive efficiency and resilience** Produce and choose efficient, climate-resilient alternatives.

Notes: EIA – Environmental Impact Assessment; ZEV – Zero Emissions Vehicle; TCO – Total Cost of Ownership.

Source: NBI-BCG project team.


Photo: Shutterstock.com

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 has run a multi-year project to understand net-zero decarbonisation pathways, sector by sector. This report is the last in a series of 11 reports produced by this project and, together, these reports provide 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 has been 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
- Mining
- Agriculture, Forestry and Other Land Use
- Transport
- Heavy manufacturing
- Building and construction
- Financing SoutH Africa's Just Transition
- Pathways to net-zero
- 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

APPENDIX

Detailed approach and assumptions for demand scenarios

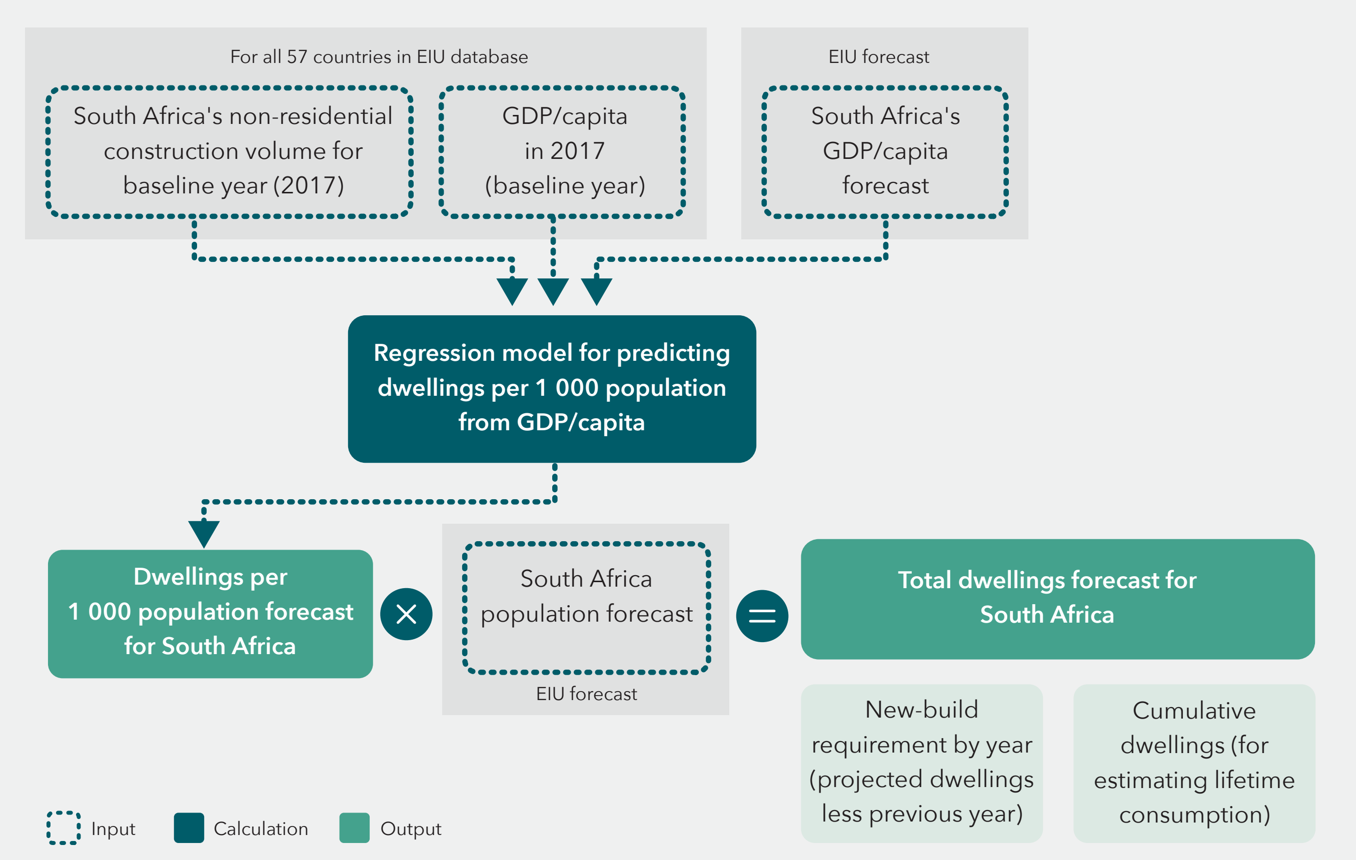
Figure 18: Key assumptions behind demand scenarios

Local demand	Low: baseline projection	High: Just Transition projection
Residential	Assume dwellings/1 000 population described by global trend, predict with GDP/population growth. Population growth 2017–2030: 19%; 2030–2050: 14%; GDP/cap. CAGR 2017–2030: 3.3%; 2030–2050: 4.8%. Potential of people owning multiple homes is lumped into occupancy factor (population per dwelling).	Same general trend as baseline, but 2.1 M additional dwellings needed due to existing housing shortfall – assume these are built over 2023–2035, distributed linearly.
Non-residential	Assume stagnant economy, so only half of projected growth is actually realised. Sector CAGR 2022–2030: 2.1%; 2030–2050: 3.0%.	Assume dwellings/1 000 population described by global trend, predict with GDP/population growth. Population growth 2017–2030: 19%; 2030–2050: 14%; GDP/cap. CAGR 2017–2030: 3.3%; 2030–2050: 4.8%. Potential of people owning multiple homes is lumped into occupancy factor (pop. per dwelling).
Urban planning[1]	For these base cases, assume that construction and planning continue as they are, with no major overhauls (for either existing stock or new construction).	
Emissions intensity[2]	Assume operational emissions intensity for new stock is the same as current built environment at 686 t CO_2e/m^2 p.a. and 435 t CO_2e/dwelling p.a. (i.e., no new-build emissions policy or retrofit efforts – to be considered with levers/pathways). Assume construction emissions (including embodied carbon in materials) will continue at current intensity of 643 t CO_2e/m^2 built (non-residential) and 1 738 t CO_2e/dwelling built (residential).	

Notes: JT – Just Transition
1 Urban planning (increasing densification and usage of buildings) is expected to be a significant demand reduction lever, but highly variable scope and extent of implementation make this too uncertain to directly model for base case scenarios.
2 In the do-nothing scenarios, emissions intensity could increase with economic growth as demand is largely driven by the middle- and upper-class due to much higher consumption lifestyles.

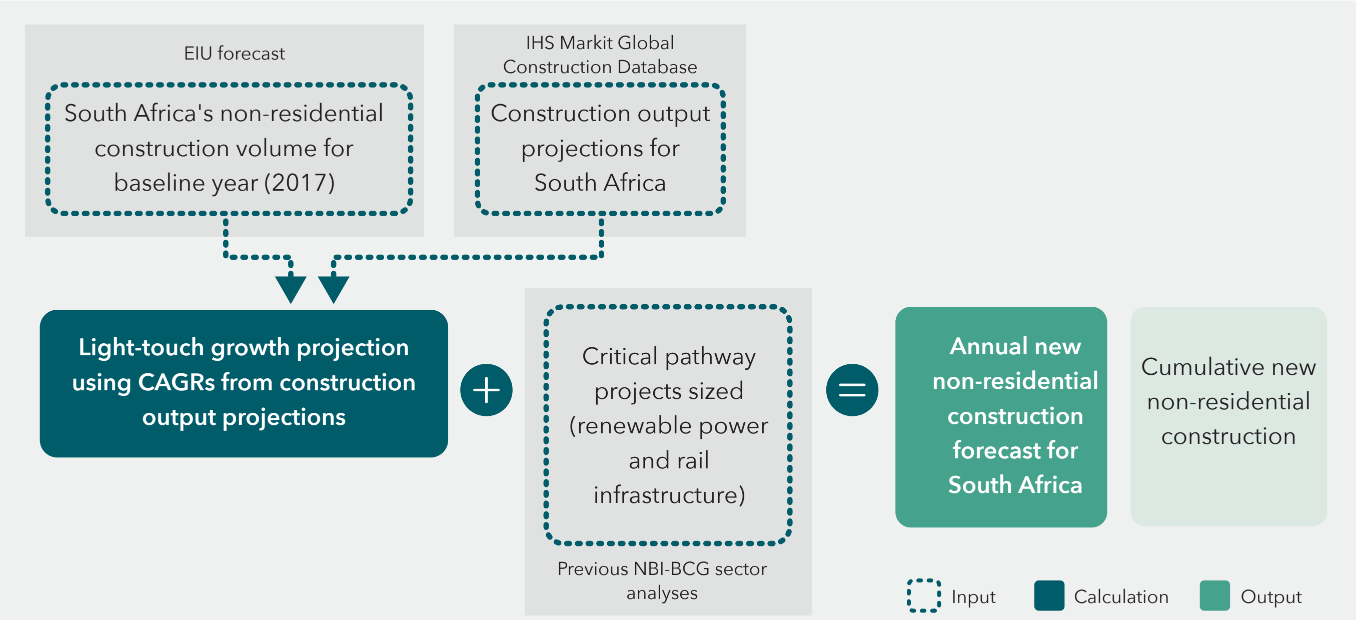
Source: NBI-BCG project team.

Figure 19: Demand projection methodology for residential



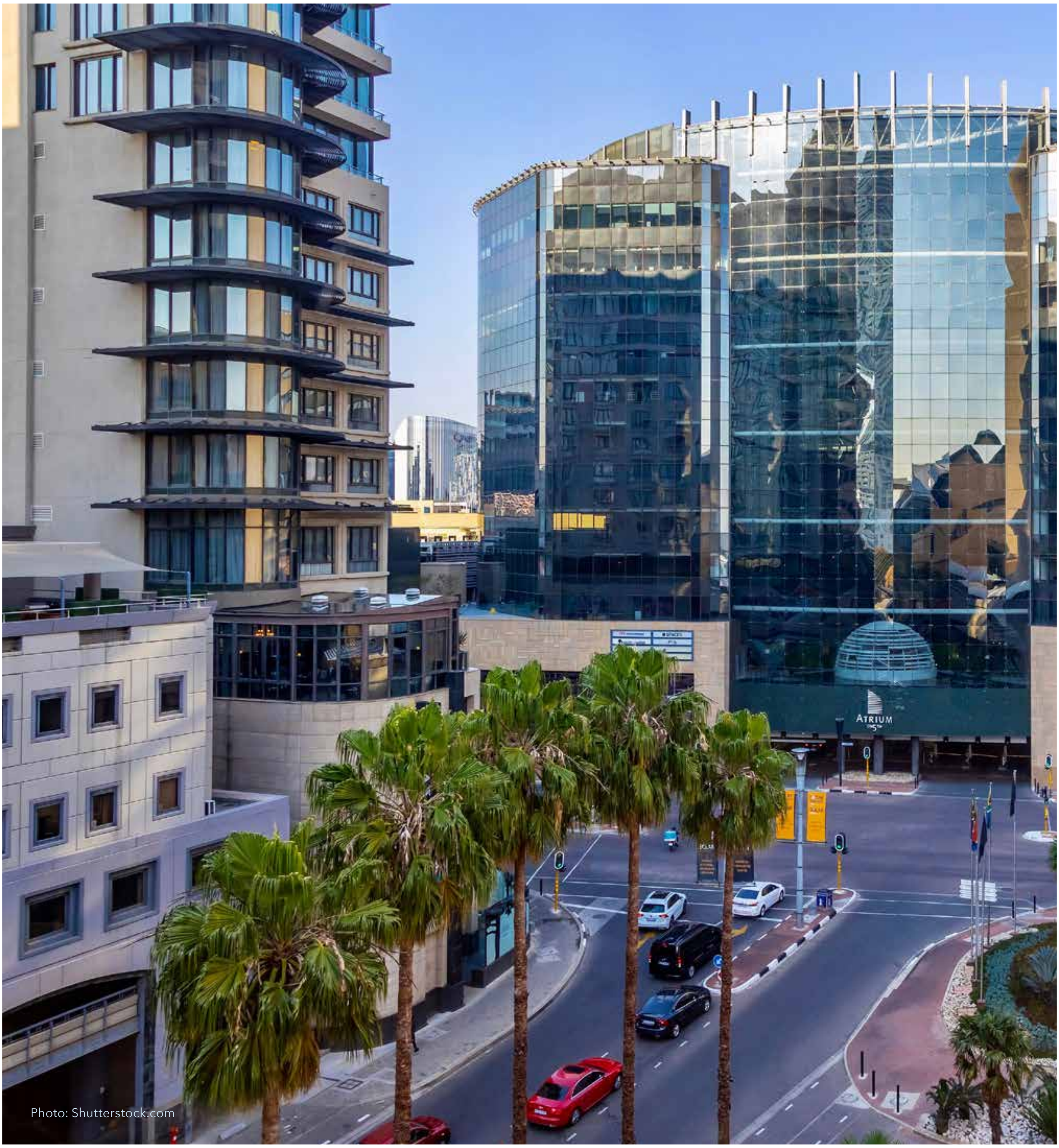
Source: NBI-BCG project team.

Figure 20: Demand projection methodology for non-residential



Source: NBI-BCG project team.

National Business Initiative



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