Presentation of key findings from the NBI Just Transition Pathways project

Mining and Petrochemicals & Chemicals sector analysis

Tuesday, 12 October 2021
14:00-15:30 (SAST)

@NBISA
@BCG
@BusinessUnitySA

#NBIJustTransition
#NetZero2050

Meeting Protocols

Please submit any questions you may have using the Q & A function

Please make sure that your microphone is muted and your video is turned off if you are not speaking

Please note that this session is being recorded

If you have any technical issues, kindly reach out to:

- Nombulelo Ndaba NombuleloN@nbi.org.za
- Justine Alston JustineA@nbi.org.za

Public presentation of key findings

Mining and Petrochemicals & Chemicals

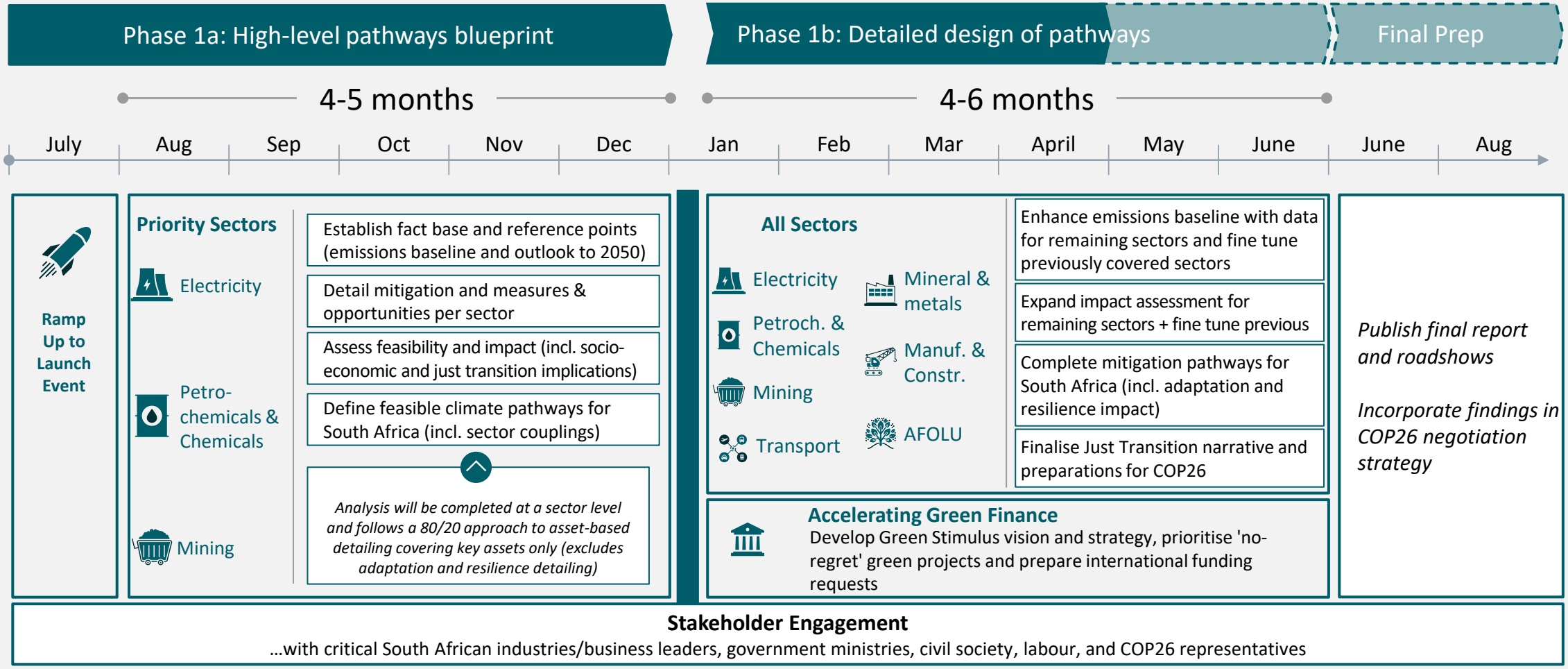
Welcome and Introduction	14:00 – 14:10
The context of this study	14:10 – 14:15
Decarbonising South Africa's petrochemicals and chemicals sector	14:15 – 14:50
Decarbonising South Africa's mining sector	14:50 – 15:25
Outlook and next steps	15:25 – 15:30

Welcome and introduction

Joanne Yawitch

CEO National Business Initiative & member of the Presidential Climate Commission (PCC)

With this study we aim to drive collaboration and create a unified voice of South African business at COP 26 and beyond



Note: AFOLU = Agriculture, forestry, and other land use| Source: NBI-BCG Project Team

What this study aims to achieve

The questions the study aims to answer

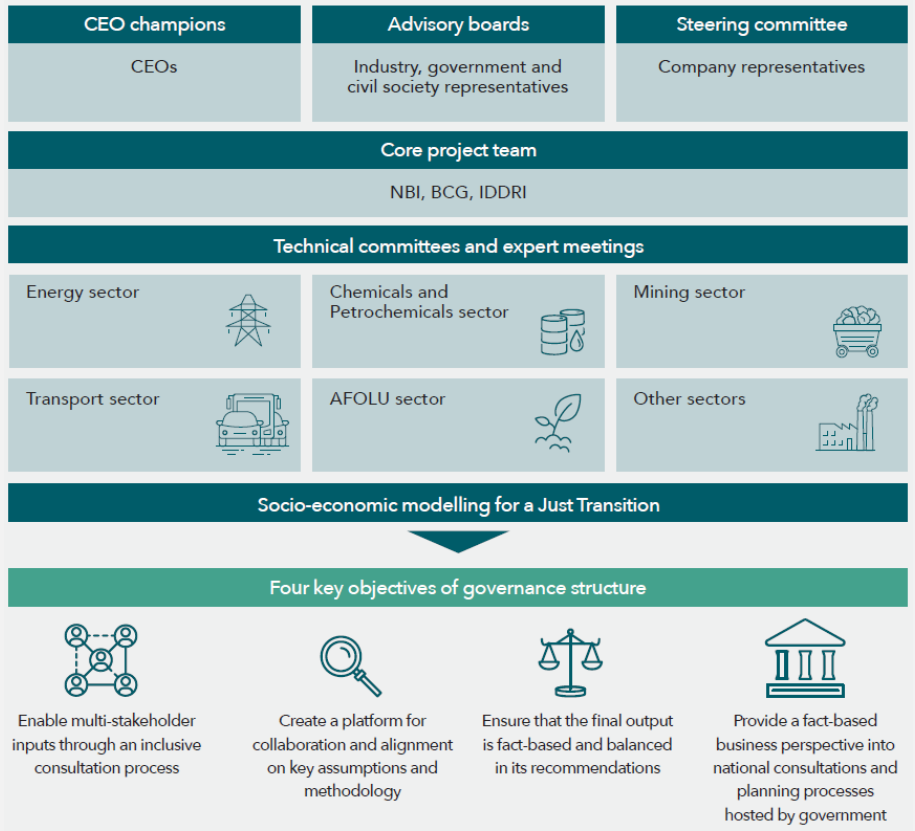
- What is the cost of inaction for South Africa?
  (i.e., of not responding to critical global economic drivers driven by global climate action)
- What would it take for South Africa to get to net-zero emissions?
  (Including practical solutions, barriers to overcome, investments and financing to enable the transition)
- What would be the social and economic implications for South Africa to reach net-zero emissions by 2050?

What the study is NOT aiming for

- Not setting an ambition for **which level of** national emission reductions South Africa should reach **and when**
- Not prescribing **sector- or company-specific** emission reduction targets

We are creating an analytical fact-base to support decision making and support coordinated effort among national and international key stakeholders

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



4 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 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

Source: NBI-BCG Project Team

OVERVIEW OF CEO CHAMPIONS

Onboarding of additional CEOs ongoing

Joanne Yawitch
NBI CEO

Cas Coovadia
BUSA CEO

André de Ruyter
Eskom CEO

Fleetwood Grobler
Sasol CEO

Mxolisi Mgojo
Exxaro CEO

Leila Fourie
JSE Group CEO

Nolitha Fakude
Anglo American SA Chairperson

Alan Pullinger
First Rand CEO

Hloniphizwe Mtolo
Shell SA CEO

Portia Derby
Transnet CEO

Lungisa Fuzile
Standard Bank South Africa CEO

John Purchase
AgBiz CEO

Paul Hanratty
Sanlam CEO

Deidré Penfold
CAIA Exec Director

Vivien McMenamin
Mondi SA CEO

Tselo Mojapelo
BP Southern Africa CEO

Roland van Wijnen
PPC Africa CEO

Njombo Lekula
PPC MD SA Cement and Materials

Gavin Hudson
Tongaat Hulett CEO

Vikesh Ramsunder
Clicks Group CEO

Nyimpini Mabunda
GE SA CEO

Mark Dytor
AECI CEO

Alex Thiel
SAPPI CEO

Mohammed Akoojee
CEO Imperial Logistics

Yusa Hassan
Engen MD and CEO

Tshokolo TP Nchocho
IDC CEO

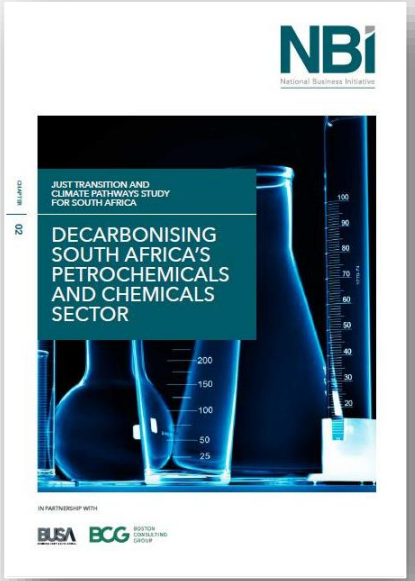
Stuart Mckenzie
Ethos CEO

Marelise van der Westhuizen
Norton Rose Fulbright CEO

Ishmael Poolo
Central Energy Fund CEO

This project finds support across business

We will present and discuss our key findings for the **Mining** and **Petrochemicals & Chemicals** sectors today



The Mining and Petrochemicals & Chemicals reports will be published on October 21

A note from our partner BCG

Lucas Chaumontet

Managing Director & Partner - Regional lead on Climate & Sustainability
Boston Consulting Group

Key findings

Many countries have already set ambitious net-zero targets

Not exhaustive

Net-zero before 2050

Net-zero by 2050

Net-zero post 2050

No net-zero commitment

Source: World Economic Forum, NS Energy, Climate Home News; NBI-BCG project team

SA committing to ambitious climate action as well

South Africa's Low-Emission Development Strategy 2050 (LEDS) states:

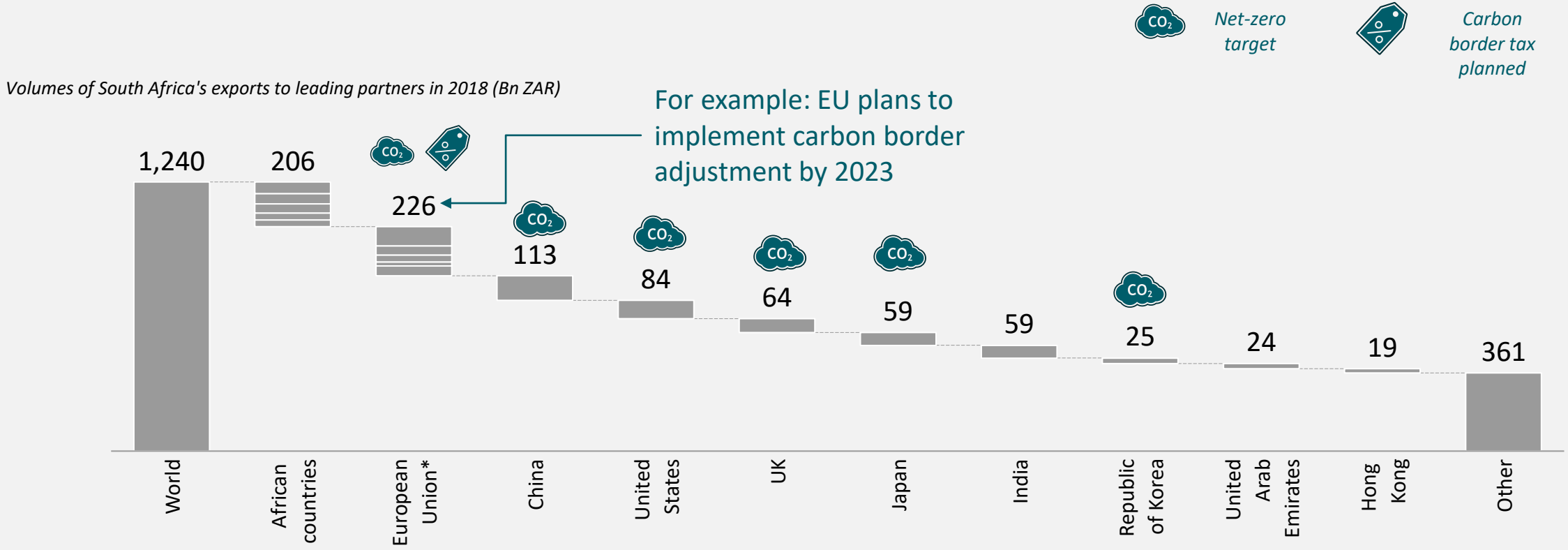
"We thus **commit to ultimately moving towards a goal of net-zero carbon emissions by 2050,** which will require various interventions to reduce greenhouse gas emissions"

Business Live interview 02-Oct-20

In a discussion on LEDS, DEFF Minister Creecy made several references to South Africa needing to be net carbon neutral by 2050

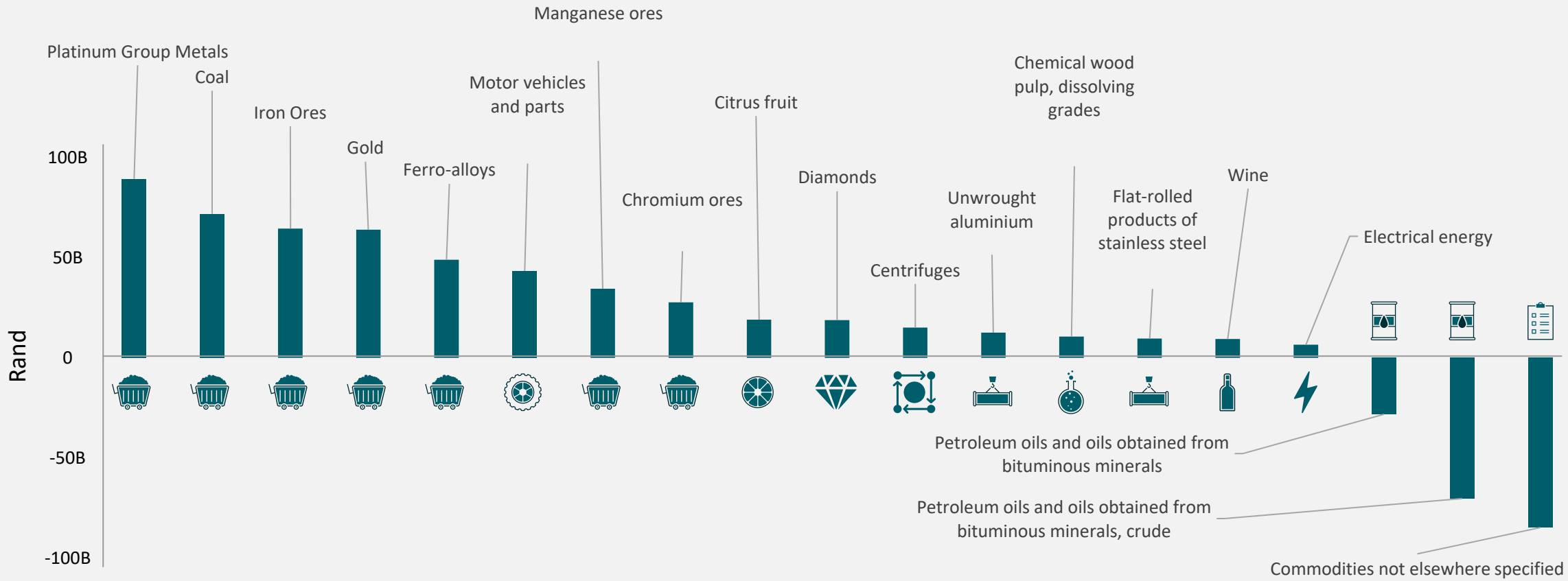
Key export markets like the EU already considering carbon border taxes – others may follow

Top export partners outside Africa have recently announced commitments to net-zero, putting SA exports at risk if carbon border taxes to be implements as planned in the EU – although Border Tax adjustments are currently not within WTO rules



* Top 4 trade partners within EU are Germany, Netherlands & Belgium, and among those with most aggressive targets. Note: Exchange rate based in 2018 average = R 13:24/US$ | Source: World Integrated Trade Solution 2018; Press research

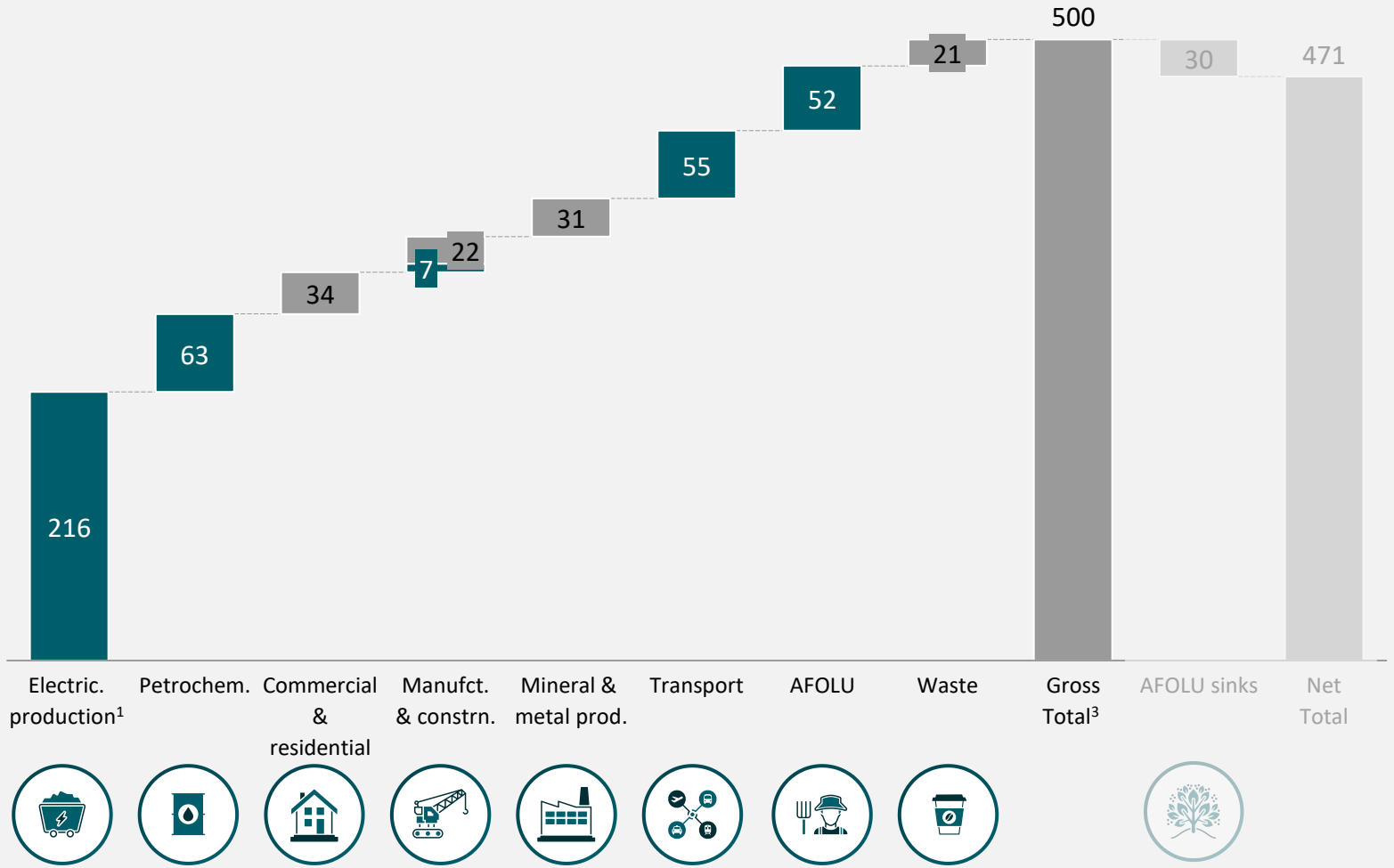
South Africa's trade vulnerability is particularly acute, commodity trade balance open to transition risk



Source: BCG analysis

Sectors addressed so far account for ~80% of national emissions and are key to ensuring a Just Transition

Emissions updated in line with latest (2021) iteration of DFFE[4] 2017 GHG baseline



1. Emission figures based on view of Electricity & Heat Production of which electricity production contributes >97% of emission 2. GHGI does not explicitly state estimate for mining emissions so this has been estimated. Assumed scope 1 emissions share of top 12 companies is same as their market share (80%) and use 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 (~51Mt, labelled as 'AFOLU excl. FOLU' in GHGI) + energy emissions in Agriculture/Forestry/Fishing (~4Mt). AFOLU sinks: FOLU (labelled as 'Land' in GHGI) + Other ('harvested wood products') from GHGI 4. According to DFFE (formerly DEFF) – however, revisions still to be published | Source: GHGI (2017), IEA (2015), WEO (2019), CDP (2015), GHGI (2015), CAT

South Africa is at significant risk from climate change, creating a need not just to decarbonise, but more importantly to adapt and ensure a just transition

Decisions taken now are critical

For example, South Africa must:

- Avoid infrastructure lock-in that will hinder long term competitiveness
- Recognise global shift in commodity value pools, plays to its strengths and invest in skills and technologies of the future, and drive international exchange of expertise and technology
- Pursue 'Green' sources of funds and preferential trade agreements to finance a Just Transition

Decarbonising South Africa's petrochemicals and chemicals sector - towards the production of green fuels and chemicals for South Africa and the world

10 Key findings of the petrochemicals & chemicals analysis – I/II

1 If SA can unlock disruptive technology, in particular green H2 and sustainable sources of carbon, **it can fully decarbonise its petrochemicals and chemicals sector**, which today drives 13% of the country's emissions, and **become a leading producer of green fuels and chemicals for local demand and export**.

2 **SA's petrochemicals and chemicals sector will face different challenges across timelines:** In the 2030s, SA could be facing weakened energy security, given a potential decline in domestic refinery capacity. In the long-term, the sector will need to adapt to a changing demand landscape: Depending on the transport sector decarbonisation scenario, conventional liquid fuels demand could decrease by 50-100%, while conventional chemicals would eventually be substituted by decarbonised alternatives – also as a result of carbon border adjustment mechanisms - globally and in SA.

3 **While in the mid-term energy security needs to be maintained and the socio-economic risks associated with declining domestic refinery capacity and a potentially resulting negative balance of payment change managed, the changing demand landscape creates an opportunity for SA in the long-term**: SA could become a leading producer of green synthetic fuels and green chemicals, particularly e-ammonia and SAF, for local demand and export, enabled by decarbonisation and conversion of SA's synfuels sector.

4 **SA's opportunity in the production of green fuels and chemicals is based on the competitive advantage in the production of green H2 and synthetic fuels:** First, SA has some of the best solar and wind resources on the planet; second, it has sufficient land and access to seawater for desalination which can also serve a dual purpose of improving water security; and third, it has unique Fischer-Tropsch technology for beneficiation of H2 into hydrocarbons such as e-methanol and SAF.

5 **Decarbonising SA's synfuels production supports the transition to the production of green fuels and chemicals, and also be critical to reduce SA's overall emissions footprint and the carbon intensity** of locally produced chemicals - given that today's coal-based synfuels sector drives ~90% of the sector's emissions and constitutes a key feedstock supplier of local chemicals production.

Note: SAF = Sustainable Aviation Fuel | Source: NBI-BCG project team

10 Key findings of the petrochemicals & chemicals analysis – II/II

6 **The ability to decarbonise the sector will depend on access to key technologies and feedstocks:** full decarbonisation of the existing synfuels production requires access to green H2 at scale below a price of US$2/kg and sustainable carbon feedstocks, supplied via for example biomass and – potentially in the long-term – DACC. For gas to support the decarbonisation as a transition feedstock, gas prices would need to be secured at an economically viable level.

7 **Depending on the timing of availability and affordability of disruptive technology and lower emissions feedstock such as CCUS, DACC, green H2, biomass and gas, different pathways towards net-zero synfuels production exist;** whereby cumulative emissions range between 0.6-1.2 GtCO2e but socio-economic trade-offs differ significantly across pathways with regards to for example timing and scale of investment requirements, impact on production cost, job impact across the sector's and adjacent value chains and the speed at which green production can be achieved.

8 **Two percent of the sector's direct emissions are linked to the downstream chemicals production;** removing those emissions will require process, energy and material efficiency improvements, fuel switching, access to sustainable feedstock and negative emission technology, such as CCUS.

9 **While the decarbonisation of the sector enables local industrialisation and realisation of new export opportunities** which help improve SA's balance of payment, it will be critical to manage socio-economic risks in the mid-term, in particular displacement of workers in the coal, refinery and adjacent value chains which together make up ~140 000 direct jobs today and the risk of increasing reliance on liquid fuels imports, which would decrease energy security and negatively impact SA's balance of payment, in the 2030s - accelerating decarbonisation across sectors will be key to mitigate those risks.

10 **It will be critical to establish cross-sectoral and international partnerships and pilot projects to drive research and development, off-take agreements to secure cheap financing at an early stage and a conducive local policy environment** to unlock the key technologies and feedstock needed to drive decarbonisation and the establishment of green fuels and chemicals production in SA – if this cannot be achieved, the sector is at risk of losing its competitiveness and eventually demise.

Note: SAF = Sustainable Aviation Fuel, DACC = Direct Air Carbon Capture, CCUS = Carbon Capture and Storage | Source: NBI-BCG project team

Petrochemicals & Chemicals sector significant contributor to GDP and jobs in South Africa

Product categories included in sector definition

- Liquid fuels (including synthetic fuels), basic chemicals, rubber products, plastic products, other chemical products, man-made fibres

The sector's contribution to South Africa's GDP in 2019

- Sector contributed R232Bn (6,22%) to GDP
- The top three companies by 2019 revenue are:

Company	Revenue	GDP contribution	GDP contribution (%)
Sasol	R204Bn	R10,9Bn	4,70%
AECI	R24Bn	R0,348Bn	0,150%
Omnia	R19Bn	R0,254Bn	0,110%

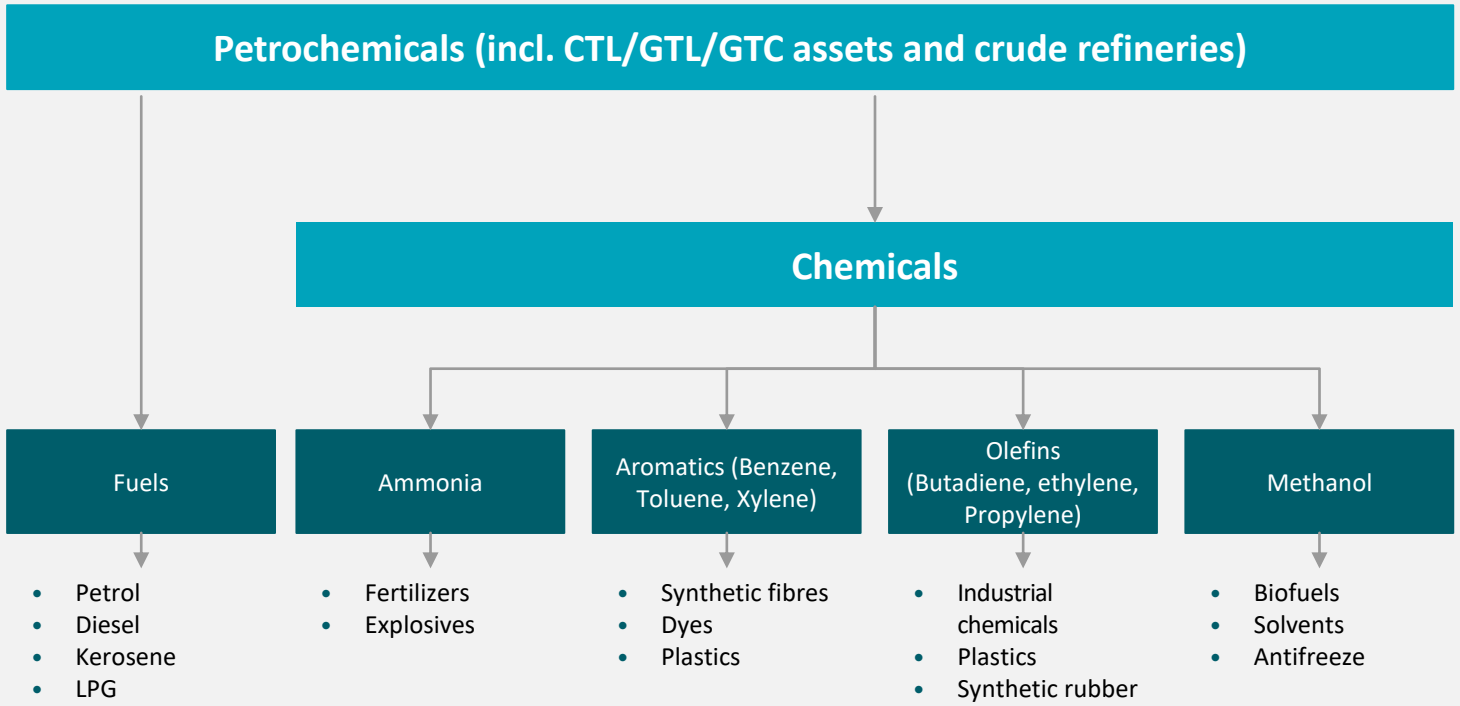
Jobs related to Petrochemicals & Chemicals sector in 2017

- 169K direct jobs and 693K indirect jobs
- Direct job contribution of top three companies

Company	Direct jobs	Direct job contribution (%)
Sasol	28000	17%
AECI	8000	5%
Omnia	3489	2%

Note: Top three companies based on revenues of companies listed on JSE
Source: Oxford Economics, African Markets, S&P Capital IQ, Sasol, AECI, Omnia, BCG Analysis

Upstream petrochemicals sector supplies key feedstock for downstream chemicals production



Synfuels sector produces key feedstock for downstream chemicals production including

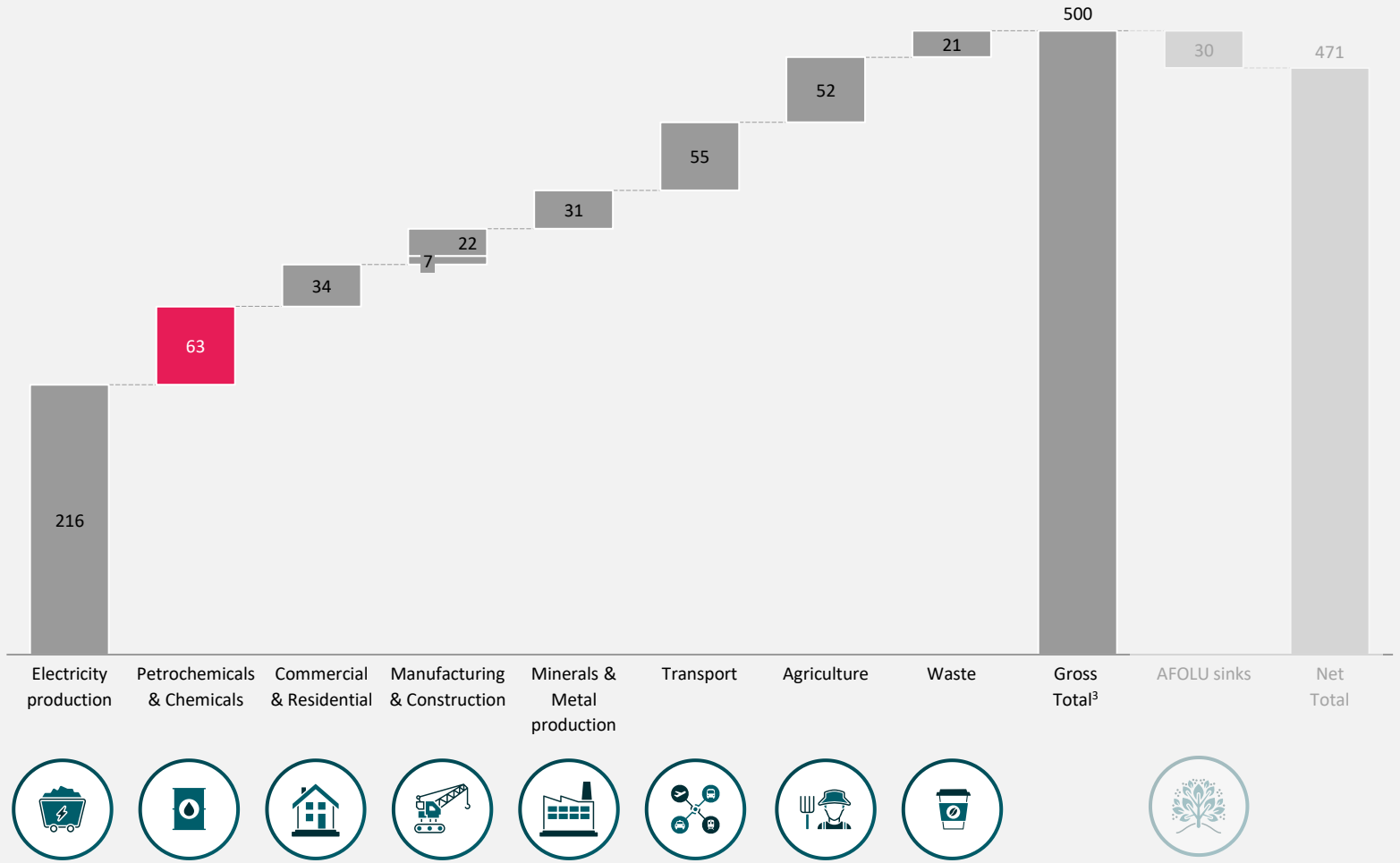
- Polymers[1] for plastics production
- Ammonia, used in fertilizer and explosives industries
- Methanol, for fuel production
- Aromatics, for benzene[2] and nylon production

However, feedstock highly carbon intense today

1. Polypropylene/propylene 2. Plastics, resins, synthetic fibres, rubber lubricants, dyes, detergents, drugs, and pesticides
Source: TIPS (2019), NBI-BCG Project Team

Petrochemicals and Chemicals make up ~13% of SA's gross emissions – of which ~90% driven by synfuels production

Emissions updated in line with latest (2021) iteration of DFFE[4] 2017 GHG baseline



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5

Key questions to address to understand the future of petrochemicals and chemicals in South Africa

1. How will the petrochemicals and chemicals demand landscape change globally and locally?
2. How can the sector respond to a changing demand landscape and where can South Africa build on existing competitive advantages?
3. What decarbonisation pathways exist for the South African petrochemicals and chemicals sector?
4. What are the socio-economic risks and opportunities that arise with the decarbonisation of the petrochemicals and chemicals sector?
5. What are key enablers for the decarbonisation of South Africa's petrochemicals and chemicals sector and the development of local green fuels and chemicals production?

Source: NBI-BCG project team

Demand for lower-carbon fuels to grow in the mid-term, while "climate compatible" fuels to dominate in the long-term

Directional 2050 net-zero view

Conventional fuel

Gradual reduction in the mid- to long-term, in a net-zero world demand for conventional fuels negligible

Lower-carbon fuel

Increased demand in the mid-term but decreases in the long-term (e.g. biofuels in transport vehicles, aviation)

Net-zero fuel

Significant uptake in the long-term across industries, particularly in hard-to-abate sectors (e.g. steel making, aviation)

Source: NBI-BCG Project Team

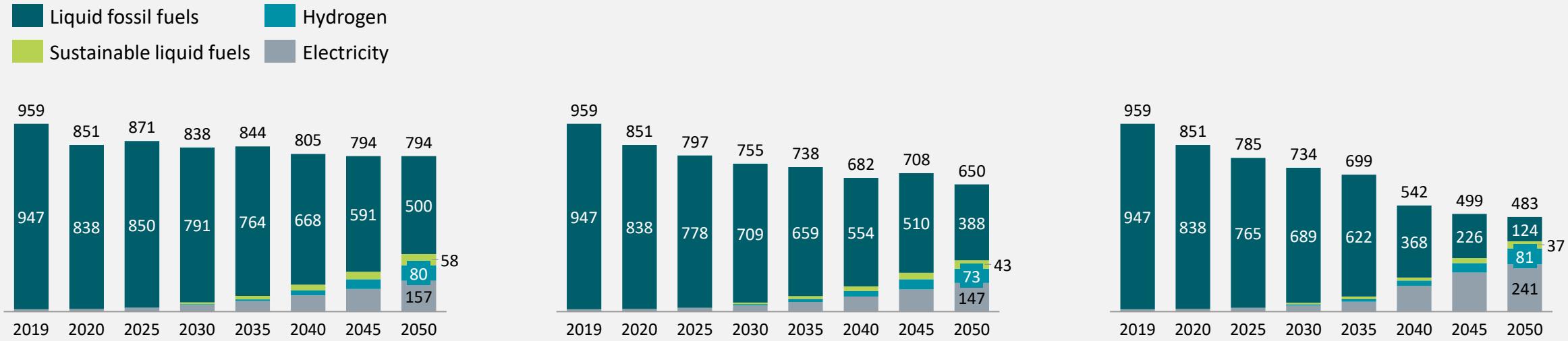
Example Transport: Liquid fuels demand will decrease significantly in South Africa as a result of decarbonisation

Base case (Reference Tech Scenario)

Base case (Sustainable Dev. Scenario)

Base case (Global net-zero scenario)

Energy demand in PJ



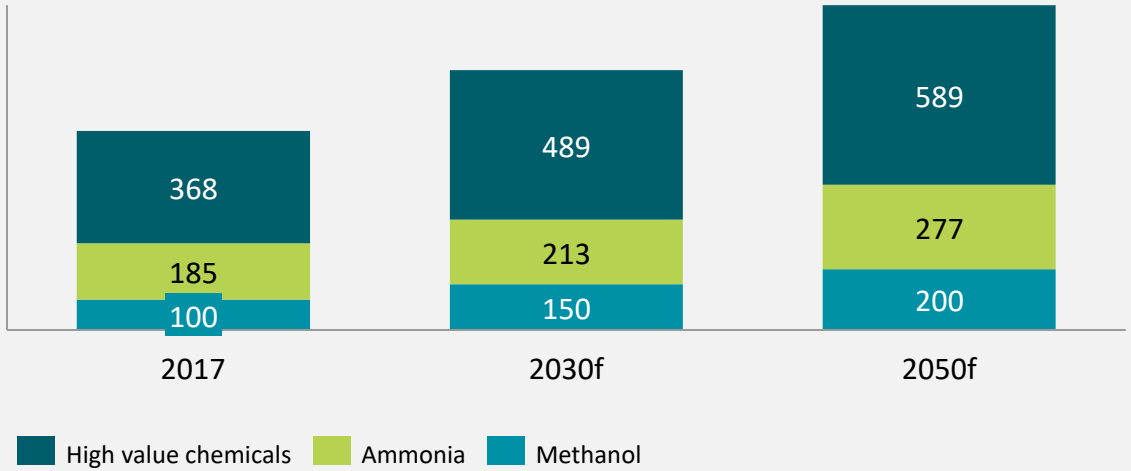
Note that this analysis includes energy demand from domestic aviation, rail, and road transport

Note: liquid fossil fuels refers to conventional diesel, petrol, LNG and jet-kerosene; Sustainable liquid fuels or sustainable aviation fuel (SAF) refers to synthetic jet-kerosene;
Source: eNatis; ICCT; IEA; IHS Markit; Marklines; NAAMSA; BCG battery model; NBI-BCG project team

However, chemicals still growing in demand: Primary chemicals demand forecasted to grow by ~60% in 2050…

With highest areas of growth in key chemical feedstocks: methanol, high value chemicals[1] and ammonia

Global chemicals production forecasted to 2050 (Mt per year)



…but pressure to reduce product life-cycle carbon-intensity increasing

Investor pressure and shifts in value pools are already being reflected in petrochemicals companies' valuations

Markets considering stricter requirements around carbon intensity of products e.g.,

- The EU accounted for ~20% of SA's chemicals export market. This will decrease the competitiveness of SA's carbon-intense chemical products
- EU carbon border tax to be implemented by 2023 to prevent carbon leakage

Source: International Energy Agency, The Future of Petrochemicals 2018; World Integrated Trade Solution 2018; Press research

Global green H2 demand could reach ~160-300mt by 2050

Tradeable H2-relevant products – for power, heat, non-energy and transport applications – require up to ~300mt green H2 globally in a potential "Paris" compatible 2°C uptake scenario; 'stated policies' and 'selected application H2 acceleration' scenarios yield ~100mt and ~230mt global H2 demand in 2050 respectively

Today, EU (Germany, Netherlands) and Japan emerging as 1st import markets, with concrete figures / targets around 2050 H2 product import demand (~25-30mt)

If SA were to capture only 10% of EU and Japan's 2050 H2 import demand, SA's total demand could reach ~6-7 mt by 2050

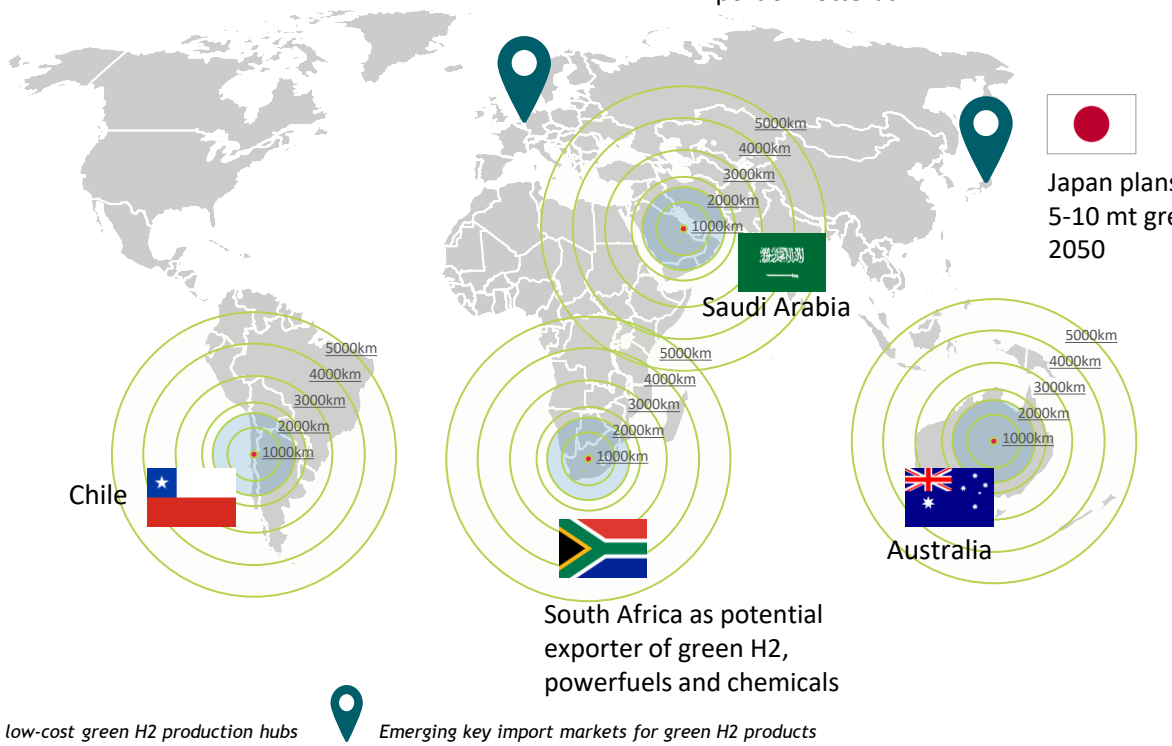
~100-300mt
global H2 demand 2050[1]

~30mt
H2 demand 2050 in key markets in EU & Asia

~3mt
add. H2 demand in SA to meet 10% of key market demand`

View of emerging green H2 product import and export markets

EU demand for imported H2 / H2 powerfuels equals ~20 mt H2 by 2050, expected to be imported via port of Rotterdam



Japan plans to import 5-10 mt green H2 by 2050

• *Potential low-cost green H2 production hubs*

Emerging key import markets for green H2 products

1. 300 mt demand figure linked to Paris Agreement compatible decarbonisation scenario ("BCG 2°C Scenario") of BCG Global H_2 Demand Model May 2021. Assumes 34% penetration for ocean shipping, 33% penetration for aviation, 20% penetration for heavy road vehicles, 52% penetration for ammonia, 46% penetration for methanol, 61% penetration for refineries, 4% penetration for industrial power and 8% penetration for industrial heat; differences in demand between demand scenarios due to different assumed penetration rates | Source: BCG analysis, BCG Global H_2 Demand Model - v.Beta: May2021, AURORA Energy (2021), CSIR (2021), Enertrag

South Africa is well positioned to play in the green H2 value chain with 3 structural competitive advantages

SA with large scale, high quality RE potential

Power sector decarbonisation requires ~84 GW solar PV and ~64 GW wind installed by 2050

REDZ alone can hold **~922 GW[1] RE** capacity (assuming 60% solar PV, 40% wind split) at an average load factor of **23-26% for solar PV and 36-44% for wind**

Average load factors in SA **amongst the best in the world** and on par with major competitors like Chile, Saudi and Australia

Sufficient land and synergies in solving for water security

Just **1% of SA land area** (1.1MHa) would be sufficient to produce **~1330PJ (10Mt) green H2**

SA with vast land available, with **~ 5.35 Mha in REDZ** alone (areas not in competition with agriculture or settlements and with RE potential)

Water requirement for 1330PJ/a green H2 production only **31% of current power sector use** in coal-based generation, and could be produced via desalination (~$0.005-$0.01/kg green H2) at the coast

Unique FT expertise for beneficiation into e-Fuels

Proprietary Fischer-Tropsch (FT) technology – lacking in other countries (critical for PtL)

Existing assets and knowledge allow for local beneficiation of green H2 and enhance potential for large scale local demand

Opportunity to capture portion of global export market for e.g., green ammonia, methanol, jetfuel

Note: REDZ = Renewable Energy Development Zones - areas in SA selected for large scale renewable energy development and identified as having a combination of available land, sufficient RE resources, and potential to have meaningful socio-economic impact on surrounding communities (new REDZs currently under consideration) 1. Assuming 3 ha/MW solar PV, 10 ha/MW wind | Source: CSIR/Fraunhofer; BCG analysis

SA has the opportunity to become a green fuels and chemicals producer

Specialist producer for future demand by 2050

For local consumption and as feedstock

For local consumption and export

Green H2

Requires RE power and H20 as feedstock

Green aviation fuel

Requires green H2 and biomass as feedstock

Green chemicals

Requires green H2 and biomass, potentially also fossil carbon source

Green ammonia

Requires H2 and N2 feedstock

Source: NBI-BCG project team

Different technical pathways exist towards green fuels and chemicals production in SA, and they are dependent on the availability of **currently disruptive technology (green H2, access to sustainable sources of carbon) and the potential role of gas as a transition fuel**

Conventional refinery capacity expected to shut down in the mid-term, green production could be established via converted synfuels assets and new assets

Conventional refineries

Turn down

conventional refineries due to decreasing competitiveness against imports

Existing synfuels assets

Decarbonise and transform synfuels assets

whereby three pathways considered

1. Disrupt and leapfrog gas
2. Leverage gas at scale
3. Extend coal

New green assets

Build additional, new green assets

to complement existing production for local and global green fuels and chemicals demand

Specialist producer for green fuels and chemicals by 2050

Pathways differ in cumulative emissions, production cost increase and socio-economic impact

Today's production landscape

Conven. refineries and GTL assets

Turn down

conventional refineries and GTL assets due to decreasing competitiveness against imports

Existing synfuels assets

Decarbonise and transform synfuels assets

- Disrupt and leapfrog gas
- Leverage gas at scale
- Extend coal

New green assets

Build additional, new green assets

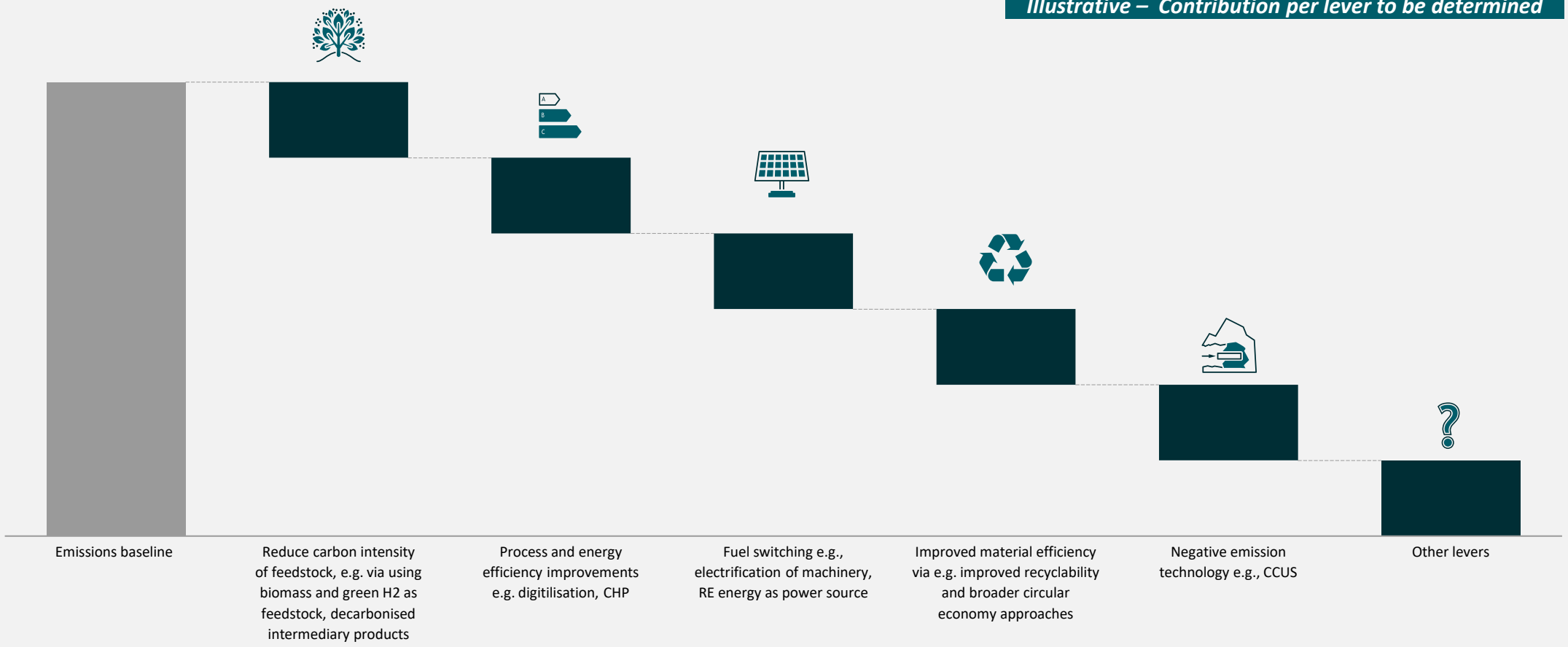
to complement existing production for local and global green fuels and chemicals demand

Cum. emissions (GtCO2e)	~0.2-0.4	~0.6-1.0	~1.0-1.2	~1.2-1.3	Net-zero
Add. Cost (R/l)		~7	~5	~2*	

* Assuming 127 ZAR/t CO2 carbon tax, no carbon budgets / penalties for exceeding caron budget

Various measures required to decarbonise SA's downstream chemicals, which drives 2% of sector emissions

Illustrative – Contribution per lever to be determined



Source: Source: TIPS 2019; Deloitte: 2030 decarbonization challenge; BCG analysis

Four key signposts for the Petrochemicals sector

1

Sustainable Sources of Carbon

Availability of sustainable sources of carbon at an affordable price (delivered to production facility) will be critical to build a national competitive advantage

2

Delivered Price of Green H2

The evolution of levelized cost of Green H2 will drive the affordability and competitiveness of lower carbon fuels & chemicals (eFuels, Green Ammonia etc.)

3

Policy and Incentives

E.g. Blending mandates (particularly in the EU), Carbon Tax and other regulatory levers will determine affordability and drive demand

4

Availability of affordable Gas

Availability of gas at scale and at an affordable price (including the risk-adjusted cost of midstream infrastructure)

Source: NBI-BCG project team

Key no-regret action that needs to be pursued now by private and public sector to enable the sector's transition

Coal mining	• **Facilitate coal decommissioning** and manage socio-economic impact
Convent. Refineries & GTL assets	• **Assess feasibility of GTL asset conversion** to a green synfuels production asset • **Assess socio-economic and energy security impact of refinery shutdowns identify counter measures** that could mitigate the socio-economic risk
New green assets	• **Develop a green fuels and chemicals industrialisation plan;** and assess the need for the construction of new green fuels and chemicals assets
RE & Green H2	• **Develop a conducive policy framework that** enables large scale renewables and energy storage deployment • **Develop national green H2 vision and commercialisation** strategy; launch pilot projects • **Launch public-private green H2 consortium**, **secure off-take agreements** with key trade partners (e.g., for the supply of SAF and shipping fuels)
CCS	• **Drive research regarding the existence** of suitable carbon storage sites (e.g., feasibility of storage in the Durban basin) • **Establish a cross-sectoral, public-private CCS consortium,** which determines the requirements for the development of potential CCS clusters
Sustainable sources of carbon	• **Develop a national biomass strategy** which focuses on the availability, accessibility and affordability of biomass • **Drive further research and development around the deployment of DACC** technology in South Africa • **Assess the role of CCU as an interim, alternative source of carbon** (e.g., captured from other industrial processes such as stell making)
Gas	• **Establish an inter-disciplinary task team to fast-track the gas masterplan** • **Finalise local content requirements for upstream participation** as part of the Upstream Petroleum Resources Development Bill

Note: SAF = Sustainable Aviation Fuel; GTL = Gas to Liquid; CCS = Carbon Capture and Storage; DACC = Direct Air Carbon Capture

Q&A

Please post your questions in the chat

Decarbonising South Africa's mining sector – towards unlocking the mining of a net-zero future in South Africa

SA's mining sector is a key socio-economic contributor – with coal and PGM accounting for the largest share of revenues and jobs

SA mining is a significant contributor to the economy, representing more than 4% of direct jobs and more than 8% of direct GDP (2019)

Coal and PGM mining are the largest mining sectors in SA, accounting for 50% of total sales in mining in 2019

In 2019, the mining sector provided ~460K direct jobs of which PGMs, coal and gold accounted for ~168K, 94K and 93K respectively

Despite the recent uptake in commodity markets, mining has historically been in structural decline…

Between 2010 and 2017/18: -10% in real production output, -50k in total direct employment, -43% decline in CAPEX

…with climate change worsening the situation

Source: BCG analysis

Global climate action will require SA mining to respond to 3 key challenges, **whilst ensuring a Just Transition**

Shifting value pools in commodity markets

Global climate action will have severe business impact for mining players—affecting global demand for several major commodities

Pressure to decarbonise

New disclosure standards, activist investors, regulators, and the public put pressure on companies to curb their own carbon footprint and develop resilience strategies

Need to adapt to climate change

SA to be impacted by local climate change (incl. more extreme weather events) – which mining operations need to adapt to

Source: BCG analysis

Key questions addressed in Mining sector analysis

1. How will global and local decarbonisation trends affect South Africa's mining sector?
2. How can the mining sector respond to challenges that arise with global and local climate action and the local impacts of climate change?
3. How can a Just Transition in South Africa's mining sector be ensured?
4. What are pathways towards a 2050 South African net-zero economy for South Africa's mining sector?
5. What enablers need to be put in place to support the pursuit of a net-zero pathway for mining in South Africa?

The future of South Africa's Mining sector

1. **If the South African mining sector drives decarbonisation along the value chain and adapts to the global shift in mining commodity value pools, it can remain internationally competitive and promote socio-economic development in South Africa via enabling green opportunities across sectors**

2. In the context of climate change, the South African mining sector faces four key challenges: value pools are shifting away from South Africa's key mining commodities towards green tech. commodities; the pressure to decarbonise from stakeholders is mounting; there is a growing need to adapt mining operations; and ensuring a Just Transition will be critical

3. South Africa's key mining commodities will be impacted by climate action – thermal coal will be phased out and overall PGMs demand could decrease towards 2050. South Africa should strive to meet Department of Mineral Resources and Energy (DMRE) targets of 4–5% of global exploration expenditure (~ZAR8 billion per annum [bn/a]) by 2026, to drive exploration of green tech commodities in South Africa, while putting in place the policy environment and infrastructure, particularly clean energy supply, that will enable increased local beneficiation

4. Decarbonisation of the mining sector will be driven by cleaner, renewable electricity supply, which eliminates ~73% of Scope 1 and 2 emissions, while electrification of mobility and stationary machinery would eliminate ~15% of Scope 1 and 2 emissions. Furthermore, the phase-out of coal would remove most fugitive emissions

   a. Clean electricity supply via a hybrid supply concept, leveraging both self-generation and grid electricity, is the most cost-effective electricity decarbonisation option for the mining sector, requiring ~12 GW of self-generated RE and ~5 GW of battery capacity (~50 times the current distributed RE capacity in South Africa and a ~ZAR290 bn investment over the next 30 years

   b. The decarbonisation of mining vehicle fleets will require a ~ZAR90 bn total investment over 30 years and will produce cost savings post-2024 as a result of reduced vehicle fuelling cost, provided that OEMs and miners drive collaboration to overcome today's technical challenges around battery electric vehicle (BEV) and fuel cell electric vehicle (FCEV) deployment

   c. As coal phases out, Scope 3 emissions in mining will mainly be driven by iron ore usage in steel production and, to a lesser extent, metal processing; eliminating those emissions requires a transition towards green steel production

5. Increasing temperatures, changing rainfall patterns and more frequent extreme weather events will impact mining operations in South Africa significantly and will require mining companies to develop adaptation pathways that account for risk thresholds along the value chain

6. A well-managed phase-out of coal will be critical given the pressing need to reduce the carbon-intensity of South Africa's economy to maintain competitiveness. While developing a clear Just Transition plan to protect the livelihoods of coal miners and coal value chain workers is critical, this segment only represents ~20% of current employment and ~26% of current revenue in the mining sector, highlighting that significant opportunity will remain in the sector

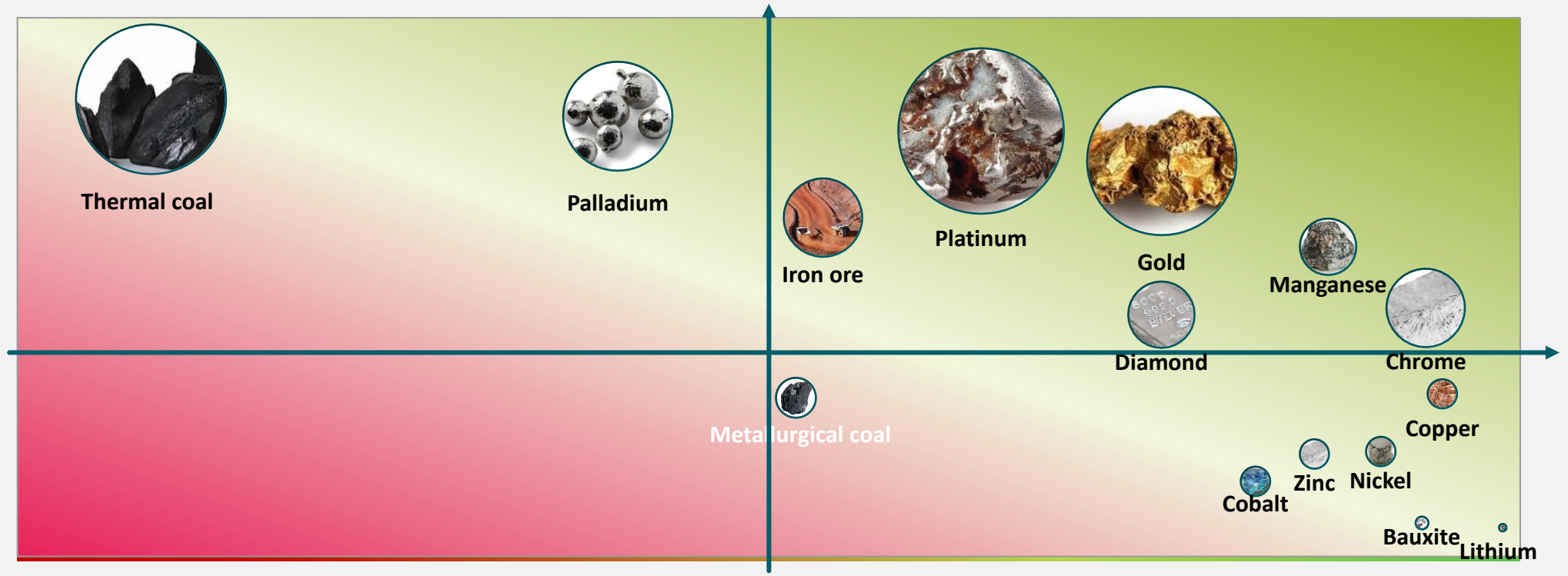
7. Enabling the development of a climate-resilient, competitive mining sector requires public-private sector coordination along a common commodity exploration, production and beneficiation strategy, a conducive policy environment, cheap finance and access to reliable, affordable, clean energy supply

8. If the existing structural issues are overcome, an enabling policy environment developed, and a clear path towards decarbonised operations, and production and beneficiation of green tech commodities exists, South Africa's mining sector could become a prime destination for global long-term investments in mining and contribute to a Just Transition in South Africa

SA coal and palladium demand expected to decline; iron ore, platinum, copper and battery materials with growth potential

INDICATIVE (not exhaustive)

Size of bubble indicating job contribution for SA



Source: NBI-BCG project team, Mining Technology

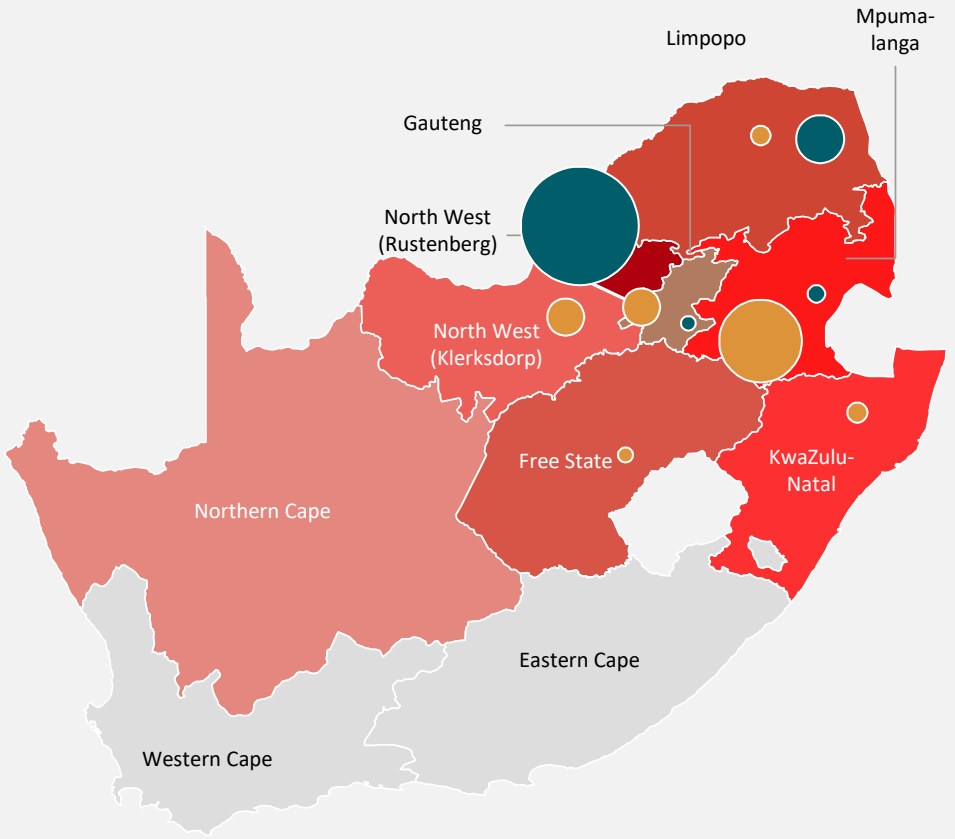
The shift in value pools puts significant socio-economic risk on today's mining regions and communities in SA

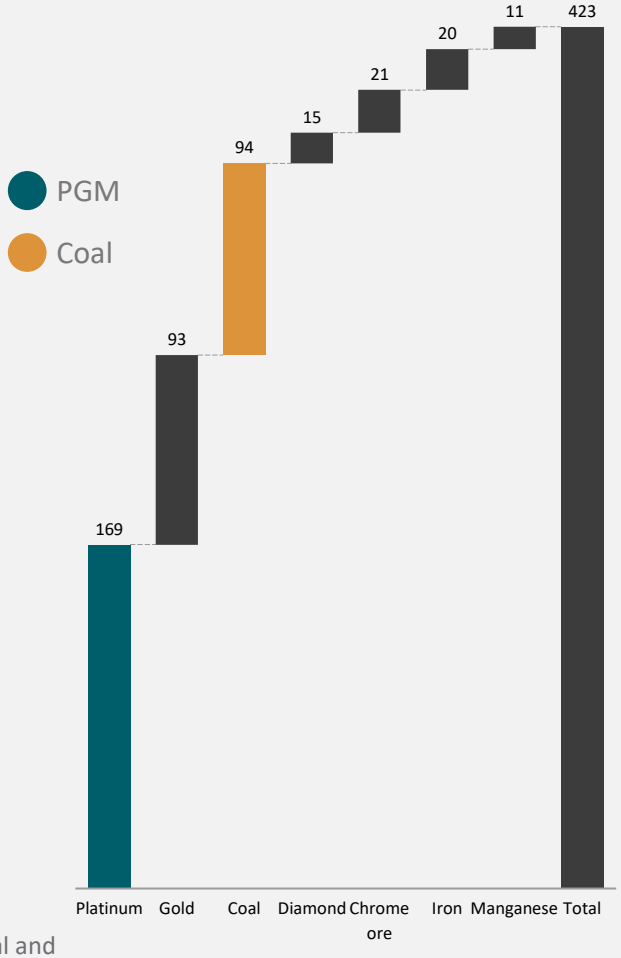
PGM and coal mining regions in the north, northeast and northwest at risk to be hardest hit from local and global decarbonisation

~60% of todays mining workforce in South Africa at risk

But risk even higher: On average, one mine worker has ~5-10 dependants, supporting **2 million – 4 million livelihoods**

Size of bubbles indicates regional number of jobs in coal and platinum respectively. Proportional to regional mining jobs in other commodities





Source: Stats SA, Minerals Council South Africa, NBI-BCG project team

Critical to leverage potential opportunities within and adjacent to the sector to address the shift in value pools

Shift mining to increasingly in demand, clean tech commodities

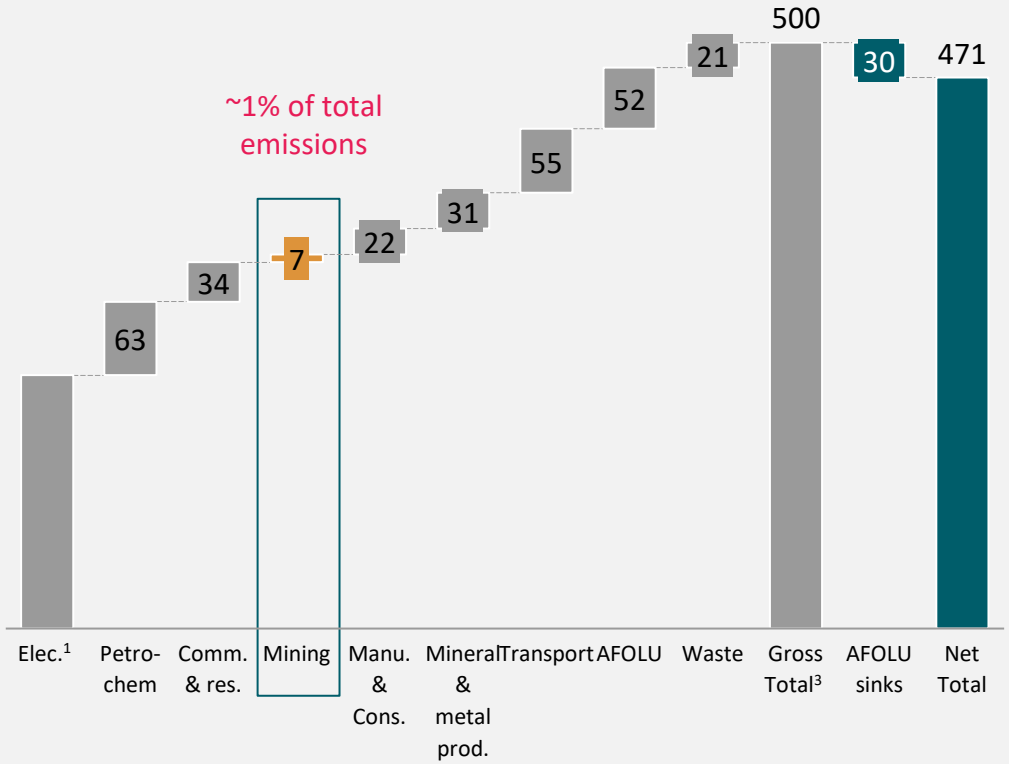
Drive market development related to the use of specific commodities in clean tech applications

Shift to new business models / products and services

Source: BCG analysis

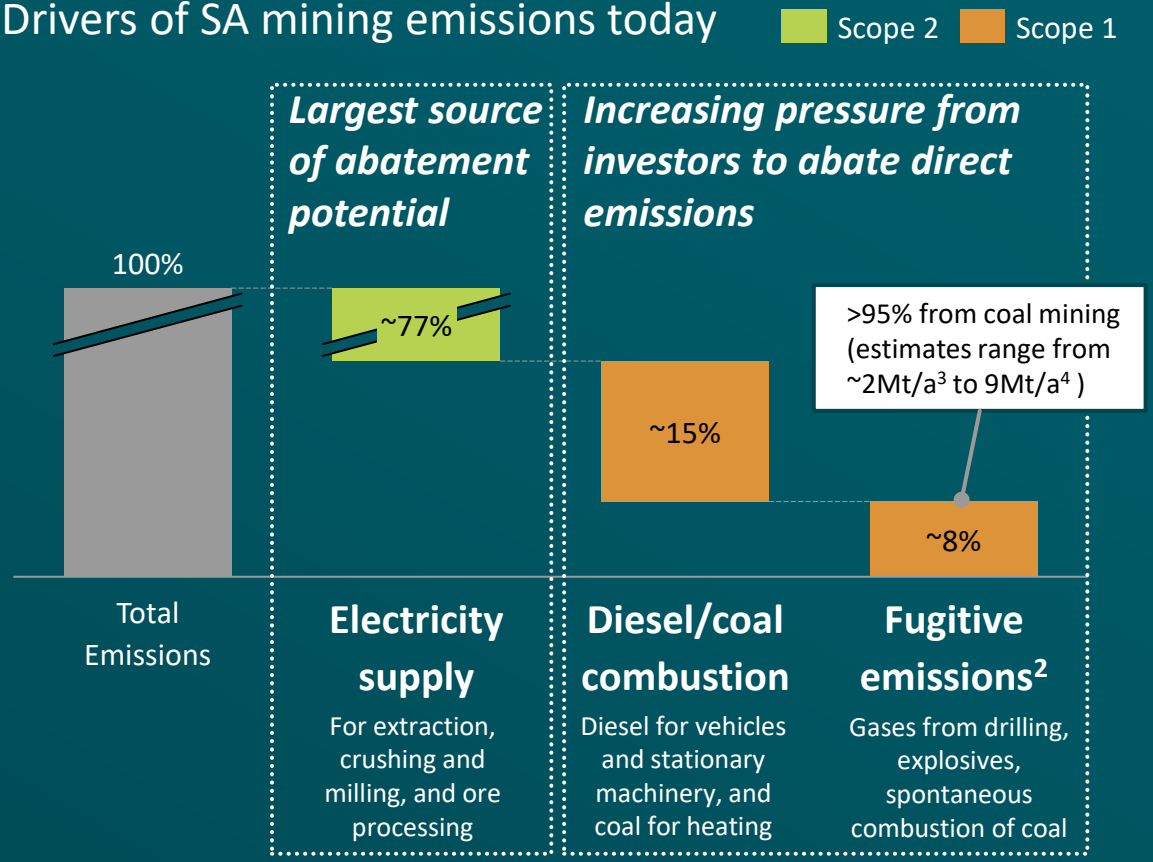
Mining sector responsible for ~1-2% of SA's total direct emissions

Overview of emissions in South Africa (MtCO2e)



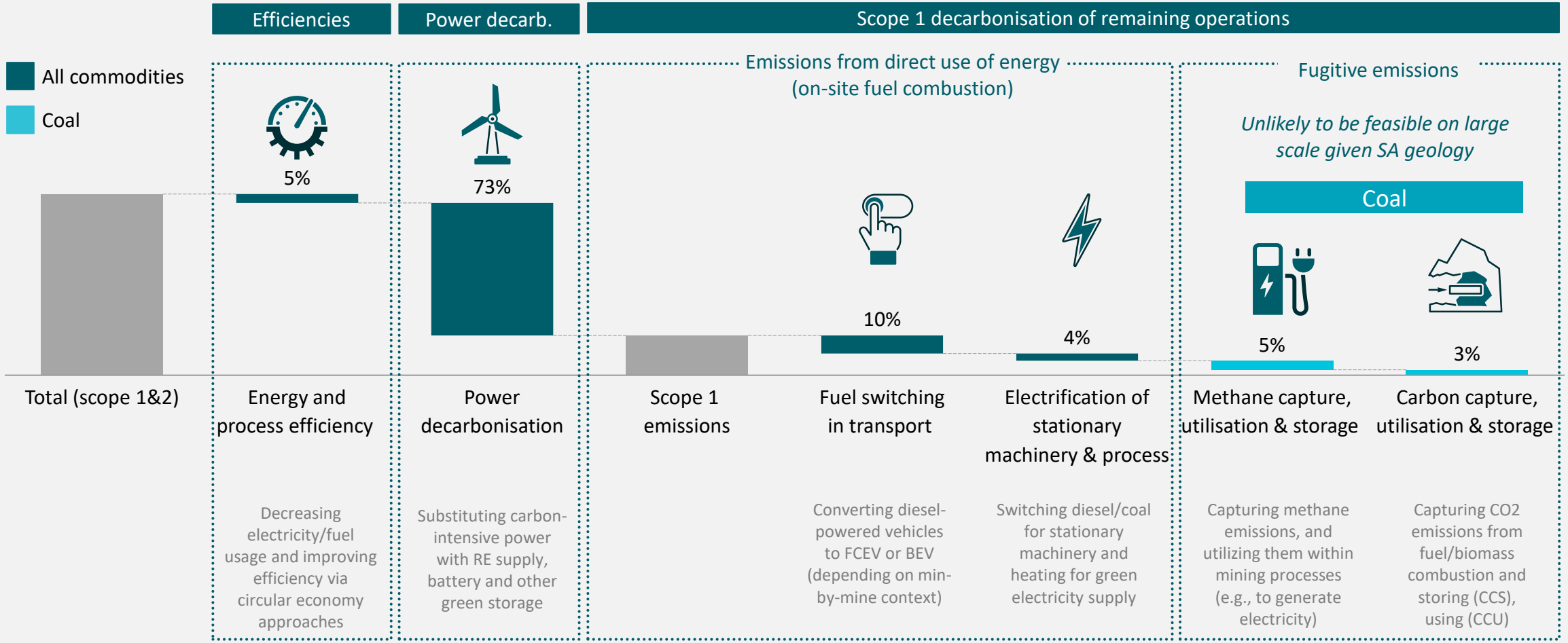
However, scope 2 emissions make up ~80% of mining scope 1 and 2 emissions

Drivers of SA mining emissions today



Note: Petrochemicals sector includes basic chemicals, rubber products, plastic products, other chemical products, man-made fibres, and liquid fuels (including synthetic fuels). Total emissions include both scope 1 and scope 2 emissions. Sector baselines are scope 1 emissions. Scope 1 emissions are defined as direct emissions from all activities within control of an organisation. Scope 2 emissions are defined as indirect emissions from purchased electricity and are therefore included in electricity production scope 1 emissions. | 1. In GHGI, Mining part of Manufact. & constrn. But emissions not explicitly stated so they have been estimated & separated out 2. Figure estimated applying emissions intensities from Lloyd and Cook (2004) 3. Extrapolation of 2004 estimates by Lloyd and Cook 4. Extrapolation of 2010 estimates from USEPA | Source: GHGI 2017, Sasol 2017, Refinitiv Database, Company Annual Integrated Reports, Company Annual Sustainability Reports, NBI-BCG project team

Emissions can be fully abated through power decarbonisation, machinery and heat electrification, and efficiency improvements



1. Fugitive Emissions 2. Dependent on mix of efficiency levers and maturity of operation | Source: Company reports, BCG Publication – Mining Needs to go Faster on Climate Change (Feb 2020), NBI-BCG project team

Over 2020-2050 period, hybrid self-generation RE and grid supply concept emerges as promising business case for accelerated power decarbonisation

Carbon tax not included

	SCOPE 1			SCOPE 2		
	Switch to FCEVs and BEVs and supply with RE			Totally decarbonise mining electricity supply by 2050 (incl. electricity required for machinery/process electrification)		
Considered dimensions[1]	0 No ZEV switch (baseline)	1a BAU ZEV switch	1b Net-zero ZEV switch	4 Decarbonise in line with grid (by 2050)	5 Hybrid grid-RE supply by 2030[3]	6 Off-grid RE electricity supply by 2030[4]
Cum. emissions (MtCO2e)	135	110	88	619	432	234
Abatement cost (R/tonne)	N/A	-4890	-2505	N/A	-272	605
Cum. CAPEX (R billion)	0	39	90	0	288	818
Cum. OPEX (R billion)	640	480	432	1116	777	531
Total cum. cost (R billion)	640	519	522	1,116	1,065	1,349

Notes: Constant grid tariff of USD 65/MWh assumed; diesel and coal prices of USD 75/MWh and USD 4/MWh assumed for 2019 and scaled with EIA projections to 2050; Green H2 delivered cost changes from USD 4.3/kg in 2025 to USD 2.1/kg in 2050 | 1. Over 2020-2050 period 2. Assume vehicles refueled during optimal RE load hours (thus constant hourly supply is not a constraint) 3. Constant hourly supply of electricity ensured by supplementing RE and battery supply with grid electricity 4. Constant hourly supply of electricity is ensured by supplementing RE and battery supply with piped green H2 which is fed into on-site turbines

Mining scope 3 emissions

Thermal coal phase-out will eliminate significant portion of scope 3 emissions, however, iron ore and steel value chain presents significant techno-economic challenge

Emissions spread along the value chain

- Sourcing — 1-5%
- Transporting — 2-3%
- Processing/use by customers — 90-95%

Source: GHG Protocol, Company Reporting; NBI-BCG team

1 Key levers: Zero emissions value chains can be reached by 2050 but require miners to help manage, incentivise, and enable downstream decarbonisation by supplying required green materials

Incentivise and enable downstream decarb.

- **Preferential pricing or product access** to customers with low CO_2 product uses
- Producing **higher quality/lump ore** to reduce processing requirements
- **Ensuring supply of 'green tech. commodities'** (e.g., lithium, copper, nickel)

Assist technology rollout

- **Vertical R&D or tech deployment** co-funding (e.g., Maersk, Rio Tinto)
- **CO_2 reduction "advisory"** to suppliers or customers (e.g., BMW, Daimler)
- Complementary **CO_2-reducting products** or initiatives (e.g., VW Elli green electricity)

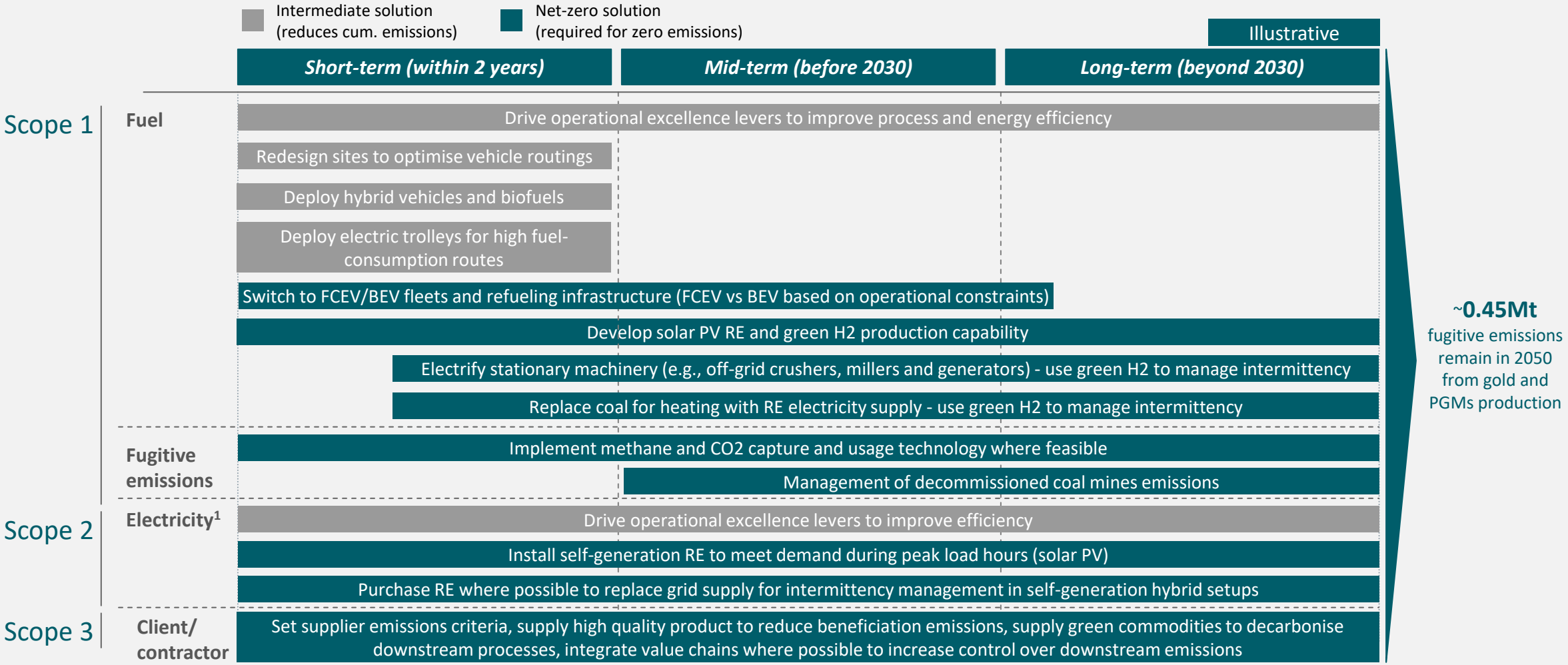
Evaluate customer/supplier mix and commodity portfolios

- Commodity/customer **portfolio management** with regards to CO_2

2 Maximising value from green ecosystems: Requires close relationship between miners and downstream players

- **Partnerships** allow acceleration of technologies already backed by downstream players, through co-funding and relationships that facilitate sharing of expertise
- **Green funding** brings CAPEX to a constrained downstream industry

Timing and scale of lever deployment will depend on tech-economic feasibilities and decarbonisation ambition



Source: Expert interviews, BCG case experience

South Africa's changing climate…

Rising temperatures

Shifting rainfall patterns

More extreme temp. events[1]

…poses significant physical risks to the mining sector

Not exhaustive

Mine facilities and operations

- Increases wildfire risk
- Risk of underground mines overheating
- Disrupts production
- Necessitates improved water treatment (pollution risk)
- Impacts slope stability near opencast mines

Critical infrastructure

- Disrupts electricity supply
- Disrupts transport routes
- Damages infrastructure (e.g. ports, roads, electrical infrastructure)

Worker safety and productivity

- Increases risk of heat-related illness
- Increases risk of contracting tropical diseases
- Impairs visibility on roads and on site due to dust/mist
- Poses health risks due to mine dust exposure
- Safety risks due to extreme weather events

1. Very hot day is classified as >35°C

Source: BSR, "Adapting to Climate Change: A Guide for the Mining Industry"; Chavalala, "An Assessment of South Africa's Coal Mining Sector Response to Climate Change Adaptation Demands"

Unlocking South Africa's vision of a Just Transition at a national and sectoral level hinges on key building blocks

Vision 1

For South Africa, the Just Transition is a shift towards environmentally sustainable economies & societies for all. Such a transition needs to be well managed and contribute to the goals of decent work, social inclusion and the eradication of poverty for all South Africans.

Challenges & opportunities 2

- Electricity
- Petro-chemicals
- **Mining**
- AFOLU
- Transport
- Manufacturing & construction
- Metals & minerals
- Other sectors of today and future

Building blocks 3

- Job creation
- Social & ecological welfare
- Managing geo. & cultural dislocation
- Education, capacitation & skilling
- Economic inclusion & participation
- Ownership
- Quality of work
- Infra. planning & roll-out
- Policy & governance
- Funding

4 **Stakeholder collaboration & coordination key to all building blocks**

Source: NBI-BCG Project Team

Pursuing these pathways requires financing, conducive policies and technology development and certainty

~380 Bn ZAR capital investment requirement

- ~290 Bn ZAR for RE deployment (in a hybrid RE-grid setup)
- ~90 Bn ZAR for BEV/FCEV switch and deployment of fuel production infrastructure

Technology certainty and development

- Feasibility of 'Tapping into' the grid for hybrid electricity supply must be ensured
- Miners & OEMs must collaborate to drive electrification pilots
- H2 delivery infrastructure strategy required for mining regions

Conducive policy frameworks and support

- Enabling policy frameworks that attract cheap green finance
- Policy that clarifies interaction between grid and self generation
- Ensuring PPA terms align with life-of-mine considerations

Mining in SA must reposition itself to capture the shift in value pools and must decarbonise and adapt to climate change to remain globally competitive – A Just Transition is paramount for all pathways considered

Q&A

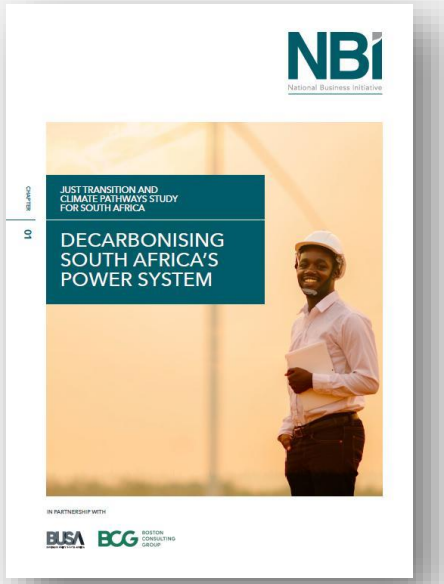
Please post your questions in the chat

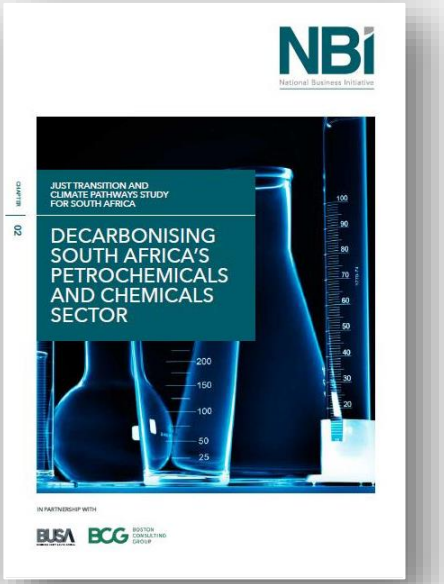
Outlook and next steps

Joanne Yawitch

CEO National Business Initiative

This is our 2nd wave of reports, the 3rd wave of reports to be released during COP26





The role of gas in South Africa's decarboniation	Decarbonising and building climate-resilience for South Africa's Agriculture, forestry and other land use sector	Decarbonising the South African transport sector

The COP26 South Africa Pavilion will be jointly hosted by business and government

This is an opportunity for us to showcase the opportunities that have emerged from Just Transition Pathways work on an international platform and position South Africa as a major investment destination to attract finance for our Just Transition to a low carbon, resilient and socially sustainable and inclusive future.

THANK YOU TO THE SPONSORS OF THE MINING AND PETROCHEMICALS & CHEMICALS SECTOR ANALYSIS

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Thank you