Growth Through Inclusion in South Africa

A Report by The Growth Lab
at Harvard University

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About the Growth Lab

The Growth Lab is a research program at Harvard University. With its multidisciplinary team of roughly 50 staff, fellows, and faculty led by Professor Ricardo Hausmann, the Growth Lab pushes the frontiers of economic growth and development policy research. The Growth Lab advances academic research on the nature of economic growth and conducts place-based engagements that aim to understand context-specific growth processes, help address key constraints, and identify promising growth opportunities. Through its research and teaching activities, the Growth Lab has become a global thought leader offering breakthrough ideas, methods, and tools that help practitioners, policymakers, and scholars understand how to accelerate economic growth and expand opportunity across the world. Consistent with the mission of the Harvard Kennedy School of Government, in which the program is housed, the Growth Lab works to expand capabilities for improved economic policymaking such that more people and societies can enjoy higher levels of wellbeing through stronger, more sustainable, and more inclusive economic growth processes.

Growth Lab applied projects utilize a variety of tools from economics and other disciplines with a focus on understanding place-specific growth challenges and enabling learning-by-doing to address these challenges locally. Key frameworks developed at the Growth Lab and applied within projects include Growth Diagnostics and Economic Complexity. Growth Diagnostics is a methodology that identifies the most binding constraints to better growth outcomes, which informs and allows policymakers to take highly impactful actions. Economic Complexity is a growing field of research that leverages network science and machine learning to understand what economic activities a given country or region could expand into next, based on what it currently does. Growth Lab applied projects aim not only to understand constraints and opportunities in specific places, but also to empower local stakeholders in real time and *in situ* to address constraints and seize economic opportunities through training, capacity building, and the development of practical, place-based tools. All applied Growth Lab projects aim to generate publicly available research of relevance to the local community as well as frameworks, tools, teaching resources and learning experiences that strengthen the HKS community.

Table of Contents

Table of Figures

1 Growth Through Inclusion

1.1 Executive Summary

When South Africans threw off the structures of apartheid three decades ago, the nation captivated the world. The early 1990s marked a victory for generations of freedom fighters, and the future of an inclusive South Africa was set in motion. There was no telling what could be accomplished with the full force of South Africa's human capabilities, creativity, and resilience in combination with its industrialized economy and established comparative advantages in global trade. There was good reason to be hopeful as the Presidency of Nelson Mandela ushered in an active period of reconciliation. By including all South Africans in the functioning of society and the economy, the Rainbow Nation seemed poised to leverage its substantial economic assets at full strength. In 1995, South Africa supported the 47th most complex economy in the world[1] – on par with China (ranked 46th) and far ahead of any other African nation (Tunisia was next at 66th). There was good reason to believe that the economy would grow rapidly, and opportunity would expand to many more South Africans.

But more than a generation later, jobs are scarce and South Africa's economic potential remains unrealized. The national economy has experienced slow, slowing, and highly vulnerable growth. Inequality is the highest in the world, and structures of exclusion remain embedded in South African society both within and across racial groups and geographies. Black South Africans continue to face poverty and joblessness at very high rates, and overall wealth, although racially more balanced, remains as concentrated in a narrow few as it was at the end of apartheid (Chatterjee *et al.*, 2022). Though government policies have worked to dismantle many structures of the apartheid state and increase living standards, these efforts have not translated into the creation of job opportunities for too many South Africans. Despite immense effort aimed at socio-economic transformation, including policies of broad-based black economic empowerment, inclusion has been very limited in practice.

South Africa is failing to achieve growth and inclusion. Income per capita has been falling for over a decade. Unemployment at over 33% is the world's highest, and youth unemployment

[1] See country rankings in the Growth Lab's Atlas of Economic Complexity (https://atlas.cid.harvard.edu/rankings). South Africa's position has since weakened to 70th (China is now 17th and Tunisia 44th).

exceeds 60%. Poverty has risen to 55.5% based on the national poverty line,[2] yet many more households depend on government transfers to sustain meager livelihoods. Most cities are failing to adequately connect people to productive opportunities and are failing to innovate, grow, and drive inclusion. Rural areas in former homelands, where almost 30% of South Africans live, exhibit dismally low employment rates and remain exceptionally poor. Individuals living in these areas need to leave for an equal chance to earn a decent living. This report aims to answer why South Africa is failing to grow and failing to move the needle on economic inclusion three decades after the end of apartheid. The evidence points to two causes: collapsing state capacity and the persistence of spatial exclusion.[3]

State capacity has collapsed across many government functions that are essential for a functioning economy. Critical network industries, including electricity, transport infrastructure and services, security, and water and sanitation have experienced major deteriorations over the last 15 years. The economy has been forced to cope with increasing electricity rationing, leading to a declaration of national disaster in February 2023 after more than 15 years of load shedding. Rail and port capacity has declined, generating large losses in exports. The collapse in state capacity to deliver key inputs has, in effect, squandered the country's comparative advantage in cheap, coal-fired electricity. Urban crime is very high, and theft and sabotage undermine the functioning of many national infrastructure systems. Communities across the country are increasingly vulnerable to all forms of disaster – both natural and manmade – due to weakened public services. National finances are under increasing strain as South Africa relies on fiscal transfers to bail out state-owned enterprises (SOEs) and to redistribute national income to households to alleviate poverty and hardship. Many municipalities now face severe fiscal challenges which undermine already weak public service delivery. South Africa is seeing signs of unsustainability in its repeated credit downgrades and large sovereign risk premia. All the while, as growth slows, exclusionary forces are becoming more entrenched.

Spatial exclusion has been entrenched by well-intentioned policies in urban areas and an absence of effective strategy to include rural former homelands. Under apartheid, townships were intentionally separated from central business districts and economic infrastructure, leading to fragmented and disconnected cities. Apartheid also relied on

[2] Poverty figure corresponds to 2014, the latest official value.
[3] Throughout the report, the terms capacity and capability are used interchangeably. They both refer to the ability of the state or organization to effectively carry out the tasks and responsabilities assigned to them.

differential treatment to former homelands vis-à-vis the rest of the country, effectively separating those areas from the industrialized economy. Despite attempts to reverse this exclusion, policies since 1994 have unintentionally perpetuated many aspects of spatial exclusion. We find that urban planning regulations and zoning policies prevent dense, affordable housing in desirable locations and consequently limit both formal and informal employment. We also find strong evidence that formal jobs are limited because long commutes from low-density areas in and around cities make transportation costs and reservation wages high, while low residential densities prevent the development of a thriving informal economy. Meanwhile, rural former homelands continue to be economies separate and distinct from the rest of the country and face extremely low rates of employment.

This report summarizes the causes of slow growth and persistent exclusion within the South African economy. It starts by laying out the unavoidable conclusion that the economy is not delivering the shared prosperity that South Africans desire and deserve. We then document why growth is weakening. We diagnose a common pattern of breakdown in state capability that has caused growth to slow *(Chapter 2)*. Unlike a natural disaster, which is followed by a recovery when the disaster recedes, South Africa's collapse in state capability will continue to erode if systemic causes are left unaddressed. But this collapse does not fully explain South Africa's unemployment and inequality, however, which trace to a longer-term problem of spatial exclusion *(Chapter 3)*. While this problem has origins in apartheid, we find that post-apartheid policies have to a significant extent reinforced rather than counteracted patterns and processes of spatial exclusion. These two issues – collapsing state capability and spatial exclusion – together leave South Africa's enormous potential in its people, land, assets, and capabilities underutilized. Achieving a better economic future will require addressing both constraints. Given the collapse of South Africa's key advantage of cheap and reliable electricity, the country must also evolve its comparative advantage in a changing global economy. Since the 1990s, the global economy has become more integrated, and the world is now moving increasingly rapidly toward decarbonization. South Africa may have lost its historic comparative advantage in low-cost electricity via coal, but it has great potential to develop new green growth drivers that will help to supply global decarbonization *(Chapter 4)*.

Progress must come from a recognition of what is not working and corresponding actions to address both proximate causes and deeper causes of these problems. The collapse in

state capacity has policy and political causes and will not be resolved without significant change and bold leadership. The deeper causes of collapse stem in part from ideological gridlock within government, which has prevented critical decisions to be made in time, as has happened repeatedly in both electricity and rail. It also stems from a particular ideology that prevents society from contributing to supply societal needs; for example, by limiting private, provincial, and municipal power generation. It also stems from the mistaken belief that preferential procurement rules could be imposed on complex organizations, such as the network industries, at little cost. These rules have instead — in many cases — overburdened critical public organizations. South Africa also has a peculiar form of fiscal decentralization that has overburdened many municipalities that do not have the local capabilities to match the responsibilities. Finally, South Africa has seen a rise in political patronage, which has interacted with the other causes of state collapse. Together, these interacting causes of state collapse have created a vicious cycle where talent becomes harder to attract and retain in government, yet talented public servants are needed to restore and rebuild state capacity.

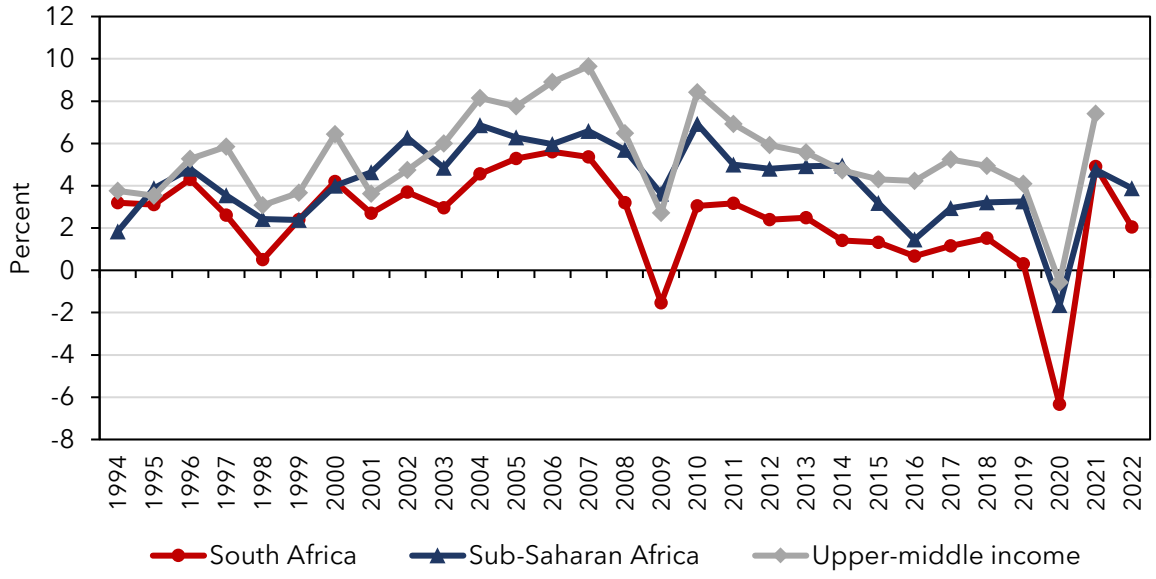
To reach its true economic potential, South Africa must include more of its citizens in the growth process. The path to growth through inclusion must include the recovery of state capacity and increasing the power of all members of society to exercise economic choice. The country cannot prosper with over half of its working-age population not working. It cannot afford to keep its citizens spatially disconnected. It cannot expect to grow with a collapsing state that *de facto* uses its power to limit society's capacity to help accomplish essential goals of the nation. South Africa's economic challenges may seem overwhelming at the current moment, but the promise of the Rainbow Nation is not out of reach. This report seeks to inform new paths to growth that will come through more effective economic inclusion. Inclusion must start by understanding and tackling key issues that drive exclusion. For the economy to function and leverage all the human capabilities, productive knowledge, physical assets, and natural endowments that South Africa has, the government needs to work. South Africa needs a more effective form of statism that does not overburden state organizations with additional goals that undermine their core mission. South Africa also needs to develop new and better mechanisms for driving inclusion, empowerment, and transformation that include far more of society. Central to this challenge is spatial inclusion, which is ultimately about giving people the choice of where to live and what markets to access. This includes not only the labor market,

but also markets for ideas, innovation, entrepreneurship, capital, finance, and partnerships that are undermined by the segregation of cities and other spaces.

1.2 Growth and Inclusion in Numbers

South Africa has a growth problem, which has intensified over the last fifteen years. Annual GDP growth averaged 3.6% per year from 1994 through 2008, or 2.0% in per capita terms, lower than that of upper-middle income countries and Sub-Saharan Africa on average (Figure 1.1). At its peak in 2006-2007, South Africa grew at a slower pace of growth than most peers and then experienced a sharper contraction in 2008-09. After the Global Financial Crisis, South Africa's growth remained more subdued. In fact, growth declined to an average of 0.7% (-0.5% in per capita terms) in the five years prior to COVID-19. In 2020, South Africa's contraction was again sharper than others. Since 2020, income per capita has not yet recovered to its pre-pandemic level even as South Africa has benefited from high commodity prices of several resources. Expectations are that South Africa faces difficult years ahead. Figure 1.2 shows the path of GDP per capita indexed to 100 in the year 2019 (before COVID-19), according to the IMF's projections. While Sub-Saharan Africa and emerging economies are expected to return to growth but without a recovery to the pre-pandemic path (Panels B & C), South African GDP is projected to continue to stagnate without returning to its pre-pandemic level (Panel A).

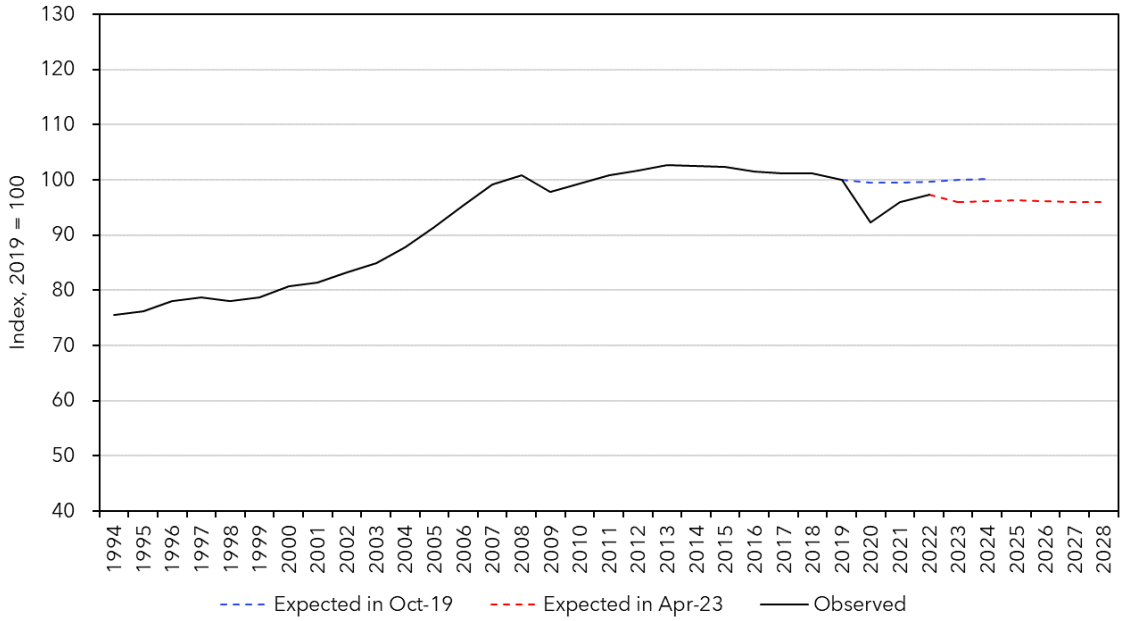
FIGURE 1.1: REAL GDP GROWTH – SOUTH AFRICA VS. PEERS



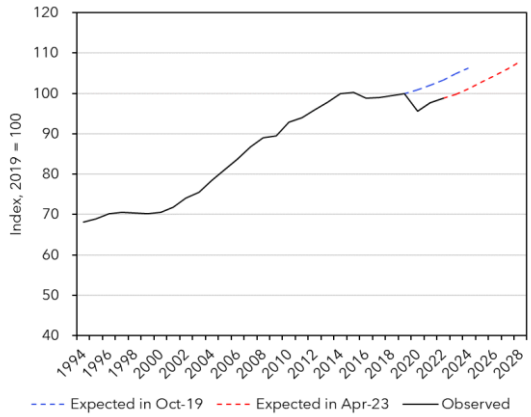
Source: Own elaboration based on World Economic Outlook (April 2023) for South Africa and Sub-Saharan Africa and World Development Indicators for Upper-Middle-Income Countries.

FIGURE 1.2: REAL GDP PER CAPITA – OBSERVED AND FORECASTS

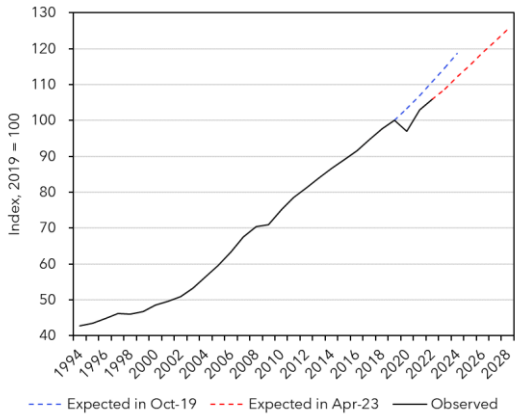
Panel A: South Africa



Panel B: Sub-Saharan Africa



Panel C: Emerging Economies

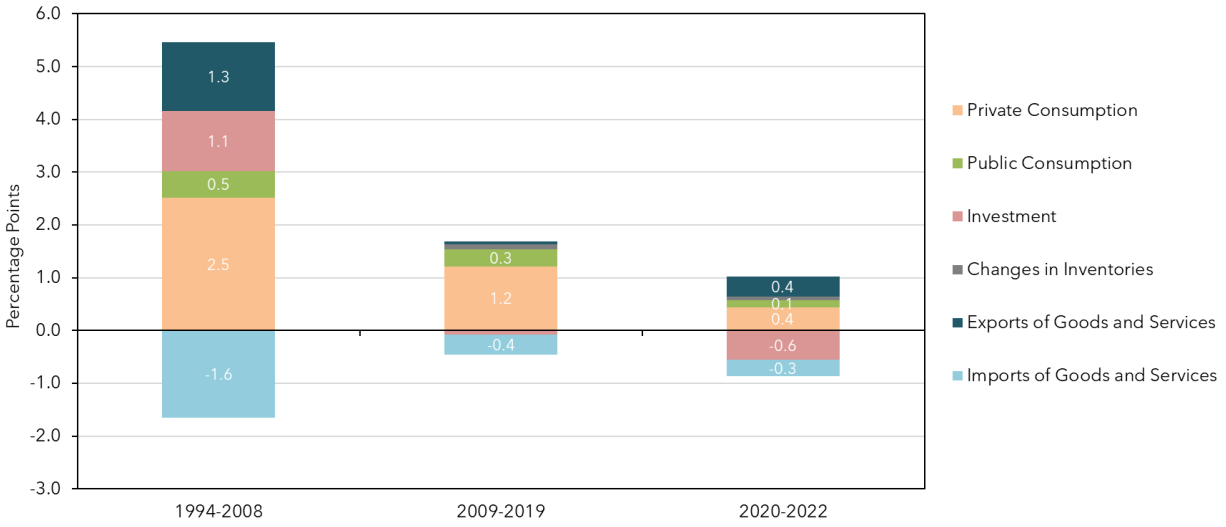


Source: Own elaboration based on World Economic Outlook (April 2023 and October 2019)

The COVID-19 pandemic hit South Africa hard, which exacerbated a pre-existing problem of declining global competitiveness across several sectors. As documented by Hausmann *et al.* (2022), over the fifteen years since 2008, sustainable growth drivers increasingly faded away, leaving an economy driven only by consumption: exports and investment contributed virtually nothing to overall growth over 2009-19 (Figure 1.3). This change cannot be explained by a decline in commodity prices alone because export volumes also stagnated. As a sign of declining competitiveness in the global economy, South Africa has

lost global market share since 2015 across numerous manufacturing industries, including textiles, machinery, chemicals, and electronics, as well as across agriculture and travel, and tourism exports.[4] If South Africa's global market share had just remained constant at its 2004-11 average, exports would have been 13.3% greater in 2019. South Africa then faced four intensive waves of COVID-19 infection over 2020-22. The onset of COVID-19 led to a further rapid decline in exports (by 25%) and investment (by 12%), and investment has not recovered to pre-pandemic levels. Meanwhile, private and public consumption continued to grow but at a slower rate than before COVID-19.

FIGURE 1.3: CONTRIBUTION OF EXPENDITURE COMPONENTS TO CAGR OF REAL GDP



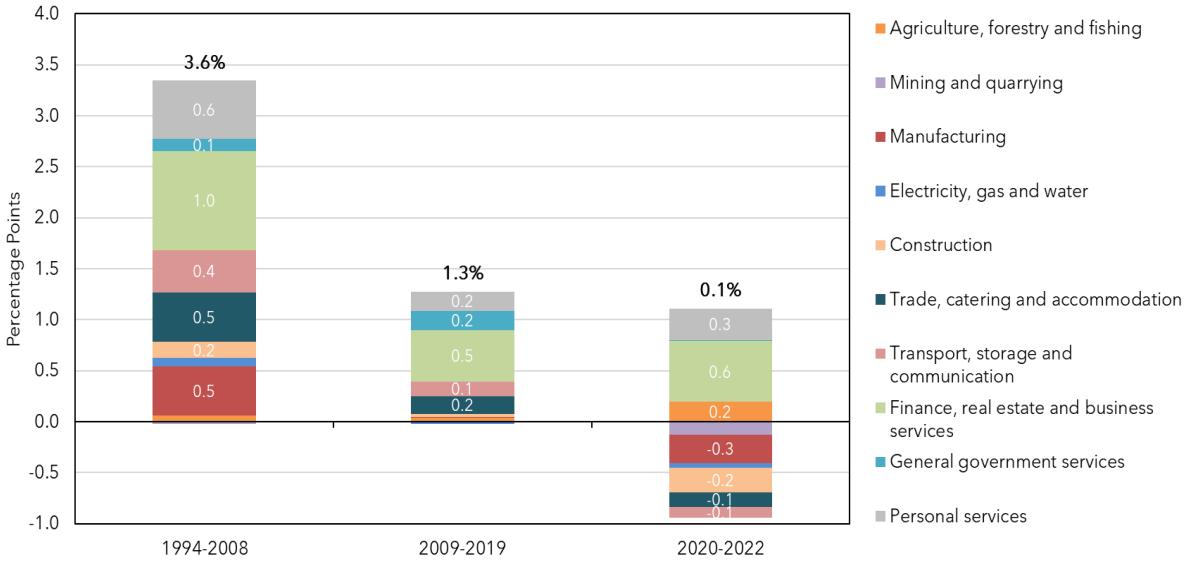
Note: Due to data discrepancies, the sum of the contributions of each expenditure component for each period slightly differs from the CAGR of the real GDP.
Source: Own elaboration based on StatsSA.

Sector performance patterns over time are reflective of key supply-side constraints. At the sector level, the economic slowdown has been driven by declines in utilities, manufacturing, and mining (Figure 1.4). The weakening of mining began before 2008 – despite global commodity prices remaining strong for several years after – while the fall in utilities and manufacturing occurred over the last fifteen years. The declining growth of manufacturing was especially noteworthy as the sector has been an important source of government attention and middle-class jobs. Manufacturing shed jobs since 2008 at a pace well beyond what global trends of "premature deindustrialization" can explain, as shown by Fortunato (2022). This exceptional deindustrialization can be traced to key supply-side

[4] See South Africa on the Atlas of Economic Complexity (https://atlas.cid.harvard.edu/countries/246/market-share)

constraints – especially the intensifying electricity crisis – and a high reliance on domestic demand, which has declined amidst South Africa's overall growth slowdown. With the core of the economy not generating jobs, the few jobs that were created tended to be in security, household services, and publicly funded community services. It is hard to imagine how this form of job creation can generate economic dynamism to move the economy forward. Public work programs in recent years have created some job opportunities, but these are temporary and of much lower quality than the productive jobs that were destroyed or never created.

FIGURE 1.4: CONTRIBUTION OF SECTORS OF ACTIVITY TO CAGR OF REAL GDP

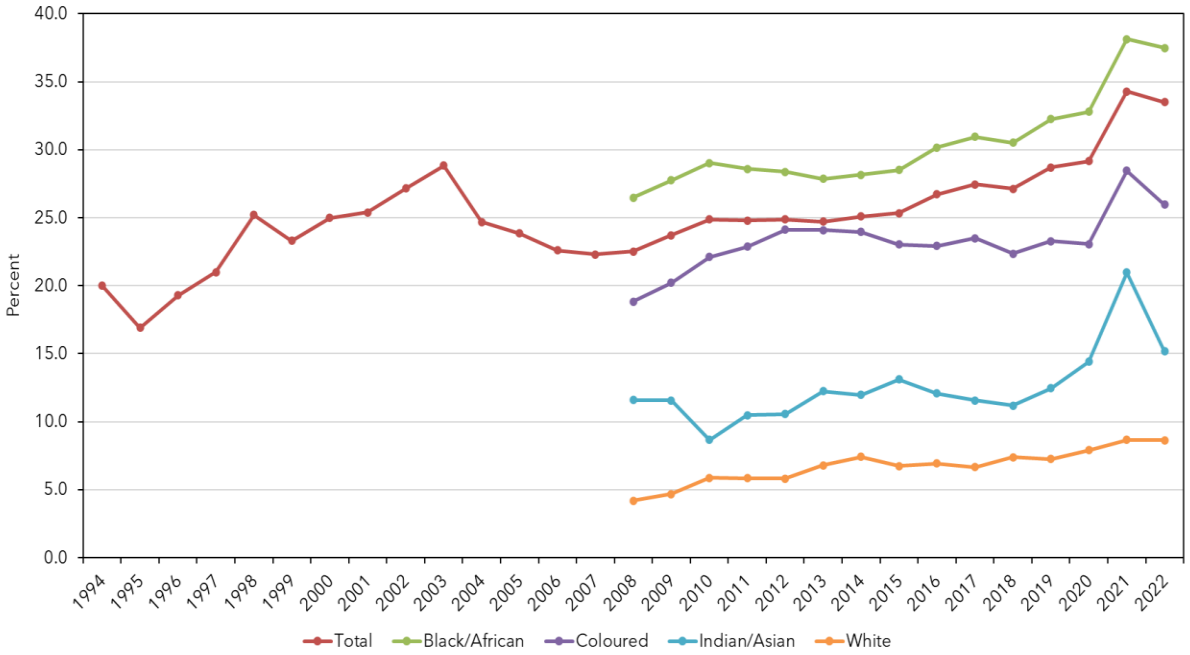


Note: Percent bold labels refer to the CAGR of the real GDP.
Source: Own elaboration based on StatsSA.

The modern South African economy is defined by exceptional levels of labor market exclusion. South Africa's unemployment and inequality levels are among the worst in the world. In a labor market diagnostic, Shah (2022) puts this in perspective with the observation that the richest decile in South Africa is about as rich as the richest decile in Greece while the poorest decile in South Africa is as poor as the poorest decile in Cameroon. This results in a very high poverty rate for South Africa's level of income. But these are not new problems; they were defining features of South Africa back in 1994, although they have worsened. On average, unemployment has been increasing by 0.5 percentage points per year since the end of the apartheid, reaching 33.5% in 2022 (from 20% in 1994) (Figure 1.5). Perhaps most worrisome, youth unemployment reached more than 61.5% in 2022, according to StatsSA. Black South Africans are not only the population group with the highest level of unemployment but the

difference in unemployment rates between Black and White South Africa has widened substantially. If one looks instead at employment rates, so as not to overlook people who are outside of the labor market because they have given up looking for work, South Africa has one of the worst employment rates in the world (39% in 2022). The number of individuals not engaged in education, employment, or training (known as "NEETs") has also been on the rise. While this is not a new or emerging problem for South Africa, low growth has worsened labor market exclusion. But even the higher growth prior to 2008 did not fully reduce the problem.

FIGURE 1.5: UNEMPLOYMENT RATE, TOTAL AND BY POPULATION GROUP

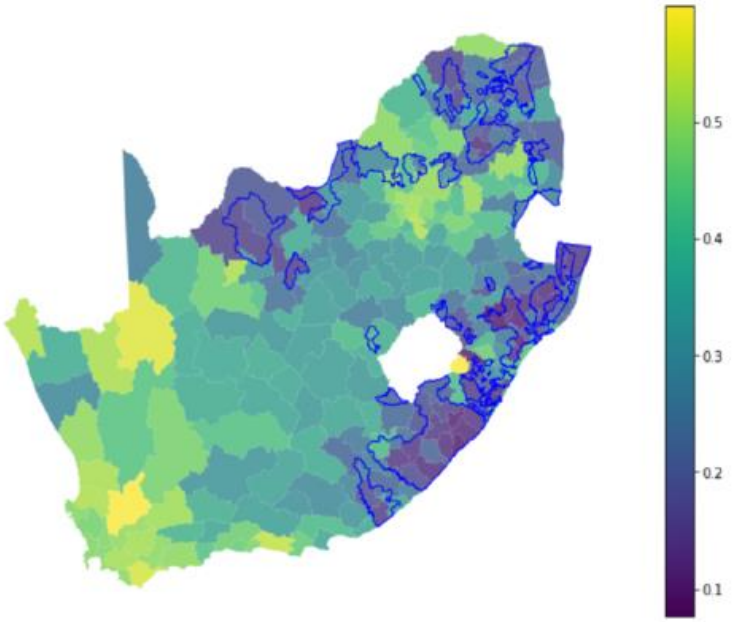


Source: Own elaboration based on SARB and StatsSA.

Spatial divides play a crucial role in South Africa's high unemployment rate, especially for Black South Africans. Nothing expresses more the extreme spatial imbalances in South Africa than the difference in employment rates between the former homelands and the rest of the country. The dismally low national rate of employment at the national level of 39% is an average of two very different worlds. In the areas outside of non-metro former homelands (i.e., excluding Pretoria and Durban), where 63% of the working-age population lives, the employment rate hovers around 46% – low but not uncommon by international standards. Inside the non-metro former homelands, the employment rate of the working-age population was barely 26%. In some municipalities that are within the former homeland boundaries, it is below 10% (Figure 1.6). Within the non-metro former homelands, the problem seems to be

concentrated in the rural areas, which include almost 80% of the population of these areas. In these places, the employment rate is barely 21%, while it is 42%, twice as high, in the urban areas of the former homelands.

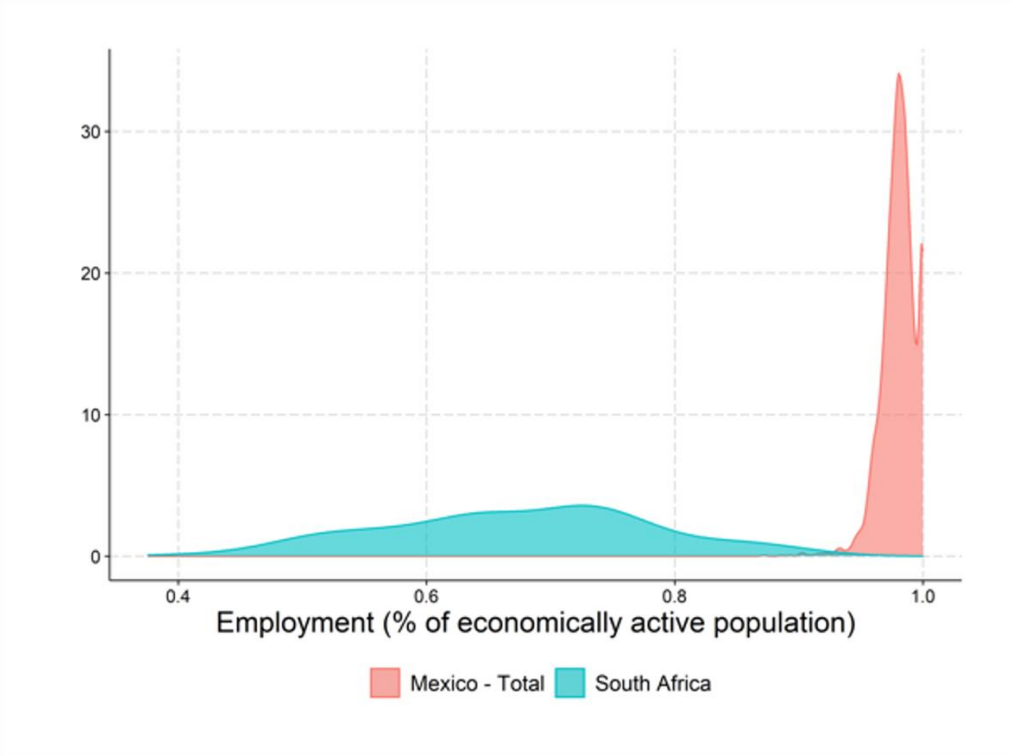
FIGURE 1.6: EMPLOYMENT RATES BY MUNICIPALITY



Source: Lochmann (2022)

The persistent exclusion of rural former homelands from the modern economy is one critical type of exclusion that South Africa must reverse to achieve growth through inclusion. The fact that the rate of employment in urban areas of former homelands is very similar to the rates in both rural and urban areas outside the homelands indicates that there are uniquely low job opportunities in the rural areas of the former homelands, where some 32% of South Africans live. These differences cannot be explained by the personal characteristics of those living in the former homelands, because individuals who leave the former homelands tend to find job success in other areas of the country at a similar rate to anyone else (Lochmann, 2022). This implies that homelands face place-based economic challenges that have not been overcome through various improvements to infrastructure and social transfers in these areas. Furthermore, this means that education and skill gaps in the former homelands, though significant, are not the binding constraint to more employment in those areas. South Africa is extreme in both its low level of employment overall and the variance in how low employment rates are across municipalities, as can be seen in a comparison with Mexico, which is a country with a similar level of per capita income (Figure 1.7).

FIGURE 1.7: DISTRIBUTION OF EMPLOYMENT RATES ACROSS MUNICIPALITIES – MEXICO (2019) & SOUTH AFRICA (2011)



Source: Own elaboration based on South African National Census of 2011 and INEGI.

Space also plays a large role in explaining low employment rates in urban settings across the country. In urban areas, workers on average face very long commute times and high transportation costs, making them unusually far and disconnected from centers of productive formal jobs, which tend to concentrate near central business districts. Relatedly, South Africa has a surprisingly low rate of informal employment, especially as expressed as self-employment or employment in microenterprises. Worldwide, these jobs tend to be spatially more dispersed and closer to people's homes. In most middle-income countries, let alone low-income countries, self-employment, and micro-enterprises tend to provide work and incomes for a significant fraction of the labor force. For a country at South Africa's level of income, the expected level of own account work, given the international experience is around 20%. But in South Africa in 2019, before the COVID-19 recession, the rate was just 4%. According to Shah (2022), this outcome cannot be explained by the larger presence of social grants, by stringent labor market regulations, by low education, or by high crime. Evidence provided by Shah and Sturzenegger (2022) suggests that South Africa's unusual urban structure with very distant and low-density residential areas leads to very high transport costs, lowering formal employment, but also very low foot traffic near people's homes, lowering the viability of informal work. To

make formal work viable, employers must compensate workers for the large direct and indirect commute costs, making labor expensive for formal firms and less attractive for workers. In this way, spatial exclusion can be understood as a key driver both of low formal employment and extremely low informal employment in South Africa.

The urban structures of South Africa have origins that date back to apartheid, but these structures have been exacerbated by housing policies and urban planning adopted since 1994. The urban areas where many South Africans live are far and disconnected from centers of formal jobs. Although post-apartheid policy has aimed to break down spatial divides, policies have had unintended consequences that have entrenched many of the same outcomes. Housing policy following apartheid has centered on state-provided homes in far away, low-density places, with an emphasis on providing publicly supplied housing through the Reconstruction and Development Programme (RDP). City centers were kept at unusually low densities through restrictive floor area ratios, maximum height regulations, and parking regulations. In this context, the informal settlements that were created are telling as they are better located and provide housing units that are smaller than the typical government-provided RDP housing, indicating that the trade-offs implied in government policy do not reflect the preferences of citizens.

It is unfortunately clear that South Africa's trajectory is not one of growth or inclusion, but rather stagnation and exclusion. South Africa's economy is stagnating and, in fact, losing capabilities, export diversity, and competitiveness. While the racial composition of wealth at the top has changed, wealth concentration in South Africa has not and remains very high. Moreover, the broader structures of the economy have not allowed for the inclusion of the labor and talents of South Africans — black, white, and otherwise. There appear to be major spatial impediments to labor market inclusion in cities and large spatial patterns of exclusion in former homelands. As the performance of network industries and public capabilities have deteriorated and growth has slowed, exclusion has only worsened. Empowerment of a few has *de facto* come at the expense of the many. Since the policies that are in place today are not accomplishing their essential goals, South Africa needs new tools and attention devoted to more effectively achieving economic inclusion, empowerment, and transformation.

1.3 Prioritizing Constraints to Growth and Inclusion

Change is required to achieve South Africa's growth and inclusion goals, but where should change be focused? It is one thing to accept that outcomes are not in line with the overall goals of society, but it is another thing to identify and address the constraints that are preventing the goals from being achieved. Even in good times, governments cannot address all constraints facing an economy all at once; but when challenges are mounting, prioritizing binding constraints is even more important. South Africa has battled several waves of COVID-19 infections, devastating flooding events, and episodes of violence over the last several years. Regular and worsening rationing of electricity through load-shedding led the President to declare a "State of Disaster", which was later revoked, while water supply crises, port functionality, and other severe breakdowns are also becoming disasters in their own right. Under these conditions, it becomes natural for the government to prioritize the emergencies it faces. However, in doing so, effective responses must also treat the deeper causes of recurring problems, which are rarely as obvious. In some cases, response actions that treat symptoms may worsen underlying problems.

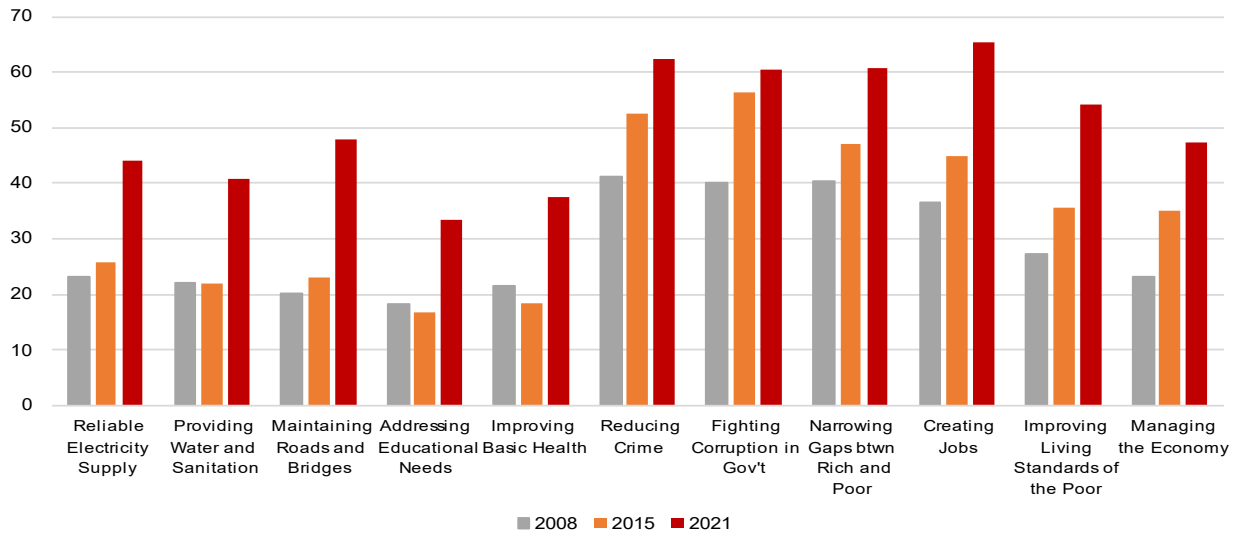
This report provides an assessment of the causes behind South Africa's economic challenges and identifies a resulting set of priorities for how South Africa can achieve growth through inclusion. Using principles of growth diagnostic research in tandem with collaborations with numerous South African policymaking bodies, research organizations, and private sector stakeholders, we arrive at two fundamental constraints. One of these constraints – the destruction of capabilities to provide public goods – has been worsening over the last fifteen years and is responsible for declining national growth. The other constraint – the inefficient spatial structure of the economy – has been an issue for longer and helps to explain both low dynamism over the long-term and persistent lack of inclusion even during times of higher growth. Taken together, these two fundamental issues are at the heart of South Africa's economic challenge. They explain why previous research (Hausmann *et al.*, 2022) finds that the economic slowdown is not due to macroeconomic problems or external shocks, but rather to persistent and worsening domestic supply-side constraints. This has meant that demand stimulus measures via fiscal policy have proven ineffective or even counterproductive. In addition to dissecting these constraints and offering pathways forward on each in a proximate

sense, we also identify several deeper issues that have undermined the state from acting on solutions to known problems.

1.3.1 Collapsing State Capacity

The fundamental reason that growth has slowed over the last fifteen years is a collapse of state capabilities to provide the public goods on which the economy depends. Few things are as clear evidence of a system not working as it should as when the power goes out. When this happens regularly and systematically, this is evidence that the electricity system has broken down. And when similar system breakdowns happen across a variety of public goods (Figure 1.8), this is evidence of causes that extend beyond the electricity system and a particular SOE responsible for providing the public service – Eskom, in this case. But how do we know when such systems are binding economic growth and inclusion? A summary of evidence is provided here. In Chapter 2 of this report, we provide a full diagnosis of the crisis in the electricity system to understand both electricity-specific failures and broader causes of state collapse as well as a discussion of the problem of municipal government collapse.

FIGURE 1.8: SHARE OF RESPONDENTS INDICATING GOVERNMENT HANDLING AS "VERY BADLY"



Source: Own elaboration based on Afrobarometer Surveys.

The declaration of a state of disaster in the electricity system in early 2023 reflected acceptance of a problem that was evident long before. Beginning in 2007, peak demand for electricity began to outstrip supply, and Eskom started to use load-shedding to balance the system. Since then, the electricity issue has only worsened with load-shedding intensifying and

electricity prices rising. Recently, the South African Reserve Bank (SARB) estimated that load-shedding causes about a USD 50 million daily loss, on average, and without power outages the reserve bank would have projected South Africa's growth in 2023 to be 2.3% rather than 0.3%.[5] This 2% difference is enormous and could get worse. During the winter months, load-shedding was anticipated to reach stage 10 – meaning that upwards of 1 GW must be reduced through rationing — in a system that only has a little over 6 GW in total capacity. But, as this report discusses, this problem was obvious well before the rapid rise in load-shedding over the last two years. For the situation to have gotten to this point after 17 years of load shedding is an indication of a more severe governance failure. Countries that face similar electricity crises, such as Colombia in 1992 and Chile in 2007 were able to turn the situation around in less than 5 years.

Ending load-shedding is not a sufficient policy goal. Rather, South Africa needs to rebuild the electricity system to deliver low-cost and reliable electricity to all users. The crisis is particularly damaging for South Africa because the country's international comparative advantage was based on its cheap coal-fired electricity and on the energy-intensive industries that formed around it, such as mining and mineral processing. The collapse of utilities overall can explain around 40% of South Africa's growth slowdown even before the recent escalation of the crisis (Hausmann *et al.*, 2022). With electricity now being a comparative disadvantage and with coal being phased out in the context of the global energy transition, the country's key industries face present and future challenges.

Outages and load-shedding have considerably increased losses for all types of firms in South Africa but particularly for energy-intensive firms. As studied by Fortunato (2022), while there were around 2 hours of outages per month in 2007, this increased to 20 hours in 2020, which resulted in annual losses of approximately 7% for the median formal firm. While 15% of firms reported electricity as a constraint in 2007, 55% did so in 2020 — far and away the top-reported constraint. To overcome the loss of reliable electricity from the grid, firms increased their use of backup generators; 60% of manufacturing firms owned or shared a generator in 2020 (versus only 20% in 2007). In 2020, reliance on generators was in line with far poorer countries and countries in conflict, including Yemen, Lebanon, Iraq, and the DRC. More recently, firms have expanded off-grid renewable solutions where possible. While many

[5] See Statement of the Monetary Policy Committee, January 2023.

African nations have struggled with electricity provision, South Africa is somewhat unique in that it had reliable cheap electricity, which was at the core of its comparative advantage in energy-intensive industries. The country has catastrophically lost this ability to produce and supply electricity.

The electricity system failure helps to explain why the growth slowdown has been driven by the collapse in manufacturing, mineral processing, and utilities that was previously noted. Since the manufacturing sector is three times more energy-intensive than other sectors in the economy, it is not surprising that its contribution to real GDP growth fell from 0.5 percentage points per year during 1994-2008 to zero during 2008-2018. Moreover, the subsectors within manufacturing that are more intensive in energy (measured by the share of electricity as intermediate input) have shown even lower growth rates during the latter period (Fortunato, 2022). Since Eskom as a company was also devastated by increasingly weak revenues alongside highly unproductive investment, its financial position worsened. While manufacturing also faced other challenges, electricity is the leading cause of their negative productivity growth and loss of competitiveness. The electricity problem looms large across all sectors, even those that have seen recent growth, such as business process outsourcing (BPO).

Unfortunately, this pattern is also present in other network industries – including ports, rail, water and sanitation, and digital communications. This is why the government's current reform effort, based on the wide-ranging Economic Reconstruction and Recovery Plan and implemented through Operation Vulindlela, is focused on responding to challenges in each of these systems. While electricity is the most binding constraint for the economy overall, industries that intensively need other public inputs are also facing increasing headwinds. The Port of Durban has experienced its own visible collapse that can be seen in the persistent backlog of ships in the harbor, and the failings of the rail system can be seen in the bottleneck it represents for mining output and in the complete shutdown of passenger rail lines. Water supply is worsening due to administrative failures, and under the pressures of climate change, many fear that water availability will be the subject of the next national disaster. Locally, Nelson Mandela Bay has been facing a water supply crisis. While these priorities are clear, the reform efforts of Operation Vulindlela are increasingly revealing the complexity and interrelatedness of the breakdown in public capabilities across government.

As SOEs' core competencies have deteriorated, capabilities within national and local governments have weakened, as have their financial health. Municipalities play a significant role in the provision of public services, often acting as intermediaries in distribution. This is the case for the distribution of water and quite unusually in electricity. Surveys of satisfaction with these services show a decline over time for most municipalities, and measures of water access have worsened. Municipalities, even as intermediaries, face related financial difficulties. The State of Local Government Finances report of 2022 found that 169 municipalities across the country were in financial distress at the end of the 2021/22 financial year (South Africa National Treasury, 2022). As of 2022, municipalities owed water boards and Eskom around R15 billion and R53 billion, respectively. Municipalities are unable to collect water and electricity payments from consumers, which has substantially undermined local government solvency, worsening underlying challenges of effective and efficient local spending. As discussed in Chapter 2, there is a large variance in public satisfaction with local service delivery, which traces to a fundamental pattern of shifting a high level of spending authority and responsibility to local municipalities without the underlying capabilities to deliver these responsibilities effectively. This is a problem sometimes referred to as "premature load bearing," which was brought upon by a rapid decentralization of expenditures, which precedes the more recent crisis of financial distress of municipalities.

In electricity, the proximate cause of the crisis is poor management and under-investment in generation, transmission, and storage capacity, but the deeper cause is a distinct type of political gridlock. South Africa's deficit in electricity is due to a lack of capacity in the system. When this became apparent in 2007, South Africa committed three errors that made today's crisis worse. First, it bet heavily on badly designed coal power plants as the costs of renewables were falling. Second, it delayed maintenance in its aging fleet to create more capacity in the short run. Third, it waited too long to seriously bring in private investment. Liberalizing the participation of society especially in generation and transmission will be the most effective way to mobilize the necessary investments South Africa needs to get out of this current crisis. Yet, it has taken nearly 17 years for South Africa to make serious moves in allowing for private and municipal participation, and even now the progress of reforms is unconscionably slow. In the meantime, South Africa bears large costs for this inaction and gridlock. The current reform bills meant to establish an electricity market have not been

passed, nor do they clarify important aspects about the role of market participants and alternatives to the current failing system of distribution by municipalities.

A current focus on emergency response and a lack of clarity in the vision for the future shape of the electricity market prevents society from contributing more to solving the electricity supply problem. Even if the final design of the market only takes shape over time, economic agents need to have a much clearer idea of the direction and contours of future policies to be able to participate today. Thus, South Africa needs to create a functioning market for electricity with the following principles: (1) greater participation of society in generation, transmission, distribution, and storage; (2) efficient distribution markets that are not too small to benefit from economies of scale (as many municipalities currently are); (3) clear rules for all market participants that eliminate conflicts of interest and prevent discriminatory treatment; and, (4) final prices that reflect the marginal cost of production, including intra-day pricing. Additionally, given the current state of the electricity crisis, the goal should be to procure as much power as efficiently and cheaply as possible. This means relaxing preferential procurement rules and focusing the power of government procurement more strategically. Eskom has been forced to procure expensive, low-quality coal, and struggles to get good parts and technical capacity for required maintenance. Removing such rules should be a priority not only during the emergency response but also during the permanent functioning of the system. The current procurement of energy through the Renewable Energy Independent Power Producer Programme (REIPPP) should be extended to include transmission and storage investment needs so that transmission and stability constraints do not limit the expansion of generation.

In electricity and beyond, a collapse of public capabilities has become systematic and requires a more systematic response. Breaking systems is usually easier than repairing them. Repair requires a clear diagnosis of failure at a system level in both technical and wider political, administrative, and organizational dimensions. Four primary factors contribute to state capacity decline: political gridlock, entrenched ideology, overburdening of state organizations with objectives beyond their core mandate, and political patronage. This reality has empowered a minority to the detriment of the majority. Rekindling growth requires recovering and strengthening state capacity, and we close Chapter 2 with an outline of how to do so by reversing excessive "load bearing", building up and protecting capacity, and leveraging rather

than restricting capabilities that exist in wider society. Certain capacities have been rebuilt (for example the tax collection ability of the South African Revenue Service), showing that change is possible.

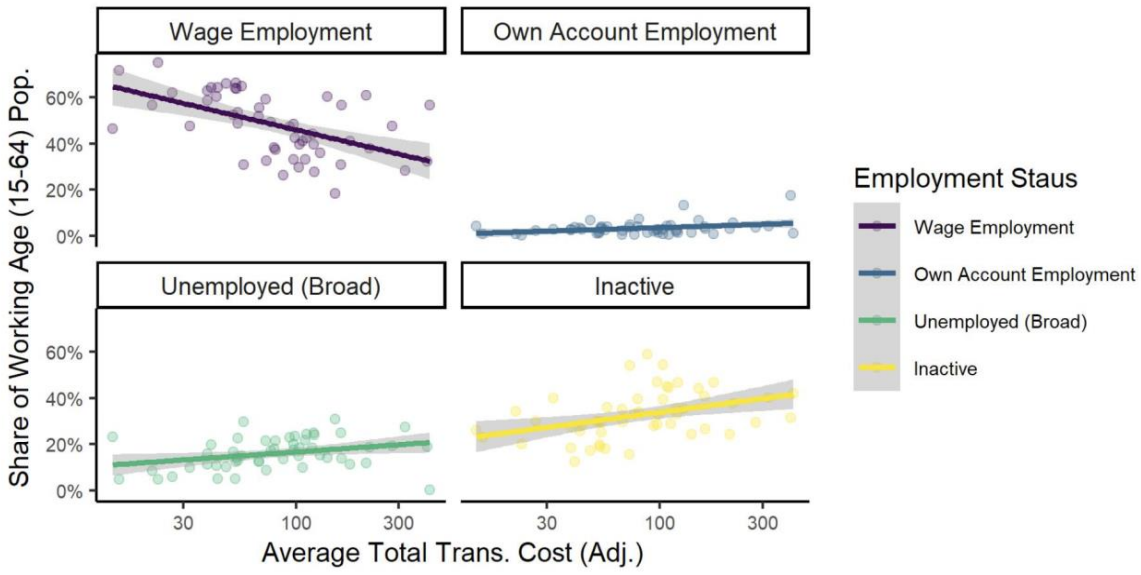
1.3.2 Spatial Exclusion

South Africa is exceptional in its human geography, and its spatial patterns undermine growth through inclusion. South African cities are unique in their degree of fragmentation, with long distances between where people live and central business districts. The economics of cities shows that the essential role of cities is as labor and product markets (Bertaud, 2018), that is places where workers can bring their skills and abilities together, organized within business establishments, to produce goods and services. If people cannot effectively move from home to work and back at a reasonable cost in terms of money and time, the benefits of agglomeration cannot be realized. This is precisely the problem facing South Africa's cities, and it is reflected in the very long travel times and high commute costs that South Africans face in getting to and from work. At a certain point, paying the commute cost becomes prohibitive for workers and businesses, especially at lower levels of skills and expected wages. Many places in urban South Africa are beyond this threshold. South African cities are characterized by a sprawling, low-density, and disconnected urban structure.

Spatial exclusion in cities has been entrenched through housing policies and urban development norms followed since 1994. Though many South African cities bear the spatial imprint of apartheid, we find that post-apartheid policies have entrenched spatial exclusion. A national push to provide free low-density detached housing in the periphery of cities, rather than through higher-density solutions closer to the center of cities, has made commute costs a serious impediment to labor market participation. This problem is being repeated in fast-growing secondary cities through norms in urban planning and policies that disincentivize density and incentivize sprawl. Because the government housing supply excludes people from market opportunities, informal settlements have been growing in better-connected areas. However, they often lack the complementary public goods that make them vulnerable to flooding, crime, and other hazards. Nevertheless, people choose to live in these vulnerable conditions because they are closer to opportunity.

The direct consequence of the low proximity to labor markets is high commuting times and transport costs, which discourage job creation. Commuting time and transport costs are very high in South African cities. As studied by Shah (2022), while direct commuting costs were 17% of net wage income, the total cost (including the opportunity cost of time when commuting) averaged 57% of net wage income. These are averages across all workers and do not even count those who cannot afford to get to work,[6] and the picture looks much worse for disadvantaged socio-economic groups as the ratio of transportation costs to wages is highly regressive. While direct costs of transport to work represented more than 35% of labor income for those in the lowest income quintile in 2010, they represented less than 10% for those in the highest quintile of the income distribution. In addition, the total time of transport and the risks of crime are much higher for the modes of transport used by low-income individuals, such as bus, taxi, and train systems. Shah and Sturzenegger (2022) study this issue through a spatial labor market matching model and find that this distortion can explain much of South Africa's labor market exclusion. Higher costs of transport are associated with a decline in wage employment (both formal and informal) and an increase in unemployment (Figure 1.9).

FIGURE 1.9: LABOR MARKET INDICATORS VS. TOTAL TRANSPORT COSTS BY DISTRICT MUNICIPALITY



Source: Shah and Sturzenegger (2022) using 2017 National Income Dynamics Study and 2020 National Household Travel Survey.

[6] Banerjee and Sequeira (2020) found, using a randomized control trial, that providing transport subsidies to young job seekers revealed that the cost of commuting was high in relation to the actual returns from job search, leading beneficiaries to search for opportunities closer to home.

Reversing this recurring problem is possible through more compact cities, which is a job for policy. This can be achieved by removing restrictive regulations that disempower housing choice and redirection in public housing spending to support smaller and better-located housing options. Inertia in city design and numerous regulations on housing development severely disincentivize organic densification and instead incentivize the development of dislocated housing. As argued in Chapter 3 of this report, the solution must start by addressing key constraints on housing development that come from overly restrictive building codes and zoning regulations that prevent the development of denser housing. Taking national and local restrictions together, these jointly restrict where you can build, how you can build, and how dense you can build. At the same time, urban planning and infrastructure investment implicitly incentivizes the sprawl of metro areas rather than strategically putting better-connected parts of cities into housing production. By addressing these issues, cities can improve their economic prospects through increasing labor market inclusion, while both cities and the national budget can improve their fiscal positions through better allocation of public infrastructure spending. Cities that are positioned to better absorb surplus labor, ideas, and human capacities from the rest of the country will benefit everyone.

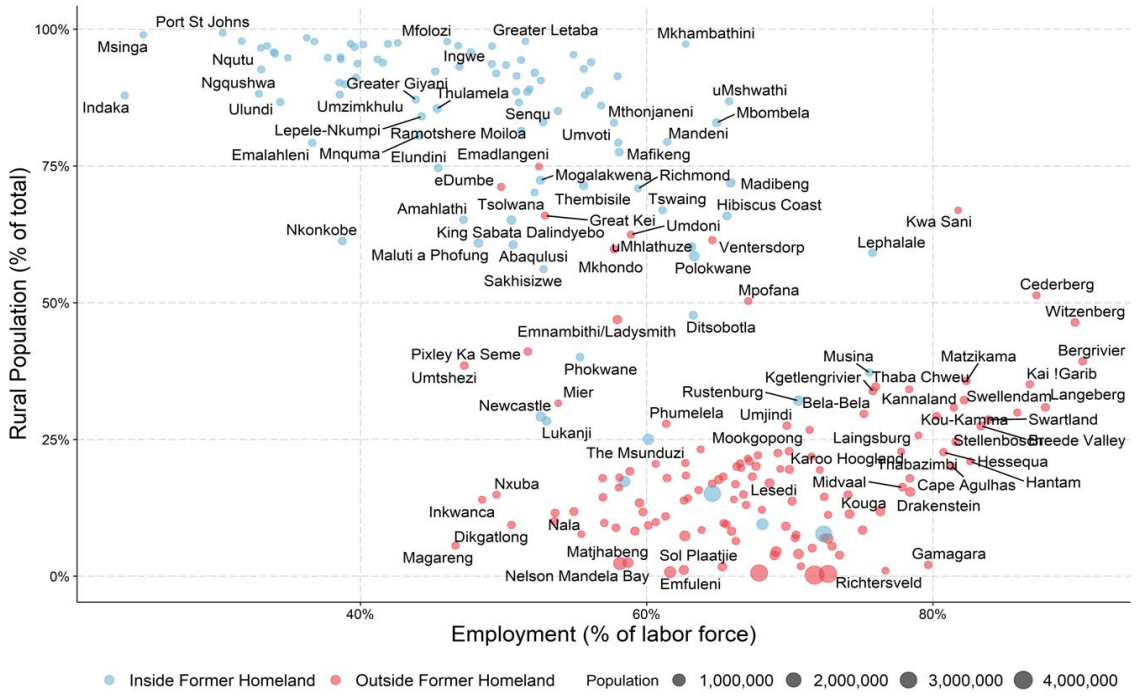
The spatial problem also manifests itself across regions and larger distances, especially for residents of the rural areas of former homelands. The largest inequalities and wholesale exclusion occur within rural areas of former homelands. While employment outcomes in South Africa's metros and rural areas outside of former homelands are not great, what drives South Africa's labor market indicators to extraordinary levels is the extremely poor labor market outcomes in rural areas of the former homelands. Since the end of apartheid, former homelands have become more connected through infrastructure, but very long physical distances remain. In some cases, paved roads and other basic infrastructure remain glaringly lacking, including in large portions of the Eastern Cape Province. There has been a clear pattern, documented by Lochmann (2022), that despite overall infrastructure improvements and support to households, the economies of former homelands remain weaker than can be explained by observable characteristics.[7] Workers from former homelands have been

[7] For more discussion see Chatterjee *et al.* (2022), Von Fintel (2014, 2018), David *et al.* (2018), Schotte *et al.* (2022), Neves and Du Toit (2013, 2014), Kwenda *et al.* (2020), Mudiriza and Edwards (2020), Leibbrand *et al.* (2010), Todes and Turok (2018), Visagie and Turok (2020), Turok (2021), Wittenberg (2003), Abel (2019), among others.

migrating out in search of opportunities and landing jobs on par with others, indicating that the problem is with the places and not the people.

A place-based approach for the former homelands should make it more attractive for businesses to move in rather than for workers to move out. Whereas internal migration is natural and observed globally, South Africa does not reap its full possible benefits. It needs more dynamic urban growth centers that can absorb more people and provide more jobs. At the same time, if barriers to rural success are removed, rural areas of former homelands could capitalize more on their latent comparative advantages. Employment patterns in rural areas outside of former homelands are illustrative, as more rural areas outside of homelands tend to have higher employment rates than more urban areas outside of homelands. The reverse is true within homelands (Figure 1.10).

FIGURE 1.10: EMPLOYMENT RATES AND RURAL POPULATION BY MUNICIPALITY



Source: Own elaboration based on the South African National Census of 2011.

Exceptions to the general rule of worse economic performance in homelands are powerful examples of what can change. There are cases of economies within former homelands that are relatively more connected to markets and production that have managed to capitalize on market opportunities. For example, villages around Makhado and Elim in

Limpopo have achieved higher employment by developing enterprises that serve demand in the surrounding market under the umbrella of a community trust. More disconnected areas have in some cases found ways to integrate into the modern economy through different types of commercial partnerships, especially in agriculture (Klinger *et al.*, 2023). What has worked in these cases echoes organizational structures in franchising, which is a very mature business sector and an important source of jobs in South Africa (Klinger, 2022). But these are a few isolated cases which are exceptions to a rule of a highly dualistic agricultural sector leaving large swaths of land idle and underutilized (Sturzenegger *et al.*, 2023). There are also cases of growing urban agglomerations within former homelands – for example, Mthatha in the Eastern Cape – which are evolving quickly as they absorb internal migration and serve as hubs of retail and other services. These cities appear to face similar problems to non-homeland cities in their low density and sprawl but also function differently in that they are spatially less disconnected and allow for more informal work to occur. Much of the housing expansion of these areas occurs on communal land.

To include more residents of rural homelands in the modern economy, two responses are needed. The first need is to better connect the most rural population centers through paved roads and other basic infrastructure. These network expansions remain incomplete and dramatically reduce the development pathways for large parts of the country. But lack of physical connectivity is only one part of the problem. Even those areas that have much greater physical connectivity often lag far behind their surrounding areas in economic activity. The solution to this problem is an approach that we refer to as "bridging knowhow" and explain in more detail in Chapter 3. Productive knowhow needs to be bridged between competitive businesses and industries outside of homeland areas and communities within former homelands, and this takes place most directly through business partnerships. South Africa has reached a point where the benefits of such business models are proven, and several types of entities have emerged as connectors and enablers of partnerships., namely: partnership advisors, local NGOs, and community trusts. There are important challenges that must be overcome when these partnerships work – including developing trust and technology transfer – and issues of communal land and governance systems can be hurdles. However, a deeper and more dynamic market for such partnerships is possible, which would better connect businesses in need in need of land and labor with communities with matching comparative

advantages. As more areas of former homelands gain physical connectivity, these opportunities will expand further.

1.3.3 Green Growth Potential

South Africa has lost a critical source of comparative advantage in cheap and reliable electricity because of the collapse of state capacity. As studied by Fortunato (2022), industries that use electricity most intensively have seen the sharpest declines in output and employment. This has undermined South Africa's export capacity and had an outsized impact on the larger economy due to the very high energy intensity and electricity intensity of South Africa's exports overall. South Africa has effectively lost its comparative advantage in cheap and reliable electricity. In the face of this constraint, efforts to grow through localization and fiscal stimulus have been ineffective and may have narrowed growth opportunities further. Localization strategies have prioritized the local market at a time when demand was not growing and disadvantaged downstream industries in value chains, and fiscal policy has led to rising interest rates and crowding out of capital-intensive industries. As South Africa addresses the two binding constraints of collapsing state capacity and spatial exclusion, growth will need to be driven by a re-emergence of comparative advantage that is consistent with changes in the global economy. In the context of global decarbonization, this will not be possible by simply returning to the energy mix of the past because industries and consumers are increasingly demanding production with a lower carbon footprint.

Promisingly, South Africa has an immense opportunity to capitalize on changing global demand due to decarbonization. It has strengths and potential for export growth and innovation that can help to supply many of the goods, services, and innovations that the world will need to decarbonize. Over the last decade, international agreements have tended to focus on the demand side of decarbonization by asking countries, cities, and companies to reduce their demand for fossil fuels and their carbon footprint more generally. At the same time, global decarbonization creates transformative supply-side opportunities for countries to produce goods and services that will allow the world economy to decarbonize. South Africa represents only about 1% of global carbon dioxide emissions and a lower share of cumulative historic emissions, so its impact on global climate change through reductions in its emissions will have a very limited direct impact on climate change. However, South Africa has an impressive set of assets in its resources, companies, and knowhow that could have a very substantial impact on

supplying the inputs to global decarbonization in the years to come. This "green growth" opportunity could be a substantial driver of South Africa's recovery in the future, but opportunities will not become realities automatically. Reversing collapsing state capacity – particularly the loss of cheap and reliable electricity – and more targeted industrial policies are both needed to help to jumpstart new sources of growth. Green growth has such high medium- and long-term potential in South Africa that we devote Chapter 4 to discussing this in detail.

South Africa has natural and historic advantages for three strategic pillars of green growth. These advantages are currently undermined by collapsing state capacity, spatial exclusion, and certain policy levers that are currently used (within industrial policy, trade policy, and immigration policy, for example), but these conditions could be changed. The three strategic pillars that we explore in detail are: (1) making the enablers of global decarbonization; (2) making green versions of grey products for the global market; and (3) exporting green knowhow. Taken together, these strategies would help to recover and expand new comparative advantage for South Africa and, potentially, the larger region of Southern Africa. Each requires highly targeted industrial policies.

Each of these strategies includes a range of opportunities. Under the first strategy, South Africa could participate much more in the supply of critical minerals and provide the world with many of the enablers of clean tech such as vanadium redox flow batteries (for grid-level storage), platinum-metal-group-based fuel cells, and electric vehicles, among others. We explore several relevant green supply chains in detail in this report. Under the second strategy, South Africa could harness its ample resources of sun and wind to be a competitive location for energy-intensive production with a low carbon footprint. These opportunities could be spurred on initially by the development of green industrial parks, but the scale will ultimately depend on South Africa regaining cheap and reliable electricity and sustainably reducing the cost of capital for new projects. The third strategy of exporting green knowhow is relevant for South Africa because the country has both excellent research and development capabilities and existing companies – like SASOL – with unique knowhow in decarbonization-related technologies.

Achieving South Africa's green growth potential will require a new way of looking at the energy transition together with targeted industrial strategies. South Africa has launched initiatives focused on a "Just Energy Transition," with a focus on responding to challenges of

regionally concentrated coal economies but which also recognizes the benefits to all of society from new technologies that can both respond to the electricity crisis and serve as new drivers of growth. On paper, this is consistent with the green growth opportunity, but in practice, there is a risk that too much attention is focused on phasing out coal more quickly and too little national policy and international support on the three strategies discussed in this report. There may be potential to leverage more international finance and knowhow through incorporating these strategies into the Just Energy Transition framework.

Green growth opportunities show that the South African economy does not exist in isolation from a globalized economy, which has implications for current industrial, trade, and immigration policies. As the growth of the South African economy has slowed, industries that have relied on domestic demand have faced not only direct pressures on their productivity – due to collapsing state capacity – but also faced declining demand. This has occurred in manufacturing, construction, transportation services, and business services, among other industries. Over the last decade, the government has relied increasingly on localization strategies, which have focused on capturing more domestic demand by substituting imports. In a context where the decline in domestic demand is worsened by supply constraints, this strategy can be counterproductive. It also misses the larger opportunity of reaching global markets that are much larger and where demand growth is much stronger than in South Africa. As South Africa focuses inward, firms can miss out on numerous emerging opportunities to reach global and regional demand. This is true for both existing businesses that would benefit from government actions to expand market access and for the entry of new businesses that could capitalize on South Africa's comparative advantages. An inward-looking strategy in a slowing economy is costing South Africa many jobs. As South Africa has increasingly turned to protective measures in recent years, it may lose out on the opportunities created by the African Continent Free Trade Area (AfCFTA), which has the potential to benefit many South African exporters and attract new exporters.

South Africa continues to miss out on the benefits of high-skill immigration. Though reforms to South Africa's visa regime have been prioritized as one pillar of Operation Vulindlela, the country remains out of step with peers who recognize the importance of high-skill immigration as an engine of growth and transformation. Most worrisome, the country has experienced rising numbers of skilled worker outmigration, losing more skilled workers than

what it receives (Halstein, 2021) and patent data shows that South Africa is seeing weakening innovation capacity. South Africa needs access to global talent and immigration policy can be a tool for attracting talent. The importance of high-skill immigration is not a new observation as a straightforward policy response was already recommended by the International Advisory Panel on ASGISA in 2008 to enable high-skill immigration (Hausmann *et al.*, 2008, Banerjee *et al.*, 2008). This remains essential for South Africa to leverage its greatest strengths and expand growth drivers, which inescapably require complementing the knowledge of South Africans with outside expertise.

1.4 Macroeconomic Consequences

Attempts to address the effects of both the collapse of public goods and the spatial constraints through fiscal means have weakened the macroeconomic position of the country. Collapsing state capacity – in electricity, rail, ports, water and sanitation, security, and local services – has caused GDP and export growth to weaken, negatively affecting tax revenues. State capture also reportedly undermined the tax administration capacity of the government, which has thankfully been largely recovered through improvements at the South African Revenue Services, which have been reflected in tax revenues. With unemployment and poverty high, there have been large pressures for social transfers and public employment. For instance, social transfers have increased from 4.9% of GDP in 2010 to 6.0% in 2022. These transfers were sharply increased during the COVID-19 pandemic through the Social Relief of Distress Grant, but transfers to households were already on an upward trend prior to the pandemic. These fiscal measures are meant to compensate people for their exclusion rather than increase inclusion. The result of these forces was a worsening of the fiscal balance.

The poor performance of SOEs also led to large capital transfers, which had a significant impact on national debt accumulation. Total contingent liabilities coming from guarantees to public enterprises have increased at an annualized rate of 12.1% since 2005. More than two-thirds of this increase comes from bailing out Eskom, followed by bailouts of other independent power producers as well as the South African National Roads Agency Limited (SANRAL). Contingent liabilities from Eskom grew at an annualized rate of 53.1% between 2005 and 2022, reaching 5.1% of GDP in 2022. Moreover, they imply an increase in gross

borrowing requirements of 3.4% of GDP between 2023 and 2025. This debt accumulation puts increasing pressure on the budget.

These two macroeconomic responses to the growth slowdown and SOE mismanagement worsened the fundamentals of fiscal sustainability, leading to an increase in the cost of borrowing and a deterioration in the country's creditworthiness. South Africa's gross debt rose from 23.6% of GDP in 2008 to 71.1% in 2022, an increase of 47.5 percentage points in 15 years, leading to several downgrades of the credit rating to BB- in 2020, below investment grade. In 2022, interest payments represented 4.8% of GDP and 17% of total revenues, limiting the capacity of the government to use its revenues to address other needs. The rise in debt has been the consequence of deficits that have been above sustainable levels. The consolidated government overall fiscal deficit increased from 3.6% in 2011 to 9.9% in 2020, though the government has been able to reduce the overall fiscal deficit to 4.2% of GDP in 2022 through exercising fiscal discipline together with a recovery of revenues.

Given that the nature of the constraints facing the economy are on the supply-side, fiscal demand stimuli have been counterproductive. In fact, fiscal multipliers have been negative (Hausmann *et al.*, 2022); rather than helping growth, they have been hurting it, largely by increasing the cost of capital and crowding out investment. However, while negative, the size of the expenditure multiplier is estimated to be small. This implies that fiscal policy cannot be blamed for low economic growth. The central point is that expansionary fiscal policy is merely not the right policy tool to respond to the challenges that South Africa faces today.

Looking ahead, while the primary focus of this report is not centered on macroeconomic policies, it has become increasingly evident that the macro-fiscal situation presents a rather challenging outlook. Despite the commendable efforts of the National Treasury, fiscal targets have been difficult to achieve. The collapsing state not only directly impacts the increasing debt levels but also indirectly contributes to a low tax collection due to the anemic economic growth it ushers in. A lower-than-expected mining tax revenue – a sector dependent on electricity, rail, and port capacity – is an example of it. Furthermore, higher-than-expected public wages increases have constrained the reduction of government spending this year. Finally, while SARB has succeeded in keeping inflation within its targeted band, deteriorating public finances – in a context on increasing global uncertainty – can risk driving prices up.

While challenging, it is imperative for South Africa to regain investment grade. Through the collapse of Eskom, the country has lost its comparative advantage in coal-based electricity generation. Cheap electricity underpinned the comparative advantage in energy-intensive industries such as mining and mineral processing. The global energy transition will require that South Africa increasingly forgo the use of coal and expand the use of renewable energy. Electricity is a highly capital-intensive industry as are mining, mineral processing, as well as green versions of hydrogen, ammonia, and steel. The country's long-term comparative advantage in these new green growth opportunities will depend on keeping the cost of capital low. This requires a reduction of sovereign risk by returning the country to investment grade. Given the presence of negative fiscal multipliers, fiscal consolidation can be growth-enhancing in South Africa by crowding in investment. Hence, both the short- and long-term goals of the country will benefit from a focus on the return to investment grade.

1.5 Summary of Recommendations

The remainder of this report discusses South Africa's constraints in more detail and arrives at proximate and deeper recommendations. Proximate recommendations reflect actions that would directly impact the constraints that have led to weak growth and exclusion. Deeper recommendations aim to address the deeper causes of these constraints and reasons why proximate solutions have often not been implemented. Figure 1.11 provides a list summarizing the recommendations included throughout this report.

FIGURE 1.11: SUMMARY OF RECOMMENDATIONS FOR GROWTH THROUGH INCLUSION

On Strengthening State Capacity	
On the Electricity Crisis	Create a functioning market for electricity with the following principles: (1) Greater participation of society in generation, transmission, distribution, and storage; (2) Efficient distribution markets that are not too small to benefit from economies of scale (as many municipalities currently are); (3) Clear rules for all market participants that eliminate conflicts of interest and prevent discriminatory treatment; and (4) Final prices that reflect the marginal cost of production, including intra-day pricing.
	Appoint a reform and unbundling sherpa/Czar to push implementation.
	Remove all preferential procurement requirements for the REIPPP. Develop strategic procurement programs that strengthen industries with clear potential to eventually compete in global markets (and move toward this targeted approach instead of widespread, ineffective preferential procurement).
	Use REIPPP design for investments in transmission and storage. Include transmission and storage (with geographical considerations) in the next REIPPP procurement window.
	Rent existing power plants to other operators incorporating high incentives for efficiency.
	Enable new comparative advantage in green electricity: (1) streamline approval of renewable generation, transmission, and storage projects; (2) promote private green industrial zones powered by renewable energy to attract energy-intensive industries that want to decarbonize quickly; (3) explore pumped storage hydropower with Lesotho to facilitate the absorption of more renewable projects.
On Municipal Governments	Reassign responsibility for electricity and water distribution to geographically efficient regulated monopolies. Such companies could then collect other fees on behalf of municipalities via their monthly bills.
	Develop public "capability banks" and position national/regional entities as service providers to municipalities for activities where local governments cannot be expected to have local expertise nationwide.
On State Capacity Overall	*Unburden Capacity* – Expand relaxation of preferential procurement requirements on all SOEs and other public entities.
	Build Up and Protect Capacity – Gradual civil service reform to replace the reliance on cadre deployment. Explore long-term system of civil service cadres that are recruited nationally but deployed across different municipalities and levels if government.
	Leverage Existing Capacity – Establish clear markets that allow for societal capabilities to help fill supply gaps in network industries (rather than selling assets through privatization).

On Spatial Inclusion	
On Urban Planning and Building Regulations	Three main areas of regulatory change: • Relax National Building Regulations (overly restrictive materials and accessibility restrictions). • Relax Local Building Regulations (FAR, BCR, parking, and elevator requirements to allow for higher density). • Change zoning regulations to allow for greater density and mixed-use multi-family housing.
	On urban planning and development: • Incorporate underutilized urban land for housing and development. • Ensure that development impact fees are evenly applied in the city core and periphery.
	Process rules: Move towards regional and provincial zoning standards to limit highly localized NIMBY vetoes to housing.
	Develop and incentivize active public-private problem-solving task forces for housing expansion.
On Budget Reorientation	Revise the human settlements budget to increase demand-side housing subsidies as opposed to direct supply programs that dictate where housing is built. Partner with the financial sector to expand mortgages/lending to those with limited credit histories.
	Link conditional grant funding for housing and related infrastructure to where local building and zoning regulations meet minimum standards for increasing density or where demand-side subsidies are mobilized.
	Reorient budget towards more experimental, innovative mixed-use urban projects, especially on well-located government-owned land.
On public transportation	Prioritize the revival of passenger rail, especially by devolving key functioning routes to more capable metros.
	Additional pilots and scaling of efforts to formalize and expand the minibus taxi system in a way that can support public transport systems.
On Bridging Knowhow	Create and expand markets for business partnerships through supporting investments in hard infrastructure (i.e., roads) and soft infrastructure and services (information systems for matching, partnership advising).
	Leverage agents to enable partnerships through matching third-party trust: Partnership advisors, local NGOs, traditional governments (incl. trusts), possible new roles for universities.

On Green Growth Potential	
On Green Growth	Targeted industrial policy for opportunities that are growing in global demand and where South Africa can develop comparative advantage: • Pillar 1: Make the enablers of global decarbonization – mining strategies for critical minerals, targeted support actions for pioneers in emerging green supply chains, and policies to transition the automotive industry towards electric vehicles. • Pillar 2: Make green versions of grey products for the global market – promote privately-operated Green Industrial Parks (w/ dedicated renewable power). Leverage SASOL's technological strengths to develop green fuels. • Pillar 3: Export green knowhow – Develop capabilities to export knowledge-intensive services in engineering, procurement, and construction (EPC) of green projects, develop new mastery over green technologies (e.g., Fischer-Tropsch for green products, Vanadium Redox Flow battery technology for grid-scale storage, membrane technology for fuel cells and electrolyzers). Strengthen R&D support policies for green technologies. Deepen international partnerships and allow for easy entry of talent through more open high-skill immigration and business travel.
	Return South Africa to investment grade to lower the cost of capital of new investments in the electricity system and other green growth opportunities and develop a world-class electricity market to lower industry-specific risks.
	Prioritize actions to reduce development costs for investment in renewable generation, transmission, and storage infrastructure (e.g., easy permitting; grid interconnection, government-facilitated land).
On Trade Policy	Redirect industrial policy away from import substitution for a limited and stagnant domestic market and instead target industries that can leverage the domestic market but that have the potential to grow by supplying the global market.
	Move from laggard to leader in the African Continental Free Trade Area to increase market access and opportunities for South African companies.
On Knowhow Access	Make South Africa a competitive destination for global talent.
	Continue to reduce administrative delays and costs of business visas.

2 State Capacity as a Constraint to Growth

2.1 Executive Summary

Economic growth in South Africa is constrained by the insufficient availability of critical public goods and services essential for production. As briefly discussed in Chapter 1 of this report, the provision of electricity, transport infrastructure (including freight rail, ports, roads, and passenger rail), water and sanitation, and security have deteriorated substantially over the last generation. The deterioration of utilities alone explains upwards of 40% of the country's growth underperformance since the global financial crisis (Hausmann *et al.*, 2022). The most immediate of these challenges is electricity; projected load-shedding is severe and lowers current growth forecasts by more than 2 percentage points, according to the South African Reserve Bank. Simultaneously, freight and logistics challenges have acute impacts on export sectors. Rail networks have shut down entirely, and port delays have become endemic. Despite favorable external conditions, exports of minerals, metals, and agricultural products are weakening as the cost of getting products out of the country rises. This indicates that the loss of public goods and services has undermined South Africa's historic areas of comparative advantage. The electricity systems failings have undermined South Africa's comparative advantage in cheap and reliable electricity. Meanwhile, many population centers of South Africa are either currently facing or vulnerable to severe water supply crises, as has most recently been experienced in Nelson Mandela Bay Municipality. Vulnerabilities of water and sanitation systems are growing as long-term weaknesses in maintenance and system management meet increasing patterns of drought due to global climate change.

Many public goods and services that were previously provided effectively have experienced substantial deterioration. South Africa's electricity system, rail infrastructure, and ports were once exemplary on the continent. State-owned entities like Eskom and Transnet were well-run and efficient, and ports like the Port of Durban were among the busiest globally. However, over time, there has been a widespread collapse in state capacity, leading to system failures and breakdowns in these industries and systems. Parastatals have experienced a major decline in effectiveness, rendering them unable to fulfill basic mandates. At the same time, municipalities across the country have seen public services decline and increasing levels of financial distress. As infrastructure has deteriorated, aged, and been subjected to sabotage

(through both theft and more systemic influences), new investments have not been mobilized effectively, leaving supply gaps across network systems. As the capacity to supply public goods has broken down, so too has the ability for network industries to sustain themselves through service fees, which has led to insolvency across the system. SOEs, including Eskom, Transnet, and PRASA, are in dire financial situations, necessitating ongoing fiscal support and bailouts from a fiscally constrained national government.

This chapter will argue that the collapse in state capacity within national network industries can be traced to recurring issues of gridlock, ideology, overburdening of public organizations, and political patronage. Gridlock within the legislative process and leadership of government has prevented critical decisions from being made in time to address system breakdowns. This has happened repeatedly in both electricity and rail. Ideology has prevented the full capabilities of society from contributing to address supply needs, for example, by limiting private, provincial, and municipal power generation or devolution of the management of urban passenger rail to capable city governments. Things have been made worse by a mistaken belief that preferential procurement rules could be imposed on complex organizations, such as the network industries, at little cost. Rather, these rules have overburdened critical public organizations by adding financial costs, reducing effectiveness, and expanding space for patronage systems to take hold. Political patronage has been a widespread problem, as well documented by South Africa's Judicial Commission of Inquiry into Allegations of State Capture, Corruption and Fraud in the Public Sector including Organs of State, better known as the Zondo Commission. While it can be easy to place the blame of state collapse on corruption and patronage, this would overlook the direct ways that gridlock, ideology, and overburdening have contributed to struggling and failing public systems. Overall, these causes have resulted in a continued loss of technical capacity and competent management across public organizations, making capacity loss harder to overcome.

Collapsing state capacity at the local level can also be traced to issues of "premature load bearing" alongside the breakdown of national systems. South Africa has a fiscal system that is unusual in the degree of expenditures that take place at the local government level, especially in contrast to its much more limited decentralization of the powers to tax and borrow. South African municipalities were given significant local powers in the distribution of electricity, water and sanitation management, and road development over the decade following

apartheid. This was done in an effort to address regional inequalities. However, many of these responsibilities were inconsistent with local capabilities, causing service delivery to be strained. For example, the maintenance of water systems required more experienced engineers than many municipality governments could mobilize. Additionally, a large share of local revenues is dependent on the collection of fees from water and electricity delivery, which has broken down. This has led to an issue of circular debt. Municipalities have failed to collect tariffs from households for electricity and water, resulting in their inability to pay Eskom and state-owned water boards, further impacting infrastructure maintenance and investment.

The subsequent sections of this chapter delve into the decline in state capacity, its causes, and its consequences for South Africa. First, we describe the overall collapse in state capacity across various service systems and levels of government, which has slowed South Africa's growth and undermined inclusion. The following section examines the electricity sector crisis, which has had the most widespread impact on growth. We unpack the technical challenges of the system and critically assess the reform pathway to rebuild a reliable and low-cost electricity system. We further identify the deeper underlying causes of failed policies and strategies, namely gridlock, ideology, overburdening of public entities, and patronage, which affect public goods provision far beyond electricity. We then explore the challenge of premature load bearing through rapid decentralization that has contributed to state capacity collapse at the municipal level. This problem is essential for understanding issues of circular debt and reimagining the role that municipalities and provinces can play in rebuilding public capabilities. This is especially important for spatial inclusion across the country.

Addressing the collapse of state capacity requires more than just identifying technical fixes and long-term reforms — it requires grappling with the deeper policy and political drivers that have caused public goods to deteriorate with little implementation of known solutions. While many of the technical fixes and long-term reforms are well-known and even outlined in proposed legislation, the political process for implementation has often been incompatible with necessary actions. Take, for example, the electricity system. South Africa's electricity system lacks sufficient generation, transmission, and storage capacity, while its existing coal-fired plants are aging and increasingly unreliable. South Africa urgently needs substantial investment in renewable generation, grid infrastructure, and storage. This must come from sources beyond Eskom, with increased participation from private firms with the

knowhow and balance sheets to execute investment. To facilitate such participation, the government must establish a well-functioning market with transparent rules and non-discriminatory treatment of participants. These principles have been long-known and documented in government white papers. Yet, these actions have not been taken for many years and legislation has not been passed at the time of writing, leading to perpetual crisis management. Current emergency actions will likewise remain insufficient in the absence of long-term market clarity and non-discriminatory treatment. But with such steps, new sources of generation, transmission capacity, and innovations in grid storage would enable both the emergency response to the crisis and power a sustained economic recovery.

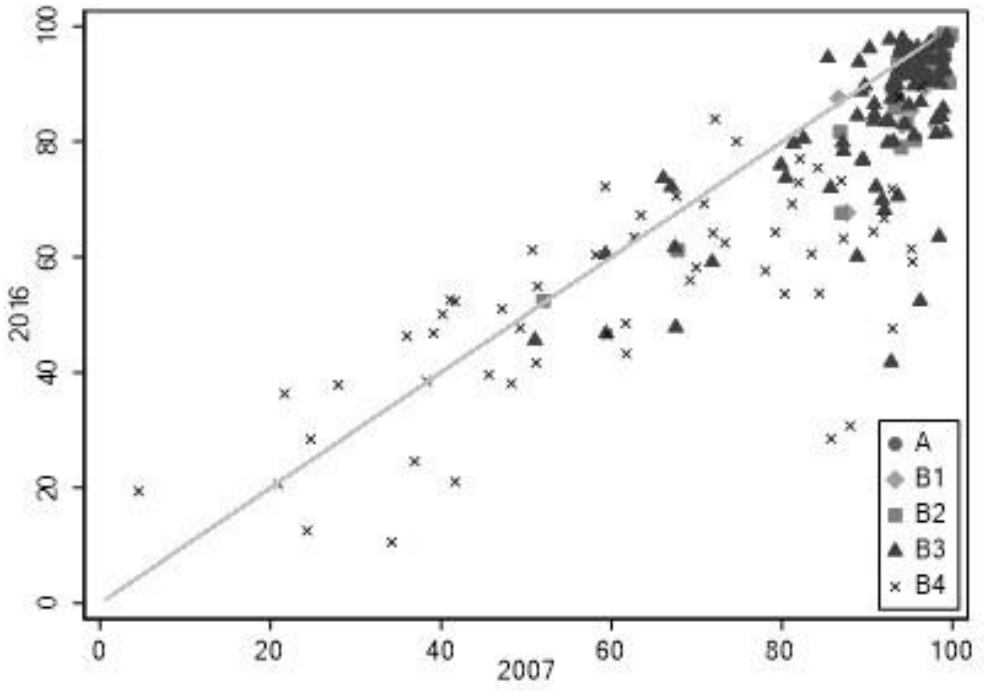
This chapter closes with a strategic direction for strengthening state capacity. We can view actions to strengthen state capacity as covering several dimensions. This includes actions to *unburden capacity* by further relaxing preferential procurement rules to allow public entities to deliver on their core functions more effectively. Unburdening municipal governments must include reducing problematic responsibilities where local capacities are poorly suited to deliver in most municipalities, particularly in electricity and water distribution. The government must seek to *build up and protect capacity* through civil service reform to replace the reliance on cadre deployment over time. In the process of building capacity, this could include more centralization of challenging government capabilities alongside "capability banks" or other public tools that position national and regional entities as providers of technical services to municipalities for project planning and execution. Importantly, South Africa has much to gain by *leveraging existing capacity* by establishing markets with long-term clarity that can crowd in new capacity and strategic procurement of services by SOEs. This is likely to be a faster and more effective way to recover capacity in key public goods than through privatizing state assets.

2.2 Patterns of Collapsing State Capacity

Over the last 15 years, South Africa has seen a broad-based collapse across critical public goods and services. There has been a deterioration in the provision of electricity, freight rail, ports, roads, water, and passenger rail. Figure 2.1 shows a particularly glaring example of collapse. Whereas piped water access is expected to grow over time in any developing economy not facing conflict or widespread natural disasters, South Africa has seen a

widespread decline in access. At the time of writing, the provision of services across many areas appears to be getting worse despite clear government efforts, as prioritized Operation Vulindlela from the wide-ranging Economic Reconstruction and Recovery Plan that followed COVID-19. In the first half of 2023, total load-shedding in South Africa was more than the entirety of 2022, which had previously been the worst year of load-shedding on record (Business Tech, 2023). Freight rail volumes are 30% lower than their peak in 2015, and since 2014, the percentage of freight transported by rail has declined from 30% to 20% of total payload (News24, 2021). This has meant that more freight has needed to travel by road, which has put additional pressure on the road system. The ports of Durban and Cape Town, South Africa's two largest ports, which saw port throughput in South Africa decline prior to COVID-19, now have some of the lowest performance scores of all ports in the world (World Bank, 2023). Similarly, passenger rail has seen a steep decline in ridership and an increase in delays.

FIGURE 2.1: PERCENTAGE OF HHS WITH ACCESS TO PIPED WATER 2007 VS. 2016

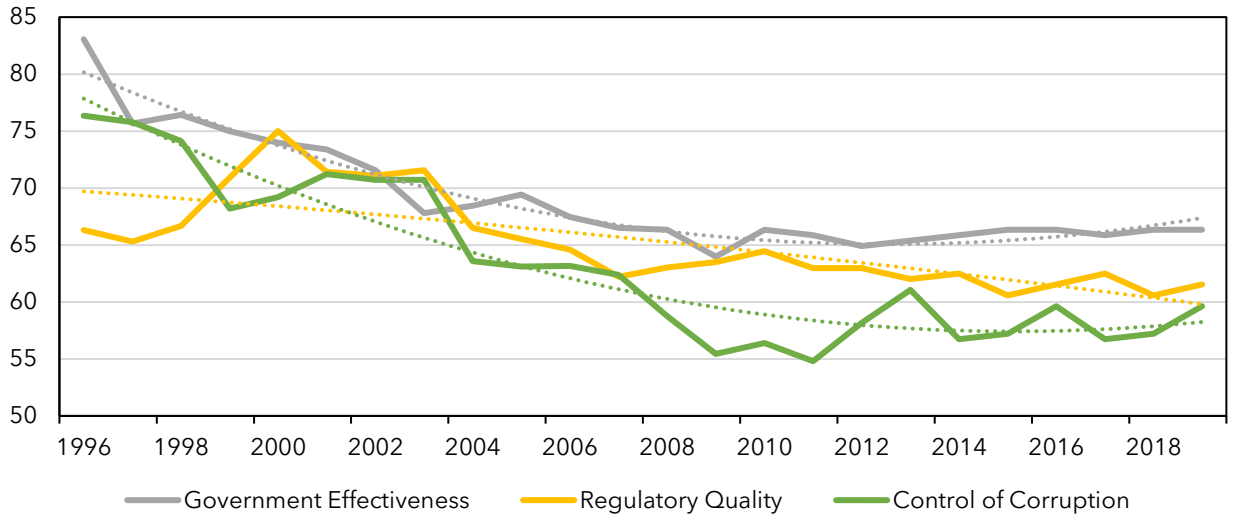


Source: Own elaboration based on South Africa Community Surveys.

The simultaneous collapse of these public services is indicative of a general collapse in state capacity. One system showing a decline in service delivery might suggest a specific problem in that sector, but the deterioration in public service provision across many areas

associated with SOEs and municipal governments suggests deeper causes at play. This is also reflected in a general decline in South Africa's position in the Worldwide Governance Indicators compiled by the World Bank (Figure 2.2). South Africa's global ranking in government effectiveness and control of corruption declined steadily in the late 1990s and the first decade of the 2000s. This decline clearly preceded the Zuma administration of 2009-18 and widely reported issues of state capture that occurred during that period.

FIGURE 2.2: SOUTH AFRICA'S PERCENTILE RANK IN SELECT GOVERNANCE INDICATORS

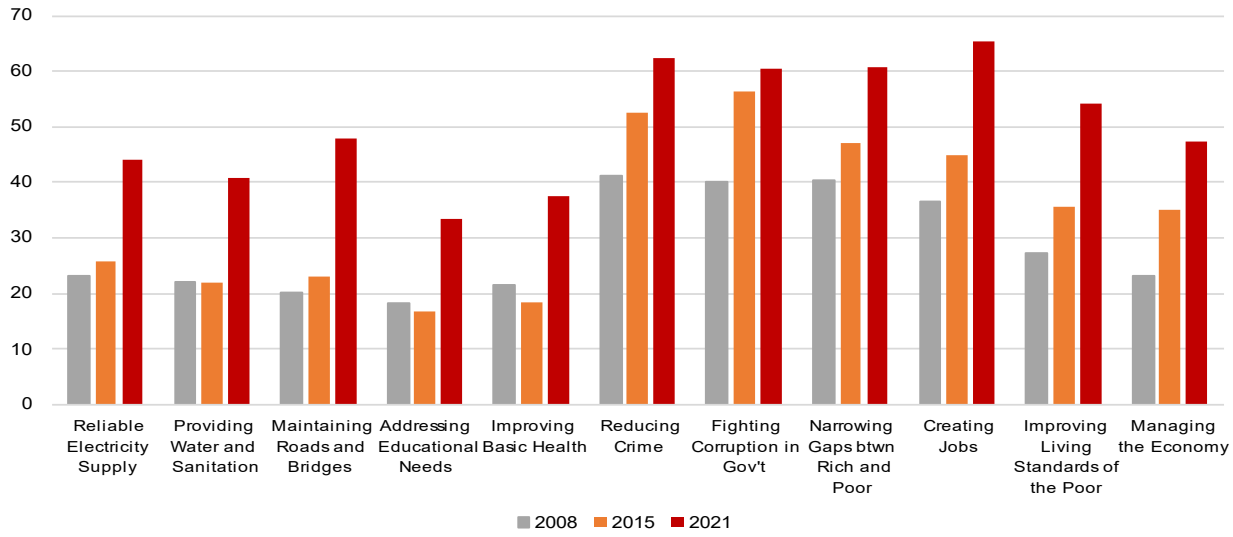


Source: Own elaboration based on World Governance Indicators, World Bank.

Public perception surveys indicate a sharp decline in service provision. The Afrobarometer survey, which has been repeated in two-to-three-year waves since 2000, reflects a continuous decline in public perceptions of many services (Figure 2.3). This includes a large increase in the share of respondents who selected "very badly" in response to questions on government performance in providing reliable electricity (from 23% in 2008 to 44% in 2021), providing water and sanitation services (from 22% in 2008 to 41% in 2021), and maintaining roads and bridges (from 20% in 2008 to 48% in 2021). This is likewise true for fighting corruption and a wide range of economic performance questions, from "managing the economy" to "improving the living standards of the poor" to "creating jobs" and "narrowing income gaps." Since surveys in 2021 capture the impacts of COVID-19, Afrobarometer surveys across countries tend to show poorer performance across all these areas. However, South

Africa shows a distinct collapse of performance across many public services after 2015 that is well above and beyond the norm across African countries.

FIGURE 2.3: SHARE OF RESPONDENTS INDICATING GOVERNMENT HANDLING AS "VERY BADLY"



Source: Own elaboration based on Afrobarometer Surveys.

The collapse in state capacity has been a major drag on overall economic performance. In early 2023, the SARB estimated that load-shedding is costing the South African economy nearly USD 51 million a day and has reduced its forecast for growth by two percentage points due to the intensity of power cuts. Some estimates suggest that the impact of the logistics challenges might have lowered growth by a similar amount or more (The Economist, 2023). Hausmann *et al*. (2022) find that South Africa's slow growth since the Global Financial Crisis is not explained by external factors affecting terms of trade or macroeconomic stresses but rather by a decline in total factor productivity (TFP) resulting from a supply shock in South Africa's network industries. If left unaddressed, these breakdowns will continue to constrain economic growth. Even during favorable external conditions, such as the commodity boom in 2021, South Africa's ability to benefit has been hampered by these supply-side bottlenecks. Consequently, demand-side policies, such as monetary and fiscal measures, are ineffective in reviving growth because they would only exacerbate supply constraints.

The primary channel through which the collapse of state capability has undermined growth is through the deterioration of core functions of SOEs. Many public services in decline center on SOEs, including Eskom for electricity, Transnet for logistics, PRASA for

passenger rail, SANRAL for roads, and water boards in the case of water – that have seen a decline in operational efficiency and a loss of technical capacity and talent. While underlying issues of SOE mismanagement, financial distress, and outright corruption are all intertwined and difficult to unpack, the resulting low productivity and underinvestment in infrastructure maintenance and expansion are clear to see. This has resulted in declining public services in terms of measurable performance and public perceptions. Yet, the lack of adequate investment does not mean that SOE spending has been low. The sector received bailouts and recapitalizations totaling USD 14 billion or 6 percentage points of GDP in the 2009-2020 period, and in addition, borrowed USD 35 billion (8% of GDP) (Hausmann *et al.*, 2022; Research and Markets, 2021). In 2023, the South African government took on an additional USD 14 billion of Eskom's total USD, while SANRAL and Transnet have received additional support through the last medium-term budget. These bailouts have weakened the government's ability to put its debt on a sustainable path.[8]

With these larger patterns in mind, the next section unpacks the electricity crisis and Eskom's role in revealing larger patterns of state failure. The case reveals that necessary investments in generation, transmission, and storage were delayed, and then hampered by fundamental disagreements within government leadership as to the vision for the sector, especially regarding allowing the private sector a role in electricity generation. As the system weakened, decisions were taken with increasingly short-sighted timeframes and expectations. As a consequence, facilities were not taken offline for regular maintenance in order to temporality limit load-shedding. But this made the problem progressively worse through declining plant availability factors, as power plants experienced persistent breakdowns that forced them to be taken offline. Large investments in new generation had serious design flaws, experienced extreme cost overruns, and faced delays, intensifying the generation shortfall and Eskom's massive financial burden (Hosken, 2019). In this context, Eskom was not allowed to leverage private generation due to highly restrictive limits on private electricity generation, which limited investment in supply. This has left the system more reliant on Eskom, a company with deteriorating capabilities, a weak balance sheet, and an inability to repair and expand the system. Similar patterns underlie the decline of logistics networks. Transnet is no longer able to maintain its rail network, including by protecting it from sabotage and cable theft, while it

[8] Based on authors' Debt Sustainability Analysis.

also does not have the rail stock to run trains. Ports have seen deteriorating productivity and a backlog of maintenance and investments needed to be able to process the volumes they used to process. Similarly, passenger rail has been left to deteriorate as PRASA has also faced deteriorating productivity and underinvestment while wages and other expenditures increased rapidly (Stent, 2022).

2.3 The Electricity Crisis and Broader Lessons

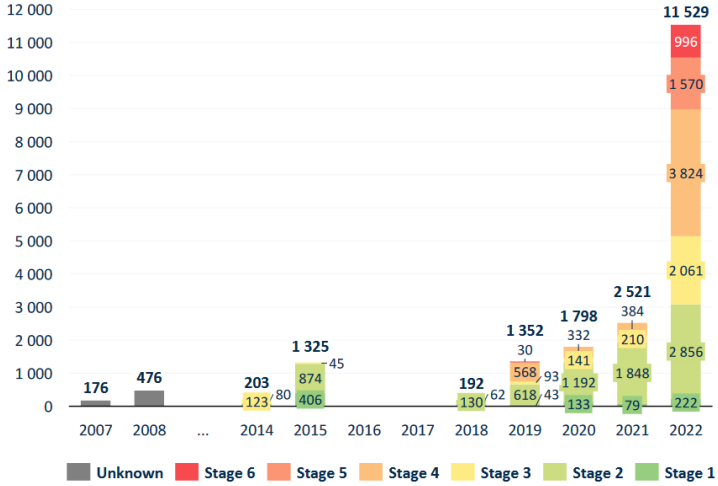
2.3.1 Current State of the Electricity Crisis

South Africa is facing an enormous crisis in electricity provision. In the early part of 2023, the Government of South Africa declared a National State of Disaster due to the ongoing electricity crisis. At the time, South Africa was facing load-shedding (i.e., rolling blackouts) with some areas losing power for nearly 10 hours (stage 6 load-shedding). This year has seen an acceleration in the long-term dynamic of the rationing of electricity that started in 2007 (Figure 2.4) (Pierce and Le Roux, 2022). This state of national disaster, as an official measure, was later revoked due to legal issues, but the problems in South Africa's electricity system remain as dire now at the time of writing as they were in the earlier part of the year. Load-shedding for the first three months of 2023 alone was greater than the total amount of load-shedding for the years 2018-2021 combined, and South Africa saw daily power cuts without a break for more than three months (Daily Investor, 2023b).

South Africa's traditional sources of comparative advantage in mining, metals, and capital-intensive manufacturing developed in a context of low-cost and reliable electricity. South Africa has historically had access to cheap coal and historically, it took advantage of this resource not just by exporting its coal, but also creating an electricity system that could translate that cheap coal into cheap electricity. This allowed South Africa to develop a comparative advantage in energy-intensive export sectors like mining, metals, and manufacturing sectors like automobiles. Figure 2.5 shows how dependent South Africa's exports are on electricity relative to the export baskets of other countries. The boxes represent the middle 50% of countries for each year in the electricity intensity of their exports. From this figure, we can see that South Africa has historically had an export basket that was highly intensive in electricity as an input – always among countries in the top 25% of electricity intensity of exports. But the electricity crisis both in terms of prices and reliability has destroyed

the foundations of South Africa's historical comparative advantage. Additionally, all countries with high electricity intensity are facing a global change in demand, which we can begin to see in the final years of this figure and will be discussed at length in Chapter 4 of this report.

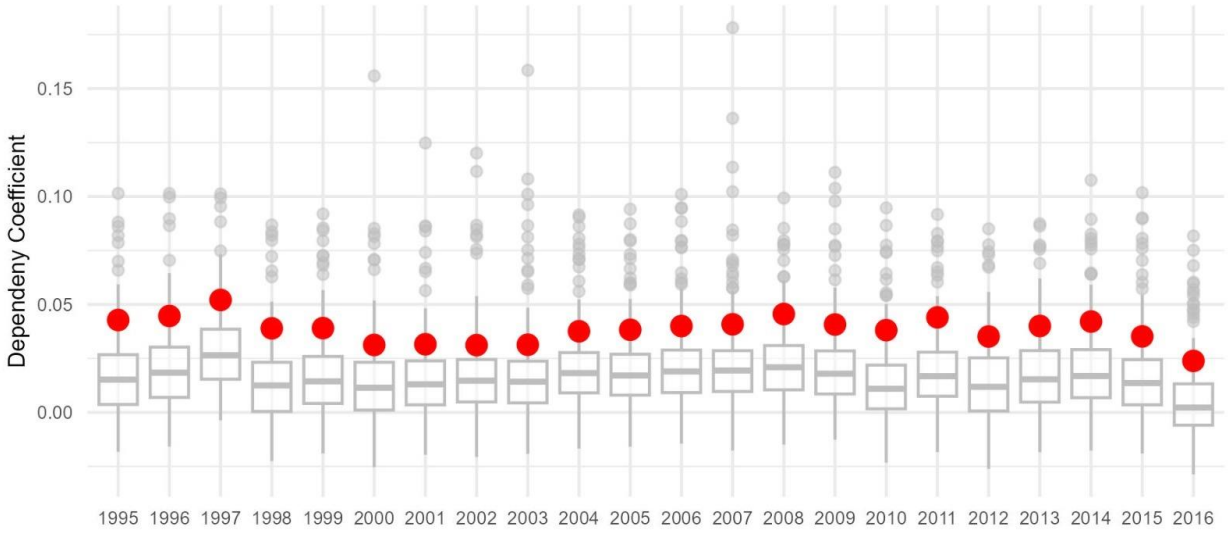
FIGURE 2.4: LOAD-SHEDDING IN SOUTH AFRICA (2007 TO 2022)



Year	Duration of outages (hours)	Energy shed (GWh)	DSR (GWh)
2007	-	176	Not available
2008	-	476	Not available
....	....	....	....
2014	121	203	Not available
2015	852	1 325	Not available
....	....	....	....
2018	127	192	392
2019	530	1 352	1 362
2020	859	1 798	1 426
2021	1 169	2 521	1 936
2022	3 773	11 529	8 301

Source: Pierce & Le Roux, CSIR (2022).

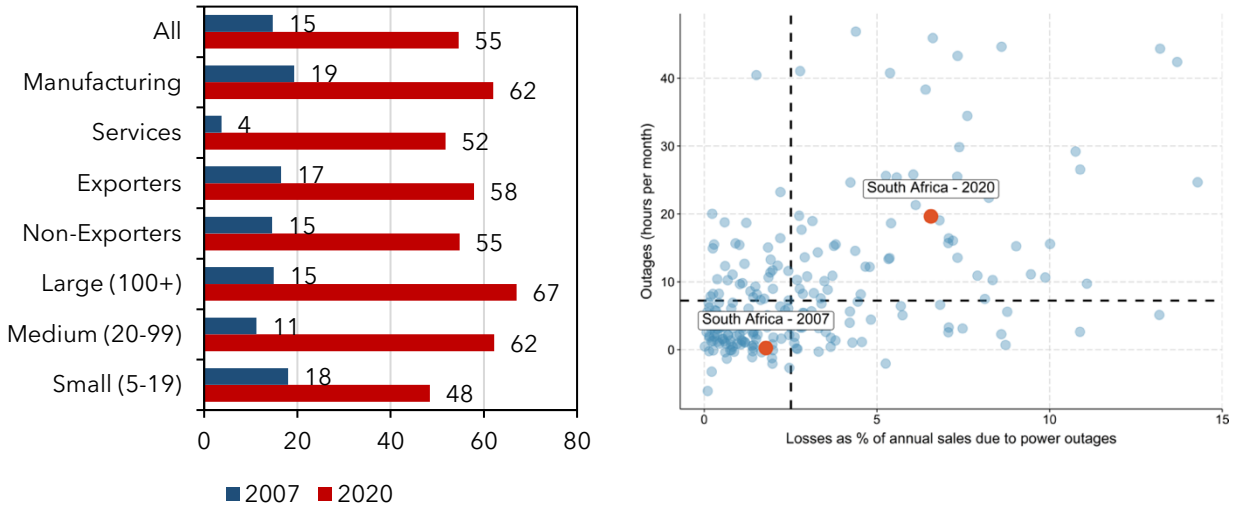
FIGURE 2.5: ELECTRICITY DEPENDENCE OF SOUTH AFRICA'S EXPORTS



Note: Red dots highlight South Africa.
Source: Own elaboration based on UNCTAD, US BEA Input-Output Tables, Atlas of Economic Complexity.

South Africa's collapse in electricity provision has been the most immediate binding constraint on South Africa's growth. In fact, the electricity crisis showed clear signals of being the binding constraint on economic growth well before the rapid acceleration of load-shedding and declaration of the state of disaster – revoked soon after – in 2023. The relatively high price of electricity price and extreme unreliability have created a large strain on firms across sectors and especially in manufacturing (Fortunato, 2022). Electricity tariffs in South Africa have skyrocketed since 2007, rising by a factor of roughly 6.5 from 2007 to 2022 as general inflation has only raised prices by a factor of just 1.3 (Moolman, 2022). This was in part a consequence of tariffs not being cost reflective prior 2007. Yet, this large increase has not cleared the market, necessitating that the government ration electricity demand through load-shedding. Electricity has become the number one obstacle for all firms of all types in South Africa as businesses have faced a large increase in outages and the cost of outages, putting South Africa out of line with international norms (Figure 2.6). As further analyzed by Fortunato (2022), there has been a proportional increase in generator and off-grid renewable energy use as businesses strive to bypass the challenges in the electricity sector. The same report finds that it is precisely the industries that are most intensive in electricity use that have seen the largest shocks to their growth.

FIGURE 2.6: SHARE OF SOUTH AFRICAN BUSINESSES REPORTING ELECTRICITY AS THEIR BIGGEST OBSTACLE (LEFT) AND OUTAGES VS. COST OF OUTAGES FOR ALL COUNTRIES (RIGHT)



Source: Fortunato (2022) using World Bank Enterprise Surveys.

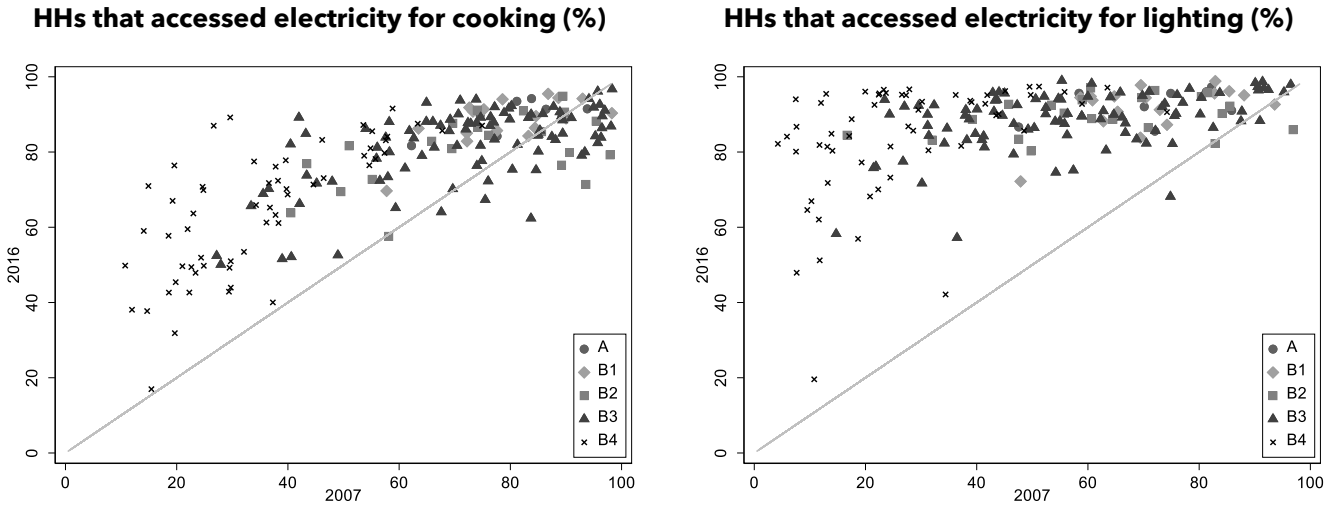
South Africa currently finds itself in a permanent "emergency mode" due to unreliability and constant breakdowns of its existing plants and an absence of spare generation capacity. Emergency maintenance lowers capacity, requiring load-shedding to make sure there is not a system-wide blackout. Other emergency responses include using very expensive diesel generation and further delaying planned maintenance or decommissioning, which increases the likelihood of more breakdowns in the future. As the supply shortfall intensifies, additional emergency supply measures are considered, including procuring energy imports through "powerships". There are limits to how far "emergency mode" can go to solve the problem, and the escalation of load-shedding in 2023 is one indication that such limits have already been reached. Recently – in 2020/21 – the crisis finally convinced the government to allow for greater private sector participation in generation. This is an important step for moving past emergency mode, but it does not bring new generation online immediately and comes with power purchase agreements at elevated costs to compensate private generators for the risks of investing in a sector without clear rules and with a weak counterparty. The government has also removed a requirement for independent power producers of embedded generation to have a license and has eliminated the caps on capacity that previously existed. REIPPP has also been re-opened for new bids. This program has seen some success in attracting investment interest, but projects have faced difficulties in moving forward. In the last round, only around 1,000 MW out of a call for 5,600 MW could be allocated because of insufficient grid capacity (Daily Investor, 2023a).

Eskom now faces a situation where it cannot avoid persistent load-shedding as low electricity availability factors (EAFs), unplanned maintenance and breakdowns, theft, non-payment, and shaky financials persist alongside transmission and storage challenges for bringing new generation online. Eskom's overall EAF in 2022 was only 59% compared to a target of 65%, and this EAF has worsened each year since 2017 (when it stood at 78%). Just in the last 6 months, Eskom has had major issues with nine of its powerplants which has left nearly 4,700MW offline (five stages of load-shedding) for extended periods of time (Daily Investor, 2023c). So long as these problems continue, Eskom will be unable to use its current fleet to service South Africa's electricity needs.

2.3.2 Causes of the Electricity Crisis

There is broad consensus that the proximate cause of this dynamic is an electricity system that lacks the generation, transmission, and storage capacity to meet energy demand. In 1998, the Department of Minerals and Energy commissioned a white paper on the power sector in South Africa. This paper warned that though Eskom was operating with excess capacity throughout the 1990s, this excess capacity would soon run out by 2007 if there were no additional investments in generation (Department of Minerals and Energy, 1998). In addition, the government embarked on a successful plan to electrify all households by the year 2012, especially in previously underserved areas (Figure 2.7) (Bekker *et al.*, 2008). Despite this plan to increase demand further, no new investments in generation were carried out, and as predicted, the reserve margin did indeed run out by 2007, causing the first load-shedding to occur.

FIGURE 2.7: CHANGE IN HOUSEHOLD ACCESS TO ELECTRICITY BETWEEN 2007 AND 2016



Notes: Metros (type A) and local municipalities (types B1-B4 which reflect different levels of socioeconomic development). HHs stands for households.
Source: Own elaboration based on Community Surveys.

Once it was clear that demand would outstrip supply in 2007, South Africa made three strategic errors on the way forward. The first error was doubling down both on coal and on Eskom to increase generation capacity. At the time the plants were announced, coal was still the cheaper source of additional capacity, but costs for solar and wind were declining. By the time the Medupi units came partially online in 2015, the cost advantage of coal was no longer clear, and by now it has now disappeared. Regardless of cost competitiveness

questions, bad technology and design choices, and well-documented issues of corruption meant that the Medupi and Kusile plants were delayed and faced large cost overruns. The two are still not fully operational. Today's alternative generation choices look very different, but South Africa continues to wait for the two plants to come fully online. While rapid reductions in the cost of solar, wind, and other technologies were not predicted in 2007, the choice to go with very few and very large new plants and exclusively through Eskom can be viewed as an error, even without the benefit of hindsight. This was compounded by the next two issues.

Second, while South Africa waited for new capacity to come on through these two new power plants, Eskom increased the energy utilization factor (EUF) of existing plants. This decision implied operating the plants close to their limits (Oberholzer *et al.*, 2022). This reliance also meant delaying or skipping planned maintenance to increase plant availability in order to avoid even worse load-shedding. This might have made sense if the additional new capacity from the Medupi and Kusile plants were to come online without delays, but this was not the case. Instead, delaying maintenance and overrunning the plants created systemic problems by 2011/2012. As the System Status and Outlook notes, it was around this time that the EAF of Eskom's plants started to fall behind peers, with the identified reason being that maintenance and breakdowns became unavoidable for such an old fleet that had been worked so much beyond capacity. These problems may have been reduced if more forceful demand management policies rather than rationing had been adopted at the time, e.g., by allowing electricity tariffs to reflect actual scarcity, especially for industrial consumers.

Third, South Africa stalled and then actively prevented participation of the private sector in generation and transmission. There were multiple attempts at allowing more participation of the private sector — including proposals to privatize some generation through the introduction of feed-in tariffs in 2009, and renewable energy bids in 2011 — but these attempts were stalled and aborted at the time in favor of the strategy focused on the construction of two large coal-fired power plants. Had South Africa allowed more private sector participation, the electricity crisis might have been resolved long ago. The case of Chile is informative of what an alternative path might have looked like in South Africa (see Box 2.1). Chile faced its own electricity crisis in 2007, around the same time South Africa began to first experience load-shedding. However, through a combination of quick action on long-term reforms together with effective short-term emergency management, Chile allowed the system to adjust quickly

through strong private sector investment in generation, transmission, and distribution. The result was that Chile was able to avoid load-shedding and resolve its electricity issue in less than 5 years.

Box 2.1: Managing an Energy Crisis and Making Long-Term Reforms: The Case of Chile

Chile was a pioneer in the liberalization of its electricity sector in the early 80s. Thus, by the 2000s, it had competitive market for electricity generation. In this market, power companies and large customers could freely negotiate bilateral supply contracts and there was an exchange market for generators to trade their instant energy imbalances. In 1995, Chile signed the Gas Integration Protocol with Argentina. As a result, the private sector built seven pipelines uniting both countries, while electricity generators and gas distribution companies negotiated long-term contracts with Argentinian natural gas producers. As additional power plants were built and connected to the grid, the share of gas in the generation mix grew continuously through 2004, when they reached 36% of electricity generation (see Figure below).

Unfortunately, due to domestic economic difficulties and dubious policy choices, Argentina froze natural gas prices, leading to a precipitous decline in gas production. In this context, Argentina defaulted on their long-term gas contracts with Chilean generators. At the same time, Chile faced additional negative shocks to its electricity supply, including a historic dry season that reduced hydropower generation capacity and earthquake in the north of the country that took several plants offline for a period.

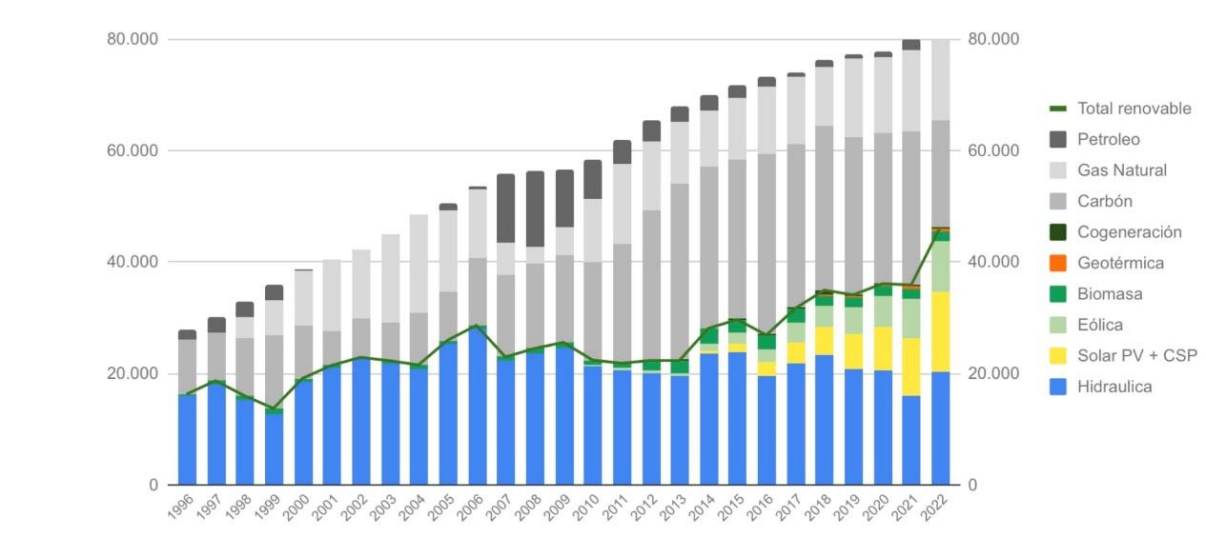
To address the collapse in the supply of Argentinian natural gas, which affected 36% of electricity generation, the government plan involved a combination of medium term measures to encourage private investments in regasification plants to allow the importation of liquified natural gas (LNG), and in alternative energies, while adopting a short term plan to let prices reflect the actual scarcity, which encouraged plants to shift back to liquid fuels and coal, while high prices encouraged industrial consumers to curtail their demand. The system adjusted without the need for load-shedding. An initial move to oil to fill the gap was quickly reversed once LNG arrived. Later, the private sector moved quickly to solar and wind. In sum, the emergency response used prices to encourage short-term demand shifts and long-term supply response, while the market institutions were strengthened to allow new energy sources to compete on equal footing with each other. The system adjusted without load shedding and without blackouts.

In short, South Africa and Chile faced similar deficits in generation capacity at the same time, but Chile was able to resolve these challenges permanently in less than 5 years while avoiding blackouts, South Africa has faced severe loadshedding and continues to see the crisis worsen after more than 15 years.

Box 2.1: Managing an Energy Crisis and Making Long-Term Reforms: The Case of Chile (cont.)

There are a few lessons for South Africa. First, the participation of the private sector was crucial to flexibly respond to the crisis. Second, using prices rather than rationing during the emergency phase encourages a faster private sector response both on the demand and the supply side. Third, structural reforms that allow the market to function more effectively can accelerate the supply response and lower the long-term costs of the system. Finally, the emergency itself can create a consensus for substantial reforms that can overcome the narrow interests that oppose change.

Chile's Electricity Generation by Source, 1996-2022



Source: CNE.

South Africa's errors in planning and system operations were exacerbated by corruption, a loss of talent at Eskom, declining productivity in coal mining, cost overruns, and municipal non-payment. All these gutted the capability of Eskom. The company lost critical talent and technical expertise in the lead-up to and during the crisis (News24Wire, 2022). It did not help that the crisis coincided with the height of a period of state capture, where Eskom was hard hit by corrupt contracts and mismanagement. Among the most prominent examples of such were the contracts for building Medupi and Kusile, which not only were delayed in their construction but had excessive cost overruns and design flaws. These two projects alone generated USD 20 billion in overruns and delays by 2019 (Smit, 2022). At the same time,

despite large increases in electricity tariffs, revenues did not fully cover the ballooning costs of Eskom, widening its losses.

The deeper causes of the crisis can be traced to political gridlock, ideological choices, overburdening through preferential procurement rules, and political patronage. Political gridlock has prevented prompt action, even in the context of a catastrophic situation with large social and political costs. Ideology justified excluding other parts of society from contributing to a solution, at immense cost to the economy and society. Additionally, the use of procurement power of SOEs for additional goals beyond the delivery of cheap and reliable electricity has raised costs and undermined productive capacity. For example, Eskom has been affected by preferential procurement requirements that have required it to source expensive and often low-quality coal from mines far away from where its plants are located. Deriving from a constitutional mandate, preferential procurement as structured by the Preferential Procurement Framework of 2000 has led to numerous inefficiencies (National Treasury, 2015). In fact, the impact of these policies became so problematic that the government eventually had to roll them back as it became clear that procurement of critical equipment for maintenance of infrastructure would not be possible under these stricter guidelines (Boonzaaier, 2022). At the same time, Eskom has been one of the government entities most affected by cadre deployment and then state capture. It is a long-standing policy of the ANC to place party members in influential roles across government and crucially parastatals. Academic research on the subject suggests that this policy laid the groundwork for state capture (Swanepoel, 2021). In addition, the Zondo Commission's findings said that the ANC's cadre deployment process can be abused to facilitate corruption and possibly state capture. In fact, they found substantial evidence as indicative that multiple appointments were made to key positions in order to facilitate state capture (Judicial Commission of Inquiry into State Capture, 2022).

2.3.3 Addressing the Electricity Crisis

A long-term solution to the electricity crisis must accomplish a broader set of goals; a narrow goal of ending load-shedding is not enough. A great deal of media and political attention has been focused on load-shedding and it harms the economy. There is no doubt that the extent of load-shedding is causing massive harm to the economy. But Growth Lab research shows that electricity was a constraint for the South African economy even prior to the

current situation of extreme load-shedding. Even as prices of electricity rose with less load-shedding (or firms had to rely on expensive generators and diesel), there were many negative impacts since South Africa's traditional source of comparative advantage was its reliance on cheap electricity. Ending load-shedding would be major a relief to South African society, but ending load-shedding is not enough for South Africa to overcome the constraint on electricity.

A larger set of goals must be achieved for South Africa to regain a comparative advantage in energy-intensive production and exports to the global economy. An overemphasis on the narrow goal of eliminating load-shedding is risky because the current emergency approaches to end load-shedding are expensive, both to users of electricity and to the South African government, and unsustainable. The South African government has needed to backstop the entire system through its financial support of Eskom and municipalities. This is not sustainable in the long run. There will ultimately be tradeoffs between price and access. While South Africa has made great strides in electricity access, according to World Development Indicators, some 10% of the population still lacks any access, and many places do not have full access still. Finally, South Africa must develop an electricity system that not only delivers reliable and cheap electricity today but also that is positioned to give South Africa a comparative advantage in the future. For this reason, rebuilding the system cannot be isolated from the realities of global green transition (see Box 2.2 and Chapter 4). Taken together, we can understand the goal of addressing the electricity crisis not just as one goal of ending load-shedding but rather as a set of goals listed below:

1. Load-shedding ends (i.e., the market fully clears).
2. Tariffs to consumers are low and fair.
3. Every part of the system is fiscally/financially sustainable.
4. Access to electricity is expanded to all sections of society.
5. Renewable energy strategy is incorporated to position South Africa for the future.

It is important to evaluate both the current approach and alternatives on their ability to accomplish all these objectives over the long run. It is possible to make progress on one goal but in a way that undermines one or more other goals. For example, in theory, South Africa could end load-shedding and make the entire system financially sustainable by allowing

prices to rise enough to clear the market. This would reduce demand on the system so that load-shedding ends and would allow Eskom to recoup costs, but at such high prices businesses and economic activity would need to be severely curtailed and it would be the poor that would especially lose access. Similarly, the current approach may end or reduce load-shedding through emergency measures and private generation through IPPs while increasing some renewables on the system. But such a system would not lead to lower prices, a more efficient grid, or financial sustainability for all actors. At the end of the day, either energy consumers or the government will be liable for the costs of expensive diesel, "powership" contracts, and sovereign guarantees to REIPPP participants.

At the same time truly solving the electricity crisis requires addressing both the more proximate causes of system failure and the deeper causes of dysfunction. The proximate solutions that address all goals hinge on creating long-term clarity of market fundamentals to crowd in broader participation and investment in generation as well as transmission and storage. Private investment comes with knowhow, efficiencies, and balance sheets that Eskom lacks, but the state must set clear and reliable rules of the game to benefit from private capabilities. This will require creating a functioning market based on a set of broad principles, which we list below. At the time of writing, Eskom is expanding its purchase of power from private generators, but Eskom and South African society overall must pay a premium to these generators to compensate them for the risk of selling to a failing system with unclear rules. In addition to generation, transmission and energy storage infrastructure have become especially important given the rise of cost-competitive renewable generation sources. Storage is essential because wind and solar are not dispatchable: they only generate power when the wind blows and the sun shines. Storage allows the system to use them on demand. The transmission buildout is needed because wind and solar resources are concentrated in parts of the country that are not currently connected to the grid. But history shows that addressing these proximate causes will not be possible without also tackling deeper issues that have caused the crisis to begin with and that have hampered effective solutions for over 15 years. Thus, actions today must confront the challenge of a government with divided interests and ideologically-driven policies that have proven counterproductive, and with an endemic use of SOEs for political patronage.

To establish an electricity market that will power South Africa in the long term while also allowing for a stronger emergency response, clear rules must be based on four principles. First, the market must enable much greater participation of society not only in generation, but also in transmission, storage, and distribution. Second, it must allow for efficient distribution markets that are not too small to benefit from economies of scale. Third, there must be clear rules for all market participants that eliminate conflicts of interest, especially for the system operator, and prevent discriminatory treatment of market participants. Fourth, final prices must reflect the marginal cost of production, which must include dynamic intra-day pricing. Taken together, if a system achieves these principles, it will be positioned to provide reliable electricity across the country at low costs and with the ability to adjust over time, including in the context of the global energy transition.

Box 2.2: Electricity in a Decarbonizing World

South Africa faces its electricity crisis in a context where the world economy is beginning to decarbonize. Thanks to technological advancements, renewable energy costs have fallen substantially and continue to do so, and this has made it possible for developed countries to demand faster decarbonization globally. This creates pressure for developing countries to decarbonize faster, even in cases where countries have significant supply gaps.

This complicates the task of solving the electricity crisis in South Africa but also creates opportunities. South Africa needs coal generation as part of its electricity system to overcome the crisis, but the role of coal will undoubtedly change in the future. South Africa has significant renewable potential in wind and solar, as well as opportunities for battery and pumped hydro storage. South Africa needs to leverage all capabilities. This underscores the importance of a competitive, functioning market, where market players can freely trade with one another and make investments with no discrimination.

Renewable sources of solar and wind are intermittent and fluctuate based on weather and time of day. As a result, a system based on renewables will need large investments in battery and other storage as well as transmission to make energy dispatchable. South Africa's solar is concentrated in the Northern Cape where needed grid infrastructure is lacking, and wind potential is high offshore. A system based on renewables will require massive investments in not just generation but also transmission and storage.

South Africa's path forward may be better enabled by international support via the Just Energy Transition (JET) framework. Rather than a focus on accelerating the removal of coal and other fossil fuel generation, international support could more forcefully help to finance and build the transmission and storage infrastructure in South Africa. This would better respond to the crisis and enable a fuller transition to a decarbonized system over time.

A new Electricity Regulation Amendment Bill, drafted and approved by the Cabinet in March 2023 and recently tabled in Parliament, attempts to address the proximate causes of the electricity crisis, but there remain unresolved issues that continue to undermine market clarity. The bill aims to unbundle Eskom into separate generation, transmission, and distribution entities, which would then allow for fluid trading of electricity with private sector participation. The unbundling of Eskom has begun, and a new entity TSO (Transmission System Operator) has been established. Generation licenses have already been made less onerous to acquire through deregulation, and the new bill attempts to create a market for private generation to be sold to the TSO as well as private buyers through PPAs and through a trading platform. The unbundling of Eskom into separate entities is crucial for creating a level playing field for all players, especially in generation and distribution where they are envisioned to play a much stronger role. The National Energy Regulator of South Africa (NERSA) will have an expanded role in determining pricing, investments in the grid, and regulating this market. However, several areas lack clarity, adversely impacting long-term decisions of potential entrants into all areas of the electricity business, including transmission and storage.

- **First, the bill does not clarify key dimensions of the future marketplace.** For example, it has not decided whether South Africa would have a centrally mandated pool, like is the case in Chile, where all private players are required to operate within a common framework of rules, or if the market will be voluntary like the one in some states in the United States. It leaves potential lack of clarity and consistency in the roles of NERSA and TSO, as these entities currently have many functions which are handled by separate entities in other countries. Since electricity investments are capital intensive, with costs being sunk upfront and justified based on expectations of positive cash flows over a long period, this creates the need for clarity now about the rules of the game in the relatively distant future. If current reforms are not clear enough about that future, this creates risks that will be reflected in the cost of capital and the price of electricity today.

- **Second, regardless of the market structure, there remains high potential for government to change the rules of the game in ways that harm private actors.** Governments have incentives to promise high profits to get the investment going but once in place, they will have incentives to renege on those promises to *de facto* lower the cost of electricity to voters (e.g., either with artificially lower tariffs or by not collecting payment).

One way in which this risk shows up is as counterparty risk for generation investments that sell to Eskom. This risk increases the cost of capital and makes electricity more expensive. These risks can be reduced if generators are free to sell their output in the free market and the rules of the market are well understood. Uncertainty about the future will mean lower investment and higher electricity costs today. That is why it is important to solve these issues now, rather than to leave questions unanswered until the emergency has been resolved.

- **Third, the bill may not adequately address what role municipalities can and should play in the system going forward.** Currently, municipalities are distributors for a significant part of the electricity market, but they have been plagued by non-payment and poor service. When municipalities have attempted to secure their own electricity through PPAs, these decisions have been effectively overridden by load-shedding. With the expected growth of private investment, contractual relationships between such companies, municipalities, and Eskom will need to work within a clear and predictable system. Otherwise, the result will again be underinvestment by the private sector and higher prices to compensate for risk.

- **There is no reason for transmission and storage to be excluded from private investment.** Transmission lines can be contracted out to the private sector in exchange for service fees that the TSO would have to collect from market participants to compensate investors. This is technically trivial. More complex is the issue of storage in a world of renewable energy. Storage can make renewable energy dispatchable, but this requires a significant difference in price between mid-day, when the sun shines, and peak demand, to justify the investment. Moreover, it is not clear what technologies will dominate the storage market going forward. Some competing technologies are grid-scale batteries (of various types), pump storage in hydro dams, molten salts, and green hydrogen, inter alia. The pricing system needs to be flexible enough to allow investors to explore different storage needs: from minute to minute, from day to night, from windy days to calm days, and from summer to winter. Moreover, storage can save on transmission lines: while traditionally these lines are designed for peak power, they remain underutilized most of the day. It is more efficient to transmit during the day and store the energy for peak time. This increases the capacity of the existing transmission system.

Market-related issues with the new bill aside, there may not be a clear enough commitment to the process of reform and to the unbundling of Eskom to overcome prevailing issues of gridlock, ideology, overburdening, and political patronage. The lack of reforms to date, as well as the slow pace with which the crisis has been addressed, reflect that there is no clear consensus within the government on the direction of reform. Ideological differences and constituencies result in a problem where the President's own cabinet is not necessarily aligned on the direction of reform. In recent public statements, Cabinet members have stated that the unbundling of Eskom is not necessarily a major priority of the government (Tandwa, 2023). This dampens private willingness to invest in the sector, lengthening the crisis. To crowd in generation and grid capacity, the government needs to credibly signal that the priority of this crisis supersedes business-as-usual politics.

There are several ways that government can signal credible commitment and enable proximate solutions to the crisis to take hold. A first meaningful step would be a clear change in the public orientation of the Presidency to prioritize reforms that would establish the long-term market. This could include making the passage of the Electricity Regulation Amendment Act its essential priority – ideally while also addressing the issues discussed above within the bill. Another meaningful action would be implementing proposals advocated by experts, such as appointing an Eskom "Unbundling Czar" (Eberhard, 2023). Importantly, it is not effective to continue to place additional restrictions on private sector participation during an emergency. There have already been steps to remove red tape for new renewable energy projects, and the executive has moved with various waivers to expedite the regulatory process (The Presidency Republic of South Africa, 2023). But this focus could be stronger. The suggested Omnibus Bill to amend various regulations and laws seems to have stalled. The local content requirements for solar modules have reportedly been lowered from 100% to 30% this year. But in such a crisis, the rationale for even keeping them at any such level is unclear. Local content and black economic empowerment-related requirements for procurement and private energy projects raise costs at a time when every effort to get projects operating is necessary. These steps would not replace the need for emergency management but would help indicate to market participants that now marks the end of 15 years of treating the crisis through only emergency measures.

In the short to medium-term, action must focus on two things: (1) relieving the most pressing constraints on additional private generation, and (2) removing any obstacles that make such generation more expensive or difficult. An outright ban on private generation had been the obvious constraint in the past. But with this relaxed, the last bid window showed that the most immediate constraint for greater private renewable generation is not the willingness of generation companies to participate (at a cost that justifies risk), but rather transmission and storage since awarded bids cannot secure grid access. Thus, transmission investment is complementary to additional generation. A redesign of the bid window process should take geography and capacity of the grid as well as project proposals on transmission and storage into greater account when awarding bids. In addition, the system must quickly move to allow for contracting out extra transmission and storage on a competitive basis. For this to happen, it may be required to move further on the unbundling of at least the transmission entity of Eskom. Since transmission is pressing in the short run to allow generation, this unbundling process should be prioritized above other unbundling decisions and processes of the future that may be more contentious.

The continued struggle to improve the EAF of existing plants suggests new avenues for their operation, such as rental contracts with incentives for efficiency, may be needed. Improvements in the operation of existing plants remain essential for the system to provide reliable baseload power and will remain the engine of the electricity system for years to come. South Africa simply cannot build a reliable and cheap electricity system on renewable energy sources alone with existing technologies. Rather, dispatchable renewable sources and conventional baseload power are complements in the system. This makes it problematic that performance continues to decline despite a range of emergency measures. One option that has not been utilized yet is to rent existing power plants to private operators. This would not need to be done across all plants. Doing this in select cases may improve the performance of select plants and would also increase competition across plants. If renting proves effective in initial cases, it could be used for more plants. Rental contracts would require careful design and should incorporate high incentives for efficiency, but these would have to achieve a balance that does not make the contracts so risky that private operators are unwilling to enter.

South Africa has high potential to activate more renewable generation at lower costs. As will be discussed in more detail in Chapter 4, South Africa has significant natural advantages

for solar and wind generation. Along with the market development actions discussed above, there are a few policy improvements that could go a long way to directly enabling this potential. First, there is space to streamline approvals of renewable generation and storage projects to reduce unnecessary transaction costs and delays across the board. Second, South Africa is strategically positioned to promote private green industrial zones powered by renewable energy. Such zones would have multiple benefits. They would make for attractive places for energy-intensive industries whose customers demand a lower carbon footprint to locate. They would also encourage the rapid entry of renewable generation at low cost because of the dedicated demand they would provide. Since renewable generation would need to be developed in excess capacity to account for variability, these zones could become net exporters of electricity to the grid and accelerate the increase in overall electricity supply. Third, South Africa may have a unique opportunity to leverage the hydropower capability of the Lesotho highlands as a source of pumped storage. This would be a complement to the rest of the system. Pumped storage hydropower operates like a battery by allowing for variable renewable power to pump water into reservoirs when there is excess generation, which is then dispatched to generate hydropower when needed.

2.3.4 Broader Lessons for Addressing Declining State Capability

There are several commonalities and lessons from the case of electricity with other SOEs that have seen a collapse in capacity. In many instances, the proximate causes of collapsing services are an undersupply of public goods and services that could have been provided by more open access to state-owned infrastructure. Numerous SOEs face issues of poor management, patronage networks, and inefficient procurement. Together these issues lead to financial problems that constrain investment and proper maintenance of infrastructure. This situation causes service levels to decline. In the cases of electricity, freight rail, ports, roads, and passenger rail, the emerging solution requires crowding in other actors in society with the balance sheets and capabilities to help fill supply gaps. As discussed in South Africa, this is not a matter of privatizing SOEs but rather of mobilizing other actors and granting them access to the relevant market.

Thus, there are technical reforms that South Africa will need to undertake to allow for greater participation and investment from the rest of society in many network industries. Just as electricity requires a functioning market for the expansion of generation, transmission,

and storage, addressing the freight rail crisis requires the ability of the private sector to invest in rail stock and play a stronger role in security, maintenance, and operations. Similarly, for ports, investment will likely need to come from more private participation in the aspects of port services that are causing backlogs. In passenger rail, there is a need to implement a stated policy to devolve functions to capable municipalities. But like in electricity, many of these solutions are, in fact, known or already written in pending legislation. The challenge tends to be in a lack of consensus across different political actors to confront the narrow interests that keep critical network industries in crisis.

The deeper causes of collapsing state capacity in electricity and beyond center on gridlock, ideology, overburdening, and political patronage. Ideological differences on the role of the state and suspicion towards alternative growth models have impeded progress and created political gridlock on necessary actions. Despite the limited financial and managerial capabilities of Eskom, South Africa was egregiously slow in allowing private firms, metro governments, and households to invest in much-needed energy generation, transmission, and storage. The government's historic reluctance to devolve the management of the urban passenger rail system to capable and willing metros, despite PRASA's failures, is another example. Meanwhile, preferential procurement rules have created a burden on tendering that has *de facto* increased costs, limited options, and ultimately reduced service quality. Finally, political patronage rather than effectiveness is often an explicit goal of appointments to SOEs. Specifically, the policy of cadre deployment within SOEs is a longstanding practice to place party members in influential roles. There are clear interactions between these deep issues of gridlock, ideology, overburdening, and patronage. For example, the preferential procurement system has exacerbated patronage opportunities, and this patronage is reflected in contract opacity and failed investments.

Ultimately, politics needs to be the solution to gridlock, ideology, overburdening, and political patronage. In a democratic system, citizens are empowered to change the system when it becomes ineffective. Power is contestable and political patronage is constrained by the need to attend to the needs of an electoral majority. This often is enough to constrain abuse and prompt action. It has not been so in South Africa yet, maybe because of the political dominance of the ANC. But as this dominance wanes, prioritizing state capacity and overcoming narrow interests becomes essential for political survival. Moreover, as the public's

priorities shift towards a greater emphasis on government effectiveness, many political players will have strong electoral incentives to offer a platform that overcomes the interacting causes of gridlock, ideology, overburdening, and political patronage.

There is no path to growth and inclusion in South Africa without rebuilding and expanding the capacity of the state. Up to this point, this chapter has focused on network industries and the respective national SOEs. However, state capacity has also been unraveling at the local level, which has resulted in a pattern of extreme financial distress affecting hundreds of municipalities. Local governments collectively owed nearly USD 5 billion at the end of 2022, of which USD 3 billion was owed to Eskom alone. Clearly, the financial distress of municipalities is linked to the electricity crisis, but patterns of municipal service delivery suggest additional challenges beyond fiscal management. We next discuss the deeper challenges of municipal service delivery in the next subsection, including critical failures in fiscal decentralization and how weakening municipal balance sheets linked to national systems have further undermined local public capabilities. This raises important questions about the role that local public capabilities can play in including more South Africans in the productive economy – a topic that will continue in the following chapter. This chapter then closes with recommendations for restoring and strengthening state capacity.

2.4 Municipal Capacity

2.4.1 Symptoms of the Crisis of Municipalities

There is a widespread view that South Africa's municipal governments are in crisis. The most recent Consolidated General Report on Local Government Audit Outcomes (MFMA 2021-22) of the Auditor General of South Africa states that only 38 of 257 municipalities received clean audits reflecting "sound financial and performance management disciplines" and that they "perform their functions in accordance with applicable legislation." The report finds that the financial health of municipalities has been deteriorating in recent years. The MFMA 2021-22 report finds 70 municipalities in a "concerning financial position," with at least three such municipalities from each province and many of these municipalities showing financial distress year after year. But the underlying causes of financial distress are more widespread. The Auditor General's report discusses systemic issues in revenue collection, where municipalities do not collect what they are owed, including significant losses in water

and electricity distribution. The MFMA 2021-22 report estimates that municipalities in total will only recover 34% of revenues they should collect according to their rates and taxes. While failures in revenue collection are likely the most immediate cause of financial distress, the report also notes widespread problems in spending related to poor payment practices, unfair or uncompetitive procurement practices, under-delivery of services procured, and outright fraud.

While the financial distress of many municipalities is important, ultimately, the problem is poor service delivery. The performance shortfall is most evident in water delivery (Figure 2.1), a highly decentralized service in South Africa, as discussed below. Observers regularly point to shortages in water engineers and skilled professionals across municipalities, and this problem has been persistent for a long time.[9] In water systems and beyond, the Auditor-General's report documents patterns and examples of inadequate planning, services that are not delivered, and reporting systems that reflect an inability to monitor the delivery of core services. In the building of infrastructure, projects are plagued by endemic delays, cost overruns, and – arguably most problematic – poor build quality. Moreover, there are glaring deficiencies in resources spent on infrastructure maintenance. The 2021-22 report finds that 39% of all municipalities spend 1% or less of the value of their infrastructure on repair and maintenance, well below acceptable norms.

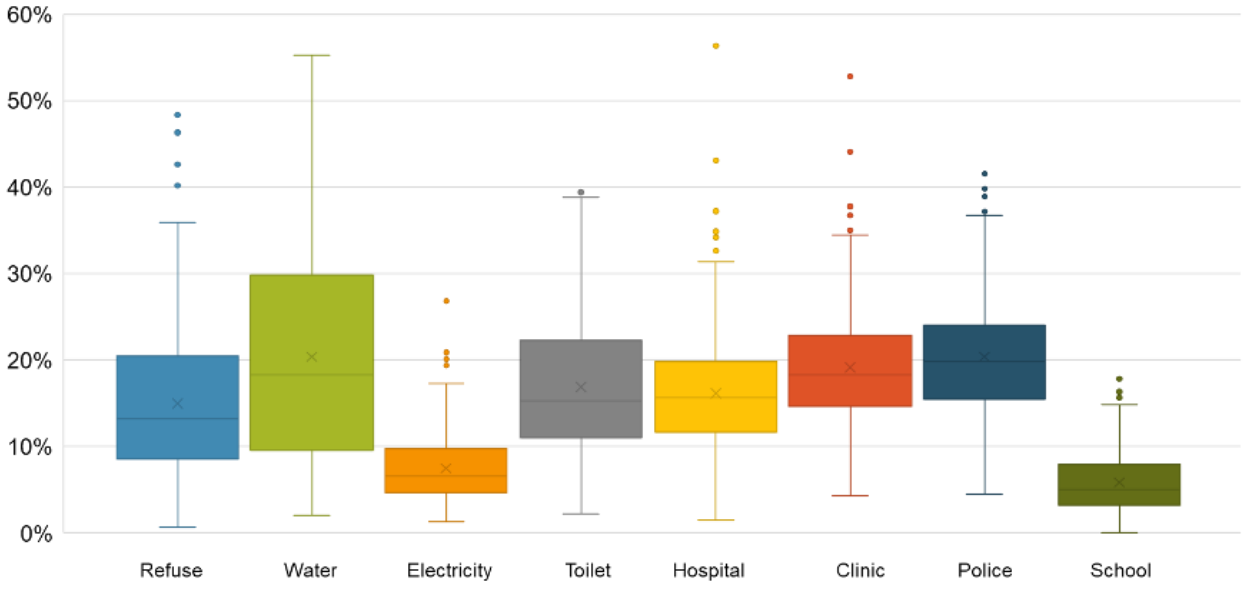
There is widespread variation in local service delivery and financial performance. Though the issues underlying the municipal capability crisis are systemic, some municipalities do manage to deliver core functions and remain fiscally sound. While very few municipalities have expanded reliable water access, some have sustained high levels of access. For example, eThekwini Municipality maintained a level of piped water access close to 90% over the period when many municipalities saw declining access. This reflects a sufficient level of state capacity to deliver the service. The MFMA 2021-22 Auditor General's report notes that eThekwini and Cape Town are the only two metros that mobilized higher levels of spending on maintenance of infrastructure assets overall, at 8-9% of the value of the infrastructure. Figure 2.8 shows a high variance in public service delivery across municipalities in many areas based on the share of households that report each service quality as "poor". The largest differences occurred in

[9] See, for example, "Navigating the water crisis: where do we need the skills?" reported by Stats SA in based on 2014 data (https://www.statssa.gov.za/?p=5787).

water, with very high variance in sanitation, healthcare services, policing, and refuse removal. Lower variances occur in electricity and education, which are services that have somewhat higher national uniformity.

This variation in local performance suggests that at least some drivers of the collapse of state capability have locally determined causes and are not due to the collapse of national systems alone. We argue that these patterns reflect a clear problem of "premature load bearing" of municipal governments – that is, putting too much responsibility on local governments when they do not have sufficient capacity to deliver, to begin with. In this sense, the decentralization process that transferred spending responsibilities to new municipal governments led to many of them failing to deliver on core mandates immediately after they were devolved those responsibilities. However, the more capable municipalities could cope with the assigned responsibilities, succeeding while the median municipality failed.

FIGURE 2.8: SHARE OF HHS WHO RATE QUALITY AS POOR ACROSS MUNICIPALITIES (2016)



Source: Own elaboration based on the 2016 Community Survey and StatsSA.

2.4.2 Failed Decentralization Due to Premature Load Bearing

During the late 1990s, South Africa significantly changed the responsibilities of local governance by enacting the Municipal Systems Act and the Municipal Structures Act, effectively creating new local governments. The new system was motivated by the

necessity to rectify the historical imbalances in spatial economic development. The White Paper on Local Government (DPLG, 1998) assigned local governments a key role in economic development, with the primary goal of municipalities being to work with their constituencies in finding "sustainable ways to meet their social, economic, and material needs and improve the quality of their lives" (DPLG, 1998). This resulted in "developmental local governments" that would embrace multiple functions and responsibilities (Palmer *et al.*, 2017). Through substantial decentralization, especially in spending responsibilities, local governments assumed critical roles in areas that determine the economic and spatial development of places.

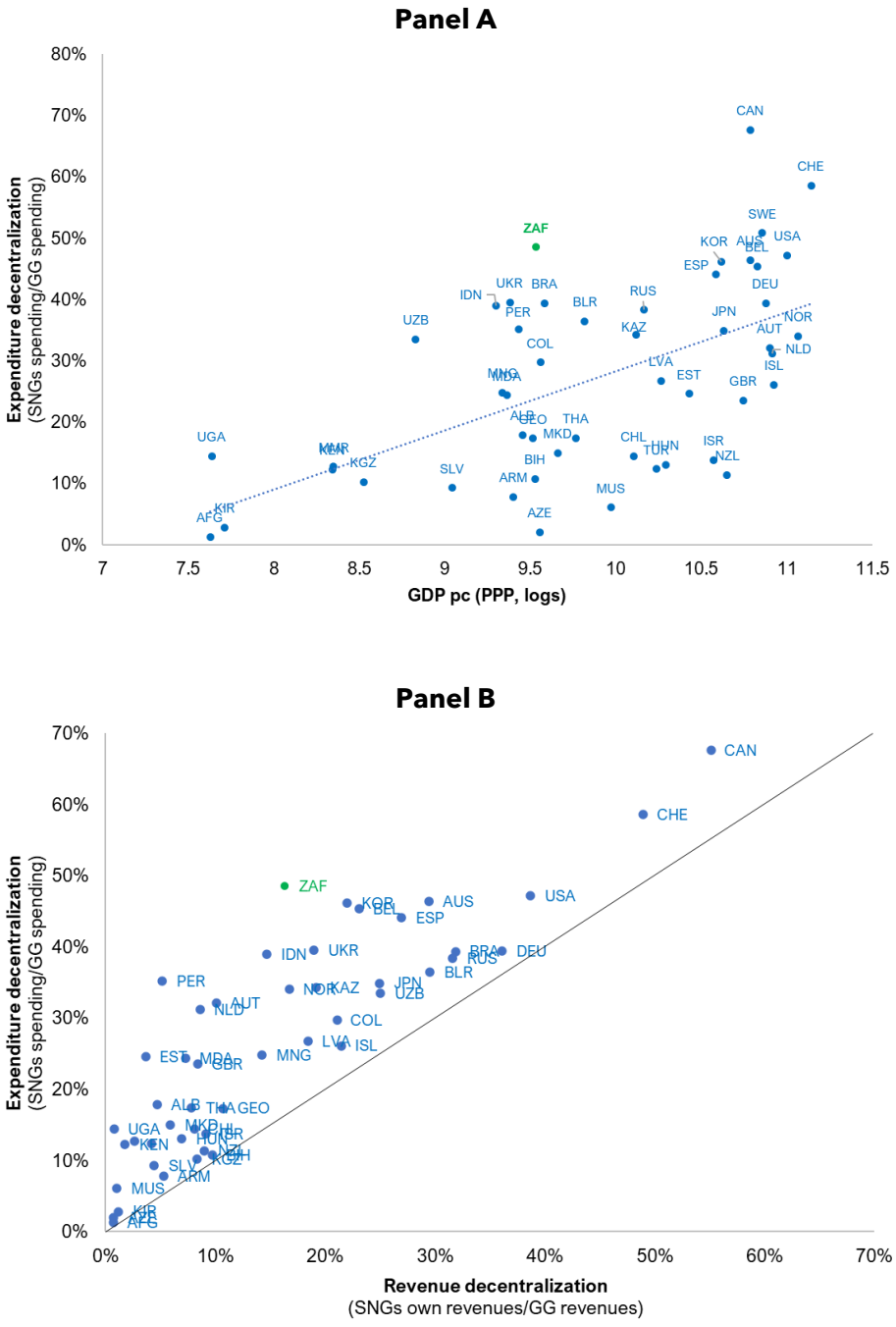
The design of a post-apartheid local government system resulted in the creation of numerous district and local municipalities, which had to be built from the ground up. Primary responsibilities of district municipalities included: the design of Integrated Development Plans (IDPs), which serve as a foundation for a region's spatial development through infrastructure design, service coverage reach, and land use planning; support functions to local municipalities for service delivery and capacity building; and disaster management. Meanwhile, local municipalities were given responsibilities for a wide range of functions. This included primary responsibilities in public service delivery, including water and sanitation, electricity distribution, waste management, and road construction and maintenance. Local municipalities took on roles in management of municipal finance, including selected areas of revenue collection, budgeting, financial management, and procurement. They also were given powers in land use management and urban planning, including zoning regulations and the issuance of building permits. Finally, local municipalities also were made responsible for the enforcement of regulations and implementation of key processes such as local elections.

The new system led to very high decentralization of public spending by international standards. South Africa's subnational governments execute over half of the general government spending, which is very high for a middle-income country and more in line with much wealthier countries like Canada, Switzerland, and the United States (Figure 2.9, Panel A). South Africa is also exceptional in how high expenditure decentralization is in comparison to revenue decentralization (Figure 2.9, Panel B). It is normal for spending to be more decentralized than revenues, but the difference is especially large for South Africa, which necessitates large transfers from the central government. This is reflected in Figure 2.10.

Whereas provinces are overwhelmingly funded through transfers from the national government, municipalities receive over half their revenues, on average, from the collection of fees and other non-tax revenues. A large portion of these fees are from electricity and water tariffs, which are collected locally. However, these fees do not become sources of discretionary local spending. The municipalities must pay the providers of electricity (Eskom) and water (usually water boards). Municipalities often charge an extra fee, which is meant for local use, but this system at present is not delivering reliable local revenues as there are widespread challenges in bill collection and resulting municipal debts.

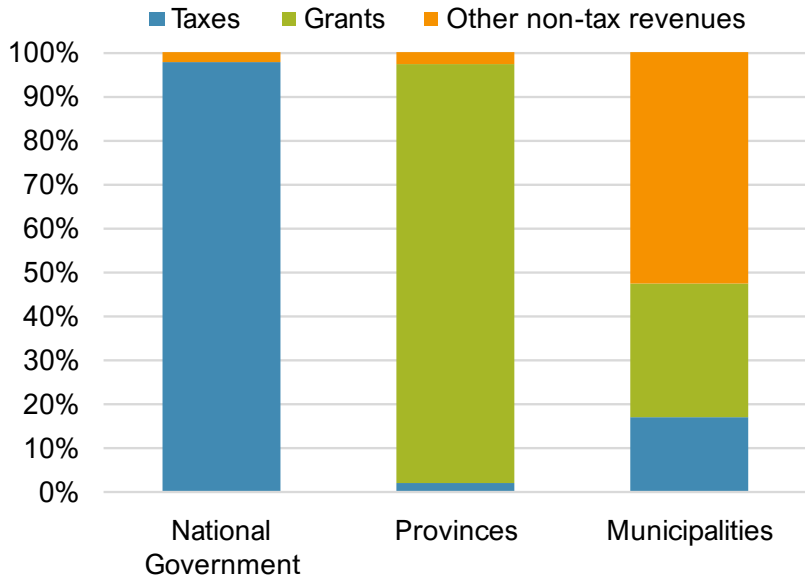
The abrupt transition to this peculiar decentralization system layered on too many responsibilities too soon for many municipal governments. The "too much, too soon" phenomenon has been called "premature load bearing" (Andrews *et al.*, 2017). This is an apt description of what happened in South Africa: by giving newly created local governments the same or similar responsibilities that metros had, responsibilities overwhelmed capacity. These responsibilities were designed to address the fundamental problem of spatial inequality. However, the reform had the opposite effect due to the absence of the necessary organizational capabilities and specialized staff to execute these responsibilities across more than 200 local governments. Increasingly, the collapse in network industries at the national level has interacted with the challenge of local government capacity as lower revenue collection from electricity and water bills — including evasion of bill payment — undermined substantial revenue sources for municipalities. Figure 2.11 summarizes the composition of expenditures, on average, for the three distinct categories of municipalities in South Africa: metros (of which there are 8), district municipalities (of which there are 44), and local municipalities (of which there are 205). Having assumed responsibility for the distribution of electricity and water, metros and local municipalities became heavily reliant on residents' water and electricity bills as sources of revenue to pay for operational spending and investment.

FIGURE 2.9: EXPENDITURE DECENTRALIZATION VS. NATIONAL INCOME LEVELS



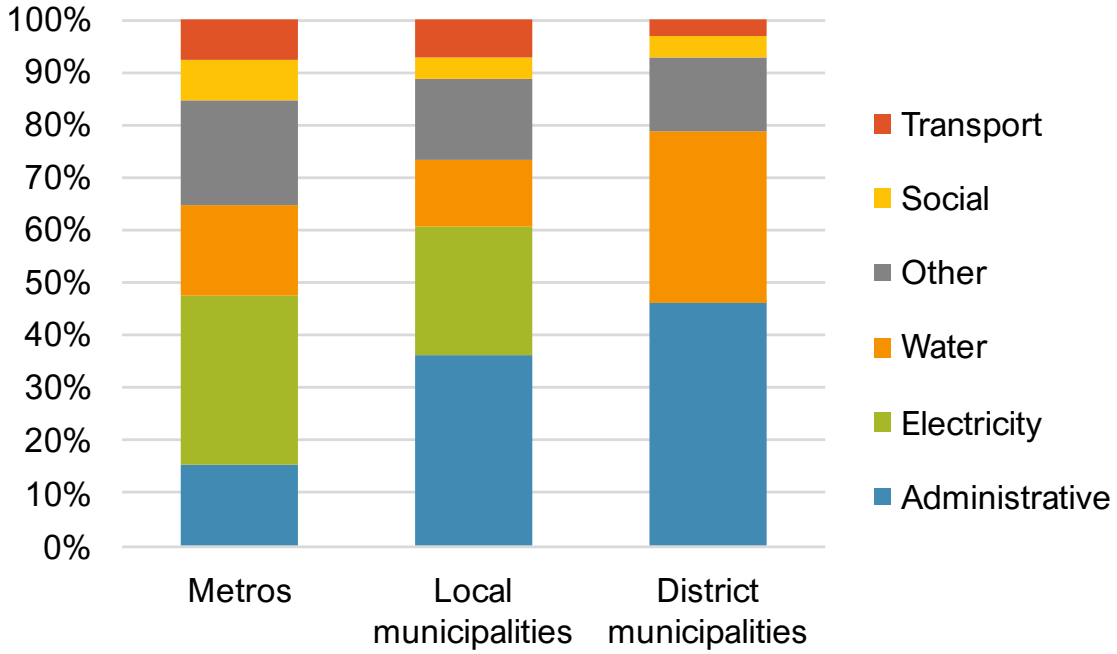
Notes: Data for 2017. SNGs = Subnational Governments, including provincial and local municipalities. GG = General Government, including SNGs and central government.
Source: Own elaboration based on IMF Fiscal Decentralization Database 2020.

FIGURE 2.10: REVENUE COMPOSITION BY LEVEL OF GOVERNMENT



Notes: Data for 2019. Grants comprise current and capital transfers from foreign governments, international organizations, and other general government units. Other non-tax revenues include sales of goods and services (user charges), fines, penalties, and forfeits, and property income (interest and dividends).
Source: Own elaboration based on SARB.

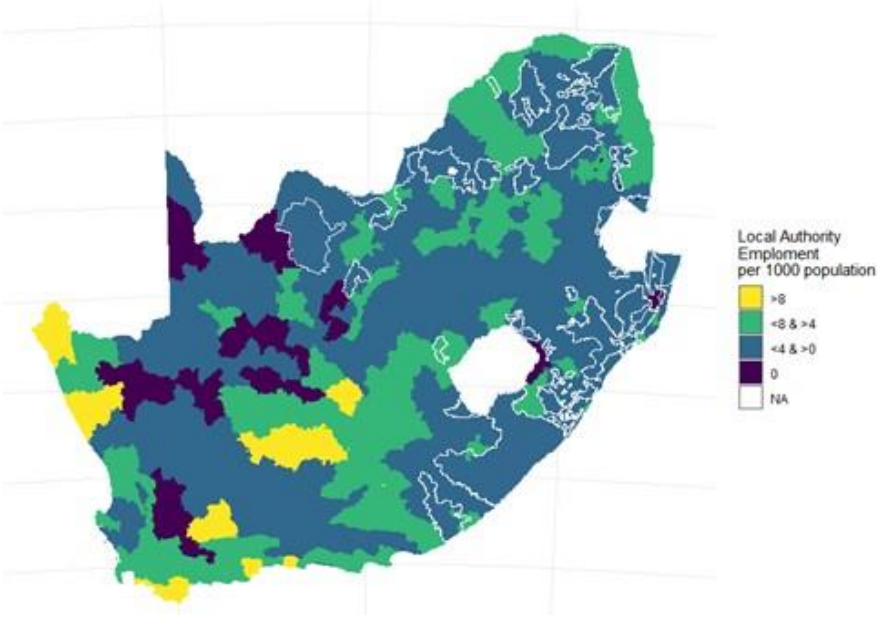
FIGURE 2.11: EXPENDITURE COMPOSITION BY FUNCTION FOR MUNICIPALITIES



Notes: Data for 2019. Grants comprise current and capital transfers from foreign governments, international organizations, and other general government units. Other non-tax revenues include sales of goods and services (user charges), fines, penalties, forfeits, and property income (interest and dividends).
Source: Own elaboration based on SARB.

Although the metros already had capable governments at the time of decentralization, many secondary cities, small towns, and rural areas had yet to develop local state capacity. Figure 2.12 shows employment in local authorities per 1,000 people in 2001, soon after the creation of local governments. The size of the government gives a blunt indication of the heterogeneity in the starting points of the different types of places. Metros and secondary cities already had between 8 and 4 local government employees per 1,000 people, while many rural areas had less than 4 local government employees. Approximately 35% of local municipalities had less than one employee per 1,000 people. Several areas of the Northern Cape had yet to establish local authorities, which may partially explain why the Northern Cape has a very high prevalence of local municipalities in financial distress today. In many cases, the first term of office of the newly created municipalities was almost entirely dedicated to understanding and setting up the complex institutional mechanisms that were recently put in place (Pieterse and van Donk, 2008).

FIGURE 2.12: EMPLOYMENT LEVELS IN LOCAL MUNICIPALITIES



Source: Own elaboration based on the South African Census of 2001 and StatsSA.

As one tool for overcoming the challenge of local state capability, municipalities often outsource roles to private providers. An example of this is the distribution of electricity. Although the municipalities are Eskom's largest customers and are mandated to distribute electricity in their jurisdictions, most of them outsource the operations and management to the

private sector. According to data from Stats SA, this tendency fluctuates from a minimum of almost half of the municipalities in the Western Cape to a maximum of 80% in the Eastern Cape.

2.4.3 Preferential Procurement Policy

In addition to challenges in delivering core functions due to premature load bearing, municipalities have also been subject to additional demands through procurement policy. Preferential procurement in South Africa traces to a constitutional requirement and is structured according to the Preferential Procurement Policy Framework Act (PPPFA) of 2000. The purpose of resulting preferential procurement rules is to enable socio-economic transformation by giving preference to previously disadvantaged groups, SMMEs, and local production. This was a response to the pre-1994 public tendering system, which favored large and predominantly White companies such that "it was almost impossible for newly established businesses to enter the public tendering system" (SALGA, 2020; Ministry of Finance and Ministry of Public Works, 1997). However, many critical issues were documented with PPPFA in a Public Sector Supply Chain Management Review by the National Treasury in 2015, which outlined paths forward based on system and process improvements to address severe fragmentation of rules. Yet, those proposed changes were not enacted to replace the existing framework, neither at the time of the study or when later introduced through a new Public Procurement Bill. This remains a bill rather than a law at the time of writing.

Compliance with preferential procurement requirements has led to increased administrative costs for both the public sector and contractors. Implementation of the PPPFA has been problematic for public supply chain management (National Treasury, 2015). This has been particularly concerning for impact on the value for money in infrastructure development carried out by local governments. For the public sector, added costs can involve more extensive tendering processes, evaluation criteria, and compliance monitoring, all of which require time, resources, and expertise, which are scarce for local governments. Perhaps more importantly, a more limited pool of contractors can drive up prices for goods and services – particularly in smaller local markets. On the suppliers' side, compliance with PPPFA adds a layer of complexity to the process of applying for contracts with the public sector, which adds barriers to entry. The increase in costs can also be due to the lack of specific technical skills that are not available within local or designated providers, which in turn need to hire other

subcontractors or consultants at an additional cost. This affects the quality of the pool of bidders and impacts project timelines, quality, and overall value for money.

Scattered evidence indicates that the cost of PPPFA compliance is notably high both in direct costs and in more systemic effects. Migro (2011) documents procurement costs in different government departments of the North West Province in 2006-2007. He shows that the premium paid for PPPFA compliance in this period was 27% in the transport department, 28% in agriculture, 9% in education, 28% in public works, and 62% in sports, arts & culture (Migro, 2011). In this case, not only was the cost of compliance very high on average (31%), but the very high variation in the premium paid across departments suggests large differences in the resulting market power of qualifying contractors in different municipalities and different activities. In 2020, the South African Local Government Association (SALGA) identified a series of challenges for public procurement in a study conducted after 24 years of enacting the first procurement regulations. They collected information from officers directly involved in supply chain management and procurement compliance in local governments. The research highlighted widespread issues: high prevalence of fronting (i.e., misrepresentation by companies to qualify); compliance challenges for smaller businesses; lack of understanding of rules and laws; supply chain delays; inadequate screening; limited rotation of companies; escalating corruption and weak oversight; limited transparency; political pressure on supply chain management officials; and a rise of "tenderpreneurs".

The PPPFA essentially functions as a direct tax on tenders, while also undermining the effectiveness of local procurement. When PPPFA raises costs for contractors, these additional expenses are passed on to the local population, including by crowding out other potential uses of public spending. But widespread qualitative observations and formal reports (e.g., the MFMA 2021-2022 Auditor General's report) point to an arguably worse problem than higher prices, which is a substantial loss of quality and even outright failures to deliver what is procured. This is highly problematic in infrastructure procurement. For example, when shoddy construction causes a bridge to fail, communities pay the consequence.

A key question is whether the benefits of PPPFA are worth the costs. Importantly, given decades of experience, this is not a theoretical question but rather a practical one that can be answered based on quantitative evidence. According to the 2020 study on public procurement by the SALGA, the PPPFA did not foster a more competitive environment for government

procurement as intended. Instead, it has made securing public contracts more challenging for new businesses. In 2023, the IMF published an issue paper on the topic and noted that improved procurement practices as proposed by the Treasury's review could amount to up to "20 percent of the cost of goods and services procured (3 percent of GDP or 12.7 billion US dollars)". By distorting the market for inputs, the system has increased costs, worsened the effectiveness of public spending, and expanded space for systems of patronage. Furthermore, the rise of 'tenderpreneurs' and fronting practices suggests that the most successful bidders are not necessarily the most productive suppliers nor the intended beneficiaries of the policy. There is strong evidence that the costs of the system are high, and the benefits are not just low, but negative.

2.4.4 Municipal Finances and the Spiral of Circular Debt

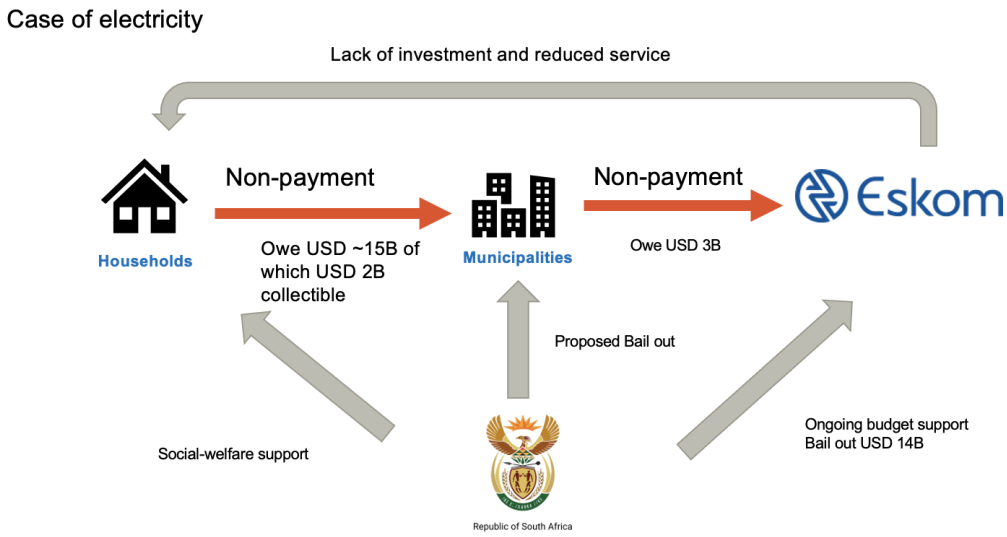
Although service delivery failures at the local level are driven by premature load bearing, exacerbated by preferential procurement rules, financial problems interact to create vicious cycles. While the Municipal Structures Act, followed by the PPPFA, are almost 25 years old, service delivery has been deteriorating at an accelerated pace over the last decade. This is due to additional dynamics associated with poor finance, which causes growing financial distress and a pattern of circular debt. Understanding this cycle of debt is essential to developing an effective plan of action to strengthen state capacity at the national and local levels, while also addressing the compounding debts in the system.

The electricity crisis has created a chain of debts across government. Municipalities purchase electricity in bulk at wholesale prices from Eskom and then sell it to the end user with a markup which ranges, according to NERSA, between 20-150%. This already highlights the inefficiency of many distribution systems. Even in normal times, many municipalities have severe deficiencies in bill collection, due to gaps in metering, billing systems, and staffing. But the electricity crisis has put additional strains on the system as load-shedding means reduced sales as well as increased consumer dissatisfaction and lowered willingness to pay.[10] While collections have been strained, Eskom's wholesale prices are increasing as the SOE tries to

[10] Further, consumers are actively working to circumvent high tariffs and outages: wealthier residential and commercial consumers are moving to generating their own energy through viable off-grid technologies. Yet, these consumers still rely on the grid at times and for transmission.

recover its own financial standing. In practice, municipalities are not being paid by households and businesses, who are in arrears to local municipalities, and municipalities are not paying Eskom. This chain of debt further undermines Eskom's finances and increases the need for national bailouts to unburden Eskom's balance sheet. In the process, municipal capabilities are further weakened. Figure 2.13 shows this problem as well as how fiscal support from the Treasury is used as a response to financial distress across the system.

FIGURE 2.13: PROBLEM OF CIRCULAR DEBT AND ELECTRICITY SYSTEM FAILURE



Source: Authors' elaboration.

2.5 How to Strengthen State Capacity

If South Africa is to return to growth, it must arrest the collapse of state capacity and start a process of rebuilding capacity. The economy cannot grow and include more people without a capable state and the provision of essential public goods. Strengthening state capacity comes from a conscious and consistent effort to address both the proximate and deeper causes of failures in SOEs, network industries, and national government institutions as well as through response actions to address longer-term problems of premature load bearing of local governments. Recovering municipal capacity will require a rethink of decentralization and procurement. Instead of helping to address spatial inequalities, the current system has exacerbated them. Given the problem of circular debt, large fiscal resources are already being devoted to addressing the solvency crisis, but these resources can be better targeted and better supported through strategies that treat causes rather than symptoms of state collapse.

Strengthening state capacity will be a challenge but the upside is that recovering core functions in the most binding areas – especially reliable electricity in the current moment – will have immediate positive impacts on growth.

Rebuilding state capacity is a big task, but informed by the findings of this chapter, the path to strengthening state capacity can be achieved through actions along three dimensions. First, it is essential to *unburden capacity* by relaxing secondary and tertiary goals that are layered onto the functioning of public entities, at both the national and local levels. Addressing the imbalance of responsibilities and capabilities on most local governments (premature load bearing) in distribution markets is also critical for developing functional electricity markets and a more sustainable fiscal system. Second, South Africa must *build up and protect capacity*. It is not sufficient to only unburden government entities; the process of building and protecting public capabilities. Civil service reforms from other countries show that it is possible to gradually transition from systems of cadre deployment to merit-based employment and building of a civil service system that attracts and retains talent increasingly over time. This is essential for ensuring that the collapse of state capabilities does not re-emerge. At the same time, South Africa can re-organize public service delivery in areas where capabilities are spread too thin by centralizing units and deploying them to municipalities in the form of a "capability bank". Third, South Africa can much better *leverage existing capacity* by involving the capabilities of society in the response to struggling systems, especially across network industries.

Unburdening Capacity

The state faces major burdens in preferential procurement rules that undermine core functionality in the pursuit of black economic empowerment and localization aims. These overly broad systems should be revisited as there are more effective ways to include previously disadvantaged groups in all parts of the economy and to promote local production, including SMMEs. The evidence suggests that preferential procurement – through its costs on state performance – may be doing much more harm than good for the intended beneficiaries. Instead, procurement should be strategically used to support early-stage industries with potential to compete in international markets (see Chapter 4 for examples). In the context of collapsing state capacity, any secondary and tertiary goals should be set aside urgently to unburden public entities to serve their core functions. Thus, we recommend continuing to

expand the relaxation of preferential procurement requirements on all SOE procurement, including and especially within the procurement of electricity system investment in generation, transmission, storage, and distribution. This is a necessary condition for South Africa to better achieve its ultimate goals of empowerment and inclusion, though more direct and effective measures will be needed (see Chapter 2 for findings on spatial exclusion).

Given the fundamental challenges of premature load bearing, South Africa's current and peculiar type of decentralization will need to change. There needs to be a move to a system that allows for variance in municipal-level expenditure responsibilities based on their underlying capabilities. For municipalities that currently deliver public services effectively, especially metros, and which have maintained fiscal solvency, no change may be needed, but for most municipalities, there needs to be a change in decentralization to centralize the roles that have put municipalities under strain. The clearest areas for change are the municipal government's current roles in managing the distribution of electricity and water. Electricity distribution is an area that has become such a strain on local governments that it has impacted their abilities to serve other functions. At the same time, addressing the failing national electricity system through an electricity market will be aided by distribution markets that are larger than the typical municipality to achieve better economies of scale. Municipalities often already outsource as much of their electricity functions as they can and, distribution companies internationally often have significantly better capabilities for bill collection and technology adoption.

This change can come with benefits to municipalities and must occur within a process to address the financial crisis of local governments. Municipalities may be unwilling to release any responsibilities to higher levels of government voluntarily, but changes must be initiated within the unfortunate context of municipality financial distress. If municipalities cannot show a viable path to service delivery and fiscal stability with current capabilities, national policy can enforce a change. This change can also be accompanied by benefits to municipal governments. Change in this system would affect municipality revenues but would also impact their expenditures, with the net impact likely varying greatly across municipalities. Many of the most financially distressed communities may benefit. This re-organization could be accompanied by new tools for municipalities to finance their operations, while also being careful not to burden municipalities with taxing responsibilities prematurely. Currently,

property taxes play a relatively small role in municipal finances, and this may be an area to scale up through voluntary application since these play a much stronger role in other countries.

Building Up and Protecting Capacity

Building up and protecting capacity entails moving away from cadre deployment and replacing this with a different organizing principal. An example would be broader civil service reform that changes the appointment of civil servants especially for more technical positions into a more merit-based system rather than one that is overly influenced by politics. Such changes do not happen overnight; they can and should instead be built and expanded gradually. Eventually achieving a system of merit-based appointments for operational and higher-level bureaucratic roles is an important milestone for a country's development. Take the example of the United States which transitioned from a "spoils system" of the federal bureaucracy to an initial merit-based system for just 10% of the federal workforce after the passage of the 1883 Pendleton Act. Today, merit-based appointments and exams are the norm in U.S. federal employment.[11]

While civil service reform should start at the national level, the principal can be expanded to enable more capable decentralization over time. Given South Africa's challenges of spatial exclusion and its history of premature load bearing across municipalities, systems of civil service rotation across the country should be explored. By recruiting talent nationally and deploying individuals in multi-year appointments across geographies, South Africa may be able to better bridge gaps in capabilities across municipal governments over time. For example, the experience of India in developing a prestigious civil service system — e.g., its Central and State Engineering Service — is illustrative of what such a system can look like, even in a country with very high ethnic diversity and significant development challenges. Simply hiring locally can reinforce capability gaps between wealthier municipalities and historically disadvantaged communities. This approach helps to break this cycle. This approach could be a longer-term strategy whereas "capability banks" can be utilized much more quickly.

Some capabilities could be more effective if centralized to meet local needs through new administrative structures. In the relationship between the municipal, provincial, and national governments, it can be useful to trial a model where local governments can "contract" or

[11]See https://www.archives.gov/milestone-documents/pendleton-act.

"procure" services from higher levels of government when needed. Rather than maintaining a local staff with all the relevant expertise for water system planning or major road development contracting or a range of other functions that are technically complicated and require specialized skills, municipal governments could simply hire support from dedicated teams that are based in the province or national level. Such a model can more efficiently use scarce human capabilities. Such a system could create strong incentives for effectiveness, especially if multiple teams within the government system compete for service contracts with local governments. This concept can be thought of as a "capability bank" that municipal governments can draw upon, especially for planning and project execution roles. Under this structure, historically disadvantaged places could be given advantaged access to the capability bank through fiscal mechanisms and national outreach to local governments based on needs.

Leveraging Existing Capacity

At the heart of a strategy of growth through inclusion is a recognition that South African society has far more capabilities than are currently leveraged. This is true when it comes to network industries as private companies have shown the willingness and ability to provide needed investment and service delivery roles. By including more of these capabilities in the response to the collapse of state capability, the economy will in turn be able to include more individuals, regions, ideas, and assets in the South African economy of the future. Leveraging this capacity is not, generally speaking, a matter of privatizing state companies and assets, which is time-consuming and fraught with risks to manage. Much can be leveraged through opening access to existing infrastructure through more open markets. This approach was discussed at length in the case of the electricity crisis earlier in this chapter, but the opportunities are also clear in other areas where state capability has weakened and supply gaps have deepened – including roads, ports, passenger and freight rail, water, sanitation, and likely more. To leverage the capacity of South African society in this way, the government must overcome gridlock, ideology, and patronage that has delayed and prevented the establishment of relevant markets in the past. Overcoming the politics as usual to leverage capacity is the single most important step that government can take to reverse South Africa's economic struggles and jumpstart growth. It would mark the beginning of the end of a period of emergency management by enabling long-term solutions.

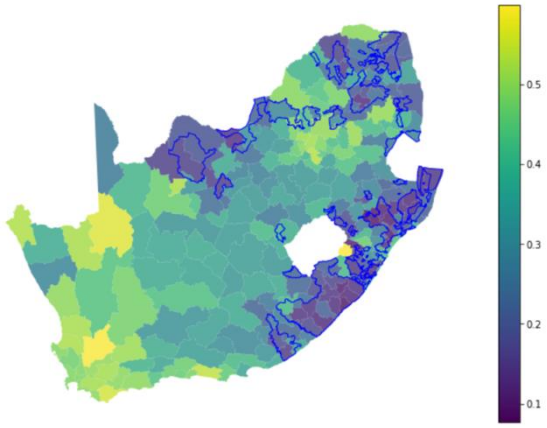
3 Spatial Exclusion as a Constraint to Growth

3.1 Executive Summary

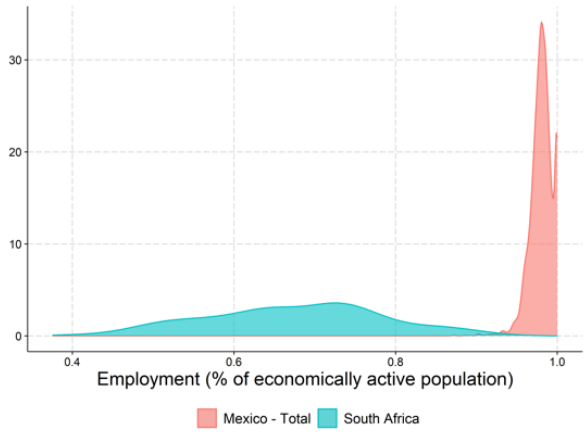
South Africa is exceptional in its spatial patterns of economic inclusion. As discussed in Chapter 1 of this report, South Africa faces some of the world's highest rates of inequality and unemployment, which vary greatly across geographic space. Municipalities are highly unequal in their employment rates. For example, Witzenberg in the Western Cape had an employment rate of 60 percent in 2011, comparable to an advanced economy, whereas Msinga in KwaZulu-Natal had employment rates as low as 9 percent. Figure 3.1, Panel A shows that low employment rates largely overlap with the former homelands. Despite three decades of explicit efforts to reverse this spatial exclusion, post-apartheid policies have done little to address spatial inequality of job opportunities.[12] Whereas regional divides are not uncommon along the path of economic development (World Bank, 2008), the *extent* to which South Africa is unequal in space is unique. When compared to Mexico, a country with a similar level of GDP per capita, we observe that South Africa's employment rates vary enormously (Figure 3.1, Panel B). Furthermore, the highest employment municipalities in South Africa tend to have lower employment rates than the lowest employment municipalities in Mexico.

FIGURE 3.1: EMPLOYMENT PATTERNS IN SOUTH AFRICA AND MEXICO

Panel A: Employment Rates across Municipalities in South Africa, 2011



Panel B: Distribution of Employment Rates across Municipalities in Mexico and South Africa, 2011

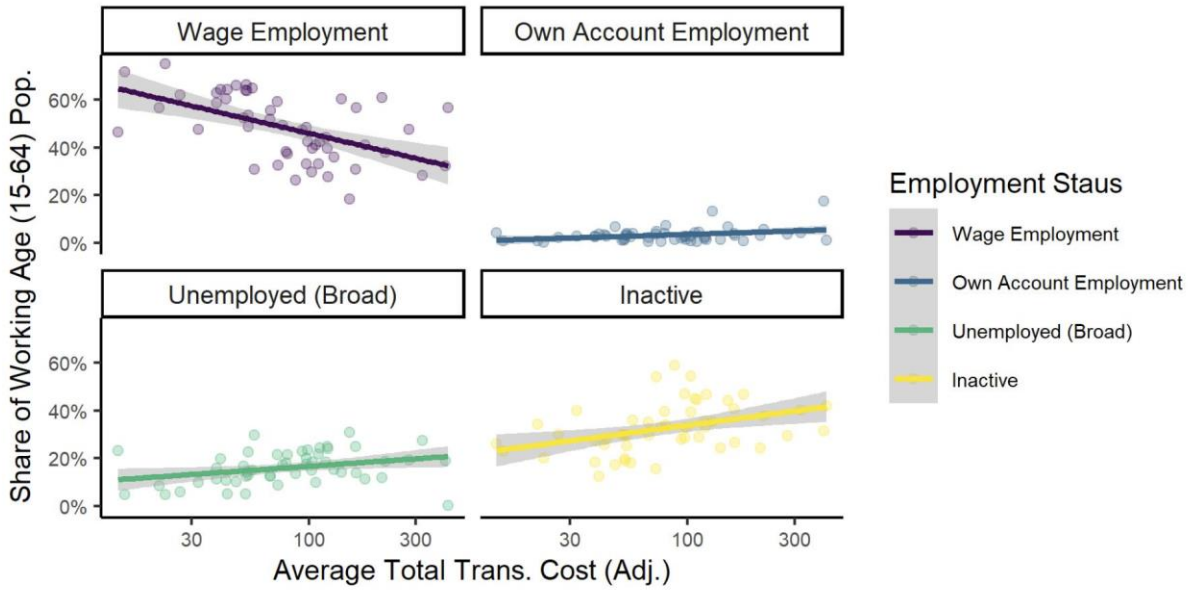


Source: Own elaboration based on the South African National Census, 2011 and Instituto Nacional de Estadística y Geografía.

[12] See, among others, Lochmann (2022), World Bank (2008) and Chatterjee *et al.* (2022).

South Africa's unique labor market structure can be explained in large part by issues of transportation costs. When we further compare Mexico with South Africa, both countries look relatively similar in their formal employment rates, but there are huge differences in their informal employment rates and consequently in their rates of unemployment (Shah, 2022). Therefore, a key puzzle of South Africa is why people end up unemployed in South Africa rather than in informal employment as they do in other developing countries. Shah (2022) and Shah and Sturzenegger (2022) explore a large variety of barriers to both formal employment and informal employment and find that high transport costs (direct costs and time costs) create a wedge in the South African labor market that reduces employment. This is an especially salient feature for major and secondary cities. Cities are, at their essence, labor markets, but high transport costs undermine efficient cities. Figure 3.2 shows that places with higher total transport costs (including the opportunity cost of time spent in transit) tend to have lower-wage employment and higher rates of inactivity. Own-account employment increases only very slightly with transport costs in comparison.

FIGURE 3.2: LABOR MARKET INDICATORS VS. TOTAL TRANSPORT COSTS BY DISTRICT MUNICIPALITY



Source: Shah and Sturzenegger (2022) using the 2017 National Income Dynamics Study and 2020 National Household Travel Survey.

We find that South Africa's high unemployment rates and low informality rates are a direct consequence of its exceptional spatial structure. Transport costs are highly regressive and such high costs for lower-income level individuals can effectively wipe away any

take-home pay. For the lowest quintile of incomes, we find that direct transport costs amount to more than a third of wage income for workers on average. The result is even more striking when for total transport costs, which amount to over 80% of income for the lowest income workers and more than 50% of income for all but the highest quintile of incomes. Under these exceptionally high costs of getting to work, the logical decision of workers is therefore to remain out of the workforce. Access to a car makes transport costs a much lesser constraint for higher-income households, but roughly two-thirds of households do not have a car (Stats SA), let alone a reliable car. Meanwhile, the extreme population dispersion across South African urban centers makes it expensive to implement most types of public transport in cities, since public transport systems (like Bus Rapid Transit systems) are designed to connect higher-density areas. It also undermines the effectiveness of bicycles and motorcycles as a means of getting to work. As a consequence, city labor markets are made inefficient by spatially excluding workers from opportunities. This creates significant costs for businesses, which must pay higher wages to attract workers than they would in denser labor markets to compensate for the cost of transport.

Housing in desirable locations is prohibitively expensive while most affordable housing is in the periphery. This chapter explores what drives this extreme spatial organization of urban areas. The root of the problem is with the housing policy and housing markets, which have an overwhelming impact on defining where housing is built and how dense housing can be built. Although South Africa's exclusionary urban structures have a history dating back to apartheid and before, post-apartheid housing policies explain the continuation of spatial exclusion of cities today, including the continuation of spatial exclusion in growing secondary cities. Reasons beyond apartheid itself must explain the fact that South Africa continues to see low housing density in emerging cities both outside of and within former homeland areas. Post-apartheid housing policies have aimed to deliver free or highly subsidized housing combined with tight regulations that prohibit diverse and dense housing. This has naturally pushed housing to the periphery of cities, leading to long travel distances and high total costs of transportation. Many individuals respond to the lack of job opportunities reachable from where they live by choosing to live in informal settlements closer to the city, even though the size of these houses is much smaller, and housing is generally of much lower quality.

Low-density housing settlements also lower the profitability and therefore the scale of potential informal activities. South Africa's very high unemployment is in part a consequence of its very low informality. We find that the spatial structures of cities also go a long way to explain South Africa's unusually low level of informal work — even after accounting for mismeasurement and surveying challenges. The reason for this is that whereas many informal business activities in other countries are centered around the home, low-density and disconnected housing limits the foot traffic around people's homes. This limits the market size for home-based businesses in many areas of the country. In the areas where densities are high, such as in denser townships of Alexandra (in the Johannesburg metro area) or Dunoon (in the Cape Town metro area), an informal sector is much more present. Moreover, when housing is located very far from the city center, where foot traffic is higher, this disincentivizes individuals from commuting to denser areas of the city for informal work. This pattern is common in South African cities but may be less pronounced in cities within former homelands (e.g., Mthatha) where housing is sprawling but where distances between population centers are not as far as in established metro areas (e.g., Johannesburg).

Forces of spatial exclusion extend far beyond cities in South Africa. South Africa faces a particular pattern of low rural opportunity concentrated across former homeland areas. South Africa's rural areas are not universally poor by any stretch of the imagination. Many rural areas of the country support employment rates at or above that found in cities. But there are highly notable geographic exceptions to this pattern. Employment rates in rural areas of former homelands, on average, are roughly half of what they are in all other parts of the country, including in urban areas of former homelands. This is not explained by any observable features of the populations who live there (Lochmann, 2022), and low wage levels are not well explained based on income levels of surrounding areas as they are for the rest of the country (Mudiriza and Lawrence, 2021). Since individuals who leave former homelands fare equally well in the labor market as anyone else (Lochmann, 2022), this reflects a place-based problem affecting these areas where roughly 30% of the population continues to live.

This section explores why South Africa faces such striking patterns of spatial exclusion, both across the country and within cities, and identifies solutions. We find distinct drivers of these two types of exclusion. Within cities, housing, zoning, and urban development policies are at the root of spatial exclusion and cause a repeated pattern of low-density housing being

built in disconnected areas rather than high-density housing in the core of cities. Therefore, we recommend changes in housing market policies – especially zoning and regulations – and in the structure of budgetary spending on city infrastructure – especially through budget mechanisms on human settlements. Ultimately, South Africa could reverse the pattern of spatial exclusion of cities and enable organic growth of higher-density cities by relaxing restrictions on denser housing, channeling more fiscal resources toward demand-side housing instruments that enable households to choose where to live and ensuring that infrastructure spending does not *de facto* incentivize the building out of cities at the expense of building up. This shift would be strengthened by a coordinated national policy shift, but there are also substantial opportunities for local governments to lead and jumpstart changes in their urban structure through strategic uses of urban land.

Extreme spatial exclusion of rural former homelands comes less from active policies (unlike urban spatial exclusion) and more from a lack of physical connectivity and connections in knowhow. We find that although many infrastructure gaps have narrowed between homeland areas and the rest of the country, there remain critical shortfalls in basic connecting infrastructure, especially paved roads. This is the binding constraint for some of South Africa's most rural and disconnected communities. The underlying causes of these gaps were discussed in the previous chapter, along with recommendations for strengthening state capacity in relevant ways. However, we also find that connecting via physical infrastructure is not enough to fully close the gap in employment outcomes between homeland areas and non-homeland areas. Once connected physically, economies of rural former homelands do not automatically connect to surrounding productive ecosystems and discover new comparative advantages, even if these are established in very nearby communities.

We find that one approach that has been successful and which can be built upon is partnerships between established commercial entities and communities within the rural former homelands. We find that there are examples of success in agriculture through diverse organizational structures and broad similarities to South Africa's successful franchising sector (Klinger, 2022; Klinger *et al.*, 2023). Success cases are limited, however, and face large challenges in building trust, overcoming information asymmetries, achieving technology transfer, and managing risk – especially climate risk. At the same time, limited success shows that committed and well-structured partnerships can work to bridge knowhow, even in

situations of communal land ownership and traditional governance. For more of these partnerships to take place, there needs to be a thicker market for businesses and communities to find one another and a scale-up of tools for structuring partnerships based on success cases – like what exists in the franchising sector. We find that South Africa has several "agents of change" that currently support the matching and building of such partnerships, including partnership advisors and local NGOs. We also find that, in the best cases, communities themselves can seek out such opportunities through their local trusts or enterprises. There should be an important role for the government to play in supplying public resources and initiatives that help to create a larger market for such partnerships, including through leveraging the public university network.

This chapter argues that addressing the collapse of state capacity discussed in the previous chapter is only one necessary step toward growth through inclusion. For a recovery of growth to be enhanced by the inclusion of more people, actions to reverse historic drivers of exclusion must also take place. The path to spatial inclusion in South Africa must include housing policy change and urban planning and spending changes that would "bring people to jobs". This would increase the ability of cities, including secondary cities, to absorb more job seekers and, to some extent, lower the pressure on rural unemployment. Meanwhile, there is also a need for a focus on connecting infrastructure and bridging knowhow to "bring jobs to people" in the country's most struggling areas. The next section discusses the challenge of inclusive cities, and the following section discusses the challenge of bridging knowhow.

3.2 Building Inclusive Cities: Bringing people to jobs

The core function of a city is that of a market – a market for products, labor, ideas, innovation entrepreneurship, partnerships, and more. Cities are places where people choose to live to be near other people. Urban economics focuses on the role of "agglomeration economies", where firms, people, and economic activities cluster together in a particular geographical area. Through agglomeration, cities can support highly diversified, productive, and high-income economies as businesses have access to a large pool of differentiated workers, access to suppliers, and access to markets. But to achieve agglomeration economies, cities must be physically connected through transportation infrastructure that allows people to interact, especially for workers to get to work. Efficient cities tend to have high density in the

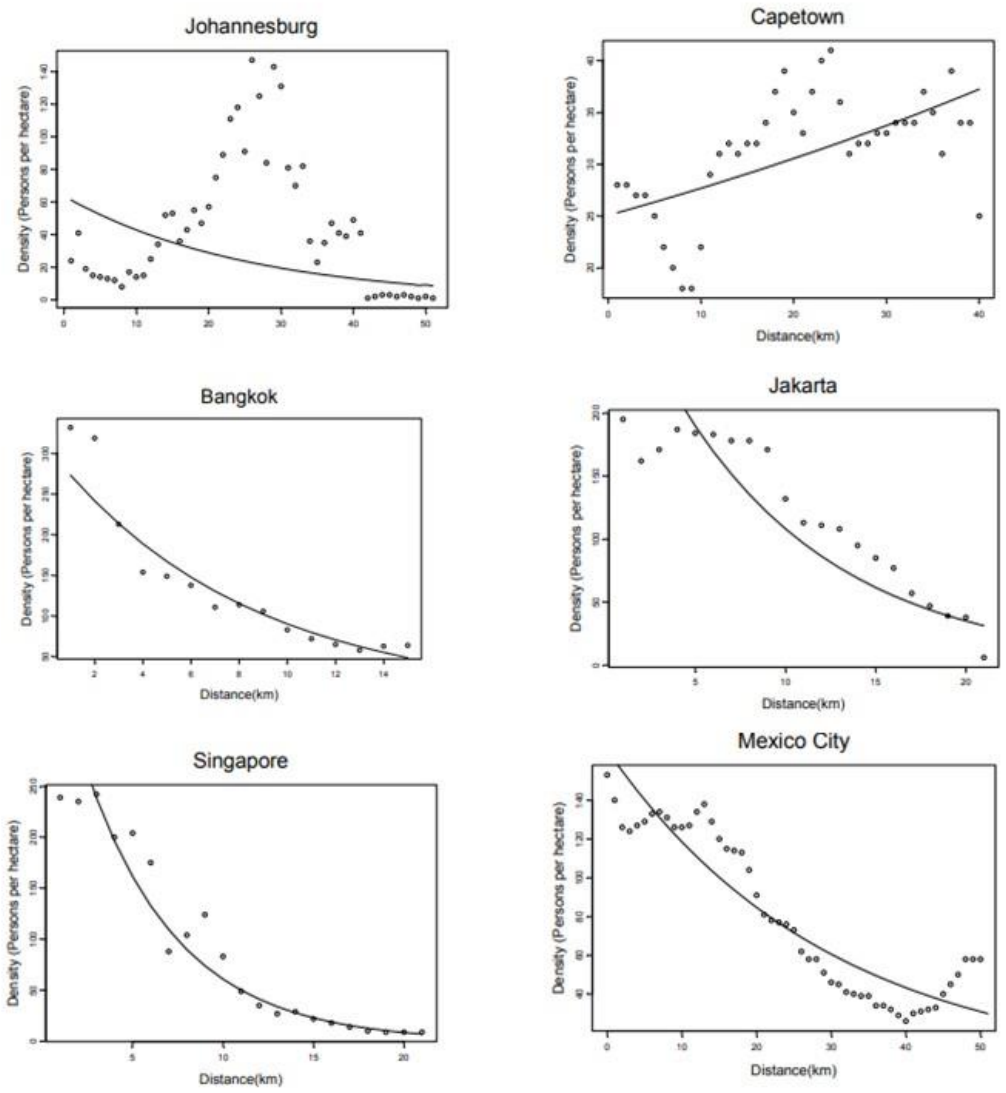
city core or multiple city cores, with high land prices, and lower density with lower land prices as one moves outward from the city core (Bertaud, 2018). This is the natural outcome of businesses and firms bidding up land prices for the greatest connectivity, which then supports the construction of dense build-up and housing in small units. As cities expand outward, individuals and businesses trade-off space for connectivity. For cities to continue to benefit from agglomeration as they grow outward, urban infrastructure must allow people to travel efficiently across the city.

South Africa's largest metros diverge from spatial patterns of efficient cities. As shown in Figure 3.3, Johannesburg and Cape Town are distinctively different from most global cities in the distribution of their population across space. Each city lacks a traditional city core and declining population density as one moves away from that core. This pattern has been attributed to apartheid planning. However, this explanation must be critically assessed by looking at more recent indications of urban density and spatial patterns of emerging cities that have not been as subject to apartheid-era planning. More recent data tends to show a recurring pattern for South African metro areas. Figure 3.4 shows the relationship between population density and distance from the city center for eThekwini and Buffalo City – in both 1-dimensional and 2-dimensional space. These two urban areas reflect a common pattern across South African cities, which tend to lack a dense urban core and instead have largely disconnected and dispersed populations. Later in this chapter, we will explore additional examples.

South African cities are growing horizontally, but people continue to be attracted to more connected areas. In growing cities, market pressure for housing densification is expressed either vertically (by building up) or horizontally (by building out). If densification is expressed vertically, we would observe a *decreasing* built-up density gradient with increasing distance from the central business district (CBD) in the graphs above. Expressing densification vertically means enabling developers to build higher-rise mixed-use buildings. Meanwhile, expressing it horizontally, as we tend to see in South Africa, implies urban sprawl. However, this does not mean that people choose to live far from the city center by choice. Instead, South African cities have significant infill squatting and growing informal areas as people choose to live in more connected areas. Furthermore, if given the choice, many South Africans express to prefer better location and shared amenities over single-family homes, and rental over ownership. Backyarding is a signal that many people who are given single-family homes on

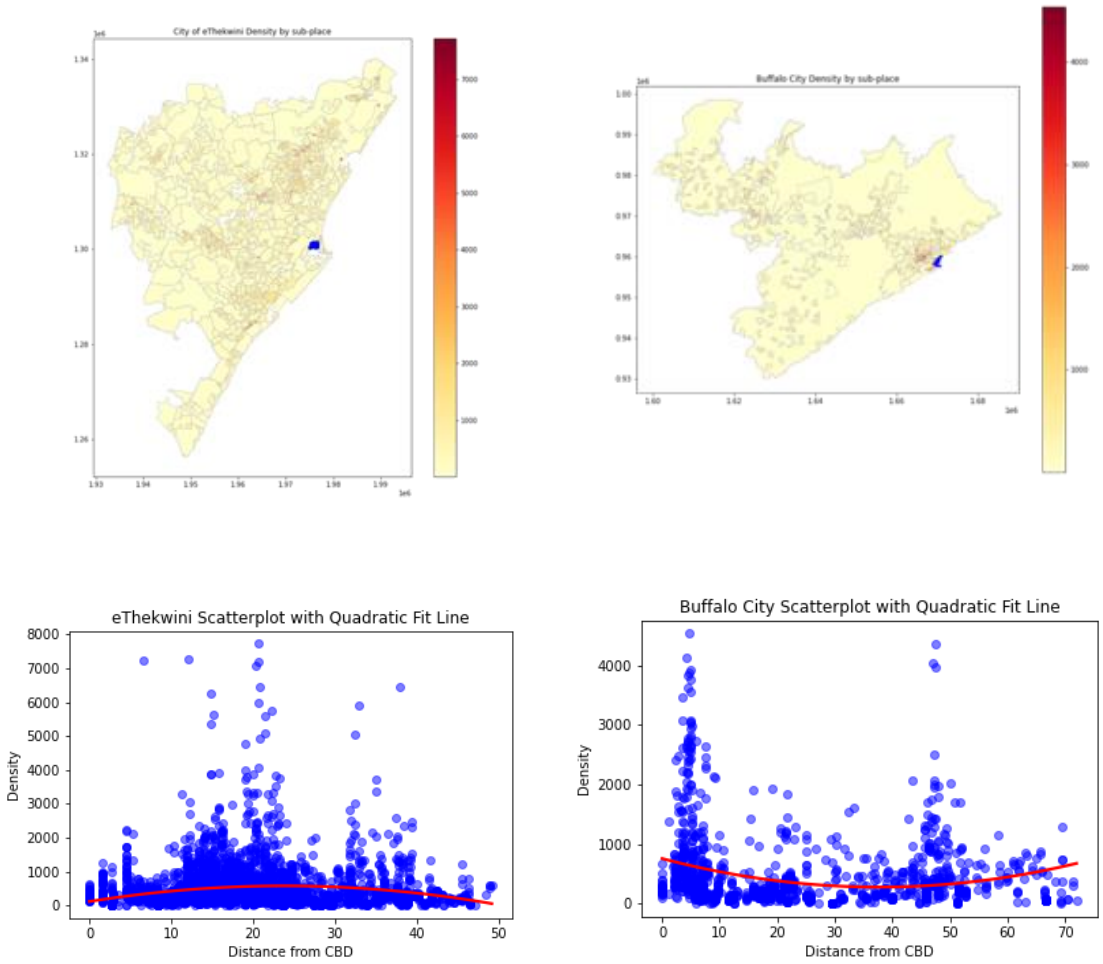
little land plots will informally build up the area, which implies that they prefer additional income over space. Other strong signals come from Maboneng, Johannesburg. Jewel City is an affordable housing complex that provides ample shared amenities and proximity to economic opportunity. The success of the housing complex, which provides affordable rental units for over 1,000 units and is currently over-subscribed, further showcases that, if given the choice, many South Africans would choose location and shared amenities over single-family homes in the disconnected periphery.

FIGURE 3.3: RELATIONSHIP BETWEEN DENSITY AND DISTANCE FROM CENTER FOR SELECT CITIES



Source: Bertaud and Malpezzi, 2003.

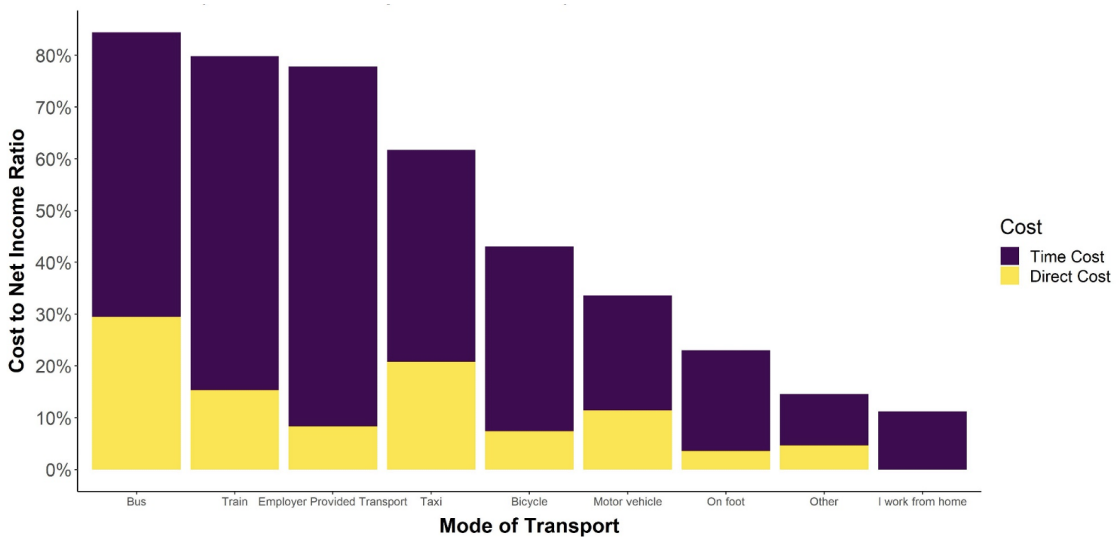
FIGURE 3.4: POPULATION DENSITY PROFILES OF ETHEKWINI AND BUFFALO CITY



Note: Blue colored part in the map is the central business district (CBD).
Source: Own elaboration based on South African National Census 2011.

As a result of their spatial structure, South African cities suffer from problematically long commute times. An efficient city is good at locating people and jobs close to each other. One "golden rule" is that efficient cities keep maximum commuting times under one hour (each way), regardless of the mode of transport (Bertaud, 2018). In South Africa, we see that commuting is very expensive and it takes a long time. Taking national averages, the total cost of commuting (including time cost) is close to 80% of net income for those who commute by bus, train, and even employer-provided transportation (Figure 3.5). This cost is primarily driven by the cost of the time spent commuting (based on hourly wages). In other words, workers spend a very large portion of their workday commuting.

FIGURE 3.5: RATIO OF COMMUTING COST TO INCOME BY MODE OF TRANSPORT



Source: Shah and Sturzenegger, 2022.

These costs tend to be regressive in a variety of ways. As reflected in Figure 3.5, the cost as a share of income is relatively lower for those with access to a car, but access to a car remains out of reach for most South African at their income levels. Given the large distances in South African cities, network coverage of buses and trains is impossible without very large public subsidies, which South African municipalities cannot afford. This urban structure makes minibuses or taxis the cheapest and most efficient mode of transport. When other forms of public transportation have been built, such as Gautrain in Johannesburg or MyCiTi in Cape Town, ridership is very low, and access is limited to higher-income commuters rather than addressing the very large transport needs of the population. The differences are striking in comparison to other global cities. For example, Cape Town's BRT system runs a similar length to that of Bogotá, but Cape Town has only about one rider for every 50 in Bogotá (see Box 3.1).

Patterns of spatial exclusion repeat themselves in growing cities. During apartheid, spatial policies generated sprawling and disconnected cities, excluded certain population groups, and prevented cities from densifying naturally through price mechanisms and the build-up of city centers. However, three decades after apartheid, we continue to see these problems repeat themselves in growing secondary cities. Secondary cities are important destinations for internal migrants and drivers of inclusive growth. According to a report from the South African Cities Network (SACN), secondary cities contribute approximately 15% of the national GDP. These cities tend to have a more diverse economic base than rural areas. Between 2008 and

2018, secondary cities in South Africa contributed to around 23% of national employment growth (South African Cities Network, 2021a). These cities have different growth drivers (Figure 3.6), but they share one thing in common. They tend to recreate patterns of spatial exclusion.

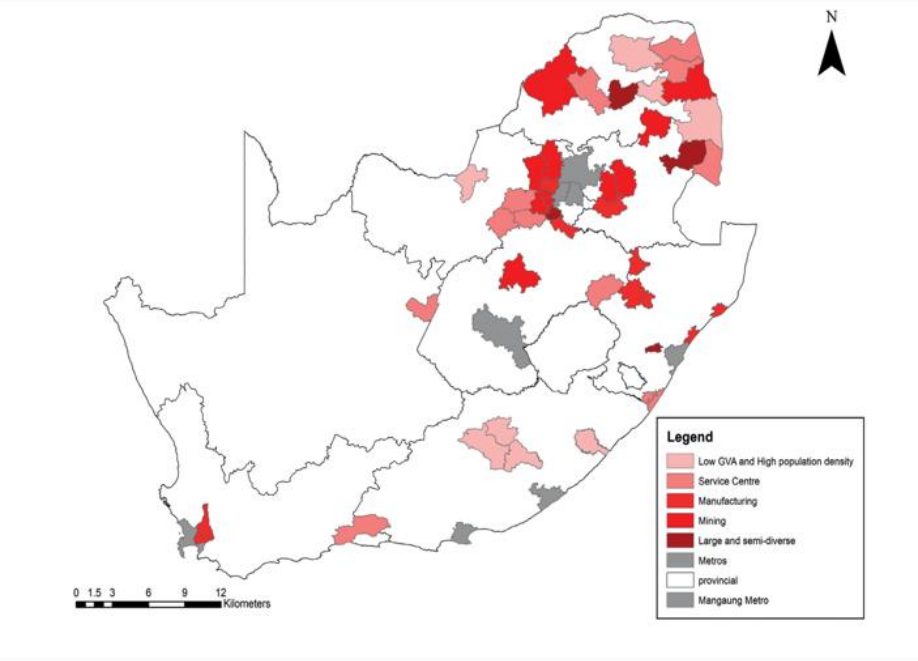
Box 3.1: BRT in Bogotá vs. Cape Town

Bogotá's BRT system, known as TransMilenio, began operations in 2000 and has grown to become one of the largest and most extensive BRT systems in the world. As of 2021, it had over 12 lines covering approximately 114 km of dedicated busways. Cape Town's BRT system, known as MyCiTi, started operations in 2010. As of 2021, it consisted of 42 stations along eight main routes, covering about 80 km of dedicated busways. In 2021, TransMilenio's ridership was around 2.4 million passengers per day, whereas MyCiTi had a daily ridership of around 50,000. MyCiTi is a bit smaller than TransMilenio but has only one-fiftieth of the ridership.

Bogotá is a dense city with a large population, which makes it ideal for a high-capacity mass transit system like the BRT. The demand for public transportation is high, and the BRT system offers an affordable and relatively fast solution for many commuters. Cape Town has a more sprawling urban layout, with lower population density and a more extensive car-centric transportation infrastructure. This makes it more challenging to create a successful BRT system, as the demand for public transportation is not as high and the existing infrastructure favors private car use.

Sources: www.transmilenio.gov.co; www.myciti.org.za

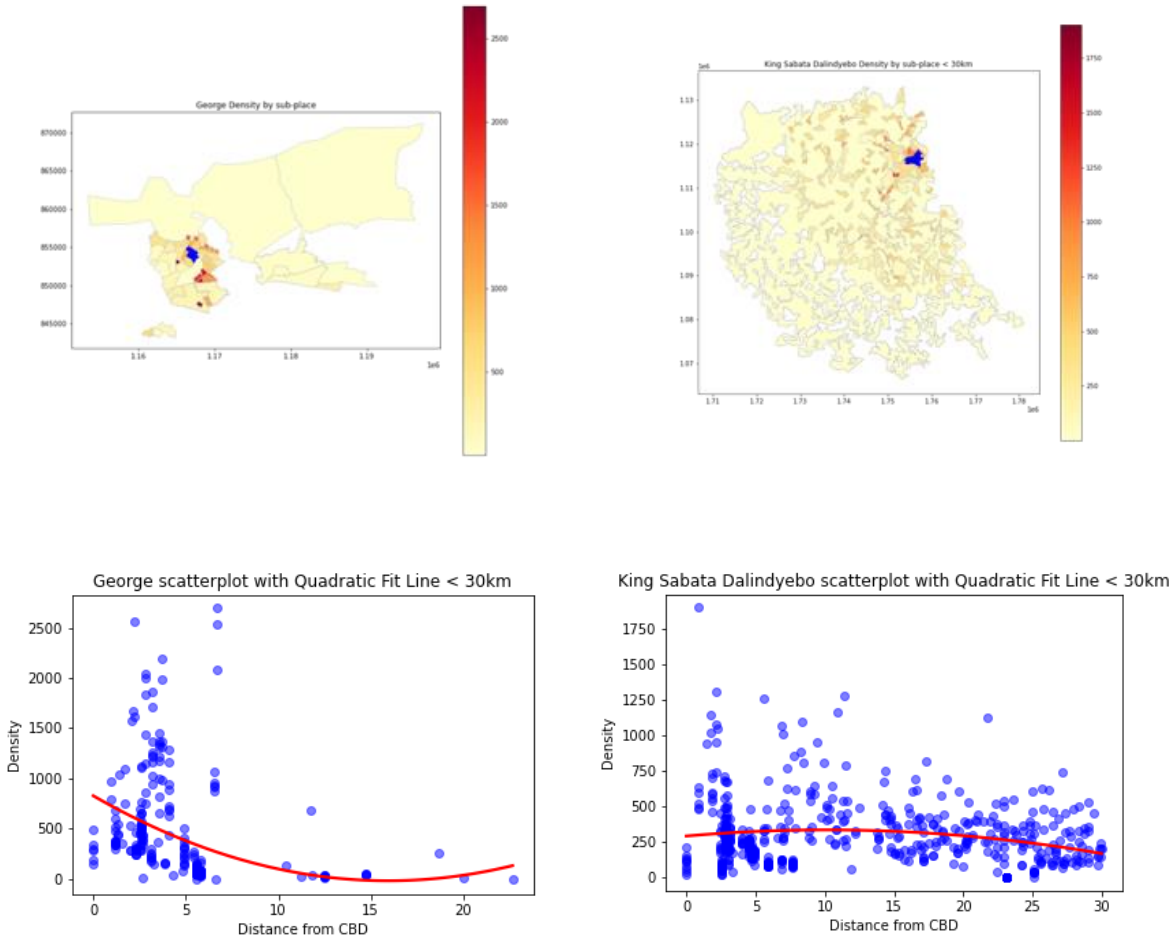
FIGURE 3.6: ECONOMIC CLASSIFICATION OF INTERMEDIATE CITIES



Source: South African Cities Network (2021b.)

Recurring spatial exclusion can be seen in very different cities. Figure 3.7 shows the population density of two growing secondary cities, George and King Sabata Dalindyebo (which contains the city of Mthatha), and Box 3.2 profiles each of these cases. George lacks a dense city center but is more compact than larger cities discussed earlier, with an estimated population of around 160,000. However, as it grows, it appears to be recreating disconnected spaces at a larger scale despite a desire to grow more inclusively. Mthatha has become a sprawling population center with a rapidly growing periphery where housing is being built on communal lands surrounding the formal boundary of the city. There appear to be common drivers that result in spatial exclusion in very different circumstances across South Africa.

FIGURE 3.7: POPULATION DENSITY PROFILES OF GEORGE AND KING SABATA DALINDYEBO



Note: Blue colored part in the map is the central business district (CBD).
Source: Own elaboration based on the South African National Census 2011.

Box 3.2: Deeper dive into two secondary cities: George and Mthatha

George: A growing but disconnected city with advantages in tourism and agriculture
George is known for its tourism, agriculture, and forestry industries. It is the sixth oldest town in South Africa. Located on the popular Garden Route, George attracts many domestic and international tourists each year. Agricultural output is concentrated in dairy, fruits, and vegetables. Population inflows provide increased growth in these tradable sectors, but also jobs in non-tradable services. Informal activity is encouraged and supported, with stands in strategically important areas, as well as the development of smaller business centers in -denser areas like Thembalethu, a township in the model of larger cities. George has experienced significant growth in population, which accelerated during and after the pandemic. According to interviews and city strategies, absorbing people in an inclusive way is high up on the agenda of the policymakers. Yet, George still faces non-inclusive outcomes. Although Thembalethu is only 5km away from the CBD (close by South African standards), it is still difficult for residents to commute to work outside of the township. They need to cross a major highway with one bridge that is highly congested during peak hours. The commute is, hence, either a long walk, or a very slow drive. George has recently introduced GoGeorge, a bus transport system that has yet to be extended to Thembalethu. Densifying the CBD with focus on affordable and mixed-use housing is high on the priority list of the policymakers, yet progress is proving difficult. Zoning restrictions, historic (no longer active) parking regulations, red tape, and building costs make those kinds of developments unprofitable.

Mthatha: A growing and sprawling but more connected city in a former homeland
Mthatha was the capital of Transkei. As South Africa transitioned to a democratic system, this led to a re-orientation of the city. Like many other cities in South Africa, Mthatha has experienced significant urbanization over the past thirty years. The surrounding rural population continues to migrate to the city in search of better economic opportunities, education, and services. This has led to a rapid increase in the city's population, putting pressure on its infrastructure, housing, and services. The economy of Mthatha has shifted from being predominantly government-driven to a more diverse mix of sectors, and Mthatha plays a notable role as a services hub for the surrounding area. Mthatha has an active informal economy, especially in the city core, in contrast to many other cities in South Africa. Nonetheless, even Mthatha faces spatial sprawl – not from apartheid planning, but from a combination of a low-density city core and the pull from the periphery where communal land is cheap home building is easy. Unlike more disconnected cities, Mthatha a relatively constant density with distance. This time lapse shows new developments in Mthatha in terms of where new settlements are arising in the time span 2016–2023: https://www.planet.com/stories/mthatha-and-surrounding-hU48KHf4g

We see that these three requirements of efficient, inclusive cities are missing across South Africa: people and economic opportunities are disconnected, formal housing is exclusive, and mobility is expensive. Post-apartheid policies are not reversing these outcomes. In fact, we find that they are exacerbating them. In the next section, we describe how post-apartheid housing policy is at the center of these recurring outcomes. A push to provide high-quality housing for all South Africans through public supply led to housing on the

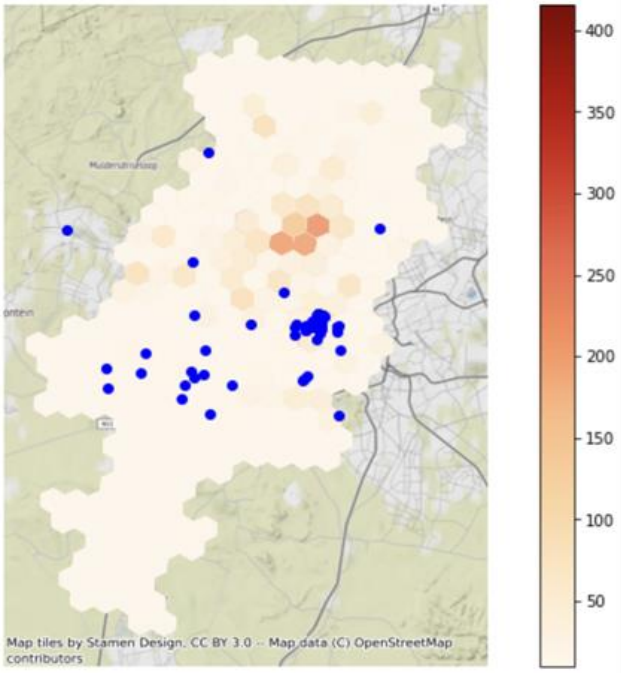
periphery of cities, where land prices are lower, which has worsened spatial exclusion. Affordable housing is rare in city cores, which leaves people with the choice to live in the periphery or informal settlements. Commutes are expensive, especially on the lower end of the income distribution, disincentivizing formal and informal work, and creating poverty traps. Public transport options are costly and inefficient due to lacking density.

3.2.1 Housing Policies at the Heart of Exclusive Cities

Due to South Africa's RDP-style housing programs, housing is disproportionately built in economically disconnected areas. South Africa's Constitution states that "everyone has the right to have access to adequate housing". Although South Africa still suffers from a shortfall of adequate housing, this has been the motivating goal of housing policy. In the immediate post-apartheid period, housing policy was highly supply-driven: RDP and, later, Breaking New Ground (BNG) housing programs built single-family unit homes on a massive scale. This provided many poor households with a relatively high-quality home. However, by taking away the agency of people to choose where they want to live, these programs exaggerated spatial exclusion in cities, locating RDP and BNG housing in areas where land is cheap. This resulted in the pattern seen in Figure 3.8, where housing for the poor (blue dots) was systematically located away from concentrations of businesses and economic activity (color scale).

This orientation of housing policy has had long-lasting consequences and created substantial inertia. Although the focus of housing policy – at least on paper – has partially shifted from supply-side policies towards demand-side approaches over the past decades (under programs like the Finance Linked Individual Subsidy Programme (FLISP) that provide individuals money to choose their own housing), these programs remain very small within the budget structure of the Department of Human Settlements. In practice, the approach has had immense staying power as well as implications for local infrastructure spending and the functioning of private housing markets. Because of the need for infrastructure buildout to connect low-cost land, a large share of Department of Human Settlements grants to municipalities are earmarked for arterial infrastructure. Given the large presence of RDP-influenced home building, similar construction is provided by the private market due to established supply chains and business models of housing developers. Moreover, free or highly subsidized housing has become an expectation of many South Africans, even if beneficiaries are often dissatisfied with housing quality and location.

FIGURE 3.8: LOCATION OF SOCIAL HOUSING VS. BUSINESS PRESENCE IN JOHANNESBURG AREA



Note: Blue dots on the map indicate social housing complexes as of 2018.
Source: Own elaboration based on economic data from Nell, A. Visagie, J. Spatial Tax Panel 2013-2018, Version 1. National Treasury - Cities Support Programme and Human Sciences Research Council, 2021 and Housing data from Scheba *et al* (2021).

Small-scale demand-side instruments have faced numerous problems. The uptake of FLISP has been very low (at less than 16,000 households and half the target for 2012 to 2020), and there are widespread explanations for the low uptake (Department of Human Settlements, 2021; Hoek-Smit and Cirolia, 2019).[13] These point to the following causes, among others: the type of subsidy that is granted, which is on the down payment rather than a subsidy on mortgage interest rates; the rigidity of the financial system, which is inaccessible to many people; the titling backlog, which constrains people in the access of financial resources; and low marketing and limited public knowledge. However, a simpler but important explanation is that the program is very small in comparison to other uses of the Human Settlements budget. A scale-up of the transition from supply-side policies, which dictate where housing is built, what kind of housing, and how dense, to demand-side instruments that allow demand to dictate each of these dimensions would be a step in the right direction. At the same time, it is important to explore why denser housing is not already built on a larger scale on the private market.

[13] See also several studies by the Center for Affordable Housing Finance (CAHF) - https://housingfinanceafrica.org/

Significant supply-side restrictions affect housing construction today and would not be resolved by a larger shift to demand-side subsidies. National and local zoning and building regulations make it expensive, and in parts illegal, for developers to build high-rise buildings at affordable rates in desirable locations. The regulatory framework disincentivizes building up in the core and implicitly subsidizes building out in the disconnected periphery. For a demand-side subsidy to have its desired effects, supply must be responsive in desirable locations. This requires making it more attractive for developers to build in the city core (Hoek-Smit and Cirolia, 2019). Regulations make it practically impossible – and illegal – for developers to build housing supply that would reflect a better spatial equilibrium in cities. Below are some of the most binding regulations and distortions to inclusive housing developments in desirable locations, which are necessary to revisit. The optimal level of building regulations is not zero, but these areas are noteworthy because they do not appear to be necessary public safeguards, yet they have large unintended consequences.

- **National Building Regulations:** The National Building Regulations and Building Standards Act 103 of 1977, last amended in 2008,[14] provides a framework for the establishment of uniform building standards and regulations across the country. The act covers a range of aspects of building construction and management: building standards, building regulations, building plans, and approvals and penalties. Some specific regulations stand out as rather unique in South Africa when compared to other countries in their restrictiveness, for example, single-point access staircase regulations, as well as building material requirements. The use of traditional materials like wood and glass is more restricted in South Africa, as is the construction of prefabricated homes – a form of construction that has advanced significantly globally. Such restrictions not only increase the building cost significantly but make it more difficult to build units of different sizes and diversity – leading to more expensive and less versatile housing units that cannot accommodate different price ranges. We, therefore, recommend relaxing overly restrictive materials and accessibility regulations at the national level.

[14] Besides SANS 10400-XA: Energy Usage in Buildings, which has been amended in 2020.

- **Local Building Regulations:** An increasing body of research has studied the role of restrictive land use policies on increasing racial segregation and income segregation.[15] Restrictive floor area ratios (FAR) and building coverage ratios (BCR) are two measures. With limited space for development, land values in areas with low FARs and BCRs tend to be higher, which can make it difficult for developers to build affordable housing and for people to afford housing in those areas. Certain types of developments, like higher-rise, mixed-use buildings with a variety of different apartment sizes become infeasible with low FARs and BCRs. These measures in South Africa differ across cities and zones but tend to be low. In several municipalities' housing codes, FARs of 1, oftentimes in combination with low BCRs, appear to be constraining in zones that could lend themselves to densification. As an indication of how binding FARs can be, Paris doubled its number of housing units built per annum from 40,000 to 80,000 between 2009 and 2019, partly explained by a national law that eliminated floor-area-limits in local plans (Denoon-Stevens and Nel, 2020). Finally, parking minimum regulations which have been eliminated in many places, can also significantly increase building costs and skew the type of buildings that can be viably built. The same is true for elevator requirements and other local regulations. We recommend that municipal governments relax FAR, BCR, parking and elevator requirements, and other restrictive local building regulations to allow for higher density.

- **Zoning Regulations:** Extensive empirical research has demonstrated a strong connection between exclusionary zoning and increased housing costs, diminished housing construction, and reduced overall welfare.[16] Zoning restrictions inflate building costs, limit housing variety, and discourage diverse, affordable housing. Single-family home zoning especially limits the development of apartments, multi-family, or mixed-use homes, thus artificially reducing housing supply and increasing prices. Furthermore, these regulations frequently result in housing types being concentrated in specific areas, which can contribute to economic segregation and reinforce existing inequalities in the housing market. Like South Africa, the United States is often noted for its extensive single-family zoning. In the U.S., this type of zoning was historically used to segregate neighborhoods by class and race, and it continues to shape American cities today. However, in recent years,

[15] See, among others, Rothwell, and Massey (2009); Sahn (2021); Trounstine (2020); Lens and Monkkonen (2016); and Rothwell and Massey (2010).
[16] See, among others, Glaeser and Gyourko (2018); Glaeser *et al.* (2005), and Hsieh and Moretti (2019).

there has been a growing push in some U.S. cities to reform single-family zoning to allow for more diverse types of housing and promote greater affordability and inclusivity. In Europe, on the contrary, single-family homes are common in suburban and rural areas, but multi-family buildings predominate in urban centers. We recommend a local shift to less single-family zoning, prioritizing mix use in city cores.

Based on international experience, a few additional policy dimensions could be important in enabling more inclusive housing. First, denser and more inclusive housing is often blocked at the project level by narrow non-in-my-backyard (NIMBY) interests at the expense of wider benefits to society. Countries that have struggled with this have discovered some solutions. Second, it is important to leverage development charges or impact fees equally across space so as not to *de facto* incentivize building on the city periphery. Third, since housing development is a dynamic challenge, policy changes should not be limited to one-off regulatory changes. Rather, the government can utilize active problem-solving approaches in coordination with the private sector to understand emerging challenges and partner to find solutions. Each of these policy dimensions is discussed below.

- **Addressing NIMBYism proactively:** In the United States and other countries (like France and New Zealand – see Box 3.3), land use and housing policy control is increasingly being moved to higher administrative levels, for example, the state rather than cities and towns.[17] When decision-making power is shifted from local municipalities to higher levels of government, very narrow local opposition to development can have less direct influence. Higher-level authorities can reflect the needs of broader society. For instance, if a state mandates that all towns must allow multi-family housing in residential areas, local opposition can do little to prevent it. Additionally, systems that pre-approve projects based on a pre-determined spatial development plan and simple criteria can also limit opportunities for NIMBYism. Under such arrangements, community approval is front-loaded in the form of strategic plans and neighbors must pre-approve projects that are in the common good even if they happen to develop in their backyard.

- **Ensure impact fees are equally applied:** Impact fees, also known as development charges, are fees charged by local governments on new developments to help pay for the

[17] See Denoon-Stevens and Nel (2020) for the case of Paris.

costs of providing services and infrastructure to support growth. Development charges are typically charged on new residential, commercial, or industrial developments and are calculated based on the type, size, and location of the development. The fees are intended to facilitate necessary improvements in water and sewer systems, roads and transportation infrastructure, parks and community facilities, and other municipal services that are needed to accommodate the growth of the community. The purpose of development charges is to ensure that the costs of new development are borne by the developers and new property owners, rather than being passed on to existing taxpayers. By doing so, development charges help to ensure that growth and development are sustainable. It is important to ensure that municipalities do not waive or reimburse development charges on peripheral development in ways that undermine the natural functioning of housing markets and inadvertently incentivize building out rather than filling in and building up.

- **Establish continuous public-private problem-solving:** Public-private problem-solving task forces can be effective ways to continuously address constraints in particular sectors or around specific constraints. By regularly meeting and incrementally addressing issues, such task forces can develop trust, reveal information, and develop innovative solutions. Such task forces could be nationally focused but may be more effective at the city level to uncover and address city-specific constraints. Understanding the key constraints of the relevant stakeholders in the housing market, notably, developers, helps shift the focus from a system that operates entirely on fiscal incentives towards addressing the real costs and hurdles that undermine diverse and spatially inclusive housing construction. Such initiatives are effectively free to the public sector and can lead to a much more effective use of resources.

Taken together, a relaxation of supply-side restrictions and an increase in demand-side instruments would have a profound impact on housing development and spatial inclusion in South African cities. Shifts in the spatial structure of cities would occur gradually, but this is the path to fundamentally changing the exclusive spatial structure of cities. Inclusive cities would be stronger economically and eventually reduce demand for informal settlements. In the shorter term, this shift would enable growth in housing construction, creating jobs and demand in the supply chain of housing construction materials. Growth in the private housing market would also allow municipalities opportunities to grow their tax base through property

tax revenues and opportunities to put underutilized land to use for urban development goals. In either the long- or shorter-term the shift would be expected to have a positive impact on crime by increasing inclusion and job opportunities. Other countries have taken similar measures at a large scale, for example, New Zealand in addressing restrictive supply-side regulations and Colombia in leveraging demand-side instruments (see Box 3.3).

Box 3.3: New Zealand and Colombia Approaches: Liberalize Supply and Support Demand

New Zealand: Relaxing Supply Side Restrictions

New Zealand has experienced a significant rise in housing costs over the past decade, with the median house price increasing by around 130% between 2011 and 2021. This increase in housing costs is partly due to an undersupply of housing. In response, the New Zealand government has introduced several housing reforms aimed at increasing housing supply and affordability. One of these reforms is the Medium Density Residential Standard, which requires the most populous cities in the country to allow medium-density housing on all existing residential parcels of land. This reform is a reversal of previous land use policies, which encouraged low-density housing in residential areas. The zoning reform is expected to stimulate housing construction through redevelopment, with the Auckland Unitary Plan providing a blueprint for the policy's success. The Auckland Unitary Plan, introduced in 2016, led to a construction boom in the city, with a significant increase in new housing units permitted and a shift towards attached multifamily housing.

Another policy introduced by the New Zealand government is the National Policy Statement on Urban Development, which requires large cities to zone for residential structures of up to six stories within walking distance of rapid transit stations. This policy aims to promote more compact cities and lower energy consumption through shorter commutes and increased use of public transit. These reforms have increased housing construction in New Zealand, but it remains to be seen whether they will significantly improve housing affordability.

Colombia: Demand-Side Policy Focus

In 2021, the UN named Colombia a standout in social and affordable housing. Several Latin American nations have subsequently taken cues from Colombia's "Mi Casa Ya" program in developing their own housing strategies. Colombia's housing policy is multifaceted and has seen some notable progress, such as a 17% annual increase in the housing sector's GDP, a 40% increase in sector employment in four years, and a 70% growth in the mortgage portfolio over three years. It also improved social housing quality, decreased urban segregation by moving less affluent people closer to city centers, and ensured that most subsidies reach the poor.

Box 3.3: New Zealand's and Colombia's Approaches: Liberalize Supply and Support Demand (cont.)

Colombia's approach to housing policy is based on three pillars:

1. *The flagship of the housing policy is "Mi Casa Ya", the demand-driven program.* The demand-side subsidy is provided to the poor by default. Each mortgage is supported by a Guarantee Fund. Down payment is provided by the government and poor people are intended to pay less for the mortgage than they previously paid for the rent. Meanwhile, supply-driven programs remain in place but are mainly associated to reallocations, risk management, catastrophes, or victims of violence.

2. *Each subsidy for a new house has been accompanied by four subsidies for house and neighborhood improvement.* Responding to the qualitative deficit has been prioritized. This has included legalization of informal neighborhoods and providing public goods including schools, libraries, police stations and hospitals, and improving dwellings.

3. *A new housing law and many regulatory innovations facilitated by sub-national governments.* The central government financed studies for the expansion plans of some municipalities, included instruments to effectively capture the value of the land in time (Tax Incremental Financing) and manage to simplify the process to provide construction licenses.

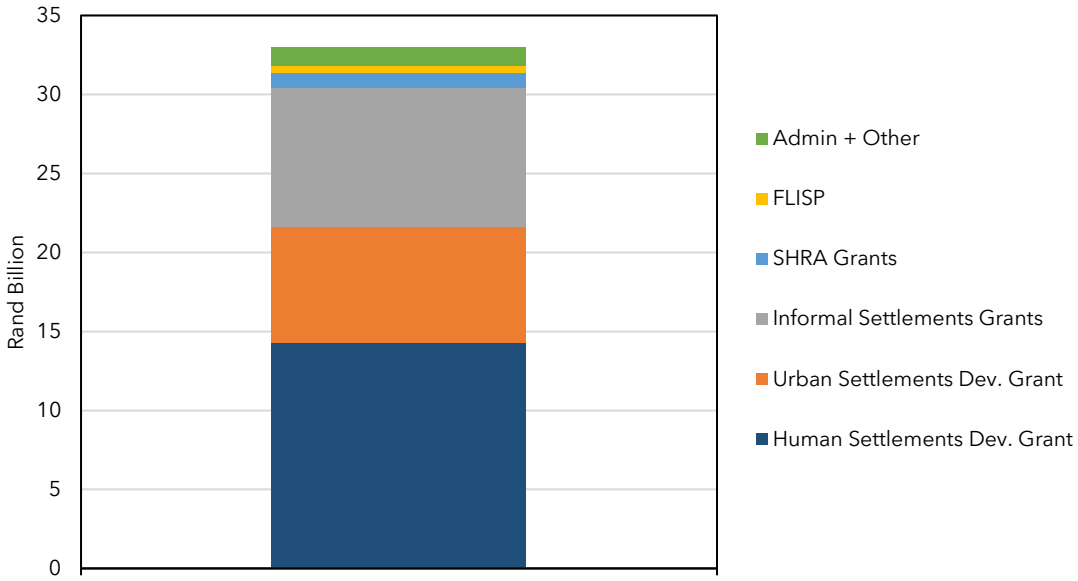
Source: Greenaway-McGrevy (2022) for New Zealand's case and Jonathan Malagón, former Ministry of Housing of Colombia for Colombia's case.

3.2.2 Better Utilizing the Human Settlements Budget

To capitalize on the relaxation of supply-side restrictions, we recommend a substantial shift in the Human Settlements budget to demand-side instruments. Human Settlements spending is a concurrent function between the national and provincial departments. The largest share of the budget occurs through block grants to provinces and metros, largely for subsidized housing and settlement upgrades. Close to two-thirds of this spending (more than ZAR 20 billion in 2022/23) flows through two grant programs – the Human Settlements Development Grant (HSDG) and Urban Settlements Development Grant (USDG) – and another 8.8B Rand flow through the Informal Settlements Grants (Figure 3.9). The HSDG is administered by provinces to finance housing-related infrastructure in local municipalities, whereas the USDG is administered by the metros. The end uses of these two grants are not fully transparent (especially, USDG), with spending choices made at these local levels of

government. Historically, these programs have *de facto* favored housing construction on the periphery of cities, serviced sites, and public infrastructure investment that implicitly subsidize urban sprawl. The National Department of Human Settlements directly controls budget spending on less than 10% of the budget, through the remaining programs including SHRA grants, FLISP, and Admin and other (a total of only ZAR 3 billion out of ZAR 33 billion).

FIGURE 3.9: HUMAN SETTLEMENTS BUDGET 2022/2023 (TOTAL: 33B RAND)



Source: Own elaboration based on 2022 Estimates of National Expenditure, National Treasury.

We recommend three steps for restructuring the Human Settlements budget:

1. Shift of the budget towards demand-side subsidies spending.
2. Review and restructure the USDG grant with the possibility to transform it from a "schedule 4" to a "schedule 5" grant.
3. Provide mechanisms to tie USDG and HSDG spending to where demand-side subsidies follow peoples' housing choices, instead of *de facto* promoting supply-driven sprawl.

First, we recommend a shift in this spending toward demand-side subsidies. The main advantage of demand-side subsidies is that they provide greater consumer choice at the lowest cost to the government. However, they perform best in markets where they can trigger a supply response. If supply is tight, demand-side subsidies can exacerbate affordability problems for non-subsidized low-income households as rents or prices increase. This is why,

South Africa needs to unlock the housing supply constraints as a pre-condition for demand-side subsidies to unlock the affordable housing market.

The design of demand-side instruments is not a trivial matter. A combination of rental subsidies, up-front subsidies/down payment support for home buyers, and subsidized mortgage payments can benefit different population groups more flexibly than one type of subsidy. The instruments should enable a large segment of society to access housing options that meet their needs, but at the same time, the instruments must not create fiscal guarantees that undermine fiscal policy goals. Some considerations of different demand-side supports are discussed below.

- **Up-front Subsidy / Down Payment Support:** Subsidies applied on the down payment are the current mechanism used within FLISP. Other options of up-front subsidies could apply to closing costs or the mortgage insurance premium. These tools are useful for many households who lack significant savings, and the fiscal implications are straightforward because payments are one-time. Yet, this form of subsidy is not effective in targeting households in the lowest income tiers and can exclude low-income households with low credit scores. This is a challenge in South Africa since many households do not have a savings history or a prior property title deed as collateral.

- **Subsidized Mortgage Payment / Interest Payment:** These subsidies lower the monthly cost of housing payments. These subsidies are more useful for households who can cover larger down payments (through savings or Stokvels in the case of South Africa), but who struggle to afford mortgage payments over time. This pool of beneficiaries may be narrow, so these could be combined with down payment support. If not designed and managed carefully, these subsidies can create fiscal risks as they are recurring payments. If subsidies are fixed in value, this planning is straightforward, but if these payments are variable, fiscal management can become a challenge.

- **Rental Subsidies:** Rental subsidies target renters rather than home buyers and homeowners. In the case of Colombia, these rental subsidies allowed individuals without credit history to build a credit history that then allowed them easier access to mortgage markets. The development of the rental sector comes with real advantages to the economy. It enhances labor mobility and is an option for households who don't have the means to

buy a home or wish not to, including young adults and new migrants. A thriving rental sector further provides a choice for asset investment and a source of complementary income. Demand for rentals in the affordable segment is clearly present, as shown by the rapid increase in "backyard" rentals, as well as by the high demand for rental units in the city core. Rental subsidies are typically paid out continuously and do not directly impact home ownership and home construction.

Regardless of the combination of demand-side subsidies, certain administrative improvements will be needed in South Africa. Hoek-Smit and Cirolia (2019) raise several administrative issues. These include a need to better delineate responsibilities between provincial governments, the entity with the budget, and the National Housing Finance Corporation (NHFC), which is the national overseer. Municipalities need to play a larger role in disseminating information about housing programs and managing these programs. Municipalities often serve as the initial contact for residents seeking housing, manage waiting lists, gain insight into local housing markets for both new and existing homes, and develop relationships with the key participants in the real estate market. Municipalities also maintain connections with local employers and other groups that can contribute to the successful operation of demand-side subsidy programs.

Second, we recommend reviewing and restructuring the USDG grant. USDG grant is currently a "schedule 4b" grant, which implies allocations to metros to supplement the funding of programs or functions funded from metro budgets. This limits the margin of action of the Department of Human Settlements, which has no impact on how and if the budget is spent. According to the Department of Human Settlements (2015), large chunks of the budget are not spent on housing-related programs and infrastructure, and allocated money is often not allocated until a rush ad the end of the calendar year. The HSDG, meanwhile, is a schedule 5 grant, entailing specific purpose allocations. Aligning HSDG and USDG by restructuring USDG to schedule 5 would help to provide greater oversight of how the budget is spent and allow for more direction to projects that enable more compact urban housing. Another possibility is to transfer the infrastructure parts of USDG to the Department of Cooperative Governance and Traditional Affairs CoGTA (and align it with MIG grants to local municipalities) while structuring the remaining budget tied to housing infrastructure via schedule 5 grants.

Finally, it is possible and desirable to link demand-side spending instruments with the relaxation of supply-side restrictions discussed previously. This can involve tying a certain amount of grant funding to municipalities that have implemented a set of reforms. For example, supplemental grant funding could be available for local governments that have relaxed counterproductive zoning and regulatory barriers to density. Or, alternatively, grant funding for urban infrastructure could be tied to the actual mobilization of demand-side subsidies, such that the communities that are seeing more uptake automatically gain additional resources for infrastructure upgrades to support more housing. In addition to the human settlements budget, transport budgets could, in principle, also be used to incentivize local regulatory change. For example, new public transport projects could be nationally funded conditionally on a municipality densifying its housing (through relaxation of overly restrictive building regulations and actively working to reform zoning regulations). Developing an easy-to-implement set of local regulatory and zoning reforms could be a task for the Department of Human Settlements together with the City Support Programme of the National Treasure and the larger research community.

3.2.3 Other Urban Policy Priorities for Inclusion

Local governments can further enable inclusion by incorporating underutilized urban land for development purposes. Publicly owned land, particularly in key urban centers or near transport nodes, has a high potential for developing inclusive housing. As the government already owns this land, the cost of acquiring land (which can be a substantial part of total development costs) is eliminated. This significantly reduces the overall cost of developing affordable housing units, making it more financially feasible for the government or private developers to build such housing. An example of this is the Air Force Base Ysterplaat in Cape Town, which is a large and strategically located area that no longer serves its original public purpose. This creates an enormous opportunity to change the urban fabric. Innovative housing development in the area can also serve as a model for other areas and the process can also deliver significant revenues to the city to be reinvested.

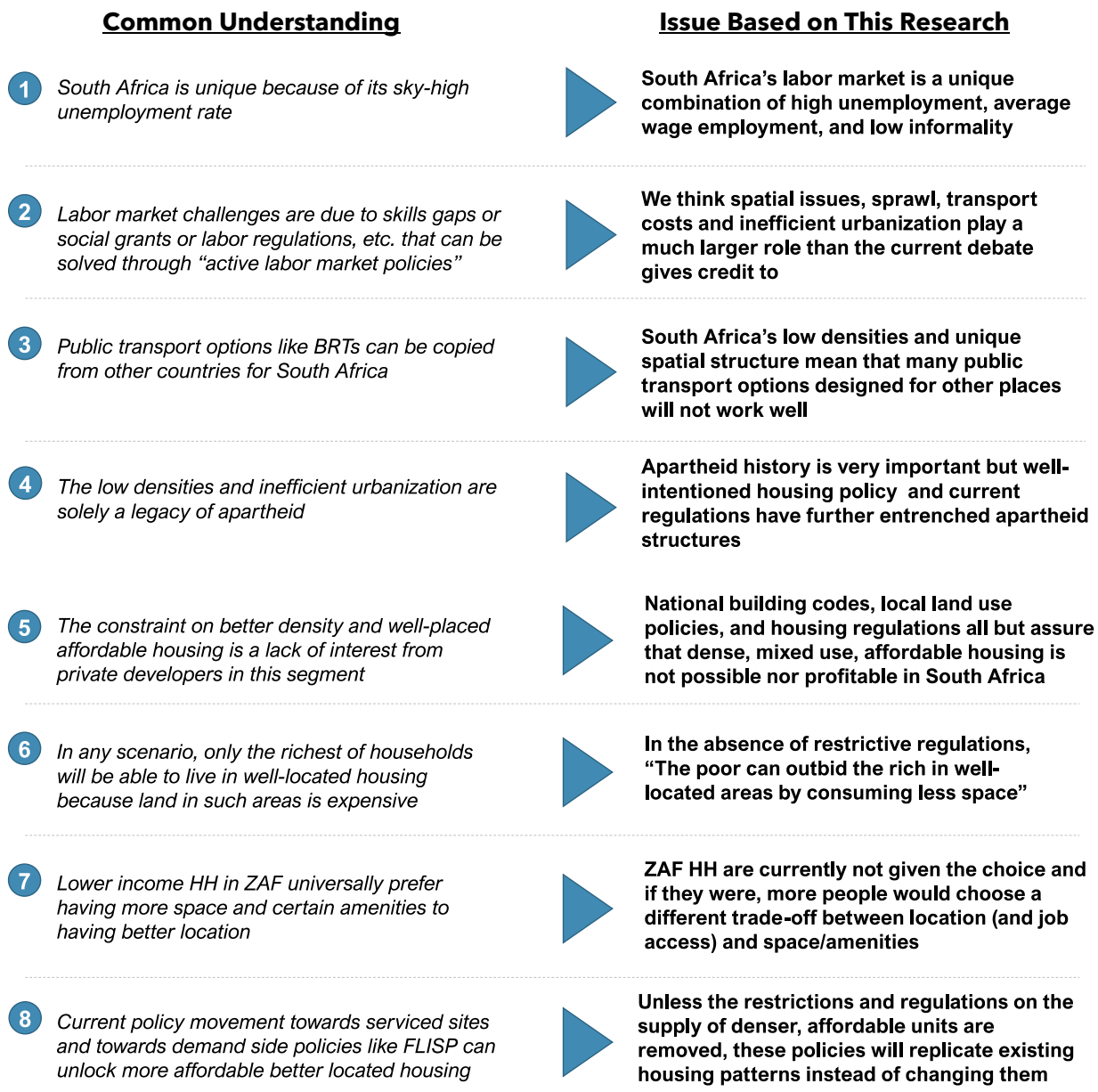
Given the spatial sprawl of South African cities, which undermines cost-effective public transport options, there is likely scope for improvements through the existing minibus system and reviving once-functioning passenger rail systems. Large-scale public transport solutions that assume a certain urban density will become efficient in a new spatial equilibrium,

but more immediate improvements in the quality and efficiency of urban transport may come through collaborative solutions with the minibus network. The Department of Public Works and Infrastructure Africa has detailed a wide-ranging strategy to reform and restructure the nation's public transport system in its National Infrastructure Plan 2050. The department plans to create a more integrated transport system by 2050, focusing on new technologies such as electric vehicles and green hydrogen. Major goals include linking transport and housing policies, transforming and formalizing the minibus taxi industry, encouraging private-sector involvement, accelerating dedicated road space for public transport, reviving rail networks, ensuring daily frequency of bus or minibus taxi services in rural areas, and promoting green hydrogen and other alternative energy sources. Among these priorities, actions to formalize the minibus taxi industry and reviving existing passenger rail lines especially through devolvement to metros are likely to have the highest potential for short-term improvements in transport times and connectivity of cities.

Many work opportunities could be enabled by bringing down barriers to informality in cities. Hostility against informal work poses significant barriers to informal activity. Across cities in South Africa, there are still restrictions on informal activities such as street vending, even within township areas. These regulations include zoning limitations and strict enforcement of space usage. For instance, restrictive zoning in busy city areas, close to or intersecting with townships, reserves them exclusively for residential purposes, preventing microenterprises from operating in potentially more successful locations (Shah, 2022). In the context of the South African labor market where formal jobs are limited, this has a direct result in increasing unemployment. After the problem of spatial exclusion in urban structures, direct restrictions on informal work are likely the second biggest cause of low employment in South African cities. Ongoing research is exploring priority policy responses to address this problem in ways that would be complementary to the actions discussed in this report.

Finally, it is important that urbanization, which allows for economic agglomeration in cities, be treated as a national priority. Overall, we find that the binding issues to spatial inclusion in South Africa's urban labor market differ from what is commonly assumed in many ways. Figure 3.10 summarizes some common beliefs and compares these with findings from this research.

FIGURE 3.10: BINDING ISSUES IN SOUTH AFRICA



Source: Authors' elaboration.

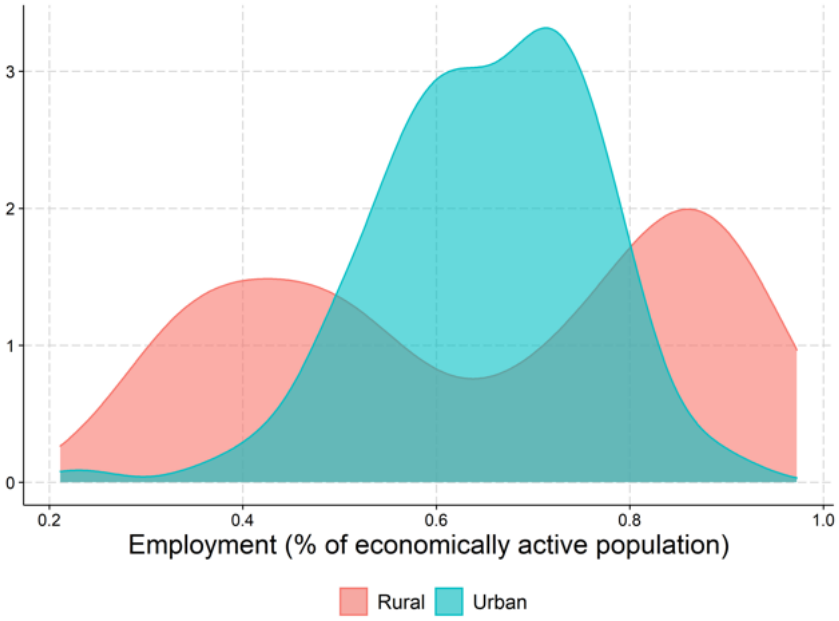
3.3 Bridging Knowhow: Bringing jobs to people.

Inclusive cities alone would not address South Africa's most extreme form of spatial exclusion – that of the rural former homelands. Inclusive cities would be able to absorb more people into their labor markets. All things equal, this would be expected to reduce unemployment in rural areas by some degree. However, the presence of more jobs in urban

areas would do little to nothing to improve employment outcomes among those who remain in rural former homelands. There is already a strong pull for individuals from struggling areas to migrate, at least temporarily, to cities and other places where work can be found, including seasonal jobs in agriculture and work in mining. This results in flows of remittances back to homeland areas. However, Lochmann (2022) and others find that these remittances do not alter the productive opportunities of the areas that workers left. Rather, money tends to be invested in rural houses and used to increase living standards. As cities hopefully absorb more people in the future and offer more permanent employment opportunities and housing options, pressure on rural areas will decrease, which could free up more areas of land productive uses. This makes it more important to strengthen place-based pathways to growth that would provide more residents of rural former homelands the opportunity to stay and participate in productive work.

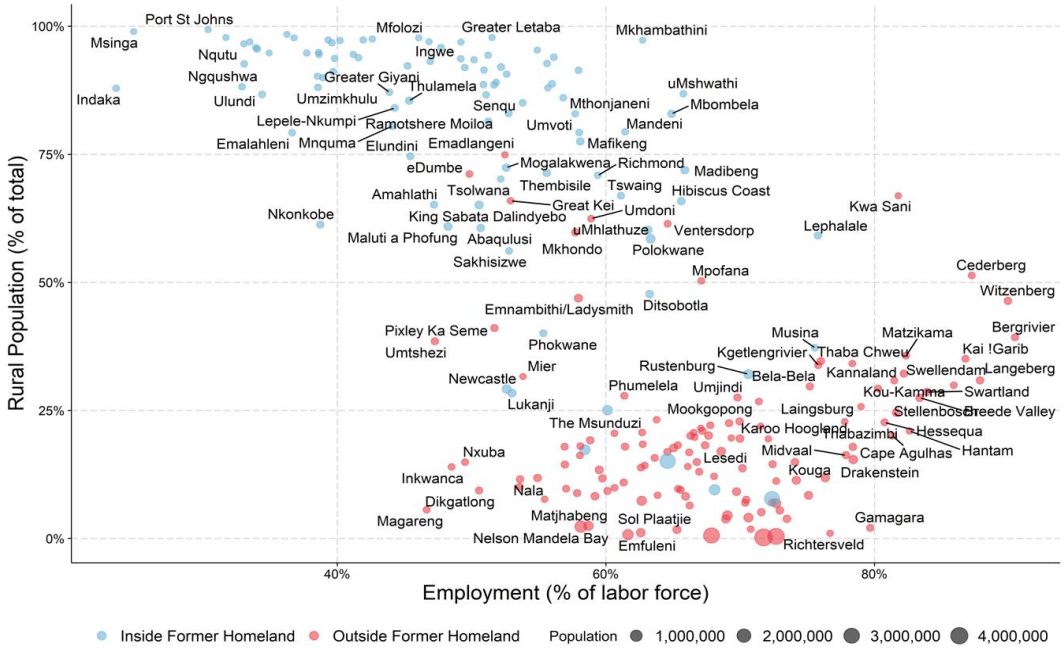
Employment patterns underscore that it is possible to generate economic opportunity in rural South Africa. South Africa's rural areas offer a dual picture of employment outcomes (Figure 3.11). Among municipalities that are classified as "rural," there is a dramatic divergence of employment rates — calculated here as the share of the active labor force that is employed (i.e., 1 minus the unemployment rate). One group of rural municipalities achieves employment rates that tend to exceed most urban areas. While employment rates in this group are still low by international standards (note that the group centers on an unemployment rate of close to 15%), employment is several times higher than the other group of rural municipalities, which tend to have employment rates that tend to be lower than most urban areas. Figure 3.12 shows this same duality but with more information. In this case, the colors represent municipalities that are within the borders of former homeland areas and those that are not. The horizontal axis is the same as the previous figure, but the vertical axis captures the share of the population in the municipality that is classified as rural, as opposed to the municipality overall. This shows that nearly all the rural municipalities in the lower employment group are within former homelands and almost all the rural municipalities that have higher employment are not within the former homelands.

FIGURE 3.11: EMPLOYMENT RATES ACROSS SOUTH AFRICAN MUNICIPALITIES, URBAN & RURAL



Source: Own elaboration based on the South African National Census of 2011.

FIGURE 3.12: EMPLOYMENT RATES & RURAL POPULATION BY MUNICIPALITY



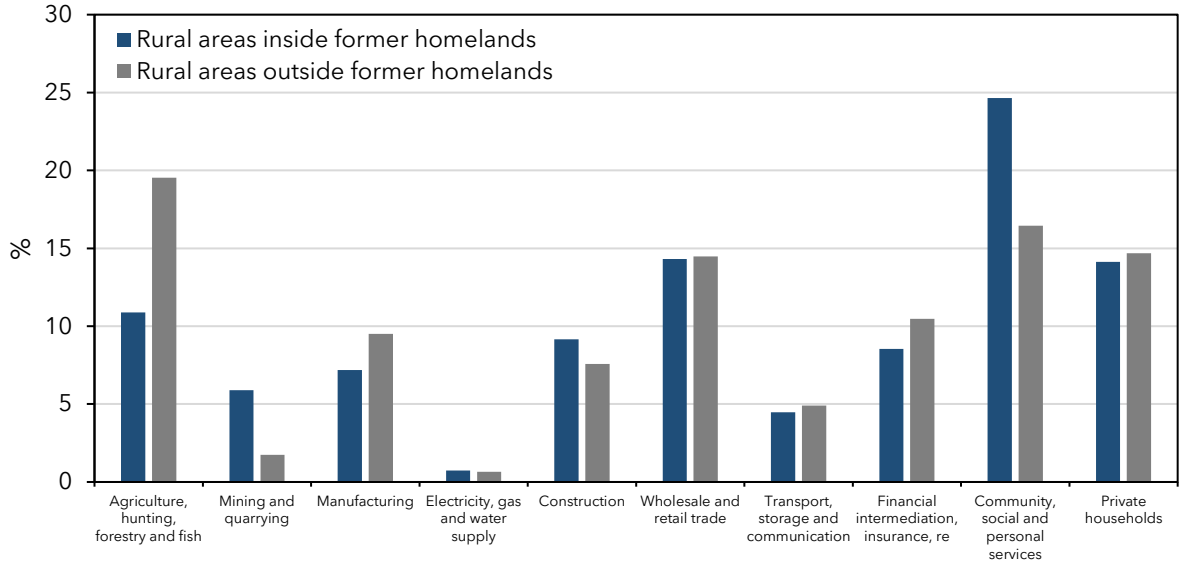
Source: Own elaboration based on the South African National Census of 2011.

South Africa's rural employment challenge is distinctly faced by former homeland areas, which have effectively been left excluded from the modern economy. This glaring divide between economic outcomes in former homelands and the world outside is well known and has been studied Lochmann, 2022; Mudiriza & Edwards, 2021), but the particular divide between rural former homelands and rural areas beyond is especially important. There are growing divides globally between urban agglomerations and rural areas, but this type of rural-urban divide does not explain South Africa's particular problem. The employment rate in rural former homelands is, on average, half of the employment rate of rural areas outside. South Africa faces a rural-rural divide, where the rural areas that are excluded from job opportunities share a common history as former homelands that were set apart from the functioning of the rest of the South African economy for many decades prior to the end of apartheid. However, this does not explain why three decades after the end of apartheid this large difference continues to persist. A relevant policy framing is asking what it would take communities in the top-left of Figure 3.12 to move to employment levels more like communities on the right side of the graph.

There are clear differences between the two extremes of rural employment, which begin to explain the mechanisms behind exclusion. First, there is a clear pattern in Figure 3.12 that the excluded areas tend to be significantly more rural (i.e., a higher share of the population in the municipality that is rural) than rural, non-homeland areas with the highest employment rates in the country. The rural areas of former homelands can be understood to be more remote and less likely to have population agglomerations within rural municipalities. Interestingly, this does not mean that the rural former homelands are more concentrated in agriculture than rural areas elsewhere in South Africa. Figure 3.13 shows the share of employment based on South Africa's latest population census. In rural areas outside of the former homelands, upwards of 1 in 5 jobs is in agriculture, forestry, and fishing, roughly double that of rural areas within former homeland areas. Rural areas outside homelands are also slightly more concentrated in both manufacturing and financial intermediation but these differences may be statistical noise. Rural former homelands, meanwhile, have a higher concentration of jobs in community, social, and personal services (1 in 4 jobs), as well as in mining, though this is a smaller source of jobs (1 in 20 jobs), and a slightly higher concentration of jobs in construction, which may again be statistical noise. Rural areas do not look different

in other large sectors of employment including wholesale and retail trade and household-based work.

FIGURE 3.13: SHARE OF EMPLOYMENT BY INDUSTRY IN RURAL AREAS



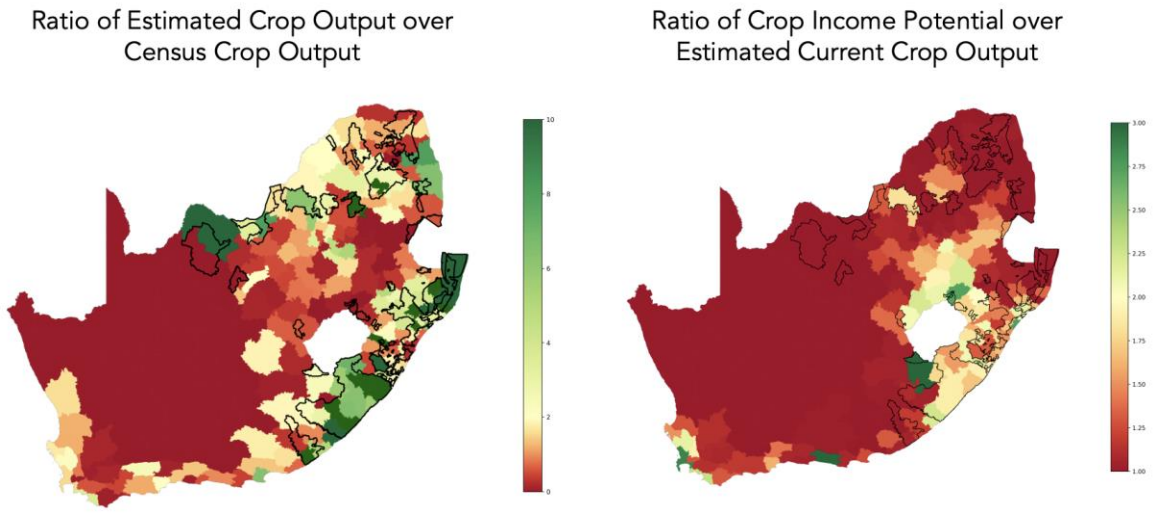
Source: Own calculation based on the South African National Census of 2011.

The difference in agriculture does not come from differences in the natural endowment of land for crop production. Given the stark differences in agriculture employment and even starker differences in commercial agriculture output, Klinger *et al*. (2023) use satellite imagery together with estimates of potential yields by the Food and Agriculture Organization (FAO) of the United Nations to better understand the potential for crop production across the country. They confirm a well-known issue that actual crop production is underestimated by South Africa's Census of Commercial Agriculture, which captures only commercial agriculture (Figure 3.14, Left Panel). But they also find that some areas – particularly across former homeland areas in the Eastern Cape and KwaZulu-Natal, as well as Free State Province – have crop production potential well above their best estimates of current production (Figure 3.14, Right Panel). Explaining this pattern, therefore, can help to explain why employment opportunities are low for some areas within the former homelands, but not others.

Yet, the employment gap in former homelands cannot be explained by gaps in agriculture alone. Figure 3.15 maps the overall employment rate (i.e., the number of individuals employed over the working age population) by municipality. The problem is more

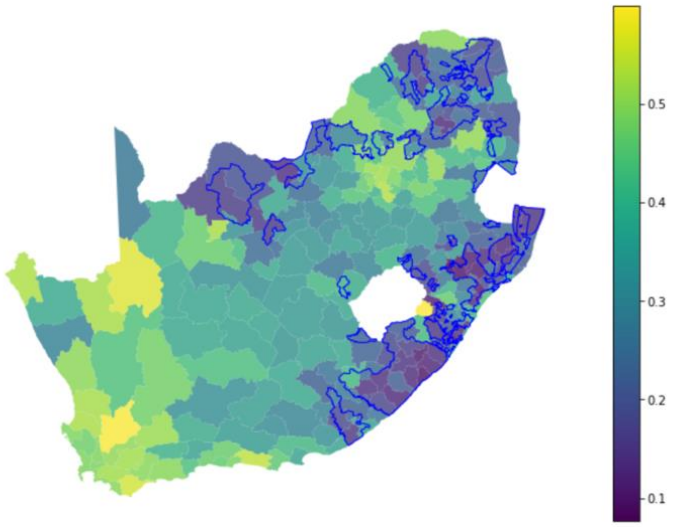
widely faced than gaps in agricultural production and employment can explain. Approximately 30% of South Africa's population – upwards of 20 million people – live in rural former homelands. Thus, it is essential to better understand the drivers of this type of spatial exclusion and what policymakers can do to better include people and latent capabilities of these places in the productive economy.

FIGURE 3.14: GEOGRAPHIC PATTERNS IN UNDERREPORTED CROP PRODUCTION AND POTENTIAL



Note: Former homeland areas are outlined in black.
Source: Sturzenegger *et al.* (2023).

FIGURE 3.15: EMPLOYMENT RATE (# EMPLOYED/WORKING AGE POP.) BY MUNICIPALITY



Note: Former homeland areas are outlined in blue.
Source: Own elaboration based on the South African National Census of 2011.

3.3.1 Understanding the Drivers of Exclusion

The exclusion of former homelands has obvious roots in apartheid and before, but history cannot explain the post-apartheid failure to include these places. A long legacy of spatial exclusion, from the early colonizers through the institutionalization of spatial exclusion in the form of the Bantuastans ("homelands"), has distorted the spatial equilibrium of South Africa. The total effect was to keep these areas separated from the emerging modern economy of South Africa for decades[18]. This history is foundational, but the current degree of exclusion is surprising three decades after the end of apartheid. Moreover, there are no indications that opportunity gaps are on pace to close within the foreseeable future. There is no reason why South Africa cannot overcome its past, yet it is clear that the current approach is not working to include these historically excluded places.

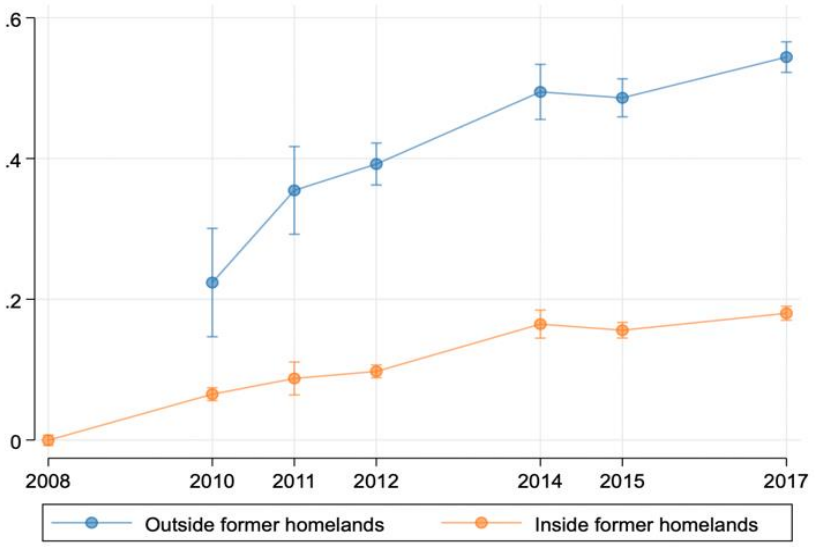
The problem is much more driven by the productivity and opportunity of places than by the characteristics of people. Lochmann (2022) investigates what drives the differences in employment outcomes and finds that various policies that have worked on the individual level – for example, improvements in education and health – have not counteracted what is a place-based problem. One strong indication of this is captured by Figure 3.16, which shows what happens if you take an unemployed individual from within the former homelands and move them to another place in the country. The employment probability of those that move immediately doubles and grows over time to reach an employment probability three times higher than those who remain. The fact that these individuals were unemployed at the start of the period accounts for some of the "selection effect" of those who choose to leave former homeland areas in search of work. Not shown here but important for reference is that the overall employment probability of working-age people in areas outside the former homelands is only 30-35% over this period (Lochmann, 2022). In other words, individuals from former homelands who leave for opportunity tend to have more success than the rest of the population.

Equalization grants and other monetary transfers have been unable to include rural former homeland areas and overcome the place-based challenge. The former homeland areas are today characterized by small local economies that are largely consumption-based

[18] See, among others, Butler *et al.* (1977), Christopher (1994), and Beinart (2001).

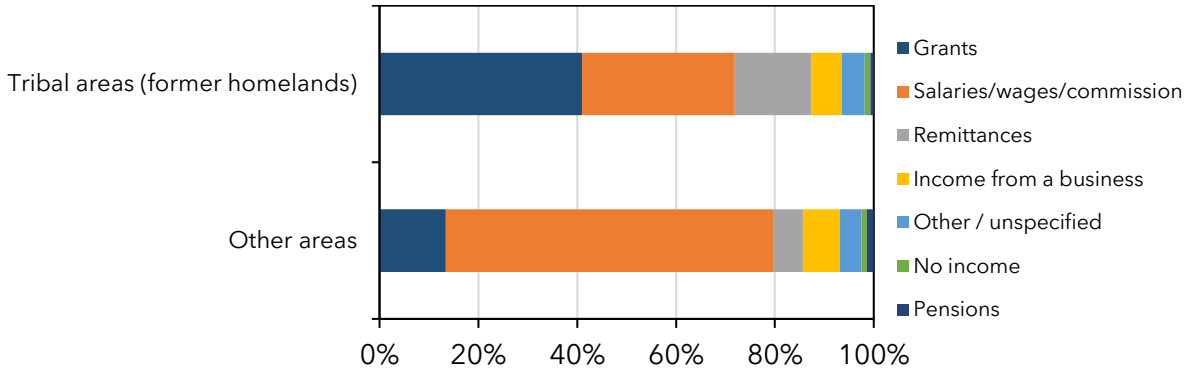
and lacking business investment and production. And yet, these places are not lacking in terms of several important production factors: there is underutilized arable land, unused labor force, and there are significant monetary inflows to these areas in the form of government grants and transfers as well as in the form of remittances from internal migrants who leave these areas to work in more productive places in the country (in agriculture, mining, and urban labor markets). Figure 3.17 captures how grants and remittances make up a large share of household income, while Figure 3.18 shows the share of municipality revenues that come from equalization grants.

FIGURE 3.16: EMPLOYMENT PROBABILITY AMONG INDIVIDUALS WHO WERE UNEMPLOYED AND LIVING IN FORMER HOMELANDS IN 2008



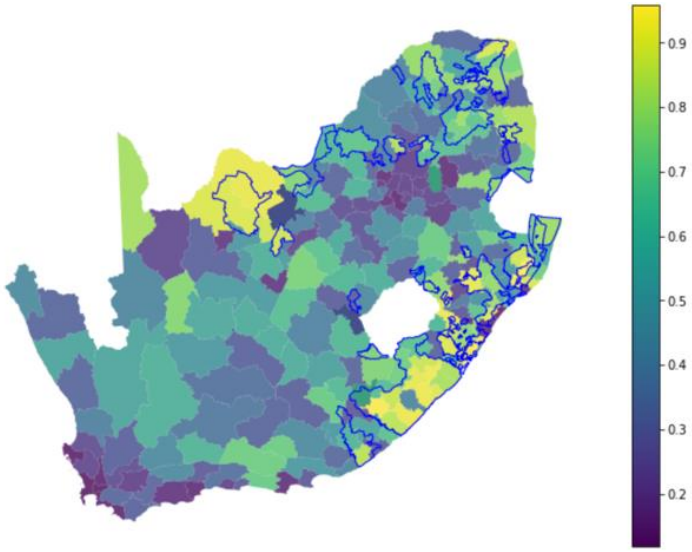
Source: Lochmann (2022) using the National Income Dynamics Study (NIDS) panel.

FIGURE 3.17: HOUSEHOLD INCOME COMPOSITION BY AREA, 2014



Source: Lochmann (2022) using the General Household Survey, 2014.

FIGURE 3.18: SHARE OF MUNICIPAL REVENUES FROM EQUALIZATION GRANTS, 2014

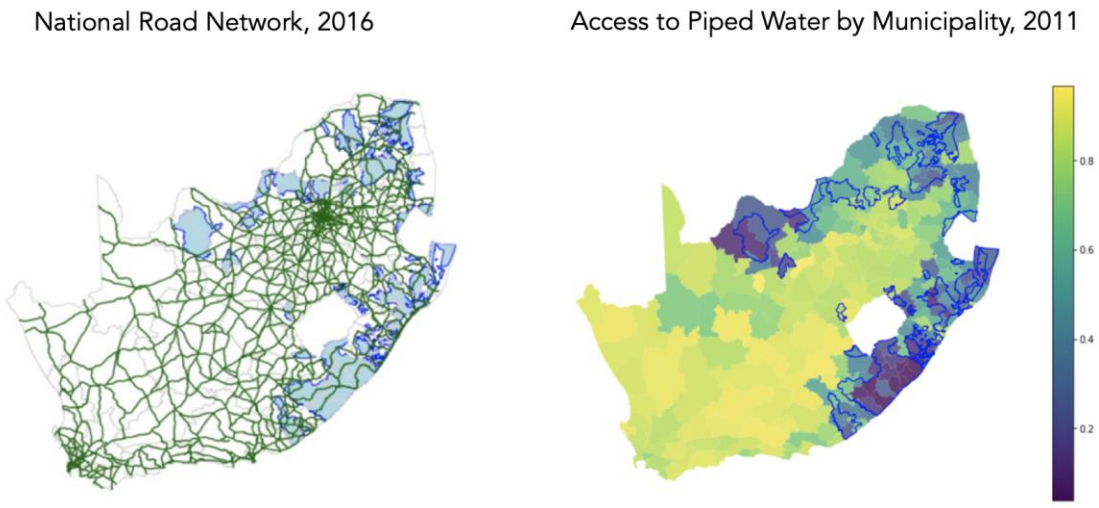


Note: Former homeland areas are outlined in blue.
Source: Lochmann (2022) using the South African National Census, 2011.

Physical Connectivity

One critical input that remains missing is connecting infrastructure – many rural former homelands remain surprisingly disconnected from markets and surrounding economies. Over the last few decades, access to many types of infrastructure and services has increased for former homeland areas. According to General Household Surveys, electricity access increased from 60% to nearly 100% in former homeland areas over the years 2002 to 2014, though some of the most rural areas of the country are continuing to be connected to the electricity grid. As of 2014, there was almost no gap in electricity or cell phone access within and outside former homelands, and access to nearby health facilities and secondary schools and above had likewise expanded, though smaller gaps with the rest of the country remained. However, former homelands remained much more disconnected than the rest of the country in road connectivity as well as access to piped water. Road connectivity is especially important for connectivity to markets, inputs, and the mobility of people. Figure 3.19 shows how stark the gap in the national road remained for former homeland areas in 2016. Large gaps in the network exist across several areas, despite these regions supporting larger populations than large parts of the country with better road connectivity.

FIGURE 3.19: INFRASTRUCTURE GAPS IN ROAD CONNECTIVITY AND PIPED WATER ACCESS



Source: International Steering Committee for Global Mapping and own elaboration based on South African National Census, 2011.

This lack of connectivity reduces the comparative advantages of rural former homelands. Anyone who has traveled for multiple hours on unpaved roads, especially after heavy rain, knows how this impacts a place's competitiveness. The absence of paved roads not only adds hours to travel times to get inputs in and products out but also dramatically increases damage to sensitive products and the potential for disruptions in supply chains. In the context of South Africa's competitive commercial agriculture, the disadvantage of road connectivity has large implications. For regions with underexploited crop potential, for example in the Eastern Cape (Figure 3.14), any potential to produce high-value fruits and vegetables that match the demand for quality of domestic supermarkets and international markets is constrained. Time, damage, and uncertainty all act as a form of tax on potential production. Outside of agriculture, these costs also help to explain the lower prevalence of manufacturing in rural former homelands versus other rural areas of South Africa. As captured by Figure 3.19, infrastructure shortfalls appear most prevalent in the former Transkei region of the Eastern Cape, parts of the former Bophuthatswana region of the North West Province, and regions of KwaZulu-Natal. The infrastructure gaps for these areas are compounded by their large size and disconnected geography. Although road connectivity is poor within former homeland areas within Limpopo, these areas are less disconnected from surrounding areas with denser infrastructure networks and are located on high-traffic international corridors.

The underlying reasons for these infrastructure shortfalls and the resulting lack of connectivity to the rest of the South African economy were discussed in the previous chapter. Premature load bearing within the country's decentralization framework together with collapsing state capacity can help to explain why these types of infrastructure shortfalls persist. In the case of former homelands and the presence of communal land ownership and traditional governance, there is an additional layer of challenge in land use and permitting. This adds some complexity to the situation, but it is municipality governments that have had authority and responsibility for local roads and water planning. As discussed in Chapter 2, preferential procurement frameworks can create intensive challenges in areas such as the rural former homelands because a limited pool of building contractors leads to poor quality construction and state resources channeled to "tenderpreneurs" at the expense of effective infrastructure development.

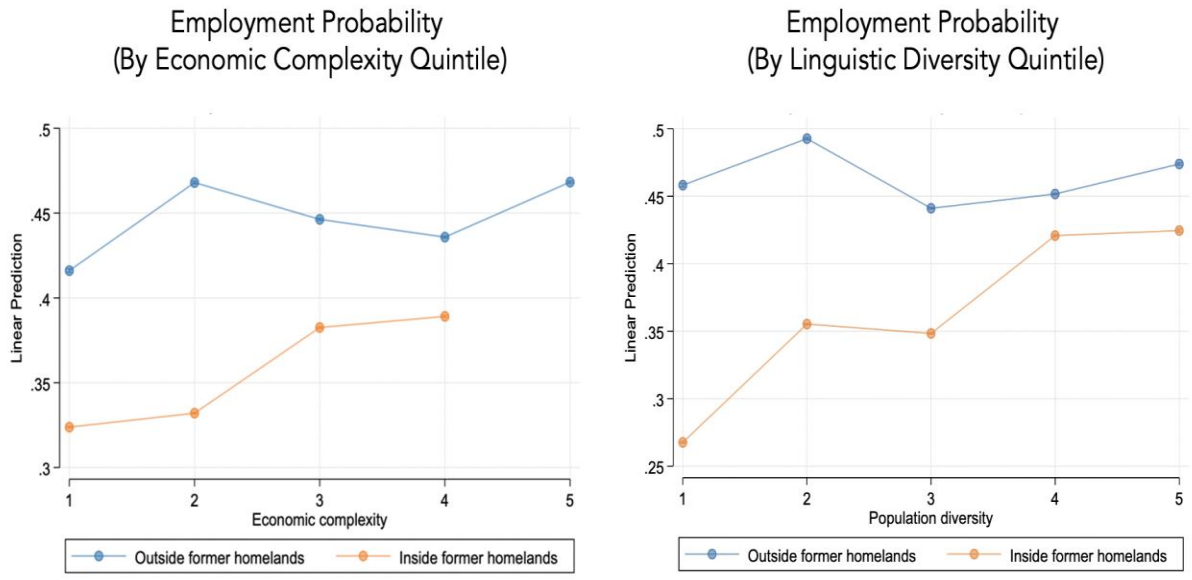
Knowhow Connectivity

Beyond physical infrastructure connectivity, bridging knowhow between rural former homelands and the rest of the South African economy is critical. Even for areas of rural former homelands that are relatively more connected, employment rates remain extremely low. This indicates that physical connection is not enough; what is missing from the system is the knowhow to employ factors of production in the rural former homelands. Knowhow – or tacit knowledge – reflects the aspect of technology use that cannot be transferred simply access to the tools themselves (i.e., machines or software) or the written knowledge of how to use them (i.e., owner's manuals). Putting technology to use requires expertise that is gained through experience. This is true for any technology, and it is also true for the production of goods and services. Competitive production of goods and services requires not only the use of a range of technologies but also knowledge of markets, suppliers, and a large range of built-up expertise. Given the sophistication of the South African economy – including its commercial agriculture sector – it makes sense that knowhow would be the limiting factor that prevents former homeland areas from integrating with the rest of the economy even after infrastructure connectivity improves. Physical connectivity makes bridging knowhow easier, but this process is not automatic.

When areas of former homelands do gain the ability to participate in the same industries as surrounding areas, they begin to catch up, and this seems to require the mixing of

companies and people. A strong indication of this reality comes again from Lochmann (2022), which shows that when municipalities converge in either their economic complexity, which is a measure of economic diversity based on their industry composition, or in linguistic diversity, employment outcomes tend to converge with the rest of the country (Figure 3.20). Thus, in addition to improving physical connectivity of rural former homelands, strategies that actively work to bridge productive knowhow between places are essential. We find that the most direct mechanism of knowhow transfer – investment by companies outside of rural former homelands in expansions within former homelands – is limited. Direct investment is rife with risks and uncertainties, including due to systems of communal land ownership. However, we do find that there are other mechanisms for bridging knowhow that are occurring at a limited scale and in limited cases. These operate through business partnerships between competitive companies outside former homelands and firms, entrepreneurs, and communities within the rural former homelands. Klinger *et al.* (2023) explore how partnerships have emerged in select cases in the space of commercial agriculture in South Africa using a range of organizational designs and how these overcome prevailing constraints. We also find signals that these models could scale significantly and pave a path to fully overcoming constraints to direct business investment with time.

FIGURE 3.20: EMPLOYMENT PROBABILITY BASED ON ECONOMIC AND LINGUISTIC DIVERSITY



Source: Lochmann (2022) using the National Income Dynamics Study (NIDS) panel.

3.3.2 Partnerships as an Opportunity for Bridging Knowhow

Partnership models have emerged to overcome the challenges of investing in the context of communal land. Communal land in South Africa is typically governed by traditional authorities. This does not mean that there is not a land market, but it does mean that land markets operate differently and are disconnected from national systems, including the legal system and the financial system. Properties have locally provided "permission to occupy" (PTO) rights but do not have legally binding land titles and are thus not recognized by the formal banking system. This can be problematic for local startups that may struggle to access capital, which is an important problem, but it is not necessarily a constraint when local entities partner with outside commercial entities. In the long-term, increasing land titling and more effective interaction between communal land governance and national systems should be a strategic priority, but in the shorter-term partnerships have shown an ability to bridge knowhow despite this constraint. Such partnerships could even pave the way for innovations that bridge formal and traditional systems.

Partnerships between commercial agriculture companies and communities in rural former homelands provide examples of what is possible and reveal constraints that must be overcome for models to scale and duplicate. Klinger *et al.* (2023) explore three distinct cases of organizational models where commercial agriculture businesses (Wiphold, Amadlelo, and Zamkulele) have partnered with communities to the sustained benefit of both parties. The commercial entities expand their operations by utilizing the land and latent comparative advantages of the communities, while the community members benefit through income streams, jobs, and the learning-by-doing that occurs as knowhow is transferred. However, these partnerships face numerous challenges, many of which they are still actively working to overcome. Each of these three partnerships has developed iteratively as both parties contributed to developing organizational structures and tools that met their context. This resulted in different approaches to property frameworks, governance structures, risk-sharing approaches, and a range of other dimensions summarized in Figure 3.21. These partnerships are nascent and scattered, but they could become a larger tool for bridging knowhow across space, both within the agriculture sector and in other areas. Scaling successes, however, requires wrestling with the constraints faced by these and other initial examples.

FIGURE 3.21: DIFFERING ORGANIZATIONAL MODELS OF AGRICULTURE PARTNERSHIPS

Summary chart

	AMADLELO AGRI (TOGETHER WE GROW • TOGETHER WE REAP)	WIPHOLD	ZAMUKELE (Part of the Schoeman Group)
Property framework with the community	Shared property between Private Party and community at holding and company level	Shared property of the operating company	No property sharing as it is an out-grower model
Governance	Board of trustees with a majority for the community while Amadlelo's management make everyday operational decisions	Wiphold oversees both strategic and operational decisions	Local farmers in full charge of strategic and operational decision only advised by Zamukele
Plot consolidation	Communal land owned by the community consolidates in a single plot	Communal land owned by the community consolidates in a single plot	There is no plot consolidation, each farmer operates its plot by its own
Compensation to local community	Land lease linked to fixed sum and dividend distribution based on the operation performance	Land lease linked to fixed sum and cash distribution following a performance score	Farmer's individual profits on its operation
Trust building	By making decision process transparent and including the community in it as well as payment of fixed rent	By paying a fixed rent to farmers plus using own money to honor that guarantee	Based on knowledge of Schoeman in the area
Risk sharing between private party and local community	Farmers reduce risk by sharing it with private party and by receiving a fixed compensation for land use	Farmers reduce risk by sharing it with private party and by receiving a fixed compensation for land use	Farmers reduce risk by rolling over with private party their debt obligations
Risk sharing between communities	There is risk sharing between subsidiary companies through Amadlelo shares in subsidiaries, but local communities absorb the impact of the performance of their company in their community	Significant, since all communities are part owners of the single company in charge of CMAI, but cash distributions may have a penalty in individual landowners according to performance of each plot	None, since each farmer is responsible for its own operation
Involvement of community in farming activities	Large share of employees work directly in dairy farms in core chores	Communal landowners perform non-core farming chores	Local farmers oversee production decisions and crop management and hire farm contractors on their own, assisted by Zamukele
Knowhow diffusion	Significant as local communities employed in its different operations climb in the company's organizational chart	Even though Wiphold executes a training program for the local community there is little "learning by doing" of farming chores	Significant as farmers adopt not only a new crop, but also a management approach that relies on data
Technological upgrade	Significant as private partner brings in machinery, know-how and management skills	Relevant as through consolidation allows for mechanized extensive agriculture	Significant in terms of commercialization, financing and the use of digital apps
Profitability	Profitable for both, private party and community	Farms are not profitable after 7 years of operation	Profitable for both, private party and community

Source: Klinger *et al*. (2023).

Klinger *et al*. (2023) identify four key challenges faced by these partnerships. First, building trust is critical yet difficult. Second, there are massive information asymmetries that companies and communities face in finding one another and establishing organizational structures that work. Third, technology transfer is difficult. Fourth, partnerships must manage many risks, and climate risk is a particular challenge for agriculture partnerships. The ways in which the partnerships are tackling these challenges provide important lessons.

- **Mechanisms to build trust at scale:** Trust building at scale is pivotal in the execution of such large-scale initiatives. In the beginning, there is natural mistrust, and it tends to take a lot of time and money to build trust naturally. Trust emerges from familiarity and repeated interactions, and can be facilitated by mutually trusted third parties, so mechanisms to build trust at scale focus on reliable intermediaries sharing past experiences (both successes and failures). This could take the form of universities and NGOs studying partnership experiences and sharing them with communities and corporates in conferences and publications, or by the public sector sponsoring study tours for both community leaders and potential corporate partners. Generating trust takes much more than an attractive sales pitch, but rather a credible track record.

- **Creating a market between communities and farms:** The concept of creating a market for partnerships between communities and commercial agriculture provides a promising avenue for bridging knowhow at a greater scale, as today these partnerships are few and far between. The marketplace is an important part of what allows the franchising sector to work, as companies and franchisees can find one another and follow an established roadmap for operations. In a marketplace for partnerships, communities with idle or underutilized land would be presented with a variety of proposals and potential partners, such that they can match their community's goals and constraints with the right partner. Likewise, corporate agriculture seeking to partner with communities would have mechanisms to express this interest to a wide set of potential partners and connect with those that are most interested in their proposition. Both sides of the market would have access to information on the track record of the other party. Without such a market, matching between communities and commercial agriculture is very time-consuming and will fail to reach a relevant scale.

- **Transferring technology to smaller farms:** Transferring technology to smaller farms is an essential part of establishing competitive operations, but it is infamously difficult. Government-led extension has limited scope and impact in helping farmers to compete in a highly competitive landscape. Public extension is likely better suited to improving the productivity and resilience of the smallest farmers and in a narrow range of products. The corporate sector, on the other hand, can enable technology transfer in a broad range of areas through the operations of joint companies. In the partnerships studied, this technology transfer is an integral part of the partnership, as the closer partnership ties allow more focus on transfer than is possible in traditional out-grower models. There is a degree of trial and error in technology transfer in these partnerships, which requires that companies take a long view of the partnership as an investment, which will take years to generate returns.

- **Reducing the risk through parametric climate insurance**: Partnerships are full of risks. As Figure 3.21 shows, the cases studied have developed approaches not only to share risks between communities and outside companies but also to share and manage risks between communities. In agriculture, climate risk is a growing problem. Each of the partnerships studied is facing climate risk but without an adequate response. On this

challenge, there is a tool that has been developed and utilized in other countries in parametric climate insurance. This type of insurance uses predefined weather events to trigger payouts, rather than assessing actual damage. This has benefits for hard-to-reach insurance markets. Given South Africa's highly developed financial sector, this is a tool that could be applied in South Africa.

There are pathways for these types of partnerships to expand in scale by leveraging agents of change. Following the study of these agriculture partnerships, the Growth Lab conducted an exploration to see if similar partnerships could be found in other sectors and what local conditions could explain where partnerships are found. Despite their limited scale and impact today, the partnership approach could significantly impact the economic trajectory of rural former homeland areas where they operate and pave the way for more complete integration into the national economy. Key to the expansion is leveraging "agents of change" – organizations that have already emerged to spur partnerships or that could be leveraged to do so in the future. Several types of agents of change are discussed below.

- **Traditional Authorities and Local Governments:** Both formal and traditional local authorities can play crucial roles in spearheading these changes. By leveraging their influence, resources, and relationships, these authorities can serve as agents of change within their communities, catalyzing efforts toward economic development. Enabling productive access to land and promoting infrastructure development are both essential elements in this approach. Access to land allows for a variety of productive activities, while infrastructure is crucial for supporting these activities and ensuring their sustainability. Traditional governments tend to have more authority over land whereas local governments (municipalities) tend to have control over infrastructure. Traditional governments can be the most effective agents of change when local leadership and governance are aligned toward the goal. An example of a community that develops partnerships is the community of Matsila in Makhado Municipality in Limpopo. Through its Matsila Community Development Trust, the community owns enterprises in agriculture, meat processing, tourism, and energy generation, among others. In the formation of these enterprises, the community partners with outside entities, including commercial agriculture entities located nearby to utilize their supply chain infrastructure and gain expertise. The Trust has proven able to drive change and seek out partners that

are consistent with its vision and business opportunities that it identifies. As it has gained experience, it is considering new ventures ranging from banking to supermarkets.

- **Facilitators:** Given the challenges in communities and companies in finding one another, developing organizational models that work in their context, and building trust, facilitating entities have emerged as important agents of change. Such entities can help with matching, share models and lessons across partnerships, and can serve a role in trust building if they are viewed as trusted and impartial third parties. Two distinct types of facilitators are worth noting based on current practice in South Africa. The first type of facilitator serves the role of partnership advisor. By working across geographies on many partnerships, such entities develop expertise and a proven track record. An example is the Vumelana Advisory Fund,[19] which is a non-profit organization that assists communities in the structuring of commercial partnerships between investors and local community groups. Vumelana reports have concluded 23 projects in 18 communities. Many of these projects are in high-value agriculture products, but partnerships also include tourism enterprises, other natural resources, and local energy generation. Another type of facilitation occurs through locally based NGOs. These entities are not positioned to serve the same matching and knowledge-sharing roles as partnership advisors, but they can be powerful in establishing trust and helping partnerships solve problems in the places where they are located. One example of this is the Bulungula Incubator, a non-profit located in a remote area of the Eastern Cape. Enabling partnerships is not the central focus of the Bulungula Incubator, but the non-profit itself runs a lodge and has been approached to serve as a trusted third-party intermediary in opportunities ranging from lemongrass production to exploring renewable energy generation opportunities given the wind resources of the area. However, aside from building trust, such entities are not able to provide the full range of support as facilitators that partnership advisors are.

- **Universities:** Universities, especially public universities in former homeland areas, are well positioned to play a larger role in supporting partnerships. As centers of knowledge and research with access to resources and deep local connections, existing programs and new university-based initiatives could play a similar role to partnership advisors. Additionally, universities can leverage their physical space and networks to help create

[19] See https://www.vumelana.org.za/

markets for partnerships. Universities commonly play such a role in supporting entrepreneurship, business incubation, and industry-related research. South African universities could also play a pivotal role in jumpstarting partnerships and serving as a public source of knowledge about what works. Moreover, an impartial analysis of corporate and community track records would go a long way to building trust between the two. Finally, universities could play important roles in enabling technology transfer.

- **National and Provincial Governments:** Higher levels of government can facilitate these partnerships, and possibly play a more active role in creating or partnering with already existing agencies and facilitators. Governments could develop their own partnership advisory services, building on the innovations of the non-profit entities that have emerged. They could also serve the goal indirectly by providing resources to the agents of change listed above. Government resources may be especially useful in helping to establish markets for partnerships, through such approaches as national exchanges and conferences, study tours, and online resources to help communities and companies find one another.

Efforts to expand partnerships would be complementary to improvements in connecting infrastructure. When communities are better connected to surrounding economies and productive ecosystems, their potential opportunities can increase exponentially. In the example of the Matsila Community Development Trust provided above, foundational businesses in fruit and vegetable production and high-end tourism would not be viable in communities much more disconnected from surrounding economies and transportation corridors. By contrast, the community of Bulungula, where the Bulungula Incubator operates has ventured into lemongrass production, a product that can more easily withstand long travel distances without refrigeration and benefits from backpacker tourism as opposed to high-value tourism. But increasing physical connectivity merely increases the opportunity set for partnerships. Most reasonably well-connected former homeland areas have not capitalized on partnerships and continue to have very limited economic opportunities. Thus, there is considerable potential to scale the success of partnerships with very little need for national budgetary resources.

Connecting infrastructure requires not only strengthening state capacity but also sufficient fiscal resources and focus on connecting rural former homelands. Chapter 2

summarizes the path to strengthening state capacity as needing to leverage, unburden, re-centralize and distribute, and protect capacity. In terms of road connectivity, unburdening procurement is especially important as the focus should be on building quality roads with efficient use of fiscal resources. Within a process of re-centralizing responsibilities, where more of the buildout and maintenance of roads may be moved to SANRAL (reflected in South Africa's National Infrastructure Plan 2050), deficiencies in paved road connectivity of rural homelands could be prioritized in how resources are allocated. This would provide a chance for South Africa to reverse a pattern of worsening road quality under the current institutional arrangement that currently depends on national, provincial, and municipal road authorities. By centralizing responsibilities such that technically capable teams can be structured and then allocating spending on high-need areas, South Africa has the potential to better connect and include rural former homelands.

4 South Africa's Green Growth Potential

4.1 Executive Summary

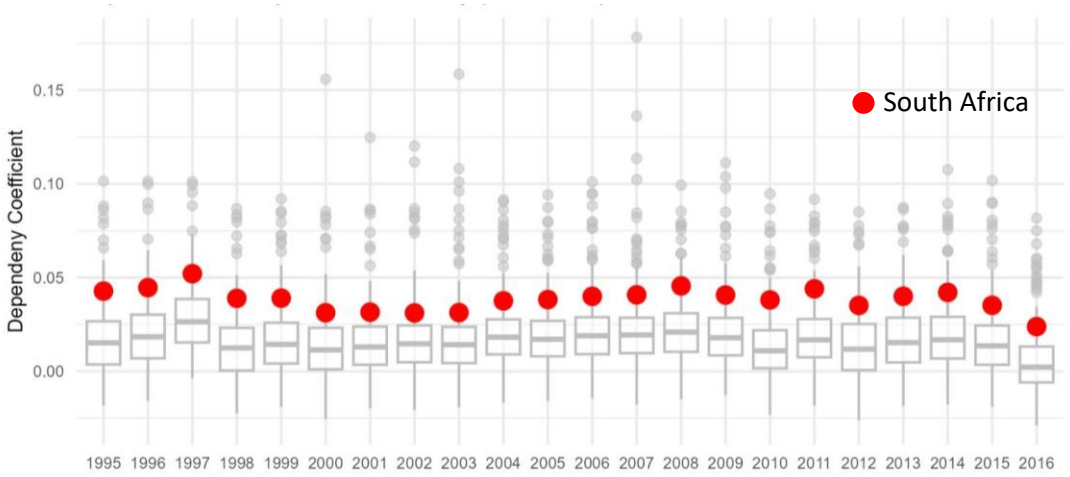
The South African economy is hampered by supply-side constraints that limit its economic growth. Chapter 2 of this report showed how a collapse in state capacity to supply and maintain key infrastructure and services have slowed growth. Chapter 3 discussed longer-term causes of spatial exclusion and how these have limited South Africa's growth potential by preventing individual capabilities from interacting. These two issues constrain the ability of the South African economy to create and maintain jobs. At the time of writing, the ongoing electricity crisis hinders business productivity, while freight and port operations disruptions limit the productivity of mining and other regional value chains. Problems in network industries also obstruct businesses' capabilities to fulfill demand due to widespread delays stemming from port conditions, electricity shortages, and freight disruptions. Addressing these supply-side constraints is crucial to enhancing the competitiveness of the economy.

The electricity crisis is especially critical because South Africa had previously developed a comparative advantage in electricity- and electricity-intensive industries. Figure 4.1 shows the electricity intensity of South Africa's exports in comparison to other nations.[20] South Africa's electricity intensity of exports has remained consistently high - at around the 90th percentile - relative to the rest of the world from 1995 to 2016. Figure 4.2 shows that the energy consumption by the country's industrial sector (manufacturing, construction, and mining) as a share of GDP is also high compared to the rest of the world. Both South Africa's exports and its domestically oriented industrial sector are highly intensive in electricity and energy use. In other words, South Africa has developed a comparative advantage in industries that demand high levels of energy and electricity. The most prominent example of this can be seen within the mining sector and its downstream activities (products that use mined resources as inputs) and upstream activities (mining services, mining machinery, etc.). However, this also applies to the manufacturing sector more broadly, where the metal and chemical industries consume significantly more electricity per unit of value than mining (Fortunato, 2022). South Africa has

[20] The coefficients were calculated using the same model Rajan and Zingales (1998) used to analyze financial dependence's role on economic growth.

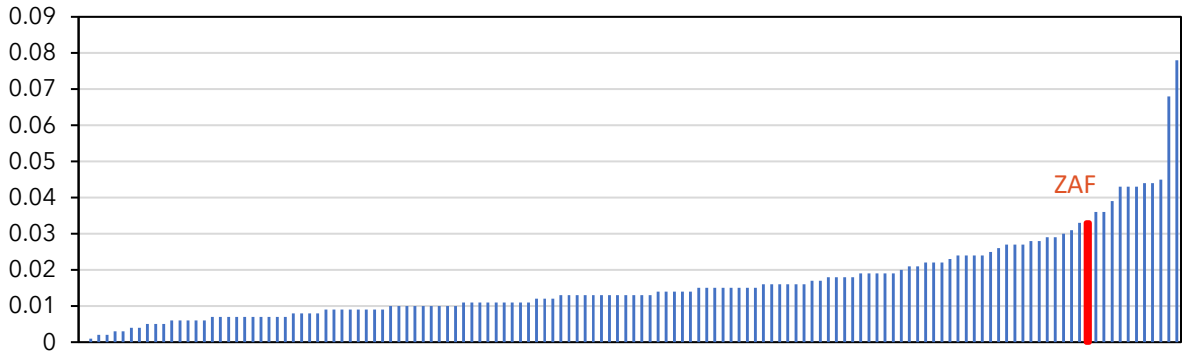
also developed multiple downstream industries with solid linkages with energy- and mineral-intensive activities, like fabricated metals, structural metals, and alloys.

FIGURE 4.1: GLOBAL DEPENDENCE OF EXPORTS ON ELECTRICITY (1995-2016)



Sources: Own elaboration based on International Trade Data from Atlas of Economic Complexity and US BEA Input-Output Tables.

FIGURE 4.2: ENERGY CONSUMPTION OF INDUSTRY (TOE) / GDP (2015 USD PPP) IN 2018



Source: Own elaboration based on International Energy Authority (IEA) World Energy Indicators.

South Africa developed this comparative advantage many decades ago thanks to the availability of cheap energy from coal. Since the 1920s, Eskom has been using abundant deposits of cheap coal. By 1930, Eskom's electricity was one of the cheapest in the world (Eberhard, 2007). Until around 2007, Eskom was able to supply the economy fully with cheap electricity. By that time, energy-intensive customers in the mining, metals, and manufacturing industries represented a large fraction of the electricity demand. Eskom's sales to direct large-scale customers represented 60% of total sales (Eberhard, 2007). Historically, this ability to

provide ample amounts of cheap energy was predicated on the country's capacity to exploit coal. As a result, South Africa has consistently been one of the ten countries that consume the most coal per capita in the world (BP, 2021).

Modern South Africa has lost the ability to transform coal into cheap energy, and coal is not as competitive as an energy source as it used to be. Several factors have changed. First, Eskom lost its capacity to produce energy cheaply. Between 2007 and 2022, electricity prices increased by a factor of 6.5 while the overall price index increased by only a factor of 1.3 (based on data from Eskom and StatsSA), meaning that the real price of energy (i.e., the price after controlling for inflation) increased by more than 200%. This implies a major deterioration in the country's comparative advantage in electricity-intensive production. Part of the initial increase in tariffs was the result of a recognition that tariffs were set below long-run marginal costs and implied not just a comparative advantage but a distortive subsidy. However, the problem is not only with price. At the same time, load-shedding means that actual tariffs do not fully measure the loss of competitiveness of the industry: unreliable supply has become a major source of disadvantage. Moreover, coal has become relatively less competitive as a cheap fuel source for electricity generation, given changes in energy-producing technologies. For example, the relative price of solar and wind energy has declined exponentially over the past decade, eroding the competitive advantage of coal in electricity generation. According to IRENA (2022) estimates, newly installed solar-powered energy plants in 2021 had lower costs than the cheapest coal-fired option in the G20. This implies that relative to the rest of the world and other energy sources, even if Eskom's problems are overcome, South Africa's comparative advantage in coal-fired energy will not be as important as it used to be.

For these reasons, it is vital for South Africa to focus on creating new sources of comparative advantage by leveraging the global changes that the energy transition is creating. As is well known, global emissions of Greenhouse Gases (GHGs), particularly carbon dioxide, are causing climate change. Reductions in GHG emissions will require an energy transition that can only work at a global scale. This represents a fundamental change to the structure of the global economy and the determinants of comparative advantage. Beyond electricity generation, economic shifts are beginning to take shape across transportation, industrial and agricultural sectors, which also produce GHG emissions. While the transition represents a challenge for the countries and industries that rely heavily on fossil fuel energy

today or export fossil fuels, it will create ample economic opportunities. This chapter will characterize what these changes might entail and explore ways to exploit them to create new sources of comparative advantage and growth in South Africa.

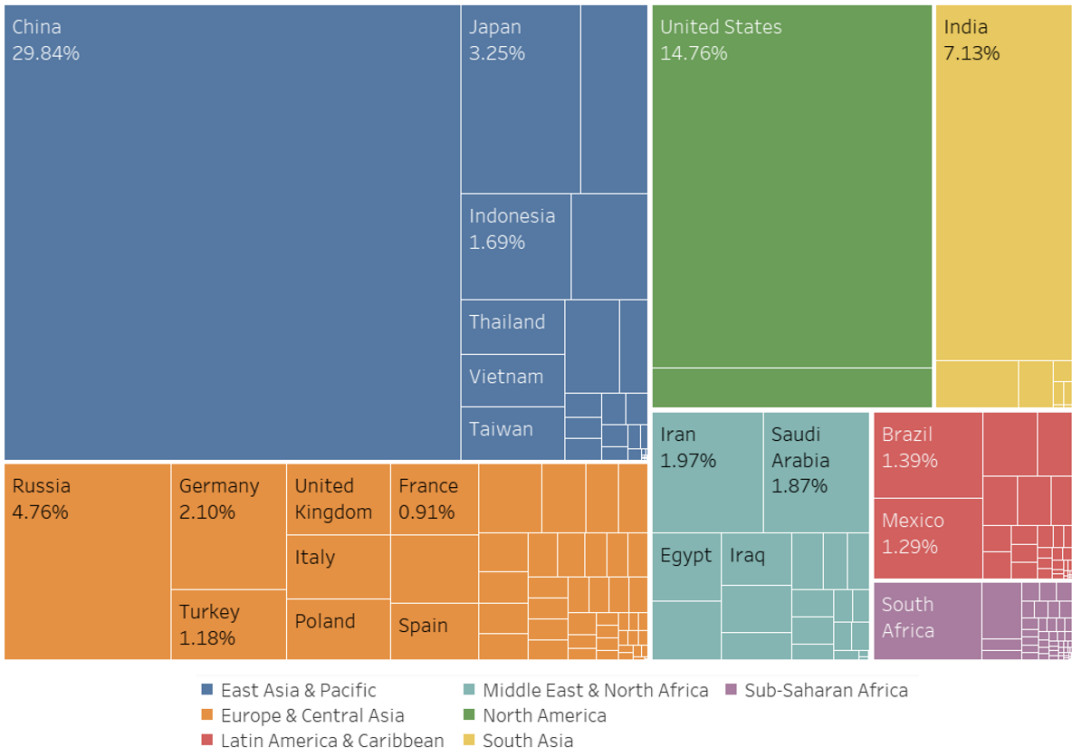
4.2 "Green Growth" in a Decarbonizing World

Though not yet at the pace needed to meet international climate change goals, the world is making substantial strides toward decarbonization. Regardless of whether the Net Zero Emissions (NZE) goals are met sooner or later, there is no doubt that global demand for clean energy and technology will continue to increase. The International Energy Agency (IEA) estimates that to achieve the NZE goals by 2050, solar-powered energy generation needs to grow at an average annual rate of 25% in 2022-2030 (IEA, 2022b). This rate is not impossible, considering that solar PV manufacturing increased at a compound annual growth rate of 25% between 2015 and 2021 and by 35% in 2022 (IEA, 2023b). In addition, electric vehicle (EV) sales have been exploding since 2022. The EV share of the overall car market went from 4% in 2020 to 14% in 2022, and it is expected to reach 18% in 2023, according to IEA's projections (IEA, 2023a). Battery manufacturing capacity increased by 85% in 2021-2022 (IEA, 2023b). In short, the attempt by many countries to decarbonize their economies is leading to very rapid growth in certain enablers of that decarbonization. These enablers have emerged - after years of research and development - as economically viable technologies. Averting increasingly disastrous global impacts of climate change will require innovation and scaling of technologies that reduce GHG emissions across the economy through a process that is sometimes referred to as "deep decarbonization".

The international framework that has taken hold through landmark accords such as the Paris Agreement of 2015 is focused on achieving global decarbonization by having each country focus on targets for their own decarbonization. Countries identify and announce their "nationally determined contributions" and international systems attempt to monitor progress toward achieving them. To reach international goals, these commitments must become increasingly ambitious over time. Countries are asked what they can do to reduce their own emissions. Yet, CO_2 emissions are concentrated in a handful of countries (Figure 4.3). China (30%), the United States (15%), India (7%), and Russia (5%) represented 57% of global emissions in 2015-2021. South Africa represented only 1.3% of emissions during the same

period. Therefore, drastically reducing South Africa's emissions will have very minor effects on global emissions and climate change.

FIGURE 4.3: CO2 EMISSIONS BY COUNTRY (% OF TOTAL), 2015-2021



Source: Global Carbon Atlas, 2023.

However, there is much more that South Africa can do to contribute to global decarbonization under a different "green growth" paradigm. If one thinks beyond the narrow and constraining notion of "what can you do to reduce your emissions" and instead ask "what can you do to help the world reduce its emissions," South Africa has much more to contribute to the global effort. As the world strives to meet the Paris Agreement goals, demand for a wide set of products will have to increase very significantly. South Africa could become a major exporter of these products. In other words, beyond decarbonizing itself, the country can strive to become a major supplier of the means of global decarbonization. These products have the potential to propel the country by leveraging rapidly growing global markets. The world is going to need a large increase in the products and services that will enable (or supply) decarbonization. This makes the global fight against climate change perhaps the most exciting driver of innovation and growth potential in this generation.

The path toward global decarbonization is full of uncertainties, but there are some clear directions of change based on fundamental economic realities and emerging shifts. First, the world will need to electrify anything that can be electrified. Good examples are electric vehicles for transportation and electric arc furnaces for producing and recycling steel and making alloys. Second, electricity must be made in green ways, leveraging solar, wind, hydropower, and nuclear technologies. Variable sources of energy will require balancing the electric grid with storage, using either grid-scale batteries or pump storage. Transmission lines will have to connect new sources of energy to the grid. All of this will require metals made by refining minerals that must be dug out of the ground. There is no way to decarbonize the planet without a mining boom. Third, manufacturing processes that emit CO_2 for chemical reasons will have to be abandoned in favor of alternative processes. For example, the reduction (i.e., de-oxidation) of minerals to make metals currently use coal and natural gas as reducing agents and emit CO_2 in the process. Technologies using hydrogen as the reducing agent or electrolysis will compete to make green steel and other alloys. Fourth, things that cannot be electrified, such as ships and airplanes, will need green ways of making fuels. Finally, the world is going to need ways to capture carbon. These changes require a major transformation to the global economy and a shift in the underlying determinants of comparative advantage.

We propose a framework to formulate strategies and policies that can explore and exploit these emerging opportunities. We classify the opportunities into three main buckets that are of the highest relevance to South Africa:[21]

1) Make the enablers of global decarbonization,
2) Make green versions of grey products for the global market,
3) Export green knowhow.

Strategy 1: Make the enablers of global decarbonization. To decarbonize, the world will need a vast set of goods that will enable low or zero-carbon electricity systems. This will include equipment for electricity production (e.g., solar panels, wind turbines), transmission (e.g., cables, converters, capacitors), and storage (e.g., batteries, pump storage) of clean energy.

[21] One additional strategy would be to monetize carbon sinks and carbon storage. Stakeholders are already working on identifying the feasibility of carbon capture and underground storage (CCUS) in South Africa. The national government, in collaboration with partner institutions, has already started a Pilot CO2 Storage Project (PCSP) in a preliminary analysis phase focusing on the onshore Zululand and Algoa Basins (Surridge et al., 2021).

Electric vehicles (EVs), fuel cells, and other products and technologies are emerging that allow for transportation and other human necessities to be done without the use of fossil fuels. Other types of machinery, for example, electrolyzers as a key technology for green hydrogen production, are poised for rapid growth. These goods are also heavy users of metals and rare earth minerals. Strategy 1 involves a move to participate in the emerging supply chains that enable the rest of the world to decarbonize.

Strategy 2: Make green versions of grey products for the global market. Oil and coal are highly energy dense. This makes them cheap to transport. Consequently, the local availability of energy has not constrained the location of production over the last several decades. For example, energy-poor countries such as Japan, Korea, and Germany have been able to specialize in energy-intensive products such as steel. Since the cost to transport energy has been low, they just import energy. Green energy, by contrast, is much harder to transport. Solar PV became the cheapest source of electricity in 2020, providing a levelized cost of electricity of less than 34 dollars by barrel of oil equivalent (BOE) (IEA, 2020). Still, in 2019, storing that energy in the form of green hydrogen increased the cost to over USD 476 per BOE on average (BloombergNEF, 2020). When converting the green hydrogen to green ammonia for more accessible transport, the costs increased to over USD 884 per BOE (Ibidem). Additionally, the transport of green hydrogen requires significantly higher degrees of infrastructure. Hydrogen would need 3-4 times more storage infrastructure to replace natural gas in today's global economy. This is anticipated to come at an expense of USD 637 billion by 2050 if it were to ensure a comparable degree of energy security (Ibidem). This implies that there will be a great incentive to use energy close to where it can be produced efficiently. One implication is that global decarbonization can be achieved more easily if energy-intensive activities such as steel, aluminum, and ammonia production or data storage move to places that, because of their endowments, can produce green energy cheaply. Strategy 2 is based on developing a local capacity to produce cheap green energy to attract energy-intensive industries that must relocate to reduce their carbon footprint.

Strategy 3: Export green knowhow. Much of the knowledge needed to decarbonize will not be embodied in tools – such as solar panels or electrolyzers – or in easily replicable protocols or other codified knowledge that can be easily moved between places. Knowledge will intensively require the deployment of human capabilities in the form of services. For example,

projects require engineering, procurement, and construction (EPC), often bundled with finance. Complex manufacturing requires knowledge that may be licensed, such as the Fischer-Tropsch process that SASOL has mastered. These knowledge-intensive services will be in high demand in a decarbonizing world. The strategy aims to maximize the export of such activities to grow by supplying the knowledge needs of a decarbonizing world.

South Africa's green growth strategy should seize these opportunities to capitalize on the changes brought about by global decarbonization. In the rest of this chapter, we analyze a series of topics that are strategic for South Africa under each of the above approaches. This is not a comprehensive list of issues and opportunities but instead a list of opportunities that should be evaluated in the context of a national green growth strategy.

4.3 Strategy 1 – Make the enablers of global decarbonization.

South Africa is well-positioned to supply the world with critical minerals needed for the energy transition and to enter strategic segments of clean energy value chains. Mineral opportunities include those related to platinum group metals, chromium, vanadium, and others. Opportunities of interest in supply chains for energy technologies include the production of membranes, catalysts, and assembly of fuel cells and electrolyzers within the hydrogen supply chain; research, demonstration, and production of flow batteries based on vanadium and other chemistries; the electric vehicle supply chain; and the wind energy supply chain. Policies to promote entry into each of these supply chains must be industry-specific, and depend highly on industry characteristics, South Africa's context, and the component parts of supply chains that South Africa seeks to occupy. The following subsections expand on these opportunities.

4.3.1 Critical Minerals

The world needs a mining boom to develop clean energy systems. Clean energy technologies are significantly more mineral-intensive than technologies based on fossil fuels. For example, an electric vehicle currently requires six times more minerals than an internal combustion engine (ICE) vehicle, and a wind farm requires nine times more minerals than a coal-fired power plant (IEA, 2021b). These technologies are driving huge increases in demand for specific minerals. For example, according to IEA projections (IEA, 2021b), the demand for

rare earth minerals could increase three to seven times between 2021 and 2040. The demand for lithium, cobalt, and copper is currently high and projected to increase even further in the upcoming decades.

South Africa is a leading producer of critical minerals. Figure 4.4 lists minerals that have been classified as critical for the green energy transition and reports the share of South Africa in their current global production. South Africa is, by a substantial margin, the world's largest producer of platinum and platinum-group metals (PGMs). These are essential to produce and use hydrogen because they are essential for the membranes that go into electrolyzers and fuel cells. South Africa is also a major producer of chromium. This mineral is used as a catalyst in these membranes, goes into lithium-ion batteries, in high-performance solar panels, and in making stainless steel alloys used in solar, hydro, and geothermal plants. According to IEA, the demand for chromium will double by 2040, in a scenario that only includes currently announced nationally determined contributions (NDAs). It would quadruple in a scenario consistent with achieving net zero by 2050 (IEA, 2021b).

This bodes well for the demand for South Africa's mining products, but these opportunities are constrained by collapsing state capacity. As discussed in previous chapters, the mining industry has been hampered by the electricity crisis, problems in rail and port services, policy uncertainty, and cumbersome licensing and regulations specific to the mining sector. For example, platinum production hit record under-production due to power outages in 2023 (Dempsey, 2023). Since the electricity crisis started to intensify in recent years, exports of platinum have decreased significantly. Even before load-shedding started in 2007, regulations prevented the country from expanding its market share during the commodity super-cycle that started in 2004. If the country is to maximize the benefits of the coming global boom in mineral demand, it will need to address these issues.

FIGURE 4.4: SOUTH AFRICA'S CRITICAL MINERAL RESOURCES

Mineral	South Africa's Global Market Share (2021)	How many countries have the resource?
Chromium	43.5%	Seven countries produce Chromium.
Fluorspar	5%	14 countries produce Fluorspar. Most Fluorspar mining is in China.
Manganese	38%	17 countries produce Manganese.
Palladium	40%	Six countries produce Palladium.
Platinum	73%	Six countries produce Platinum.
Tellurium	< 1%	Eight countries produce Tellurium.
Vanadium	8%	Six countries produce Vanadium. Most Vanadium comes from China.
Zirconium	<1%	Eight countries produce Zirconium.

Source: Own elaboration based on U.S Geological Survey.

To take full advantage of the global mining boom, South Africa must improve its policy framework specific to the expansion of critical minerals exploration, production, processing, and innovation. South Africa has the knowhow needed to claim a place in these markets, but it will need to address the state failures that have limited its potential to date. Projects to supply critical minerals often require significant time to develop. IEA (2022c) estimates that the major mines that began operations from 2010 to 2019 took, on average, over 16 years to progress from the discovery to the initial production stage. However, the exact time frame is context-specific: it can differ based not only on the physical characteristics of the project (e.g., the mineral concentration, location, and type of mine) but also on licensing bottlenecks, regulatory burdens, availability of infrastructure services, and policy uncertainty. Countries like Australia, China, and the United States are pursuing aggressive policies. South Africa would need to change its current practices to seize the opportunity.

4.3.2 Green Supply Chains

Beyond mining, South Africa has the potential to participate in multiple value chains that use minerals. Mineral processing is highly concentrated in China, which holds around 35% of nickel refining, 50-70% of cobalt, and 90% of rare earth elements (IEA, 2021b). This shows that the local availability of the mineral is not enough to translate into a comparative advantage of downstream products in South Africa. Previous research (Hausmann *et al.*, 2008) has shown that countries that are rich in mineral resources do not necessarily acquire a comparative advantage in downstream industries. Conversely, the industries with high potential in each country are not necessarily those that are downstream from their own raw materials. After all, most products do not rely on a single raw material, meaning that the others will have to be imported anyway. If transportation costs are low enough, places can become globally competitive in industries for which they do not have any relevant raw materials locally available. China is a good example of this. In cases where transport costs are more significant, places with locally available raw materials do have an advantage. Currently, geopolitical forces are creating opportunities for countries like South Africa in mineral processing. Excessive dependence on China is seen as a strategic risk both in the US and Europe, who want to diversify their suppliers to "de-risk rather than decouple" from China, as Janet Yellen, the US Treasury Secretary, has argued. South Africa could exploit this moment of opportunity to attract investment in mineral processing, but to do so, it would need to credibly address its electricity, rail, and port issues, among others.

South Africa may also be able to innovate much more around the development of clean technologies. The world is focused on improving technologies that can balance the supply and demand of electricity in grids that rely on variable sources of energy like sun and wind. Two technologies – grid-scale batteries and pumped storage hydropower – are increasingly used to balance electricity supply and demand. Between 2020 and 2021, the world increased by 100% its installed capacity in grid-scale battery storage, and according to IEA's Net Zero Scenario, it is expected to expand 44-fold by 2030 (IEA, 2022a). South Africa has companies like Bushveld Energy working on making vanadium redox flow batteries (VRFB) cost competitive. It could be strategic for South Africa that this technology succeeds in carving a role for vanadium in this market since South Africa has ample sources of vanadium and a potential first-mover advantage in developing storage technology. To do so, it would need to

invest in R&D and get on a more rapid learning curve. This can be enabled by developing a strategic partnership between Eskom and Bushveld Energy to buy and test VRFB batteries. The process could also be accelerated by acquiring foreign firms that have key capabilities in this area. This is a somewhat unique opportunity for South Africa given its natural endowment. At the same time, South Africa may have potential to incorporate more pumped storage hydropower in its electricity system, but it does not have the same noteworthy advantages for innovation and positive economic spillovers through research and development as with grid-scale battery storage.

An area of opportunity for South Africa is to innovate around flow batteries for grid-scale storage of electricity. Flow batteries are considered important for the energy transition but are yet to be employed at scale in energy systems (IEA 2023c). The most mature flow battery chemistry is the Vanadium Redox Flow Battery (VRFB), though many groups are trying to innovate in flow battery chemistries to overcome cost and technological constraints in VRFBs. South Africa is a leading supplier of Vanadium, has companies attempting to commercialize VRFBs (such as Bushveld Energy), and could marshal expertise to innovate around flow battery chemistries. Complexity analysis suggests that flow batteries are a high-potential opportunity in South Africa (below). As an emerging technology, supporting flow batteries involves applied research, piloting, and demonstration projects, attracting frontier knowhow from abroad, and making limited investments to develop knowledge and test assumptions around whether commercialization benchmarks are realistic and achievable (such as those related to learning curves and potential cost reductions for VRFBs). To manage risk across different technologies, South Africa should endeavor to explore multiple battery chemistries, before doubling down on vanadium-based chemistries around which it has expertise.

If the hydrogen economy takes off globally, South Africa has the potential to participate in several ways. Despite a rapid uptick in national strategies for hydrogen production, there remain critical questions about the potential size and reach of the hydrogen economy given its high current costs and challenges in transporting hydrogen. However, if these challenges are overcome and hydrogen becomes a critical fuel vector globally, South Africa is well positioned to play several roles in the supply chain. First, the hydrogen economy will need an ample supply of electrolyzers to convert electricity into hydrogen and fuel cells to convert the energy back into electricity. One of the technologies used in both processes is proton exchange

membranes or PEMs. One of the dominant technologies today uses platinum as a catalyst in fuel cell membranes and iridium and ruthenium — two platinum group metals or PGMs — for the PEMs used by electrolyzers. Hydrogen South Africa (HySA) has been investing in these technologies since its founding in 2008 and has established a fully owned subsidiary, Hyplat, to commercialize catalysts for fuel cell PEMs. South Africa could also have strategic advantages in other parts of the upstream supply chain as well as the downstream use of hydrogen in production processes — especially in coordination with the wider region — which is an opportunity discussed under the strategy of utilizing energy resources to "make green versions of grey products," which is discussed in the next subsection.

Fuel cell manufacturing represents an interesting potential entry point for South Africa into the hydrogen value chain. South Africa hosts a nascent ecosystem around fuel cell use and manufacturing, comprising homegrown component makers such as Hyplat, international manufacturers such as Chem SA, and pioneers in frontier applications of fuel cells such as Anglo American (which is developing a fuel cell mining truck). As a technology that is entering commercial deployment at scale (IEA 2023c), policy to support this industry may involve identifying niches in which South Africa is well-positioned, supporting the scaling of supply chains and demand within these niches, and attracting foreign direct investment.

There is in fact a wide range of industries with the potential to take advantage of the global energy transition. Clearly, a decarbonizing world will need massive amounts of more mature products like solar panels, electric vehicles, lithium-ion batteries, transmission lines, as well as emerging products, like electrolyzers and grid-scale batteries. Many more products will likely emerge in the years to come. Each of these products are at the end of long value chains that open many opportunities for participation. We use the product space methodology (Hausmann *et al.*, 2014), and add to it a database of industries and products from relevant supply chain reports using natural language processing techniques.[22] Products comprising this database are not exclusively utilized in green supply chains, which means that they can also cater to other markets. Figure 4.5 below shows each of the identified supply chains along with a high-level disaggregation of stages for some of them. It also shows the total number of internationally traded products involved in each of them, along with the share of those

[22] Most supply chain reports are from the Department of Energy of the United States (DoE); also utilized IEA reports on critical minerals and green hydrogen; excluded primary cells and primary batteries (HS code 8506), and semiconductor devices (HS code 8541), which are challenging to manufacture.

products present in South Africa with a revealed comparative advantage (RCA>=1). The fact that South Africa produces 50% of the products that are involved in the storage and injection stage of carbon capture does not imply that those products are being utilized for that specific industry within the country. Rather, it indicates that South Africa possesses the capability to diversify into that industry, considering its competitive edge in exporting half of these products. The construction of this database can help identify what are South Africa's areas of opportunity when it comes to green growth drivers.

In the landscape of products involved in green supply chains, multiple opportunities can help drive diversification moving forward. As we can see in Figure 4.6, South Africa's green exports are concentrated in platinum, although this mineral holds a relatively small share of green exports globally. Electronics, machinery products, chemicals, and metals are prominent in global green supply chains, and South Africa has clear capabilities in each of those sectors as shown by its current exports. The rapidly growing demand for many of these products presents a window of opportunity for South Africa to tap into the global just energy transition by developing industries for which the country has productive capabilities. Some of the inputs are utilized in highly concentrated stages of the supply chains, but others are part of stages that are more ubiquitous. For example, some of the products on this list are required for producing semiconductors or solar PVs, so entering their markets might be more challenging because of their concentration levels. In turn, other products that are in the metals, electronics, or machinery sections are used for the distribution, transportation, and operation of green supply chains. For example, developing electric grids requires multiple types of electric devices and metal goods, and green hydrogen distribution requires different measuring and regulating apparatuses.

FIGURE 4.5: GREEN SUPPLY CHAIN PRODUCTS

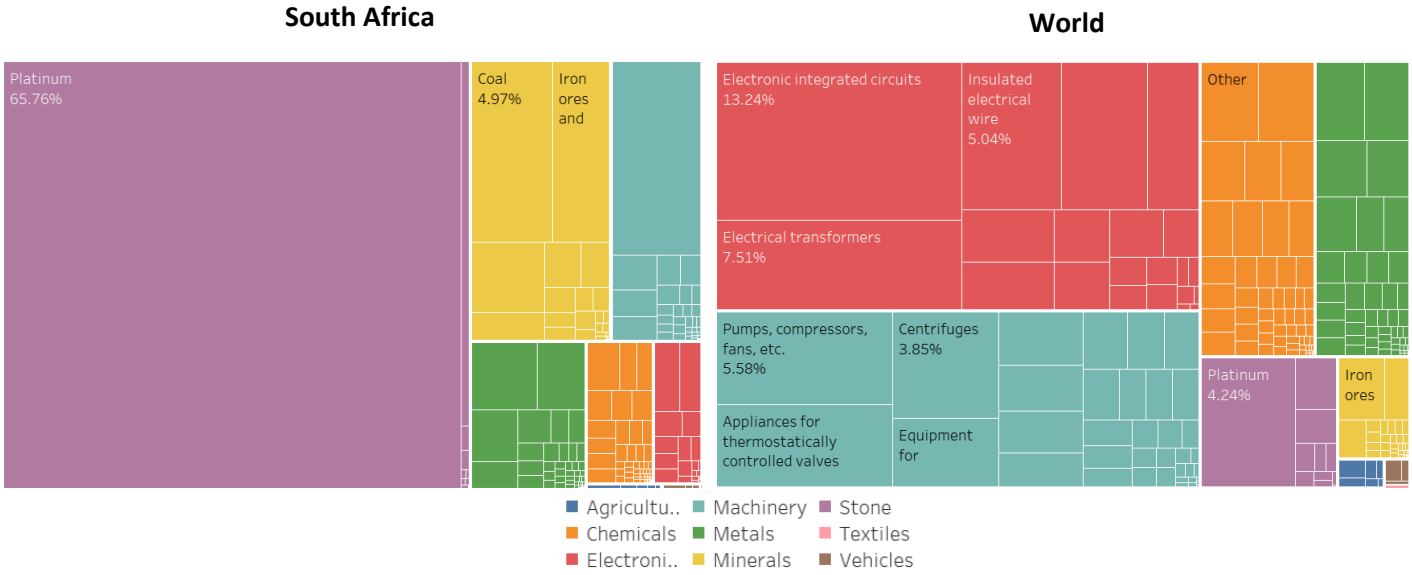
Green Supply Chain	Stage	Number of Products (4 digits)	Products that are present in South Africa (% of total)	Products that are competitive in South Africa (% of total)
Carbon Capture	Capture	22	73%	36%
Carbon Capture	Drying and liquefaction	8	75%	25%
Carbon Capture	Storage and injection	2	100%	50%
Carbon Capture	Transportation	3	100%	0%
Electric Grids	Production	37	68%	22%
Flow batteries	Production	13	92%	15%
Green Hydrogen	Distribution	22	82%	14%
Green Hydrogen	Production	67	90%	24%
Green Hydrogen	Transportation	13	85%	15%
Green Hydrogen	Utilization	6	83%	33%
Hydropower	Production	10	80%	0%
Lead-Acid Batteries	Production	9	89%	56%
Lithium-Ion Batteries	Production	15	73%	27%
Nuclear	Production	45	82%	20%
PGM Catalysts	Production	21	90%	48%
Rare Earth Magnets	Production	19	74%	21%
Semiconductors	Assembly, Testing, Packaging	3	67%	0%
Semiconductors	Fabrication	8	50%	25%
Semiconductors	Utilization	1	0%	0%
Solar PV	Production	28	75%	14%
Wind	Production	25	84%	12%

Source: Own elaboration based on multiple DoE and IEA reports.

Many products are involved in global green supply chains In which South Africa can become competitive. These represent strong pathways to growth in a decarbonizing world. Figure 4.7 shows the Product Space (Hausmann *et al.*, 2014), which provides a comprehensive perspective on how approximately 1,200 internationally traded products are related in terms of the similarity in the capabilities required in their production. The links between the products are based on a measure of how likely they are to be exported by the same country (proximity) or, in other words, their co-location probability. The proximity of products reflects the overlap in the productive capabilities that are required to be competitive in them. The products highlighted in Figure 4.5 are those that belong to green supply chains. Outside of minerals and primary commodities, these tend to be located at the center of the Product Space, indicating that they share capabilities with many products. As a result, they represent powerful

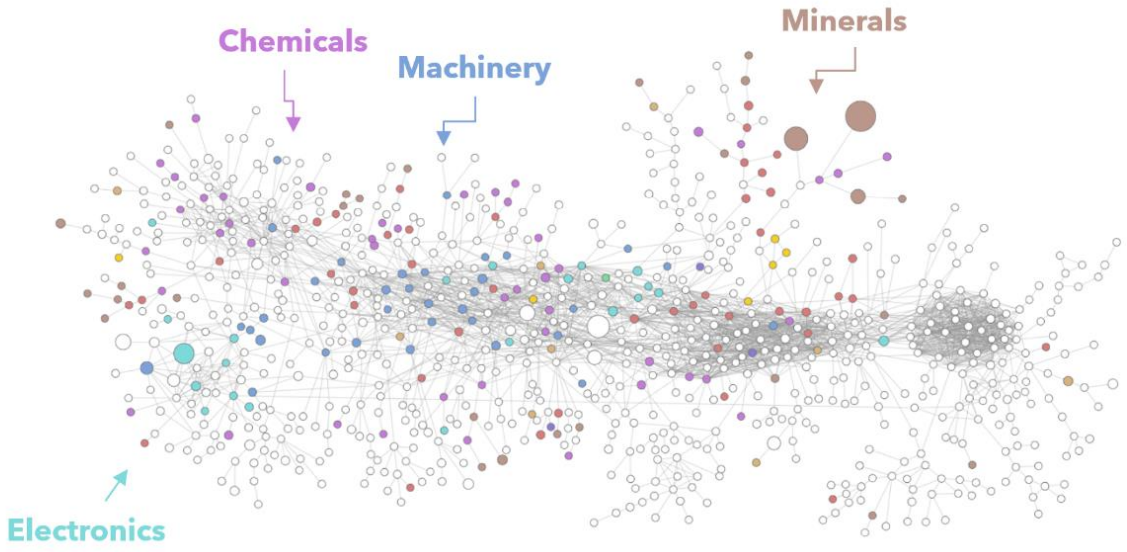
pathways to also develop wider productive capabilities that can strengthen South Africa's comparative advantages in exports over time.

FIGURE 4.6: EXPORTS OF GREEN SUPPLY CHAIN PRODUCTS (2015-2020)



Source: Own elaboration based on international trade data from Atlas of Economic Complexity and Growth Lab internal dataset constructed using DoE and IEA green supply chain reports.

FIGURE 4.7: GREEN SUPPLY CHAIN PRODUCTS IN THE PRODUCT SPACE



Sources: Own elaboration based on international trade data from Atlas of Economic Complexity and Growth Lab internal dataset constructed using DoE and IEA green supply chain reports.

South Africa has a presence in or is close to having a comparative advantage in several products in green supply chains. It is possible to measure whether a country has a

comparative advantage in an internationally traded product by utilizing the Balassa index to express its revealed comparative advantage (RCA) in trade. The RCA is measured as the share of that product's exports within a country's total exports over the share of that product's exports in global trade. In that sense, it measures whether a country exports more (RCA > 1) or less (RCA < 1) than its "fair share" of that product. South Africa has RCA over 1 in many green supply chain products within the metals sector (e.g., aluminum plates), electronics (e.g., electrical insulators), or chemicals (e.g., lead oxides). However, the country is also close to having a comparative advantage in several other products like primary cells, special-purpose motor vehicles, pumps, and surveying instruments. South Africa's position in the Product Space shows that the country has productive capabilities similar to those required by products in green supply chains. These products are therefore compelling areas to focus attention on because South African firms (or foreign companies looking for investment locations) will be more likely to develop global competitiveness in these products.

The appendix provides a detailed list of South Africa's opportunities for participating in green supply chains. The theory of economic complexity provides tools for evaluating these opportunities based on several factors: a product's complexity (i.e., the span of capabilities the product requires); its density (i.e., how close it is in terms of capabilities to products that South Africa already exports competitively) and its complexity outlook gain (i.e., how developing the capabilities to excel in that product would improve the opportunities for further diversification). Using these three variables, we can construct a composite score that indicates how feasible and strategic a product is for South Africa. Furthermore, we can weigh each of these three variables differently depending on whether we want to put more focus on products that are more feasible because they rely more heavily on existing capabilities (i.e., more weight on density) or that open up more opportunities for further growth (i.e., more weight on strategic outlook gain). The appendix shows a list of five products per green supply chain that rank high in terms of their opportunity score on the "extensive margin" – that is, products that South Africa does not already export with relative comparative advantage. The table contains two different measures of opportunity scores: one that prioritizes the feasibility of a product and another one that prioritizes the attractiveness of a product in terms of its complexity and outlook gain.[23] It also reveals five products within each supply chain that South Africa can

[23] The first way of constructing the opportunity score belongs to a strategy of parsimonious industrial policy, and the second one to a strategy that prioritizes strategic bets. In the first case, the score is constructed by assigning a

leverage in the intensive margin, that is, with an RCA greater than 1. These represent the top five products ranked by their PCI.

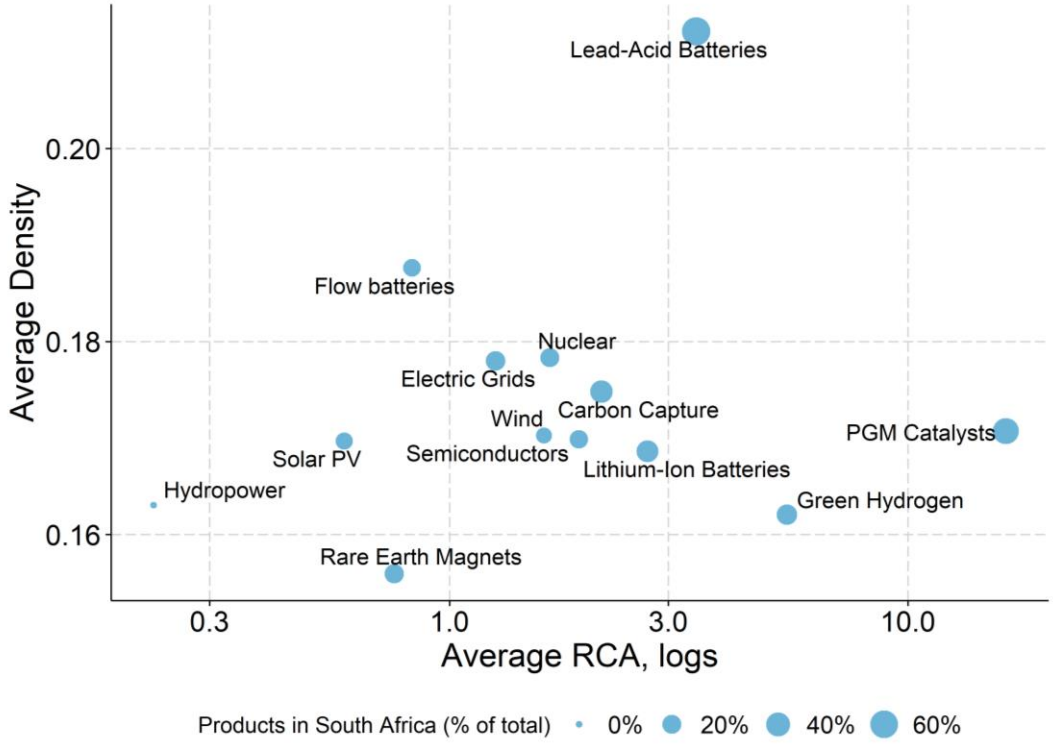
The industries involved in green supply chains that have high potential in South Africa are primarily in metals, chemicals, machinery, and electronics. Out of the 66 identified products on the extensive margin, 30% are chemicals, another 24% are machines, 22% are metals, and 15% are electronics. Meanwhile, 50% of the products in green supply chains that are already exported by South Africa (i.e., the "intensive margin") are chemicals. This is a strong indicator of South Africa's potential to repurpose its chemical industries to make the enablers of global decarbonization. South Africa's chemical industries are diversified in terms of products but not in terms of their markets. Over 80% of its chemical exports are destined for the rest of the African continent (and 90% in 2020). South Africa could leverage global decarbonization to increase chemical exports to the rest of Africa and diversify its markets to the rest of the world, where they are in increasing demand. The country also has a comparative advantage in several products within the machinery, electronics, and metals sections, but exports have been steeply declining since 2008 for reasons discussed earlier in this report.

This analysis reveals varying potential in the different green supply chains. Figure 4.8 shows the competitiveness of South Africa in the RCA vs. the average density of products grouped by green supply chain in South Africa. On the horizontal axis is the average RCA in South Africa for products in the indicated green supply chain (in logs), and the bubble size shows how many products within each supply chain are present in South Africa as a percentage of the total number of possible products. The vertical axis is a measure of how feasible it is to develop products that are not currently present in South Africa based on Product Space density. These measures can help understand the potential of each supply chain in South Africa. For example, the lead-acid batteries supply chain shows growth potential in South Africa since the average density of its products is the highest. The average RCA is also high, and over 50% of the products are already competitively made in South Africa. Nevertheless, South African exports of lead-acid batteries as a final product are a small fraction of global exports. Their RCA in 2020 was below 0.3. The figure also shows high density in the supply chain of flow batteries. Meanwhile, green hydrogen and PGM catalysts supply chains both show high RCA

weight of 60% to density, 20% to PCI, and 20% to COG. In the second case, the score is calculated by giving a weight of 50% to density, 20% to PCI, 30% to COG, and filtering out the PCI that is lower than the mean PCI for South Africa.

on average, but low density, meaning that South Africa is already competitive in producing part of the value chain, but other parts of the value chain are far from South Africa's current productive capabilities. These are long jumps or strategic bets for South Africa because they would involve developing many capabilities that are relatively new to the country.

FIGURE 4.8: DENSITY & PRESENCE OF GREEN SUPPLY CHAIN PRODUCTS IN SOUTH AFRICA (2020)



Source: Own elaboration based on international trade data from Atlas of Economic Complexity and Growth Lab internal dataset constructed using DoE and IEA green supply chain reports

The world is moving quickly towards BEVs, with important consequences for South Africa's automotive industry. Sales of BEVs grew by a factor of 10 between 2016 and 2021 based on Statista and grew by 35% in 2022, moving from 9% to 14% of total sales. This is the consequence not only of policy stimuli but also of technological improvements and cost reductions alongside increasing consumer demand. Capital markets assume that the tangible and intangible assets that companies own to produce ICE vehicles are not going to be worth much. For example, the current combined market value of Toyota, Mercedes, BMW, Ford, Nissan, and Isuzu (6 OEMs present in South Africa) at USD 501 billion,[24] well below that of Tesla

[24] Toyota at USD 255 billion, Mercedes USD 87 billion, BMW USD 70 billion, Ford USD 60 billion, Nissan USD 17 billion, Isuzu USD 12billion, as of July 2023.

(USD 882 billion) alone, even though these companies produced 30 times more cars than Tesla. Consequently, most major car companies are now playing catch-up. They will have to confront new Chinese entrants such as BYD that produce more BEVs than all the OEMs present in South Africa combined. Given this horizon, it is unlikely that OEMs will be planning to expand capacity and even R&D efforts for ICE vehicles and will concentrate their efforts on the move to EVs. Some may shrink as new entrants such as Tesla and BYD expand their presence, as markets currently expect.

This is problematic for South Africa because the automotive industry represents almost a fifth of manufacturing activity, with over 100,000 jobs and 10% of the export of goods in 2019. Since plants take years to plan and build and are expected to be in operation for at least a decade, it is unlikely that the OEMs present in South Africa and their suppliers will be willing to consider either major investments or greater localization in their current product lines, which are focused on ICE vehicles. The exception that proves the rule is BMW, a company that announced a new investment in South Africa to produce plug-in hybrids (Reuters, 2023), a transition product that currently sells half as many vehicles as BEVs and is expected to be just 1/3 of BEVs by 2028 based on Statista. Moreover, over 60% of South Africa's automotive exports go to high-income countries in Europe, North America, and Japan that are not expected to be buying ICE vehicles by 2035. These markets are likely to move massively towards battery-electric vehicles by that year. Therefore, South Africa faces the choice of seeing its automotive industry shrink significantly or move aggressively towards BEVs through either substantial change in product lines by existing OEMs in the country or the entry of new companies with BEV production.

South Africa's move from ICE vehicles to BEVs is made more difficult because of the electricity crisis. Given the shortage of generation capacity, it makes sense that the authorities have not prioritized the move to BEVs in the domestic market through investment in charging infrastructure and other subsidies at the scale of many other countries. Moreover, charging BEVs with electricity made from coal has scant environmental benefits. However, car manufacturing facilities are long-term investments that take time to materialize. By that time, hopefully, the electricity crisis will be over, and the country will be living through a boom in electricity investments. South Africa would benefit from developing an integrated power and transportation strategy to rebuild the country's comparative advantage. The strategy should

leverage the capabilities that the country already has in the value chains that supply ICE cars but will have to be enhanced with capabilities in the production of batteries, IT systems, and other components that play a bigger role in BEVs than in ICE vehicles. It will be important to design a strategy to develop the domestic market by making sure that the country is covered with charging stations as quickly as possible, in a manner consistent with the recovery of the electrical grid. In this respect, off-grid charging stations may be an important contributor. It will be important to explore the possibility of attracting upcoming Chinese players such as BYD in cars and CATL in batteries. Having a large local or regional market is always important to convince OEMs to move their plants and value chains to the country.

Fuel cell electric vehicles (FCEVs) might constitute a potentially large market in the long term, but a few relevant applications might take off earlier. While BEVs appear to be the dominant emerging technology today, some countries, and U.S. states (e.g., California) are betting on FCEVs for a longer time horizon. The absence of an ample hydrogen distribution system limits adoption, but two features of FCEVs make them attractive for some uses. First, FCEVs, just like BEVs, do not emit noxious gases. Second, FCEVs can be refilled more quickly and made more powerful than BEVs. This is particularly useful for mining equipment, since they need to be very powerful, must be refueled quickly, and not emit gases that might endanger workers in underground mines. Also, pressures to decarbonize minerals and metals may force the adoption of equipment that runs on clean energy. South Africa already has a presence in this industry with companies such as Bell. Becoming a leader in the development of FCEV technology as applied to mining equipment might be an interesting niche.

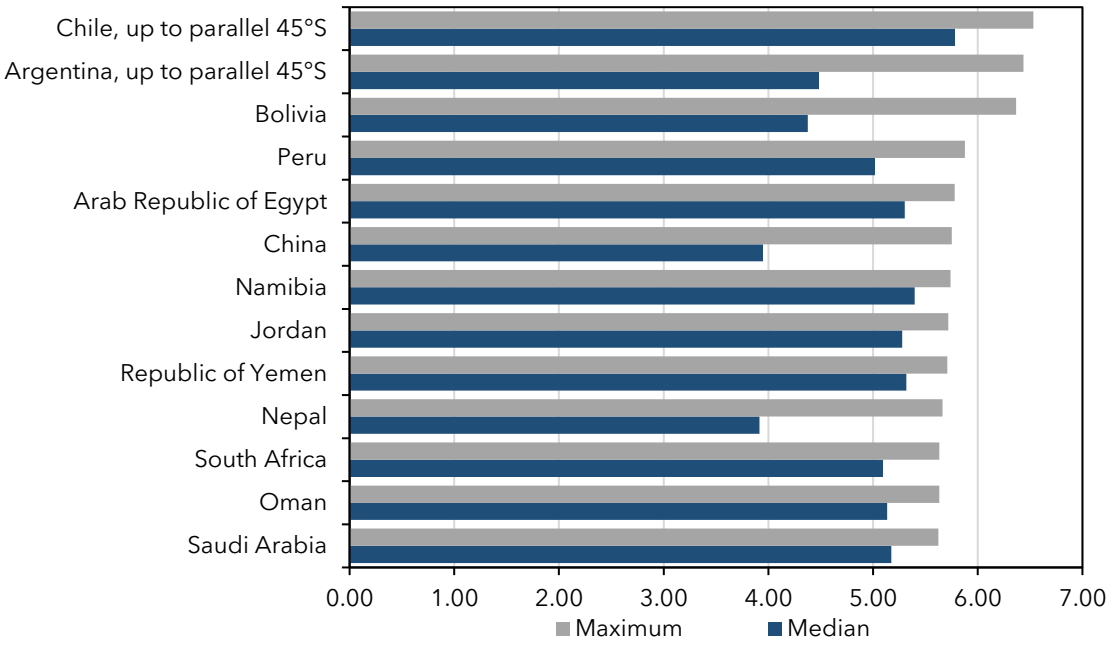
4.4 Strategy 2 – Make green versions of grey products.

As noted earlier, green energy is much more expensive to transport than fossil energy. Therefore, to be competitive, energy-intensive industries that want to decarbonize will need to relocate near cheap sources of green energy. They will also need to be substantially redesigned, justifying new greenfield investments. For example, green steel will either be made with electric-arc furnaces and hydrogen or with electrolysis of iron ore. These processes are sufficiently different from traditional production such that they cannot easily be done as brownfield investments justifying their development in new locations. Regions that develop competitive green sources of energy will be able to participate in this investment trend. The

industries that are likely to relocate include *inter alia* chemicals, steel, aluminum, and mineral processing. South Africa has a long history and relevant accumulated capabilities and knowhow in many of these industries.

South Africa has remarkable potential for renewable energy production, which should be an advantage for this second strategy. Figure 4.9 shows the fifteen countries with the highest maximum yields of photovoltaic power, excluding land with identifiable obstacles to utility-scale PV plants. In addition to having high maximum solar yields (comparable to Namibia, Saudi Arabia, or Egypt), South Africa also has high median yields, higher than China, Nepal, or Argentina. South Africa also has enough wind power potential to complement its PV energy. All of which makes it an attractive location for the development of renewable energy projects. The pace at which these picked up after the government allowed the licensing for it in 2022 indicates that the market is aware of this potential.

FIGURE 4.9: PRACTICAL SOLAR POTENTIAL IN 2020 (PVOUT LEVEL 1, KWH/KWP/DAY), LONG-TERM



Source: Own elaboration based on Global Solar Atlas, World Bank, ESMAP and SOLARGIS.

However, in addition to its electricity system failure, South Africa's current energy mix is highly carbon intensive. With over 90% of its generation capacity based on coal, South Africa has one of the most carbon-intensive energy systems in the world. It will take decades for the

country to transition towards cleaner energy. In the meantime, electricity from the South African grid will be carbon-intensive on average such that industries that rely on the grid are bound to have a high carbon footprint, negating the incentives to relocate to the country. Moreover, dirty energy will be a competitive disadvantage for existing energy-intensive exporting industries in reaching markets.

One way to deal with this disadvantage and leverage the country's renewable energy resources is to develop green industrial parks, where dedicated renewable power is supplied to businesses located in the parks. However, it may not be acceptable to global consumers and regulators to simply reallocate green energy sources to some export-oriented industries and increase the share of grey energy in the rest of the economy. Given this risk, green industrial parks must meet specific criteria. First, their establishment must be based on new sources of clean energy, not merely repurposing existing capacity. Second, to prevent non-emission-reducing reallocations, South Africa must still abide by its previously announced nationally determined contributions, or even increase its level of ambition. Third, for the sake of efficiency and stability, it would be important to connect the new green zones to national electricity grids, but this should be conditional on the zones becoming significant net exporters of clean energy to the grid rather than net importers from the grid.

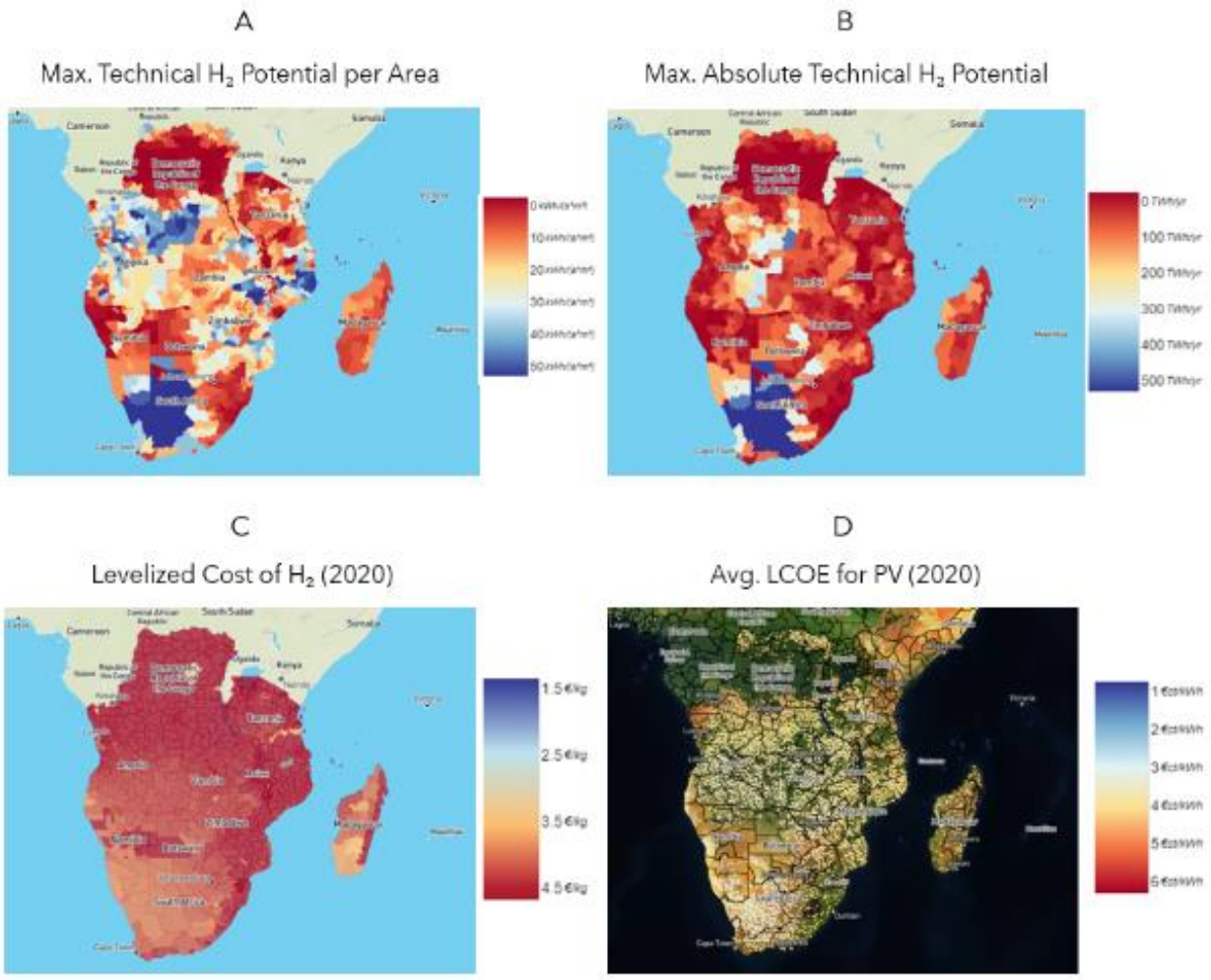
Establishing green industrial parks and their clean-energy resources would not necessarily require government funding. Such real estate and energy investments should be profitable and thus privately financed. Nevertheless, this does not mean that governments should play no role in their establishment. On the contrary, to become competitive, these zones must also strive to compete on the availability of other production inputs, such as human resources, local supply chains, research and development capabilities, logistics, and more. Government can accelerate the process by introducing effective green-energy regulations, facilitating right-of-way provisions for transmission lines, adjusting zoning regulations, building arterial infrastructure, and investing in urban development and human resources. Other countries have already started this process. Indonesia, for example, has an aggressive strategy toward attracting green industries to utilize its renewable energy resources. The Kalimantan Industrial Park Indonesia (KIPI) project aims to attract EV battery manufacturing to utilize its hydropower plants as energy sources (Hafisa, 2023).

The case of the green steel industry stands out as a promising area for South Africa. Devlin *et al*. (2023) have found that locations with renewable energy resources and iron ore mining will likely be cost-competitive for developing green hydrogen-based steelmaking. Within the group of regions identified in that paper, South Africa stands out as one of the places where the cost of producing green-hydrogen-based steel is potentially the lowest. In addition, South Africa has a long tradition of steelmaking which means that it has relevant capabilities and knowhow compared with other locations that also have abundant renewable energy resources. Competitive local provision of green hydrogen would also attract other industries. Some industrial processes require very high temperatures that cannot be achieved by using electricity. These so-called hard-to-abate industries require a green fuel that can play a heating role and green hydrogen is likely to be the fuel of choice. According to IEA (2022d), in the Net Zero Emissions by 2050 Scenario, approximately 65% of the primary steel production in the G7 nations is expected to be achieved through the hydrogen (H2) DRI-EAF method. In theory, it is also a potential solution to decarbonize long-distance heavy transport as it might be more cost-competitive than electric transportation, given the limitations of battery storage systems. In addition, as with green steel, hydrogen can play the role of a reducing agent. So, green industrial parks may choose to offer green hydrogen as an additional valuable input.

The country has clear potential to develop green hydrogen in a competitive way. Figure 4.10 presents four indicators that show South Africa's potential for green hydrogen production vis-à-vis the rest of Southern Africa. The developers of the indicators calculated the amount of hydrogen that can be produced in each geographical region in theory and considered available resources and conditions. The first two maps (A and B) show that South Africa and, especially, the Northern Cape, has the highest green hydrogen production potential in the region, both per unit of area and in absolute terms. This results in a relatively low cost of hydrogen production (map C), which is partly due to the low cost of electricity from PV (map D). The country shows even more potential for developing green hydrogen production when adding South Africa's existing infrastructure and its productive capabilities in the metals and chemicals sectors to the mix. According to IEA's hydrogen projects database, there are five projects currently being evaluated for feasibility, located in Bogoebaai NC (Sasol), Nelson Mandela Bay EC (Hive Energy), Sasoulburg FS (Sasol), Secunda MP (Sasol), and Siyathemba NC (Prieska). The private sector, including influential agents of change like Sasol, is aware of South Africa's potential for green hydrogen development. Nevertheless, to actualize this

potential, the country needs to build a comparative advantage in electricity, although this time not through coal but by harnessing renewable sources of energy.

FIGURE 4.10: KEY INDICATORS OF GREEN HYDROGEN POTENTIAL



Source: SADC H2 Atlas, Institute of Energy and Climate Research - Techno-Economic Systems Analysis (IEK-3), Forschungszentrum Jülich, https://africa.h2atlas.de/sadc

For South Africa to develop cheap renewable electricity it must achieve a low cost of capital. The sun shines for free and the wind blows for free. The bulk of the costs are associated with the cost of installing the capacity and the cost of financing that capacity. Therefore, having access to capital at a low cost is one of the main determinants of competitiveness in green energy. Renewable energy projects require a combination of debt and equity, with equity demanding higher returns than debt. The riskier the country, and the industry, the higher the cost of both debt and equity and the larger the share of equity in the financing mix, causing the weighted average cost of capital (WACC) to go up more than proportionally. Countries

with good natural renewable resources could squander them because of high financing costs. In the case of South Africa, the weakening of the fiscal solvency indicators and repeated credit downgrades have caused an increase in the yields that the government needs to pay to attract capital. Beyond this so-called sovereign risk, other sources of risk are specific to energy projects. The Cost of Capital Observatory of IEA describes the factors that can influence these variables (Figure 4.11). Off-taker risk is serious because of Eskom's weak performance and balance sheet, requiring repeated recapitalizations. That is why the government has been guaranteeing payments to generation projects, but this comes at a fiscal cost. In addition, several other factors are problematic in South Africa, including land, permitting, regulatory, and political risks. If these are not addressed, they can radically diminish the feasibility of South Africa's green growth prospects.

Hydropower and pumped storage could accelerate the energy transition in South Africa. It is hard to incorporate sun and wind into an electric grid because these sources of energy are not dispatchable (i.e., they cannot be adjusted up or down at will). To absorb more sun and wind generation, the system needs more sources of dispatchable energy. The dominant technology today is natural-gas or diesel turbines, which depend on fossil fuels. The green alternatives include grid-scale batteries as well as hydro and pump storage. South Africa could explore expanding both hydropower and pumped storage by exploring the complementarities with Lesotho. Currently, Gauteng buys water from the Lesotho Highlands Water Project. The project and resource have been historically conceived of as a source of water rather than as a source of energy. When the last deal was negotiated in 1985, South Africa did not perceive a need to import electricity, given its ample coal-fired generation. Today, things are radically different. Not only is there a shortage of electricity generation in South Africa, but Lesotho could provide two important elements that are extremely valuable to South Africa. First, hydropower is dispatchable and hence can be used to balance the grid so that it may absorb a larger supply of sun and wind generation. Secondly, the waterworks can be used as storage, pumping water up the mountain in periods of excess sun and wind generation and using the water at peak times. The potential of the Lesotho Highland Water Project should be evaluated in the context of a strategy to green South Africa's electricity supply. South Africa will be able to absorb more solar and wind generation in the presence of more electricity generation and storage capacity in Lesotho.

FIGURE 4.11: RISK FACTORS AFFECTING CAPITAL AND DEVELOPMENT COSTS

Risk name	Description of risk
Political	Changes in expected revenues/return as a result of political or social instability
Regulatory	Fear of changes in law/regulation
	Unclear laws/regulations
Sovereign	Risk of public debt becoming unsustainable and the government not being able to pay its debt obligations in time and form
Currency	Risk of changes in foreign exchange rates
Transfer	Inability – or complicated processes – to convert local currency to hard currency, or to repatriate hard currency
Off-taker	Delays in the payment of power purchased by off-taker(s)
Bankability of PPA	Delays in the signing of PPAs; higher-than-expected project costs relative to a fixed-price contract
Land	Low availability of land
	High land cost
	Long lead times
	Complications arising from overlapping planning permits, fragmented ownership, or unregistered land
Transmission network and evacuation	Insufficient exchange of electricity and system services across states, which can hamper balancing
	Risks around the infrastructure available to evacuate power (e.g., uncertain availability of local grid connections)
Permitting	Long lead times
Volume	Curtailment of power
	Low electricity demand
	Meteorological variations
Technology	Underperformance of technology
	Little experience with the technology being used in the country
	Faulty operation and maintenance, etc.

Source: Cost of Capital Observatory, IEA.

South Africa could become a major producer of green hydrocarbons, including sustainable aviation fuels (SAF). One of South Africa's unique technological capabilities is the mastery of the Fischer-Tropsch process by Sasol. Initially developed to make liquid hydrocarbons out of coal, the process can be adjusted by changing the feedstock to make low-carbon fuels. Sasol is currently developing a plant capable of using green hydrogen and the CO_2 captured from other industrial processes – such as the Arcelor-Mittal's South African steel plant – to make hydrocarbons. Burning such hydrocarbons emits CO_2, but those molecules had already been emitted by a previous industrial process. According to European Union rules, fuels made from captured CO_2 will be considered green until 2040 in the hope that other

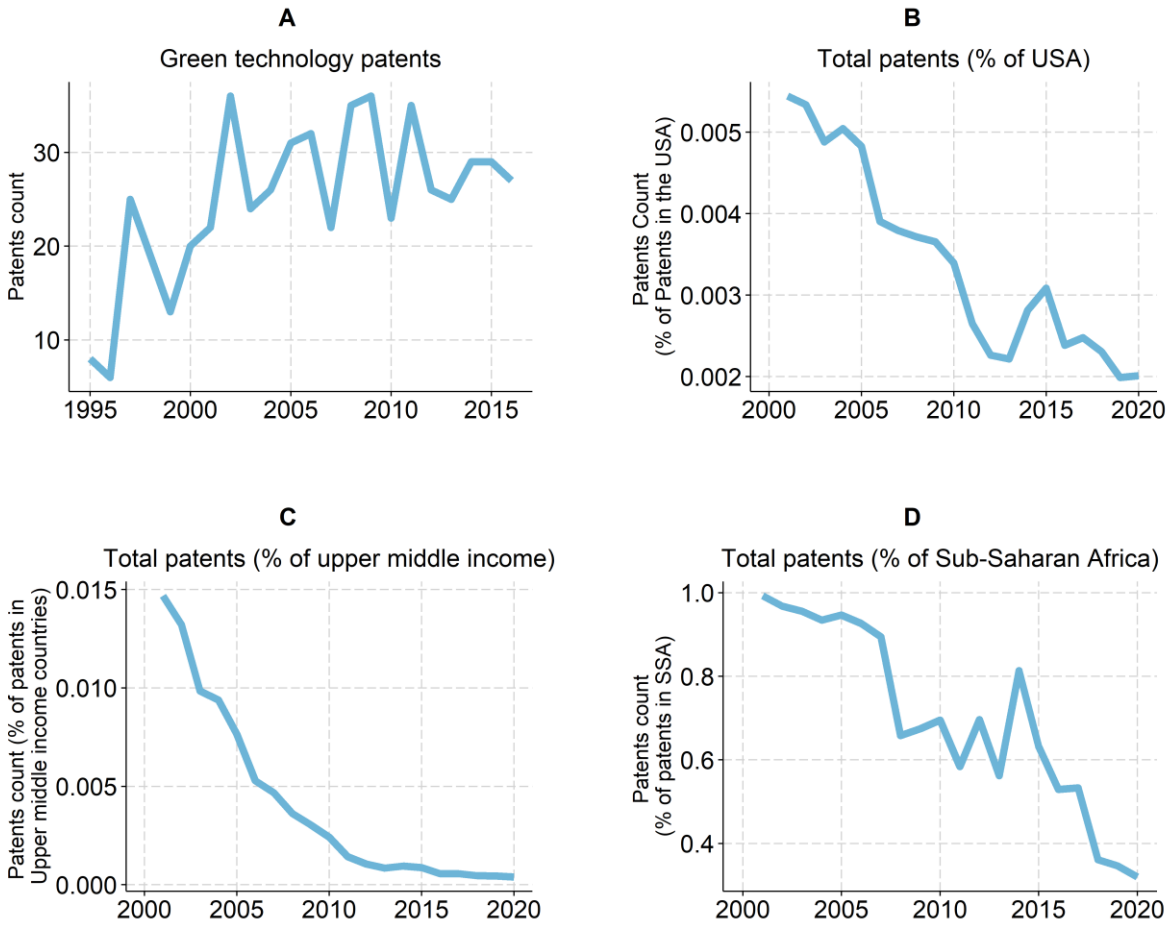
cleaner technologies will have been developed by then. Air travel is one of the hardest to abate industries, making SAF a promising market for the coming decades. South Africa has several unique advantages to becoming a major supplier: unique expertise in the Fischer-Tropsch process; good natural endowment of sun and wind to produce green hydrogen; and industrial sources of captured CO_2. Mastering the technology will require further research and development to control the kind of hydrocarbons that the process creates, by tweaking the catalysts that are used. By 2040, captured CO_2 will need to be substituted by biomass, direct air capture (DAC), or other more sustainable sources of carbon.

4.5 Strategy 3 – Export green knowhow.

South Africa has a long history of innovation in technologies that are relevant to the energy transition, but the country appears to be losing innovation capacity. Figure 4.12, Panel A shows the number of patents[25] in green technologies and processes that were issued to South African assignees in 1994-2016,[26] as documented by the European Patents Office (EPO) in the Worldwide Patent Statistical Database (PATSTAT). The surge in the registration of patents until 2002 indicates that South Africa had the capability to create green technologies[27]. However, after that, the number of green patents stopped growing at a time when they ballooned in the rest of the world. As a consequence, measures of relative innovative capacity show a significant decline. This decline is true whether one looks at the number of total patents issued to South African assignees as a share of the U.S. (Panel B), upper-middle income countries (Panel C), or Sub-Saharan African countries (Panel D).

[25] Patents counts normally just sum the total number of patents awarded in all patent offices. These include patents that have been registered in more than one location, leading to double- or multiple-counting. In these numbers, we use so-called patent families that correct for this issue.
[26] As classified by the United States Trademark Office (USTO) under Y02 to Y02W.
[27] According to IRENA, many of the green patents that were registered in South Africa during the period until 2011 are within a diverse group that IRENA calls "enabling technologies" (38% in 2011): smart grids, energy efficiency, CCUS, fuel cells, electromobility-related technologies, and others. A number of patents were also filed for solar energy (33% in 2011). Source: IRENA's patents evolution data in https://www.irena.org/Data/View-data-by-topic/Innovation-and-Technology/Patents-Evolution

FIGURE 4.12: EVOLUTION OF GREEN AND TOTAL PATENTS IN SOUTH AFRICA



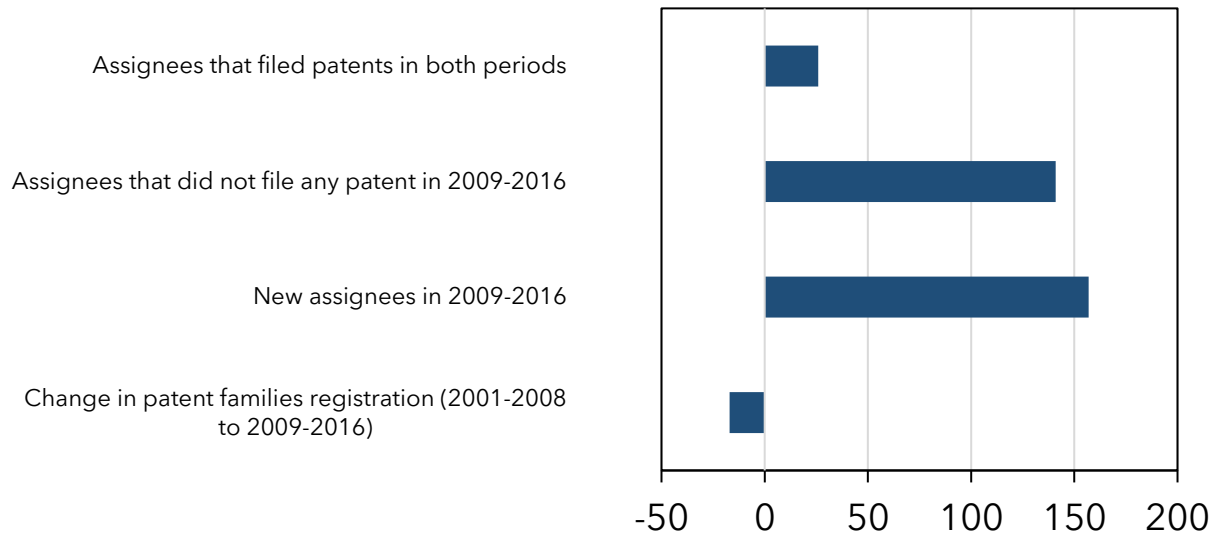
Note: Panel A shows patent families of "climate change technologies as classified by USTO under Y02 to Y0W.
Source: Own elaboration based on PATSTAT and World Bank Data.

South Africa must achieve a higher pace of innovation to keep up with the development of green knowhow worldwide. Figure 4.10 shows a comparison between the assignees that filed patents in 2001-2008 and those that did so in 2009-2016 in South Africa. These numbers are broad estimations given the data's limitations when it comes to identifying assignees.[28] Several patterns stand out when comparing the two periods. The number of green patent families decreased overall, even as many new assignees registered patents in the latter period. Few individuals filed patents during both periods. Rather, most of those who filed patents in the earlier period did not do so in the later period and most of the assignees in the later period were new. Taken together, these patterns show a clear shift in green patents in recent years.

[28] Many of them change their name in time or fil patents under different names. The registry of patents might have duplicated names or firm ids.

Thus, as South Africa's general environment for patenting has weakened a few areas of strength appear to be emerging.

FIGURE 4.13: COMPARING GREEN PATENTS IN SOUTH AFRICA BETWEEN 2001-08 AND 2009-16



Source: PATSTAT.

South Africa may be able to better leverage these emerging sources of innovation. The case of Hydrox Holdings LTD[29] is illustrative since the company was granted a special distinction in the 2022 Monaco Prize for Innovation in Renewable Hydrogen[30] for their innovations in the development of a membrane-less electrolysis system. Another illustrative case is Solar MD[31] (Parker, 2021; Kuhudhai, 2023). The company assembles batteries with components imported from CATL and sells them in South Africa and across Southern Africa. They developed a 14.3 kWh pack that filled a gap in a market where customers facing load-shedding needed more storage capacity than the one provided by the batteries directly imported from China. The company has also created its own battery and energy management system. Because of the electricity crisis, the company faces such high demand that, as of March 2023, it had a three-month backlog for delivering orders (Kuhudzai, 2023). Finally, they are exporting decarbonization knowhow since the company expanded its operations to Bulgaria in 2023 (Todorovic, 2023). The development of businesses like this one can help South Africa

[29] See: https://hydroxholdings.co.za/home/
[30] See: https://monacoh2.org/prize-2022/
[31] See: https://www.solarmd.com/

spur its green growth process. The energy storage solutions are especially strategic for the country, given their upstream and downstream linkages with the metals sector.

Overall, Sasol stands out as a key source of knowhow in South Africa. Increasingly, South African research universities may play a greater role. As noted previously, Sasol's mastery of the Fischer-Tropsch process is one source of intellectual property that may be adapted for future green growth uses. By measure of patents, Sasol is also the most innovative company in South Africa, with 14% of patents filed in 2001-2008 and 12% in the following period (Figure 4.14). Sasol already exports this knowhow as it is now utilizing a flexible approach that combines licensing of its technology, entering partnerships, advisory agreements, and other forms of collaboration. Producing at home and exporting knowhow are not substitutes but complements. It is because the company produces at home that it can master, test, improve, and develop the technology so that it becomes a more effective and credible exporter of knowhow. Figure 4.14 also highlights that some of the shift in patenting that has occurred over the last two decades has come through an increasing role of several South African universities. This is a promising development to build upon through partnerships that combine university resources and capabilities with the production and market knowledge of private companies.

FIGURE 4.14: CLIMATE CHANGE PATENTS BY ASSIGNEE IN SOUTH AFRICA

Assignee	2001-2008	2009-2016
Sasol	50	47
PEBBLE BED	35	4
BHP BILLITON	25	2
Anglo American	12	2
ESKOM	10	2
University of Cape Town	9	11
North West University	7	12
MINTEK	6	6
University of Witwatersrand, Johannesburg	6	11
Azoteq PTY	5	3
University of Stellenbosch	0	44
The South African Nuclear Energy Corp LTD	0	5
University of Pretoria	0	5
CSIR	0	4
HYDROX Holdings LTD	0	4

Source: Own elaboration based on PATSTAT.

South Africa can further capitalize on its productive capabilities to expand its engineering, procurement, and construction (EPC) exports. In addition to Solar MD, other companies have the potential to expand exports of green services and energy systems solutions. PVinsight,[32] for example, is a company in Port Elizabeth developed by researchers from Nelson Mandela University that offers consulting and testing services for solar projects. Companies like PVinsight can take advantage of the fact that EPC services are and will continue to be an essential element in the deployment of renewable energy worldwide and on the African continent.

4.6 Summary of Green Growth in South Africa

While the previous chapters discussed two fundamental constraints to growth in South Africa, this chapter explored growth opportunities moving forward in the context of global decarbonization. These noteworthy green growth opportunities show that the South African economy could have a promising future, but the nature of these opportunities also highlights the ongoing damage from collapsing state capacity. Many of the opportunities explored here are disincentivized by the failing electricity system, collapsing state capacity in other critical public goods, and high cost of capital. Addressing these problems will be central to achieving the promising green growth future that is possible for South Africa. Given that these opportunities depend on reaching the global market, policies focused on boosting demand through fiscal means or localization policies can be of limited benefit. In fact, given the country's precarious creditworthiness, a demand-side focus would run the risk of raising interest rates and the cost of capital of green investment. South Africa's growth potential moving forward comes from the supply side of green growth – that is, capitalizing on its potential to help the world decarbonize through producing many goods, services, and knowledge that global decarbonization will require.

Fully addressing the electricity system failure and rebuilding state capacity are urgent challenges that not only undermine green growth today but in the future. The opportunities of decarbonization favor first movers. This historical opportunity will relocate industries to places that can provide cheap green energy. However, once industries start to cluster in new places, late entrants will have a harder time gaining a foothold in maturing

[32] See: https://www.pvinsight.co.za/page/about

industries. China was able to become a world leader in manufacturing solar systems, electric vehicles, and batteries because they started long before the cost of electricity from PV became lower than the cost of coal-fired electricity. Meanwhile, South Africa doubled down on and then lost its comparative advantage in cheap electricity via coal. A wide range of countries are pursuing aggressive strategies to develop first-mover advantages. The Inflation Reduction Act (IRA) case in the U.S. is noteworthy, though a similar approach that is heavy on state subsidies would be infeasible and likely counterproductive in the South African context. Many other countries (e.g., Australia, Chile, Indonesia, and Namibia) are also gaining strength on the road toward green growth by focusing on their existing and potential comparative advantages. South Africa needs a strategy that matches its strengths and its limitations.

South Africa needs an active strategy for pursuing green growth opportunities that would allow the country to build new comparative advantages. Based on the opportunities previously identified, this strategy should be based on three pillars: (1) making the enablers of global decarbonization; (2) making green versions of grey products for the global market; and (3) exporting green knowhow. In addition to solving cross-cutting economic issues, this strategy requires industry-specific policies that target each of the areas of opportunity that have potential in South Africa. Rather than relying on government procurement and localization, which have become South Africa's main approaches to industrial policy as the economy has stagnated, the strategies explored here would be far more targeted and focused on capturing expanding demand in the global market in areas where South Africa has clear possibilities to grow. This has obvious advantages versus reliance on government's highly strained fiscal resources and the weakening domestic market.

Within Strategy 1 (making the enablers of global decarbonization), two main areas of opportunity are taking advantage of the mining boom and promoting the development of industries that are both likely to see rapid global demand growth and are consistent with South Africa's knowledge base. In addition to addressing collapsing state capacity, which constrains many of these opportunities, South Africa also needs targeted approaches. South Africa needs tailor-made mining and industrial policies. In the first case, a focus on exploration, production, and innovation is required to ensure that the country maximizes the benefits of mineral resource extraction. A revision of the mining policy framework is crucial for South Africa to take advantage of the critical minerals boom. In the case of other green supply

chains, the government must be an enabler rather than a central planner. Some emerging opportunities might need supply-side measures to enhance competitiveness via a more efficient provision of public inputs; others might need targeted demand-side policies to ensure they are price-competitive during their early stages. Pursuing one-size-fits-all solutions without considering the industries' specificity would be less effective than defining industry-specific policies. Generally, companies that are first movers in emerging supply chains need easy access to imports and markets. This makes local content requirements (LCRs) a risky policy tool in many cases. However, LCRs may be powerful instruments in select cases and there is also a role for government procurement to be used to spur innovation within South African companies. The analysis included in this chapter merely provides a starting point for understanding emerging opportunities, and this information could be leveraged within emerging strategies and "masterplans" in development in South Africa today.

For Strategy 2 (making green versions of grey products), the electricity crisis is by far the most fundamental constraint. South Africa needs a boom in renewables to make green versions of grey products, and a boom in renewable generation also requires a rapid expansion of transmission in storage. South Africa has advantageous natural conditions for renewable energy generation but major disadvantages in electricity market design and the cost of capital for project development. Therefore, South African policymakers should focus on establishing a long-term market for electricity and lowering capital costs by reducing sovereign risk. Reducing development costs chiefly depends on state capacity. These improvements will take time, but South Africa also has high potential to kickstart this strategy through the development of green industrial parks. These parks could crowd in both dedicated generation and storage, which could be exported to the grid, and electricity-intensive manufacturing for exports. Green industrial parks should not be a public investment but rather a private sector opportunity that is enabled by government policy, including expedited permitting, and supporting infrastructure. The operators of parks would be capable and highly motivated to find tenants and create the environment that they need to succeed. These tenants may include such industries as mineral processing, green steel, ammonia-based fertilizers, as well as highly electricity-intensive services like data centers.

Strategy 3 (exporting green knowhow) presents South Africa with the opportunity to employ its top-tier technological resources to address global and regional challenges.

South Africa has several examples of companies that have developed solutions that are much needed in a decarbonizing world. Sasol's capacity to utilize the Fischer–Tropsch is rare in developing countries, making it a strategic player in exporting that technology to other parts of the world. At the same time, South Africa has seen noteworthy success in private innovators in the green economy and has advantages in the research capacity of its university system. Building on these advantages requires bringing capabilities of the private sector and academia together and mixing South African talent with global talent. For this strategy, the issues discussed in Chapter 3 on spatial exclusion are of particular importance. Additionally, South Africa's highly restrictive policies on high-skill immigration and inefficiencies in business travel are very problematic. For businesses that cannot bring the complementary human resources that they need into South Africa, the natural response is to move their businesses out of South Africa. Finally, South Africa should be well-positioned to expand its position in engineering, procurement, and construction globally, but especially across Africa. However, this industry requires the flexible movement of people, which is limited by South Africa's immigration policies. Ultimately, excelling in the green knowhow space will depend on South Africa becoming a place where talent from across the country and from around the rest of the world can more easily come together. South African metros have the building blocks to be such hubs, but their full potential is constrained by policy.

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6 Appendix

6.1 List of Strategic Products within Green Supply Chains

Parsimonious industrial policy

HS Code (4 digit)	HS Name	HS Code (2 digit)	Section	Opportunity Score	PCI	Green Topic
2910	Epoxides	Organic chemicals	Chemicals	1.05	1.62	Carbon Capture
8481	Appliances for thermostatically controlled valves	Industrial Machinery	Machinery	1.04	1.51	Carbon Capture
8414	Pumps, compressors, fans, etc.	Industrial Machinery	Machinery	0.95	1.14	Carbon Capture
8419	Equipment for temperature change of materials	Industrial Machinery	Machinery	0.93	1.09	Carbon Capture
8104	Magnesium	Other base metals	Metals	0.80	0.81	Carbon Capture
7225	Flat-rolled products of other alloy steel, width > 600 mm	Iron and steel	Metals	1.03	1.50	Electric Grids
8541	Semiconductor devices	Electrical machinery and equipment	Electronics	0.95	1.44	Electric Grids
8547	Insulating fittings for electrical machines	Electrical machinery and equipment	Electronics	0.91	1.02	Electric Grids
8546	Electrical insulators of any material	Electrical machinery and equipment	Electronics	0.89	0.98	Electric Grids
8532	Electrical capacitors	Electrical machinery and equipment	Electronics	0.88	1.06	Electric Grids
8413	Pumps for liquids	Industrial Machinery	Machinery	1.00	1.39	Flow batteries
8419	Equipment for temperature change of materials	Industrial Machinery	Machinery	0.93	1.09	Flow batteries
8506	Primary cells and primary batteries	Electrical machinery and equipment	Electronics	0.89	1.09	Flow batteries
6815	Articles of stone or of other mineral substances	Articles of stone, plaster, cement, etc.	Stone	0.85	0.88	Flow batteries
7019	Glass fibers	Glass and glassware	Stone	0.69	0.40	Flow batteries

9027	Instruments for physical or chemical analysis	Apparatuses (optical, medical, etc.)	Machinery	1.11	1.80	Green Hydrogen
7318	Screws and similar articles of iron or steel	Articles of iron or steel	Metals	1.09	1.60	Green Hydrogen
3914	Ion-exchangers based on polymers	Plastics	Chemicals	1.09	1.69	Green Hydrogen
8481	Appliances for thermostatically controlled valves	Industrial Machinery	Machinery	1.04	1.51	Green Hydrogen
9031	Measuring instruments	Apparatuses (optical, medical, etc.)	Machinery	1.02	1.41	Green Hydrogen
8481	Appliances for thermostatically controlled valves	Industrial Machinery	Machinery	1.04	1.51	Hydropower
8482	Ball or roller bearings	Industrial Machinery	Machinery	0.98	1.21	Hydropower
8454	Machines used in metallurgy	Industrial Machinery	Machinery	0.89	0.96	Hydropower
8501	Electric motors and generators	Electrical machinery and equipment	Electronics	0.81	0.74	Hydropower
7326	Other articles of iron or steel	Articles of iron or steel	Metals	0.81	0.75	Hydropower
8506	Primary cells and primary batteries	Electrical machinery and equipment	Electronics	0.89	1.09	Lead -Acid Batteries
7804	Lead foil <2mm	Lead	Metals	0.59	0.04	Lead -Acid Batteries
3915	Plastic waste	Plastics	Chemicals	0.33	-0.84	Lead -Acid Batteries
7801	Lead refined unwrought	Lead	Metals	0.13	-1.53	Lead -Acid Batteries
3818	Chemical elements for electronics	Miscellaneous chemical products	Chemicals	1.10	1.96	Lithium-Ion Batteries
3910	Silicones in primary forms	Plastics	Chemicals	1.05	1.57	Lithium-Ion Batteries
8541	Semiconductor devices	Electrical machinery and equipment	Electronics	0.95	1.44	Lithium-Ion Batteries
8507	Batteries	Electrical machinery and equipment	Electronics	0.90	1.10	Lithium-Ion Batteries
8506	Primary cells and primary batteries	Electrical machinery and equipment	Electronics	0.89	1.09	Lithium-Ion Batteries

8481	Appliances for thermostatically controlled valves	Industrial Machinery	Machinery	1.04	1.51	Nuclear
8413	Pumps for liquids	Industrial Machinery	Machinery	1.00	1.39	Nuclear
8406	Steam turbines	Industrial Machinery	Machinery	0.97	1.16	Nuclear
8408	Compression-ignition internal combustion piston engines	Industrial Machinery	Machinery	0.97	1.23	Nuclear
7505	Nickel bars, wire etc.	Nickel	Metals	0.97	1.29	Nuclear
8543	Electrical machines with individual functions n.e.c.	Electrical machinery and equipment	Electronics	0.95	1.34	Platinum Group Metal Catalysts
5911	Textile articles for technical use	Impregnated, coated or laminated textile fabrics	Textiles	0.90	1.04	Platinum Group Metal Catalysts
8506	Primary cells and primary batteries	Electrical machinery and equipment	Electronics	0.89	1.09	Platinum Group Metal Catalysts
2915	Saturated acyclic monocarboxylic acids	Organic chemicals	Chemicals	0.75	0.73	Platinum Group Metal Catalysts
8108	Titanium	Other base metals	Metals	0.72	0.51	Platinum Group Metal Catalysts
8414	Pumps, compressors, fans, etc.	Industrial Machinery	Machinery	0.95	1.14	Rare Earth Permanent Magnets
8505	Electromagnets	Electrical machinery and equipment	Electronics	0.93	1.17	Rare Earth Permanent Magnets
8417	Industrial furnaces	Industrial Machinery	Machinery	0.90	1.05	Rare Earth Permanent Magnets
8542	Electronic integrated circuits	Electrical machinery and equipment	Electronics	0.90	1.14	Rare Earth Permanent Magnets
8471	Computers	Industrial Machinery	Machinery	0.83	1.03	Rare Earth Permanent Magnets
3818	Chemical elements for electronics	Miscellaneous chemical products	Chemicals	1.10	1.96	Semiconductors
9031	Measuring instruments	Apparatuses (optical, medical, etc.)	Machinery	1.02	1.41	Semiconductors

8541	Semiconductor devices	Electrical machinery and equipment	Electronics	0.95	1.44	Semiconductors
8542	Electronic integrated circuits	Electrical machinery and equipment	Electronics	0.90	1.14	Semiconductors
2903	Halogenated derivatives of hydrocarbons	Organic chemicals	Chemicals	0.85	0.94	Semiconductors
3818	Chemical elements for electronics	Miscellaneous chemical products	Chemicals	1.10	1.96	Solar PV
2812	Halides of nonmetals	Inorganic chemicals	Chemicals	1.01	1.73	Solar PV
8483	Transmission shafts	Industrial Machinery	Machinery	1.00	1.27	Solar PV
9030	Instruments for measuring electricity	Apparatuses (optical, medical, etc.)	Machinery	0.97	1.27	Solar PV
8541	Semiconductor devices	Electrical machinery and equipment	Electronics	0.95	1.44	Solar PV
7226	Flat-rolled products of other alloy steel, width < 600 mm	Iron and steel	Metals	1.04	1.56	Wind
7225	Flat-rolled products of other alloy steel, width > 600 mm	Iron and steel	Metals	1.03	1.50	Wind
8483	Transmission shafts	Industrial Machinery	Machinery	1.00	1.27	Wind
8414	Pumps, compressors, fans, etc.	Industrial Machinery	Machinery	0.95	1.14	Wind
8542	Electronic integrated circuits	Electrical machinery and equipment	Electronics	0.90	1.14	Wind

Strategic bets

HS Code (4 digit)	HS Name	HS Code (2 digit)	Section	Opportunity Score	PCI	Green Topic
8481	Appliances for thermostatically controlled valves	Industrial Machinery	Machinery	1.03	1.51	Carbon Capture
2910	Epoxides	Organic chemicals	Chemicals	1.02	1.62	Carbon Capture
8414	Pumps, compressors, fans, etc.	Industrial Machinery	Machinery	0.92	1.14	Carbon Capture

8419	Equipment for temperature change of materials	Industrial Machinery	Machinery	0.91	1.09	Carbon Capture
8104	Magnesium	Other base metals	Metals	0.74	0.81	Carbon Capture
7225	Flat-rolled products of other alloy steel, width > 600 mm	Iron and steel	Metals	1.02	1.50	Electric Grids
8547	Insulating fittings for electrical machines	Electrical machinery and equipment	Electronics	0.89	1.02	Electric Grids
8541	Semiconductor devices	Electrical machinery and equipment	Electronics	0.88	1.44	Electric Grids
8546	Electrical insulators of any material	Electrical machinery and equipment	Electronics	0.86	0.98	Electric Grids
8532	Electrical capacitors	Electrical machinery and equipment	Electronics	0.82	1.06	Electric Grids
8413	Pumps for liquids	Industrial Machinery	Machinery	0.98	1.39	Flow batteries
8419	Equipment for temperature change of materials	Industrial Machinery	Machinery	0.91	1.09	Flow batteries
8506	Primary cells and primary batteries	Electrical machinery and equipment	Electronics	0.84	1.09	Flow batteries
6815	Articles of stone or of other mineral substances	Articles of stone, plaster, cement, etc.	Stone	0.81	0.88	Flow batteries
7019	Glass fibers	Glass and glassware	Stone	0.63	0.40	Flow batteries
9027	Instruments for physical or chemical analysis	Apparatuses (optical, medical, etc.)	Machinery	1.10	1.80	Green Hydrogen
7318	Screws and similar articles of iron or steel	Articles of iron or steel	Metals	1.09	1.60	Green Hydrogen
3914	Ion-exchangers based on polymers	Plastics	Chemicals	1.07	1.69	Green Hydrogen
8481	Appliances for thermostatically controlled valves	Industrial Machinery	Machinery	1.03	1.51	Green Hydrogen
9031	Measuring instruments	Apparatuses (optical, medical, etc.)	Machinery	1.01	1.41	Green Hydrogen
8481	Appliances for thermostatically controlled valves	Industrial Machinery	Machinery	1.03	1.51	Hydropower

8482	Ball or roller bearings	Industrial Machinery	Machinery	0.96	1.21	Hydropower
8454	Machines used in metallurgy	Industrial Machinery	Machinery	0.85	0.96	Hydropower
7326	Other articles of iron or steel	Articles of iron or steel	Metals	0.77	0.75	Hydropower
8501	Electric motors and generators	Electrical machinery and equipment	Electronics	0.76	0.74	Hydropower
8506	Primary cells and primary batteries	Electrical machinery and equipment	Electronics	0.84	1.09	Lead -Acid Batteries
7804	Lead foil <2mm	Lead	Metals	0.52	0.04	Lead -Acid Batteries
3915	Plastic waste	Plastics	Chemicals	0.23	-0.84	Lead -Acid Batteries
7801	Lead refined unwrought	Lead	Metals	0.01	-1.53	Lead -Acid Batteries
3818	Chemical elements for electronics	Miscellaneous chemical products	Chemicals	1.07	1.96	Lithium-Ion Batteries
3910	Silicones in primary forms	Plastics	Chemicals	1.03	1.57	Lithium-Ion Batteries
8541	Semiconductor devices	Electrical machinery and equipment	Electronics	0.88	1.44	Lithium-Ion Batteries
8507	Batteries	Electrical machinery and equipment	Electronics	0.85	1.10	Lithium-Ion Batteries
8506	Primary cells and primary batteries	Electrical machinery and equipment	Electronics	0.84	1.09	Lithium-Ion Batteries
8481	Appliances for thermostatically controlled valves	Industrial Machinery	Machinery	1.03	1.51	Nuclear
8413	Pumps for liquids	Industrial Machinery	Machinery	0.98	1.39	Nuclear
8406	Steam turbines	Industrial Machinery	Machinery	0.96	1.16	Nuclear
8408	Compression-ignition internal combustion piston engines	Industrial Machinery	Machinery	0.95	1.23	Nuclear
7505	Nickel bars, wire etc.	Nickel	Metals	0.94	1.29	Nuclear
8543	Electrical machines with individual functions n.e.c.	Electrical machinery and equipment	Electronics	0.90	1.34	Platinum Group Metal Catalysts
5911	Textile articles for technical use	Impregnated, coated or	Textiles	0.87	1.04	Platinum Group Metal Catalysts

		laminated textile fabrics				
8506	Primary cells and primary batteries	Electrical machinery and equipment	Electronics	0.84	1.09	Platinum Group Metal Catalysts
2915	Saturated acyclic monocarboxylic acids	Organic chemicals	Chemicals	0.68	0.73	Platinum Group Metal Catalysts
8108	Titanium	Other base metals	Metals	0.66	0.51	Platinum Group Metal Catalysts
8414	Pumps, compressors, fans, etc.	Industrial Machinery	Machinery	0.92	1.14	Rare Earth Permanent Magnets
8505	Electromagnets	Electrical machinery and equipment	Electronics	0.88	1.17	Rare Earth Permanent Magnets
8417	Industrial furnaces	Industrial Machinery	Machinery	0.87	1.05	Rare Earth Permanent Magnets
8542	Electronic integrated circuits	Electrical machinery and equipment	Electronics	0.84	1.14	Rare Earth Permanent Magnets
8501	Electric motors and generators	Electrical machinery and equipment	Electronics	0.76	0.74	Rare Earth Permanent Magnets
3818	Chemical elements for electronics	Miscellaneous chemical products	Chemicals	1.07	1.96	Semiconductors
9031	Measuring instruments	Apparatuses (optical, medical, etc.)	Machinery	1.01	1.41	Semiconductors
8541	Semiconductor devices	Electrical machinery and equipment	Electronics	0.88	1.44	Semiconductors
8542	Electronic integrated circuits	Electrical machinery and equipment	Electronics	0.84	1.14	Semiconductors
2903	Halogenated derivatives of hydrocarbons	Organic chemicals	Chemicals	0.80	0.94	Semiconductors
3818	Chemical elements for electronics	Miscellaneous chemical products	Chemicals	1.07	1.96	Solar PV
8483	Transmission shafts	Industrial Machinery	Machinery	0.99	1.27	Solar PV
2812	Halides of nonmetals	Inorganic chemicals	Chemicals	0.96	1.73	Solar PV

9030	Instruments for measuring electricity	Apparatuses (optical, medical, etc.)	Machinery	0.93	1.27	Solar PV
8541	Semiconductor devices	Electrical machinery and equipment	Electronics	0.88	1.44	Solar PV
7226	Flat-rolled products of other alloy steel, width < 600 mm	Iron and steel	Metals	1.02	1.56	Wind
7225	Flat-rolled products of other alloy steel, width > 600 mm	Iron and steel	Metals	1.02	1.50	Wind
8483	Transmission shafts	Industrial Machinery	Machinery	0.99	1.27	Wind
8414	Pumps, compressors, fans, etc.	Industrial Machinery	Machinery	0.92	1.14	Wind
8542	Electronic integrated circuits	Electrical machinery and equipment	Electronics	0.84	1.14	Wind

Intensive margin

HS Code (4 digit)	HS Name	HS Code (2 digit)	Section	Opportunity Score	PCI	Green Topic
8421	Centrifuges	Industrial Machinery	Machinery	NA	0.94	Carbon Capture
2901	Acyclic hydrocarbons	Organic chemicals	Chemicals	NA	0.44	Carbon Capture
8112	Other metals	Other base metals	Metals	NA	0.27	Carbon Capture
2841	Salts of oxometallic acids	Inorganic chemicals	Chemicals	NA	0.24	Carbon Capture
7606	Aluminum plates > 0.2 mm	Aluminum	Metals	NA	0.43	Electric Grids
7309	Tanks etc. > 300 liters, iron or steel	Articles of iron or steel	Metals	NA	0.29	Electric Grids
8112	Other metals	Other base metals	Metals	NA	0.27	Electric Grids
2850	Hydrides, nitrides, azides, silicides and borides	Inorganic chemicals	Chemicals	NA	1.67	Green Hydrogen
2914	Ketones and quinones	Organic chemicals	Chemicals	NA	1.17	Green Hydrogen
7110	Platinum	Precious metals and stones	Stone	NA	1.15	Green Hydrogen
3815	Catalytic preparations	Miscellaneous chemical products	Chemicals	NA	1.00	Green Hydrogen

8421	Centrifuges	Industrial Machinery	Machinery	NA	0.94	Green Hydrogen
2824	Lead oxides	Inorganic chemicals	Chemicals	NA	0.45	Lead -Acid Batteries
3902	Polymers of propylene	Plastics	Chemicals	NA	0.29	Lead -Acid Batteries
3801	Artificial graphite	Miscellaneous chemical products	Chemicals	NA	0.58	Lithium-Ion Batteries
7219	Flat-rolled products of stainless steel of a width > 600 mm	Iron and steel	Metals	NA	0.99	Nuclear
8421	Centrifuges	Industrial Machinery	Machinery	NA	0.94	Nuclear
8101	Tungsten (wolfram)	Other base metals	Metals	NA	0.83	Nuclear
3801	Artificial graphite	Miscellaneous chemical products	Chemicals	NA	0.58	Nuclear
7308	Structures and their parts, of iron or steel	Articles of iron or steel	Metals	NA	0.37	Nuclear
7110	Platinum	Precious metals and stones	Stone	NA	1.15	Platinum Group Metal Catalysts
3815	Catalytic preparations	Miscellaneous chemical products	Chemicals	NA	1.00	Platinum Group Metal Catalysts
8421	Centrifuges	Industrial Machinery	Machinery	NA	0.94	Platinum Group Metal Catalysts
2808	Sulfonitric acids	Inorganic chemicals	Chemicals	NA	0.29	Platinum Group Metal Catalysts
7115	Other articles of precious metals	Precious metals and stones	Stone	NA	0.09	Platinum Group Metal Catalysts
8112	Other metals	Other base metals	Metals	NA	0.27	Semiconductors
7308	Structures and their parts, of iron or steel	Articles of iron or steel	Metals	NA	0.37	Solar PV
7110	Platinum	Precious metals and stones	Stone	NA	1.15	Wind
7308	Structures and their parts, of iron or steel	Articles of iron or steel	Metals	NA	0.37	Wind