AFRICAN DEVELOPMENT BANK GROUP

KOAFEC
Korea-Africa
Economic Cooperation

unlocking the potential of the fourth industrial revolution in Africa
study report

COUNTRY CASE STUDY
SOUTH AFRICA

tc
table of contents

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4IR	Fourth Industrial Revolution
AfDB	African Development Bank
AI	Artificial Intelligence
AIC	Africa Innovation Centre
BPESA	Business Process Enabling South Africa
BPO	Business Process Outsourcing
CHPC	Centre for High-Performance Computing
COSTECH	Commission on Science and Technology
CPI	Corruption Perception Index
CRC	Cyber Response Committee
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DAS	Data Acquisition Systems
DER	Distributed Energy Sources
DoHET	Department of Higher Education and Training
DST	Department of Science and Technology
DTI	Department of Trade and Investment
DTPS	Department of Telecommunications & Postal Services
ECTA	Electronic Communications and Transactions Act
EHRs	Electronic Health Records
EMR	Energy Management System
ESS	Energy Storage System
ETRI	Electronics and Telecommunications Research Institute
EV	Electric Vehicles
FDI	Foreign Direct Investment
FTA	Free Trade Area
LNG	Liquefied Natural Gas
LTE	Long Term Evolution
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GIA	Global Impact Accelerator
HDI	Human Development Index
ICT	Information and Communication Technologies
IFWG	Intergovernmental FinTech working group
IoT	Internet of Things
IP	Intellectual Property
IPAP	Industrial Policy Action Plan

A list of acronyms

IT	Information Technology
JCPS	Justice, Crime Prevention and Security Cluster
NACI	National Advisory Council on Innovation
NBII	Namibia Business Innovation Institute
NCPF	National Cyber Policy Framework
NCRST	National Commission on Research Science and Technology
NDP	National Development Plan
NeSPA	National e-Skills Plan of Action
NERSA	National Energy Regulator of South Africa
NHI	National Health Insurance
NIA	National Information Society Agency
NIPF	National Industrial Policy Framework
NRF	National Research Foundation
NRI	Networked Readiness Index
NTBC	National Technology Business Centre
OECD	Organisation for Economic Cooperation and Development
POPI	Protection of Personal Information
PPPs	Public-Private Partnerships
R&D	Research and Development
REDZs	Renewable Energy Development Zones
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
RISDP	Regional Indicative Strategic Development Plan
SADC	Southern African Development Community
SANSA	South African National Space Agency
SANREN	South African Research Network
SARB	South African Reserve Bank
SITA	State IT Agency
SME	Small and Medium Sized Enterprise
STEAM	Science, Technology, Engineering, Arts and Mathematics
STEM	Science, Technology, Engineering and Mathematics
STI	Science, Technology and Innovation
TTA	TechTribe Accelerator
TVET	Technical and Vocational Education and Training
US	United States
WEF	World Economic Forum
WIPO	World Intellectual Property Organization

1 introduction

this document is one of the five country case studies drafted in the framework of the Study to Unlock the Potential of the Fourth Industrial Revolution (4IR) in Africa.

The overall study aims at i) understanding the preconditions for adoption of 4IR technologies, challenges and drivers, positive and negative effects; ii) describing the technologies for knowledge dissemination, including domains of application; iii) benchmarking emerging countries; iv) demonstrating applications in Africa; v) in order to conclude on a business case and vi) recommend interventions and vii) design specific ICT components for AfDB projects, which will showcase the feasibility of supporting the 4IR in Africa.

This case study thus looks in depth at the potential for the adoption of key 4IR applications with diverse geographic, political, economic, technological and social preconditions:

- it reviews the socioeconomic situation of the country and the implications for technological readiness for 4IR;
- it assesses the potential for 4IR to be used in the key economic sectors of the country, i.e. the High Five AfDB priority fields, which are agriculture, energy supply, industry manufacturing, regional integration and well-being (including financial inclusion, smart cities, education and healthcare);
- it concludes on the business case for the 4IR in the country.
- it proposes recommendations at the national level;
- it envisions potential AfDB interventions or projects.

Our team collected data drawing on existing research and public policy documents and by consulting local stakeholders. This was done either by telephone, online or in person. One field visit per case study country was organised to allow the team to gain a deeper understanding of the local conditions and peculiarities and to be able to identify the most relevant use cases. The field visit took place on site and included face to face meetings with key stakeholders from government, the private sector, researchers and NGOs (about 25 meetings).

The structure of the document is based on eight chapters. It has been enriched and finalised following a workshop with stakeholders that was held in early June 2019.

The term AI encompasses so many evolving systems and applications that it is not possible to attach this technology to a specific technological readiness level (TRL). Rather, some AI applications are already at a high TRL, including natural language processing and chatbots, fully self-driving cars (considered to be at a TRL of 7). Other AI systems are still in their infancy, at lower TRLs, such as autonomous surgical robotics, robotic personal assistants and cognitive cybersecurity. At a very low TRL are systems such as real time emotion analytics (Robotics Society Japan, 2015).

2
country presentation

2.1 ECONOMIC, SOCIO-DEMOGRAPHIC AND INDUSTRIAL PROFILE

Although no longer the largest economy by GDP since it lost its leading position in that respect to Nigeria, South Africa's GDP stood at $276.1 billion in 2017. The population is estimated to be over 55.4 million, with over 73.5% living in urban areas. Real GDP growth was an estimated 0.7% in 2017/18, down from 1.3% in 2016/17. Elevated global risk factors and domestic policy uncertainty have had a negative impact on South Africa's economic outlook, with the country performing well below global and emerging market averages. Global growth for 2019–2020 is projected to be only marginally above the 2018 estimate of 3.5% while emerging markets and developing economies are expected to maintain their edge of 1% above that.

South Africa's economic growth has been well below that. The country found itself in economic recession in the first two quarters of 2018, with the economy contracting by 2.7% in the first quarter and by a further 0.5% in the second quarter. Despite this, growth in the third (2.6%) and fourth (1.5%) quarters pushed overall growth for the year into positive territory, reaching 0.8% for the full year, still below the 1.5% that had been forecast by the Treasury. Similar low figures going forward are projected by the International Monetary Fund (IMF).

Traditionally, South Africa's economy has been dependent on the primary sectors, particularly mining and agriculture. In recent years, however, the contribution of the mining sector has dropped significantly, while the tertiary sector - which includes wholesale and retail trade, tourism and communications - has moved to centre stage. This can be seen from the fact that, in 2017, 63% of GDP was accounted for by the services sector – finance (20%), government (18%), trade (15%) and transport and communication (10%). By contrast, the contribution of the mining sector fell to a mere 8%, as it contracted, along with construction and agriculture (by as much as 4.8% in the case of the latter).

The telecommunication and finance sectors are among the most developed sectors in South Africa, comparing favourably with those of industrialised countries. In recent decades, the banking sector has moved from providing traditional banking services, at first supplemented by the installation of an extensive, world-class network of automated teller machines, to rolling out online and mobile e-banking services. A 2018 survey by Research ICT Africa shows that more than half of the South African population has access to financial services, far above the average of 30% in the 10 African countries surveyed. These developments include digitally based products such as e-wallets, internet banking platforms, Blockchain-driven crypto-currencies and the advent of branchless banking.

2.2 BROAD POLICY OBJECTIVES

South Africa's leaders have joined others in giving the moniker, the Fourth Industrial Revolution (4IR), to the current wave of digitalisation. The strength of this raft of technological innovations has the potential to propel digitally ready countries into a new age of prosperity. However, inconsistent policy and regulatory failure in key enabling areas, particularly the telecommunications and energy sectors, have hamstrung South Africa's readiness for more widespread 4IR adoption.

Three central policies are shaping technological developments in South Africa, both at the government level and industry level. These policies are the 2012 National Development Plan (NDP), the 2013 National Broadband Policy (SA Connect) and the 2016 National Integrated ICT Policy White Paper.

National Development Plan.

The National Planning Commission's National Development Plan conceives of the ICT sector primarily within the context of economic infrastructure and not as the central system of the wider digital economy. The NDP's vision for the ICT sector is that, by 2030, it is "*expected to underpin the development of an inclusive dynamic information society and knowledge economy" through the development of a "comprehensive and integrated e-strategy that reflects the cross-cutting nature of ICTs*".

For its goals to be achieved, the NDP refers to new means of assigning the spectrum that will become available following the migration of terrestrial television broadcasting from

analogue to digital transmission and sets out a strategy for universal access, including targets, monitoring and evaluation indicators. The NDP also identifies the need for demand-side stimulation strategies, such as e-literacy, skills development and institutional development, and other strategies to promote ICT diffusion. Another key focal point of the NDP is to build affordable access to a number of services through effective regulation of competitive markets.

For the medium term, the period from 2015 to 2020, the NDP endorses the target (proposed by the then Department of Communications) of achieving 100% broadband penetration by 2020 but expands the definition of broadband from 256 Kbps to at least 2 Mbps. In the longer term it envisages the state making extensive use of ICTs in the delivery of services to citizens, including entertainment, information and education. And it suggests greater collaboration between the state, industry and academia as being critical to the success of any e-strategy. The NDP's broad vision of eliminating poverty and of reducing inequality by 2030 is supported by various stated outcomes from the government's 2014-2019 Medium Term Strategic Framework, notably to ensure decent employment through inclusive economic growth (Outcome 4), Comprehensive rural development and land reform (Outcome 7) and to protect and enhance environmental assets and natural resources (Outcome 10). The NDP is currently under review to assess South Africa's readiness for the 4th Industrial Revolution.

SA Connect

Completing a process launched in 2009, a national broadband policy, SA Connect, was finally announced in 2013.

In addition to responding to South Africa's NDP, SA Connect attempted to lay the ground for an integrated supply-side and demand-side strategy to meet the NDP's goals, and envisaged that a:

"seamless information infrastructure will be universally available and accessible and will meet the needs of individuals, business and the public sector, providing access to the creation and consumption of a wide range of converted services required for effective economic and social participation".

The policy identifies the need to overcome 'structural constraints' in the sector along with the need to satisfy pent-up demand for affordable broadband. The sharing of resources and infrastructure, including spectrum, is further seen as a responsibility of the regulator to encourage service-based competition in the market.

However, the implementation of the plan has stalled. The first-round target for 2016 of connecting 50% of the population at an average download speed of 5 Mbps has not been met by a wide margin. Other targets to connect 50% of schools and health facilities at a speed of 10 Mbps are therefore impossible to meet.

National Integrated ICT Policy White Paper

In 2016, the DTPS released the National Integrated ICT Policy White Paper to give effect to the 2015 recommendations of a multi-stakeholder ICT Policy Review Panel. Despite omitting to deal with audiovisual content and services, including broadcasting, the White Paper aims to address the development of converged technologies, digitalisation, communication, work, as well as the role of the internet.

The White Paper aims to facilitate access to quality communication and services by all South Africans with the purpose of enabling economic growth, employment and wealth creation. The policy also aims at promoting and stimulating domestic and foreign investment in ICT infrastructure, manufacturing, service, content and research and development. To achieve universal access, the policy aims to ensure that services, devices, infrastructure and content are accessible to all, including people with disabilities.

ICT Policy Assessed

South Africa's ICT policy and regulatory environment over the last ten years has not enabled the economy to capitalise on the country's resource and financial endowments. The sector, a key economic enabler, has struggled through the

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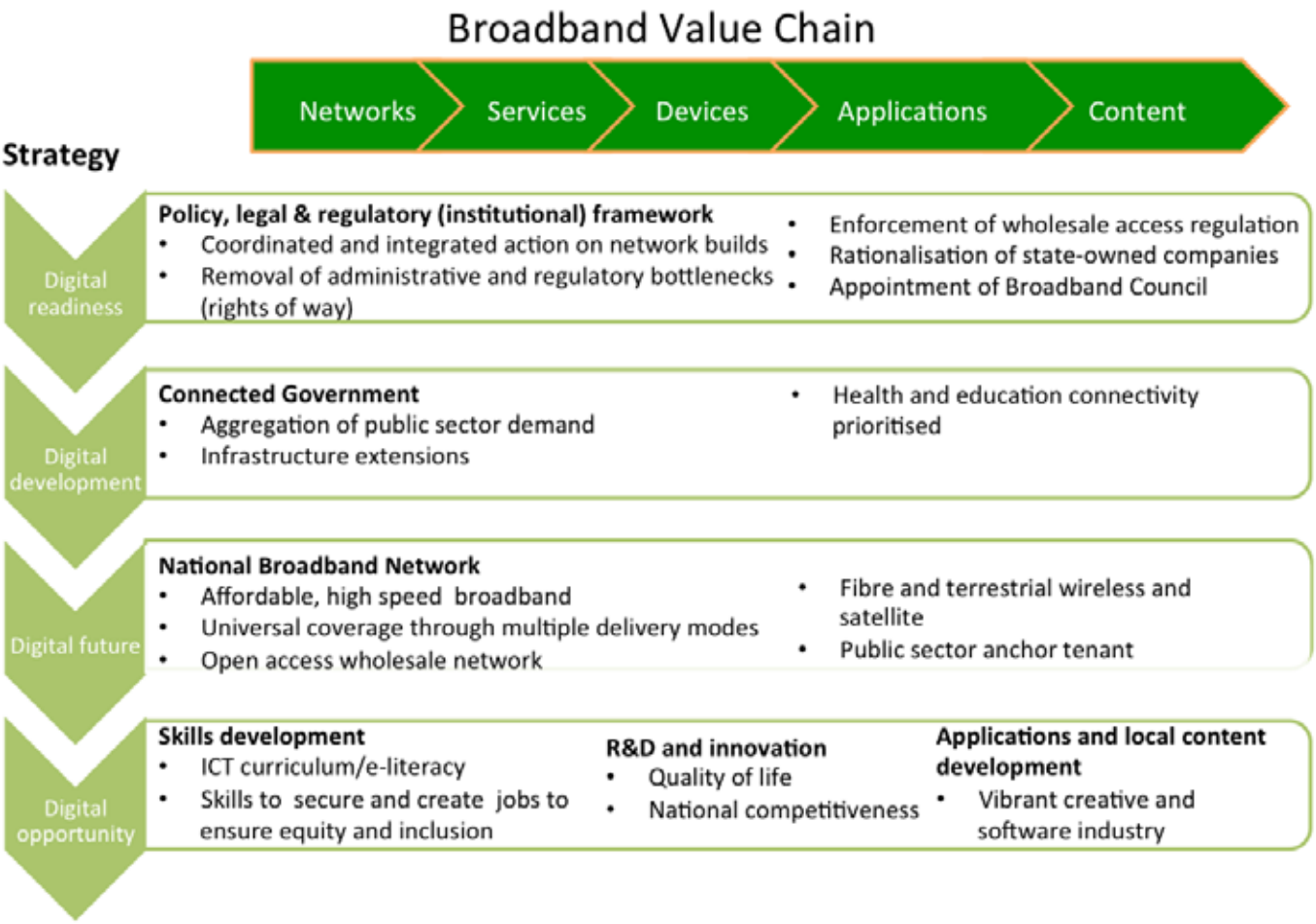
figure 01

SA Connect Vision, SA connect Policy Brief (RSA 2013)



mire of political, institutional and leadership incapacity, leaving the wider economy to lag behind in terms of performance as others ride the wave of economic and social digitalisation.

The lack of progress in implementing SA Connect can be attributed to a number of poor policy decisions, diversion from consultative policy processes by government, lack of state co-ordination and protracted legal and regulatory processes and indecision. At the core of this was the division of the former Department of Communications into two: an old-style Department of Telecommunications and Postal Services and a Department of Communications. This undermined a decade of convergence legislation and regulations, leaving critical policy and regulatory actions in limbo.

However, the urgent need to develop a realistic set of smart policy interventions attuned to the challenges that the digital revolution will bring to the economy and the society remains and has led the DTPS to propose a slew of legislative changes (see Figure 3 below). Some of these have been enacted, but most are currently stalled.

figure 02

DTPS White Paper Interventions

LEGISLATIVE PROGRAM

Action	1. Amendment of the following legislation ICT sector laws: Electronic Communications Act (ECA), Electronic Communications and Transactions Act (ECTA), Postal Services Act (PSA) and State IT Agency Act (SITA) 2. Development of the following Bills (rationalisation of current institutions): ICT Commision and Tribunal Bill, Ikamva National e-Skills Institute (INESI) Bill, Digital Development Fund (DDF) Bill and ICT State Infrastructure Bill, South African Post Office Amendment Bill
Progress	1. Bills to be introduced to Parliament in 2018/19 ECA, INESI, Postal Services Amendment Bills 2. Bills to be introduced to Parliament in 2019/20 Digital Development Fund, ICT Commission and Tribunal, Postbank Amendment 3. Bills to be introduced in Parliament in 2021/22 State IT Agency Amendment Bill, State ICT Infrastructure Bill, Electronic Communications and Transactions Act Bill
Next steps	1. Cabinet has approved the SOC Rationalisation Framework Document, Business Cases being developed to support legislation drafting 2. Development and approval of the Business Cases to establish the ICT Sector Commission & Tribunal, Digital Development Fund, SITA and State Infrastructure company 3. Development of Money Bil for the DDF
Impact	Policy coherence and certainty, enabled environment for investment, enhanced competitiveness of the sector, consumer protection, transformation, improved capacity of the State to deliver, universal service and access, opening access to critical infrastructure, modernisation of SAPO and transformation of the postal sector
Timelines	1. ECA and INESI already introduced 2. Postal Services Amendment Bill in Cabinet Committee 17/10/2018 3. DDF ICT Sector Commission and Tribunal Bill to be gazetted for public consultation by end of financial year 4. Input into the Financial Related Matters Amendment Bill - to support the Postbank Amendments

SOURCE
Department of Telecommunications and Postal Services

The DTPS has subsequently adopted the moniker of the 4th Industrial Revolution and is involved in a number of initiatives as the country searches for a comprehensive, converged and cross-cutting strategy to prepare for the 4IR and its implications for all sectors of the country. These initiatives include developing a national digital skills strategy, along with a draft 4IR framework, and appointing a 4IR Commission.

2.3 POLICIES SPECIFIC TO 4IR TECHNOLOGIES

In 2019, President Ramaphosa appointed a Commission on the 4th Industrial Revolution (4IR Commission), consisting of some 30 stakeholders, including successful start-ups, academics, captains of industry and public officials. Co-chaired by Professor Tzilidizi Marwala from the University of Johannesburg, the 4IR Commission will assist the government in directing attention to the opportunities that the digital revolution may present to many sectors in South Africa, including agriculture, manufacturing and mining.

According to its terms of reference, the 4IR Commission needs to ensure that the integration of digital processes boosts and enhances competitiveness while achieving inclusive growth, with particular attention to rural development and encouraging the participation of youth and women across the 4IR value chain.

Furthermore, a 4IR Inter-Ministerial Committee has been established to co-ordinate efforts within government and with the Council. The Ministries of Science and Technology and Trade and Industry, have, together with higher education and energy sectors, successfully driven

innovation policy and already developed 4IR focal points and initiatives. Supporting the 4IR Commission will require a substantial shift and take-up of skills within the Department, which has historically lacked the capacity to undertake policies.

Public sector use of ICT

The adoption and use of ICT by the public sector in South Africa has been notoriously bad. For example, whilst South Africa is ranked 2nd in Africa (behind Mauritius), it is in 68th place out of 193 countries on the UN's 2018 E-Government Development Index.

Partly in response, the DTPS has developed a National e-Government Strategy aimed at modernising and transforming future public service delivery, following the 2014 move of the State IT Agency (SITA) from the Department of Public Service and Administration to DTPS, on the back of poor performance and widespread corruption and maladministration.

The diagnostic report of the NDP had already pointed to problems at SITA as underpinning poor performance of the public sector in terms of ICT adoption and usage. Rather than reducing state expenditure on ICT services through the economies of scale and scope, services which national and provincial departments were statutorily obliged to use came at a premium. A new CEO (the 18th in almost as many years) started a turnaround seen at SITA but it was not completed before he left in 2019 after not renewing his contract.

Within the public sector, intergovernmental communication is poor. There is no sharing of data and information between national departments and between national and provincial governments, and at local government level it is arguably worse.

Adopting a business approach instead of a bureaucratic one and 4IR projects planned by SITA seek to address this by creating a new business model. This has required shifting to wholesale operating from an old tendering and procurement business that was riddled with inefficiency and corruption. The aim is to have a transparent digital market place of goods and services via a cloud-based ecosystem that is accessible to users and sellers.

Developing digital skills

To provide citizens with the requisite skills to take part in South Africa's digital economy and to protect their employment potential, a comprehensive turnaround strategy was developed by the Department of Higher Education and Training (DoHET) for the 50 Technical and Vocational Education and Training (TVET) Colleges. The DoHET has also identified on-the-job training and short courses as the approach to take for workplace upskilling in the face of the likely employment impacts of the 4th Industrial Revolution and to achieve the national objective of global competitiveness.

A policy priority area to prepare for the 4th Industrial Revolution, aligned with the objectives of the NDP and SA Connect, is the development of digital skills across the board from pre-primary to tertiary levels and covering both attitudinal approaches and soft skills such as critical thinking as well as harder ICT skills. The DTPS is currently developing a comprehensive National Digital Skills Strategy to update its earlier National e-Skills Plan of Action (NeSPA) and is seeking the passage of enabling legislation for the iKamva Digital Skills Institute.

Science technology and innovation

While ICT sectoral policy lagged behind, the Department of Science and Technology (DST) has taken a leading role in the last two decades with regard to innovation, foresight planning and implementation. It has established an integrated national research and innovation framework in the form of a series of White Papers on research and development, innovation and roadmaps for ICT and innovation. The National Advisory Council on Innovation (NACI), which was established in 1997, continues to articulate and implement a vision that seeks to contribute to the realisation of the NDP's vision for science, technology and innovation. Its strengths include the ability to mobilise science, technology and innovation (STI) stakeholders and to access both local and international experts. The NACI aims to continue to strengthen STI planning, monitoring and evaluation capability and plans to conduct a foresight

exercise whose results will contribute towards the development of a decade-long plan for STI.

Furthermore, a recently updated White Paper on Science, Technology and Innovation specifically sets out to update the country's science, technology and innovation (STI) policy in the light of the "significant changes that are associated with the Fourth Industrial Revolution". The new White Paper offers several strategies and revised institutional arrangements to improve South Africa's preparedness for the 4th Industrial Revolution. One is that, while the NACI will continue to provide advice on innovation trends and to focus on the foundational STI discipline, on developing infrastructure and human resources on addressing poverty, unemployment, inequality and on promoting economic growth and social development, a high-level structure of ministers whose functions overlap with STI will be established. This will provide the financing for much-needed interventions that cut across departmental budgetary and performance silos. Engagement with the private sector through industry associations such as MINTEK (mining) and AgriSA (agriculture) will also be boosted.

The DST focuses on the Council for Scientific and Industrial Research (CSIR) to strengthen industrial policy in the country. Beyond investing extensively in military and industrial research, the CSIR is actively engaged in national ICT research, development and innovation through the Meraka Institute.

The DST's ICT RDI strategy aims to increase advanced human resource capacity, to promote world-class research and to build innovation chains for the creation of new high-tech ICT Small, Medium and Micro Enterprises (SMMEs). Although the strategy includes partnerships with the private sector and higher education institutions, the bulk of state investment has gone into the Meraka Institute, which manages and coordinates the implementation of the strategy.

Through the South African National Space Agency (SANSA), the country's capacity to design, build, maintain and possibly even launch satellites is being developed. As part of a four-country African initiative, work has begun on the ZA-ARMC1 satellite, which will boost Africa's ability to monitor and manage its precious natural resources.

Trade and industry

The Department of Trade and Industry has also engaged with the 4th Industrial Revolution, establishing a Future Industrial Production and Technologies unit to investigate the possible impacts of the 4IR and to prepare to address the ensuing challenges. The DTI points to some potential threats of the 4IR:

- structural changes to global value chains, including selective 'reshoring' of industrial processes to major markets in advanced economies;
- significant technology-driven job losses in retail and services, mining and parts of manufacturing value chains, particularly for lower-skilled workers;
- growing inequality and exclusion;
- the danger of 'winner-takes-all' outcomes, leading to a greater concentration of production and higher barriers to entry17.

Policy Capacity

The standard policy cycle is not suited to responding quickly enough to these technological and scientific developments. This leaves policy and regulation floundering to keep up with the pace of change. In addition to often being subsumed by ongoing updates, policies in South Africa tend to lack regulatory clarity. For example, while a clear and integrated data governance framework is required to provide a safe and secure environment for citizens and enterprises to transact online, laws dealing with part of the governance framework are legislated without reference to each another, with some even facing constitutional challenges.

It has proven difficult to enable sector regulators to carry out their mandates with industry cooperation and without ambiguity, as illustrated by the controversies surrounding the now withdrawn amendment to the Electronic Communications Act and the soon to be promulgated Film and Publications Board Amendment Act. Furthermore, updates to other legislation with a key impact on 4IR

readiness are long overdue: in particular, to the 2002 Electronic Communications and Transactions Act (ECTA), from which other regulations related to cybersecurity derive and the 2002 Regulation of Interception of Communications and Provision of Communication-Related Information Act.

With regard to the 4th Industrial Revolution specifically, South Africa will soon join the World Economic Forum's Centre for the 4th Industrial Revolution (C4IR) network - alongside China, India and Japan - by launching an Affiliate Centre as a public-private partnership based at the Council for Scientific and Industrial Research (CSIR). The C4IR was launched in 2017 as a hub for global, multi-stakeholder co-operation to develop policy frameworks and advance collaborations that accelerate the benefits of science and technology. The key portfolios include: Artificial Intelligence and Machine Learning; the Internet of Things, Robotics and Smart Cities; and Digital Trade.

2.4 LEVEL OF READINESS OF THE COUNTRY FOR THE 4TH INDUSTRIAL REVOLUTION

An examination of a range of global indices compiled by international entities is commonly used to chart progress with regard to ICTs, which are a pre-requisite to economic growth and human development and to achieving the Sustainable Development Goals (SDGs) of the United Nations.

South Africa has slipped down the rankings in a number of global economic indices over the last 10 years. For example, once ranked 45th in the WEF's Global Competitiveness Index, the country is now rated 67th out of 140 countries assessed. However, South Africa' performance is uneven, ranking 18th in the financial systems sub-index, 35th in the market size sub-index and 46th in the innovation capacity sub-index. By contrast, the country performs poorly in a number of human development sub-indices - 125th in health, 85th in ICT adoption and 84th in skills.

Corruption is also an issue, with South Africa having fallen 14 places since 2000 under 'control of corruption' in the Worldwide Governance Indicators, dropping out of the top quartile.

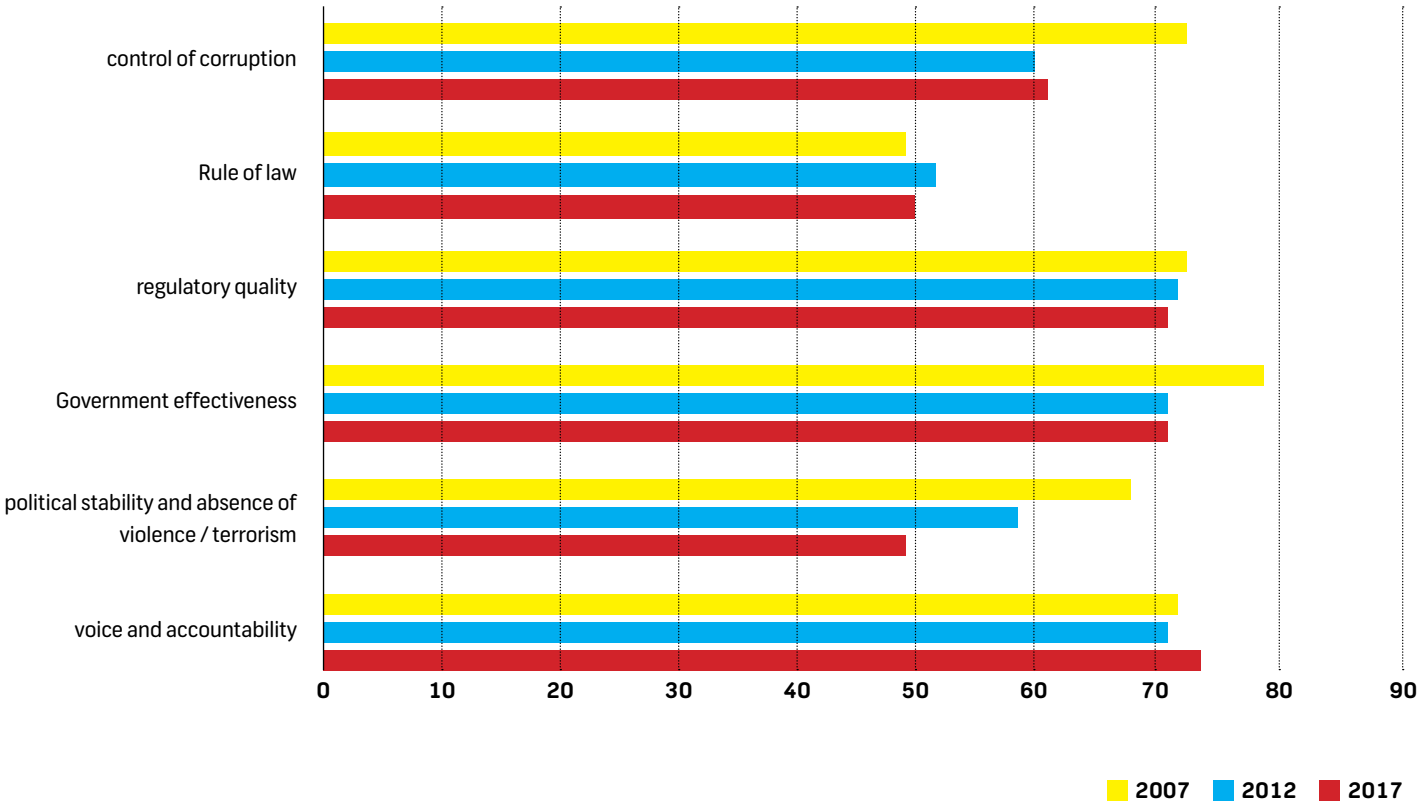
The figure 3 shows the evolution of South Africa's governance indicators over time.

Despite problems associated with global data collections and indices, they are broadly indicative of performance - and South Africa does not perform well. For example, South Africa is ranked 92nd out of 176 countries in the 2017 ICT Development Index of the International Telecommunication Union (ITU), which comprises four sub-indices addressing access, use and skills, respectively, and 22nd out of 58 countries on the Affordability Drivers Index (ADI) from the Alliance for Affordable Internet. The GSMA's 2017 Mobile Connectivity Index - which measures the performance of countries in four areas: infrastructure, affordability, consumer readiness and content - ranks South Africa 90th out of 163 countries and EIU's 3i (Inclusive Internet Index) has South Africa ranked 27th out of 75 countries. The figure 4 summarises this.

By 2016, out of 100 persons, there are an estimated eight internet users in South Africa. According to the GSMA's Mobile Connectivity Index, 156% of South Africa's population use mobile phones, with mobile broadband penetration standing at 90%. Figures like these rely on numbers of 'active' SIM cards not unique subscribers, which substantially overstates the user base, particularly in prepaid markets. In 2017, Research ICT Africa conducted nationally-representative demand-side surveys in 10 African countries, including South Africa, providing more accurate take-up estimates and showing that South Africa has the highest internet use (53%) among the countries surveyed (Ghana, Kenya, Lesotho, Mozambique, Nigeria, Rwanda, Senegal, South Africa, Tanzania and Uganda) and the second highest mobile penetration at 85%. Whilst the gender-based disparity in internet usage gender disparity is a relatively low 12% in South Africa, a significant gap exists between rural and urban areas: 61% of South African urban residents use the internet whilst less than half (39%) of those in rural areas do so. With the highest GINI coefficient in the world – at 0.62 - nationally aggregated figures such as GDP per capita or internet penetration figures mask extreme inequality.

figure 03

WGI South Africa's rank- Percentile rank 0 (lowest) to 100 (highest)



SOURCE

World Bank's Worldwide Governance Indicators (WGI) Database

The state of infrastructure development and technological advancement is a critical component of the ability of countries to embrace the 4th industrial Revolution. For many industries, advancements in Artificial Intelligence, robotics, 3D printing and the Internet of Things will put pressure on companies to move towards automation to remain competitive in the global market. The ability of industry to embrace the 4IR relies on available, affordable high-speed internet as well as access to stable and reliable electric power.

The adoption of 4IR technologies also implies a substantial shift in labour market demand and a need to realign and improve the skills base. A pipeline of future talent that can embrace the 4IR dynamic in an increasingly complex environment needs to be built. The 2017 After Access survey shows that lack of education and the consequent lack of income is a critical barrier to adoption and use of the internet.

Labour supply and demand in the country is misaligned, with an oversupply of graduates and a shortage of technicians. Furthermore, graduates are primarily in the humanities and social sciences rather than in science, engineering and computer science. Despite significant growth in the number of PhD graduates since 2009 (with 2,797 doctoral graduates in 2016) , this is far below other middle income and emerging economies.

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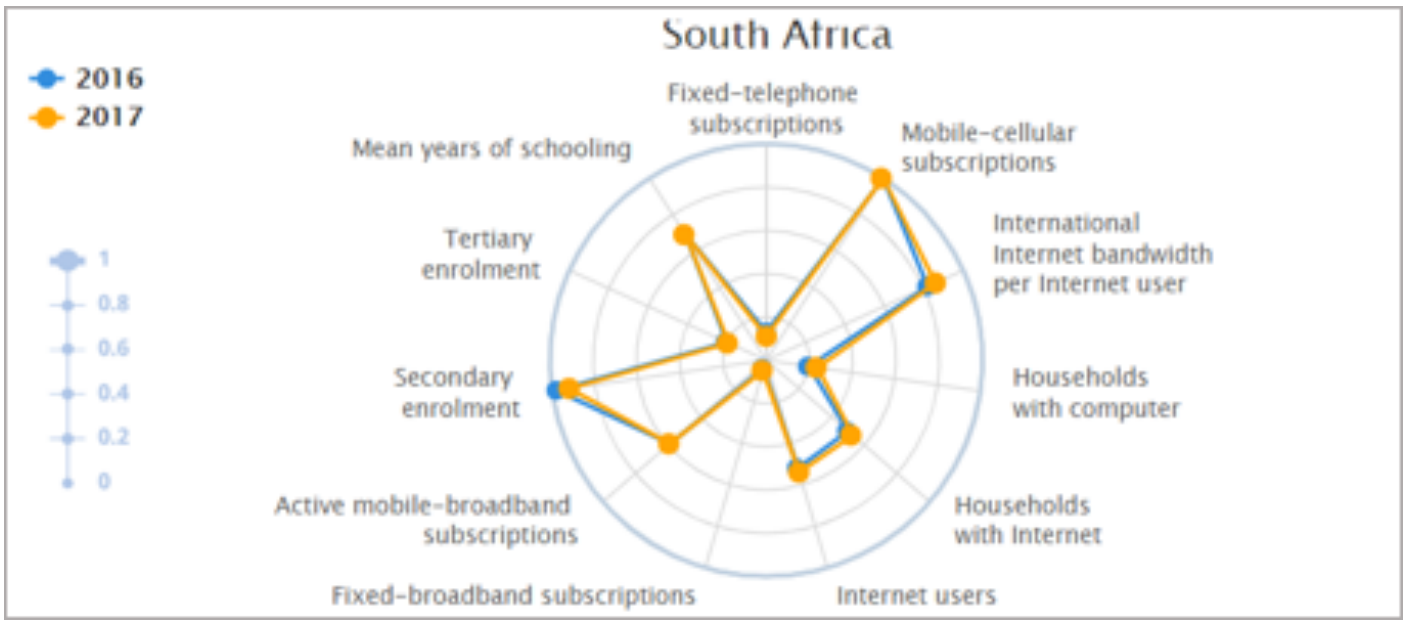
figure 04

South Africa's ranking in the ITU's ICT Development index, 2017



Based on the WIPO's 2018 Readiness for the Future of Production Report, which measures the rate of technology and innovation across 100 countries, South Africa is in 45th and 49th position on the structures of production and the drivers of production, and according to this report, South Africa is one of the three G20 countries that showed the lowest levels of readiness. Concerning the ability to innovate, South Africa is one of the highest ranking countries in Africa, even though its values (on a scale on 0-10) still fall slightly below the median for state of cluster development, company investment in emerging technology, companies embracing disruptive ideas, multi-stakeholder collaboration, R&D expenditures, scientific and technical publications; but needs to improve more on R&D expenditure and patent applications.

An effective cybersecurity framework and proper data governance measures are essential in the context of the 4IR. However, South Africa's readiness for the 4IR is constrained by the lack of an overarching data governance framework or an open data policy framework. Government has not shown leadership either in co-ordinating with the private sector or in the adoption of new technologies for the purposes of administration or for service delivery. The troubled SITA did attempt to develop a public sector plan for the 4IR but was unable to secure sufficient budget before parliament rose.

Cybersecurity also lacks institutional mechanisms for promoting safe information flows across government regarding cyber threats and how to respond to them. In

addition, the Cybersecurity Response Committee, which is chaired by the Director-General of State Security, has not surprisingly been criticised for lack of transparency. Furthermore, the National Cybersecurity Policy Framework (NCPF), which has been slow in implementation, does not deal directly with 4IR issues, and its approach to dealing with issues related to the internet leaves much to be desired.

A number of different departments and agencies have had responsibility for different aspects of data governance, including the Department of Telecommunications and Postal Services, the Security and Justice cluster, and now the Information Commissioner, appointed in terms of the Protection of Personal Information Act (POPI).

The 2013 Protection of Personal Information (POPI) Act has substantial similarities to the EU's 2016 General Data Protection Regulation (GDPR). It was released in 2009 and enacted in 2013 but has as yet only partially come into full effect. The new information regulator, established by POPI, has only recently started actively investigating privacy breaches. As with the GDPR, POPI provides a measure of cross-border protection for data subjects.

Nonetheless, a number of measures are being put in place to deal with cybersecurity issues. These include: the 2012 National Cyber Policy Framework (NCPF), setting out measures and mechanisms for better co-ordination across government; the 2015 National Cybersecurity Policy Framework (NCPF); followed by a troubled Cybercrimes and Cybersecurity Bill, now substantially reworked and renamed as the Cybercrimes Bill (with its cybersecurity provisions removed) .

From an institutional design point of the view, South Africa has adopted an interagency approach to cybersecurity. The government recognised that the issue of cybersecurity is cross-cutting and cannot be addressed by one department alone. In line with this, a number of government departments are jointly involved in cybersecurity. These include:

- the Cabinet Justice, Crime Prevention and Security Cluster (JCPS) Cluster, led by the Minister of Justice, is in charge of reviewing all related legislation to ensure harmonisation and alignment;
- the DTPS is part of the Cyber Response Committee (CRC) established under the Cluster and is thus involved in ensuring alignment with the ECTA; and
- the State Security Agency, which is tasked with the overall responsibility of cybersecurity.

The plethora of organisations, clusters and structures involved – many of which involve potential traditional rivalries – suggest that coordination could be problematic. Other challenges relate to implementation efficacy, including the degree to which the NCPF demands institutional arrangements for which it still lacks administrative and technological skills to actually deliver.

ICT LANDSCAPE IN SOUTH AFRICA

International bandwidth

Since 2009, a number of new undersea cables have been laid around South Africa, on both the east and west coasts. Today, there are six submarine cables connecting the country to the rest of the world, with more being planned. These investments have improved the quality and speed of broadband and led to a massive reduction in prices and a consequent surge in demand.

National transmission

Considerable backbone and backhaul investments have been made in recent decades by a number of network providers, including Telkom, Liquid Telecom, Broadband InfraCo and the mobile operators, giving South Africa the most advanced and extensive infrastructure on the continent. This has been supplemented in recent years by a greater focus on the expansion of fibre networks in the affluent suburbs in large metropolitan areas. Together with the backhaul investments made by the MTN, Vodacom, and Neotel, South Africa is estimated to have over 80,000 km of unduplicated and 120,000 of duplicated fibre.

Mobile coverage

These developments have given South Africa one of the most advanced telecommunications infrastructures

t

table 01

South Africa's performance on the NRI's sub-indicators

ENVIRONMENTAL– 33	READINESS– 69	USAGE – 75	IMPACT–93
Political and regulatory environment, **26th**	Infrastructure and digital content development, **44th**	Individual, **77th**	Economic impacts, **57th**
Business and innovation, **65th**	Affordability, **74th**	Business, **32nd**	Social impact, **112th**
	Skills, **95th**	Government, **105th**	

SOURCE
WEF Global IT Report, 2016

on the continent. The country's ranking on the WEF's Networked Readiness Index (NRI) has improved since 2014 to 65th out of 139 countries, second only to the top-performing African country, Mauritius. This upsurge is, however, mainly business driven, as the country performs best in business usage (32nd), followed by individual usage (77th) and government usage (105th). In terms of business innovation, South Africa is ranked 65th out of 139 countries.

The Centre for High-Performance Computing (CHPC), the South African Research Network (SANREN) and the Very Large Databases are the three pillars of cyber-infrastructure that the DST supports. Hosted by the University of Cape Town and managed by the CSIR's Meraka Institute, the CHPC was the first of its kind in South Africa and is making scientific supercomputing a reality for South Africa.

Another major DST initiative, jointly with the National Research Foundation (NRF), is the multibillion-rand Square Kilometre Array, hosted in South Africa and Australia, and extending into eight African countries. When it becomes operationally mature in 2020, it will be the world's biggest telescope. It is also one of the biggest ever scientific projects involving multinational collaboration. With thousands of linked radio wave receptors in Australia and in southern Africa, the amounts of data being collected and transmitted by the SKA mean that the project requires supercomputing power and Big Data management and analytics capabilities, along with unprecedented data connectivity. Meeting the advanced technological and engineering needs of this project has resulted in significant local skills development and enabled innovative new businesses and employment in the science, technology and engineering fields.

Human capital development is already taking place as a result of the SKA project, with bursaries and scholarships being granted to allow students to learn the necessary cutting-edge science, technology, maths and engineering skills to support the project. Given that the SKA is a long-term project over decades, its effect will increase. There is also an effort being made through significant investments by the NRF in PhD registration with some positive results and a DST programme to support developers of patents, though they remain low in number. Going forward, there will be a strong drive to leverage the SKA as a spearhead for other programmes, including next-generation high-performance computing and Big Data.

South Africa also hosts the world's largest 3D printer, which uses titanium powder to build very complex objects. The

project is funded by the DST and it has been developed from a collaboration between the Aerosud Innovation Centre and the CSIR's National Laser Centre on Pretoria.

Taken together, these initiatives by the State compensate enormously for low R&D investments by the private sector. On average, and compared to the value of their sales, South African manufacturing firms spend seven times less than American companies on research and development (R&D).

The following sections will provide an analysis of the sectors that are using some sort of 4IR technology and the potential that they present for investment. The sectors analysed are agriculture, energy, industrialisation, regional integration and well-being.

Tech Hubs, Incubators

To encourage the development of technological innovators and their conversion to viable businesses, South Africa has a strategy to support incubators and technology hubs. By 2018, the GSMA was reporting 442 technology hubs and incubators in Africa, with some 13% of them located in South Africa. These include the Gauteng's Innovation Hub, Jozihub and the Cape Innovation and Technological Initiative (CiTi), and MLabs in both centres.

The World Bank was responsible for seeding MLab in Tshwane as a start-up incubator and activities are focused on a skill acceleration programme with consistent funding from the Department of Science and Technology. Combined with shorter term grants and partnership with the private sector (particularly some of the bigger names such as Nokia, Google Play, Microsoft and Intel) the lab is more engaged in enterprise skills development programmes with the major local skills accelerator and job connector Harambee.

The Department for Science & Technology (DST) also funded the Industry Innovation Partnership, which was developed by MLab specifically in response to the NDP identification of e-skill needs in the economy. The programme is rolled out at the provincial level with co-funding from provincial departments of economic development. Although it was a success in terms of the numbers of people trained, the head of MLabs mentioned that trying to extend the programmes into provinces and townships was a complex task, with initiatives reinforcing apartheid spatial realities and dependencies rather than integrating those acquiring skills into the urban markets and elite parts of the cities where there are job opportunities.

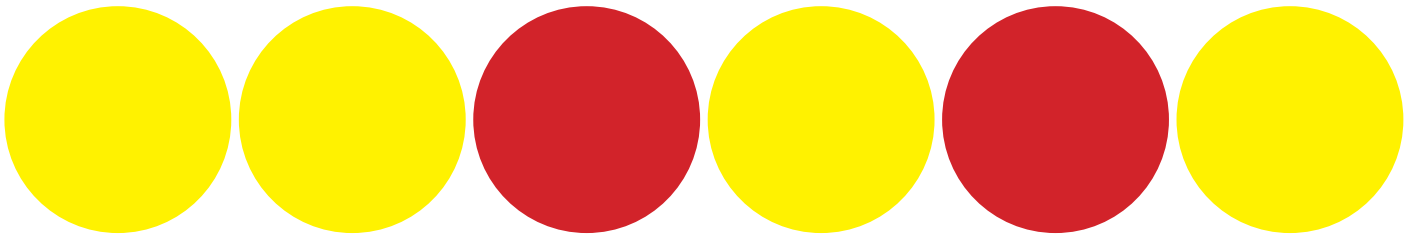
The more economically developed provinces of Gauteng and Western Cape have also developed innovation initiatives often together with the megacities of Johannesburg and Cape Town – the Gauteng's Innovation Hub, Jozihub and the Cape Innovation and Technological Initiative (CiTi).


TRANSMET

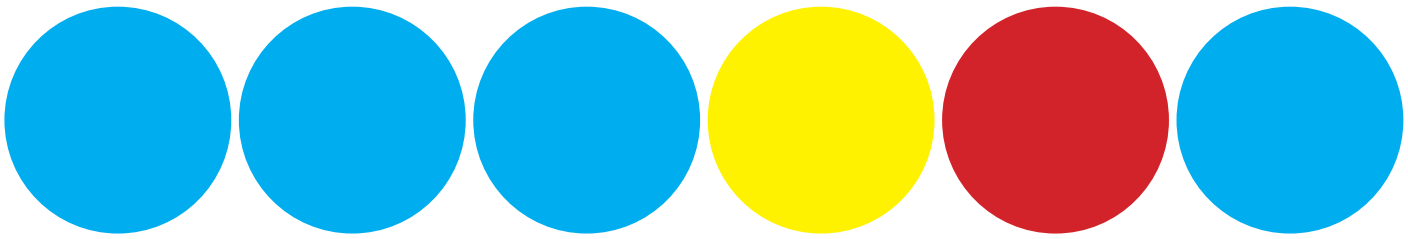
3
agriculture

figure A

current level of utilization of technologies



potential for applications



LEGEND

red, not many / few examples; **yellow,** nascent / some examples; **blue,** good potential /numerous examples

3.1 PRESENTATION

The agriculture sector accounts for a relatively small share of the country's total GDP. The sector's contribution to GDP has declined from 3.9% in 1994 to just 2% in 2018. However, agriculture, forestry and fishing were the sectors with the highest growth during Q4 of 2018, at 7.9%. Despite its small share of total GDP, the sector is an important sector in the South African economy. It remains a significant provider of employment, especially in rural areas, and is a major earner of foreign exchange. It is estimated that close to 8.5 million people are directly or indirectly dependent on the industry for their employment and income. In addition, the issues of land redistribution and job creation, together with those of food security, are increasing the importance of the agriculture sector in the government's transformation agenda.

South Africa has close to 35,000 registered commercial farms, 40% of which are engaged in field crop farming, with 60% focused on livestock farming. Over 2017/18, agriculture production was estimated at 62.9 million tonnes (a 24% increase from 2016) valued at R281,370 million (a 4.7% increase). Since 1994, the agriculture sector has shown a growth rate of 7.5% per year.

According to the AfDB, the agricultural productivity index (which measures the relative level of aggregate volume of agricultural production for each year by comparison with the base period of 2004-2006) of South Africa has increased to about 148 from 117 in 2006. In 2019, there were over a million people involved in agriculture, with women representing about 30% of this population. Commercial farmers produce most of the agricultural output in South Africa. The country has a total of close to 70,000 commercial farming units, but only 4% have an annual turnover exceeding R5 million. Some 75% of all South African farming is carried out by smallholders, with small-scale farming the primary source of food in rural areas.

The contribution of the agriculture sector has waxed and waned in relation to the resources and services sectors. Its make-up has almost entirely shifted over the last century from mixed subsistence and commercial farming to large-scale capital-intensive farming. The growth in the sector is hampered by many socio-political issues, such as lack of title deeds, limited access to finance, especially for smallholders, water rights issues and infrastructure constraints such as limited road network, storage and warehousing facilities. Many farms are not connected to the internet.

The current political debate surrounding appropriation of land without compensation is creating uncertainty within the agriculture sector, which is delaying investments and strategic business ventures. Agriculture yield and total production are also directly affected by adverse weather conditions - flooding in some parts of the country and drought in others. The effects of global warming and climate change have without doubt also affected agricultural output. While this cannot be controlled, it can be avoided by better irrigation planning and also by the appropriate use of technology.

The Department of Agriculture, Forestry and Fisheries (DAFF) is responsible for the agriculture sector in South Africa. Its mandate is to ensure collaboration across sector value chains, inputs, production and consumption in the agriculture, forestry and fishery sectors.

The DAFF's focus is to improve food security; create jobs; increase the sector's contribution to the GDP; enhance primary animal healthcare services and enable trade in the global economy. The agriculture sector can potentially play an important role in achieving the goals of the NDP, especially in ensuring household food security and through job creation (the NDP sets a target of close to one million new jobs by 2030). This requires areas under irrigation to be more than doubled, the cultivation of underutilised land in communal areas, support for commercial agriculture with the highest growth and employment potential and finding creative ways to increase collaboration between commercial and small farmers. The sector is seen as a creator of jobs and recognised as a driver of inclusive and sustainable growth, providing a foundation for nutritious, safe and affordable food. However, there are no clear implementation plans to implement the NDP goals.

3.2 RATIONALE FOR SUPPORTING THE ADOPTION OF 4IR TECHNOLOGIES

3.2.1 Potential applications and impacts

The government's objective is to eradicate poverty, inequality and unemployment. As noted above, the NDP identifies agriculture as a key sector for economic growth and job creation. But, with the current reality and uncertainty around land reform, it is unlikely that the NDP's targets will be met.

The available commercial agricultural land currently stands at 82.2 million hectares. The population is expected to increase by some 15% over the next 15 years to reach 70 million by 2035 and the current rate of urbanisation means that 75% of the population will live in cities, leaving fewer people in rural areas to work the land. Furthermore, arable land around larger cities is increasingly being taken for housing. Projections therefore suggest that the amount of available commercial agricultural land will fall to 70.2 million hectares by 2035. The current per capita availability of agricultural land is thus expected to decrease from the current 1.6 hectares to only 1.1 hectares of land by 2035. Together, this means that greater productivity is needed to sustain the growing population and ensure food security, presenting opportunities to adopt technology solutions of the kind offered by the 4IR. This will likely lead to automation and loss of some manual jobs, although new technology-intensive jobs will also be created, requiring new skill sets and the realignment of labour supply and demand.

There is a need to ensure inclusive transformation and upliftment of the agriculture sector, integrating small farmers into the larger agriculture value chain, building collaboration and a sense of a shared economy between large and small farmers. Awareness needs to be built as to how integrating technology can lead to more efficient farming practices and help address challenges like water deficits and rising input costs. The increased use of IoT sensors, drones and satellite imaging will lead to the increased use of Artificial Intelligence and Machine Learning. Blockchain also has application for the resolution of conflicting land claims and the registration of land previously without title deeds, such as tribal land.

The technological developments in the agriculture sector should not be seen as an alternative to existing farming practices or a way of substituting labour but as a complementary and supporting tool that can provide benefits in terms of both inputs and outputs. The increase in agricultural productivity and production has the potential to contribute substantially to economic development. Failure to integrate new technologies into the agriculture sector can lead to more job losses, decreased output and lower economic growth.

The agriculture sector reflects South Africa's dual economy, with medium to large farmers using drones and satellite imaging for data collection whilst small farm holders struggle to obtain financing even for seeds and irrigation. Integrating the right technology is essential to modern farming. It increases farming efficiency, which, in the long run, can influence the profitability of the sector and, in turn, lead to a scalable and sustainable way of ensuring food security in the country.

3.2.2 Current use cases and level of technology take-up

The make-up of South Africa's farming landscape differs dramatically from the rest of the region, with close to 90% of farming output produced by commercial farmers, whereas in the east and west Africa 90% of output comes from small farmers. Unsurprisingly then, the large commercial farmers are the early adopters of technology in South Africa, with the exposure to new technologies and the resources to deploy them to enhance efficient and sustainable farming practices.

In terms of farming practices, drones, satellite imaging and Artificial Intelligence are the key technologies shaping the sector in preparation for the 4th Industrial Revolution, with Blockchain a possible, albeit still embryonic, option to resolve land registry issues relating to apartheid land claims. Furthermore, Artificial Intelligence can provide solutions for control of agriculture inputs, for monitoring soil moisture and irrigation, water management services and for predicting areas that may be at risk of developing pests and diseases.

However, smaller farmers are apprehensive about adopting new technologies due to their cost and have limited awareness as to the benefits of leveraging a drone or satellite imaging to increase productivity. Furthermore, connecting small farm holders to agribusiness continues to be an important gap, together with identifying who these farmers are, where are they located and what they are producing. It is, however, one that can be addressed with the technology. For example, one supplier has developed a platform to communicate with small-scale farmers via their mobile phones using SMS. Technology can empower small farmers to have a large footprint in the agriculture value chain, not only addressing challenges but unlocking opportunities.

Providers see the use of technology as a complementary tool to make farming more efficient and more cost effective and to increase yields and reduce costs – rather than to re-invent farming processes. Technologies - such as wireless communication technologies, data management and analytical tools, remote sensing, robotics, drones, satellite systems and Artificial Intelligence - are being integrated to develop services that enable precision agriculture, reducing costs, conserving resources, optimising inputs and maximising outputs and allowing statistical analysis and predictions of output.

3.2.3 Drivers and challenges specific to agriculture

Apart from start-ups driving technological adoption in the sector, the key preconditions for the take-up of 4IR technologies are reliable electricity supply, affordable internet connectivity and increased access to finance for small farmers.

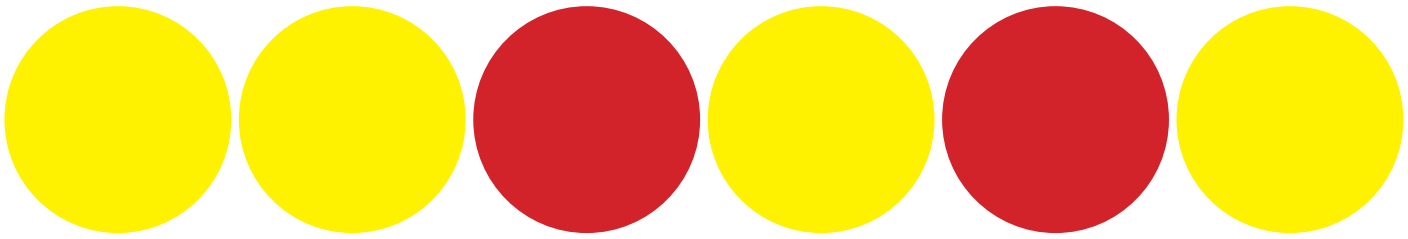
The technological development of the agricultural sector is, however, constrained by a lack of qualified professionals and technicians as agricultural colleges are struggling to deliver technically skilled people required for both farm management and skilled workers, and to increase students' exposure to modern agricultural practices and practical fieldwork.

However, the payoff for success is substantial: agriculture is estimated to be twice to four times more effective in reducing poverty than any other sector.

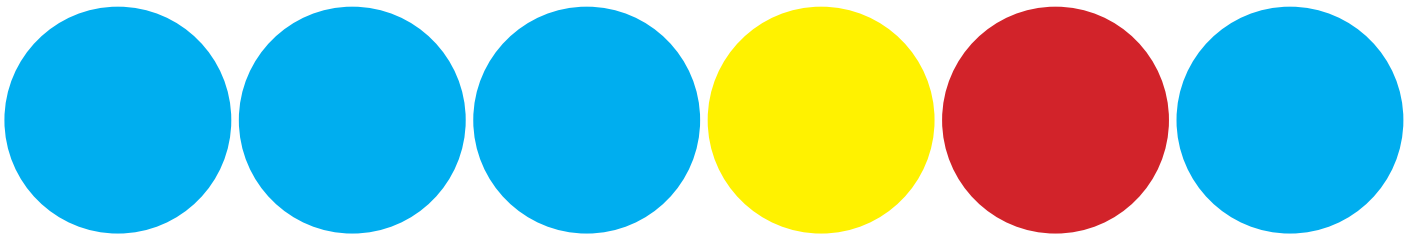
4
energy

figure B

current level of utilization of technologies



potential for applications



LEGEND

red, not many / few examples; **yellow,** nascent / some examples; **blue,** good potential /numerous examples

4.1 PRESENTATION

The focus of this chapter is on the pressing issue of South Africa's shift from its fossil fuel-based energy economy to a more sustainable future based primarily on renewable energy and the potential application of 4IR technologies in that transition.

Traditionally, the sector as a whole is divided into two main sub-sectors – namely the electricity sector and the liquefied fuels sector – mostly used in transport. This chapter, however, focuses on the electricity sector. The significant changes with regard to liquefied fuels and the transport sector (e.g. innovations in batteries and energy storage) that will have a profound impact on South Africa's cities, tax structure and industrial base are not addressed in this chapter.

South Africa is endowed with a broad spectrum of abundant energy resources, primarily fossil fuels such as coal, uranium, liquefied fuels and gas while biomass forms the main energy source for rural households. Renewable energy sources, such as solar and wind power, pumped storage and hydro-power schemes, are already being explored. This should provide the necessary infrastructure as an economic basis to attract foreign investments into the energy sector. South Africa's current energy mix is made up of coal (81%), nuclear (4%), gas (5%), hydro (4%) and wind/solar (5%). However, the inability of the sector to guarantee a stable supply of electricity presents a major challenge to the ailing economy and curtails the opportunities of the 4IR. Electricity production from solar, wind, tide, wave and other renewable sources has been increasing in recent years standing at 899.64GWh in 2015. By 2012, about 100% of South Africa had access to electricity already. Figure 6 below provides more insight on some energy parameters in South Africa.

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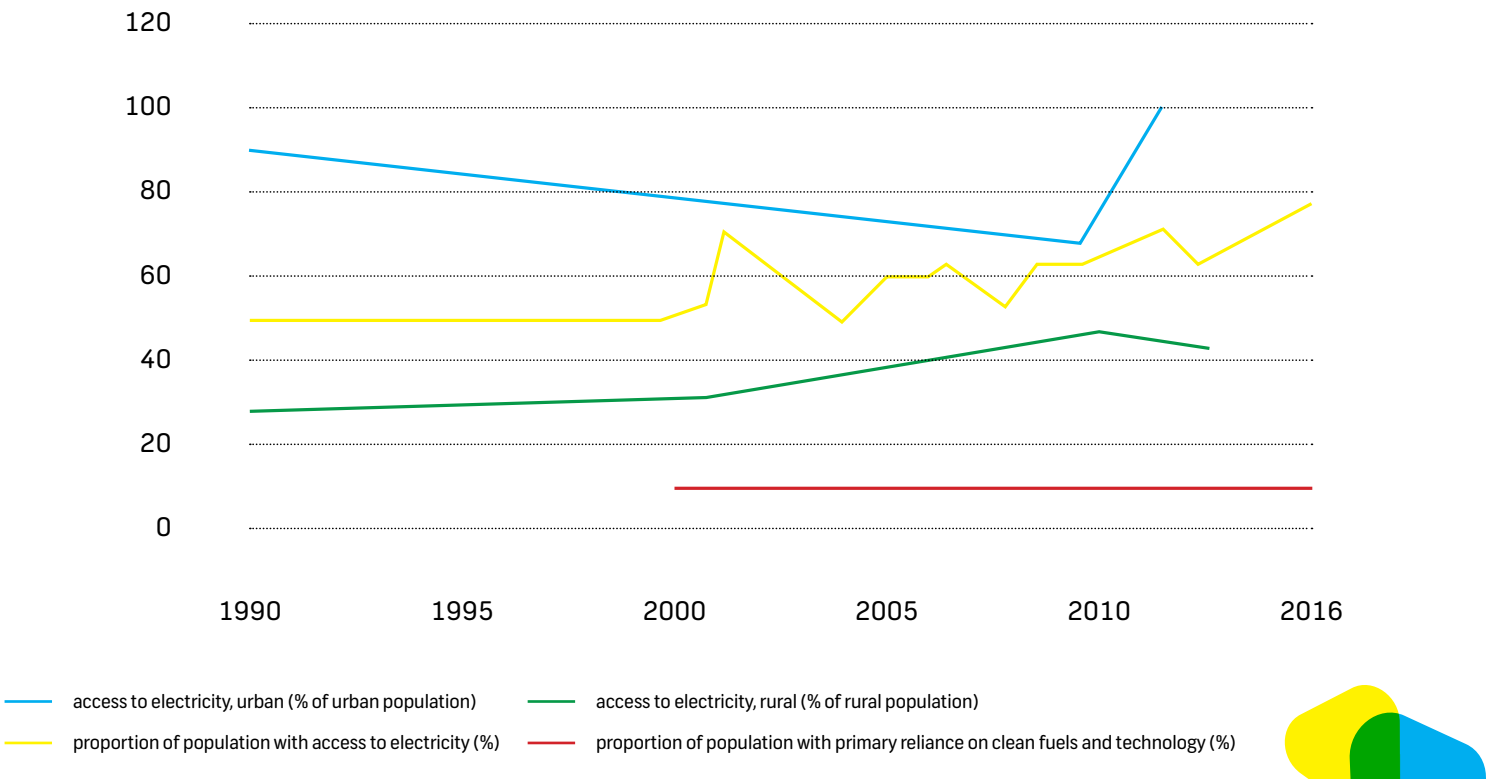
figure 05

evolution of access to electricity in South Africa



Eskom is synonymous with electricity in South Africa, providing 95% of generation capacity (of which 90% is coal fired) and has been run as a vertically integrated electricity monopoly since the 1970s. There have been efforts to restructure Eskom since the 1990s. For example, the 1998 Energy White Paper, which remains official energy policy, contemplated breaking up Eskom and allowing competition and private investment. Consequently, at the time, any new investment by Eskom was discouraged. However, its management responded to this threat by entering into a series of price pacts in which it sold electricity below the cost of production (taking capital depreciation into account). Furthermore, Eskom's important role in the government's electrification programme enabled the company to sidestep any attempt to introduce private investment or competition.

With revenues of about R180 billion, Eskom ranks as one of the largest companies in South Africa, with 3.5 million customers (including domestic users), and a massive distribution business. Its nominal generating capacity of 44 MW and generation of over 200 TWh of electricity annually ranks it amongst the top twenty electricity utilities in the world. Its 28,000 km transmission grid is one of the world's biggest. With a bloated workforce of 47,000, it is one of the biggest employers in the country and ranks as one of the top 10 utilities worldwide measured by the number of employees.

But Eskom faces significant challenges. After many years of over-capacity and selling electricity below the long term costs of supplying it, Eskom found itself in the mid-2000s with a shortage of capacity. As a result, the country was plunged into a series of rolling black-outs, starting from 2006 and returning intermittently until 2019. The capacity shortage resulted in the decision to build two mega coal-fired power stations, Medupi in the Waterberg and Kusile in Mpumalanga. In addition, Eskom now faces the issue of an ageing plant that is unreliable, more expensive to run and in need of replacement.

The Constitution requires the government to establish a national energy policy to ensure that energy resources are adequately managed and developed to cater for the needs of the nation. Accordingly, government has sought to ensure that affordable energy be available to all. However, energy production and distribution should not only lead to an improvement in the standard of living for all of the country's citizens but should also be sustainable. Policy flip flops in the early reform years and the failure to implement reforms intended to transform the public utility into an efficient and competitive company, together with large scale mismanagement and corruption, have undermined Eskom's critical role.

Energy White Paper of 1998

Aligned to the policy of reconstruction and development, the White Paper addresses the challenges of transforming state-owned entities and of reshaping their governance principles, together with enhancing socio-economic welfare for communities, and even changing people's attitudes towards the value and use of national energy resources . Its policy objectives included extending access to affordable and sustainable energy to a wide range of communities and establishments.

In line with global reform, the government established a clear distinction between its primary policy-making role and its secondary role as a facilitator in the supply of energy services. Accordingly, in 2004, the National Energy Regulator of South Africa (NERSA) was established as an autonomous dedicated entity to regulate the energy sector . Planning for the sector was also moved from the Department of State Enterprises to the Department of Energy and is now undertaken through a process known as the Integrated Resource Plan (IRP). Nonetheless, electricity regulation, governance and policy formation remain somewhat haphazard and uncoordinated.

White Paper on Renewable Energy 2003

This White Paper aimed to develop sustainable, renewable energy supplies to rural communities and entities far from the national grid. The policy also focuses on supplying energy for rural water supply and solar water heating for households and businesses, both urban and rural. It sees that large-scale utilisation of renewable energy will reduce carbon dioxide emissions and benefit the environment.

Renewable energy has a significant role in promoting integrated sustainable rural development and in improving the quality of life of rural communities. Decentralised mini grids with hybrid systems are already running at two pilot sites in the eastern Cape (at Lucingweni and the Hluleka Nature Reserve).

National Development Plan

According to the objectives of the NDP, by 2030 South Africa should have an energy sector that drives economic growth with an adequate supply of electricity, with at least 95% of the population having access to the grid or to off-grid electricity. By 2018, 90% of South Africans had access to power and 80% of rural areas had been electrified through the integrated national electrification programme.

The biggest challenge, therefore, is not the electrification rate but instead ensuring a constant and sustainable power supply. However, the renewable energy targets of the NDP – that wind, solar and hydro-electricity should also make up at least 20,000 MW of the additional 29,000 MW of additional capacity – are far from being achieved. By 2018, renewable energy contributed only 8.8% towards the total domestic electricity generation capacity of 51,309 MW. Despite modest economic growth over the last ten years, the shift from energy-intensive sectors towards services means that South Africa now consumes less electricity than it did a decade ago.

Mismanagement, 'state capture' and corruption, along with ongoing dependence on ageing coal plants, mean that the current South African electricity supply system is no longer sustainable as it is. Accordingly, the presidential task team set up to address the inconsistent power supply has recommended, inter alia, the break-up of Eskom into smaller units (generation, transmission and distribution) and the deregulation of electricity distribution, allowing for localised microgrids. More controversially, the task team recommends reducing the role of coal in South Africa's energy mix, and the gradual closure of coal-fired power plants over the next 30 years. Although in line with the draft Integrated Resource Plan, this will require huge political will and plans to mitigate against job losses.

However, an energy system based on renewables offers significant comparative advantages. Even without such advantages, other countries are already investing in renewable energy, which is now cheaper than legacy fossil fuel-based systems. Should South Africa fail to exploit its comparative advantages, it risks falling behind the rest of the world and becoming a high-cost energy jurisdiction.

4.2 RATIONALE FOR SUPPORTING THE ADOPTION OF 4IR TECHNOLOGIES

4.2.1 Potential applications and impacts

Eskom is currently configured so that its power is mostly generated from very large, remote, coal-fired power stations and fed into a single national grid. The resulting long-distance transmission grid leads to power losses, which are most severe during peak periods when there is greater competition for access to power on the grid.

The distributed, digital transaction ledger technology of Blockchain, which underpins controversial cryptocurrencies such as Bitcoin, also has potential applications in the area of energy supply and trading, permitting transparent supply chain management and the introduction of smart contracts. In the transition to a more decentralised, digitalised and decarbonised world, Blockchain might further enable automated bill payments and the sharing of transferable renewable energy credits. Blockchain could also offer a smart transaction platform where households could also become producers and sellers of energy with a high degree of autonomy, increasing efficiency by balancing supply and demand in real time. There are a number of smaller companies around the world focusing on peer-to-peer energy trading, but the field is still new and difficult to manage. Blockchain might facilitate peer-to-peer trading. The potential for South Africa really lies in investment in the smart grid (Blockchain and AI) and, in the context of advanced renewables, as a way to streamline the different power production inputs and re-distribute them in a more efficient way via the integration of technology.

The technical architecture of Blockchain is, however, extremely energy intensive. To overcome this problem, energy Blockchains eschew the proof-of-work processes

involved in Bitcoin mining and use something less secure called 'proof-of-stake'. However, sharing sensitive financial and transactional data via Blockchain falls foul of General Data Protection Regulation (GDPR) rules. Nevertheless, if this can be overcome, Blockchain solutions might allow more energy trading in deregulated markets such as some of those in the USA, Australia and parts of Europe. In South Africa, the use of Blockchain will require changes to regulation for both peer-to-peer trading and the use of Blockchain itself.

The Sun Exchange is a South African start-up company that works like a crowdfunding platform for small- to medium-scale solar projects in developing countries. It acts as the middleman between local communities and investors. The focus of the start-up is to identify areas with significant potential for solar panel systems. These modules are then sold to private investors who in turn can lease to local communities, schools and businesses. By doing so, local communities can benefit from clean and affordable electricity while investors are ensuring long term power supply and generating income through the solar panel lifespan, which is usually twenty years. All transactions can use national currency or Bitcoin payment. Allowing the use of Bitcoin payment is especially crucial for international investors as it provides a way to simplify international monetary operations. Currently, Sun Exchange has funded two projects, which includes an 18kw rooftop solar plant in Cape Town for a non-profit organisation and a 60kw system for an elephant park in Knysna.

4.2.2 Current use cases and level of technology take-up

South Africa's Renewable Energy Programme. In 2010, South Africa commenced a renewable energy programme. This initiative - the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) - arises

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table 02

South Africa energy projects by main technology

	BW1		BW2		BW3		BW4		BW5		TOTAL	
Projects	capacity in MW	number of projects	capacity in MW	number of projects	capacity in MW	number of projects	capacity in MW	number of projects	capacity in MW	number of projects	capacity in MW	number of projects
Onshore Wind	649	8	559	7	787	7	-	-	1 362	12	**3 357**	**34**
Solar PV	627	18	417	9	-	-	-	-	813	12	**2 292**	**45**
Solar CSP	150	2	50	1	-	-	200	2	-	-	**600**	**7**
Landfill Gas	-	-	-	-	18	1	-	-	-	-	**18**	**1**
Biomass	-	-	-	-	17	1	-	-	-	-	**42**	**2**
Small Hydro	-	-	14	2			-	-	5	1	**19**	**3**
	1425	28	1040	19	1457	17	200	2	2205	26	**6327**	**92**

SOURCE
WEF Global IT Report, 2016

from commitments made under World Bank funding of the Medupi power station. Procurement of generating capacity for REIPPPP is done through Eskom and it is managed via the IPP Office under the Department of Energy. Since November 2011, more than 6,327 MW from 92 renewable energy projects has been awarded in projects covering solar PV, onshore wind, biomass, small hydro, Concentrated Solar Power (CSP) and landfill gas. This represents a total investment of R192 billion, over a quarter of which is foreign direct investment. Many of the projects are already in commercial operation, contributing about 1,827 MW to the generation mix.

As the REIPPPP has matured, project funding and ownership structures have also changed through better understanding of project risk, increasing competition and economies of scale. Larger operators, often foreign utilities or specialist developers with access to funding on concessionary terms or investors with patient capital, are beginning to dominate. The breakdown of projects by main technology is as in Table 2.

As is evident from Table 3, the fully indexed average price (Rand/kWh) reflected in the Power Purchase Agreement with Eskom has fallen at each bidding round. The cumulative effect is dramatic.

Beyond the significant cost savings offered by REIPPPP, the shortened lead time from build to commercial operation is significant. Renewables are now the cheapest new build energy option.

t

table 03

index average price in the Power Purchase Agreement

	BW1	BW2	BW3	BW4	BW5
Onshore wind	1.36	1.07	0.78	-	0.68
Reduction from previous round	-	21.3%	27.1%	-	12.8%
Total decline from BW1	-	-	-	-	50%
Solar	3.39	1.96	1.05	-	0.82
PV reduction from previous round	-	42.18%	46.43%	-	21.9%
Total decline from BW1	-	-	-	-	75.8%
CSP	3.2	3	1.74	1.62	-
Reduction from previous round	-	6.25%	42.0%	6.9%	-
Total decline from BW1	-	-	-	49.38%	-

Most renewable energy development takes place in defined Renewable Energy Development Zones (REDZs), which are geographical areas where wind and solar development will have the lowest medium- to long-term impact on the environment while yielding the best social and economic benefit.

In 2016, the REIPPPP became stalled, with Eskom refusing to sign new Power Purchase Agreements on the grounds that renewables are too expensive and that it had sufficient generating capacity itself. Under incoming President Ramaphosa, however, the final rounds of bids were assigned to contractors. There are some tentative efforts to restart the programme.

Both the current transmission grid and the distribution grids need significant upgrading, the latter more seriously so, particularly in order to deploy Internet of Things (IoT) technologies along with smart (time of use (ToU)) metering and to allow disaggregation of charges from the standard set kWh rate into their various components. Widespread deployment of variable energy sources requires that these cost elements be unbundled and charged separately. Furthermore, smart renewables-friendly grids allow for better management of supply and demand and offer an intelligent electricity network that can integrate the actions of generators, users and consumers to deliver an efficient and secure electricity supply.

4.3 Drivers and challenges specific to energy

Although South Africa's electricity system, operated as it has been by a vertically integrated monopoly, has not encouraged the development of the requisite skills, the electricity system itself is relatively large. As such, there are many opportunities to repurpose existing skills and to draw in skills from other sectors such as finance, IT, telecoms and construction. The REIPPPP experience shows that South Africa is capable of delivering large projects within budget and on time and that it is possible to adapt existing infrastructure to accommodate more renewables. The real work lies in the distribution networks and there is already significant progress in beginning to adapt distribution networks for more renewable energy.

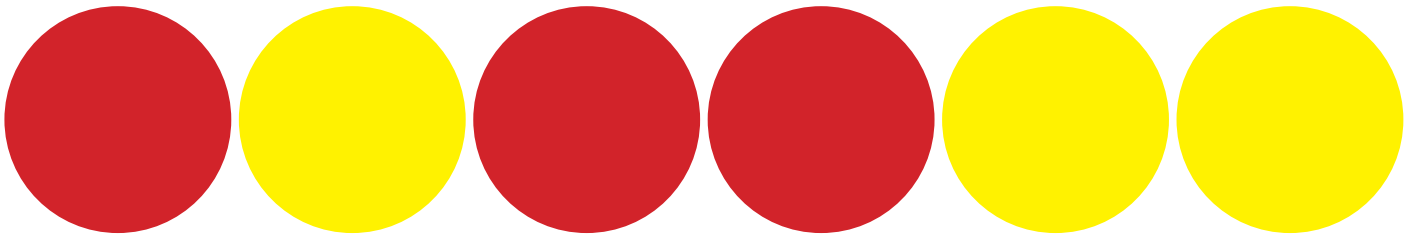
One area requiring urgent attention is in regulation, system governance and the institutions that should be facilitating the energy transition. These are simply not fit for purpose, as can be seen from the delays at the NERSA to license privately-funded facilities of less than 10 MW, and its inability to issue regulations for permits for embedded generators of less than 1 MW.

4
industrialisation

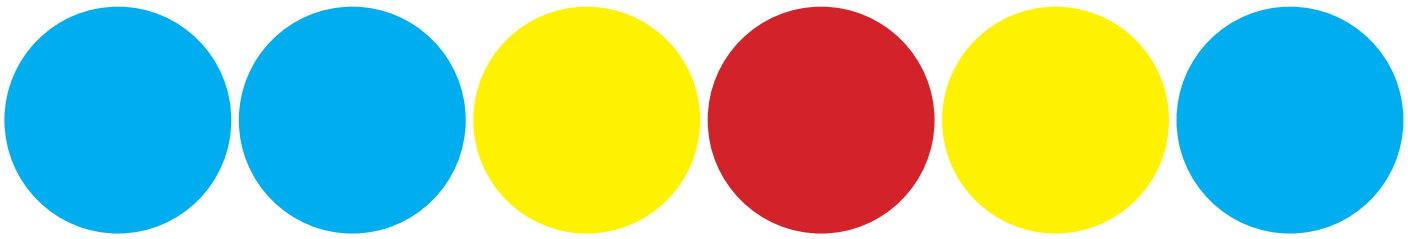
Manufacturing is South Africa's fourth largest industry, contributing 14% to Gross Domestic Product (GDP) and employing about 1.2 million people. Growth within the manufacturing sector has created high-income jobs, upstream relations to local businesses and multiplier effects throughout the economy for both formal and informal workers.

figure C

current level of utilization of technologies



potential for applications



LEGEND

red, not many / few examples; **yellow,** nascent / some examples; **blue,** good potential /numerous examples

5.1 PRESENTATION

For the purpose of the paper, the main focus under industrialisation is manufacturing, which comprises various sub-sectors, as highlighted below. Manufacturing is South Africa's fourth largest industry, contributing 14% to Gross Domestic Product (GDP) and employing about 1.2 million people. Growth within the manufacturing sector has created high-income jobs, upstream relations to local businesses and multiplier effects throughout the economy for both formal and informal workers. The growth in the manufacturing sector correlates with the growth in the manufacturing production index (which shows the number of total value-added in the manufacturing production sector only) of South Africa has been increasing up to about 141.9 in 2006 from about 100 in the year 2000.

Food and beverages are the most important sub-sector, contributing 25% to manufacturing. Other key contributing sectors include petroleum and chemicals (24%), iron and steel (19%), wood products, paper and printing (11%), motor vehicles, parts and accessories (7%), textiles and clothing (7%).

In the mid-1990s, industry contributed around 20% to South Africa's GDP. But greater international trade has seen the ratio of imported goods over locally imported goods rise from 54% in 2010 to 61.9% in 2018). In addition, incentives extended to other sectors have seen their contribution to GDP grow. Furthermore, the manufacturing sector's growth has been near zero over the last 20 years, with the volume of goods produced increasing by less than 1.5% per year and the value of goods produced flatlining .

These trends are likely to continue, underpinned by several factors. Firstly, companies are not investing in new plants and factories due to restrictive laws and union rigidity; power supply constraints in recent years, and the cost of electricity; and political instability, including the possibility of land expropriation.

Secondly, South Africa's manufacturing capital stock has declined by some 17% since 2008 to reach R561 billion (having grown by 26% in the preceding 15 years) . This means that there has been a decline in the country's capacity to produce manufactured goods, undermining efforts to build and sustaining a successful manufacturing base, increase manufactured exports or expand employment.

Thirdly, South Africa is a more open economy with greater international trade driven by the import of manufactured goods. The situation for the manufacturing sector has been made more difficult given the lack of skills due to the 'brain drain'. Furthermore, the advent of Machine Learning, automation and robotics has created redundancies in human capital intensive industries such as textiles and mining, negatively impacting on the number of people employed in the industry114.

The 2017 National Industrial Policy Framework (NIPF) aims to provide an overarching framework and rationale for supporting industrial growth in order to develop and roll out an Industrial Policy Action Plan (IPAP). With its strong focus on the manufacturing sector as a key driver of balanced development, the IPAP sets out to address cross-cutting and sector-specific constraints to boost South Africa's economic growth and attempts to support investments in productive capacity, skills and increased local manufacturing capabilities for export-led industrialisation .

The Department of Trade and Investment (DTI), which leads South Africa's industrialisation agenda , recently launched a revised version of IPAP, the objectives of which include:

- economic transformation to re-structure and diversify the economy with a focus on manufacturing;
- a developmental model focused on radical economic transformation and social inclusion;
- sustainable job creation by focusing on labour-intensive industries and promoting the integration of primary manufacturing and service value chains across industries and sectors;
- emphasis on R&D and movement towards a knowledge economy;
- private-public partnerships to address the challenges associated with digitalised production and logistics related to 4IR; and

- contribution to regional (SADC and Africa) industrial development.

However, despite these policies supporting the industrialisation of South Africa, manufacturing and industrial development has not yielded the intended macroeconomic impact.

5.2 RATIONALE FOR SUPPORTING THE ADOPTION OF 4IR TECHNOLOGIES

5.2.1 Potential applications and impacts

One research report claims that the adoption of Artificial Intelligence (AI) can boost South Africa's manufacturing gross value-added growth rate by 1.4 percentage points by 2035. There are opposing views on the impact of 4IR technologies such as robotics. On the one hand, they may help by increasing productivity and competitiveness in global value chains; but on the other there is likely to be employment disruption – job losses, the disruption of job roles, requiring new forms of work and updated skills for the workforce.

4IR technologies in the manufacturing sector enable factories to become integrated, intelligent, adaptable and efficient. South Africa is moving towards leveraging smart technologies to move towards automation and advanced manufacturing. For example, predictive maintenance involving the use of AI algorithms can aid planning and reduce unplanned downtime, thereby saving costs. AI algorithms are also used to identify production faults that may impact on product quality. Human-robot collaboration will lead to increased efficiencies and safety as more robots enter the production line and work alongside humans. Furthermore, AI can assist in product design processes and supply chain administration such as changes in demand and supply patterns[143].

4IR technologies applications have a particular impact on South Africa's automotive industry. Robots enable higher production, improved efficiency and safety in the automotive industry. Furthermore, the use of specialised robots with advanced sensory capabilities improves efficiency, increases production and improves the quality of products.

In the mining sector, robotics can also increase cost efficiency, improve safety and reduce the environmental impact in mines. The high incidence of mining fatalities caused by rock falls could be reduced by the deployment of robotic technologies to access areas that are inaccessible to humans in case of an incident. Robots equipped with sensors to identify hazardous gases can be sent ahead of miners, thereby increasing safety in mines. Task-specific autonomous mobile robots used in mining extraction can help mines to achieve cost efficiency and workplace safety by automating heavy vehicles used in mining extraction. Robots may reduce expenses related to water and electricity consumption needed for cooling mining chambers before miners can enter the underground shafts, resulting in a substantial impact on mines' bottom line and profits.

Business Process Outsourcing (BPO) and IT-enabled services (ITES) also benefit from 4IR technologies. BPOs (popularly known as call centres) have found a new lease of life within the 4IR environment, with migration from the more transactional voice channels to new platforms such as webchat, app servicing etc.

Business Process Enabling South Africa (BPESA) operates both as a specialist investment promotion agency for the BPO industry and as a national trade association and networking body. From having been a weak competitor in BPO and IT-enabled services (ITES) a decade and a half ago - due mainly to the high cost of international bandwidth and labour - South Africa is now highly ranked as an offshore destination category, providing high quality services at competitive prices and is able to compete with India and the Philippines.

5.2.2 current use cases and level of technology update

South Africa ranks favourably and ahead of India, Brazil and Russia in terms of digital competitiveness under several critical criteria including technology skills, access to capital, existing innovation ecosystems, R&D expenditure and regulatory frameworks162. South Africa also leads in terms of ICT exports and digital knowledge, putting the country in a favourable position for industrialisation. However, this relatively stronger digital position has not

translated into higher economic and industrial growth as expected.

In manufacturing

There are, however, positive examples. For instance, DataProphet, a start-up company, supplies an Artificial Intelligence (AI) programme to improve efficiency in manufacturing plants by collecting data from all measurable dimensions of a manufacturing process and then uses Machine Learning to predict anomalies, quality errors and areas where operations can be improved.

In 2018, ABB, a European multinational corporation, introduced a collaborative robot into the South African manufacturing sector, which can be quickly and easily installed on the production line to work with a human colleague. Omron, a Japanese provider of industrial automation, has pioneered the introduction of motion control using AI, enabling a machine automation controller to monitor the production process and intervene accordingly.

3D printing technology has been used to enable additive manufacturing, which is used to manufacture high-tech specialised parts such as biomedical prosthetic hip joints.

In mining

There are also a number of examples of AI support for mining. For example, in 2016, General Electric launched its first Africa Innovation Centre (AIC) in Johannesburg with the aim of incubating sustainable local innovation for Sub-Saharan Africa. The AIC participated in a pilot programme for a mining equipment manufacturer to deliver a remote monitoring software platform that enables remote monitoring of equipment allowing for proactive maintenance. In 2016, Kumba Iron Ore introduced automated drills, which are expected to reduce drilling costs by 15%, at its Kolomela mine in the northern Cape. Rather than laying off the drill operators, the company retrained them to operate automated drills remotely, resulting in greater efficiency and improved safety.

In automotive

Here too, examples abound. In 2016, Volkswagen installed 320 new robots with advanced sensory capabilities at their Uitenhage factory. These robots perform high precision tasks while shop floor workers have been redeployed to focus on tasks that require human involvement. The introduction of the robots has increased efficiency and reduced strain on Volkswagen employees. Furthermore, the technology enables the production of more than one model in a single assembly line.

5.3 DRIVERS AND CHALLENGES SPECIFIC TO INDUSTRIALISATION

The 4IR presents an opportunity for industrial development in South Africa but comes at some risk. It is expected to disrupt work in some areas of industry through automation, particularly where semi-skilled labour is deployed. Automation is not new and has been leading to redundancies in the automotive industry for some time. With Machine Learning and AI this may intensify and move to higher level skills although there is evidence that job losses can be managed through reskilling. The World Economic Forum (WEF) suggests that very low-level manual jobs are unlikely to be replaced and that AI and robotics are not able to simulate creative areas of work for those requiring 'soft skills' or emotional engagement. Countries that are unable to keep abreast of rapid technological advancement and innovation may also become less competitive in increasingly globalised markets. Working with a number of other agencies and industrial research centres, the DTI has already begun implementing strategies to improve preparedness. To avoid the disruption by the 4IR in the manufacturing sector, the following key enablers need to be put in place.

A well-established manufacturing sector. The World Economic Forum has commissioned a framework study to measure the readiness of countries for future production technology and processes. To this end, countries are positioned with regard to four categories or archetypes. These are:

- Global Leaders – countries with a strong current manufacturing base, well-positioned for the future;
- Legacy Champions – countries with a strong current manufacturing base but at risk for the future;

- Followers – countries with a limited current manufacturing base that are unprepared for 4IR and are at risk for the future;
- High Potentials – countries with a limited current manufacturing base but that are well-positioned for the future.

South Africa can be classified as a 'Follower', but with industrialised and third world economies existing side by side, the country lies close to the intersection of all four categories. South Africa could therefore slip back or advance into any one of the other three categories. It has a well-established and diversified manufacturing sector, supported by a well-developed infrastructure, and is positioned close to other rapidly-growing African markets. However, its weaknesses include rising costs of production, skill shortages, ongoing job losses and uncertainty about government policy. To position the manufacturing sector for the 4IR, the focus must be on leveraging its strengths to prepare for emerging technologies[143].

Skills

The manufacturing sector in South Africa needs the requisite skilled personnel to work with advanced and emerging 4IR technologies143. At present, the poor education system and lack of skills development means that there is limited availability of skilled labour in the manufacturing sector. South Africa will need to rectify this in order to mitigate future job losses caused by 4IR technologies and to have an adequate skills pool to leverage advances that come with the 4IR in manufacturing[143].

Enabling Infrastructure

Key enabling infrastructure for the manufacturing sector in the 4IR includes digital infrastructure and services, and reliable electricity[143]. The effectiveness of the IoT relies on pervasive, high speed, stable bandwidth, and most other advanced technologies such as robotics and data analytics equally rely on 'always on' connectivity. South Africa's critical communications and electricity inputs are inefficient and costly, which could hamper the take-up and impact of advanced technologies and processes in the manufacturing sector.

Research & Development for Innovation

Innovation has become increasingly important to enable industrial companies to gain a competitive advantage. Furthermore, companies will need to balance investment and resource allocation between these in order to translate innovation into business growth. A key issue that South Africa faces is limited platforms for commercialisation of local innovations. This has created a trend where local innovations are commercialised abroad before being reimported.

In response to this trend, the DTI is working with industry and the DST to commercialise a larger proportion of local innovations. For instance, the DTI and CSIR have jointly developed the National Industrialisation Support Initiative to provide a product lifecycle support platform; the DTI has also set up government-sponsored Mining, Manufacturing and Sustainable Development Hubs as innovation hubs for the mining and manufacturing sectors[143].

Regulations

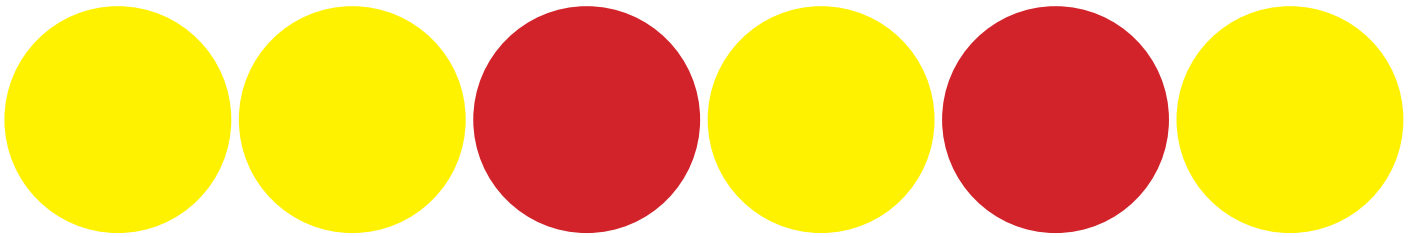
There is a need to develop a smart set of regulations that address the challenges related to the 4IR. A key example of this is the Patriot Corporation Incentive being set up by the DTI to encourage companies to establish their headquarters in South Africa on a voluntary basis and to produce a significant proportion of their goods and services locally. Benefits under this incentive scheme will be givenn for products linked to 4IR, including localisation of activities in the fields of AI, robotics and Machine Learning143. Expanding such incentives to companies in the manufacturing segment would encourage availability and/or adoption of 4IR technologies and processes for manufacturing.

6
regional integration

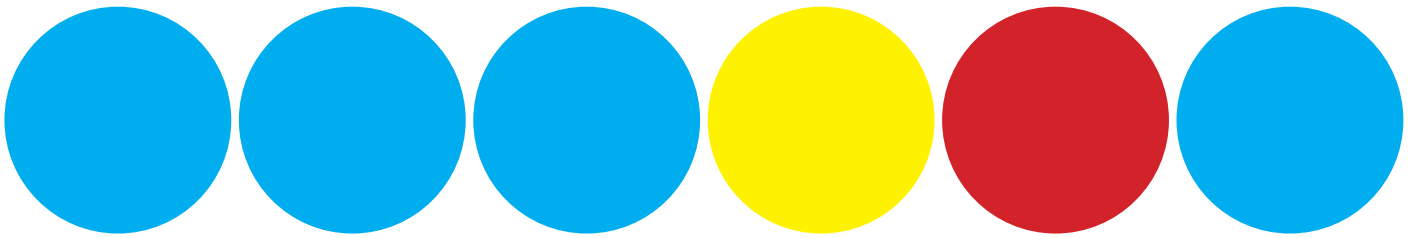
For the purpose of the paper, the main focus under industrialisation is manufacturing, which comprises various sub-sectors, as highlighted in this chapter.

figure D

current level of utilization of technologies



potential for applications



6.1 PRESENTATION

Industrial growth in the Southern African Development Community (SADC) is low and lacking in diversification, with countries in the region relying on a few commodity exports. Key bottlenecks in trade facilitation that have an impact on industrial development within the SADC include inadequate infrastructure, slow customs procedures and weak logistical systems. These could undermine industrial development.

Regional integration in the SADC consists of internal trade between SADC countries, which is dominated by South Africa, and trade between SADC member states and other parts of the world, which is dominant in the SADC region. Over the years, the SADC has succeeded in opening up several international markets for exports originating from the region, for example, through the 2016 Economic Partnership Agreement, which opened European markets for SADC exports, albeit at the cost of intra-regional trade. Despite several initiatives to advance intra trade, this has not increased significantly. Intra trade has increased slightly since the SADC Free Trade Agreement was launched in 2008. Regional intra trade stood between 10% and 17%147 in the SADC, compared to 24% in the Association of Southeast Asian Nations (ASEAN) and 40% in the European region. Low intra trade in the SADC is due to tariff and non-tariff barriers, underdeveloped trade-related infrastructure, weak manufacturing capacity and poor implementation of trade agreements.

Some interventions to bolster intra-SADC trade include the establishment of the SADC Customs Union, the SADC Free Trade Area and the SADC Common Market. Furthermore, the SADC has earmarked the development of regional value chains (in which member states will trade in various products or services that are at various stages of the value chain)146.

The Regional Indicative Strategic Development Plan (RISDP) is a development and implementation framework guiding the regional integration agenda of the SADC over a period of 15 years (2005-2020). It is designed to provide strategic direction to SADC programmes, projects and activities in line with the SADC Common Agenda (the key strategies and policies of the institution) and strategic priorities set out in the SADC Treaty of 1992 (the founding agreement of the SADC).

The main objective of the RISDP is to increase regional integration with the aim of: i) alleviating poverty and inequality and underserved areas; ii) achieving sustained economic growth and development supported by regional integration to increase market size, improve intra-regional trade, investment flows and increase transfer of investment flows; iii) other related priorities including diversifying SADC economies and increasing the participation of member states in the regional value chains and non-economic development goals such as maintaining the peaceful status quo in the region by ensuring good governance, regular elections, peace and stability.

The SADC identified 12 priority sectors for intervention to achieve regional integration. These include poverty eradication; combating the HIV and AIDS pandemic; gender equality and development; science and technology; information and communication technologies; environment and sustainable development; private sector; and statistics. Sectoral cooperation and integration focuses on trade and economic liberalisation and development; infrastructure support for regional integration and poverty eradication; sustainable food security; and human and social development.

To achieve the RISDP goal of deeper integration of the SADC, integration milestones have been defined to help the SADC and its partners to measure the progress that is being made towards the integration agenda of the SADC. These include the following:

- a Free Trade Area formulated to support intra-regional trade, which was achieved in August 2008 following a phased programme of tariff reductions since 2001, when 85% of intra-regional partner states achieved zero duty;
- a Customs Union, where members agree on common external tariffs and common trade policies. An SADC-wide Customs Union (a pre-existing customs union brings together Botswana, Lesotho, Namibia, South

Africa and Eswatini, outside the SADC) has been repeatedly delayed and postponed. Its failure affects the achievement of the other SADC integration milestones;

- a Common Market, where countries agree to remove all trade barriers between themselves, establishing common tariff and non-tariff barriers for importers, allowing the free movement of labour, capital and services amongst the countries. The SADC has not achieved a Customs Union, which is a pre-requisite for a Common Market;
- a Monetary Union, where countries achieve macroeconomic convergence, with stable and harmonised exchange rate systems, liberalise capital and current account transactions and adopt market-oriented approaches to monetary policy. This milestone is unlikely to be achieved in the absence of the achievement of the aforementioned milestones.
- an Economic Union, the final step in deepening regional integration resulting under a single currency. To date, the SADC has achieved political union and is unlikely to achieve an Economic Union if the other milestones are not achieved.

In terms of more recent redevelopments, if the SADC wants to take full advantage of the 4th Industrial Revolution, its policies have to improve to fall in line with global trends on digitalisation. The SADC's regional priorities to unlock the 4th Industrial Revolution are related to digital infrastructure and connectivity, affordability, skills and awareness, entrepreneurial development and local content.

6.2 RATIONALE FOR SUPPORTING THE ADOPTION OF 4IR TECHNOLOGIES

6.2.1 Potential applications and impacts

The SADC has considerably grown its internal regional market by deepening the integration of its policies and regulations, specifically in the e-commerce, e-transaction, data protection and cybersecurity sectors. More compatible and harmonised digital policy and regulatory frameworks, especially in the domain of data protection and cybersecurity, backed up by improved access to ICT, are increasing customer confidence in e-commerce and e-transactions and therefore boosting regional trade in both goods and services.

A coordinated approach to tax policies is expected to facilitate trade throughout the region and coordinated tax incentives have the potential to encourage foreign investment.

Although much progresses has been made in the SADC with regard to deepening integration, SADC member states are at different stages of economic, political and social development, which inhibit member countries from adopting common priorities and common models or frameworks.

In the regional integration context, the vital task is to increase trade within the region. To facilitate this, greater harmonisation of regulations to facilitate the cross-border flow of data and digital transformation processes are necessary. The internet enables businesses and governments to participate in regional trade and this is more important for small businesses as it has the potential to drive inclusion. A region that is digitally connected can empower the small and medium enterprises (SMEs) which are considered to be the backbone of the southern African economy and the broader continent. In other regions, for instance the ASEAN region, between 89% and 99% of enterprises are SMEs and they provide between 52% and 97% of employment in member states and are seen as a vital source of innovation.

The implementation of policy to simplify regional business is necessary if the SADC region as a whole, including South Africa, wants to pursue regionalisation as a strategy to reduce poverty, develop digital skills for both learners and teachers and encourage and empower the participation of small businesses in the wider digital economy. Lastly, in order for the SADC region to harness the benefits of the 4th Industrial Revolution, it is necessary to improve cross-border as well as internal infrastructure development, not only digital. A regional market would also ultimately benefit the agriculture and manufacturing sector, which would extensively benefit from an increase in regional trade.

The role of the SADC in this context is to ensure that the right coordination and harmonisation mechanisms are in place to digitalise the economy and to increase trade flows across

borders. In the context of the 4th Industrial Revolution, the business case for regional integration would be to design and implement more effective and efficient trade rules and customs, such as the development of paperless trade systems161. Digitalisation of cross-border transactions can also enable transparency in trade processes by enabling information on existing laws, regulations and procedures to be shared on online platforms.

This will require the SADC region to amend their policies to adopt common international standards on data protection; to complete the harmonisation of legal frameworks on financial services, e-commerce and e-transactions and taxation; to improve digital infrastructure and increase skills; to increase public, private and civil society sector co-operation; to ensure that there is an intergovernmental coordination mechanism161.

6.2.2 current use cases and level of technology take-up

Most countries in the southern Africa region, aside from South Africa, have grown rapidly in the last two decades. Overall, high growth rates experienced in the SADC proceeded alongside an increase in trade between countries, led by exports from South Africa to the rest of the neighbouring countries. The growth of trade has been fostered by the realisation of an SADC free trade area (FTA) and the successful implementation of tariff reductions agreed upon within the 2005 SADC Protocol on Trade.

The growth of regional trade in goods has been accompanied by a rapid growth of regional trade in services alongside significant foreign direct investment (FDI) in SADC, notably by South African firms, in sectors such as banking, insurance, transport, retail and business support services. To date, regional trade and investment flows have largely originated in South Africa. This is not surprising given the historical competitive advantage of South African firms, which allowed them to grow relatively large in size and increase their capabilities.

In the innovation and high-tech sector, South Africa is becoming the battleground for a number of multinational platforms, which are establishing their data centres in South Africa as a strategy to grow their regional market. Huawei is working with local South African partners to build data centres in Johannesburg initially and later in Cape Town. The Chinese telecommunications equipment and consumer electronics manufacturer, which is currently at the centre of global security concerns, is looking to challenge Amazon.com Inc, which, through Amazon Web Services (AWS), a global leader in cloud computing, is also expanding its presence in the emerging technology hub of Cape Town in a market share race against cloud computing rival Microsoft Corp. In the last quarter of 2018, AWS's revenue grew by 46% to $7 billion while Microsoft's revenues grew by 76% to $4 billion to remain in second place. In order to secure its position in the South African market and in response to data localisation pressures, Microsoft has located its latest Africa data warehouses in Cape Town and Johannesburg. Similarly, other large data centres in the country are Teraco and Standard Bank.

6.3 DRIVERS AND CHALLENGES TO REGIONAL INTEGRATION

Industrial development is at the core of SADC's regional integration and economic development narrative. There have been ongoing conversations around the need for the SADC to embrace the 4IR and its disruptive effect on economies. Most of the discussions revolve around identifying policy changes and initiatives that the SADC must consider in relation to the 4IR.

The SADC's industrial policy development framework needs to include a new dimension – an SADC Co-operation Framework on Digital Industrialisation – to collectively face common challenges to the region from disruptive technologies and increased competition. This framework proposes a five-step approached that entails: i) building a data economy; ii) strengthening broadband infrastructure in the region; iii) adopting similar regulations at the national level on consumer protection, cybersecurity and tackling unjustified geo-blocking; iv) Building the capacities of Small Medium Enterprises (SMEs) and preparing them for digitalisation; v) Building trade statistics for designing digital industrial policies.

Skills development and Public-Private Partnerships (PPPs). A recent gathering of SADC Ministers of Education

& Training, Science, Technology and Innovation reviewed progress and implementation of ongoing programmes and initiatives in these sectors, particularly in relation to the regions agenda around the 4IR. The consensus was that the development of digital skills for both learners and teachers is paramount and Public-Private Partnerships are needed to drive change and innovation required for the 4IR. However, lack of funding could hamper these efforts. In 2018 the SADC approved the establishment of the SADC University of Transformation to train citizens in innovation to facilitate industrialisation in the region. It is not yet clear when the university will become operational.

The role of start-ups. Start-ups are vital to ensure that the SADC is part of the 4IR. The technology start-up space drives the growth of homegrown starts-ups using innovation solutions to solve problems in the region. A key obstacle is the lack of funding in this space. SADC governments need to create favourable environments for investment and to be more involved in local start-up ecosystems.

SADC countries recognise the importance of a vibrant start-up sector as evidenced by the implementation of several support initiatives such as the Angola Invest initiative, Malawi's Youth Entrepreneurship Development Fund, Namibia's SMEs Compete, and Botswana's Citizen Entrepreneurial Development Agency Young Farmers' Fund. However, although underpinned by good intentions, these interventions have produced uneven results and the start-up ecosystem in the region remains suboptimal.

More recently, several government organisations and the SADC have established the Southern Africa Innovation Support Programme (SAIS 2), a regional initiative that supports the growth of start-ups by strengthening innovation ecosystems and by promoting cross-border collaboration between innovative private players in southern Africa. SAIS 2 is supported by the Ministry for Foreign Affairs (MFA) of Finland in partnership with the Ministries responsible for Science, Technology and Innovation of Botswana, Namibia, South Africa, Tanzania and Zambia, and the Southern African Development Community (SADC) Secretariat. The fund aims at supporting early stage entrepreneurship through training on innovation ecosystems and assisting entrepreneurs in the SADC region. During the first phase, which ran from 2011 until 2015, the SAIS programme stimulated policy design in the innovation domain, provided training, created networks and funded projects that piloted new models for innovation support mechanisms. In the second phase, which started in 2017 and will provide funding until 2021, the programme is providing new opportunities to students, technologists, start-ups and citizens to participate in employment and value creation not only in the SADC region but globally. The private sector and non-state actors, including special interest groups such as SMEs, women in business and young entrepreneurs, are playing a growing role in the programme as drivers for innovation in southern Africa.

The SAIS programme has also established a network of hubs which include the BongoHive, the Botswana Innovation Hub, BuniHub, the Commission on Science and Technology (COSTECH), Dololo Namibia, Injini, MashUp, mHub, mLab Southern Africa, the Namibia Business Innovation Institute (NBII),the National Commission on Research Science and Technology (NCRST), the National Technology Business Centre (NTBC), NestHubs, the Slush Global Impact Accelerator (GIA), the South Africa Innovation Summit, the Southern Africa Startup Awards, OneBio, Technology Innovation Agency (TIA) and WECREATE Zambia.

As part of the South Africa Innovation Summit, a TechTribe Accelerator (TTA) has been established as an acceleration platform to leverage an e-learning system and virtual mentorship to support high-tech impact ventures across the SADC region to become investment ready, to access capital and to access new networks. This SADC virtual accelerator programme will be implemented in four SADC countries aligned to the Southern African Innovation Summit, the NEPAD SANBio nodes and the Malawi mHub. An e-learning platform will be available to innovation hubs, universities and accelerators in the SADC region, to run their own programmes with the support of NEPAD SANBio and the Malawi Innovation Hub.

Harmonisation of legislation, policies and regulations. The SADC process towards regional harmonisation of ICT

policy and regulation is part of the African Commission (AC) effort to support harmonisation efforts via such frameworks at a continental level. An African Union (AU) Reference Framework was adopted and endorsed in 2008. Subsequently, during the AU assembly in 2010, the commitment to intensify activities to implement the Reference Framework was renewed and implemented through the ITU/European Commission project on the Harmonisation of the ICT Policies in Sub-Sahara Africa (HIPSSA). The first activity launched by HIPSSA and the SADC Secretariat was the review and update of the SADC ICT Policy and Legal Framework. In addition, three non-binding Model Laws for SADC Members were developed: 1) the SADC Model Law on Data Protection; 2) the SADC Model Law on Cybercrime; and 3) the SADC Model Law on Electronic Transactions & Electronic Commerce.

Nevertheless, poor implementation of policies coupled with a lack of political commitment is hampering efforts towards harmonisation of policies. In particular, the SADC is facing the following challenges to ICT policy and regulatory harmonisation:

- existence of multiple ICT policy and programme initiatives, some of which are often in competition with each other;
- very little ownership of regional ICT policy and regulatory initiatives by national African governments;
- few institutional mechanisms in place on the part of regional organisations and institutions to ensure compliance with model policies and frameworks or to monitor and evaluate implementation;
- member states belonging to the SADC are sovereign states with no obligation to adopt and adjust national ICT policy and regulatory frameworks according to policy guidelines or model laws issued by regional bodies.

The SADC has also made progress in terms of strengthening and harmonising financial systems to facilitate the availability and movement of capital to support policies that promote technology know-how, modernised production systems as well as skills development, science and technology. The 1996 Protocol on Finance and Investment focuses on harmonising the financial and investment policies of SADC member states to develop banking, financial regulation and investment. To date, most of the financial reforms in the SADC have focused on creating a functioning banking sector by liberalising the financial sector, by removing the official management of interest rates and by simplifying access to banking services. Nevertheless, access to credit and capacity for small or informal businesses remain a concern and current reforms have failed to address that large economic sector.

7 wellbeing

7.1 PRESENTATION

Within the context of this paper, the term well-being describes how innovative technology of the 4IR can be integrated into society to improve management and governance of the environment and to implement systems that lead to the sustainable use of natural resources as well as driving inclusive economies. For the purpose of this study, the main focus will be on financial inclusion but also on healthcare.

7.2 RATIONALE FOR SUPPORTING THE ADOPTION OF 4IR TECHNOLOGIES

Digital connectivity and communication are creating a substantial amount of data, which, in turn, is driving the development of technologies like Artificial Intelligence, data analytics and Machine Learning. Devices such as drones, satellites, mobile phones, robots and sensors are used to gather data in various forms and, when analysed, can enable people, businesses and governments to make data-driven and predictive analysis.

The opportunities rely on the implementation of the right technologies to bridge the gap by improving quality of life, employing new (and home-grown) technologies, building smarter infrastructure and harnessing the dynamism of the informal sector123.

Efficiency in public services such as transport, healthcare, energy, water, waste management, telecoms, housing or general security can be achieved with the introduction of technology.

There is a need to accelerate investment and encourage technology deployment for smarter urban infrastructure. Start-ups will play an essential role in developing such technologies and they will require support from government and the private sector to increase their scalability.

Financial inclusion

Financial inclusion refers to the ability of individuals and business to access financial services to facilitate their consumption and investment activities. It allows families to meet their consumption needs and to invest in their futures through improved education and health programmes. Financial inclusion is generally associated with economic and social development and plays a significant role in reducing extreme poverty and inequalities. In past decades, physical banking has been transformed by automation and by the introduction of electronic banking services. South Africa was a world leader in the introduction and early extension of automated teller machine installations across the country in 1981 and also introduced phone banking and then internet banking services early on.

Research by Research ICT Africa shows that more than half of the South African population have access to financial services, significantly more than the average 30% in the other Africa countries surveyed. The deepening of financial services can be attributed to the development of digitally based products such as e-wallets, internet banking platforms, Blockchain or crypto currencies and some other new products.

Blockchain technology application in finance and e-administration

Although there is no specific regulation yet in South Africa, there has been a positive response from regulators who are working with the FinTech and banking industries to find the most effective and appropriate way to regulate cryptocurrencies in South Africa. The treasury is studying the potential of distributed virtual currencies to streamline the South African Multiple Option Settlement system through Project Khokha. The National Treasury's Taxation Laws Amendment Bill 2018 proposed amendments to tax legislation, including changing the way cryptocurrencies are classified in South Africa. In December 2018, the South African Reserve Bank published its review of the National Payment Systems Act, number 78 of 1998, for public comment.

The South African Reserve Bank (SARB) appears to recognise that there may soon be little difference between domestic and international payments. Likewise, digital currencies could become part of the national payment system in the future. This may end the exclusivity that commercial banks have on processing payments with a digital South African fiat currency.

In a significant step forward, the South African Reserve Bank, South African Revenue Service, National Treasury, the Financial Sector Conduct Authority and the Financial Intelligence Centre created the intergovernmental FinTech working group (IFWG), which released a consultation paper on policy proposals for crypto assets in January 2019. The efforts by the IFWG aim to provide a platform for regulators and policy-makers to engage with industry and work towards a harmonised approach to regulation and is a first for the region.

There are many opportunities relating to the use of Blockchain such as in improvements in transparency within the public sector and constraining corruption, securing land title deeds and transparency in value chains. However, it is clear that there are also substantial challenges. Besides the fact that large numbers of people are offline, it would currently only have back end application with public and private systems. The capacity and cost of the massive servers required for the mining of the data is beyond the reach of most Africans, so they are mostly offshore. Their energy requirements are currently even greater than their bandwidth requirements, thereby also excluding many African countries as locations for them.

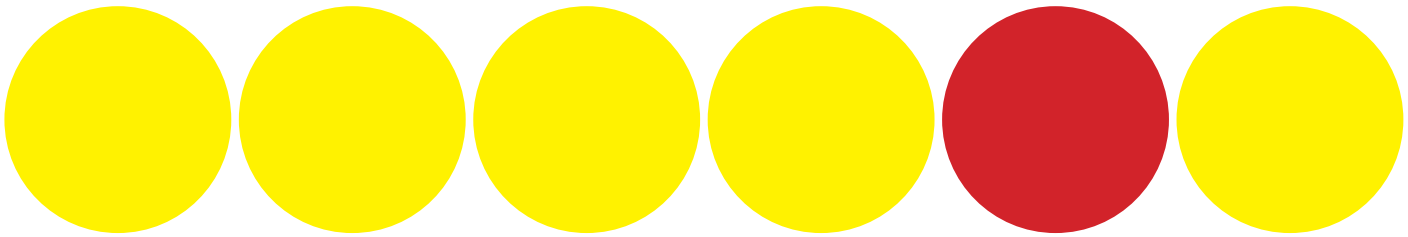
Health

There is a strong case for the adoption of 4IR technologies within the healthcare sector in South Africa and Africa. The wheels are already in motion. These advances will address a lack of resources across these regions and will make healthcare more accessible for people living in remote communities. High rates of infectious diseases (such as HIV and TB) as well as the growing incidence of chronic diseases (e.g. diabetes, cancer, cardiovascular disease) provide the opportunity for technology integration in the sector. However, barriers such as substandard telecoms infrastructure will inhibit growth in the market. There are also opportunities to manufacture equipment locally (good infrastructure and creation of jobs) although expertise is still lacking.

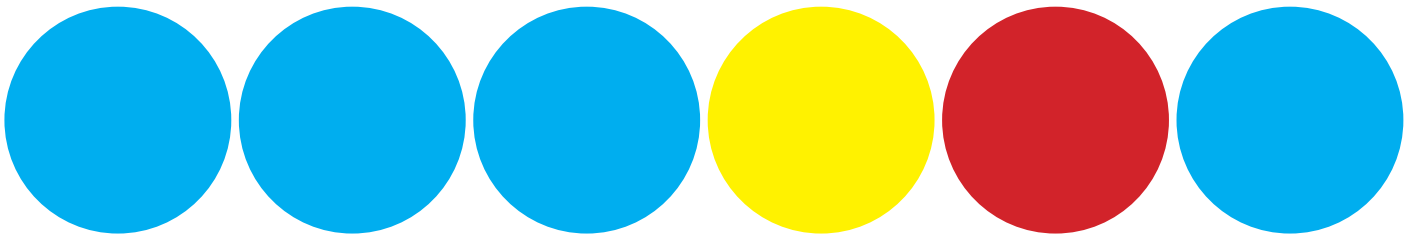
The adoption of new technologies is always slower in Africa, particularly in the healthcare sector, as patient privacy and safety is always at stake. We are seeing local healthcare giants increasingly turn towards technology innovations to drive operational efficiency and performance. For example, Netcare, South Africa's leading private healthcare provider, invested R600 million to digitalise their entire operation so that patients can have access to their Electronic Health Records (EHRs). This will also remove fragmentation between service providers within Netcare's various divisions and lead to improved treatment protocols. The project is expected to be completed in 2022.

figure E

current level of utilization of technologies



potential for applications



There are also smaller local players who are leading the way, including a company called Kardio Group, which is part of Brandmed, who have recently partnered with the pharma giant, Cipla. The company offers a comprehensive suite of integrated digital solutions with the aim of managing NonCommunicable Diseases (NCDs).

Furthermore, changes in policy and regulatory environments such as the National Health Insurance (NHI) and Medical Schemes Amendments Bills and the results of the Health Market Inquiry are expected to change the healthcare landscape radically. This will require robust collaboration between the private and public sectors. Patient-centric healthcare, where there is a high level of medical convenience, will become a priority for healthcare service providers.

7.3 Drivers and challenges specific to well-being

Increasing connectivity reach is without a doubt the foundation that bridges the digital divide between rural and urban areas. Connectivity will also allow a number of new services to reach people in rural areas, such as digital banking and remote healthcare, and improve the efficiency of service delivery such as power, water, transport and logistics. Until proper implementation plans are in place and until there is increased political will to digitalise processes, South Africa may run the risk of falling behind in terms of its efforts to create a digitalised economy.

Digital Inequality

Another critical issue is the digital divide. Although South Africa performs relatively well in terms of African benchmarks, the survey findings indicate that technological forms of exclusion are a reality for significant segments of the South African population and that, for many people, digital exclusion reinforces and deepens existing inequalities. Furthermore, ICT deprivation can be considered alongside and strongly linked to more traditional twentieth century social exclusion factors, such as low income, unemployment, poor education and social isolation. In the case of South Africa, a society with more pronounced income and educational inequalities, the survey shows that, despite the hype surrounding smartphones connecting the poor, the digital divide between the poor and the rich is significant in South Africa. Furthermore, the data shows that, while the digital gap between genders is disappearing, it exists between urban and rural dwellers, with about 40% of rural areas not using the internet compared to only 25% of urban residents being unconnected. While the increased levels of connectivity suggest that the digital divide is being bridged, paradoxically, as more people are connected, digital inequality increases. This is not only the case between those online and those offline, but between those who have the skills and financial resources to use the internet optimally and those barely online. Without policy interventions to reduce these disparities, offline inequalities will simply be mirrored online or potentially amplified as the information society matures and not everyone is equally well served by ICTs.

With such digital inequalities, even if industry is ready to digitalise their processes and services to the citizens, this will only reach those that are connected. Services such as e-government services, e-education, e-health, smart metering for energy and water and smart lighting cannot benefit those that have the greatest needs mainly due to limited access to the internet.

Urbanisation

South Africa needs to be prepared for the urban explosion and is in a better position than many other countries on the continent and requires an adequate vision from government and policy-makers and collaboration from the private sector. According to the World Economic Forum, the African continent is experiencing a significant urban infrastructure gap. The annual national public expenditure on infrastructure was an average of 2% of GDP between 2009 and 2015, compared to 5.2% in India and 8.8% in China. Also, African urban areas are likely to suffer from climate change as the region as a whole is warming up 1.5 times faster than the global average. The strain on essential services and natural resource endowments, as Cape Town's water crisis shows, is set to increase. South Africa has to find a way to build sustainable cities with greater access to private capital and to avoid the risk of becoming both uninhabitable and indebted.

8
overall conclusion for a business case in the country

South Africa has amongst the most advanced telecommunications and financial sectors in Africa, comparing favourably with those of industrialised countries. It is, however, wracked by structural inequality and rising unemployment (27.5% in 2018 vs 20% in 1994) exacerbated by a chronically under-performing education system to address this. Economic growth - a low 2.1% over the last decade - has failed to keep pace even with population increases. Key state-owned entities, such as the energy utility Eskom, and the state-owned transport entity Transnet, are the victims of policy weakness, planning failure and are bedevilled by corruption and patronage that have undermined their ability to play a critical role in the economy.

In 2018, President Ramaphosa called an investment summit, followed by a jobs summit, in an attempt to kickstart the economy and create jobs. His recognition of the importance of the digital economy in achieving this is reflected in the recent appointment of a 30-person 4th Industrial Revolution Commission. He has also revived the National Planning Commission to undertake a review of the 2012 National Development Plan, which had been developed with the goal of eradicating poverty, inequality and unemployment. The NDP had identified ICT as critical to realising a more inclusive and equitable society. However, many of the strategies to achieve the NDP were not implemented due to poor policy interventions, several of which do not align with the outcomes of national consultative processes. This in turn created uncertainty in industry, along with the failure to implement key regulatory and pro-competitive measures necessary for effective competition and increased consumer welfare.

Nevertheless, South Africa ranks ahead of India, Brazil and Russia in terms of digital competitiveness, ICT exports and digital knowledge. Despite South Africa's relatively stronger digital position and the fact that growth in the ICT sector is outstripping national growth, ICT's contribution to GDP at 4% is considerably lower than emerging countries such as India and Brazil, where ICT contributes 7.7% and 7.1% respectively.

The 4th Industrial Revolution presents a vital opportunity for industrial development in South Africa. However, the 4IR is also likely to marginalise the poor and the disadvantaged, who will not be able to keep abreast of rapid technological advancement and innovation. Developing people with the requisite digital skills to operate and manage advanced and emerging 4IR technologies is key. Without adequate preparation, South Africa will not be able to keep pace with the new 4IR modes of production.

At present, there is little alignment of the education system to the current needs of industry, let alone those of industry 4.0. The schooling system fails to produce young adults with the ability to think critically, work in teams, engage with digital technologies or innovate. There is an oversupply of graduates in the humanities and social sciences and a critical undersupply of artisans and technicians, scientists and engineers. An ongoing skills gap weakens the manufacturing and advanced industries.

Despite the country having the highest mobile phone penetration and internet use in Africa, South Africa does not perform well in the global indices focusing on usage and adoption. Even these indicators mask the extreme inequalities in South Africa. A full 50% of South Africans remain offline, largely those in rural areas, with low levels of education and little disposable income to afford devices necessary to access the internet. Furthermore, they lack the education and digital skills to utilise or benefit from internet access.

This is the case despite pockets of excellence, particularly in the services sector (which uses Big Data analytics and AI for financial and insurance forecasting) as well as in mining (where automation is available) and large- scale commercial farming (where drones and the IoT are used).

Empowering start-ups is vital in ensuring that South Africa is part of the 4IR. The technology start-up space drives the growth of homegrown starts-ups and SMMEs using innovative solutions to solve problems in the region. A key obstacle is the lack of funding in this space: Government needs to create a favourable environment for investment and provide support for the local start-up ecosystem.

While the manufacturing sector in South Africa is substantial, contributing to 14% of the GDP and employing about 1.2 million, agriculture only contributes 2% to GDP. Manufacturing is hampered by a lack of foreign investment and a decline in capital stock and by increased imports of manufactured goods. To boost trade in the country and beyond South African borders, infrastructure, customs procedures and logistical systems need to be improved. Cross-border collaboration will be crucial.

With regard to regional integration, if the SADC region wants to take full advantage of the 4th Industrial Revolution, its policies must be aligned with global trends on digitalisation. Its regional priorities to unlock the 4th Industrial Revolution are related to digital infrastructure and connectivity, affordability, skills and awareness, entrepreneurial development and local content.

Despite the agriculture sector's relatively small contribution to the GDP, it is vital in the South African economy. The use of 4IR technologies can make farming more efficient and cost-effective and increase yields whilst reducing costs. Furthermore, there is a significant gap to be addressed by connecting small farmers to the agribusiness and to commercial agriculture and by giving them access to the necessary technologies to improve productivity and increase outputs.

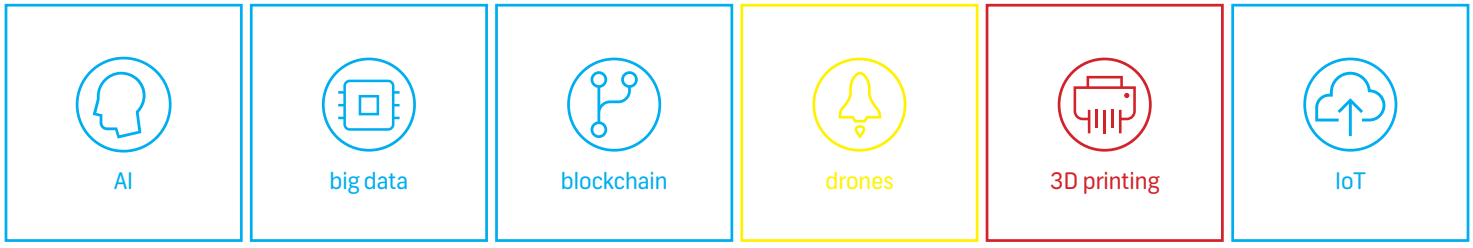
The government's role is to create an enabling environment for investment and innovation. In the context of the 4th Industrial Revolution and regional integration, this would entail less complicated and more efficient trade rules and harmonised regulation and taxation, with the ultimate objective of developing paperless trade systems. The internet can also enable transparency in terms of trade processes by sharing information on existing laws, regulations and procedures on an online platform.

A summary of markets that can be targeted by sector and technology is presented below.

LEGEND

red, not many / few examples; **yellow,** nascent / some examples; **blue,** good potential /numerous examples

TECHNOLOGIES TO BE TARGETED BY PUBLIC POLICIES AND PUBLIC BANKS



LEGEND

red, not many / few examples; **yellow,** nascent / some examples; **blue,** good potential /numerous examples

9 recommendations

With the national economy on the edge of contraction and with industry struggling to inject value, opportunities and jobs into the market, the ICT sector can, under the right policy and regulatory conditions, serve as an enabler of growth. As a key input for other sectors in an increasingly digital economy and by creating new services as well as by creating formal and informal employment, South Africa's ICT sector has the potential to perform far better than it does in the global rankings and more in line with the size and sophistication of the economy.

9.1 RECOMMENDATIONS AT THE NATIONAL LEVEL

With the national economy on the edge of contraction and with industry struggling to inject value, opportunities and jobs into the market, the ICT sector can, under the right policy and regulatory conditions, serve as an enabler of growth. As a key input for other sectors in an increasingly digital economy and by creating new services as well as by creating formal and informal employment, South Africa's ICT sector has the potential to perform far better than it does in the global rankings and more in line with the size and sophistication of the economy. For this to happen, considerable effort will need to go into addressing the demand-side limitations in the sector. Specific issues to be tackled include ensuring affordability of access; addressing the digital skills deficits; improving levels of human development; ensuring greater alignment between the supply of skills and labour market needs.

To embrace the 4IR, South Africa will have to invest in developing new digital skills aligned to the technological revolution. This means building a pipeline of future talent, from primary school up to university, that can embrace the age of emerging technologies. As the 2017 After Access survey shows, a key blockage to the adoption and use of the internet is a lack of technological skills, with 48% of those in the 10 African countries surveyed (South Africa included) not knowing how to use the internet.

The 4IR makes it essential to develop a diverse, adaptive and digitally skilled workforce. Critically, the school curriculum must be revamped, not only to foster the take-up of science, technology, engineering and mathematics courses, but also to promote critical thinking, flexibility and creativity. These are challenges not specific to the 4th Industrial Revolution, but they are exacerbated by its emergence. While automation and AI can replace industrial workers and clerical competencies, they cannot substitute for leadership and creativity. The workers of the future will need to be provided with 'soft' attitudinal skills as well as 'hard' technical skills. Greater automation in industry leads to disruption and displacement in the world of work, which requires workplace upskilling and large-scale development of entrepreneurial skills.

Beyond education and skills, much needs to be done in areas such as enabling infrastructure, research and development, innovation policies and data regulation. In particular, adopting open data policies and a data policy governance framework has the potential to spur entrepreneurship and innovation and drive efficiency.

Specific interventions include:

- developing an integrated national digital policy that cuts across sectors and enables a high level of integrated planning and implementation, allowing the public and private sector co-ordination required to harness the benefits of the 4th Industrial Revolution whilst mitigating its risks;
- deepening public-private partnerships such as Business Process Enabling South Africa (BPESA) and Harambee to align skills and to create jobs in the rapidly reviving business process outsourcing sector;
- adopting open data policies within a well-developed data protection and rights framework;
- implementing the stalled 4IR strategy for the public sector developed by SITA;
- strengthening the manufacturing and the agriculture sector by encouraging the use of technology while training and creating jobs for skilled personnel;
- incorporating 4IR technologies into the health and education sectors;
- addressing not only the lack of digital skills but basic education, which needs to be adapted to new and relevant ways of learning, not in conventional silos;
- expanding power and broadband infrastructure capacity that is universal, stable and affordable; and
- supporting the commercialisation of local innovations and start-ups through microloans, hubs with subsidised bandwidth, entrepreneurial and leadership training.

9.2 RECOMMENDATIONS AT THE REGIONAL LEVEL

The southern African region is in the early stages of formulating a 4IR policy, strategy and framework. The key areas of focus for the SADC to achieve its industrialisation and regional integration objectives in the 4IR era should include:

- identifying current strengths, weaknesses, capacity gaps and opportunities for collaboration between

member states in terms of digitalisation;
- revising education systems to include digital skills and their underpinning competencies and altitudinal values to ensure relevance for 4IR technologies and advancements;
- supporting member states in transposing existing model laws dealing with e-commerce and e-transactions, data protection and cybersecurity to include provisions appropriate to the 4IR;
- promoting Public-Private-Civil Society Partnerships in areas requiring collaboration, such as regional broadband infrastructure roll-out or cybersecurity or open data;
- promoting and facilitating the commercialisation of innovations by providing support to start-ups and the informal sector in the region;
- developing a strategic plan for the 4IR and digitalisation for the region. This should also include a platform and framework for member countries to harmonise their national strategies on the 4IR and to share best practices.

9.3 POTENTIAL AFDB PROJECTS

The AfDB could finance or provide support in relation to the following projects:

Digital Infrastructure for Public Sector

Opportunity to fund the extension of the SITA Cloud for the Public Sector project described above, which will align the public sector with the government's 4th Industrial Revolution mission. This takes the modernisation programme much further, deploying advanced technologies for a virtual interface with the private sector in terms of procurement, but also includes an open data policy with the intention of sharing government data for Big Data analytics.

The strategic plan for this was to be signed off under the current administration, but, with parliament rising early for elections, this was not done. There is now some concern that, with the CEO's decision not to renew his contract, and with this being an area of contestation with vested interests, a new administration may go back to the drawing board.

Agriculture sector: Opportunity to finance agricultural co-operatives and to incentivise support for small farmers from commercial agriculture to adopt technologies such as satellite imaging from drones, the IoT and Artificial Intelligence.

Agricultural production needs to increase to sustain local demand and to feed the growing population whilst ensuring food security in the country. The sector can play a major role in the economy and in job creation. Technologies, such as drones, satellite imaging and AI, are widely used in commercial agriculture. Extending such technologies as these to small farm holders via collective ownership by the community, subsidised by government, or even through funding for commercial farmers to 'share' the technologies with the smaller farmers, could increase productivity and improve output. Collaboration between commercial agriculture, agri-food companies, government and small farmers will be an important step towards shared economic growth.

Upskilling youth: Opportunity to provide financial support for youth accelerator programmes directly engaged in training digital skills.

Harambee is an award-winning youth job accelerator and training programme that connects 500,000 youths with 50,000 employers and has given 100,000 young people a pathway to jobs . It is regarded as a blueprint for public private partnerships and youth job creation. Unlike other youth digital vocational training, such as We Think Code (which runs a two-year training course at a cost of R250,000 per individual and has only produced a few thousand employees for industry), Harambee has, on the basis of extensive research and data analysis, found ways to scale effectively. It has disrupted traditional training domains and challenged conventional wisdom about what the digital industry's needs are. It has partnered with industry and government to identify new labour needs and to find pragmatic solutions that have produced results. It has demonstrated that youth without formal qualifications of various kinds can learn and successfully perform highly digitalised tasks. With Digital Action Lab, it brought together all the major players, including IBM, Amazon, Microsoft, Dimension Data, to accurately identify new needs. After considerable deliberation over a period of time, it has identified a few job families that it is focusing on in terms

of training: data scientist, entry level Java coding, testing capability, cloud engineering and entry level cybersecurity.

Data scientists and analysts: Opportunity to identify and fund scalable projects for digital skills required by businesses and trained by youth accelerator initiatives. Harambee operates on a number of channels – mobile for candidates, a contact centre, a learning management system, prototype self-serving portals to deal with the expanding scale and scope of the business. This provides constantly evolving interaction layers between staff, employers and candidates. To do this and in recognition of the fact that the data that it generates is a major asset, it has built an entirely new data environment. Its old business model was based on one offering for millions of people. The new model now offers millions of options to a single person. They have built a platform that is intelligent enough to present unique content on the basis of the person's unique profile and journey. It is in the early stages of applying Machine Learning to automate the processes of moving candidates through training, , running diagnostics on them and pairing them with employees.

There is enormous potential to expand this business but also for this to serve as a use case in other countries. There is a massive scalable project in the crossovers between BPESA and Harambee because digital companies do not know how to provision BPO services (as they only know how to sell candidate or project-based work) and BPOs do not know how to build apps. With expanding demand for South Africa as an offshoring destination, Harambee is not only able to provide suitably trained labour but is also able to support the application of AI and Machine Learning to deal with the changing scale and scope of the business world. To take it to scale and build a sustainable business case may require funding beyond that provided by the DST and the Jobs Fund.

Blockchain in energy: Opportunity to support Blockchain initiatives within the context of renewable energy, an area where South Africa has made considerable progress. The potential for South Africa lies in investment in the smart grid (Blockchain and AI) and, in the context of advanced renewables, by integrating technology to increase efficiency in distribution channels. Blockchain offers a possible platform for the secure execution of smart contracts over peer-to-peer networks with independent power producers and the potential to create a transparent supply chain. The introduction of Blockchain might work to increase efficiency in the deployment of renewable energy by supporting its integration into the grid in a cost-effective way.

Smart townships: Opportunities to finance and support the development of smart townships. The concept of smart cities has been presented as a key application of 4IR technologies and is becoming a dominant discourse in urban planning. This discourse has permeated through to most South African metropolitan cities such as Johannesburg and Cape Town. However, there is increasing evidence that smart cities exacerbate developing country problems of poverty, inequality and poor living conditions. In South Africa the approach is likely to entrench apartheid-inspired spatial segregation and inequality.

Instead of being technology-driven, alternative strategies that meet citizen needs have been emerging. For example, the Cape Digital Foundation has argued that megacities in the global south should be redefined to be in line with the township ecosystem. What South Africa needs is the development of smart townships to ensure that the people in these areas can be a part of the 4th Industrial Revolution. Neglecting these areas will widen the digital gap and the inequality that South Africa is currently facing.

Building South Africa's smart townships requires more than just digital skills training and goes hand in hand with providing the training and skills to individuals in becoming township entrepreneurs. This can be achieved by providing digital skills training and upskilling for SMME business owners so that jobs are created and income is retained within township communities, boosting circular economy jobs. The success of smart townships will depend on the development of five core pillars, namely reliable digital infrastructure, affordable connectivity, digital skills, local content and data collection.

The role of the bank would be to invest in the smart township/village initiative to provide an alternative use case to the much-criticised smart city initiatives in Africa.

EN
end notes

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