An overview of the

CSIR STRATEGY

science & innovation

Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

CSIR

Touching lives through innovation

Updated **1 April 2022**

ENDORSEMENT

by the former Minister of Science and Technology

I am confident that the incoming board at the CSIR, under your leadership, will ensure that the implementation of the new strategy helps to grow and strengthen the CSIR while making a greater contribution to the development priorities of the National Development Plan and the policy imperatives of the new White Paper.

Mmamoloko Kubayi-Ngubane, MP
Minister of Science and Technology
(February 2018 to May 2019)

FOREWORD

by the Chairman of the CSIR Board

The Board is pleased with the strategic direction and vision of the CSIR, which aim to create a balance between scientific and industrial development in the country through directed multidisciplinary research and technological innovation.

In order to help create a capable state, the Board is of the view that the diverse pool of competencies at the CSIR should equally benefit the public and private sectors in addressing the triple challenge of unemployment, inequality and poverty, thereby contributing to improving the quality of life of our citizens.

This strategy overview document highlights the case for change and the subsequent outputs of months of rigorous research, analysis and engagement with various internal and external stakeholders as part of the strategy development process. This process culminated in a new vision, mission, objectives, values and a reconfigured research and development focus that is relevant to the needs of the country.

We invite you, our valued stakeholder, to join us on this journey and identify areas where we can collaborate or create new partnerships.

As the CSIR Board, we are fully supportive of the organisation's new strategic trajectory and we look forward to seeing the fruits of its impact on industry, government and society.

Prof. Thokozani Majozi

CSIR Board Chairperson

FOREWORD
by the CSIR Chief Executive Officer

This document is a summary of the CSIR centennial vision and strategy, which set the organisation on a new trajectory. This trajectory will ensure that the CSIR makes a balanced impact in industry, government and society. The new strategy boldly responds to the mandate of the CSIR, which is to improve the quality of life of our people, through directed and multidisciplinary research and technological innovation that fosters both scientific and industrial development.

The intent of the new strategy can be summarised as growth, sustainability, impact and relevance. **Growth** means that the CSIR will use its capabilities to contribute to the inclusive growth of the South African economy. **Sustainability** refers to the CSIR developing technologies that improve the competitive advantage of South African enterprises, and thus ensuring that they remain globally competitive and sustainable. It also speaks to the financial sustainability of the organisation in a resource-constrained environment.

Impact focuses on the commercialisation of our technologies and innovations for industrial development, as well as technology and knowledge transfer which enable a capable state. The last pillar, **relevance**, addresses the role of innovation as a key driver for industrial development and our ability to deliver on our mandate.

These four pillars of the strategy bring alignment between responding to our mandate and addressing internal organisational imperatives.

One of the key outcomes of the strategy, other than the strategy itself which sets a clear path for innovation-led industrial development, is the new CSIR operating model to effect it. As part of the strategy formulation process, the previous operating model underwent a thorough assessment, which identified gaps, including the representation of research and development at executive level, internal collaboration, customer-centricity and being market facing.

The new model brings changes to address these gaps in the form of the introduction of three divisions consisting of synergistic clusters. This allows for better integration and collaboration in research as well as the creation of a dedicated business development and commercialisation function.

The strategy development process was extensive and included inputs from various engagements with internal and external stakeholders. CSIR colleagues have played a crucial role in this process and I am grateful for their dedication and commitment.

We look forward to a progressive working relationship with all our partners and stakeholders as we use science, technology and innovation to respond to the triple challenge of unemployment, poverty and inequality.

Dr Thulani Dlamini

CSIR Chief Executive Officer

PREAMBLE

The CSIR has adopted a new strategy to ensure that the organisation makes a greater impact in industry and consequently on the economy – in addition to our role of supporting a capable state – thereby comprehensively improving the quality of life of South Africa's people in a more comprehensive and holistic manner.
A summary of the new strategy is contained in this booklet.

The organisation seeks to **leverage its strong science, engineering and technology** (SET) capability base to drive innovation-led industrial development, while creating the right **balance** between scientific and industrial development in its innovation portfolio. Against the current backdrop of the country's poor economic performance, driven by global megatrends such as geopolitical uncertainties, the lingering effects of the 2008/09 global recession, and urbanisation, the CSIR's strategic intent is to rapidly advance to a situation in which its SET capabilities and industrial development endeavours become force multipliers that **contribute to the competitiveness of South Africa's economy**.

The CSIR's industrial development efforts must **complement** its scientific and technological development efforts and vice versa. An ideal scenario is one of a **virtuous cycle** in which scientific and technological development supports industrial and societal development, and the latter, as it evolves, informs our research agenda, and so on. The strategy development process involved significant introspection as the CSIR considered how it needs to change or shift its focus to effect this complementary and mutually beneficial strategic value proposition.

The CSIR's new strategy identifies high-impact sectors in which South Africa could carve out a competitive advantage, and defined strategic focus areas and initiatives that could bring **competitiveness to the specific sectors** of the economy, stimulating overall socioeconomic growth.

The strategy takes into consideration current and future CSIR **core capabilities** and identifies relevant current programmes and new areas of research and development (R&D), opportunities for infrastructure development and new business skills. It draws on new requisite technology market analyses and foresight capabilities and highlights potential new partnerships, notably with the private sector. The strategy informs new operating and business models, industrial development, as well as research, development and innovation outputs and outcomes, and the appropriate new metrics to measure industrial development performance.

The strategy takes an organisational centennial view, a 25-year vision that prepares for industrial development interventions over three time horizons – immediate, transitionary and future – preparing and building the organisation's capabilities for the CSIR of the future.

Changes in its strategic trajectory, organisational architecture and business systems and processes were informed by **in-depth and objective information on the micro and macro socioeconomic drivers** influencing the industrial and societal landscape. It is important to note that the CSIR intends to continue with its strong focus on serving the needs and requirements of the **public sector** and generating knowledge for public good in addition to this new focus on the industrial sector.

THE CSIR'S CONTRIBUTION TO INDUSTRIAL DEVELOPMENT IS KEY TO ADDRESS SOUTH AFRICA'S TRIPLE CHALLENGE OF POVERTY, INEQUALITY AND UNEMPLOYMENT.

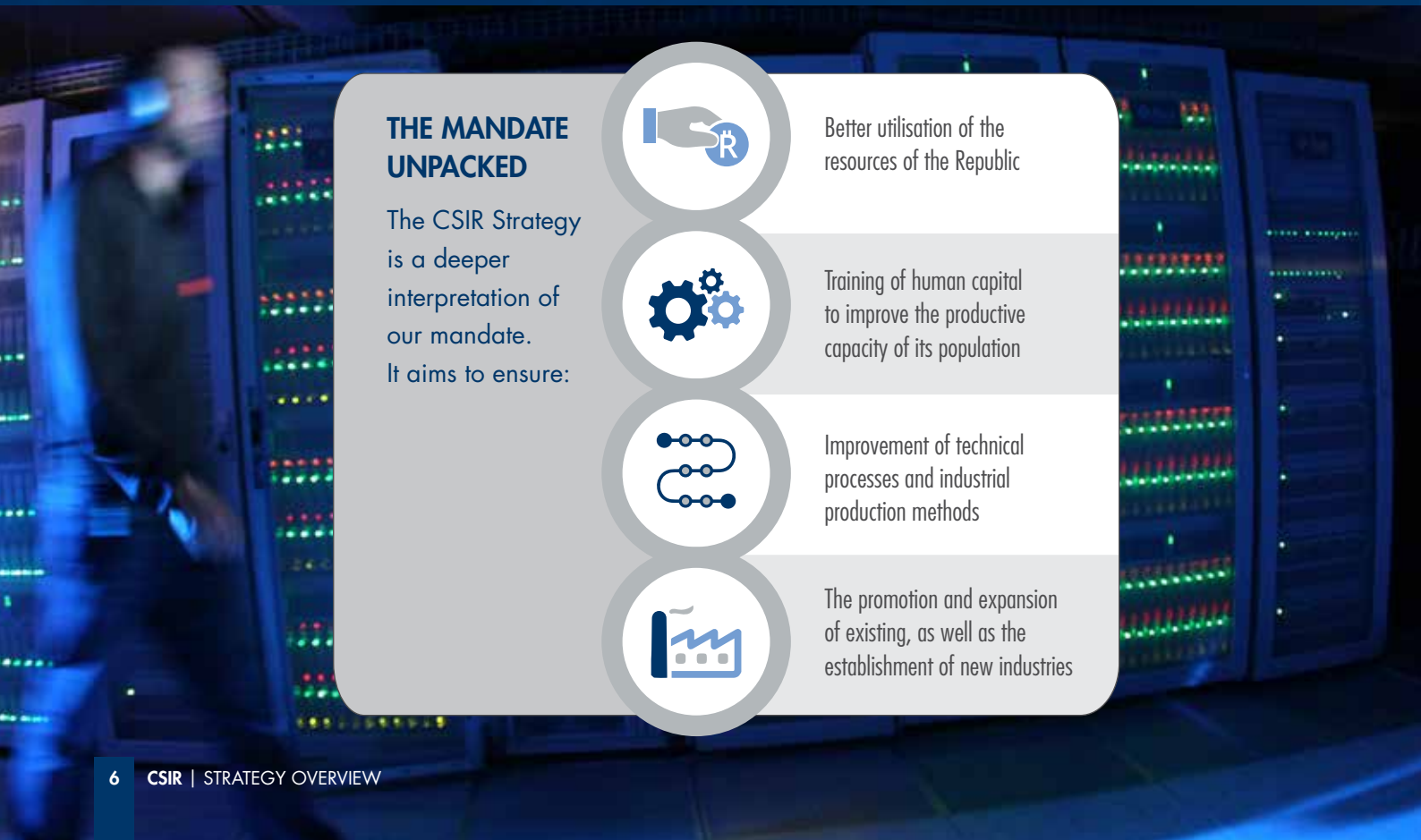
CONTENTS

Laser shock processing technology is used to straighten a winglet spar of a business jet, which resists bending loads.

CSIR MANDATE

"The objects of the CSIR are, through **directed** and **particularly multi-disciplinary research** and **technological innovation**, to foster, in the national interest and in fields which in its opinion should receive preference, **industrial** and **scientific development**, either by itself or in **co-operation with principals** from the **private** or **public sectors**, and thereby to contribute to the **improvement of the quality of life** of the people of the Republic, and to perform any other functions that may be assigned to the CSIR by or under this Act."

(Scientific Research Council Act, 1998 (Act 46 of 1998), amended by Act 27 2014)

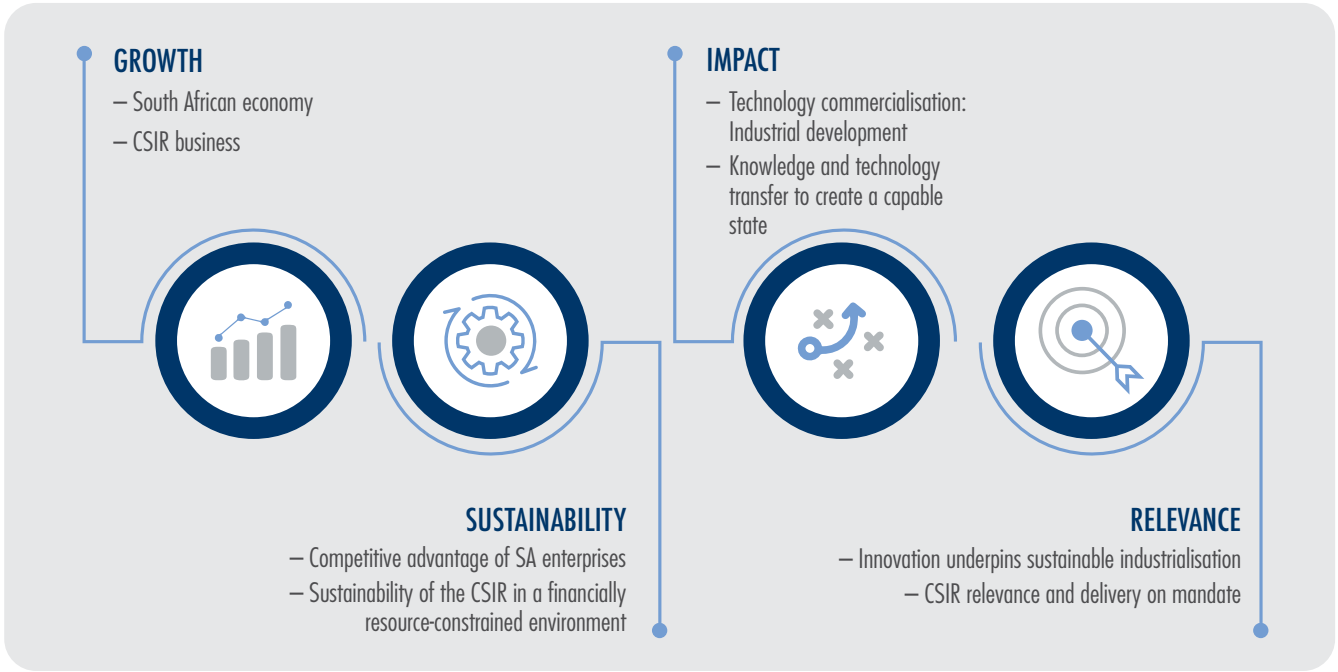


THE MANDATE UNPACKED

The CSIR Strategy is a deeper interpretation of our mandate. It aims to ensure:

- Better utilisation of the resources of the Republic
- Training of human capital to improve the productive capacity of its population
- Improvement of technical processes and industrial production methods
- The promotion and expansion of existing, as well as the establishment of new industries

THE STRATEGIC INTENT



The CSIR Strategy is underpinned by four pillars namely growth, sustainability, impact and relevance. These pillars bring alignment between responding to our mandate and addressing internal organisational imperatives.

For **growth**, the CSIR will use its capabilities, such as skilled multidisciplinary human resources, infrastructure and intellectual property, to assist in the inclusive growth of the South African economy, contributing to the alleviation of poverty, and addressing unemployment and inequality. The CSIR also intends to grow as an organisation, not only financially, but also with regard to human capital, infrastructure and other competencies required to remain a world-class organisation.

Sustainability refers to the CSIR developing technologies that improve the competitive advantage of South African enterprises, ensuring that they remain sustainable, while preserving the natural resource base. It also speaks to the financial sustainability of the organisation in a fiscally constrained environment.

Impact focuses on the commercialisation of technologies and innovations for industrial and societal development, as well as technology and knowledge transfer that enable a capable state.

The last pillar, **relevance**, relates to the appreciation of private sector decision-makers and public sector policy makers for the relevance of innovation in industrialisation, while also ensuring that the organisation is relevant.

OVERVIEW OF THE NEW CSIR STRATEGY

The CSIR Strategy is the culmination of a process that was launched in August 2017 when the CSIR embarked on a journey to amplify the 'I' in 'CSIR'. The Strategy broadens the scope of growth opportunities for the CSIR, while deepening the organisation's relationship with its stakeholders, notably industry. The CSIR's work with the public sector and public-good science is key to the fulfilment of its mandate, and is thus an integral part of the new strategy.

"THE STRATEGY PRESENTS A GROWTH OPPORTUNITY FOCUSING ON INDUSTRIAL DEVELOPMENT. THE CSIR WILL CONTINUE TO UNDERPIN ITS INNOVATION IN SUPPORT OF INDUSTRIAL PERFORMANCE AND SERVICE DELIVERY WITH SOUND SCIENCE."

– Dr Thulani Dlamini, CSIR Chief Executive Officer.

The past decade or so has seen a significant investment of CSIR resources to strengthen the science, engineering and technology (SET) base of the organisation. Evidence of this includes the establishment of emerging research areas; science-focused investment programmes, such as the thematic programme (addressing particular scientific topics); the creation of structures to support scientific excellence, such as a strategic research panel (advising the organisation on strategic R&D investments) and research career ladders (providing clear career paths for scientists and engineers) – all in pursuit of building a solid foundation of sustained capabilities.

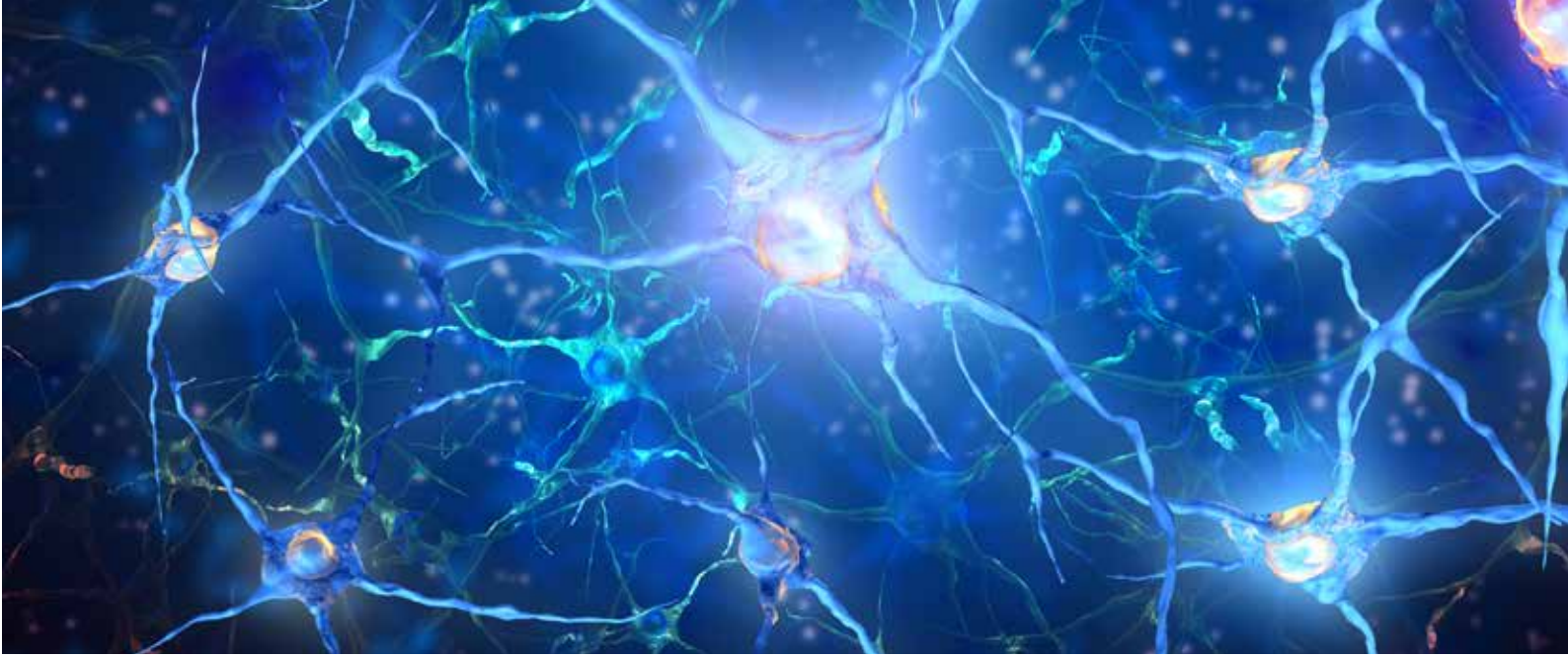
This strategic positioning was necessary, given the outlook of the CSIR and its context at the time. The CSIR will now focus on the effective and meaningful translation of its scientific endeavours into solutions that create new enterprises and make our existing industries more competitive.

The context of global and local environments provided an impetus for this new strategy. Globally, the backdrop was one of decreased economic performance, driven in part by global megatrends, such as geopolitical uncertainties, the lingering effects of the 2008/09 global recession and urbanisation. From an innovation perspective, there is a surge in the transformative applications of advanced technologies, notably those driving the fourth industrial revolution. Locally, the country continues to face the triple challenges of poverty, inequality and unemployment.

In light of the challenges that the country faces, the changing external environment and our role as outlined in the mandate, the CSIR, as the premier research and technology organisation in the country, could not continue on its trajectory without consciously adjusting its course to address national and regional challenges more effectively through innovation.

In formulating the new strategy, the CSIR considered the national imperatives as stipulated in the Sustainable Development Goals, the National Development Plan, and the White Paper on Science, Technology and Innovation. The organisation also went through a rigorous consultative process with internal and external stakeholders.

The CSIR Strategy sets out how the organisation will leverage its strong SET capability base and build on current industrial development opportunities, while creating the right balance between scientific and industrial development in its innovation portfolio – a balance that will effect a virtuous cycle in which



Synapse, the region where nerve impulses are received and transmitted, allowing for communication.

scientific and technological development supports industrial and societal development, and the latter, as it evolves, informs the research agenda. In repositioning itself and aligning with global best practice, the CSIR articulated its **vision and mission** statements, new **strategic objectives**, and new organisational **values**.

The strategy aims to drive innovation in:

- Areas in which South Africa can create a global competitive advantage;
- Sectors of the economy in which investment in innovation is required and will bring about a step change in South Africa's competitiveness;
- Particular areas within those sectors in which the CSIR's capabilities (both current and future) can be harnessed to improve performance; and
- Ways to build partnerships and make investments that will deliver sustainable growth for our economy.
- Priority areas that support the development of a capable state and respond to national priorities.

The successful implementation of the CSIR Strategy and fulfilment of its mandate, vision and mission rely on strong and mutually beneficial **collaborations** with a broad spectrum of stakeholders, partners and clients. These collaborations started in the strategy development process and continued to programme and project initiation and implementation.

The CSIR Strategy responds to national priorities and initiatives. An in-depth socio-economic and technical analysis led to the identification of the sectors that will move the needle economically for South Africa, and the relevant technologies (fourth industrial revolution (4IR) and non-4IR) that will drive their performance. Nine strategic technology sector **clusters** through which the CSIR can make the biggest impact were identified and form the backbone of the strategy. These sectors are also aligned with the mandates of the various government departments and public sector institutions. As part of the strategy, realigned and enabling **business** and **operating models** have been developed to facilitate our strategic intent.

The CSIR will leverage emerging technologies, especially those rooted in 4IR, as well as new and current capabilities, and those of its partners to position South African public and private sectors for the future.

Key elements of the **CSIR brand** have also been refreshed, in line with the new strategic trajectory.

ALIGNING WITH GLOBAL AND NATIONAL IMPERATIVES

In formulating the new strategy, the CSIR considered the Sustainable Development Goals, and national imperatives articulated in the National Development Plan (NDP), Mid-term Strategic Framework and the White Paper on Science, Technology and Innovation.

The CSIR Strategy speaks primarily to seven of the focus areas identified in the NDP:

- **Economy and employment:** The CSIR initiates programmes directly aligned to support key national economic sectors. New clusters for the chemicals (CSIR Future Production: Chemicals), mining (CSIR Future Production: Mining) and manufacturing (CSIR Future Production: Manufacturing) sectors focus specifically on this goal.
- **Building a capable state**: Interventions in this area focus on service delivery and its associated issues. Supporting government in this area are CSIR Defence and Security, CSIR Smart Mobility, CSIR Smart Places, CSIR NextGen Health and CSIR NextGen Enterprises and Institutions.
- **Economic and social infrastructure:** Research is conducted to inform policy-making and technology development for water, transport, coastal and information and communications technology (ICT) infrastructure as well as improved building design and building materials. Clusters that address these issues directly are CSIR Smart Places and CSIR NextGen Enterprises and Institutions.
- **Transition to a low-carbon economy:** The CSIR is working on improving the measurement and management of natural resources, as well as the ability to understand the long-term effects of climate change to assist government with the formulation of mitigation and adaptation strategies. The clusters focusing on manufacturing, chemicals, mining and smart places address these issues directly.
- **Transforming human settlements:** The CSIR supports metropolitan areas and municipalities in a number of areas, including spatial planning, the management of infrastructure and the transition to greener and smarter economies. The CSIR Smart Places cluster addresses elements of long-term planning and technology integration for smarter, more efficient communities.
- **Improving health:** In CSIR NextGen Health, the organisation's work in support of health ranges from technical support to the National Health Insurance initiative and the development of interconnected and inter-operable point-of-care devices, to the development of new methods to understand, manage and diagnose disease at the cellular and molecular level.
- **Building safer communities:** CSIR interventions in this area focus on supporting the acquisition and integration of technology by our security forces, national police and the security sector. The CSIR Defence and Security cluster predominantly focuses on this goal.

The CSIR Strategy and its contribution to the Mid-term Strategic Framework

The CSIR Strategy is aligned to the Mid-term Strategic Framework 2019 – 2024, which aims to address the challenges of unemployment, inequality and poverty by driving a strong and inclusive economy, building and strengthening the capabilities of South Africans and achieving a more capable state. The CSIR contributes to the priority areas as follows:

- **A capable, ethical and developmental state:** Through interventions led by its Smart Mobility, Smart Places, and NextGen Enterprises and Institutions clusters, the CSIR contributes to, for example, an efficient health-care system, the digitalisation of government services, improved intergovernmental collaboration on security-related incidences, next-generation identity authentication, and evidence based policy-making – from health-care provision to issues of energy, water and overall sustainability.
- **Economic transformation and job creation:** The CSIR's renewed focus on the future of production is aimed at stimulating the economic development of key sectors in the South African economy. The clusters focusing on mining, chemicals, advanced agriculture and food, manufacturing, as well as defence and security contribute to this priority.
- **Education, skills and health:** The CSIR has a number of programmes aimed at skills development in a changing workplace. For example, it is implementing the Data Science for Impact and Decision Enablement programme, which is funded by the DSI to build the country's data science capability. The CSIR collaborates with universities, sector education and training authority institutions and technical and vocational education and training colleges to support skills development in particular focus areas.
- **Consolidating the social wage through reliable and quality basic services:** CSIR innovations in infrastructure, health services, public transport and housing are achieved through interventions by CSIR NextGen Health, CSIR Smart Places and CSIR Smart Mobility.
- **Spatial integration, human settlements and local government:** The CSIR addresses elements of long-term planning and technology integration for smarter, more efficient communities and improved service delivery through CSIR Smart Mobility, CSIR Smart Places, and CSIR NextGen Enterprises and Institutions.
- **Social cohesion and safe communities:** Through the Defence and Security cluster, the CSIR develops and implements technology interventions to improve digital and physical security.
- **A better Africa and world:** The CSIR engages throughout the continent and particularly within the SADC region and supports the African Union and The New Partnership for Africa's Development in the implementation of various industrialisation, science and technology strategies. The CSIR also collaborates internationally on a range of issues from climate change to technology governance.

FOUNDATIONAL ASPECTS

While the mandate, with its timeless attributes, remains the launch pad for any CSIR activity, the current local and global context, internal and external engagements, as well as contemporary best practice, highlighted the need for a bridge between the mandate and the CSIR Strategy and brought about the organisation's vision and mission statements.

VISION

We are accelerators of socioeconomic prosperity in South Africa through leading innovation.

MISSION

Collaboratively innovating and localising technologies, while providing knowledge solutions for the inclusive and sustainable advancement of industry and society.

STRATEGIC OBJECTIVES

Considering various national drivers, the CSIR Strategy features renewed strategic objectives to respond to each of these, illustrated in the figure below.

STRATEGIC DRIVERS	HIGH-LEVEL RESPONSES	STRATEGIC OBJECTIVES
The convergence and the pace of new technologies are fundamentally disrupting industries and require RDI interventions	Accelerate the development and diffusion of transformative technologies in SA's high-impact industries through high-quality RD&I	Research, develop and diffuse transformative technologies
South Africa has undergone deindustrialisation over the last decade	Improve the competitiveness of SA's high-impact industries through RD&I in a collaborative manner, thereby contributing to the reindustrialisation of the country	Contribute to reindustrialisation through technology development, localisation and implementation
Economic and social development in South Africa has been constrained by the challenges of irregularity, unemployment and poverty	Play a pivotal role in the socioeconomic transformation of SA through RD&I and contribute to the development of a capable state	Support the development of a capable state
South African public-sector spend in research and development is constrained but remains a country focus. RD&I needs are changing and there is increased competition in the RD&I sector	Diversify income sources by optimising the business model to achieve competitiveness and financial sustainability, supported by efficient and sound governance	Diversify income, maintain financial sustainability and good governance
Limited capabilities exist to leverage the opportunity of new technologies impacting all industry sectors and society	Build and transform the required human capital and infrastructure to drive industrialisation and the advancement of society	Build and leverage human capital and infrastructure

Strategic drivers that shaped the CSIR's strategic objectives.

VALUES

In keeping with its refreshed business approach and focus on making an extensive impact on South Africa's competitiveness, and thus on the quality of life of the country's people, the CSIR identified a new set of values to underpin our new organisational culture. These are not only a means of enhancing a constructive work ethic and creating and environment conducive to career growth and reward, but are also intended to hold the organisation accountable – internally and externally. Our values statement reads:

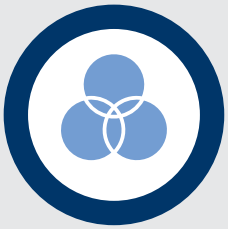
Our behaviours, beliefs, principles and the impact we wish to make to improve the quality of life of South Africans, are EPIC. Team CSIR pursues Excellence, celebrates People, personifies Integrity and welcomes Collaboration.

EXCELLENCE

We excel at R&D and industrial innovation solutions that address South Africa's challenges. Efficient and novel thinking, as well as high-quality systems and processes enable the necessary agility to change course, should our stakeholders or environment require it. We are unashamedly passionate about the impact we make and pursue excellence in every facet of CSIR life.

PEOPLE-CENTRED

We care about people – our impact through innovation aims to improve lives. We respect diversity and uphold the dignity of every person, regardless of culture or belief system. Our systems and processes enable continuous personal development and we encourage one another to seize opportunities. We treat our stakeholders the way we like to be treated.



INTEGRITY

We value integrity – in ourselves and in others. We are honest and fair in how we work and how we engage the world around us. We respect the trust that our colleagues and stakeholders place in us and commit to ethical decision-making, delivery and governance.

COLLABORATION

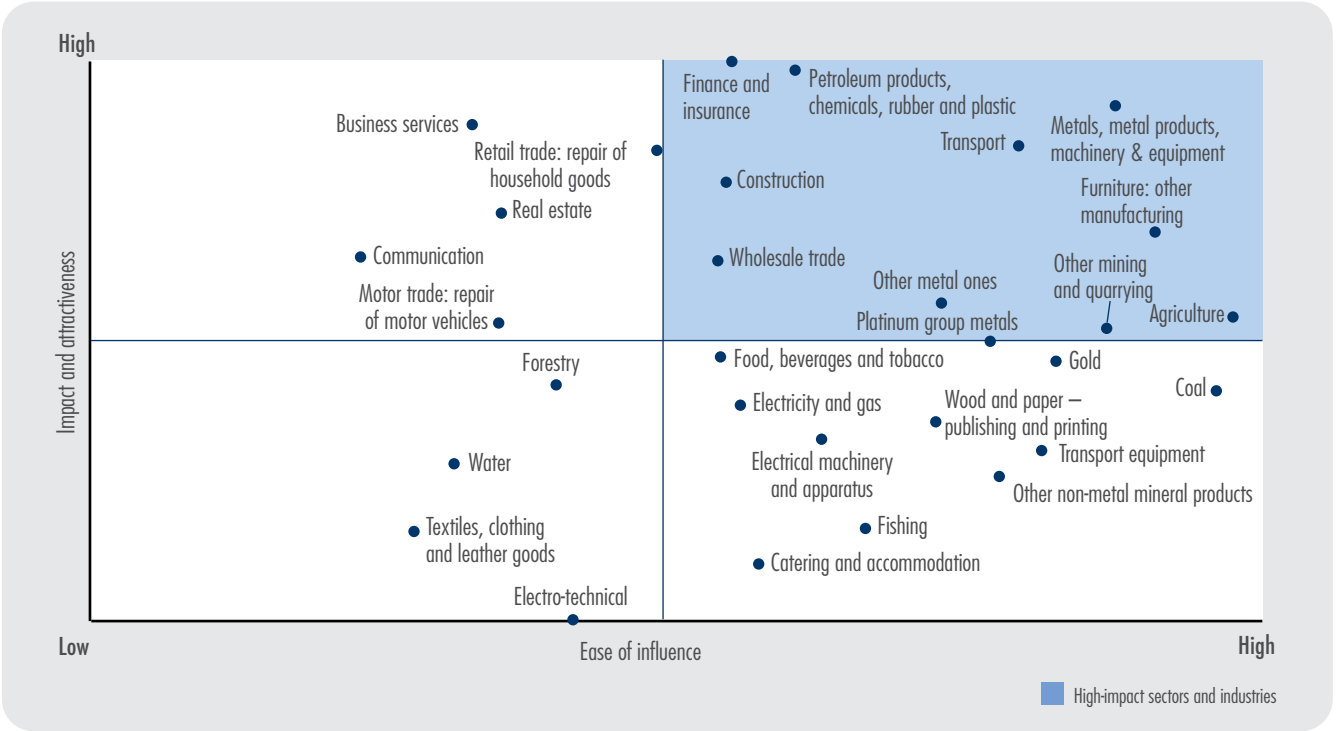
We are keen to learn from one another and collaborate across the organisation and with external partners, to ensure that our work has the best chance to innovate a better future for South Africans. We actively share our knowledge and expertise by design, formally and informally, so that we can realise large-scale impact.

TECHNOLOGY **SECTOR CLUSTERS**

The CSIR Strategy considers South Africa's readiness for the future, given that the world is currently undergoing a seismic change as it transitions to the era of the fourth industrial revolution (4IR). South Africa was assessed alongside more than 100 countries to determine their respective future readiness, using the World Economic Forum Readiness Framework – *Readiness for The Future of Production Report, 2018, World Economic Forum in collaboration with AT Kearney*. According to this country readiness assessment, South Africa is classified as a *Nascent Country*, and finds itself at a critical juncture – Will the country be ready for the future, or will it be left behind as other countries advance with the changes that the 4IR brings about? In light of South Africa's position, and given that the CSIR needs to prioritise its finite R&D resources, the CSIR Strategy defines priority industries.

PRIORITY INDUSTRIES:

- Present the greatest potential for socioeconomic impact according to a robust set of economic and social criteria that are both forward looking and retrospective — including contribution to gross domestic product, market and export growth and employment multiplication; and
- Are, to varying extents, dependent on R&D and thus offer opportunities for the CSIR to pursue. (Priority industries are reflected in the matrix below.)



Assessment of South Africa's industrial sectors to identify high-impact industries (A.T. Kearney).

A novel aircraft model, designed and tested by the CSIR as part of international research efforts to reduce the cost of air flight.

Due to the strategic importance of energy, education, health, and defence and security, these industries are by default considered priorities for South Africa. The figure below summarises the industries that constitute the CSIR's prioritised industries.

- Aerospace, defence and security
- Business services
- Finance and insurance
- Communications (ICT)
- Electricity and gas
- Water
- Petroleum products, chemicals, rubbers and plastics
- Metals, metal products, machinery and equipment
- Food, beverages and tobacco
- Agriculture
- Education
- Health
- Transport and logistics
- Metals mining and quarrying

National priority industries

CSIR priority industries.

TECHNOLOGY **SECTOR CLUSTERS** CONT.

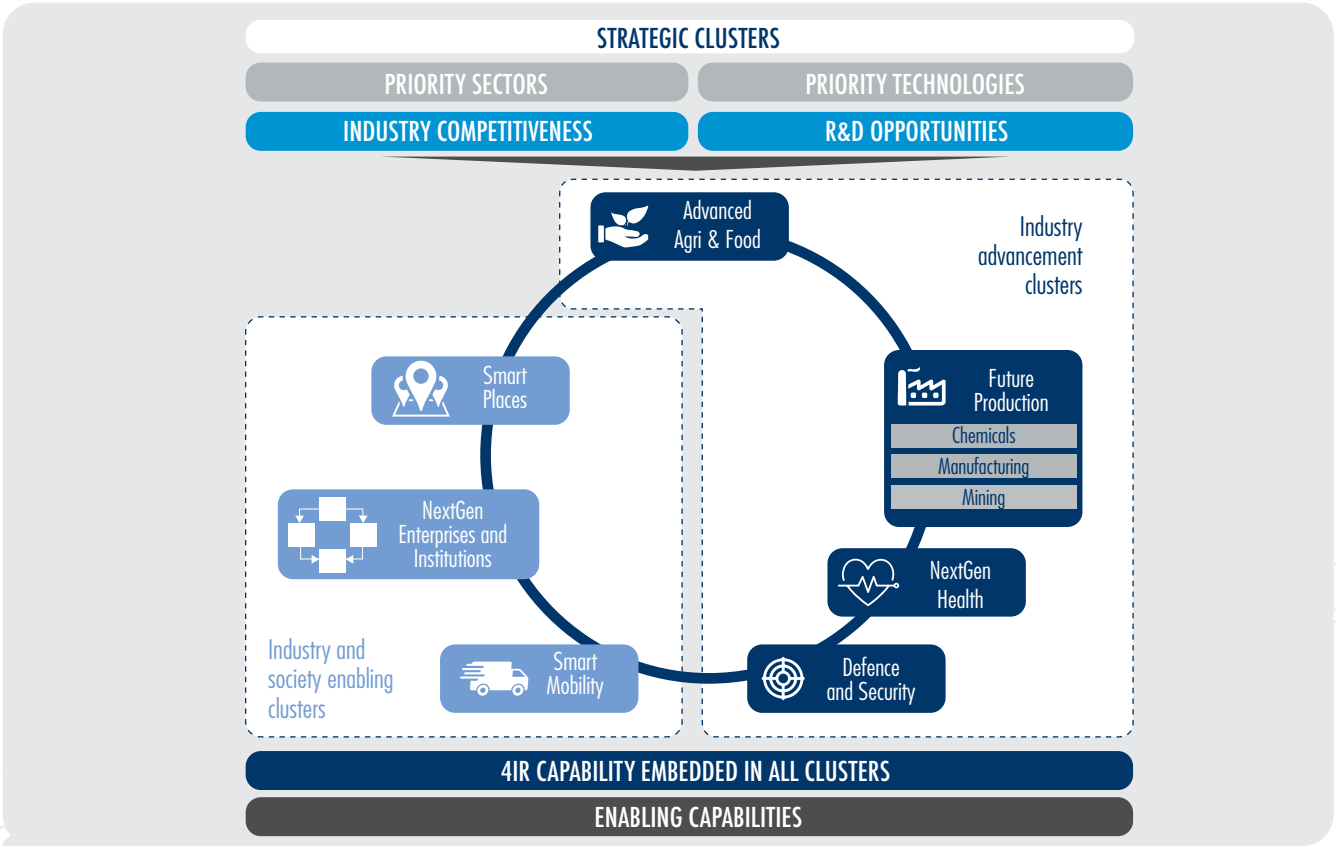
As part of the process of prioritising sectors, consideration was given to the impact of various platform technologies, notably those commonly cited as 4IR relevant (figure below). For each of the sectors (and embedded industries) that could potentially move the needle for the South African economy, the analysis highlighted those platform technologies that are expected to have the greatest transformative and disruptive effect.

Transformative 4IR technologies considered in strategy development.

An isolated industry and technology view was deemed limiting as technologies and industries continuously converge and evolve. To amplify the potential impact from these technology-industry convergences, the CSIR Strategy, buttressed by detailed economic and competitiveness analyses, defines clusters that leverage clear synergies across technologies and industries.

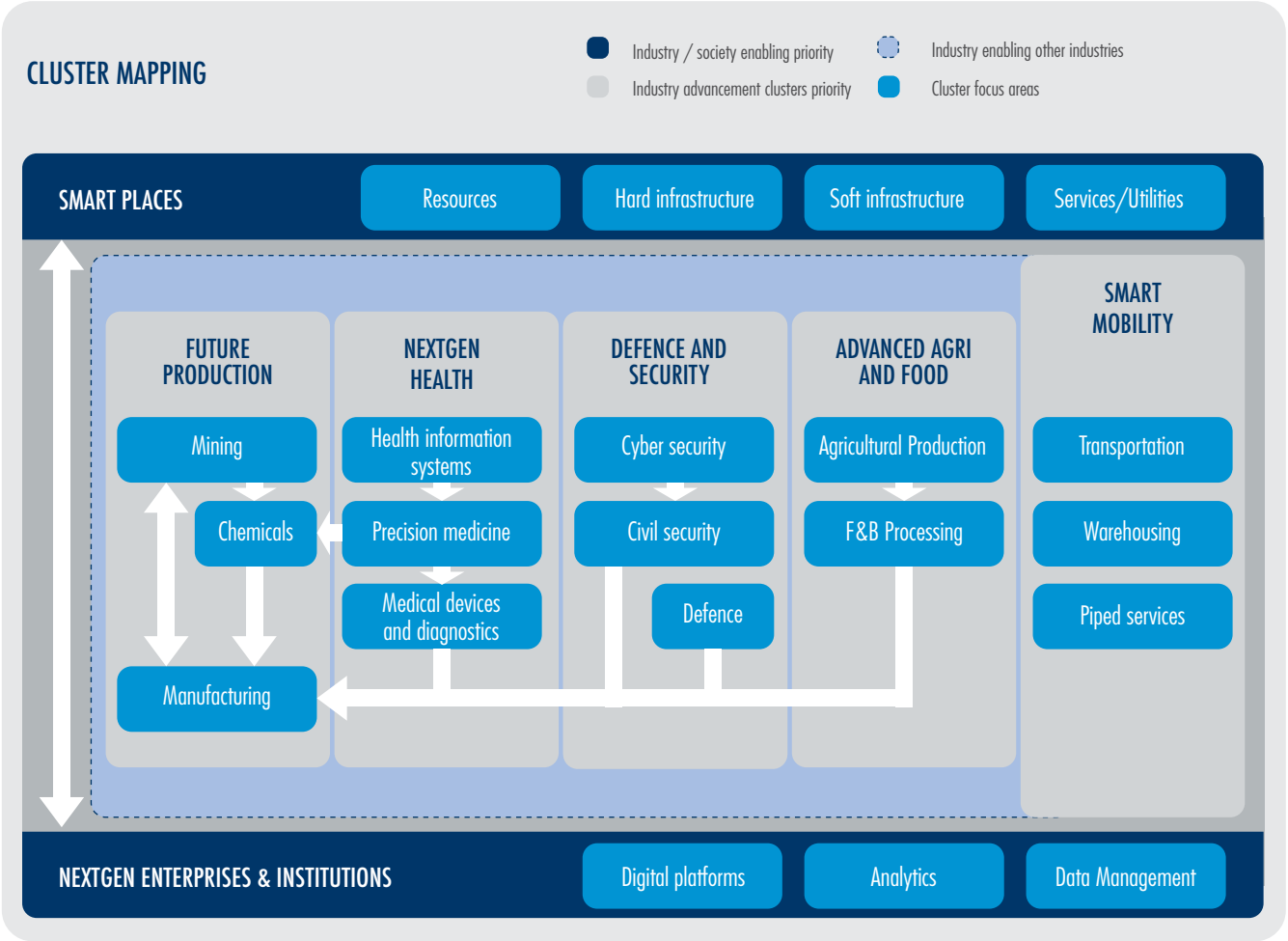
The CSIR Strategy thus focuses on nine **technology sector clusters** and supporting initiatives. In identifying specific areas of focus in these clusters, the CSIR familiarised itself with the relevant industries in particular sectors, the industry structure, value chains, challenges and opportunities, emerging trends, typical role-players, as well as current and required capabilities relevant to the sectors.

Some of the clusters are directly involved in production and service delivery and these are referred to as the **industry advancement clusters**. Three of the clusters create an enabling environment for industry and society to thrive, and these are referred to as the **industry and society enabling clusters**. The figure on page 18 illustrates the technology sector clusters, and the potential linkages between these clusters, which make them complementary and mutually reinforcing.



The synergetic technology sectors clusters that underpin the CSIR Strategy.

TECHNOLOGY **SECTOR CLUSTERS** CONT.



Interdependencies between the complementary and mutually reinforcing technology sector clusters.

CLUSTER **OVERVIEW**

In parallel with the identified transformative technologies, the CSIR will also respond to demand-driven emerging technology interventions.

CSIR FUTURE PRODUCTION: **CHEMICALS**

Preliminary testing of the gas-sensing performance of nanostructured metal oxides.

Cluster strategic intent

CSIR Future Production: Chemicals addresses the challenges and opportunities of the petroleum products, chemicals, rubbers, advanced materials and plastics sectors. (Sectors are listed as per the nomenclature of Statistics South Africa.) The cluster applies disruptive and innovative combinations of biological and chemical (bio-chemical) conversion technologies to improve efficiencies across the chemicals value chains; develops greener processes; and produces high-value novel chemical entities and advanced materials to create a dynamic African chemical industry with access to forward-looking and modern digitised production processes.

Challenges to be addressed and envisaged impact

This cluster aims to improve the competitiveness of chemical industries in South Africa by providing novel technologies that expand the product portfolio of chemical industries, supports the localised production of pharmaceuticals and advanced materials, and improves the efficiencies of mineral conversions processes to support value addition to South Africa's mineral resources.

Focus areas

The figure below illustrates a simplified version of the chemicals value chain and indicates the CSIR's primary and secondary focus areas.

The chemicals value chain.

CLUSTER **OVERVIEW** CONT.

The cluster will predominantly focus on primary, secondary and tertiary conversions of feedstocks, support the development of formulated products; and drive the technology for waste reduction and valorisation. The cluster features three strategic capability platforms namely (bio)-chemical conversions, pharmaceutical innovation technology, and advanced materials.

The **biochemical conversions platform** applies disruptive and innovative (bio)-chemical conversion technology to create a dynamic African chemical industry with access to forward-looking and modern digitised and greener production processes.

The CSIR's strategic response includes scouting for transformative technologies that are aligned with the cluster focus areas for localisation and diffusion; merging fundamental industrial biotechnology with green chemistry; and converging information technology with chemistry, synthetic biology and metabolic engineering, in line with the envisaged impact for the chemical and allied industries. The CSIR will continue to develop existing programmes and capabilities aligned with this platform, notably the Biorefinery Industry Development Facility and the Biomanufacturing Industry Development Centre.

The **pharmaceutical innovation technology platform** enables a dynamic African pharmaceuticals manufacturing industry with access to critical and modern drugs through innovative and world-class processing technology, aimed at leapfrogging current batch manufacturing, using continuous manufacturing technology instead. The CSIR focuses predominantly on upscaling locally developed and inbound processing technologies to bridge the gap between research and development and product manufacturing.

Existing interventions in this area include process modelling and development, with a specific focus on chemical process development and engineering, as well as modelling. New interventions will focus on setting up demonstrator projects to initially develop both small-molecule and biologic oncology drugs, establishing international knowledge exchange programmes, establishing open labs for translational research and the scale-up of process routes, with technology transfer mechanisms in place to localise international processes. The long-term vision of the platform will focus on the development of fully automated end-to-end green production processes.

The **advanced materials platform** aims to develop modified or advanced types of materials that have been engineered to provide superior performance across one or more characteristics. It will expand niche and specialty chemicals categories, generate novel inputs for advanced materials, green production methods and improved process efficiencies for existing and new products.

The cluster leverages existing research, development and innovation initiatives to grow polymers and composites programmes as inputs for advanced materials, and will develop new or modified materials, while introducing green production methods and focusing on process efficiencies. The Centre for Nano-structured and Advanced Materials focusing on nanocatalyst design and polymers, and the Titanium Centre of Competence remain critical enablers of this platform.

DELINEATIONS: The (bio)-chemical conversions platform intervention does not focus on traditional chemical feedstock process and product development. The pharmaceutical technology innovation platform intervention does not focus on early-stage drug discovery, proof-of-concept process development, blue-sky reactor design or Good Manufacturing Practice (GMP) manufacturing.

CSIR FUTURE PRODUCTION: MANUFACTURING

Restoration of the metallic surface of a generator rotor through laser cladding.

Cluster strategic intent

CSIR Future Production: Manufacturing addresses the challenges and opportunities of the metals, metal products, machinery and equipment sector. The structure of the industry is tiered, with very few and mostly foreign-owned original equipment manufacturers (OEMs), and a variety of players at various hierarchical levels in their supply chain. The cluster aims to strengthen the middle tiers of the value chain (fabrication, engineered products and materials and assembly of simple to complex systems); develop strategic capabilities to address high-value industries; facilitate supply chain integration technological advances; and make production and processing lines more automated, modular and responsive through Industry 4.0 technologies.

Challenges to be addressed and envisaged impact

Although the contribution of the metals products, machinery and equipment industry is significant, it is facing multiple challenges that contribute to South Africa's declining economic growth. These include limited design of original products; underdeveloped product and process testing, qualification and certification; limited capability for the assembly of complex subsystems, and systems integration; limited adoption of automation and emerging technologies, a heavy reliance on manual labour, as well as inefficient processes and capability shortfalls, which have resulted in above-average waste production. The sector relies on imported specialist steels, alloys and advanced materials, faces intense external competition, and lacks effective collaboration between public and key private sector players to create partnerships to leverage resources and scarce skills.

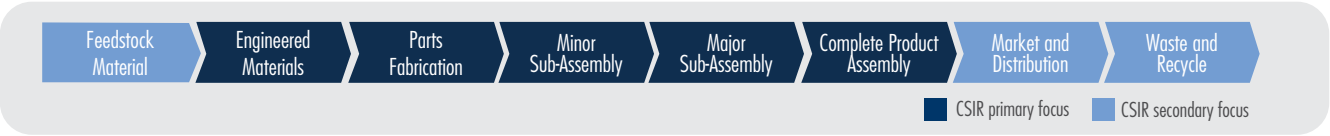
The metals, metal product machinery and equipment sector, as well as associated engineering, play a critical role in enabling growth by driving industrialisation and creating more decent, better-paying jobs. Without technology and innovation, industrialisation will not happen, and without industrialisation, development will not happen. Therefore, engineering will always be a key driver as it can simultaneously serve the three dimensions of sustainability, namely economic, social and environmental.

The envisaged impact is thus to strengthen the middle tier small, medium micro enterprises (SMMEs) and bring competitiveness to high-value manufacturing sectors by leveraging technology advancements and vibrant supply chain improvements, while focusing on machinery and capital equipment. In the long term, the cluster's focus is developing local OEMs, expanding exports and capturing a larger share of global high-value manufacturing.

Focus areas

The figure on page 22 illustrates a simplified version of the manufacturing value chain and indicates the CSIR's primary and secondary focus areas.

CLUSTER **OVERVIEW** CONT.



The manufacturing value chain.

The **engineered materials platform** focuses on raw material beneficiation, especially titanium, aluminium and the platinum group metals; import replacement of specialty metals and alloys, advanced polymers, plastics and next-generation composites and fibres; the testing and qualification capability for new material; and nurturing end-to-end value chains working collaboratively with the end users. The platform drives innovation across the materials value chain, exploiting Industry 4.0 technologies, as well as fabricates novel advanced materials to provide local industry with a globally competitive edge.

For this platform, the CSIR will develop nanoparticle-enhanced metal alloys and composites; formulate advanced polymers, as well as next-generation composites, fibres and alloys. Existing interventions that can be leveraged include the nanomaterials initiative as well as work done with respect to lightweight and titanium alloys, polymers, nanocomposite thermoplastics and nano, natural fibre- and metal-matrix composites.

The **parts fabrication platform** aims to strengthen parts fabrication and manufacturing capabilities to increase exports, expand design capabilities and intelligent technologies for manufacturing equipment and machinery, establish testing and certification capability to qualify new fabrication processes, improve the production mix flexibility, as well as streamline internal logistics and responsiveness of the supply chain.

Interventions in this area include advanced fabrication and monitoring, and developing integrated factories where issues of materials processing, planning and control, and materials handling are considered. Full integration of computer-aided design and computer-aided manufacturing will be brought to bear in the factory and supply chain. Existing CSIR programmes and capabilities focus on titanium laser additive manufacturing, titanium metal injection moulding, mould and toolmaking, the foundry initiative and laser-enabled manufacturing.

The **assembly platform** aims to support the development and integration of complex subsystems, the development of advanced factory systems and supply chain integration capabilities through streamlined internal logistics to improve production efficiencies and facilitate integration into global OEMs. It will develop agile supply chains, and contribute to increasing product exports and global market presence.

The CSIR will focus on improving global supply chain integration capabilities and establish product lifecycle management (PLM) as a supply chain integration platform. It will focus on product and systems development in advanced industries. The organisation's existing PLM and factory optimisation capabilities will be leveraged.

DELINEATIONS: The CSIR manufacturing cluster does not focus on commodity/bulk materials processing, part of which is covered in the CSIR cluster dedicated to chemicals research, traditional manufacturing planning and control, or the development of commodity fabrication equipment.

CSIR FUTURE PRODUCTION: **MINING**

A CSIR-developed robotic platform in a simulated platinum slope.

Cluster strategic intent

CSIR Future Production: Mining addresses the challenges and opportunities of the mining and quarrying, non-metal mining, manufacturing and chemicals sectors. The cluster focuses on leveraging the strong history of mining in South Africa through the modernisation of mines via mechanisation and automation, and ultimately, fully autonomous operations, as the envisaged path to improve safety, bring change to processes, technologies, skill sets and social and environmental impacts associated with current mining practices. The CSIR, through its multidisciplinary capabilities and offerings, is ideally suited to provide technological solutions as needed for the revitalisation of mining R&D in South Africa.

Challenges to be addressed and envisaged impact

In addition to the price depression in the gold and platinum group metal sectors, the issues of aging infrastructure, deepening of mines and longer travel times to underground working areas have impacted on the profitability and sustainability of the sectors. Consequently, with increasing distance from the shaft, actual face time has decreased, thereby accounting for the reduction in production and contributing to escalating costs, and also posing additional threats to health and safety standards. The cluster also aims to address the limited commercialisation of research and development in the sector.

The overall mining cluster strategy is aligned with the Phakisa outcomes via the South African Mining, Extraction, Research, Development and Innovation Strategy; and will address the challenges in occupational health and safety facing the mining sector as a partner to the Mine Health and Safety Council. Such challenges include the following thematic areas to address occupational health and safety, covering, but not limited to, mine engineering, lab testing, rope testing, human factors, occupational diseases (including silicosis), airborne pollutants, fires and explosions, machinery and transport, rock bursts and rock falls.

The envisaged impact of this cluster is to support the growth and revitalisation of the mining industry through best-in-class process improvement support, manufacturing processes and system improvement, a mineral beneficiation focus and overall mining operations safety to ensure that South Africa maximises its mineral endowment.

CLUSTER **OVERVIEW** CONT.

Focus areas

The figure below illustrates the mining value chain and the CSIR's primary and secondary focus areas.

The mining value chain.

The CSIR, in accordance with its mandate, is appropriately positioned to provide technological solutions to the South African mining industry, particularly, but not limited to, the extraction and the beneficiation of strategic minerals of the mining value chain without encroaching on the mandates of Mintek and other organisations playing in this space.

The **mining development and operations platform** focuses on processes that ensure efficiency so that mines can maximise the recovery of the mineral wealth in a safe and sustainable manner. The focus is on input resource optimisation, modernised mining engineering and non-explosive rock breaking. The CSIR will build on current programmes in geophysics and rock engineering, mining engineering, sensor development, and robotics and automation. CSIR priorities include the optimisation of current mining, advanced orebody knowledge, mechanised mining, non-explosive rock breaking, and real-time information management systems.

In the **product development platform**, the CSIR and its partners focus on the development of specialty powders, nanomaterials, and specialty alloys, building on the Titanium Acceleration Master Plan and the South African Aluminium Industries Roadmap, among others. Overall, the cluster endeavours to improve upstream and downstream linkages between mines and domestic industrial stakeholders by promoting innovation, technological advances and R&D.

In **post-mining landscapes**, the cluster aims to facilitate effective closures and the rehabilitation of mining sites to minimise environmental impact.

DELINEATIONS: The CSIR does not undertake activities that will infringe on ongoing work related to mineral processing and beneficiation of minerals, as well as minerals exploration activities.

CSIR ADVANCED **AGRICULTURE AND FOOD**

A CSIR-developed robotic system used in horticultural monitoring.

Cluster strategic intent

CSIR Advanced Agriculture and Food addresses the challenges and opportunities of the agriculture as well as the food and beverage processing sectors. It applies cross-cutting technology and business model innovation in partnership with relevant public and private sectors to strengthen the agricultural industry and associated agro-processing value chains. Best-in-class technologies and business-model innovations are applied as catalysts to strengthen both commercial and rural agri-production in pursuit of rural development and inclusive economic development.

Challenges to be addressed and envisaged impact

The agriculture sector, including primary production and agro-processing, is critically important for food security and provides opportunities for the country to develop its rural economies. In current value chains, primary agricultural production occurs in rural areas, with value addition through agro-processing occurring in urban centres. The cluster seeks to capitalise on the current rapid growth in the food and beverage subsectors.

The cluster will address challenges such as increasing food security concerns, with a large proportion of the population becoming under-nourished due to lack of access to nutritious food, (unpredictable) climate change, disease and pest outbreaks, limited automation or mechanisation to improve efficiencies of both production and processing, as well as limited impact of the sectors on rural development and growth. The spatial separation between rural areas where production occurs and urban areas where the bulk of the value addition and consumption occur, results in limited value-added benefits re-distributed to the primary producers. Land redistribution presents opportunities in land-use re-planning and support to new entrants in both primary production and processing. In value addition, slow product innovation cycles make it difficult for industry to meet customer needs. However, the health drive and increasing demand for organic and non-packaged goods, convenience and healthy products trends present opportunities for the development of new products, and require innovations in the business model of the industry to meet consumer demands.

The envisaged impact for the cluster is to harness the opportunities afforded by transformative technologies to develop the agricultural industry and associated processing activities and, in turn, use these opportunities as a catalyst for rural development and inclusive growth.

CLUSTER **OVERVIEW** CONT.

Focus areas

The figure below illustrates the agri-food value chain and highlights the CSIR's primary and secondary focus areas.

The agri-food cluster value chain.

The cluster predominantly focuses on primary, secondary and advanced conversions of agricultural feedstocks to higher value products. This cluster leverages existing interventions and expertise, including agro-processing product and process development, bioprocessing and biorefinery platforms, business model development and innovation for rural communities, food safety testing, and development of unique products from indigenous plants. These capabilities and activities are further strengthened by the adoption of digital, smart ICT and robotic technologies to support operational efficiencies, cost reduction and export readiness.

The cluster features three strategic capability platforms, namely precision agriculture, processing, and advanced processing to add value to crops and agricultural produce, including a focus on indigenous crop valorisation.

The **precision agriculture platform** contributes to the development of a more competitive industry and rural economies by supporting agricultural production through earth observation, climate change modelling, big data, and data analytics for decision support in land-use planning, to predict yields and inform markets, as well as to monitor pests and diseases. Precision agriculture tools, including equipment telematics, are to be developed further to improve farm operations.

The platform will harness existing CSIR programmes in precision agriculture, such as robotic crop monitoring (the CSIR Smart Farm initiative), to improve operations through real-time decision-making, increase efficiencies while preserving quality, as well as establish new programmes in digitalised animal tagging and health monitoring.

The **agro-processing platform** seeks to modify and facilitate the transfer of fit-for-purpose modern agro-processing technologies into rural settings, as well as to develop value-added processing of crops, including high-value indigenous plants. The programmes will incorporate the development of advanced capabilities for food safety testing efficiency and accuracy, as well as automated production line technologies. The cluster also focuses on the development of flexible and innovative business models suitable for the rural economy.

Existing interventions in this area include product and process development, value addition to indigenous plant resources through processing, and the development and implementation of community-based business models through the agriparks initiative. The CSIR will continue to focus predominantly on product and process development and upscaling of manufacturing technologies to bridge the gap between research and product manufacturing.

The **advanced processing platform** scouts for best-in-class process technologies for localisation and diffusion, and includes the integration of existing agro-processing activities with modern

New materials can be instrumental in preserving food and extending shelf life.

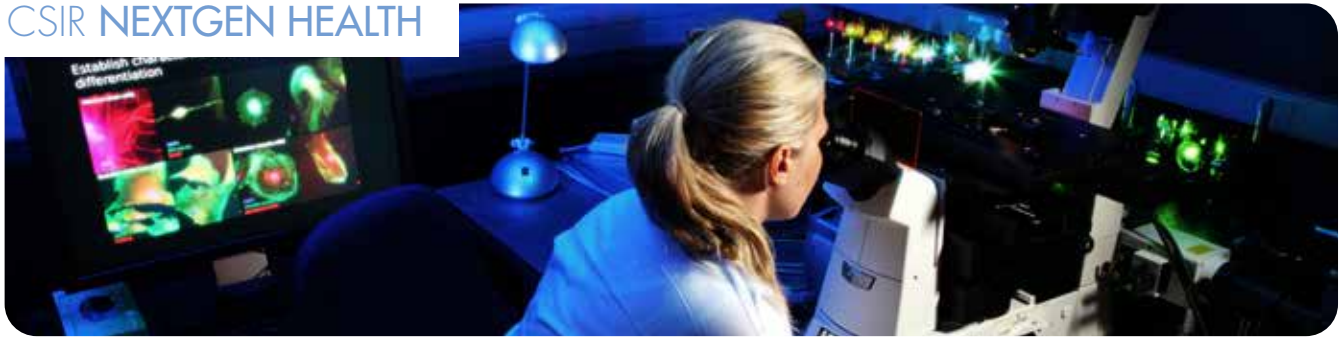
bioprocessing and biorefinery technologies, as well as modern digital technologies. Programmes also include automated and intelligent production, smart packaging development, sensor technologies for food safety and quality preservation, as well as integrated supplier development. The programme will build on existing interventions, such as the Biorefinery Industry Development Facility, the Centre for Nanostructures and Advanced Materials and the Biomanufacturing Industry Development Centre, which are important components of this integrated approach. Other relevant existing industries include produce lifecycle management, smart factories and logistics.

The CSIR's response requires close collaboration with other leading role-players in the sector, including the Agricultural Research Council (ARC). In this collaboration, integration of CSIR capabilities and outputs with ARC interventions in the agricultural sector is of particular relevance.

The CSIR will also collaborate closely with universities, communities and entrepreneurs (SMMEs) in the sector to access expertise across the value chain in this emerging industry. Integration of R&D with innovative business models suitable for distributed rural businesses also forms a core component of the value offering.

DELINEATIONS: The Agricultural Research Council is a key stakeholder in this sector. The CSIR will ensure close collaboration to harness the two entities' strengths and prevent competition or duplication of efforts.

CSIR **NEXTGEN HEALTH**



The CSIR is undertaking research to help ensure that prescription drugs are suitable for all African populations.

Cluster strategic intent

CSIR NextGen Health addresses the challenges and opportunities presented by pharmaceutical production and biomaterials as well as the ICT and electro-technical sectors to improve health outcomes and drive the local health-care industry. The cluster focuses on the improvement of access to health care, and incorporates synthetic biology and state-of-the-art diagnostic and treatment technology with advances in artificial intelligence to provide integrated digital health solutions. It thus ensures that appropriate treatments are delivered at an appropriate time and place for the patient.

Challenges to be addressed and envisaged impact

This cluster aims to improve the health-care industry in South Africa by leading technology development, adoption, innovation and integration to address the three pillars of health care, namely the health system, burden of disease and social determinants.

The CSIR aims to play a greater role in creating better industry/community cohesion along the value chain to improve efficiencies and access to health-care services, support evidence-based policy that fosters local industry competitiveness and develop interventions to maintain and build a skilled labour force. The cluster also addresses current insufficient efforts and interventions aimed at stimulating local innovation and technology development (localisation, financial and non-financial support required), particularly in the diagnostics and devices sectors. Technology development per disease focus will be undertaken for the priority conditions that are adding to South Africa's burden of disease, along with the development of enabling capabilities to facilitate the adoption of interventions.

Focus areas

The figure below illustrates the health value chain and highlights the CSIR's primary and secondary focus areas. In this instance, products or solutions are required at each stage of the health value chain.

The health value chain.

The cluster predominantly focuses on the application of continuous personalised health care and timely interventions through connected intelligent medical devices and artificial intelligence algorithms to predict risk factors and create new preventative clinical paths. The cluster features three strategic capability platforms, namely health information systems, medical devices and diagnostics, and precision medicine for pharmaceutical treatments.

The **health information systems platform** applies interoperable health information systems for continuity of care and patient-centric health-care delivery. The CSIR's strategic response ensures an appropriate and up-to-date standards framework for eHealth systems, provides technical guidance for the implementation of standards, establishes national certification of standards' compliance and establishes national shared ICT infrastructure for health data exchange.

The CSIR's strategic response includes a health normative standards framework and shared national ICT infrastructure, with an additional focus on data mining using digital and cognitive technologies to produce insights and trends for health system planning. The existing eHealth capabilities of the interoperability of health information systems and information security remain critical enablers of this platform.

The **medical devices and diagnostics platform** will contribute to the development of a thriving local medical devices and diagnostic industry, and position South Africa as a key exporter of these technologies. The CSIR will focus predominantly on synergistic molecular and integrated diagnostics that are designed to meet the ASSURED (affordable, sensitive, specific, user-friendly, rapid, equipment-free and deliverable to end-users) needs of the developing world, mobile health-care coordination and new payment systems.

Existing interventions in this area include the implementation of product lifecycle management and advanced manufacturing support. New interventions focus on facilitating and accelerating the commercialisation of medical devices and diagnostics, through the provision of advanced materials for health applications, product testing infrastructure, incubation, as well as regulatory and smart logistics support. The CSIR will continue to develop existing programmes and capabilities applicable to this platform, including materials and systems technology (lateral flow and diagnostics, micro-fabrication, nanosensors and battery technology).

The **precision medicine for pharmaceutical treatments platform** is developing innovative technology platforms and African-specific testing to reduce development time, save investment costs and lower barriers to market entry. It focuses on precision medicine, companion diagnostics and stem cell technology to discover protein-biomarker treatments, predict adverse drug reactions, develop novel models of disease and investigate nanotechnology for targeted drug delivery and precision treatments.

The cluster is leveraging existing precision medicine RD&I initiatives to grow tele-medicine, novel individual and population-specific disease treatments, and clinical integration. The existing Biomedical Translational Research Initiative and Centre for Nanostructured Materials will remain critical enablers of this platform.

DELINEATIONS: The CSIR will not get involved in the development of patient information systems that already exist or areas where there are current players who already have a competitive advantage. The CSIR will also not address direct hospital quality of service improvements and process changes.

CLUSTER **OVERVIEW** CONT.

CSIR **SMART MOBILITY**

Cluster strategic intent

CSIR Smart Mobility addresses the challenges and opportunities of transport and logistics, transport equipment, infrastructure, public services, as well as the oil and gas, and mining sectors. The cluster seeks to improve overall economic competitiveness by improving the ease of doing business and enabling other sectors from the perspective of logistics and supply chain management.

The strategic intent is to work with the transport (all modes), wholesale and retail sectors (the logistics sector) to enable South Africa to be a global leader in the provision of safe, reliable, effective, efficient, and fully integrated logistics in support of the sustainable growth of the country's strategic industries. An efficient logistics sector contributes significantly to reduced cost of doing business in the country and improves the competitiveness of products and operations across all industries. New business models are an integral part of smart mobility beyond traditional logistics.

The envisaged outcome is a connected and robotised logistics system, including infrastructure, to maximise the efficiency and productivity associated with transport and logistics. This is especially important for a resource-extraction country that is spatially divided, with raw materials centres located far away from areas of value addition and consumption.

Challenges to be addressed and envisaged impact

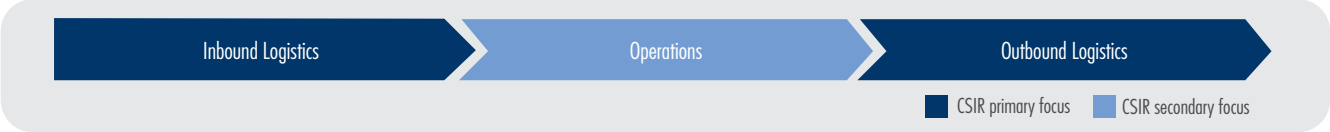
At a macro-logistics level, more informed management of transport networks, through network models, would contribute to the reduction of network bottlenecks and optimum location of facilities. There are also opportunities to increase local content in the tools and infrastructure used along the value chain, such as vehicles and locomotives. Some of the challenges to be addressed include low levels of efficiencies in ports, customs, and – within the supply chain practices of individual firms – translate to poor macro-logistics performance.

At micro-logistics level, the firm-level (as compared to sector-level) focus presents limitations; the sector value chain consists mainly of inbound logistics activities, firm-level operations and outbound logistics activities. Each of these activities is supported by infrastructure available to the firm, technical know-how, operational tools, and contract management practices. Scope exists across the value chain to reduce total costs and overall inefficiencies by adopting improved technology, improved technical and administrative skills and collaboration with other actors in the value chain.

South Africa's reality of a spatially divided country puts an additional premium on logistics. New business logistics models are emerging from redesigning the structure of the supply chain, commonly referred to as third-party and fourth-party logistics service providers. Track and trace capabilities with real-time information are becoming a basic requirement. Adoption of collaborative logistics models and the effective support of fifth party logistics entities would also contribute to improving efficiencies across the value chain.

Focus areas

The figure below illustrates the building blocks for the Smart Mobility value chain.



Building blocks of the value chain for smart mobility.

To improve logistics competitiveness across South Africa's strategic industries, improvements are required across the value chain (inbound, operations and outbound logistics) to constantly monitor and reduce logistics costs. This will require deliberate interventions in the form of improved data management in the logistics sector to match the forms of supply to demand and reduce inventory costs, reduce delivery lead times and increase asset productivity. Improved data management in the form of increasing data availability in real time; interoperability of data platforms across different actors in the value chain; and appropriate packaging of data and data analytics for end users will improve the sector's performance. The development of macro-logistics network models to help manage network bottlenecks to improve network reliability and demonstrate the ability of various technology and management tools to improve safety of operations to influence the adoption of appropriate macro-level policies, will be essential. Exporting the know-how in the logistics sector to other parts of the African continent to effectively service the ever-growing urban consumer economies, and facilitate efficient and effective inter-Africa trade, is a significant opportunity for South Africa's logistics sector.

The scope of the **inbound logistics and outbound logistics operations** component of the strategy includes integrated supply chain design, testing, modelling and optimisation, remote sensing to determine global commodity movements, driverless vehicles and unmanned aerial vehicle (UAV) solutions for UAV-autonomous delivery (last-mile logistics) and related technologies, real-time tracking, monitoring and management of fleet, infrastructure and commodities systems and platforms.

Logistics operations focuses on automated consumables management and procurement optimisation, as well as fully automated and intelligent warehouse management systems and technologies.

These initiatives will leverage current programmes, which include the Smart Vehicles programme (purpose-designed vehicles, data interoperability and intelligent monitoring), the Road Transport Management System (the South African Bureau of Standards already has a standard developed to support this system), decision support (inclusive of spatial planning and urban/rural decision support systems and transport models for various cities), as well as the Transnet modernisation programme focusing on real-time monitoring and control of fleet and intelligent operations in ports (IntelliPorts).

DELINEATIONS: The CSIR develops tools, techniques and solutions, and demonstrates how these can be used in the logistics sector. The tools and solutions developed are deliberately customised to strategic industries — not all industries. The choice of such strategic industries will be done in consultation with CSIR partners.

CSIR **DEFENCE AND SECURITY**

A web-based platform developed for collaboration and sharing of intelligence.

Cluster strategic intent

CSIR Defence and Security focuses on these two sectors and intends to build resilient defence and security capabilities for South Africa to ensure secure borders and enable the safety of all inhabitants, while fostering a secure platform for business to conduct industrial/economic activities.

Challenges to be addressed and envisaged impact

Overall, the sector is plagued by fluctuating demand and a decline in defence spending, accompanied by a decreasing research and development budget for both national defence and the South African defence industries, and limited collaboration on a number of cross-cutting manufacturing technologies. Other critical challenges include a cybersecurity industry dominated by a limited number of players who lack the agility and capabilities to meet emerging and new security threats, exacerbated by significant global cybersecurity skills shortages, and a lack of cybersecurity awareness that impacts organisations and civil society negatively. Criminal attacks on key national infrastructure are increasing. A lack of integrated security solutions, a limited focus on security R&D (in addition to limited overall national defence spending), as well as deficient private security industry regulations, which brings with it risks of militarisation and abuse of force, also trouble the sector.

Considering that the sector is a major contributor to expanding and deepening the national skills base and furthering national industrialisation policies, generating foreign currency earnings from equipment exports with related services, and creating employment, as well as other national benefits, it is clear that the South African defence and security sector is key to the strategic security of the country's sovereignty and ensuring the safety of its inhabitants. The sector plays a strategic role in contributing to economic prosperity.

The envisaged outcome is to enable integrated national defence and security solutions in South Africa, by being pre-emptive and adaptive through intelligence offerings for defence and security, linking into global supply chain markets.

Focus areas

The following figure illustrates the building blocks for the Defence and Security cluster.

Defence and Security cluster building blocks.

The **defence platform** delivers various technologies in support of a capable state, commercialises technologies to ensure industry competitiveness and develops integrated security solutions for both the private and public sectors. The CSIR pursues product development opportunities that will nurture design-for-excellence capabilities in the industry and the broader National System of Innovation (NSI), and demonstrate local manufacturing capabilities. Further developments focus on integrated, large-scale intelligence, surveillance and reconnaissance platforms; technology solutions that are interoperable, prioritising collaborative design, advanced manufacturing, and defence industry supply chain developments; and complete OEM solutions with a focus to remain in the middle tier for the short to medium term.

This effort builds on the current South African National Defence Force operations and other strategic capabilities, including weapons integration, propulsion systems and aerodynamic testing.

The **cybersecurity platform** offers analysis, modelling and decision support to strategic partners in solving complex crime problems. It includes preventing cybercrime; non-visual and visual crime-sensing systems; deep and machine learning, as well as big data crime analysis for crime prevention; bandwidth enhancement in integration of crime prevention network communication systems; identity authentication to combat cybercrime; and basic design and development of security systems that compete with large, multinational companies. These initiatives build on the national cybersecurity capability programme.

The **civil security platform** offers command and control capabilities for crowd management; sensor systems for homes, businesses and critical infrastructure that will enable authorities to identify and react quicker to criminal activities; integrated security solutions for infrastructure security; and security solutions for the cash-in-transit industry. These interventions build on the numerous security cluster capabilities and decision support tools.

DELINEATIONS: As the strategic research, development and innovation arm of government, the CSIR responds to all strategic and tactical capabilities of the sector as required.

CSIR **NEXTGEN ENTERPRISES AND INSTITUTIONS**

Cluster strategic intent

CSIR NextGen Enterprises and Institutions addresses the challenges and opportunities of public institutions and private service enterprises, such as state-owned enterprises, municipal services, notary services and insurance banking. It will enable the transition of South Africa's public institutions into a digitalised era that will support effective (public and private) service delivery, improve government transparency and accountability, and cultivate a connected platform that supports service provision, as well as industrial and societal advancement.

Challenges to be addressed and envisaged impact

The main challenges identified in the context of NextGen Enterprises and Institutions include the absence of policy coordination and alignment mechanisms by/in government departments and state institutions; paper-based processes and systems; fragmentation in systems and the inability to access or integrate data across departments/institutions. It also includes poor connectivity and high costs as a result of underdeveloped or underutilised ICT infrastructure associated with the digital divide; and privacy and security as key prohibitors for digitising public institutions. Current financing is limiting the magnitude and scope of institutional digitalising and integration.

Modernisation within the public sphere will have a positive impact on industrial development in terms of the ease of doing business (e.g. permits, licences and visas) and the confidence resulting from transparency and reliability in public sector information. The envisaged impact is the transition of South Africa's public institutions into digitalised institutions that support effective public service delivery, improve government transparency and accountability, and create a connected platform that supports industrial and societal advancement.

Focus areas

The figure below illustrates the value chain of the NextGen Enterprises and Institutions cluster.

NextGen Enterprises and Institutions value chain.

The CSIR focuses predominantly on building digital tools and systems, efficient data generation and acquisition, as well as data processing and analytics, in line with emerging trends to transition from traditional paper-based services to fully digital services. Such services range from information provision, and digitally enhanced and supported offerings, to the full conclusion of a public service.

The **digital systems platform** includes integrated platforms to digitise public institutions, intergovernmental and societal platforms in the medium term, and quantum computing in the long term.

The **data platform** focuses on authentic, secure and distributed data acquisition and management (task specific), and digital representations of all, and digital twins organisations.

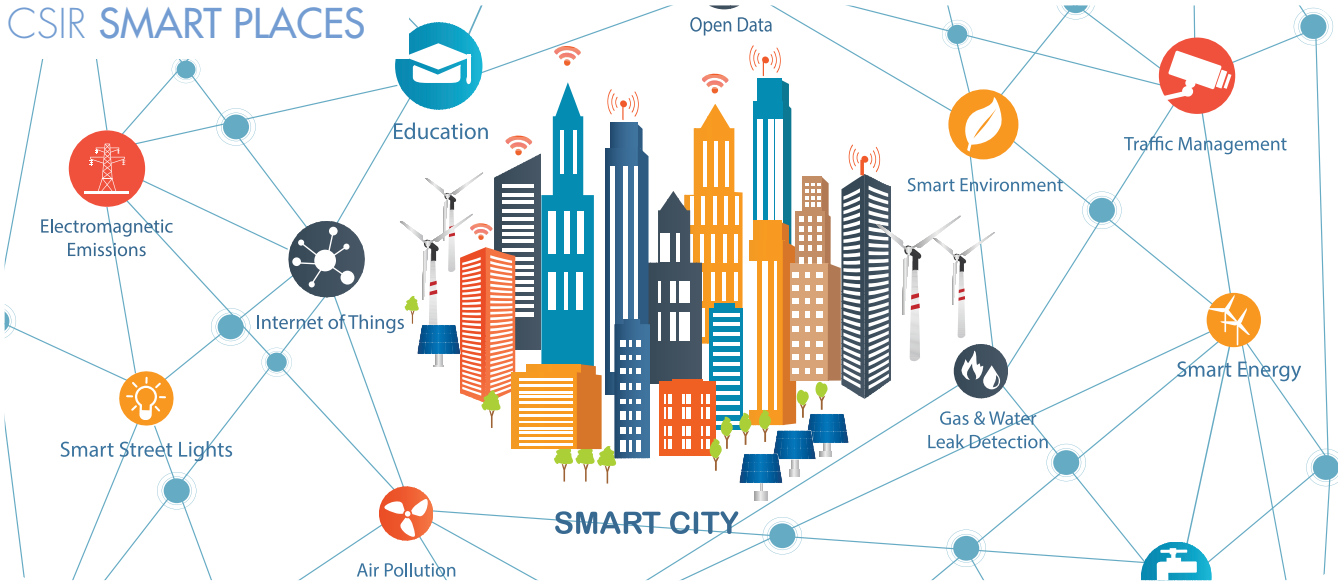
The **analytics platform** includes a focus on artificial intelligence (AI) to inform decision-making, AI-enabled data processing and analytics to drive autonomous decision-making, as well as generic or non-task specific AI.

Transformative trends that will be harnessed across the value chain will include increasing connectivity, creating data platforms, demanding greater collaboration and connectedness between departments and institutions using distributed ledger (e.g. blockchain) and AI technologies to enable personalised services, availability of data, improved insight and visibility to support autonomous decision-making.

The CSIR's work focuses on developing technology systems and solutions to support the digitalisation of public institutions, as well as focusing on government-to-government integration, and expanding to government-to-society and business integration. It will develop capabilities to support public institutions in a pragmatic, cost-effective, inclusive and citizen-centric manner and will advise public institutions on enabling policies and regulations to facilitate the safe, secure and effective digitalisation of public institutions.

DELINEATIONS: The CSIR does not focus on off-the-shelf end-user systems; services and designing; building; and deploying ICT hardware.

CLUSTER **OVERVIEW** CONT.



Cluster strategic intent

CSIR Smart Places addresses the challenges and opportunities of public institutions, transportation and logistics, utilities, ICT, business and financial services, education, and the health sector. The cluster aims to effect smarter resource use, infrastructure and service developments directed at enabling competitive manufacturing environments, and sustainable economic growth. In addition, it will improve the ease and effectiveness of doing business.

Lowering the cost of transport and communications, improving the efficiency and reliability of water and electricity delivery, as well as improving roads and other infrastructure are critical objectives of the interventions in this cluster.

Challenges to be addressed and envisaged impact

The main challenges to be addressed include the availability of natural resources in light of projected climate change and future land use; resource-use conflicts and trade-offs; and the limited availability of skills and infrastructure to address these challenges in the long term.

Hard infrastructure challenges extend to limited ICT infrastructure and specialised analytics in Africa; reliability and cost of infrastructure that hinder industrialisation; issues of quality and lack of maintenance; ageing infrastructure and new infrastructure backlogs.

Limited capacity of appropriate institutional arrangements to optimise the use and maintenance of infrastructure; policy hurdles and limited stakeholder support due to high cost and limited infrastructure are some of the soft infrastructure challenges.

Challenges regarding services and utilities include environmental factors that affect industries, communities and workers; inadequate logistic processes; the high cost of services; and municipalities that are not fully functional.

Focus areas

The figure below illustrates the building blocks for the Smart Places value chain.

Smart Places value chain building blocks.

The CSIR's response is to harness the opportunities afforded by transformative technologies to develop smarter resource-use strategies, improved infrastructure and service developments directed towards enabling competitive industrial environments and sustainable economic growth.

The CSIR will build on the following capabilities and programmes to create smarter places:

- Decision support focusing on climate change and adaptation; and spatial planning and decision support;
- Smart infrastructure programme, including smart spatial (Earth observation and IT)/intelligent systems; and advanced materials and processes;
- Municipal programmes that adopt science, engineering and technology solutions for infrastructure delivery, capacity, capability and local economic development;
- Telecommunications initiatives inclusive of dynamic management spectrum systems and network virtualisation platforms (5G);
- Water systems (resource-use planning, delivery, and reuse); and
- Energy system design operations and technologies.

Other interventions cover cleaner production, and optimising the use (circular economy) and sustainable industrialisation of resources. Hard and soft infrastructure interventions include capacitating all spheres of government to address and improve all aspects in the pursuit of creating smart places; enabling smarter connected resources and infrastructures; and revolutionising the way of doing business and delivering services through new business models and flatter organisational structures, for example. Services and utilities will benefit from quality and cost optimisation, real-time support, and innovation to effect a cleaner environment and automation.

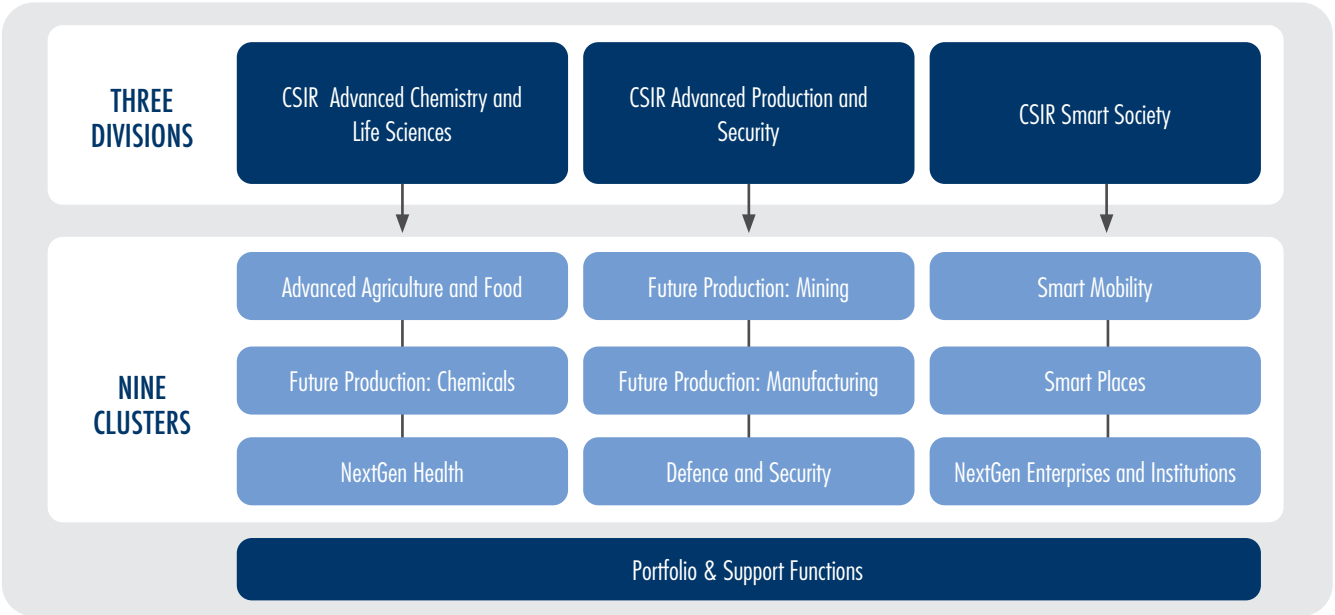
DELINEATIONS: The CSIR's work does not focus on routine, non-specialist, design and consulting work typically done by engineering firms and management consultants. Where there are organisations providing related technology and services, the CSIR will not duplicate their efforts, but rather seek to collaborate.

NEW OPERATING MODEL

The primary purpose of the operating model is to enable the execution of the organisation's strategy through the identified core business offerings. The CSIR's new operating model considered organisational design best practices applied by other research and technology organisations and service-offering firms.

The operating model design principles included translating the organisation's renewed strategic direction into directed multidisciplinary research and technological innovation with a stronger industry focus. Applying these principles informed an operating model that promotes customer-centricity and market focus; enables collaboration; promotes efficiency and agility through improved business performance; elevates core business representation at senior leadership level to enhance accountability; and endorses implementation and leadership buy-in. Other changes made to support the new operating model include, among others, the establishment of a research, development and industry advisory panel to ensure that the CSIR's work remains relevant and responsive to industry and national needs.

From a technology and sector focus point of view, the new CSIR operating model and structure focuses on three technology/sector divisions. The divisions are market-facing units – the structural home of clusters, centres, impact areas and research groups that share complementary competences to promote collaboration and drive efficiency, and that share synergies in processes, products and solutions.



CSIR structure overview.

Each **division** is composed of three strategic mutually reinforcing clusters. The **divisions** enable inter- and intra-divisional collaboration as appropriate, and have a broad, strategic view of the sectors targeted for impact to ensure that CSIR responses remain relevant. These span several industries and involve collaboration with a host of public and private sector stakeholders, funding partners, industry associations, higher education institutions and other innovation partners.

Clusters are technology/sector combinations with a distinct priority sector(s) and underpinning technologies that drive sectoral competitiveness. The nine clusters are synergetic and mutually reinforcing.

Each **cluster** comprises impact areas and research centres. The **impact areas** are an outcome and an impact-oriented organisation of competencies as required for desired impact in the anchoring and related clusters. They span the RD&I value chain, and they are designed to facilitate research, development and translation. **Research centres** in the CSIR are areas where research and technology in specific areas are consolidated and further developed into deep world-class capabilities to support multiple areas of application across the organisation. Centres are housed in clusters where the relevant competences are most established, but capabilities are deployed across all areas where they are required in the CSIR and the NSI. They may also include areas where research and technology in specific areas are consolidated and further developed into deep world-class capabilities to support multiple areas of application across the organisation. The capabilities could transition to other elements once matured.

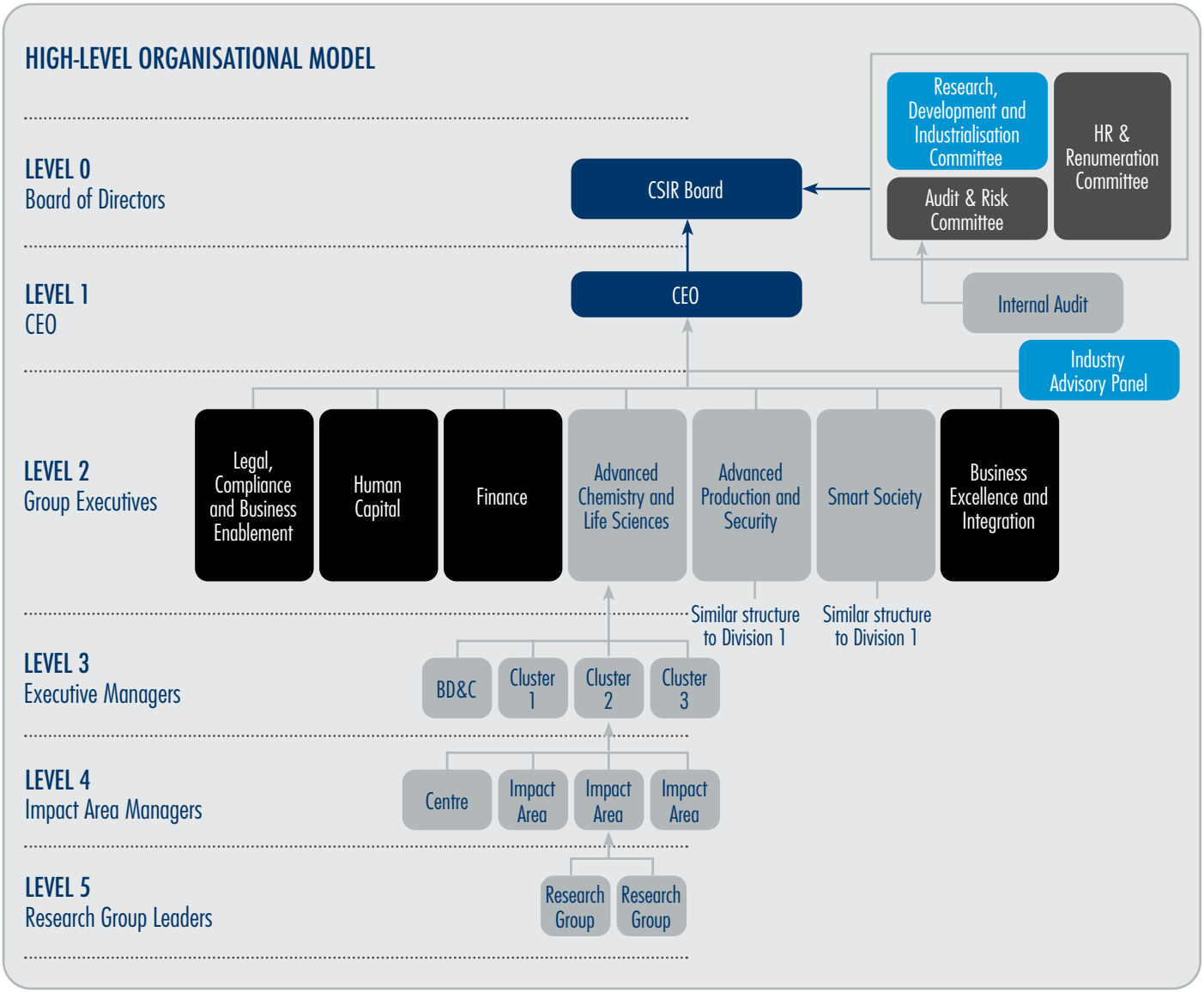
At divisional level, a **Business Development and Commercialisation (BD&C)** function has been created which requires a diversity of skills to work together as a team, managing intellectual property, collecting business intelligence, balancing business development and commercialisation demands as appropriate. This BD&C function comprises a BD&C Executive Manager, and managers specialising in marketing, business development and commercialisation. Activities across the CSIR in this area will be facilitated through a joint BD&C and Strategic Partnerships forum. This is a community of practice for practitioners in business development, strategic partnerships, IP management, technology transfer and commercialisation. It serves as the first point of contact for all organisation-wide opportunities in business development, strategic partnerships, IP management, technology transfer and commercialisation.

The **operations** of the CSIR are overseen at three levels. The Business Excellence and Integration portfolio carries the responsibility of integrating organisational operations, which is facilitated by an Operations Committee (OPCO), among other platforms. This committee also works collaboratively to facilitate the implementation of the organisation's obligations as agreed in the CSIR Shareholder's Compact and ensures efficient and effective operations in the organisation. At the divisional level, the divisional operations manager integrates the operations of a particular division. Operations managers are also deployed in the clusters, depending on the size and complexity of the business. The operations managers are responsible for the co-ordination of divisional and cluster strategy development processes that cascade from divisions into clusters, impact areas and centres. They facilitate the execution of divisional and cluster operational plans and monitoring of progress on implementation at division, cluster, impact area and centre levels. Further, they ensure that support functions deliver on their service level agreements. An operations management forum will provide CSIR-level oversight in this area, and issues of relevance across the CSIR.

Each of the divisions has a support team consisting of embedded divisional financial and human resources managers to attend to the related requirements of each division. Resources will typically be deployed at divisional level and shared across clusters to ensure that line support is optimised. Services such as safety, health, environment and quality, legal services, facilities management and enterprise risk management services will be provided centrally on the basis of service level agreements.

The operational structure and levels in the hierarchy are shown on page 40.

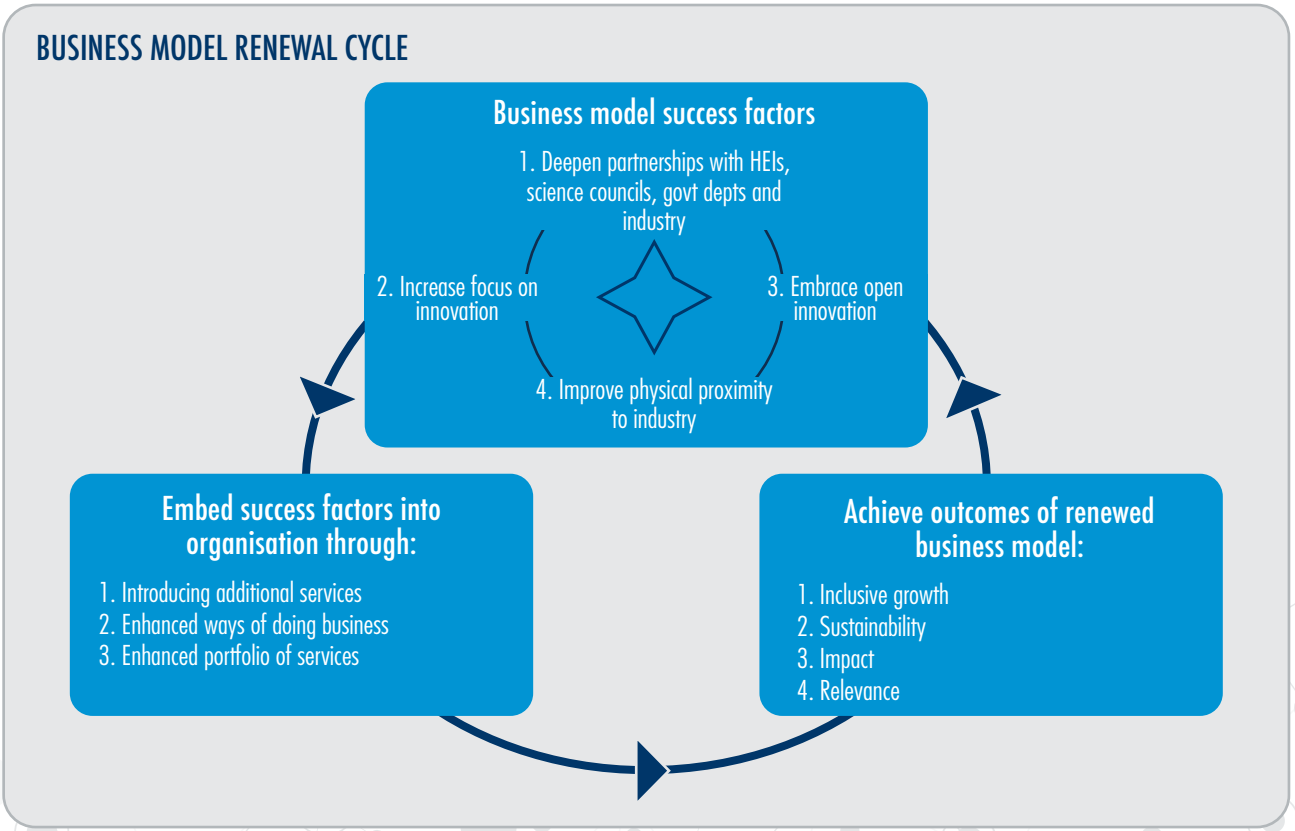
NEW **OPERATING MODEL** CONT.



The different levels of the CSIR operating model.

ENABLING **BUSINESS MODEL**

The renewed CSIR business model will enable the organisation to capture the opportunities identified in the strategy. The CSIR's business and operating models must provide the best possible environment to respond to industry's needs with agility and excellence. It pays specific attention to income sources, cost structure, customer segments and value propositions, and the effectiveness of partnerships. In line with the CSIR's strategic direction to "Amplify the 'I' in CSIR", the CSIR's business model serves to enable increased relevance to the private sector. It is important to note that, while the latter is a key imperative, the CSIR's work with and for the public sector, and its hosting of large national programmes on behalf of government, will continue and, ideally, also grow.



The CSIR will enhance its way of doing business by:

Deepening partnerships with higher education institutions

Formal partnerships with higher education institutions (HEIs) will include short- and long-term defined areas of collaboration and supporting key performance indicators. The CSIR will proactively seek opportunities to co-locate where appropriate, at universities across South Africa or will invite universities to co-locate on the CSIR campus. Increasing joint and collaborative R&D projects with HEIs remains a priority.

Deepening partnerships with industry

The CSIR's business development capabilities are being strengthened and business development functions are embedded in the operating model. Compelling value propositions are part of pursuing the development of new partnership agreements with the target public, private and innovation partners identified for each cluster. Such partnerships will be re-enforced by promoting secondments and the mobility of staff to and from industry. Industry's physical proximity to the CSIR will also be improved for greater accessibility. Co-location with industry on the CSIR's campuses will be enhanced, including sharing our space with high-priority partners and clients; and introducing spaces such as shared innovation centres to address sectoral challenges and opportunities.

Collaborating with state-owned enterprises and government

State-owned enterprises and government remain key stakeholders as they share with the CSIR mutual imperatives to effect the socioeconomic advancement of South Africans. The CSIR also has a role to fulfil in supporting a capable state. It will do so by facilitating the sharing of resources, people, infrastructure and equipment, by optimising public-sector-supported industrial development initiatives, and by contributing to evidence-based policy making, among others.

Increasing the focus on innovation and commercialisation

The CSIR aims to introduce innovation-focused services targeted at helping clients develop and implement ideas, while going beyond the provision of science and technology solutions, to include support with business model innovation. These services will require that innovation capability gaps are addressed through upskilling, partnering or hiring of staff with the required complementary skills. The CSIR will adopt open innovation practices, such as shared innovation centres and open innovation or open access platforms. The organisation will place an emphasis on commercialisation.

Creating a balanced innovation portfolio

The CSIR will enhance its portfolio of services and adjust the profile of its innovation portfolio by increasing its focus on the later stages of the technology readiness level scale and increasing its income from technology transfer. This is in keeping with best practice from globally successful research and technology organisations. (See graphic on page 43)

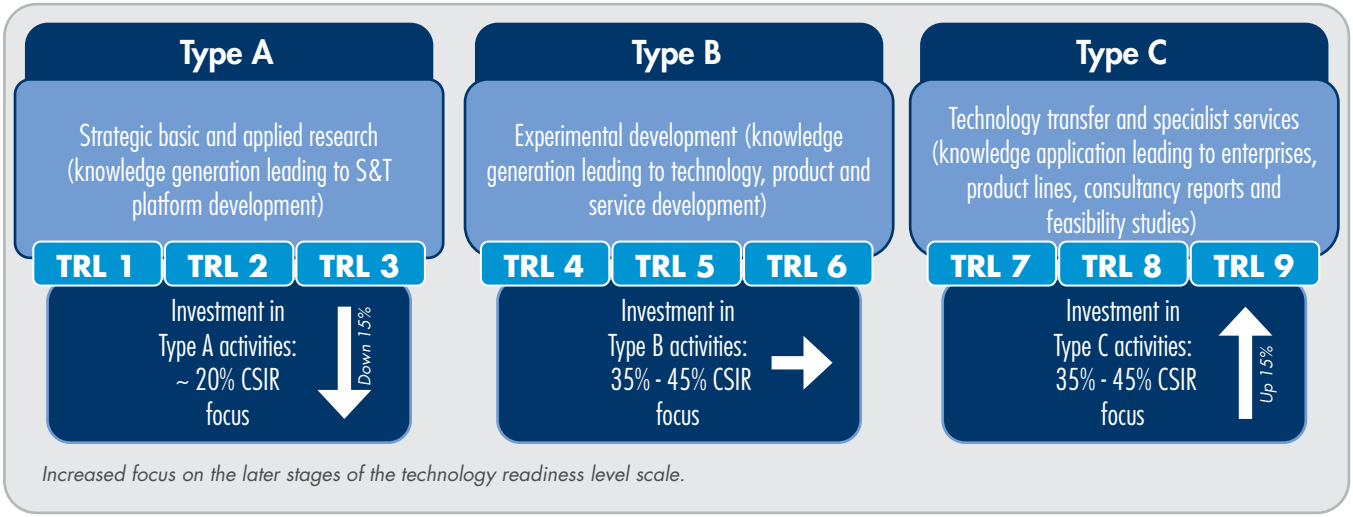
INTRODUCING ADDITIONAL SERVICES

The CSIR will explore opportunities for shared innovation centres, which involve the co-funding and collaborative undertaking of R&D. The organisation will develop translational infrastructure that addresses sector-wide problems to improve competitiveness. Secondments of CSIR staff to industry and vice versa will be introduced. The CSIR plans to increase its participation in open innovation platforms.

Streamlining cost structure

The CSIR is reviewing all cost elements associated with doing business, in order to maximise efficiencies and improve value to our clients and partners.

BALANCING THE INNOVATION PORTFOLIO



Increased focus on the later stages of the technology readiness level scale.

THE CSIR BRAND STORY

A brand is the promise that a business or entity makes to its stakeholders, customers and staff. In most cases, that promise is about the essence of the offer, or the quality of the product or service. Hence brand is a crucial part of any organisation's business strategy.

WHAT DOES THE CSIR BRAND STAND FOR?

The CSIR brand is rooted in the organisation's mandate, mission, vision and values. It is about having a passionate belief that science, technology and meaningful industrial development are the catalysts through which we can grasp the opportunities our continent has to offer and improve the quality of life of South African people. Our research is rooted in scientific excellence, leadership and innovation, as well as understanding the needs of industry. Our people deliver practical and innovative technologies that contribute to a competitive South Africa and sustainable growth. Our value is measured through improving quality of life. We use the diversity, ingenuity and energy of our people in a collaborative and agile fashion to realise tomorrow's potential.

ROOTED IN OUR VALUES

Organisational values are often described as the true north of an organisation's brand compass – regardless of the direction that the organisation takes, they remain true. The CSIR has adopted a new set of values that serves as the guide for every CSIR employee, operation and activity.

Excellence

We excel in research, development and industrial innovation that address South Africa's challenges. Efficient and novel thinking, as well as high-quality systems and processes, enable the necessary agility to change course when required. We are unashamedly passionate about the impact that we make and pursue excellence in every facet of CSIR life.

People-centred

We care about people – our impact through innovation aims to improve lives. We respect diversity and uphold the dignity of every person, regardless of culture or belief system. We treat our stakeholders the way we would like to be treated.

Integrity

We value integrity – in ourselves and in others. We are honest and fair in how we work and how we engage the world around us. We respect the trust that our colleagues and stakeholders place in us and commit to ethical decision-making, delivery and governance.

Collaboration

We are keen to learn from one another and collaborate across the organisation, and with external partners, to ensure that our work has the best chance of contributing to a better future for South Africans. We actively share our knowledge and expertise so that we can make an impact at a large scale.

Our behaviours, beliefs, principles and the impact we wish to make to improve the quality of life of South Africans are EPIC. Team CSIR pursues Excellence, celebrates People, personifies Integrity and welcomes Collaboration.

A BRAND TO REFLECT OUR VISION

The CSIR brand remains relevant in the context of the organisation's new strategic direction of making a greater impact in industry and on the economy. However, the organisation needed to find stronger expression of its vision of accelerating socioeconomic prosperity in South Africa through leading innovation. A logo and positioning statement are important elements of a brand – therefore, while the brand and its other components remain relevant, the CSIR logo with its lowercase 'i' and positioning statement that focuses exclusively on science do not embody the new vision, mission and strategic intent. The objectives of the CSIR's new strategy are to:

- Create a CSIR that responds fully to its mandate of fostering industrial and scientific development by amplifying the 'I' in 'CSIR';
- Broaden the scope of growth opportunities for the CSIR while deepening the organisation's relationships with its stakeholders, notably industry;
- Set out how the organisation will leverage its strong science, engineering and technology capability base and build on current industrial development opportunities, while creating the right balance between scientific development and industrial development in its innovation portfolio;
- Effect a virtuous cycle where scientific and technological development supports industrial development and the creation of capable state, and the latter, as it evolves, informs the research agenda; and
- Clarify how the CSIR will leverage emerging technologies, especially those rooted in the fourth industrial revolution, as well as its current capabilities in driving the competitiveness of South African industries, and supporting a capable state.

Considering the above objectives, the CSIR logo with the lowercase 'i' visually contradicts the call for the CSIR to amplify its efforts in industrial development in response to the current dire need for South Africa to improve its competitiveness. Similarly, the positioning statement – Our future through science – does not sufficiently reflect the renewed balance and importance of science and technology, and industrial development, to achieve the CSIR's mandate.

THE NEW LOGO

The new CSIR logo places an equal emphasis on both the science and industrial pillars of our mandate. The letters "CSIR" are separated and they are all equal in dimension to emphasise balance of science and industrial development. The primary colour of the CSIR lettering remains blue to indicate continuity of a regal, steady, reliable and solid CSIR brand.

An icon with human figures and the colours of the South African flag has been introduced. The human figure symbolises our value of being a people-centred organisation. They are also representative of what the CSIR mandate calls for, which is to improve the quality of life. This is a commitment by the CSIR that the work it does will have a positive impact in people's lives – the CSIR is a life-changing organisation.

The icon has a tilted circle, which symbolises collaboration, strength, resilience and continuity of the CSIR's research and its people.

The flag colours show the CSIR's commitment to South Africa (national pride) and also serves as a way of differentiating CSIR South Africa from similarly named international science councils such as CSIR Ghana and CSIR India. The flag colours also symbolise prosperity, diversity, unity and national identity.

The positioning statement

The new CSIR positioning statement is "Touching lives through innovation" which has been derived from the CSIR mandate. This summarises the intentions of the CSIR as set out in the organisation's new strategy. The CSIR wishes to create impact in industry, government and society with its innovations. It expresses that the CSIR cares about people. One of the new organisational values is People-centredness. This means that the CSIR places people at the centre of its operations. The impact of the CSIR's work must be felt by people through touching and improving their lives for a better future. The positioning statement is in line with the new strategy of contributing to the economic growth of South Africa by supporting existing industries and the creation of new industries that will create jobs.

CSIR
Touching lives through innovation

www.csir.co.za