



# ANNUAL REPORT **2017/18**



science  
& technology

Department:  
Science and Technology  
REPUBLIC OF SOUTH AFRICA

**CSIR**  
*our future through science*



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# ABOUT THE CSIR

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The Council for Scientific and Industrial Research, commonly known as the CSIR, is a world-class African research and development organisation established through an Act of Parliament in 1945. Its executive authority is the Minister of Science and Technology. The CSIR undertakes directed, multidisciplinary research and technological innovation that contribute to the improved quality of the life of South Africans.

The organisation plays a key role in supporting government's programmes through directed research that is aligned with the country's priorities, the organisation's mandate and its science, engineering and technology competences.

**The CSIR fosters partnerships** with a network of partner organisations and clients, regionally and abroad, as part of a global sphere of influence on matters of technology.

We draw expertise from diverse research fields to provide integrated solutions and interventions to support a broad range of national development programmes, as set out in the National Development Plan. Our national footprint is testament to our commitment to serving diverse communities and sectors, with the CSIR's main campus located in Pretoria and our regional offices in Durban, Johannesburg and Stellenbosch – in proximity to applicable industries across the country.

Impact is at the core of our business and the following objectives are crafted to ensure that we deliver on our mandate:

**Build and transform human capital** – Our scientific and technical contributions are only made possible through the skills and capabilities of our staff. The CSIR is an important part of the National System of Innovation and contributes to the national imperative to develop human capital and to the ongoing transformation of our society through the development and training of our scientific base.

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The CSIR fosters **partnerships** with a network of partner organisations and clients, **regionally and abroad**, as part of a **global sphere of influence** on matters of technology.

**Conduct high-quality and relevant research and technological innovation to foster scientific and industrial development** – The CSIR identifies and invests in various areas of research to enable the translation of CSIR research into solid scientific outputs, such as publications, technology demonstrators and intellectual property. The organisation selects and implements a range of research and development programmes, in collaboration with various stakeholders, to identify opportunities to support new industries and improve the efficiency and competitiveness of existing industries.

#### **Financial sustainability and governance**

– Financial sustainability and a sound track record of governance are imperative to the success of the organisation in the long term.

Key issues that the CSIR seeks to address through science, engineering and technology interventions include contributing to a vibrant economy and creating employment opportunities; building a capable state that is able to consistently deliver high-quality services for all South Africans; contributing to the development of economic and social infrastructure like transport, energy, water resources and ICT networks; transitioning to a low-carbon economy to improve our ability to understand the long-term effects

of climate change by assisting government with the formulation of mitigation and adaptation strategies; transforming human settlements; improving health and building safer communities.

Our ability to contribute to a better future for all is illustrated in our unique value proposition, which is the multidisciplinary nature of our skills base. Two-thirds of our staff consists of scientists, engineers and technologists who share a passion for shaping a better future through science and technology innovation. The organisation also invests in a myriad of training interventions to foster young talent and further develop expertise by providing bursaries, studentships, internships and exchange programmes.

Research infrastructure is fundamental to the organisation accomplishing its scientific and industrial development mandate. The investment in research and built infrastructure and the implementation of the Campus Master Plan will help us achieve this.

It is this combination of excellence in research, highly skilled staff and world-class infrastructure that puts the CSIR at the cutting-edge of research and technological innovation to improve the quality of life of South Africans.



# FROM OUR LEADERSHIP

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## Foreword by the Minister of Science and Technology

The role of our government is to create an enabling environment for citizens and organisations to boost socioeconomic development and thrive. In the context of the Department of Science and Technology (DST), it is to create an enabling research and innovation environment to allow organisations, such as the Council for Scientific and Industrial Research (CSIR), to conduct research and development (R&D) work that will assist government in providing sustainable development to our people. The work we do as a department is guided by various strategic programmes; chief among them being the National Development Plan (NDP).

**Entities such as the CSIR** play a pivotal role in helping government to implement its various programmes and provide service delivery to improve the quality of life of our citizens. The research undertaken by the CSIR has a direct impact on a significant number of the focus areas outlined in the NDP. These include the economy and employment; building a capable state; economic and social infrastructure; transitioning to a low-carbon economy; building safer

communities; improving health; as well as R&D work to transform human settlements.

The decline of the year-on-year growth of our economy during the last decade has presented us with both challenges and opportunities. Among these is a reflection that led to the timely and pertinent review of the White Paper on Science, Technology and Innovation.

Since the adoption of the White Paper on Science and Technology in 1996, significant progress has been made in advancing science, technology and innovation in South Africa. Recent reviews indicate an expanding science, technology and innovation landscape; a three-fold increase in publications; significant growth in the participation of black people and women in the research and development workforce; as well as a rise in doctoral graduation rates.

The current draft White Paper, which will be completed before the end of 2018, seeks to take advantage of opportunities presented by global megatrends, such as the emergence of new technologies, including artificial intelligence, Industry 4.0 and additive manufacturing, among other things. It seeks to take advantage of emerging trends in technology innovation, expand on what has been working and propose new approaches. This will include the strengthening and transforming of institutions, increasing research funding and expanding human capabilities.

The CSIR occupies a **very important place** in our National System of **Innovation**; therefore it is **important that it remains financially sustainable**.

The DST has invested in various initiatives and programmes at the CSIR to provide support for the development and growth of industry in a variety of sectors. These include the Industry Innovation Partnerships Programme, which seeks to attract private sector investment in translating R&D outputs into commercial products by providing specialised prototyping, piloting and upscaling infrastructure to bridge the gap between the lab and the market; the Technology Localisation Implementation Unit, which was established to implement the deliverables of the department's Technology Localisation Plan, which include increasing the productive capacity of local firms; the Waste Research, Development and Innovation Roadmap to guide South Africa's public and private sector investment in waste RD&I over the next 10 years; as well as the National Integrated Cyber Infrastructure System, which promotes scientific and industrial development through the provision of a high-performance computing capability to provide seamless access to research and education.

The CSIR has done well in managing these programmes. The outputs have resulted in the creation of internship opportunities, new jobs, spin-out companies, as well as tangible products that are competitively placed in the market and making a contribution to our economy.

Transformation is a key focus area for the department. Our aim is to create and expand opportunities for the youth, increase the participation of women in science, technology, engineering and mathematics (STEM) and bring transformation and development that also reflect the current societal demographic representation into the sector. I commend the CSIR leadership for piloting the new Accelerated Researcher Development Programme to support and accelerate promising senior and principal researchers, with the aim of rapidly developing the next cohort of black South African and female chief researchers.

The building of appropriate skills in STEM is critical in advancing South Africa so that it is on par with other developing countries. Therefore, an intentional effort to prioritise financial investment to build a pipeline of appropriate skills and competencies in STEM is critical to the growth of our economy. Our commitment is demonstrated through a number of partnerships and programmes that we are funding. Currently, there are 369 postgraduates supported through the DST/CSIR Interbursary Programme.

In addition to supporting the next generation of leading researchers, scientists and engineers, DST is committed to investing in infrastructure development to support the

concept-to-materialisation process of various brilliant ideas and innovations to alleviate some of our pressing societal challenges. I applaud the foresight of the CSIR leadership for the creation of the Campus Master Plan (CMP) to revitalise existing facilities and infrastructure to meet the CSIR's current and emerging scientific and research objectives. With the requisite support from my department and partners, the CMP will not only benefit the organisation's research priorities, but the broader National System of Innovation.

Most recently, I was honoured to be part of the historic launch of the Biorefinery Industry Development Facility. This facility, a first for South Africa, has a critical role to play in building a circular economy through the development of innovative industries, such as sugar and biorefinery for forestry, transforming what is now known as waste into valuable resources. It is also a response to the Bio-economy Strategy and the Waste RDI Roadmap, government strategies to unlock a potential R17 billion per annum for the South African economy.

Most importantly, it will provide support to small, medium and micro enterprises that are interested in the localisation of technologies to produce goods from waste wood biomass, thus creating job opportunities.

The CSIR occupies a very important place in our National System of Innovation; therefore it is important that it remains financially sustainable. I am satisfied that the CSIR has developed the necessary strategies to ensure that the institution remains financially sustainable.

I am also very pleased with the direction that the leadership is taking, focusing on industrial development, through 'Project Synapse,' a key turnaround strategy for the organisation. The focus on industrial development inherently implies a nexus with industry and associated sectors. I believe that this has the potential to make an indelible mark towards significantly addressing the triple challenge of poverty, unemployment and inequality in our society.

The DST remains committed to supporting the CSIR in fulfilling its mandate. Thank you to the CSIR Board and Executive Management team for their courageous leadership. Thank you to the staff for their continued dedication to the organisation.



**Mrs Mmamoloko Kubayi-Ngubane**  
Minister of Science and Technology

# IZWI LABAHOLI BETHU

## Isandulelo sikaNgqongqoshe wezeSayensi nobuChwepheshe

Umsebenzi kahulumeni wukwenza ukuthi izakhamuzi nezinkampani zikwazi ukusebenza ngokukhululeka ukuthuthukisa ezenhlalakahle nomnotho futhi ziphumelele. Uma kukhulunywa ngoMnyango wezeSayensi nezobuChwepheshe, lokhu kusho ukuthi kumele abasebenza ngocwaningo nokusungula izinto ezintsha bakwazi ukusebenza endaweni ekulungele lokhu nokuzokwenza izinkampani ezifana ne-Council for Scientific and Industrial Research (i-CSIR), zikwazi ukwenza umsebenzi wocwaningo nezentuthuko ukulekelela uhulumeni ukuthi uhlinzeke abantu ngentuthuko. Umsebenzi esiwenzayo njengomnyango ulawulwa yizinhlelo eziningi ezimqoka, ehamba phambili kuzona wuHlelo lweNtuthuko lukaZwelonke.

**Izinkampani ezifana ne-CSIR** zineqhaza elibalulekile ekusizeni uhulumeni ukuthi ukwazi ukwenza imisebenzi ehlukene ukwazi nokuhlinzeka abantu ngezidingo ezizophucula impilo yabo. Umsebenzi wocwaningo owenziwa yi-CSIR unegalelo elikhulu ezindaweni eziningi esigxile kuzo njengokusho koHlelo lweNtuthuko kaZwelonke. Lapha sibala umnotho nokuntuleka kwemisebenzi; ukwakha uhulumeni osebenzayo; ingqalasizinda yezomnotho neyezenhlalakahle; ukuba nezimboni ezingakhiqizi kakhulu izinto ezingcolisa imvelo; ukwakha imiphakathi ephephile; ukuthuthukisa ezempilo kanjalo nomsebenzi wocwaningo nentuthuko ukuze kushintshwe isimo senhlalo yabantu.

Ukwehla minyaka yonke kwendlela umnotho okhula ngayo kule minyaka eyishumi edlule kusilethele izinselelo namathuba. Enye yalokhu kube wukubuyekizwa, nobese kunesidingo, koMqulu oyisisekelo sethu kwezeSayensi, ezobuChwepheshe nokusungulwa kwezinto ezintsha.

Kusukela wamukelwa lo Mqulu wezeSayensi nobuChwepheshe ngo-1996, yinkulu indima esikhathuliwe

ekukhuliseni ezesayensi, ezobuchwepheshe nokusungulwa kwezinto ezintsha eNingizimu Afrika. Uma kubuyekizwa muva nje kuyavela ukuthi uyakhula umsebenzi wezesayensi, ezobuchwepheshe nokusungulwa kwezinto ezintsha; ukushicilelwa kocwaningo kukhula ngokuphindwe kathathu; wukwanda kwabantu abamnyama nabesifazane kubantu abenza ucwaningo nezentuthuko kanjalo nokwanda kwalabo abagodayo ezifundweni zobudokotela kulo mkhakha.

Umqulo osetshenzwayo njengamanje, okumele uphuthulwe ungakapheli u-2018, ubheka amathuba aqhamukayo emhlabeni njengokuqhamuka kobuchwepheshe obusha okubalwa kubo ubuchwepheshe bemishini efana nabantu, ne-Industry 4.0, nobuchwepheshe be-3D, ukubala okubalwa. Lo mqulu ubheka amathuba ezintweni ezintsha zobuchwepheshe eziqhamukayo, ukukhulisa lokhu okusebenzayo nokuthuthukisa izindlela ezintsha. Lapha kubalwa ukuqinisiswa nokuguqulwa kwezikhungo, ukunyusa imali exhasa ucwaningo nokwandisa amakhono.

UmNyango usutshale imali ezinhlelweni eziningi ezenziwa yi-CSIR ukweseka ukuthuthukiswa nokukhuliswa kwezezimboni emikhakheni enhlobonhlobo. Phakathi kwazo kubalwa i-*Industry Innovation Partnerships Programme* okuhloswe ngayo ukuheha abatshalizimali abazimele ukuthi basize ukuze imisebenzi eqhamuka ocwaningweni nasentuthukweni igcine isiyimikhiqizo edayiswayo okuhlinzekwa ngayo imifuziselo, ukuhlolwa nokuthuthukiswa kwengqalasizinda ukuze kuncishiswe igebe phakathi kwalokho okwenziwa emagunjini ocwaningo nasembonini; i-*Technology Localisation Implementation Unit*, eyethulwa ukuze yenze umsebenzi wophiko lomnyango we-*Technology Localisation Plan* ofaka ukwandisa umsebenzi okhiqizwa yizinkampani zakuleli; i-*Waste Research, Development and Innovation Roadmap* ewumhlahlandlela wokuthi izinkampani zikahulumeni nalezo ezizimele kumele zifaka isandla kanjani kulo mkhakha eminyakeni eyishumi ezayo; kanjalo ne-*National Integrated Cyber Infrastructure System*, egqugqezela ukuthuthukiswa kwezesayensi nezezimboni ngokuhlinzeka ngamakhompyutha



**I-CSIR yenza umsebenzi obalulekile** wokusungulwa kwezinto ezintsha ezweni lethu, ngakho-ke kumqoka ukuthi ibe nemali eyenele ukuze ihlale ikwazi ukwenza umsebenzi wayo.

aseqophelweni eliphezulu enza kube lula ukuthi imiphakathi yaseNingizimu Afrika ithole ezocwaningo nezemfundo.

I-CSIR yenze umsebenzi oncomekayo ukuphatha lezi zinhlelo. Umphumela walokhu ukuvela kwamathuba okuqeqesha abasafufusa, ukwakhiwa kwamathuba amasha emisebenzi, ukucaciswa kwezinkampani ngeminyango nanemikhiqizo ebonakalayo ebiza kahle nethuthukisa umnotho.

Ukuletha uguquko ngenye yezinto umNyango ogxile kuzo. Inhloso yethu ukwakha nokukhulisa amathuba angasetshenziswa yintsha, ukunyusa iqhaza labesifazane kwezesayensi, ezobuchwepheshe, ezobunjiniyela nezezibalo futhi nokuletha uguquko nentuthuko eziveza isithombe okuyiso ngabantu abasebenzayo kulo mkhakha. Ngiyabuncoma ubuhlobo be-CSIR ngokuzama uhlelo olusha lokuThuthukisa ngokuShesha abacwaningi, ukweseka nokusheshisa abacwaningi abanesipiliyoni ukuze kube yibo iqoqo elilandelayo labacwaningi abamnyama futhi besifazane abazoba ngabacwaningi abakhulu.

Ukwakhiwa kwamakhono omkhakha wezesayensi, ezobuchwepheshe, ezobunjiniyela nezezibalo kumqoka ekukhuliseni iNingizimu Afrika ukuze izohambisana namanye amazwe asathuthuka. Ngakho-ke ukutshala imali ekucijeni lamakhono emikhakheni yezesayensi, ezobuchwepheshe, ezobunjiniyela nezezibalo kuyadingeka ukukhulisa umnotho wethu. Ukuzibophezela kwethu sikukhombisa ngezinhlelo eziningi esizixhasayo esibambisene kuzo nabanye abalingani. Njengamanje kunabafundi abangama-369 abenza iziqu eziphezulu nabaxhaswe yi-Interbursary Programme yomNyango ne-CSIR.

Ngale nje kokweseka isizukulwane esizayo sabacwaningi abavelele, ososayensi nonjiniyela, sizibophezele ekutshaleni ekuthuthukiseni ingqalasizinda ukweseka imibono emihle futhi ephusile eqhamukayo yokusungula izinto ezintsha ukuze kuxazululwe ezinye zezinselelo ezikhona emiphakathini yethu.

Ngiyaweseka umbono wobuhlobo be-CSIR wokusungula i-Campus Master Plan (CMP), okuwuhlaka lokuvuselela izakhiwo ezivele zikhona nengqalasizinda ukuze izinhloso i-CSIR evela inazo kanjalo nalezo eziqhamukayo zezesayensi nocwaningo. Ngokuthola ukwesekwa ekudingayo emnyangweni wami nesibambisene nabo, i-CMP ayizukusiza kuphela inkampani kwezocwaningo

kodwa futhi izokweseka yonke imizamo yokusungula izinto ezintsha ezweni lonke.

Muva nje, kube yintokozo kimi ukuba yingxeny yomlando wokwethulwa kwesikhungo se-Biorefinery Industry Development. Lesi sikhungo, okungesokuqala eNingizimu Afrika sineqhaza elibalulekile ekwakheni umnotho ngokuthuthukisa izimboni ezisungula izinto ezintsha njengekashukela nekhizisa izinto ezingacekeli phansi imvelo kwezamahlathi ngokuguqula udoti ube yinto engasetshenziswa. Lesi sikhungo sihambisana necebo lokukhulisa umnotho oledwa yilo mkhakha nohlaka lwe-RDI Roadmap nokuyizinhlelo zikahulumeni zokuzama ukungenisa imali elinganiselwa kuma-R17 billion ngonyaka emnothweni waseNingizimu Afrika, okuyimali okuthiwa kulinganiswa ukuthi ingeniswe yilo mkhakha.

Okubaluleke kakhulu wukuthi izokweseka osomabizini abancane abazimisele ukusebenzisa ubuchwepheshe ukukhizisa izimpahla besebenzisa udoti otholalaka ezinkunini nokuzokwakha amathuba emisebenzi.

I-CSIR yenza umsebenzi obalulekile wokusungulwa kwezinto ezintsha ezweni lethu, ngakho-ke kumqoka ukuthi ibe nemali eyenele ukuze ihlale ikwazi ukwenza umsebenzi wayo. Ngigculisekile ngokuthi i-CSIR inazo zonke izinhlelo ezidingekayo ukuqinisekisa ukuthi ihlale inemali eyanele.

Ngithokozile futhi ngendlela ubuhlobo obuqhuba ngayo ngokugxila ekuthuthukiseni ezezimboni ngohlelo *"i-Project Synapse"*, nokuyindlela yokushintsha izinto enkampanini. Ukugxila ekuthuthukiseni ezezimboni kusho ukubambisana nezezimboni. Ngikholwa ukuthi lokhu kuzokwenza umsebenzi omkhulu wokulwa nezinselelo ezintathu zobubha, ukuntuleka kwemisebenzi nokungalingani emiphakathini wethu.

UmNyango wezeSayensi nezobuchwepheshe uzibophezele ukweseka i-CSIR ukuze inhlolo yayo. Ngiyabonga kwiBhodi ye-CSIR nasethimbeni labaphathi bayo ngobuhlobo babo obunesibindi. Ngiyabonga kubasebenzi ngokulokhu zizinikele enkampanini.



**Nk. Mmamoloko Kubayi-Ngubane**  
uNgqongqoshe wezeSayensi nezobuchwepheshe

# GO TŠWA GO BOETAPELE BJA RENNA

## Ketapelekakanywa ka Tona ya Saense le Theknolotši

Mošomo wa mmušo wa rena ke go hlola tikologo ya go dumelela badudi le mekgatlo go kaonafatša tšweletšopele ya ekonomi ya leago le go atlega. Ka maemo a Kgoro ya Saense le Theknolotši (DST), ke go hlola tikologo ya dinyakišišo le mpshafatšo go dumelela mekgatlo, ya go swana le Khansele ya Dinyakišišo tša Saense le Intasteri (CSIR), go dira mošomo wa dinyakišišo le tšweletšopele (R&D) woo o tlo thušago mmušo go aba tšweletšopele ya go swarelela go batho ba yona. Mošomo woo re o dirago bjalo ka kgoro o hlahlwa ke mananeo a go fapana a peakanyo; le legolo go wona e lego Leano la Tšweletšopele ya Setšhaba (NDP).

**Makala a go swana le CSIR** a kgatha tema ye bohlokwa go thuša mmušo go phethagatša mananeo a ona a go fapana le go aba ditirelo go kaonafatša boleng bja maphelo a badudi. Dinyakišišo tšeo di dirilwego ke CSIR di na le khuetšo ya thwii mo dikarolong tša nepišo tše bohlokwa tše mmalwa bjale ka ge go boletšwe ka go NDP. Se se akaretša ekonomi le thwalo, go aga mmušo wa bokgoni; infrastraktiša ya ekonomi le leago; go fetogela go ekonomi ya khapone ya fase; go aga ditikologo tša g bolokega; go kaonafatša maphelo; gammogo le mošomo wa R&D go fetoša madulo a batho.

Go palelwa ga kgolo ya ngwaga le ngwaga ya ekonomi ya rena mo pakeng ya go feta go dirile gore re be le ditlhohlo ga mmogo le menyetla. Gare ga tše, ke seswantšho seo se dirilego gore go be le tshekatsheko ye bohlokwa ya maleba ya Pego ya Mmušo (White Paper) ka Saense, Theknolotši le Mpshafatšo.

Go tloga mola Pego ya Mmušo (White Paper) ka Saense, Theknolotši le Mpshafatšo e amogelwago ka 1996, go bile le tšwelopele ye bohlokwa mo go kaonafatšeng saense, theknolotši le mpshafatšo ka Afrika Borwa. Ditshekatsheko tša gonabjale di laetša go godiša ga saense, theknolotši le tikologo ye e mpshafaditšwego ya saense; koketšogo ya gararo ka diphatlatatšo; kgolo ye bohlokwa mo go kgatheng tema ga bathobaso le basadi mo dinyakišišong le tšweletšopele ya bašomi; gammogo le kgolo ya palo ya dialoga tša bongaka.

Kakanywa ya gonabjale ya Pego ya Mmušo (White Paper), yeo e tloga phethwa pele ga 2018, e nyaka go hloga go dibaka tšeo di abilwego ke dimekatrente tša lefase, go swana le go tšwelela ga ditheknolotši tše difsa, go akaretša bohlale bja maitirelo, Intasteri ya 4.0 le tšweletšo ya tlaleletšo, gare ga tše dingwe. E nyaka go hloga go dilo tšeo di tšwelelago go mpshafatšo ya theknolotši, go katološa seo se bego se šoma le go akanaya mekgwa ye mefsa. Se se tla ama go matlafatša le go fetoša diistitūšene, go oketša thekgo ya dinyakišišo le go katološa mabokgoni a batho.

DST e beeditše mananeong a go fapana mo CSIR go fa thekgo mo tšwelotšopeleng le kgolong ya diintasteri mo makaleng a go fapana. Tšona di akaretša Lenaneo la Ditirišano tša Mpshafatšo ya Diintasteri, leo le lekago go goketša peeletšo ya lekala la praebete ka go fetolela ditšweletšo tša R&D go ditšweletšwa tša kgwebo ka go aba infrastraktiša ya mohuta wa pele, ya teko le koketšo go kopanya sekgoba gare ga laporotori le mmaraka; Lekala la Phethagatšo ya Go dira Theknolotši ya Gae, yeo e thomilwego go phethagatša tšeo di abjago tša Leano la Go dira Theknolotši ya Gae, yeo e akaretšago go oketša bokgoni bja tšweletšo ya difeme tša gae; Dinyakišišo tša tšeo di Senyegilego, Mmepe wa Mpshafatšo le Tšweletšopele go hlahlwa dipeeletšo tša lekala la praebete le tša setšhaba tša Afrika Borwa ka RD&I tšeo di senyegilego mo mengwageng ye 10; gammogo le Mokgwa wa Infrastraktiša ya Kekišo ye e Kopantšwego ya Setšhaba, yeo e godišago tšweletšopele

**CSIR e na le sekgoba se bohlokwa kudu mo mokgweng wa rena wa setšhaba wa mpshafatšo**, gomme ka gona, go bohlokwa gore e dule e swareletše ka ditšhelete.

ya saense le intasteri ka senyakwa sa khomphutha ya tiragatšo ya godimo go aba phihlelelo ya go swana ya ditšhaba ka Afrika Borwa ka dinyakišišo le thuto.

CSIR e šomile gabotse go laola mananeo a. Ditšweletšo di feleleditše ka go hlola dibaka tša go ithutela mošomo, go hlola mešomo, dikhamphani tše di aroganego, gammogo le ditšweletšwa tša nnete tšeo di ka phadišanago mo mmarakeng le go thekga ekonomi ya rena.

Phetogo ke karolo ya nepišo ya motheo ya kgoro. Maikemišetšo a rena ke go hlola le go godiša dibaka tša bafsa, go oketša go kgatha tema ga basadi ka go saense, theknolotši le boentšenero le mmetse (STEM) le go tliša phetogo le tšweletšopele tšeo le tšona di bontšhago kemelo ya dipalopalo tša badudi tša gonabjale mo lekaleng. Ke reta boetapele bja CSIR go sepediša Lenaneo la Tšweletšopele ya Dinyakišišo tše di Akgošišitšwego le lefisa go thekga banyakišišibagolo le banyakišiši ba baetapele ka maikemišetšo a go godiša ka lebelo sehlopha sa go latela sa Mafrika Borwa a bathobaso le banyakišišibagolo ba basadi.

Go aga mabokgoni a maleba ka go STEM go bohlokwa go godiša Afrika Borwa gore e swane le dinaga tše dingwe tšeo di hlabollogago. Ka gona, maitapišo ao a beakantšwego go nepiša peeletšo ya ditšhelete go aga tsela ya maleba le mabokgoni ka go STEM go bohlokwa mo kgolong ya ekonomi. Maikgafo a rena a laeditšwe ka ditirišano le mananeo a mmalwa tšeo re di thekgago. Gonabjale, go na le dialogadigolwane tše 369 tšeo di thekgwago ka Lenaneo la Dipasari tša Tsenelano tša DST/CSIR.

Go tlaleletša go thekga moloko wo o sa tlogo wa banyakišiši ba ketapele, borasaense le boraentšenero, DST e ikgafile go beeletšeng ga tšweletšopele ya infrastraktiša go thekga tšhepetšo ya kgopolo ya tšweletšo ya dikgopolo tša bohlole tša go fapana le dimphafatšo go fokotša tše dingwe tša ditlhohlo tše dingwe tše bohlokwa tša setšhaba sa rena. Ke reta kakanyo ya boetapele bja CSIR ka go hlola Leano la Tlhahli ya Khamphase (CMP) go mpshafatša dinolofatši le infrastraktiša tšeo di lego gona go fihlelela dinepo tša dinyakišišo le saense tšeo di golago. Ka thekgo ye bohlokwa go tšwa kgorong ya ka le badirišani, CMP e ka se hole fela dinyakišišo tše bohlokwa tša mokgatlo, eupša mokgwa wa kakaretšo wa setšhaba.

Kgauswanyana, ke hlompilwe ka nnete go ba karolo ya thakgolo ya histori ya Senolofatši sa Tšweletšopele ya Intasteri ya Payorefenari. Senolofatši se, sa mathomo ka Afrika Borwa, se na le tema ye kgolo yeo e swanešego go e kgatha go aga ekonomi ya leboo ka tšweletšopele ya intasteri ye mpsha, go swana le swikiri le payorefenari ya dithokgwa, go fetola seo gonabjale se tsebegago se senyegile go ya go methopo ye bohlokwa. Ke gape karabelo ya mokgwa wa Payo-ekonomi le Mmpepe wa RDI ye e Senyegilego, mekgwa ya mmušo ya go lokolla R7 bilione ka ngwaga ya ekonomi ya Afrika Borwa.

Se bohlokwa kudu, e tla aba thekgo go dikgwebopotlana, le tša magareng le tše nnyane tšeo di nago le kgahlego mo go direng ditheknolotši tša gae go tšweletša dithoto go tšwa go payomase ya kota ye e senyegilego, ka gona ya hlola dibaka tša mešomo.

CSIR e na le sekgoba se bohlokwa kudu mo mokgweng wa rena wa setšhaba wa mpshafatšo, gomme ka gona, go bohlokwa gore e dule e swareletše ka ditšhelete. Ke kgotsofetše gore CSIR e dirile mekgwa ya maleba go kgonthiša gore institušene e dula e swareletše ka ditšhelete.

Ke thabile gape kudu ka taetšo yeo boetapele bo e tšeago, bo nepiša tšweletšopele ya intasteri, ka 'Protšeke ya Senapse' mokgwa wa phetho wa motheo wa mokgatlo. Nepišo ka tšweletšopele ya intasteri ka tlhago e ra kgokagano le intasteri le makala ao a dirišanago. Ke kgolwa gore se se na le bokgoni bja go dira leswao la go ya go ile mo go šoganeng gabotse ditlhohlo tša gare tša bohloki, go hloka mošomo le go se lekalekane setšhabeng s arena.

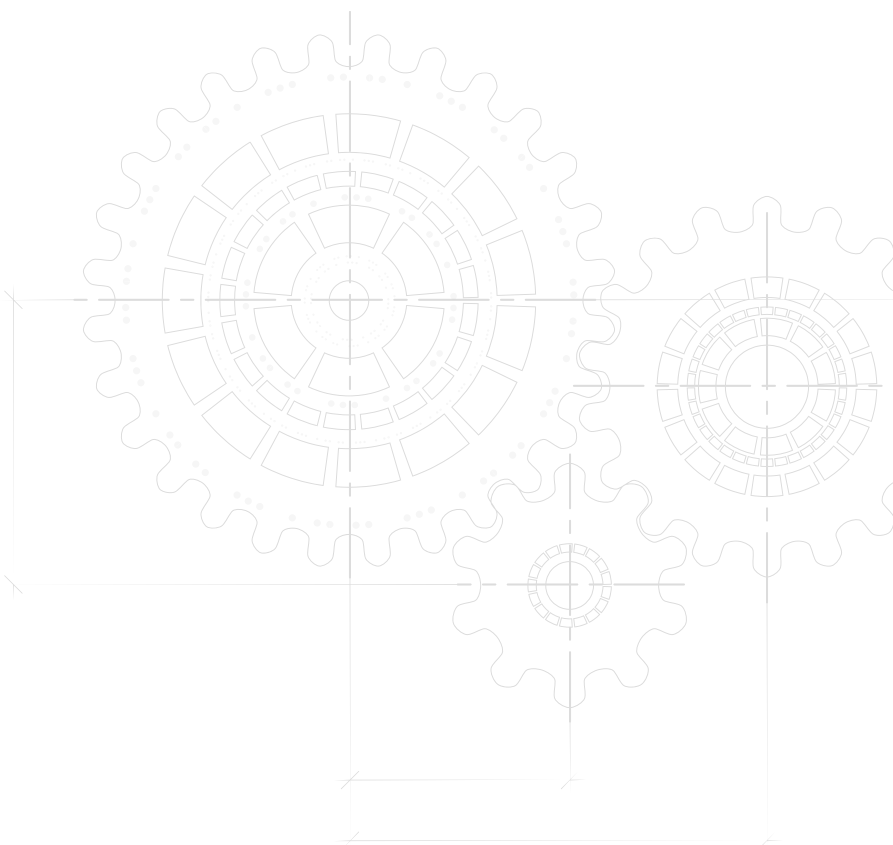
DST e dula e ikgafile go thekgeng CSIR go phethagatša taolelo ya yona. Ke leboga Boto ya CSIR le sehlopha sa Bolaodiphethiši ka boetapele bja bona bja go hlohleletša. Ke leboga bašomi ka boikgafo bja bona mo mokgatlong.



**Mdi Mmamoloko Kubayi-Ngubane**  
Tona ya Saense le Theknolotši



# FROM OUR LEADERSHIP



## Chairman's overview

The financial year under review has been a momentous one for our organisation and we have created significant value for our different stakeholders. We have embraced agility and adaptability to ensure that we remain at the forefront of delivering quality research, development and innovation to improve the lives of the people of South Africa.

**The primary responsibility** of the Board is to provide an informed and objective oversight of the application of the CSIR mandate through delivering on the annual plan and the performance of the organisation.

Under the leadership of the Chief Executive Officer, Dr Thulani Dlamini, a number of impactful decisions have been made to steer the organisation towards an innovative trajectory for the future. One such key decision is the strategic repositioning of the CSIR as an industry-centred and focused institution. As the Board, we fully support this decision and it has been equally endorsed by the Minister of Science and Technology. CSIR Project Synapse – the key turnaround strategy in driving industrial development – has enabled us to look at our scientific and technological capabilities from a

fresh perspective. In particular, it prompts us to engage with industry on their needs in order to provide tangible and innovative solutions that seek to improve their competitive edge, which will ultimately bring a positive contribution to our economy. It also provides us with a lucrative opportunity to create new businesses in our quest for alleviation of unemployment, poverty and inequality. In all these engagements, *applied scientific research will remain key*, as the fuel that propels our engine of innovation.

In order for our organisation to remain relevant, it is imperative that we embark on continuous engagements with our stakeholders so as to understand and ultimately address their needs. It is for this reason that the 6th CSIR Conference which took place in October 2017, focused on showcasing our capabilities in industrial development. Indeed, this proved to be an ideal platform for fruitful engagements with our stakeholders in the public and private sector. The theme of the conference was *Ideas that work for industrial development* and it was a great success.

Advancing the technology development and innovation discourse of our country in order to strengthen our National System of Innovation as we address the societal wellbeing and other key challenges in growing the economy, requires an intentional and coherent effort in establishing partnerships between government, industry and academia. These partnerships will enable us to maximise our cross-disciplinary expertise, accelerate innovation



In order for our organisation to **remain relevant**, it is imperative that we embark on continuous **engagements** with our **stakeholders** so as to understand and ultimately **address their needs**.

and the development of technological solutions, as well as muster broader economic and social benefits from joint investments.

In the year under review, we retained our certification as a Top Employer and received a Clean Audit Award from the Auditor General for having obtained an unqualified audit for the 10th consecutive year. This strengthens our confidence in the knowledge that the systems and controls that are in place are working.

Transformation remains a top priority for the CSIR. While the growth of the science, engineering and technology base remains a challenge in our country, it is important that we play our role in identifying strategies to build our internal pipeline of industry-relevant capabilities to contribute to the National System of Innovation. This will entail the identification, support and recruitment of highly skilled scientists from all sectors of our society, as well as creating conditions that will allow them to realise their fullest potential. Whilst the Board remains concerned with the level of transformation at the highest echelons of the scientific career ladder, we are pleased with the progress being made in this area and the strategies that will be pursued to ensure that this is addressed.

Infrastructure is an important contributor to the growth of the SET base at an organisational and national level and it impacts on the quality of the research output. The CSIR Campus Master Plan (CMP) is an instrumental initiative for infrastructure renewal to foster collaboration among our scientists, thereby leveraging on synergies inherent in our multidisciplinary environment and strengthening industrial liaison. One key feature of the CMP is the Gateway to

Science and Innovation Centre, which will serve as a powerful vehicle to inspire future scientists and bring the CSIR closer to the South African populace at large. The plan is fully endorsed by the Board and we will support funding initiatives to ensure its implementation.

Although the year has been eventful, the quality of our outputs, in the face of challenging market conditions across all operations, is commendable.

The tenure of the current Research Ethics Committee (REC) came to an end on 30 June 2018. The REC is responsible for reviewing all research projects with ethical issues to ensure that the required ethical standards are met. The committee also provides guidance and assistance to CSIR staff on issues pertaining to research ethics. I would like to thank the committee for serving this organisation with distinction over the past three years and for ensuring that the highest ethical standards are upheld.

I am grateful for the many fruitful engagements we have had with our stakeholders and various parliamentary committees throughout the year. Thank you to the staff and leadership of the CSIR for their dedicated commitment to the success of this organisation. Thank you to the Minister of Science and Technology, Ms Mmamoloko Kubayi-Ngubane, for the support and guidance that the Department of Science and Technology has provided throughout the years.



**Prof. Thokozani Majosi**  
CSIR Board Chairperson

# IZWI LABAHOLI BETHU

## Elijikayo likaSihlalo

Lo nyaka esiwubuyekazayo bekuwunyaka omkhulu enkampanini yethu futhi kunezinto ezinkulu esizenzile ukusiza abantu esibambisene nabo. Senze konke okusemandleni ukuqinisekisa ukuthi sihlala sihamba phambili ekulethweni koCwaningo, Intuthuko nezinto Ezintsha ukuthuthukisa impilo yabantu baseNingizimu Afrika.

**Umsebenzi omkhulu** weBhodi ukubhekelela ukuthi i-CSIR iyawenza umsebenzi ephathiswe wona njalo ngonyaka nokuthi inkampani yona iqhuba kanjani kukho konke ekwenzayo.

Ngaphansi kobuholi beSikhulu esiPhezulu, uDkt Thulani Dlamini, kunezinqumo eziningi ezimqoka ezithathiwe ukuze inkampani igxile kakhulu emsebenzini wokuqhamuka nezinto ezintsha ngomuso. Esinye salezi zinqumo esokubuyekeza umsebenzi we-CSIR ukuze ibe yinkampani egxile emsebenzini wokuthuthukisa izimboni. Lesi yisinqumo esisesekayo njengeBhodi futhi sigunyaziwe nawuNgqongqoshe wezeSayensi nezobuChwepheshe. I-CSIR *Project Synapse* – nokuyilona hlaka esisebenzela phezu kwalo ukuqhuba umsebenzi wokuthuthukisa izimboni – isisizile ukuthi sibheke esikwazi ukukwenza kwezesayensi nezobuchwepheshe ngamanye amehlo. Okumqoka kakhulu, lokhu kusiphoqa ukuthi sixoxisane nezimboni ngezidingo zazo ukuze sikwazi ukuzihlinzeka ngezinto ezintsha eziphathekayo ezizonika izisombululo ezizophucula

indlela ezincintisana ngayo, nokuzogcina kuhlomulise umnotho wethu. Kusilethela futhi nethuba eliyinqayizivele lokusungula amabhizinisi amasha emizamweni yethu yokulwa nokuntuleka kwemisebenzi, ububha nokungalingani. Kuzona zonke lezi zingxoxo, ukwenza ucwaningo lwezesayensi kuzohlale kubalulekile ngoba yikhona okuzosiholela phambili njengoba sifuna ukuletha izinto ezintsha.

Ukuze inkampani yethu ihlale inomsebenzi, kubalulekile ukuthi sihlale sixoxisane nabalingani bethu ukuze siziqonde futhi sizihlinzeke kahle izidingo zabo. Yingakho nje ingqungquthela yethu yesithupha, i-6th CSIR Conference eyayingoMfumu ngonyaka odlule yayigxile ekuqhakambiseni ukuthi yini esingayenza ukuthuthukisa ezezimboni. Ngempela futhi lena kwaba yindawo enhle ukuthi sixoxisane nabalingani bethu ezinkampanini zikahulumeni nakulezo ezizimele. Ingqikithi yethu ibithi *“Imibono yokuthuthukisa ezezimboni”* futhi yaba yimpumelelo enkulu.

Ukukhulisa umsebenzi wokuthuthukisa ezobuchwepheshe nokuqhamuka nezinto ezintsha ezweni lethu ukuze kuqiniseke indlela esiqhamuka ngayo nezinto ezintsha njengoba sibhekene nezinsalelo zokukhulisa umnotho wethu, kudinga ukubambisana phakathi kukahulumeni, ezezimboni nezikhungo zemfundo ephakeme.

Lokhu kusebenzisana kuzokwenza sikwazi ukwandisa amakhono ethu emikhakheni enhlobonhlobo, ukwethulwa kwezinto ezintsha, ukuthuthukiswa kwezixazululo ezilethwa wubuchwepheshe bese futhi kusizakala umnotho nokuphucula ezenhlalakahle ngokubambisana.

Ukuze inkampani yethu ihlale inomsebenzi, **kubalulekile ukuthi sihlale sixoxisana nabalingani** bethu ukuze siziqonde futhi sizihlinzeke kahle izidingo zabo.

Kulo nyaka esiwubuyezayo, sisigcinile isitifiketi sethu sokuba uMqashi Ovelele futhi sithole uMbiko Ongenagcobho kuMcwaningi-mabhuku nobesekungokonyaka weshumi iminyaka ilandelana. Lokhu kusenza sibe neqholo ukwazi ukuthi izindlela esizisebenzisayo zinomphumela omuhle.

Ukuletha uguquko kulo mkhakha kusengenye yezinto ezihamba phambili e-CSIR. Nakuba ukukhula kwezesayensi, ezobunjiniyela nobuchwepheshe kuseyinselelo ezweni lethu, kubalulekile ukuthi sibambe iqhaza ekuqhamukeni nezindlela esingazisebenzisa ukwakha amakhono izimbongi eziwadingayo ukuze sifake isandla ekusungulweni kwezinto ezintsha ezweni. Lokhu kubandakanya ukuhlonzwa, ukuxhaswa nokuqashwa kososayensi abasezingeni eliphezulu kuyo yonke imikhakha emphakathini wethu futhi siqinisekise ukuthi indawo abasebenzela kuyo iyabavumela ukuthi baphumelele.

Nakuba iBhodi ikhathazekile ngezanga loguquko ezikhundleni eziphezulu emkhakheni wesayensi, kodwa siyajabula ngenqubekela-phambili esiyibonayo nangezinhlelo ezikhona zokuqinisekisa ukuthi kuba khona ushintsho.

Ingqalasizinda imqoka ekukhuleni komkhakha wezeSayensi, ezobuchwepheshe nezeziBalo, enkampanini nasezweni lonke ngoba inomthelela ekutheni uhlobo lwocwaningo olwenziwayo lunohlonze kangakanani.

Nge-CSIR Campus Master Plan sihlase ukuthuthukisa ingqalasizinda ukuze ososayensi bethu bakwazi ukusebenzisana nokuzosiza ukuqinisa ukusebenzisana emikhakheni enhlobonhlobo nokuxhumana nezimbongi.

Enye yezinto enkulu kwi-Campus Master Plan isikhungo esaziwa nge-Gateway to Science and Innovation Centre, esizosisebenzisa kakhulu ukukhuthaza ososayensi abasafufusa futhi sisondeze i-CSIR kubantu baseNingizimu Afrika.

Lolu hlelo lugunyazwe yiBhodi futhi sizoyiseka imizamo yalo yokuthola usizo lwezimali ukuqinisekisa ukuthi liyaphumelela.

Nakuba lo nyaka ubunezigemegeme, liyancomeka izinga lo msebenzi esiwenzile oseqophelweni eliphezulu yize besibhekene nenqwaba yezinselelo yonke indawo.

Isikhathi se-Research Ethics Committee ebikhona siphelile ngo-30 Juni 2018. Leli komidi belengamele ukubuyekeza ukuthi lonke ucwaningo olwenziwayo lwenziwa ngokuthembeka yini ukuqinisekisa ukuthi yonke imigomo yokuthembeka okumele ilandelwe iyahlonishwa.

Leli komidi liphinde lilekelele abasebenzi be-CSIR ngezinto ezithinta ukuthembeka uma kucwaningwa. Ngifisa ukulibonga leli komidi ngokwenza umsebenzi omuhle kule minyaka emithathu edlule futhi nangokuqinisekisa ukuthi imigomo yokwethembeka esezingeni eliphezulu iyalandelwa.

Ngiyabonga nangokubambisana okuhle esibe nakho nabalingani bethu namakomidi ehlukeni ePhalemende unyaka wonke. Ngiyabonga kubasebenzi, nabaphathi be-CSIR ngokuzinikela kwabo ekutheni le nkampani iphumelele.

Ngiyabonga kuNgqongqoshe wezeSayensi nobuchwepheshe, uNkk Mmamoloko Kubayi-Ngubane ngosizo uMnyango wezeSayensi nobuchwepheshe osinika lona minyaka yonke.



**uSolwazi Thokozani Majozi**  
USihlalo weBhodi le-CSIR

# GO TŠWA GO BOETAPELE BJA RENA

## Kakaretšo ya modulasetulo

Ngwaga wa diitšhelete wa tshekatsheko e bile wo bohlokwa kudu mokgatlong wa rena gomme go bile le mohola wo bohlokwa kudu go bakgathatema ba go fapana. Re amogetše bokgoni bja go dira ka lebelo le go fetogafetoga go kgonthiša gore re dula re le pele go abeng Dinyakišišo tša boleng, Tšwelotšopele le Mpshafatšo go kaonafatša maphelo a batho ba Afrika Borwa.

**Maikarabelo a magolo** a Boto ke go aba taolo ya tsebo le go se tšee lehlakore tirišong ya taolelo ya CSIR ka go tšweletša leano la ngwaga le ngwaga le phethagatšo ya mokgatlo.

Ka fase ga taolo ya Mohlankedimogolophethiši, Ngaka Thulani Dlamini, diphetho tše mmalwa tša khuetšo ye kgolo di dirilwe go hlahlisa mokgatlo go ya tseleng ya mpshafatšo ya bokamoso. Se sengwe sa diphetho tšeo tše bohlokwa ke go fetoša peakanyo ya CSIR bjalo ka institušene ye e theilwego le go nepišwa go intasteri. Sepetho se re se thekga ka botlalo go swana le Boto gape go no swana e dumeletšwe ke Tona ya Saense le Theknolotši. Prošeke ya Senapse ya CSIR – mokgwa wa phetho wa motheo wa mokgatlo go sepetšeng tšwelotšopele ya intasteri, e re kgontšhitše go lebelela mabokgoni a rena a saense le theknolotši go tšwa maemo a mafsa. Kudu, e re hlohletša go boledišana

le diintasteri ka dinyakwa tša tšona gore go kgone go abja ditharollo tša nnete gape tše difsa tšeo di nyakago go kaonafatša taolo ya phadišano, yeo mafelelong e tla tlišago go thekga gabotse mo ekonoming ya rena. E re abela gape dibaka tša mohola go hlola dikgwebo tše dingwe mo nyakong ya rena ya go fokotša tlhokego ya mešomo, bohloki le go se lekalekane. Go dipoledišano tše ka moka, *dinyakišišo tša saense ya tirišo di tla dula e le tša motheo*, bjalo ka sebešwa seo se kgorometšago entšene ya rena ya mpshafatšo.

Gore mokgatlo wa rena o dule o le maleba, go bohlokwa gore re thome ka dipoledišao tšeo di tšwelago pele le bakgathatema ba rena go kwešiša le gore mafelelong go šogane le dinyakwa tša bona. Ke ka lebaka le ge Khonferense ya bo 6 ya CSIR yeo e bilego ka Diphallane 2017 e nepišitše go bontšheng mabokgoni a rena mo tšwelotšopeleng ya intasteri. Ka nnete, se se hlatsetše go ba sefala sa maleba sa dipoledišano tša mohola le bakgathatema ba rena lekaleng la setšhaba le la praebete. Morero wa khonferense e be e le *“Dikgopolo tšeo di šomago tša tšwelotšopele ya intasteri”* gomme e bile katlego ye kgolo.

Go kaonafatša tšwelotšopele ya theknolotši le poledišana ya mpshafatšo ya naga ya rena go matlafatša mokgwa wa rena wa setšhaba wa mpshafatšo ge re šogana le go phela gabotse ga setšhaba le ditlhohlo tše dingwe tše dikgolo go godiša ekonomi, go nyaka maitapišo ao a beakantšwego a go kwagala go thomeng ditirišano gare ga mmušo, intasteri le makala a thuto. Ditirišano tše di tla re kgontšha go fihliša magomong bokgoni bja rena bja ditsebontši, go akgofiša mpshafatšo le tšwelotšopele



Gore mokgatlo wa rena o dule o le maleba, **go bohlokwa gore re thome ka dipoledišao tšeo di tšwelago pele le bakgathatema ba rena** go kwešiša le gore mafelelong go šoganwe le dinyakwa tša bona.

ya diitharollo tša theknolotši, gammogo le ekonomi ya kgoboketšo ye e phatlaletšego le dikholego tša leago go tšwa go dipeeletšo tše di kopanego.

Ngwageng wa tshekatsheko, re swara setifikeitii sa rena bjalo ka Mothwadi wa Godimo gomme re amogela Sefoka sa Tlhakišo ye e Hlwekilego ka Motlhakišimogolo ka go hwetša tlhakišo ye botse mengwaga ye 10 ya go latelana. Se se matlafatša boitshepo bja rena ka tsebo ya gore mekgwa le ditaolo tšeo di dirišwago di a šoma.

Phetogo di dula di le bohlokwa kudu go CSIR. Le ge motheo wa kgolo ya saense, boentšhenere le theknolotši e dula e le tlhohlo nageng ya rena, go bohlokwa gore re dire mošomo wa rena go utolla mekgwa ya go aga tshepetšo ya ka gare ya mabokgoni a maleba a intasteri go thekga mokgwa wa setšhaba wa mpshafatšo. Se se tla ama go utolla, go thekga le go kalatša borasaense ba bokgoni bjo bogolo go tšwa makaleng ka moka a setšhaba sa rena, gammogo le go hlola maemo ao a tla ba dumelelago go lemoga bokgoni bja bona ka botlalo. Mola Boto e dula e ngongorega ka legato la phetogo mo magatong a godimodimo a kgato ya mošomo wa saense, re thabela tšwelopele yeo e dirilwego mo karolong ye le dipeakanyo tšeo di tlogo latelwa gore se se lebeletwe.

Infrastraktšha ke seabi se bohlokwa sa kgolo sa motheo wa SET mo legatong la mokgatlo le legatong la setšhaba gomme e huetša boleng bja tšweletšo ya dinyakišišo. Leano la Tlhahli ya Khamphase ke sedirišwa sa lenaneo la mpshafatšo ya infrastraktšha go godiša tirišano gare ga borasaense ba rena, ka gona ba holega kudu go ditirišano tše bohlokwa mo go tikologong ya rena ya dikarolontši le go matlafatša kgokagano ya intasteri. Sebopogo se sengwe sa bohlokwa sa Leano la Tlhahli ya Khamphase ke Kgokagano ya Senthara ya Saense le

Mpshafatšo, yeo e tla šomago bjalo ka sedirišwa se maatla go hlohleletša borasaense ba nako ye e tlogo le go iša CSIR kgauswi le setšhaba sa Afrika Borwa ka bophara. Leano le dumeletšwe ka botlalo ke Boto gomme re tla thekga mananeo a thekgo go kgonthiša phethagatšo.

Le ge ngwaga e be e le wa ditiragalo tše dintši, boleng bja tšweletšo bja rena, mo maamong a mmara wo o nago le ditlhohlo go phatlalala le ditirišo ka moka bo a retega.

Nako ya gonabjale ya Komiti ya Maitshwaro ya Dinyakišišo (REC) e fihlile mafelelong ka la 30 Phupu 2018. REC e na le maikarabelo a go sekaseka diprotšeke ka moka tša dinyakišišo ka ditaba tša maitshwaro go kgonthiša gore maemo ao a nyakegago a maitshwaro a a fihlelelwa. Komiti e aba gape tlhahli le thušo go bašomi ba CSIR mo ditabeng tša malebana le maitshwaro a dinyakišišo. Ke rata go leboga komiti go thuša mokgatlo wo ka bokgoni mo mengwageng ye meraro ya go feta le go kgonthiša gore go hlohleletšwa maemo a maitshwaro a godimo.

Ke leboga dipoledišano tše dintši tša mohola tšeo re bilego le tšona le bakgathatema ba rena le dikomiti tša go fapana tša palamente mo ngwageng. Ke leboga bašomi le boetapele bja CSIR ka boikgafo bja bona katlegong ya mokgatlo wo. Ke leboga Tona ya Saense le Theknolotši, Mmarena Mmamoloko Kubayi-Ngubane, ka thekgo le tlhahlo ya Kgoro ya Saense le Theknolotši e e filego mo mengwageng ka moka.



**Prof. Thokozani Majazi**  
Modulasetulo wa Boto ya CSIR



# FROM OUR LEADERSHIP

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## CEO's introduction

A number of significant and pertinent strategic changes were made during the year under review to optimise organisational operations and set the organisation on an upward trajectory. The review of our executive roles has proven effective in streamlining the decision-making process and ensuring a balance of competencies within the executive leadership.

To ensure that the CSIR remains sustainable in the long term, we embarked on a strategic repositioning of the organisation with the intention of making a more direct and meaningful contribution to the country's industrial development. We launched CSIR Project Synapse, the organisation's industrial development strategy project whose aim is to reposition the organisation to create an appropriate balance between scientific and industrial development in our innovation portfolio. To date, various engagements with industry stakeholders have taken place and extensive progress has been made towards the development of a strategy that will underpin our role in industrial development in the country.

Research is our core business and to fulfil our mandate of improving the quality of life of South Africans, we continue

to deliver on our strategic objectives which are to build and transform human capital; conduct high-quality and relevant research and technological innovation to foster scientific and industrial development; and maintain a financially sustainable, well-governed organisation.

We have made progress towards the implementation of the CSIR Campus Master Plan – an organisation-wide plan to guide the long-term development of the CSIR's physical and research infrastructure. A clear roadmap that gives details of the different projects to be targeted during different phases of implementation has been created. The newly established Campus Planning and Development Office will oversee the implementation and the stakeholder engagement strategy for funding – a key factor to the success of this monumental project.

Ethical conduct and adherence to governance processes are imperative to the success of any organisation. To assist us in establishing a culture of transparent and ethical conduct within the organisation, we launched the CSIR Ethics Hotline, which was a resounding success, judging by the response from our staff.

Moreover, we hosted the 6th CSIR Conference under the theme, *Ideas that work for industrial development*. The event enabled interactive engagement between CSIR researchers and our public and private sector stakeholders to understand their needs and how we, as the CSIR, can play a meaningful role in partnering with them to meet those needs.

We have **received a clean audit report** and we aim to retain this status because **governance is paramount** to what we do.

As an organisation, we play a meaningful role in supporting government to deliver on its mandate to provide services to the people of South Africa. In addition to our statutory reporting, we highlight a number of projects and research initiatives that clearly speak to the above mentioned objectives and respond to the triple challenge of unemployment, poverty and inequality.

We continue to build our competences in energy research and it is beginning to pay dividends. CSIR researchers are collaborating with their counterparts on the rest of the African continent on a range of energy-related projects. We are working with the Botswana Institute of Technology Research and Innovation and in collaboration with the International Renewable Energy Agency to develop best-practice guidelines for energy regulators to assist them in their oversight role of national power planning entities in the Southern African Development Community region. Locally, we are writing new standards for the safe and cost-effective installation of solar photovoltaic panels. We have also completed an advanced outdoor solar energy research and testing facility to support the domestic solar photovoltaic industry with industrial development, research, quality assurance, knowledge generation and human capital development.

In the area of health, a number of exciting innovations are making their way through the development pipeline. We have developed and patented a novel encapsulation technology to enhance the stability and bioavailability of probiotics. Currently, the encapsulation technology is being licensed to a supplier of health-promoting products containing probiotics, vitamins and other supplements to the nutraceutical market.

We launched the Biorefinery Industry Development Facility, which will support innovation in a range of industries, including agro-processing and other biomass-based industries, a first for South Africa.

Although the year had noteworthy triumphs, it was not without its challenges. Our operations have not been financially sustainable. This year in particular, our finances

have been strained due to a number of contributing factors. The general decline in investment in research and development and our heavy reliance on public sector income have had an impact on our financial performance. This has compelled us to increase our efforts in our business development endeavours and in applying stringent cost-containment measures through short- to medium-term targeted interventions.

Despite these challenges, we are optimistic that the new strategic repositioning will contribute to the sustainability of the CSIR in the long term. We have received a clean audit report and we aim to retain this status because governance is paramount to what we do. In the year under review, we renewed our emphasis on safety. Our goal is to attain zero harm, zero disabling injuries and zero fatalities. A number of strategies to achieve this have been set in place.

We have been awarded the Top Employer status for the eighth year. The success of the CSIR depends on the quality of our support, as well as science, engineering and technology (SET) staff. In this regard, we continue to invest in the comprehensive development of our human capital and currently, there are 164 students on the CSIR Bursary Programme. Internally, we have also introduced a pilot programme to accelerate researcher development. A number of our staff received national and international accolades for their contribution to research and technology development.

Thank you to the entire CSIR staff for their passion, commitment and hard work. I would like to thank the CSIR Board for its effective oversight and the Department of Science and Technology, under the leadership of Minister Mmamoloko Kubayi-Ngubane, for their ongoing support.



**Dr Thulani Dlamini**

*CSIR Chief Executive Officer*

# IZWI LABAHOLI BETHU

## Isingeniso seSikhulu esiPhezulu

Kunenqwaba yezinguquko ezimqoka ezenziwe kulo nyaka esiwubuyekezayo okuhloswe ngazo ukuphucula indlela okusetshenzwa ngayo ukuze inkampani iqhubeke nokudlondlobala. Ukubuyekezwa kwezikhundla eziphezulu sekuthela izithelo ezinhle uma sibheka indlela izinqumo esezithathwa ngayo manje futhi kuqinisekise nokuthi kukhona yonke inhlobo yamakhono ezingeni labantu abalawula inkampani.

**Ukuqinisekisa ukuthi i-CSIR** izokwazi ukuqhubeka nomsebenzi wayo isikhathi eside, kube khona izinguquko esizenzayo ngenhloso yokufaka isandla kakhulu futhi kangcono ekuthuthukisweni kwezimbongi zezwe. Sethule i-CSIR *Project Synapse*, okuwuhlelo onjongo yalo ukushintsha inkampani ukuze kusukela manje ikwenze kahle kokubili ukuthi ithuthukise ukwethulwa kwezinto ezintsha kwezesayensi kanjalo nezezimbongi. Kuze kube manje, miningi imihlangano esesibe nayo nabalingani bethu ezimbongini ezehlukene futhi mkhulu umsebenzi esesiwenzile ukuphucula injongo yethu esilawulayo nesiholayo ukufaka isandla ekuthuthukiseni ezezimbongi ezweni.

Ucwaningo yiwona umsebenzi wethu omkhulu. Futhi, ukuze sikwazi ukufeza umsebenzi wethu wokuphucula impilo yabantu baseNingizimu Afrika siqhubeka nokwenza izinjongo zethu zokwakha nokuletha uguquko kubasebenzi; ucwaningo lwethu olukhulisa ezesayensi nalolo oluqondene nezezimbongi; isimo nokuphathwa kahle kwezezimali enkampanini yethu kube yimpumelelo.

Sesenze umsebenzi omkhulu kwi-CSIR *Campus Master Plan*, okuwuhlaka lwenkampani yethu esisebenza ngalo

ngaphakathi ukuthuthukisa ingqalasizinda yezakhiwo ze-CSIR naleyo yokwenza ucwaningo. Kunohlelo olubonakalayo olunemininingwane ecacile yezigaba

ezihlukene nezindawo okumele zilungiswe olusunguliwe. Ihhovisi elisha elisunguliwe le-Campus Planning and Development yilona elizolawula lolu hlelo futhi lisebenzisane nesiingabambisana nabo ukuthola usizo lwemali, okuyinto emqoka kakhulu ukuze lolu hlelo luphumelele.

Ukuthembeka nokuhlonipha imithetho nemigomo yomsebenzi kumqoka kunoma ngabe iyiphi inkampani ukuze iphumelele. Ukuselekelela ekutheni lezi zinto zenzeke enkampanini yethu, sethule i-CSIR *Ethics Hotline*, nesibe yimpumelelo kakhulu uma sibheka indlela abasebenzi bethu abayemukele ngayo.

Ngaphezu kwalokho, sibe nengqungquthuthela yethu njenge-CSIR nebekungeyesithupha ongqikithi yayo ibithi *Imibono yokuthuthukisa ezezimbongi*. Lo mcimbi wenze ukuthi kube nokuxhumana phakathi kwabacwaningi be-CSIR nalabo esibambisene nabo kuhulumeni nabezinkampani ezizimele ukuze siqonde ukuthi yini abayidingayo nokuthi thina njenge-CSIR singabamba liphi iqhaza ukubambisana nabo ukufeza lezo zidingo.

Sinomsebenzi omkhulu esiwenzayo ukwelekelela uhulumeni ekufezeni umsebenzi wakhe wokuhlinzeka abantu baseNingizimu Afrika ngezidingo. Ngale nje kwalo mbiko esiwethulayo, siqhakambisa imisebenzi nezinhlelo eziningi zocwaningo ezihambisana nezinjongo zethu esesikhulumile ngazo futhi silekelele ekulweni nezinsalelo ezintathu zokuntuleka kwemisebenzi, ububha nokungalingani.

Siyaqhubeka nokuthuthukisa ulwazi lwethu ekwenzeni ucwaningo lwezamandla futhi sesiyaqala ukubona izithelo. Abacwaningi be-CSIR basebenza ngokubambisana



**Sithole umbiko** ongenagcobho **kumcwaningi-mabhuku** futhi sizimisele ukuthi kuhlale kunjalo ngoba **ukuphathwa kahle komsebenzi kumqoka** ezintweni esizenzayo.

nabalingani babo bakwamanye amazwe e-Afrika emisebenzi eminingi ethinta ezamandla. Sisebenzisana neBotswana *Institute of Technology Research and Innovation* futhi nangokubambisana ne-*International Renewable Energy Agency* ukusungula imogomo nemithetho yezinhlangano ezilawula ezamandla/ezikagesi ukuzelekelela emisebenzini yazo yokubheka ukuthi konke kuhamba ngononina na ezinkampanini ezinezinhlelo zokukhulisa ezamandla kwi-*Southern African Development Community*.

Kuleli sibhala imigomo emisha yezokuphepha nokwenza kubize kahle uma kufakwa ubuchwepheshe bokuphepha ugesi. Sesiphothule nocwaningo olujulile olubheka ukuphehlwa kukagesi ngelanga futhi sahlola nendawo yokwenza lo msebenzi ukuze seseke le mboni ukuze ithuthuke, ngocwaningo, ukuhlola izinga ukwandisa ulwazi nokuthuthukisa amakhono.

Emkhakheni wezempilo, kunezinto eziningi ezintsha eziqhamukayo esezizosungulwa. Sesisungule futhi sabhalisa nobunikazi bobuchwepheshe obusha obuzokhulisa ukwakhiwa kwemikhiqizo eyenziwe ngembiliso egeqa ithumbu.

Okwamanje lobu buchwepheshe buqashiswe inkampani edayisa imikhiqizo yezempilo enemikhiqizo yembiliso egeqa ithumbu, amavithamini nezinye izakhamzimba zemboni yezokukhiqiza ukudla okunempilo.

Sethule isakhiwo se-*Biorefinery Industry Development*, engokukhiqiza amandla nokushisa, esizokweseka ukusungulwa kwezinto ezintsha ezimbonini ezahlukeneyo okubalwa kuzo umkhiqizo wezolimo nezinye izimboni, nokuyinto eqalayo ukwenzeka eNingizimu Afrika.

Nakuba kunezinto eziningi esizizuzile, bezikhona nezinsalelo. Inkampani yethu ibingenzi kahle kwezezimali. . Bekungahambi kahle ezimalini ngenxa yezizathu eziningi. Ukuncipha kwemali efakwa abatshalizimali ocwaningweni nokuthembela kwethu kakhulu emalini eqhamuka kuhulumeni kusilimazile ohlangothini lwezimali. Lokhu sekusiphoke ukuthi sinyuse amasokisi emizamweni

yokuthuthukisa uhlangathi lwebhizinisi futhi siqinise isandla endleleni esiphatha ngayo imali ukuze sikwazi ukuyonga.

Nakuba zikhona lezi zinsalelo, siyakholwa ukuthi le ndlela entsha esesizosebenza ngayo izosisiza ekukhuliseni umsebenzi we-CSIR isikhathi eside. Sithole umbiko ongenagcobho kumcwaningi-mabhuku futhi sizimisele ukuthi kuhlale kunjalo ngoba ukuphathwa kahle komsebenzi kumqoka ezintweni esizenzayo. Kulo nyaka esiwubuyekazayo sivuselele nokubaluleka kwezokuphepha. Inhloso yethu ukuthi kungabi nazigameko zakulimala, ukukhubazeka nokufa kwezisebenzi. Ziningi izinhlelo esizethulile zokufezisa lokhu.

Siklonyeliswe ngokuba wumqashi ovelele, nobesekungokonyaka wesishiyagalombili. Impumelelo ye-CSIR incike ekubeni nohlonze kwezeSayensi, ezobuNjiniyela nezobuChwepheshe nokwesekwa abasebenzi bethu. Ngakho-ke siqhubeka ngokutshala ngokujula kwintuthuko yabasebenzi bethu. Njengamanje kunabafundi abangama-164 abahlomule ngemifundaze yethu, kwi-CSIR *Bursary Programme*. Ngaphakathi kwinkampani

kukhona uhlelo lokuqala esilwethulile ukukhuphula umsebenzi wokuthuthukisa abacwaningi. Iningi labasebenzi bethu lithole imiklomelo kuleli neyakwamanye amazwe ngeqhaza ezilibambayo ukuthuthukisa ezocwaningo nezobuchwepheshe.

Ngibonga bonke abasebenzi base-CSIR ngokuzimisela, ukuzinikela, nokusebenza ngokushiseka. Ngifisa ukubonga neBhodi le-CSIR ngokwenza umsebenzi omuhle. Ngibonga ukwesekwa njalo umNyango wezeSayensi nobuChwepheshe, oholwa uNgqongqoshe uMmamoloko Kubayi-Ngubane.



**uDkt Thulani Dlamini**  
iSikhulu esiPhezulu e-CSIR

# GO TŠWA GO BOETAPELE BJA RENA

## Matseno a Mohlankedimogolophethiši Ketapelekakanywa

Go dirilwe diphetogo tše mmalwa tše dikgolo tše bohlokwa mo ngwageng wa tshekatsheko go kaonafatša ditirišo tša mokgatlo le go bea mokgatlo mo maemong a go namelela. Tshekatsheko ya mešomo ya balaodiphethiši ba rena e bontšhitše katlego mo peakanyong lefsa ya tshepetšo ya go tšea dipheo le go kgonthiša tekatekano ya mabokgoni mo boetapelephethišing.

**Go kgonthiša gore CSIR** e dula e swarelela mo nakong ye telele, re thomile go fetoša peakanyo ya mokgatlo ka maikemišetšo a go thekga thwii gape ga mohola go tšweletšopele ya intasteri ya naga. Re thakgotše Protšeke ya Senapse ya CSIR, protšeke ya peakanyo ya tšweletšopele ya intasteri ya mokgatlo yeo maikemišetšo a yona e lego go fetoša mokgatlo go hlola tekatekano ya maleba gare ga tšweletšopele ya saense le intasteri mo potfoliong ya rena ya mpshafatšo. Go fihla lehono, go bile le dipoledišano tša go fapana le bakgathatema ba diintasteri gomme go bile le tšwelopele ye kgolo gotšweletšopele ya mokgwa wo o tla matlafatšago mošomo wa rena go tšweletšopele ya intasteri ka mo nageng.

Dinyakišiši ke mošomo wa rena wo mogolo, gomme go phethagatša taolelo ya rena go kaonafatša boleng bja bophelo bja Mafrika Borwa, re tšwela pele go phethagatša dinepo tša rena tšeo e leng; go aga le go fetoša mabokgoni a batho; go dira dinyakišišo tša boleng ba go dimo le maleba le mpshafatšo ya theknolotši le go godiša tšwelotšopele ya saense le dinyakišišo tša tšwelotšopele ya intasteri, le go swarelela ga diitšhelete le taolo ye botse.

Re tšwetše pele mo go phethagatšeng Leano la Tlhahli ya Khamphase – leano le le phatlaleletšego la mokgatlo go hlahlisa tšwelotšopele ya nako ye telele ya sebopego sa CSIR le infrastraktšha ya dinyakišišo. Go hlotšwe mmepe wa go bonagala woo o fago tshedimošo ya dikarolo tša go fapana tša phethagatšo. Ofisi ye mpsha yeo e sa tšogo hlolwa ya Tšwelotšopele le Peakanyo ya Khamphase e tla laola phethagatšo ya mokgwa wa go boledišana le bakgathatema go thekgeng – ntlha ye kgolo ya katlego ya protšeke ye ye bohlokwa.

Taolo ya maitshwaro ditshepedišong tša taol di bohlokwa mo go atlegeng ga mokgatlo. Go re thuša go hloma setšo sa go bea dilo pepeneng le taolo ya maitshwaro ka mokgatlong, re thakgotše Mogala wa Go se lefelwe wa Maitshwaro wa CSIR, woo e bilego katlego ye kgolo, go lebeletšwe karabelo go tšwa go bašomi ba rena.

Go tlaleletša seo, re swere Khonferense ya bo 6 ya CSIR ka fase ga morero, 'Dikgopolo tšeo di šomelago tšweletšopele ya intasteri'. Tiragalo e kgontšhitše poledišana ya tirišana gare ga banyakišiši ba CSIR le bakgathatema ba rena intastering ya lekala la setšhaba le la praebete go kwešiša gore dinyakwa tša bona ke dife le gore rena, bjalo ka CSIR, re ka kgatha bjang tema ye bohlokwa go dirišana le bona go fihlela dinyakwa tšeo.

Bjalo ka mokgatlo, re kgatha tema ye bohlokwa go thekga mmušo go tšweletša taolelo ya wona go aba ditirelo go batho ba Afrika Borwa. Go tlaleletša mo go begeng ga rena ga molao, re nepištše diprotšeke tše mmalwa le mananeo a dinyakišišo tšeo di bolelago gabotse le dinepo tše di boletšwego ka godimo le go arabela ditlhohlo tše tsela tharo tša tlhokego ya mešomo, bohloki le go se lekalekane.

**Re amogetše pego ya tlhakišo ya go hlweka** gomme re ikemišeditše go swara maemo a ka gore taolo e bohlokwa kudu go seo re se dirago.

Re tšwela pele go aga mabokgoni a rena ka dinyakišišo tša enetši le mathomo a tšona go lefa dikarolo. Banyakišiši ba CSIR ba dirišana le badirišani ba yona mo kontinenteng ya Afrika ka moka mo mohlwaeleng wa diprotšeke tše di lebanego le enetši. Re šoma le Institute ya Theknolotši le Dinyakišišo ya Botswana le tirišano le Mokgatlo wa Ditšhabatšhaba wa Enetši ya Methopo ya Tlhago go godiša ditlhalhi tša tirišo ye botse ya balaodi ba enetši go ba thuša mo mošomong wa bona wa taolo ya makala a mohlagase wa setšhaba mo seleteng sa Dinaga tše di Hlabologago tša Borwa bja Afrika. Mo gae, re ngwala dinyakwa tše difsa tša go tsenya diphanele tša sola ya fotovoltaiki tša go bolokega gape tša go se bitše tšhelete ye ntši le go ithuta bokgoni ba thwalo ya moya le diintasteri tša sola. Re phethile gape dinyakišišo tša enetši ya sola ya ka ntle ye e tšwetšego pele le go leka dinolofatši go thekga intasteri ya gae ya sola ya fotovoltaiki ya tšweletšopele ya intasteri, dinyakišišo, tlhola ya tsebo le tšweletšopele ya mabokgoni a batho.

Mo karolong ya maphelo, dimphafatšo tša go kgahliša tše mmalwa di thomile tshepetšo ya tšweletšopele. Re dirile le go se leke theknolotši ya go akaretša ya mathomong go kaonafatša go se fetogefetoge le go tsephša ga dipropayotiki. Gonabjale moabi wa ditšweletšwa tša go godiša maphelo tša go ba le dipropayotiki, divitamine le ditlaleletši tše dingwe mo mmarakeng wa nyutrasitikhale, o filwe laesense ya theknolotši ya go akaretša.

Re thakgotše Senolofatši sa Tšweletšopele ya Instasteri ya Payorefaenari, yeo e tla thekgago mpshafatšo mo mohlwaeleng wa diintasteri, go akaretša go laola temo le diintasteri tše di theilwego go payomase, ya mathomo ka Afrika Borwa. Le ge ngwaga o bile le diphilele tše dikgolo, o be o sa hloke ditlhohlo. Ditirišo di be di tekateka ka mašelang. Go be go na le mathata a ditšhelete ka lebaka la dintlha tše mmalwa tše di dirago seo. Go se be le maatla ka kakaretšo mo peeletšong ya dinyakišišo le tšweletšopele le thekgo ye boima go tšwa

go letseno la lekala la setšhaba go bile le khuetšo ye kgolo go phethagatšo ya ditšhelete tša rena.

Se se re gapeleditše go oketša maitapišo a rena go mešongwana ya tšweletšopele ya kgwebo le go diriša ditekanyo tša bothata tša taolo ya ditshenyagelo ka ditsenogare tša selebanywa sa nako ya gare tše di fago šoganago le šomiša. Ntle le ditlhohlo, re holofela gore go fetoša ga peakanyo ye mpsha e tla kgathatema go go swarelela ga CSIR mo nakong ye telele. Re amogetše pego ya tlhakišo ya go hlweka gomme re ikemišeditše go swara maemo a ka gore taolo e bohlokwa kudu go seo re se dirago. Mo ngwageng wa tshakatsheko, re mpshafaditše kgatelelo ya rena go polokego. Maikemišetšo a rena ke gore go se be kgobalo le e tee, go emiša dikgobalo ka moka, ke le go se be le mahu le gatee. Mekgwa ye mmalwa go fihlelela se e beakantšwe.

Re abetšwe maemo a sefoka sa Mothwadi wa Godimo ngwaga wa bo seswai ka go latelana. Katlego ya CSIR e ithekile go boleng bja SET le thekgo ya bašomi bao re ba swarago. Ke ka moo re tšwelang pele go fetoša ma bokgoni a batho. Gonabjale, go na le baiithuti ba 164 mo Lenaneong la Pasari ya CSIR. Ka gare go CSIR re thomile lenaneo la teko go akgošiša tšweletšopele ya banyakišiši. Bašomi ba rena ba mmalwa ba amogetše difoka tša setšhaba le tša ditšhabatšhaba ka thekgo ya bona tšweletšopeleng ya dinyakišišo le theknolotši.

Ke leboga bašomi ba CSIR ka moka ka maikemišetšo a bona, boikgafo, le go šoma ka maatla. Ke rata go leboga Boto ya CSIR ka taolo ya bona ya bokgoni le thekgo yeo e tšwelago pele go tšwa Kgorong ya Saense le Theknolotši, ka fase ga boetapele bja Tona Mmamoloko Kubayi-Ngubane.



**Ngaka Thulani Dlamini**  
Mohlankedimogolophethiši

# HIGHLIGHTS

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Build and transform human capital



Conduct high-quality research to foster scientific development



Conduct relevant research to foster industrial development



Infrastructure renewal and development

## BUILD AND TRANSFORM HUMAN CAPITAL

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The CSIR is keenly aware of the importance of its human capital. It is without a doubt the organisation's most valuable asset. CSIR scientists, engineers and technologists generate new knowledge and develop new technologies for industry and society. Programmes and initiatives employed to sustain the pipeline that supplies the workforce of the future include bursaries and studentships, while career development opportunities for CSIR staff are managed through formalised career ladder frameworks. The CSIR remains committed to contributing to the development of highly skilled human capital for the benefit of the National System of Innovation.





New CSIR chief researchers Dr Bonex Mwakikunga (top left), Prof. Bruce Sithole (bottom left) and Prof. Adele Botha (above).

## Reaching the ultimate level on the research career ladder

**The CSIR promoted three specialists**, whose sustained track record in research and development has led to international recognition, to the position of chief researcher. To reach the top of the research career ladder, individuals have to provide strategic research direction, create an environment where others can achieve their full potential and attract sufficient funds to cover large interdisciplinary projects.

Dr Bonex Mwakikunga holds a PhD in nanoscale physics and leads the CSIR's nanomicro device manufacturing facility. His team was the first to present a micro-nanochip technology demonstrator in 2013, which led to the CSIR's diabetes breath analyser. A provisional patent of the technology has been filed in Finland, Germany, India, Japan, Korea, the People's Republic of China and the Republic of China (Taiwan). In 2016, the full patent was granted in South Africa and in June 2017, it was granted in the USA.

Prof. Bruce Sithole is the research group leader and director of a newly launched biorefinery industry development facility. He holds a PhD in industrial chemistry and his group undertakes research aimed at the revitalisation and resilience of the pulp, paper and poultry industries by generating high-value products from biowaste through biorefinery technologies. Through this work, Sithole has extensive collaborations in South Africa, as well as Europe, Japan and North America.

Prof. Adele Botha specialises in mobile information systems. Her research interests include the use of mobile cellular technology for application in health, education and innovation. Her work on adopting and integrating mobile technology in education has resulted in collaborations with mobile producers and the design and implementation of a development initiative on information and communication technology for rural education in resource-constrained environments.

The CSIR promoted three specialists, whose **sustained track record** in research and development has led to **international recognition**, to the position of chief researcher.

## BUILD AND TRANSFORM HUMAN CAPITAL



Above (left): Dr Sindisiwe Buthelezi in the proteomics facility where she is working with a research team to find diagnostic and drug targets for HIV and cancer. Buthelezi first joined the CSIR on an internship and she is currently a postdoctoral fellow at the organisation. (Centre) Dr Christopher de Saxe received a PhD from the University of Cambridge in April 2018. His work addresses sensing challenges for articulated trucks. An electronic view (right) of one of the data processing steps involved in converting visual odometry data from trailer-mounted cameras into trailer off-tracking measurements.

## Nurturing a new generation of researchers

**The CSIR wants to be at the forefront** of developing and building a pipeline of competent young researchers to enter the science, engineering and innovation community. A studentship from the CSIR offers students an opportunity to gain practical experience, which supports their theoretical studies and also bridges the gap between academia and practice.

Dr Sindisiwe Buthelezi is part of a CSIR team that is developing diagnostic and drug targets for HIV and cancer. Buthelezi first joined the CSIR as an intern, having completed an honours degree in biochemistry and cell biology. She secured a CSIR studentship for an MSc degree in medical biochemistry through the University of Cape Town. In May 2013 she received a professional development programme grant from the National Research Foundation which enabled her to complete her PhD in biochemistry in 2017, through the University of the Witwatersrand, while being hosted at and co-supervised by the CSIR.

Funeka Nkosi also benefitted from a CSIR studentship. She holds an MSc (Chemistry) from the University of Pretoria. She was a CSIR bursary holder who obtained her BSc and BSc (Hons) degrees from the University of the Witwatersrand. Her research for her Master's earned her a CSIR Excellence Award for the best Master's degree student. She is listed as an inventor on a patent on the

strategic deployment of microwave irradiation to solve the problem of capacity fade in lithium manganese oxide spinel cathode materials and has published six research papers in reputable international journals.

In 2017, she was selected as one of the young scientists to represent South Africa at the prestigious 67th Lindau Nobel Laureate meeting in Germany and was recognised by the *Mail & Guardian* as one of the Top 200 young South Africans.

Dr Christopher de Saxe, who first joined the CSIR on a Master's studentship in 2011, received a PhD from the University of Cambridge in April 2018, having spent four years at the United Kingdom-based university. His PhD thesis was titled, *Vision-based trailer pose estimation for articulated vehicles*. The CSIR has a collaboration agreement with the University of Cambridge to jointly support PhD studies through a scholarship.

De Saxe has progressed through the career ladder, from his appointment as a candidate engineer in 2013, to a senior engineer, specialising in heavy vehicle safety and regulation. He is continuing to pursue his research and development interest as part of the CSIR's Smart Truck project. De Saxe is also a visiting lecturer at the School of Mechanical, Industrial and Aeronautical Engineering at the University of the Witwatersrand. More on his research on page 62.



*Zanele Ntshidi, a CSIR candidate researcher, is completing her PhD through the University of the Western Cape. Her studies focus on the water use of apple orchards.*

## Jointly growing the knowledge base: Multidisciplinary research collaborations with South African higher education institutions

**Zanele Ntshidi is part of a team of CSIR scientists** that is studying the use of water in apple orchards in the Western Cape. She is a CSIR candidate researcher who is doing her PhD, focusing on this issue, through the University of the Western Cape. The CSIR and the University of the Western Cape have been collaborating in various research domains for several years, including the water resources domain.

The deciduous fruit industry is a multi-billion rand industry, with apples and pears contributing up to R8 billion to South Africa's GDP. Despite this, little is known about the water use of apple trees. This is becoming increasingly important because apples are mainly grown in the Western and Eastern Cape provinces, which have been suffering from crippling droughts. Ntshidi was awarded funding through the CSIR's Young Researcher Establishment Fund and the Thuthuka Funding Instrument of the National Research Foundation to quantify the water requirements of exceptionally high-yielding apple

orchards and orchards of different ages, under the joint supervision of CSIR senior researcher Dr Sebinasi Dzikiti and Professor Dominic Mazvimavi from the University of the Western Cape. Dzikiti is leading the multi-institutional study, jointly funded by the Water Research Commission and the deciduous fruit industry, to quantify the water use of apple orchards from planting until they reach the full-bearing age. Ntshidi is particularly interested in how much water the plants on the orchard floor use during the different stages of the orchards.

Ntshidi presented her work at an international water conservation conference in Paris, France, in 2017. She was also selected to take part in the 3rd BRICS Young Scientists Forum, in Durban, in June 2018.

The CSIR has partnerships with a number of higher education institutions in South Africa and contributes to developing its staff and CSIR-funded students through these partnerships.



## BUILD AND TRANSFORM HUMAN CAPITAL



### Engaging the next generation of scientists and engineers

**The CSIR has participated** in several outreach programmes across the country to engage with the public on science and technology.

Through its public engagement activities, the organisation aims to stimulate an appreciation for the role of science and technology in building a better life for all, in line with the science engagement strategy of the Department of Science and Technology. The strategy for advancing science engagement includes making science, engineering, technology and innovation attractive, relevant and accessible, with the aim of creating an interest in relevant careers. The CSIR did this through its participation at various science festivals, such as Sasol TechnoX, Science Tube, the CSIR's Career Day and Scifest, the annual national science festival held in Grahamstown. At these various engagements, where the theme was *Innovation 4.0*, young researchers interacted with more than 200 000 young people, demonstrating the organisation's capabilities in 3D printing to enthuse the next generation of engineers.

Researchers also participated in outreach programmes in various parts of the country during which they showed communities how science and technology can be applied to change their daily lives. Campaigns around water safety, renewable energy and climate change, as well as profiling 22 young researchers across various media platforms have brought awareness to research done at the CSIR.

The organisation also partnered with the Optics Student Chapter, which nurtures the interest of young people who want to pursue a career in the photonics industry in countries within the Southern African Development Community.



### Developing skills for the fourth industrial revolution

**The CSIR** and the Manufacturing, Engineering and Related Services Sector Education and Training Authority (merSETA) are helping to develop new apprenticeship skills in preparation for the current worldwide technological transformation known as the fourth industrial revolution.

The transformation is characterised by dramatic exponential growth of technology platforms and systems that support modern society. Recent studies on South Africa's readiness for this revolution indicate that local manufacturers might face major talent challenges in this transformation process.

The CSIR and the merSETA have responded by using a fourth industrial revolution model to re-imagine and develop a high-quality apprenticeship skills development process in South Africa. Dubbed "ICT for Apprentices", it is more affordable, accessible and scalable and prepares apprentices for the fourth industrial revolution. The merSETA plays a central role in ensuring that the National Skills Development Strategy of South Africa is fulfilled. While it does not train, it facilitates the process of training by paying grants; registering moderators and assessors; identifying scarce skills; accrediting providers; monitoring the quality of training and implementing projects to close the skills gap.

The new platform will ensure a largely paperless apprenticeship implementation system for two pilot occupations that focus on the maintenance of solar photovoltaic systems and vehicle mechanical maintenance in informal settlements, respectively. It makes provision for apprenticeships for informal sector learners and acts as a stimulator for small and medium enterprises to host learners for workplace experience assignments.





*Above (from left): The CSIR's Lindelani Mbedzi, Thabang Sono and Sayco Maluka are now part of the organisation's research cadre in information and communications technology, having completed an internship.*

## Internships in media, information and communications technologies benefit young graduates

**The CSIR has trained 45 unemployed youths** as part of an internship programme to give qualified, unemployed graduates work experience. The programme is part of its agreement with the Media, Information and Communication Technologies Sector Education and Training Authority (MICT SETA) whose mandate is to generate, facilitate and accelerate the processes of quality skills development at all levels in the MICT sector in South Africa.

In addition to the training provided during the internship period, the CSIR also offered employment to 13 interns on completion of the programme. They now work in different research areas of the CSIR that rely on their skills in information and communications technology. The interns describe their experience as a great learning curve post their various education qualifications.

Sayco Maluka holds a National Diploma in electrical engineering and has been placed with the CSIR's research group in embedded intelligent systems, which specialises in hardware engineering. His most memorable experience during the training was doing mechanical designs using computer-aided design packages. Lindelani Mbedzi says his interactions and real-work experience with a team of developers motivated him to enhance his National Diploma in information technology. For Thabang Sono, his practicals on software development projects, whilst obtaining his BSc in information technology, paled in comparison to what he was exposed to during his internship period.

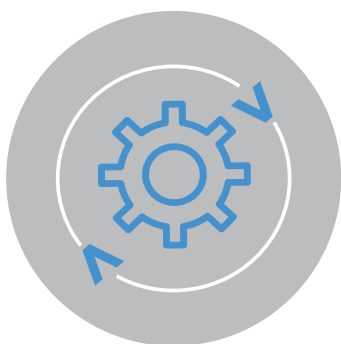
The CSIR is growing its partnerships with various SETAs as part of its strategy to address youth unemployment in the country.

The interns describe their **experience** as a **great learning curve** post their various **education qualifications**.





## CONDUCT RELEVANT RESEARCH TO FOSTER **INDUSTRIAL DEVELOPMENT**



Through technological innovation, the CSIR supports the short, medium and long-term development of the South African economy. The organisation collaborates with industrial partners, state-owned enterprises and other institutional stakeholders to identify opportunities to improve the efficiency and competitiveness of existing industries, as well as invest in the development of technologies that will underpin the industries of the future.



## Bridging the chasm between innovation and industrial competitiveness

**The CSIR mandate calls for the CSIR** to foster industrial and scientific development through directed multidisciplinary research and technological innovation to improve the quality of life of South Africans. To ensure that the work conducted by the CSIR remains relevant, it is important to consider the technological advancements and other megatrends that are taking place globally and for the organisation to respond innovatively to make an impact on our economy.

The CSIR's new vision aims to amplify the 'I' in CSIR and leverage the organisation's strong science, engineering and technology capability to build on current and future industrial development opportunities, while creating the right balance between scientific and industrial development in the organisation's innovation portfolio.

The organisation is working towards a scenario where its industrial development endeavours complement its scientific and technological development efforts and vice versa. The aim is to create a balanced scenario that will see a virtuous cycle where scientific and technological development leads to or informs industrial development, and the latter, as it evolves, leads to opportunities for further scientific and technological development.

To achieve this, the process of articulating a case for change was established and engagements with internal staff, various government departments, agencies and external industry stakeholders were held and are ongoing. An internal engagement process took place on how the organisation can tap into its current capabilities and future technologies in line with global technological advancements to be a key contributor to industry needs. Subsequently, CSIR Project Synapse was launched.

In biology, a synapse refers to a region where nerve impulses are received and transmitted. It allows for communication, permitting two separate elements to connect and is essential for enabling any kind of activity.

Its application to the CSIR is the bridging of the chasm between innovation and industrial competitiveness. CSIR Project Synapse is about the nerve connection between innovation and industry, between innovation and competitiveness, between the CSIR and its partners. The aim is to create or re-establish the connections between the country's socioeconomic needs and the role

innovation and industrial development can and must play to address these needs.

The initiative has been approved by the Board and endorsed by the Minister of Science and Technology.

The approach entails four different phases from planning to the process for change management. Throughout the phases, potential growth sectors, barriers to entry and competitiveness were identified and assessed against existing CSIR capabilities. Several work streams were created to research and capture the necessary information for compiling the draft strategy. This included looking at global megatrends, different industry sectors, business models, skills profiles, the internal operating environment, technology trends, CSIR capabilities, lessons learnt from previous reviews, cultures and values, as well as nexus issues.

To date, the initiative has identified priority sectors and focus areas therein that could benefit from innovation, particularly the adoption of the fourth industrial revolution technologies, and positively impact South Africa's economy. The programmes include the engineered assembled products cluster, the chemicals cluster, advanced materials, agro-processing, smart places, the nexus and Industry 4.0 initiatives. The programmes are industry facing, responding to market pull, while leveraging advances in technology. To be effective, such programmes would require deeper engagement with the South African system of innovation, notably private sector industry players, and they are therefore designed with this in mind. The programmes will also call for new partnership and business models in order to unlock value.

The work done on industrial development at the CSIR has been captured in the Industrial Policy Action Plan for 2018/19 to 2020/21 as one of the key action programmes that the country will be adopting in driving industrial development to improve the quality of life of South Africans.

An external advisory panel consisting of policy makers, public sector stakeholders and public and private sector players has been appointed to guide the CSIR through the industrial policy framework and advise on the strategic repositioning of the CSIR, among other things.

## CONDUCT RELEVANT RESEARCH TO FOSTER INDUSTRIAL DEVELOPMENT



Above (left): Kgama Mathiba checks the 50 L fermenter before sample taking. (Right) The CSIR biocatalysis team tasked with the development of green processes, from idea generation to pilot scale, are (back from left) engineer Monique Smit, senior researcher Kgama Mathiba and principal researcher Dr Lucia Steenkamp. (Front) Senior researcher Dr Chris van der Westhuyzen and engineer Wynand Behr. CSIR researcher Dr Varsha Chhiba was not present for the picture.

*The CSIR has successfully developed and optimised green manufacturing technologies.*

## Developing eco-friendly products through biocatalysis

**The CSIR has successfully developed** and optimised green manufacturing technologies for eight products in the last year and researchers are continuing with work on a further seven.

Biocatalysis is a method of accelerating chemical reactions by using biochemical agents, such as enzymes, to make products using environmentally friendly technologies. The team comprises researchers in biocatalysis and chemistry, process engineers and analytical researchers who develop technologies from idea-generation to the scale-up of processes.

Market samples produced at bench-scale are sent to clients and end users for evaluation and feedback. The researchers provide clients with a technology package containing manufacturing instructions and reports from the various tests. This acts as a manual for the clients to commercialise the product.

Consumers are increasingly becoming environmentally conscious and are looking for greener products that carry a 'natural' label. These products sell at premium prices, giving clients a competitive economic advantage. Manufacturers in the flavour and fragrance, pharmaceutical, biocide, cosmetics and veterinary industries called on the CSIR's expertise.

One industry partner has since registered a new broad-based black economic empowerment company that will commercialise the green technologies and natural products that have been developed. Another industry partner is set to commercialise four products, while biocide formulations developed for an established biotechnology company are being registered in the European Union. The work by the biocatalysis team has led to a significant number of disclosures of invention, as well as technology demonstrators and patents.

**Biocatalysis** is a method of **accelerating chemical reactions** by using biochemical agents to make products **using environmentally friendly technologies**.





The CSIR-developed instrument has detected particle deposits at the bottom of a slurry pipeline and issues a warning.

## Technology to detect sedimentation in slurry pipelines ready for commercialisation

**A CSIR-developed instrument** to detect particle deposits at the bottom of slurry pipelines is ready for commercialisation. The sedimentation detection device also measures the height of lodged deposits.

Pipelines used in large-scale industrial activities pump various forms of slurry. Occasionally, sedimentation occurs as heavy particles settle at the bottom of pipelines, causing blockages. This means operations must be halted. To alleviate the problem, pipeline operators either run the pipeline at a lower throughput rate or pump large quantities of water through the pipeline. These attempts lead to inefficiencies, water loss and increased costs.

The CSIR's instrument addresses the problem through a non-invasive method that alerts operators before and when blockages occur. The instrument uses individual mini-heaters, which create discrete hot-spots, and temperature sensors. When sedimentation occurs at the bottom of the pipeline, the slurry moves slower, resulting in less heat being carried away from the hot-spots. As more sediment settles, the height builds and temperatures increase, triggering a warning. Algorithms built into the sensor calculate sediment height and the extent of the impending blockage. This information is then communicated to the pipeline control room wirelessly, alerting pipeline operators.

The instrument is versatile and can be retrofitted onto existing pipelines. The device is already in use. An earlier version is in operation at the Saskatchewan Research Council, in Canada, as part of a laminar flow research and development project. A Canadian mine is preparing to conduct its own field trial on the latest version, which includes technology to measure bed height.

## Early warning and monitoring of rock stability

**The CSIR has developed** a compact, battery-operated device that monitors rock-mass for micro-seismicity. Rock instability poses mortal danger to miners and impacts production negatively. Current approaches lack advanced sensor technology to provide precise early warning on instability.

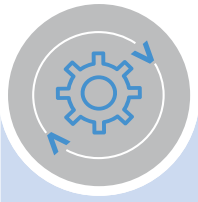
The device, named RockPulse, makes it possible to listen to raw micro-seismicity, extract micro-fracture features and analyse the resulting series of features to detect large instabilities taking place in the rock-mass quickly. Continuous real-time monitoring of instabilities also optimises safe re-entry times after hazardous events.

RockPulse has built-in, real-time data processing capabilities that enable the device to measure mining-induced seismicity through a set of vibration sensors attached to a rock-mass. The technology can also be used for general purposes, such as data logging, to measure other parameters of interest. It is highly customisable and offers various interfacing options to connect to a range of different systems in the mining environment. It is built for rugged environments and is intrinsically safe.



A CSIR-developed microseismic data acquisition and processing platform serves as an early-warning system for large rockfalls and helps optimise safe re-entry time after blasting operations.

## CONDUCT RELEVANT RESEARCH TO FOSTER INDUSTRIAL DEVELOPMENT



### Multi-robot mapping offers a solution to explore and map hard-to-reach areas

**The CSIR is developing** a solution to gain access to hard-to-reach areas and infrastructure by using multiple robots. This cooperative robotic technology has potential application in mining, such as accessing hard-to-reach, narrow reefs where mechanised mining is necessary.

The solution involves deploying automated machines in areas that are hazardous for humans. Multiple mobile, autonomous robots, fitted with 2D laser scanners, explore and map large areas. Scans from the different robots are combined to form a map of the specific environment, using a software package developed by the researchers. The task of scanning an area is thus completed more rapidly, compared to a single robot, and reduces the risks associated with non-functioning robots.

Researchers are currently improving the software, extending the mapping system to work in 3D environments and testing this in a controlled environment at the CSIR's mobile intelligent autonomous systems laboratory, before it is trialled externally.



(From left) CSIR engineer Samuel Ogunniyi, software developer Katlego Mokgokonyane and laboratory technician Mxolisi Gambushe with the Pioneer robot at the CSIR's mobile intelligent autonomous systems laboratory.



The CSIR's Pokotong TV mobile app empowers entrepreneurs to operate their own internet-based television stations over mobile networks.

### CSIR enhances its video-streaming technology

**The CSIR has added** a video-on-demand component to its Pokotong TV mobile app. The capability allows users to download videos on the app for later viewing.

Pokotong TV was developed to use a CSIR-developed platform that permits the streaming of mobile videos without buffering and makes it possible to broadcast scheduled content in both low and high-bandwidth environments. The technology empowers entrepreneurs to operate their own internet-based television stations over mobile networks.

To deliver content to audiences, a broadcast station must be able to commission, upload and schedule content. The CSIR technology enables a broadcast manager to commission work from other media professionals and upload, schedule and broadcast to audiences, while also connecting audiences to advertisers.

The new video-on-demand capability that has been added to Pokotong TV has been made available to three South African film schools, namely Big Fish School of Digital Filmmaking, the University of the Witwatersrand television and film department and the Cape Peninsula University of Technology film department, for beta-testing.





*The transparent wing of a new turbine is being tested in the CSIR's seven-metre wind tunnel for its South African inventor.*

## Analysing the performance of a novel wind turbine for its inventor

**The CSIR has tested** a novel turbine wing for its South African inventor, using its seven-metre wind tunnel.

The CSIR's wind tunnels provide a specialised test, measurement and evaluation environment that supports the aerodynamic design efforts of the South African aeronautics industry. The patented South African invention of an auto-setting morphing wing, called BRAYFOIL, has the ability to reverse lift from one surface to another instantaneously and sets an appropriate angle of attack with the shape change automatically, relying on reflex section shapes in the morphing.

The test results will help finalise the profile shape best suited to this embedded wind power application. The wing has potential application in hydro power, wingsails and active automotive force wings.

Once the desired profile shape has been determined on the test wing, the first prototype turbine will be assembled and tested in the free air at the rear of the wind tunnel, where the vertical axis BRAYFOIL turbine will be assessed for its power output potential.

The first experimental tests by the CSIR team and engineers from Worley Parsons SA showed positive results. The six wings on the first trial are 3 m high and 2.35 m wide. This is likely to produce some 40 kW of mechanical power in a 10 m/s wind, according to simulations performed by the Worley Parsons engineers. The wings have transparent surfaces for low visual impact and the speed of rotation is about half the wind speed. Therefore, the action will be slow, virtually silent and non-invasive, making it suitable for energy generation in cities.

The CSIR's wind tunnels provide a **specialised test**, measurement and **evaluation environment** that supports the **aerodynamic design efforts** of the South African aeronautics industry.

## CONDUCT RELEVANT RESEARCH TO FOSTER INDUSTRIAL DEVELOPMENT



Siemens product lifecycle management (PLM) software at a new PLM technology centre at the CSIR makes it possible to support small, medium and micro enterprises to adapt to digital transformation.



*The Industry 4.0 PLM Centre of Technology provides a collaborative product development space for industry and researchers alike.*

## New collaborative product development space to help drive industrial digital transformation

**Having recognised** the enabling role of product lifecycle management (PLM) technology, the Department of Trade and Industry supported the establishment of a new PLM technology centre at the CSIR by making Siemens PLM software licenses available to the CSIR. The software will be used to support small, medium and micro enterprises (SMMEs).

The Industry 4.0 PLM Centre of Technology provides a collaborative product development space for industry and researchers alike.

The rapid rise and convergence of emerging technologies is driving the fourth industrial revolution. This is a collective term for technologies and concepts of value chain organisation that draw together cyber-physical systems, the Internet of Things and the Internet of Services, as well as other emerging technologies, such as cloud technology, big data, predictive analytics, artificial intelligence, augmented reality, agile and collaborative robots and

additive manufacturing. By enabling smart factories, virtual and physical systems of manufacturing globally cooperate with each other in a flexible way. PLM is an important enabler of the fourth industrial revolution.

The new initiative will help to drive the digital transformation of industry with cooperation at all levels among companies, industries and institutions.

The centre will provide Industry 4.0 readiness assessments and benchmarking against similar companies; plant simulation and optimisation services; plant automation and human-centred automation solutions, including robotics; product development support; regulatory support and the building of digital replicas of physical assets for products and plants.

The CSIR was identified as a local beneficiary by assisting in the development of local SMMEs as part of an offset obligation that Rheinmetall has to South Africa.



## Introducing Industry 4.0 practices to improve the global competitiveness of a local aerospace supplier

The CSIR assisted Daliff Precision Engineering, a supplier to the aerospace industry, with introducing Industry 4.0 practices into its company. The company improved its supply efficiency by connecting its machines to a central station that enables real-time machine monitoring, as well as deeper analytics of various machine parameters and functionalities.

The initiative was led by the CSIR-hosted Aerospace Industry Support Initiative (AISI), an initiative of the Department of Trade and Industry. Daliff is a Level 1 B-BBEE company based in Cape Town.

Commonly referred to as the fourth industrial revolution, Industry 4.0 refers to the quest for automation and data exchange in manufacturing technologies, which includes cyber-physical systems, the Internet of Things, cloud computing and cognitive computing.

As part of an AISI-led technology road-mapping exercise, Daliff identified the need for an integrated digital manufacturing system at the company. There was also a need to ensure that processes at Daliff comply with the AS9100 Rev D standard to streamline time-consuming audit processes. Another challenge was real-time visibility that would enable improved decision-making, thereby improving manufacturing performance. Daliff needed support in implementing real-time machine monitoring of all of its machines, as only three of its 17 machines had this functionality. The company indicated its need for an integrated digital manufacturing system as part of its goal of reaching Industry 4.0 maturity, which is important for the company to compete globally.

The project also measured and improved Daliff's preparedness for the implementation of product lifecycle management.

## Developing new advanced manufacturing process for low-cost waveguides

The CSIR-hosted Aerospace Industry Support Initiative (AISI) supported the development of a new advanced manufacturing process for producing low-cost waveguides and other radio frequency components for space applications at a local aerospace company, NewSpace Systems. AISI is an initiative of the Department of Trade and Industry.

Despite their extensive use in aerospace, space and radar programmes, all waveguides are imported into South Africa. This resulted in a market need for cheaper and more cost-effective, locally-manufactured waveguides for communication satellites in the market.

A waveguide is a structure employed to ensure that radio waves propagate in one or two dimensions only between its end points. There are huge challenges in the manufacture of complex waveguides using conventional methods, such as computer numerical control machining, where different parts are machined separately and then joined together, as this leads to increased weight and loss of radio frequency.

While additive manufacturing or 3D printing can be used to manufacture such waveguides, a method was required for the post-processing of the 3D-printed waveguide to ensure dimensional accuracy, as well as the required radio frequency performance for the complex waveguides.

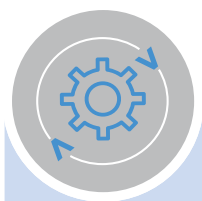
With support from AISI, the waveguides were printed in 3D in titanium alloy and aluminium alloy, as per requirement. The project also developed a post-processing method to reduce the surface roughness and improve conductivity of the 3D-printed objects in order to make the waveguides functional.

The project has created a local capability to manufacture waveguides that have mass, time and cost advantages over traditionally manufactured waveguides.

NewSpace Systems is exhibiting this capability to the world market through conferences and exhibitions in Europe and North America. In addition, a female Master's student from the University of Cape Town has been employed permanently to implement the project.



## CONDUCT RELEVANT RESEARCH TO FOSTER INDUSTRIAL DEVELOPMENT



### Valve localisation to benefit manufacturing industry

**The CSIR-hosted** Technology Localisation Implementation Unit (TLIU) supported a local company, Paltechnogies (Pty) Ltd, in its development and localisation of a valve used in the manufacturing of high-voltage transformers, which are supplied to Eskom. The TLIU is an initiative of the Department of Science and Technology.

The 80 mm aluminium radiator isolating transformer valve is used by original equipment manufacturers, such as Powertech, WEG, Actom, ABB and Siemens, in the manufacturing of high-voltage transformers. Eskom experienced problems with leaking imported valves, which had significant cost implications, as replacing each valve involves a number of departments within the Eskom group.

The local manufacturing value chain, from the aluminium industry and foundries to the machining and anodising sectors, is set to benefit economically. In addition, the power utility's localisation targets are improving as the Department of Trade and Industry designated valves for local content of 70%.

The TLIU also supported Paltech with other interventions, such as certification of their production workshop and some of its product offerings to extend its compliance. Following testing and operational verification, the Eskom Valve Testing Centre has issued Paltech with the conformance and compliance report of the valve, which has subsequently been installed in numerous transformers that are in commission.

Paltech is currently developing other sizes of imported transformer valves.

## National online technology matchmaking platform completed

**The CSIR has developed** an online technology matchmaking platform to link regional, national and international innovators, industry, public and private technology developers, as well commercialisation funding partners. The platform, the Innovation Bridge Portal, was developed on behalf of the Department of Science and Technology.

The first phase of the platform was launched at the 2017 Innovation Bridge Technology Matchmaking and Showcase event. It serves as a virtual and online complement to the biennial showcase event so that innovators, technology developers and funders can collaborate throughout the year.

Among others things, the second phase resulted in the implementation of an automatic matchmaking functionality that enables registered users to receive automatic alerts on possible matches for their expressed needs, such as funding, collaboration and licensing.

The portal currently has more than 110 technologies registered on the site. These include 23 CSIR technologies. In addition to available technologies, funding opportunities, technology needs and calls for information, the portal allows users to provide information on projects undertaken by their institutions, where collaboration or certain technological innovations are required for the project to proceed to the next phase or be taken up by industry or society.

The portal has the added functionality of searching for and finding the necessary support needed throughout the commercialisation process, including patent attorneys, incubation services, technology stations and available support facilities, like laboratories and manufacturing facilities.

Phase three focuses on enhancing the functionalities of the system for accelerated user-friendliness and more systematic intelligence and is expected to be concluded in 2019.

The portal can be  
accessed at  
[www.innovationbridge.info](http://www.innovationbridge.info)







*Above and right: A mobile laser-based refurbishment system designed and constructed by CSIR engineers. The system can repair high-value components on-site and reduce metallurgical damage on an extended heat-affected zone while offering quick turnaround times.*



## Partnership strengthens laser-based solutions for component repair

The **CSIR and Actom's Metalplus** are collaborating to drive the use of fibre laser-welding technology in component repair, where conventional welding methods are not suitable for the repair process.

In terms of an agreement signed, the CSIR will provide expertise in laser cladding and hardening as part of its laser-based manufacturing capability, while Actom's Metalplus will utilise its machining and grinding capability.

The CSIR has a sound track record in developing and customising laser-based technologies to improve the efficiency and competitiveness of numerous industry players, large state-owned companies, as well as rendering valuable support to government initiatives. The ability to render this specialised support is rooted in a first-rate laser-based manufacturing capability.

Laser welding technology is commonly used to repair components that have suffered surface damage or

wear. The technology can also be used to improve the performance of components by changing their surface properties. The low heat input and low dilution of the laser-based process also make it suitable for performing small-scale repairs and depositing fine layers of metal as weld overlays, which is beyond the scope of traditional welding systems.

In a first joint project, the CSIR and Metalplus used a refurbishment welding technique to repair a Sasol generator. A Sasol coil-retaining ring, which usually holds the generator field coil end windings, could not be held in position.

Due to the segmented design of the rotor, circumferential welding was not a feasible approach. Therefore, near-net shape weld build-up of the individual sections was required. The laser metal deposition process was successful and the approach reduced the total refurbishment time significantly.

The **low heat input** and **low dilution** of the laser-based process is suitable for making **small-scale repairs**, which is beyond the scope of traditional welding systems.





## CONDUCT HIGH-QUALITY RESEARCH TO FOSTER **SCIENTIFIC DEVELOPMENT**



The CSIR conducts directed multidisciplinary research that contributes to scientific knowledge development, which is key to innovation. In this section, we feature a selection of research and development that benefits the country in the areas of health, energy, defence and security, as well as the built and natural environments. It also covers examples of research and development undertaken with other African countries for the benefit of the continent.



Above and left: Probiotics protected via encapsulation using a harmless supercritical carbon dioxide technique ensures complete delivery to the intestines, thereby imparting optimal health benefits. The CSIR-developed encapsulation technology is being licensed to a supplier of health-promoting products under the Velobiotics™ brand name.

## RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR HEALTH

### Novel encapsulation optimises the bioavailability of probiotics

The CSIR has developed and patented a novel encapsulation technology to enhance the stability and bioavailability of probiotics. The technology has been licensed to a supplier of health-promoting products which contain probiotics, vitamins and other supplements.

The delivery of a viable colony of live probiotic to the intestines, where they impart health benefits, presents challenges to the probiotic market. Many probiotics do not meet World Health Organization recommendations on the concentration of colony-forming units of viable probiotic bacteria for a probiotic to declare health benefits. Active probiotics typically die during manufacturing, transportation or storage. In addition, large numbers of viable probiotics are degraded in the acidic gastric juices before they reach the intestines.

A common solution to addressing this problem is to protect the probiotic via encapsulation in a protective matrix. However, conventional encapsulation methods involve the use of solvents or temperature or a combination of both. Many sensitive actives, such as proteins and bacteria, cannot be encapsulated effectively using these methods.

The CSIR innovation is based on the encapsulation of the probiotic in a pH-responsive interpolymer complex in an anaerobic supercritical carbon dioxide environment. An interpolymer complex is a system whereby two different types of polymers attract each other, usually via hydrogen bonds, to form a dense network. In acidic conditions, the attraction between the polymers is strong, while in basic conditions the molecules repel each other. Thus, the encapsulated probiotic is protected from gastric acids, while being released in the small intestines where it can impart its health benefits. In addition, the structure provides a barrier to oxygen and moisture, thereby extending the shelf-life.

Carbon dioxide is used as a process medium. It is heated and compressed, turning it into a supercritical fluid that can dissolve or liquefy substances such as drugs, lipids or polymers. The result is that an active can be blended with an encapsulating material in the complete absence of oxygen and organic solvents, while operating at very mild temperatures.

## CONDUCT HIGH-QUALITY RESEARCH TO FOSTER SCIENTIFIC DEVELOPMENT



*Above (left): Only the female mosquito of the Anopheles genus species can transmit malaria. (Right) Nanotechnology is making it possible to improve the solubility of drugs.*



*Drug resistance poses a major challenge, especially in the fight against infectious diseases, like malaria.*

### RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR **HEALTH**

## Nanodrug delivery systems for antimalarial drugs

**As part of an agreement** with the World Health Organization (WHO), the CSIR is developing an innovative nano-based drug delivery systems to reformulate antimalarial drugs to improve drug absorption and uptake and reduce the dose and/or dose frequency.

Many drugs are not totally soluble in water and therefore pose a major challenge due to poor absorption into the blood stream. To compensate for this, these drugs are often administered in high doses and/or high dose frequencies and in some cases it is required that they be consumed with fatty foods. This creates a rather complex regimen, which reduces patient compliance, which can lead to drug resistance and affects the actual drug concentration to which the patient is exposed. Drug resistance has posed a major challenge, especially in the fight against infectious diseases, like malaria.

Currently, the WHO recommends the use of a fixed-dose artemisinin-based combination therapy for the first-line treatment of uncomplicated malaria, with the aim of addressing drug resistance. The artemether-lumefantrine combination is the most widely used therapy of this kind for malaria treatment on the African continent. However, these drugs are poorly soluble, with lumefantrine being practically insoluble in water. Therefore, the combination is administered in multiple daily doses over a three-day period and requires that it be consumed with fatty foods.

CSIR researchers aim to improve vital drug properties, such as solubility and absorption, thereby improving the required dosage for the antimalarials.

CSIR researchers aim to **improve vital drug properties**, such as solubility and absorption, thereby **improving the required dosage** for the antimalarials.

## CSIR produces mycotoxins to ensure sound mycotoxin measurement standards

**CSIR researchers are producing mycotoxins** that will assist the National Metrology Institute of South Africa (NMISA) to provide more affordable and easily accessible measurement standards for mycotoxin testing by laboratories locally and on the continent.

Mycotoxins are produced by different types of moulds that grow on foods and feed, such as cereals, nuts, spices, dried fruit and their by-products, such as beverages and animal feeds. Because of their toxicity to humans and animals, mycotoxin levels in foods and feed are strictly regulated around the world.

NMISA is constantly developing standards that are relevant to the region. One of the challenges is that, to validate their methods and perform routine analytical testing in the food and feed safety arena, laboratories require large quantities of traceable high-purity mycotoxins. Insufficient quantities resulted in the mycotoxins having to be imported, making it prohibitively expensive.

Fungi typically produce mycotoxins under conditions of stress. CSIR microbiologists and biochemists are using their knowledge to optimise the production of mycotoxins. In addition to the contribution to global food safety and empowering the country to support its agricultural sector, the work is also contributing to other research aims, such as optimising extraction processes and detection in the field, using other CSIR-developed technologies.



*CSIR researchers are isolating, purifying and producing mycotoxins in a biosafety level-two compliant facility. CSIR senior researcher Jeremiah Senabe has extensive experience in working with mycotoxins.*



*An eight-transistor microchip containing nanoparticles with electronic properties that are used to tune-in to specific gases.*

## International patenting well on the way for diabetes-detecting chip

**The CSIR has developed a diabetes breath analyser**, a painless alternative to the finger-prick blood test for detecting high blood sugar levels.

The diabetes breathalyser detects acetone, a by-product of high blood sugar levels, and thus a biomarker of diabetes, in breath. It basically works the same way that a common alcohol breathalyser tests blood alcohol levels, but its key innovation is a micro-nanochip, constructed to detect substances with fine-tuned precision.

The small device can be tuned to detect different substances in the same way a radio can be tuned to detect different stations. The micro-nanochip can also amplify the substance it detects, just like turning up the volume on the radio amplifies the sound it emits.

It can be used to detect light, pressure and sound; and it can also sense other gases with high accuracy. The chip is being harnessed as a gas analyser to sniff environmental pollutants, such as nitrogen oxides, ammonia, methane and sulphur compounds.

It can also detect formaldehyde, a biomarker of lung cancer, which other sensors might not be able to distinguish from acetone.

Patents on the nanosensor, which also has other applications in the mining, environmental and health sectors, have been accepted in South Africa and numerous other countries.



## CONDUCT HIGH-QUALITY RESEARCH TO FOSTER SCIENTIFIC DEVELOPMENT



Above (left): Next-generation sequencing of field samples.  
(Right) Field trials of an African-focused diagnostic for foot-and-mouth disease in Lesotho.

*The insights from the foot-and-mouth disease screening platform have led to increased engagement and developing technologies jointly with industry.*

## RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR HEALTH

### Creating a tool that safeguards livestock

The CSIR has developed a point-of-care testing capacity for disease diagnosis based on an isothermal polymerase chain reaction (PCR) technology. The gene-based technique enables disease diagnosis from relatively crude samples and can be adapted easily to detect a specific pathogen. The PCR technology has been optimised at the CSIR for diagnosis of foot-and-mouth disease, as well as other livestock diseases.

Infectious livestock diseases threaten African food security and prevent livestock commodity exports to lucrative markets. The diagnosis of infectious diseases (from both bacteria and viruses) at the point-of-care reduces long-term testing costs, improves sample viability and minimises the need for cold chain storage and the transportation

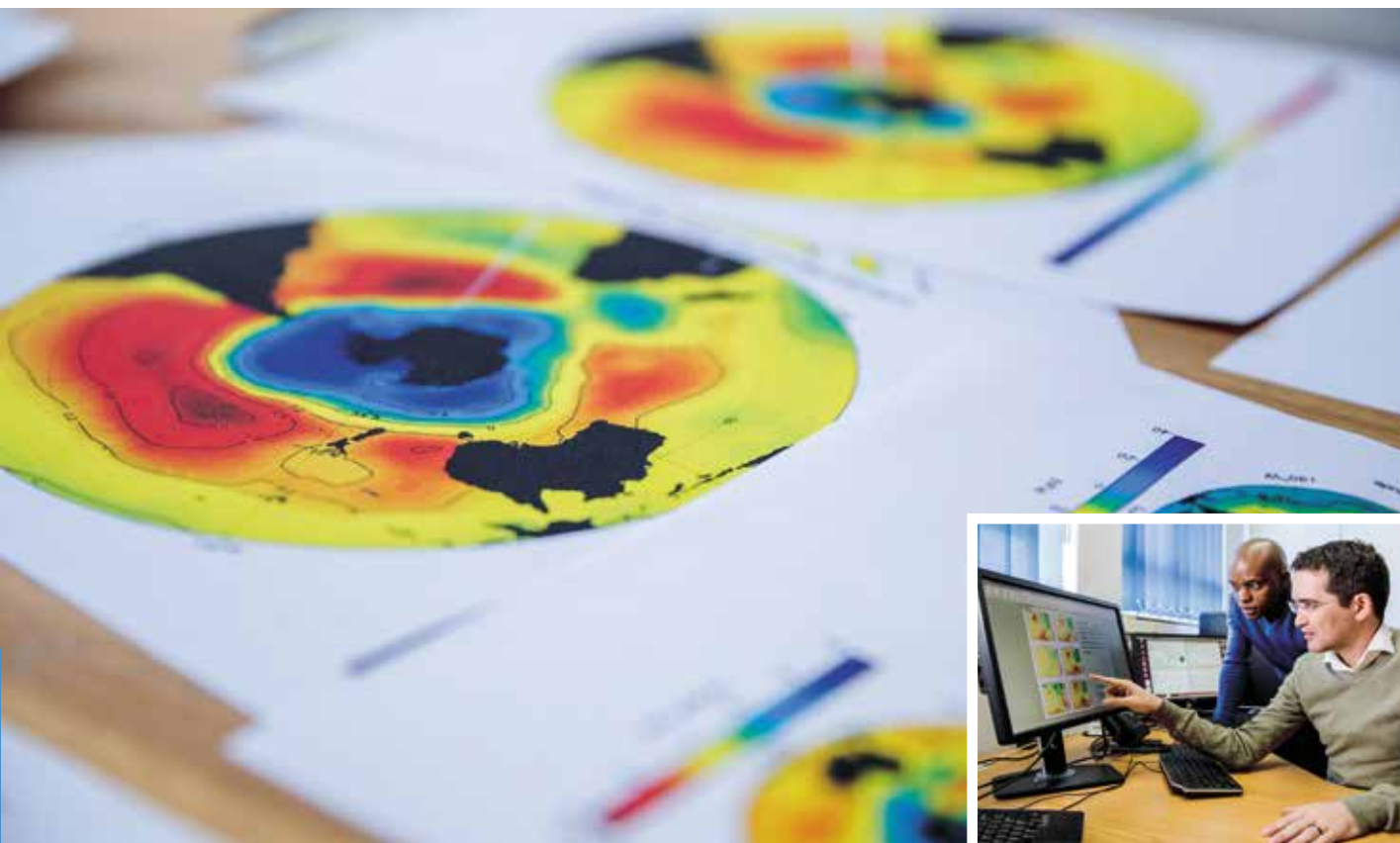
of samples. In most cases, it reduces the turnaround time of test results, which is pivotal in the event of an infectious disease outbreak, leading to better disease management and containment.

Bioscientists are conducting a field study in Rwanda, where an outbreak of the disease was successfully detected in 2017, with hopes of commercialising the technology.

Over the years, the team has built capability in the area of medical diagnostics and its offering in the veterinary sector is being licensed to start-up company, TokaBio. The insights from the foot-and-mouth disease screening platform have led to increased engagement and developing technologies jointly with industry.

The CSIR has developed a **point-of-care testing capacity** for disease diagnosis based on an **isothermal polymerase chain reaction technology**.





Above: Climate modellers have completed a new version of climate change projections at 8 km resolution over Southern Africa – representing the single most extensive climate change experiment ever performed in Africa. (Right) CSIR principal researcher Dr Francois Engelbrecht and researcher Ramapulana Nkoana.

## RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR THE **NATURAL ENVIRONMENT**

### Africa's first Earth system model to provide African-derived projections of climate change

**For the first time**, the sixth assessment report of the Intergovernmental Panel on Climate Change, due for release in 2019, will contain African-derived projections of future global climate change. The projections will be made possible by a new coupled climate model, which is being developed through collaborative research between the CSIR and Australia's Commonwealth Scientific and Industrial Research Organisation.

The new coupled model incorporates the physics and chemistry of the atmosphere and the oceans to enable accurate and more realistic climate projections over Africa. The multidisciplinary effort is driven by CSIR experts in the fields of global change, high-performance computing and modelling and digital science.

In 2017, the CSIR became the first institute in Africa to formally register for the sixth phase of the Coupled

Model Intercomparison Project. The CSIR registered with a full variable resolution Earth system model.

The reports of the Intergovernmental Panel on Climate Change assess the evidence of climate change that has occurred to date; combine climate change projections obtained from all leading climate change institutions globally and convert the information collected into a set of plausible climate futures.

The CSIR's investment in the development of the model is aimed at informing the country's adaptation strategies for climate change. Projections generated by the CSIR directly informed the Intended Nationally Determined Contributions that South Africa submitted to the 21st Conference of the Parties of the United Nations Framework Convention on Climate Change. The models have also informed the national communication on climate change of South Africa.

## CONDUCT HIGH-QUALITY RESEARCH TO FOSTER SCIENTIFIC DEVELOPMENT



Above (left): CSIR process engineer Rhulani Shingwenyana with a reverse osmosis system, which plays an important role in water purification. (Right) Shingwenyana and project leader Dr Vhangwele Masindi at the pilot plant, where the achieved water quality surpassed SANS 241 specifications.



*Wastewater treatment technologies developed by the CSIR purify mine wastewater to a standard that is suitable for different uses and recover valuable minerals from municipal wastewater.*

## RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR THE **NATURAL ENVIRONMENT**

### New technologies to treat acid mine and municipal wastewater

The CSIR has developed and patented two wastewater treatment technologies. One purifies mine wastewater to a standard that is suitable for different uses, while the other recovers valuable minerals from municipal wastewater.

Acid mine water is a by-product of the mining and mineral industry. Mines ceased pumping water as resources such as gold became depleted, resulting in water accumulating in the void and discharging into neighbouring mines and connecting underground tunnels. Active and abandoned mines discharge millions of megalitres of metalliferous and acidic drainage, laden with toxic and hazardous chemicals per year, posing serious health risks to humans and other living organisms.

The magnesite, softeners and reverse osmosis process – which has the potential to purify water to drinking quality and recover valuable minerals from acid mine drainage – is central to this innovation. Brine, a highly

concentrated water solution of common salt resulting from this treatment process, is used to recover additional salts that have commercial value, such as sodium-based salts. The first phase of the treatment chain recovers iron, which is useful in the paint-making industry; while the second phase recovers gypsum that can be used in the fertiliser industry and metallurgical processes. Phase three recovers limestone, which can be used as a starting material in the gypsum precipitation process for acid mine treatment.

The second technology entails the attenuation of nutrients from municipal wastewater effluent.

The CSIR is working on improving the robustness of the technology at an on-site pilot plant. The organisation is in discussions with government, mining houses and agencies about the uptake of the technology.

Active and abandoned mines **discharge** millions of **megalitres of metalliferous** and **acidic drainage**, laden with toxic and **hazardous chemicals per year**.

## CSIR-developed tool simulates flood risks

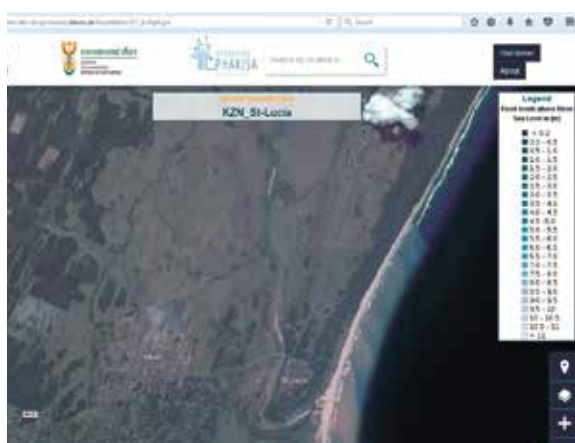
The CSIR has developed an interactive, web-based coastal flood risk viewer to improve disaster risk management and development planning. The tool allows the user to visualise the predicted extent of coastal flooding in a specific area.

Climate change projections indicate that sea levels will rise and the frequency and intensity of ocean storm-related floods will increase.

While the sea level rises constantly and relatively slowly with about 1 to 2 mm per year on South Africa's coasts, storm events hit South African coasts seasonally. These sea storms can have massive wave heights reaching up to 10 m, causing flooding, erosion of the coast lines, as well as destruction of roads, infrastructure and homes. The flood risk tool will enable visualisation of the likely effects of flooding of up to 10 m above sea level.

The tool will be useful for developers, insurance companies, disaster risk managers, as well as home owners. It allows users to zoom into the maps, while adjusting the flood levels with a slider to see which areas are likely to be flooded.

The tool forms part of a CSIR-developed oceans and coasts information management system, which is part of the implementation of the Operation Phakisa: Oceans Economy programme of the Department of Environmental Affairs. The CSIR's coastal flood risk viewer follows international trends and is similar to those implemented in Australia and the USA.



Coastal flood hazard lines in St. Lucia on the KwaZulu-Natal coastline. The coastal flood risk viewer gives a first indication of which areas are at risk of flooding.



Aerial view of harmful algal bloom on the South African West Coast.

## An early-warning tool to help protect against harmful blooms in our oceans

The CSIR has developed a tool to monitor and assess the risk of frequently occurring harmful algal blooms in the South African west and south coasts.

The harmful algal bloom decision support tool is unique to South Africa and utilises scientific insight about local harmful algal bloom conditions and highly optimised earth observation techniques.

Harmful algal blooms can have a detrimental impact on commercial marine concerns, such as rock lobster and aquaculture operations, as well as local marine ecosystems and communities.

The CSIR-developed tool has been received positively by pilot users in government and the marine aquaculture industry.

Early warnings of algal blooms allow conservation managers to investigate and analyse the blooms' potential to be harmful and mitigate the effect. Rapid detection and timely prediction may help to reduce economic losses and prevent human health issues associated with the presence of these blooms.

The tool forms part of a CSIR-developed oceans and coasts information management system that is part of the implementation of the Operation Phakisa: Oceans Economy programme of the Department of Environmental Affairs.



## CONDUCT HIGH-QUALITY RESEARCH TO FOSTER SCIENTIFIC DEVELOPMENT



### RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR THE NATURAL ENVIRONMENT



*CSIR interns Mla Vilakazi and Matome Montja installing the SmartSense technology to monitor 33 water meters and three pressure sensors on the CSIR campus in Pretoria.*

## Real-time water monitoring technology ready for licencing

**The CSIR has developed** a low-cost and energy efficient short-range communications sensor node used for real-time water monitoring. The sensor node, called SmartSense, can be easily fitted to existing water distribution networks to monitor and control system components such as water meters, pressure sensors, flow valves, pumps and pressure reduction valves. SmartSense is a core component of a smart water management system currently under development.

SmartSense collects real-time data and feeds it into a back-end system, where various techniques and tools use the data to ensure wise water use. The technology has been deployed at the CSIR campus in Pretoria to monitor 33 water meters and three pressure sensors.

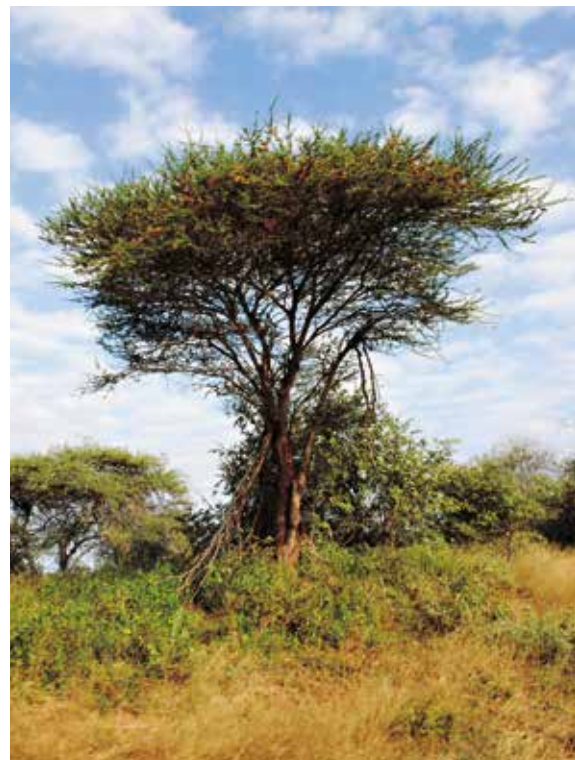
The sensor can add significant value for municipalities and businesses that need to manage their non-revenue water and upgrade their aging water infrastructure at minimal cost. Licences for SmartSense are available from the CSIR.

## Earth observation experts collaborate to improve 23 protected areas worldwide

**CSIR earth observation experts** are making significant contributions to a global consortium that is set to deliver data, models and knowledge that will improve the management of 23 protected areas across the globe, including the Kruger National Park.

The project, called Ecopotential, is funded by the European Union and has 47 international collaborators. The CSIR's role is to assess grass and trees in the Kruger National Park, using earth observation. The resulting information will be made available for planning and improving the management of the Kruger National Park. The knowledge gained from the programme will be shared with the other national parks.

All data, model results and knowledge acquired will be made available on common and open platforms. The outputs from the project will contribute to the Global Earth Observation System of Systems (GEOSS) and be fully interoperable with the GEOSS Common Infrastructure.



*Advances in earth observation data offer new opportunities to monitor the state and changes in ecosystem functions, processes and services. As part of an EU-funded project, the CSIR is assessing changes in grass and trees in the Kruger National Park.*



*The world's first comprehensive evidence-based regional assessment of biodiversity and ecosystem services for Africa was compiled by over 100 leading experts across 45 countries.*

## RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR THE **NATURAL ENVIRONMENT**

### Biodiversity experts warn of decline in biodiversity in Africa

**CSIR biodiversity experts** collaborated with over 100 leading experts worldwide to develop the world's first evidence-based regional assessment. In the African Assessment, the authors warn of a decline in biodiversity and ecosystem services. They also emphasise the need for better integration of indigenous knowledge, as well as greater use of African scenarios in decision-making.

The Africa regional assessment was approved during the sixth session of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), in Colombia, in March 2018.

As the host of the IPBES Technical Support Unit for the African Assessment, the CSIR has been instrumental in the development of the region's reports. The organisation hosted a series of writing workshops for authors to draft the assessment.

The African Assessment report is one of four regional assessments of biodiversity and ecosystem services. The other three assessments cover the Americas, Asia and the Pacific, as well as Europe and Central Asia. The assessment reports point to a decline in biodiversity in every region of the world, thus reducing nature's capacity to contribute to human wellbeing significantly.

According to the summary for policymakers of the African Assessment, biodiversity and nature's capacity to contribute to people are being degraded, decreased and lost due to a number of common pressures, including climate change, overexploitation and the unsustainable use of natural resources and habitat stress, among others.



## CONDUCT HIGH-QUALITY RESEARCH TO FOSTER SCIENTIFIC DEVELOPMENT



Above (left): While households are encouraged to separate their waste, the different bags are often placed into the same truck upon collection. The CSIR has developed a model to assist municipalities in the collection of separated waste, based on the unique context of the municipality. (Right) Waste collection in a suburb in Pretoria.



*Using a common metric, municipalities are able to make more informed decisions on the most appropriate option for implementing separation at source.*

## RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR THE **NATURAL ENVIRONMENT**

### One step closer to separating waste at source

**Municipalities across South Africa** are considering implementing separation of recyclable waste at source. A number of municipalities across South Africa used the first version of a CSIR-developed support tool to assess and compare the costs and benefits of different options for collecting source-separated recyclables, based on each municipality's unique context.

Separation at source refers to the segregation of solid waste at the location where it is generated, such as a household or business.

A second iteration of the tool that will focus on socioeconomic and environmental impacts, thereby delivering more holistic results that empower municipalities in implementing waste separation at source, has been developed.

This second iteration of the model provides for the consideration of the impacts on employment and livelihoods, landfill airspace savings and increased lifespan, among others.

These impacts are monetised to accommodate them within the economic cost-benefit framework of the model. Thus, municipalities are able to assess the trade-offs between financial, socioeconomic and environmental impacts easily, using a common metric. This empowers municipalities to make more informed decisions in identifying the most appropriate option for implementing separation at source.

Preliminary results suggest that the case for separation at source improves significantly when socioeconomic and environmental impacts are considered.



*The CSIR has developed technology for biodegradable plastic. Researchers use biopolymers and agricultural biomass by-products for flexible film packaging such as plastic carrier bags and food wrapping. Technologist Sifiso Skosana inspects a bag produced at the CSIR.*

## Biodegradable plastic products from agricultural waste by-products and biopolymers

**The CSIR has developed** fully biodegradable plastic materials from agricultural waste by-products and biopolymers.

The CSIR-developed biodegradable plastic has mechanical properties similar to conventional plastics, but when they are disposed of in natural environments, such as landfill, compost, marine water or sludge, the bioplastic biodegrades fully within three to six months, without releasing any toxic residues.

In recent years, rapid industrialisation and economic development have led to an increase in plastic production and consumption worldwide. As a result, plastic waste pollution has sky-rocketed and ecosystems are being threatened by it. Adoption of the CSIR-developed bio-based biodegradable technology in the manufacturing of plastic products could help reduce the plastic waste pollution problems associated with petroleum-based plastic materials.

The CSIR develops bio-based-polymers from renewable resources, such as starch; cellulose extracted from agricultural by-products, such as sugarcane bagasse and maize stalks; and biopolymers.

The CSIR bioplastic material has been tested and validated as per international norms and standards for biodegradability and compostability claims.

## CSIR contributes to environmental planning and assessment for desalination plants

**The CSIR has completed** two environmental assessments for desalination facilities in KwaZulu-Natal, on behalf of Umgeni Water. The organisation also assisted the City of Cape Town with site screening for a proposed desalination facility to address the water shortage resulting from the drought.

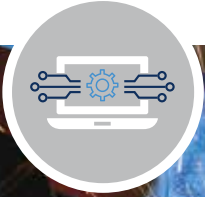
Population growth, urbanisation, deteriorating infrastructure, poor water governance and climate change all exacerbate water scarcity in South Africa. One of the implications of climate change is increased variability in rainfall patterns, making water supply for the country's growing cities increasingly challenging. South Africa still relies heavily on surface water; therefore it is critical to diversify the water supply sources. Both water reuse and sea water desalination have the potential to increase the availability of water.

Desalination is being investigated for all the main coastal cities in South Africa and Namibia as a future source of potable water and a means of improving the resilience of cities to unpredictability in rainfall. The severe drought in the Western Cape, in particular, has highlighted the need for alternative water supply options, including desalination of sea water using reverse osmosis.

Over the past five years, the CSIR has contributed to the planning and development of desalination plants in the Western Cape and KwaZulu-Natal by providing science-based assessments that inform decision-making. These assessments have included site screening studies that assist the proponents in analysing risks associated with sites in an integrated manner, based on a wide range of environmental, social, planning, technical and financial criteria.

Desalination is being investigated for all the **main coastal cities** in South Africa and Namibia.

## CONDUCT HIGH-QUALITY RESEARCH TO FOSTER SCIENTIFIC DEVELOPMENT



Above (left): The CSIR landwards mechanical workshop, where technology demonstrators and prototypes are developed. (Right) The CSIR conducted comprehensive evaluations of options, concept demonstrations and field trials to ensure that the new range of vehicles to patrol South Africa's borders, is fit for purpose.



*The end result is a fleet of commercially available vehicles repurposed as field ambulances, mobile command and control stations, logistical modules and troop carriers with novel alterations.*

### RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR **DEFENCE AND SECURITY**

## Best for border patrol: Supporting SANDF acquisition of optimal vehicle fleet

In late 2017, the South African National Defence Force (SANDF) launched a new range of vehicles to patrol South Africa's borders. The CSIR supported this acquisition project through a comprehensive evaluation of options, concept demonstrations and field trials, working with original manufacturers on technology requirements and design adaptations to ensure that the vehicles are fit for purpose.

The end result is a fleet of commercially available vehicles repurposed as field ambulances, mobile command and control stations, logistical modules and troop carriers with novel alterations that include roll-over safety frames; on-board space design to match the intended use;

added water and fuel reserves; as well as limited recovery capability and power management systems. The SANDF required that the vehicles be easy and inexpensive to maintain and robust, yet not heavy and harmful to natural ecosystems in patrol areas.

All vehicle variants were qualified to ensure that vehicle warranties are not affected. The design data packs were presented to the SANDF for industrialisation and manufacturing in the local industry.

By the end of 2018, all patrol companies within the force will have received vehicles to support efficient national border safeguarding.





Above: Showcasing the airframe of the new long-endurance, modular unmanned aerial vehicle inside the CSIR medium-speed wind tunnel are (from left) CSIR senior engineer Duncan Higgs, engineer Neall Moore, principal engineer John Monk, laboratory technician Kgaugelo Mabeko, senior engineer Jeanne Marie Roux and research and development contract manager John Morgan.



Above: The engine reliability test rig was developed to support the development of unmanned aerial vehicles (UAVs). The rig has been used to test the functioning of the new UAV engine systems and to optimise the engine cowling ducting in the wind tunnel. During tests, many engine and environmental parameters are logged and summarised data or emergency shut-down data are transmitted to the test personnel involved.

## RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR **DEFENCE AND SECURITY**

### New unmanned aerial vehicle offers longer endurance and modular design

**The CSIR has developed** a long-endurance, modular unmanned aerial vehicle (UAV) that addresses challenges relating to extended flight time and quiet operation.

The development is a refinement of the original modular airframe design, first launched in 2009. The latest version has different power options and a wing span of over six metres that enables longer flights. Few, if any, commercial UAVs are capable of matching the latest UAV in endurance and payload weight.

Two variants of the airframe are being developed. The first is powered by two fuel-injected, internal-combustion engines that provide up to eight hours of endurance for through-the-night surveillance, for example; and an electric version, powered by two

brushless motors providing up to two hours' endurance with reduced noise. Integration of hydrogen fuel cell technology for quiet and long endurance is being investigated.

Used primarily as a research platform, the airframe can assist in testing novel technology components and subsystems. The frame is manufactured from moulded composites and has a central hard point on the wing between the two fuselages, where a wide variety of payload pods can be mounted. This, in addition to its modularity, makes it ideal to test a range of applications from a single platform design. For reconnaissance purposes, the longer wings and fuselages ensure steadier footage than what is the norm.



## CONDUCT HIGH-QUALITY RESEARCH TO FOSTER SCIENTIFIC DEVELOPMENT



RESEARCH, DEVELOPMENT  
AND IMPLEMENTATION FOR  
**DEFENCE AND SECURITY**

### A solution for reliable wireless underwater communication

**The CSIR is developing** a high-bandwidth underwater data communications technology to enable unmanned underwater vehicles and sensors to communicate with surface vessels wirelessly at high bit rates.

Currently, unmanned underwater vehicles have to be recovered manually after a mission, return to the mother ship, or be connected via a communication cable to recover the recorded data. This process of data retrieval can be a lengthy, expensive and sometimes hazardous one, as was observed during international searches, such as that for the missing MH370 airplane. Using a cable limits manoeuvrability and prevents the underwater vehicle from going into confined spaces or moving freely for extended distances from the mother ship without running the risk of cable damage.

A real-time wireless solution would mean that unmanned underwater vehicles can be employed more effectively, as data can be monitored continuously, to steer them towards the desired area of interest. Being able to transmit data in real time implies a high data transmission rate, which, in turn, requires a broader system bandwidth.

The CSIR's pioneering work in the development of ultra-wideband ultrasonic transducer technology has equipped it to develop technologies to overcome these challenges. Through funding from Armscor, researchers developed a prototype that has been tested in the CSIR underwater test facility. It has a high bit rate of 200 kbps with low bit-error exceeding current commercial system specifications. The technology can be used for broadband acoustic underwater communication systems with high data rates and reliable near real-time data transmission. It can be applied in areas such as the military, oceanographic research, underwater mining, as well as the oil and gas industry.

### Multistatic radar proves its fine eye for micro drone detection

**Field trials with a multistatic radar technology facility** proved its ability to detect and localise micro-drones at ranges of up to a few kilometres. The system was developed by the CSIR, under the Swiss African Multistatic Radar Initiative, for delivery to armasuisse Science and Technology of Switzerland. It will be used in research and investigations into radar-based applications, such as protection against drone attacks.

The system is designed to look throughout the entire surveillance area to enable rapid warnings of potential drones and fine tracking of their movements.

The multistatic radar utilises multiple radar receivers, physically separated from the radar transmitter, to observe the area under surveillance from different perspectives. The advantage of this is that it eliminates any potential 'blind' directions of movement of the drones, a challenge encountered in mono-static radars used traditionally.

The multistatic radar is an active area of research internationally, with many unanswered questions and a need for published data on the bi-static radar returns from the environment (clutter) and drones.

A system with this level of sensitivity also detects radar returns from numerous other small moving objects like birds, animals and humans in the area. Examples of all of these were also recorded during recent experiments. The ability of this system to stare continuously at all targets will enable algorithms to analyse fine Doppler signatures to distinguish between drones and birds.



*The multistatic radar technology deployed at the Rietvlei Nature Reserve in Pretoria for field tests. The system can detect and localise micro-drones at ranges of up to a few kilometres. It is designed to look throughout the entire surveillance area to enable rapid warnings of potential drones and fine tracking of their movements.*



The ZACUBE-2 satellite is a 3U structure (30 x 10 x 10 cm) with the K-line camera occupying 1U (10 x 10 x 10 cm) of the volume. The term 1U is used to define one rack unit of height. The K-line camera has two channels, namely the K-line sensitive channel and a background model channel, which are in close optical wavelength proximity with each other. This ensures that the images from the two channels can be registered and subtracted with very little false-alarm content remaining, while maximising the detection of fire pixels.



## RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR DEFENCE AND SECURITY

### CSIR provides optical expertise for second South African nanosatellite

The CSIR has continued its contribution to South Africa's nanosatellite programme by developing the optical payload on the ZACUBE-2 to be launched into orbit in the second half of 2018.

The K-line camera was designed by the CSIR to detect forest fires from space by detecting traces of potassium (the element K on the periodic table of elements) emitted and radiated from burning vegetation.

The development of the satellite is an international collaborative effort supported by agreements between the UK Space Agency, the South African National Space Agency and the Department of Science and Technology (DST). The local effort, which is funded by the DST, includes the CSIR, the Cape Peninsula University of Technology – responsible for integration of the K-line camera on the satellite bus – and private company Stone3 for the software-defined radio module for communication with ground stations. The satellite mechanical structure of 30 x 10 x 10 cm, power supply modules and the on-board computer are provided by ClydeSpace UK.

The eventual goal is to establish a constellation of low-cost satellites that will produce data with high spatial and temporal resolution for a large variety of applications, including marine monitoring.

The ZACUBE-2 K-line optical payload features a medium-resolution, near-infrared, potassium-sensing imager. Data from the camera will be fed into the CSIR-developed Advanced Fire Information System that provides near real-time warnings and updates on fires to clients around the globe. The envisaged nanosatellite constellation will improve the revisit time as the size of the constellation increases and with improved spatial resolution, as a result of refinements in commercial camera detector technology.

The K-line concept makes use of commercial, off-the-shelf components, such as camera modules, lenses and filters that are space-qualified through processes and procedures developed at the CSIR.

## CONDUCT HIGH-QUALITY RESEARCH TO FOSTER SCIENTIFIC DEVELOPMENT



Above (left): The CSIR-developed electronic warfare evaluation pod was tested on the Hawk aircraft for compatibility and safe operation. (Right) The CSIR-developed electronic warfare evaluation pod underwent tests in the medium-speed wind tunnel facility at the CSIR in Pretoria.

*The pod is attractive to many air forces worldwide as a modern platform for training, test and evaluation of radar and electronic warfare applications.*

## RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR DEFENCE AND SECURITY

### Airborne electronics laboratory proves compatible with the Hawk aircraft vehicle fleet

A CSIR-developed electronic warfare evaluation pod has proven its compatibility with and safe operation on the Hawk aircraft.

During its first series of test flights on a South African Air Force Hawk, the pod, called Inundu, also operated successfully with a newly installed ram air turbine that allows it to take to the air without drawing on the power supply of the host aircraft. The ram air turbine on Inundu is a small device with an electrical generator that generates power by utilising the airstream of the aircraft in flight.

Previous pod flights were conducted on a Hawker Hunter and two Cheetah aircraft. With its successful integration

on the widely used Hawk, the pod becomes attractive to many more air forces worldwide as a modern platform for training, test and evaluation of radar and electronic warfare applications.

The functionality of the pod's various systems, including its electronic warfare payload, was tested rigorously in various operational flight profiles, including simulating anti-ship missile detection at high speeds and very low altitudes. Prior to the flight, the ram air turbine was tested at the CSIR's turbine test facility, after which it underwent wind tunnel testing.

The **electronic warfare evaluation pod**, called Inundu, operated with a newly installed **ram air turbine** that allows it to take to the air **without drawing** on the power supply of the **host aircraft**.

## Fifth-generation digital radio frequency memory technology developed

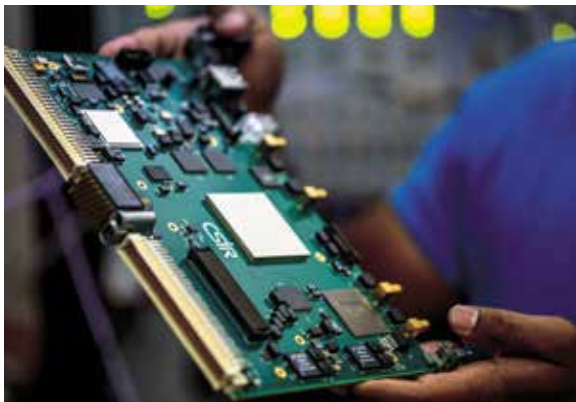
**The CSIR has developed** the fifth generation of its digital radio frequency memory (DRFM) technology to enable the rapid development and implementation of new electronic warfare attack techniques.

DRFM is an electronic method of capturing and retransmitting radio frequency signals digitally. It defeats the assumption of radar systems by shifting wave properties artificially and sending them back to the radar.

This new countermeasure technology is world-leading in radar and electronic warfare, where high-bandwidth, high-fidelity and multi-scatter returns, with low spurious hardware-in-the-loop simulators, are required.

The CSIR has expertise in the development of digital radio frequency memory, acquired over a period of more than 15 years, and has supplied the technology to local and international clients on six continents.

The technology is a key building block in countermeasure simulators. Received radar signals can be manipulated, Doppler-shifted and retransmitted to create simulated targets of very high fidelity. When designing new radar systems, these simulations are used to test and evaluate the system from early in the design process. Therefore, expensive operational evaluation, such as flight trials for airborne radars, are augmented by tests in a laboratory environment, reducing overall development cost and risks significantly.



*A component used in the CSIR's fifth generation digital radio frequency memory technology.*



*The synthetic aperture radar technology was deployed and tested in 2017 on an Atlas Angel aircraft in Pretoria.*

## Local synthetic aperture radar facility developed to ensure direct access to remote sensing data

**The CSIR has developed** an airborne synthetic aperture radar (SAR) facility. This type of radar is used for remote sensing to generate imagery akin to airborne photography, but with unique characteristics. The imagery provides information for a wide variety of applications, such as precision agriculture, disaster monitoring, urban planning, coastal monitoring and mine stockpile monitoring.

Prior to this development, South Africa, like many other countries, relied on international suppliers for the data used in local remote sensing products and had no direct access to an airborne or spaceborne SAR sensor. The sensor will support further research into SAR applications and their potential value to the economy.

The reconfigurable facility includes advanced modes, like the generation of digital elevation maps, as well as multipolarisation and/or multifrequency sensing. Thus, it can be configured to support a wide range of applications optimally.

The project is funded by the Department of Science and Technology.



## CONDUCT HIGH-QUALITY RESEARCH TO FOSTER SCIENTIFIC DEVELOPMENT



RESEARCH, DEVELOPMENT  
AND IMPLEMENTATION FOR  
**DEFENCE AND SECURITY**

### A hardcopy document integrity verification to help curb fraud

**The CSIR has developed** a hardcopy document integrity verification technology that can help to validate the integrity of a hardcopy document and pinpoint exactly where changes have been made. The technology enables a user to see the section that has been potentially modified, making it easier to launch specific investigations into the affected details.

Many countries, including South Africa, face incidences of fraudulent production of hardcopy documents, such as identity documents or academic records. Perpetrators use this forged paperwork, such as a copy of an identity record, bank statement or other forms of records, when seeking credit from institutions such as banks. The CSIR-developed software verifies the integrity of a hardcopy document. The solution uses optical character recognition to recognise important text, such as identity numbers or subject grades that should be verified.

The system implementation has two parts. During the generation process, a PDF document with validating bar codes is created. It is then printed and issued to a person, electronically or physically. A document template is used to define the document content. The barcodes contain hashed information about the content of the document, as well as a digital signature. In the second process, the integrity of an issued document is validated to make sure that it has not been altered in any way.

In essence, a person submits a document for validation, either electronically or physically. Hardcopy documents are scanned, then quick response codes are identified and decoded.

### Finding solutions for the biometric recognition of minors

**Governments have images** of the faces of adults who are linked to particular identities, as well as their fingerprints, which are unique. However, this information does not exist for children because their facial appearance is expected to change significantly from birth to adulthood.

No technology had been able to acquire biometric information from infants and match it to the same individuals during growth and adulthood successfully, until now. This left children vulnerable to exploitation through identity theft and trafficking, while also preventing the full use of smart health care management systems for children.

CSIR research aimed to determine which biometrics – fingerprints, ear shape or iris patterns – are best suited for biometric recognition of children. In assessing fingerprints for this purpose, researchers have developed a biometric recognition system that has the ability to authenticate the identities of minors from birth until adulthood. A prototype device that automatically recognises the fingerprints of infants as young as six weeks old has been produced. The prototype relies on software that processes and enhances digital photographs of fingers taken using any device capable of taking true colour digital images at a very high resolution. The software processes the photo of the finger to produce images that resemble those taken using conventional touch scanners. CSIR biometrics experts continue to examine the other biometrics in order to have multiple modalities to identify children.



*The CSIR has developed a biometric recognition system to capture clear fingerprints of infants.*



Above and left: CSIR intern Siyasanga May inspecting the wiring of the photovoltaic testing facility at the CSIR. The CSIR is developing wiring standards for photovoltaic facilities.



## RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR ENERGY

### Crafting safety standards for South Africans using solar photovoltaic energy

The CSIR is writing new standards for the safe and cost-effective installation of solar photovoltaic (PV) panels. The new standards will help to protect South African users of solar PV panels from the dangers of irregular and unregulated use.

While home owners and businesses are increasingly opting to supplement their power needs with solar energy, currently, South Africa has no regulations governing the installation of these panels, their wiring or how their batteries are stored. This creates potentially dangerous situations in households and businesses using the panels.

The outcome of the project, expected by the end of 2018, will be an installation standard and training manual for solar PV panels that generate less than 1 MW.

It will help to ensure the safety of consumers, installers and grid operators under normal and abnormal conditions. It will also help to keep installation costs as low as possible and set up these solar systems to be able to support the electricity grid when supply is low.

The CSIR is working with the South Africa PV Industry Association, Eskom and Green Cape. The project team is also working with the South African Bureau of Standards to ensure that the regulations are in line with South African national standards.

The CSIR is writing **new standards** for the **safe** and **cost-effective installation** of **solar photovoltaic panels**.

## CONDUCT HIGH-QUALITY RESEARCH TO FOSTER SCIENTIFIC DEVELOPMENT



RESEARCH, DEVELOPMENT AND  
IMPLEMENTATION FOR **ENERGY**

### CSIR conducts detailed energy audit for City of Johannesburg

The CSIR has completed a baseline audit that looks at how the City of Johannesburg uses its resources and how it can optimise these to become a green city. Efficient use of resources minimises the negative environmental impacts that arise from poor resource management, particularly energy and water.

Researchers looked at how the City of Johannesburg currently manages energy, water and waste at the Metro Centre complex. A census of all the lighting and electrical appliances was conducted, together with a review of waste management practices and water outlets. The information gathered from the assessment will inform the Department of Energy's business planning in its future programmes with municipalities.

Although some measures, such as fitting energy-efficient lights and appliances; using water-wise ablution facilities; as well as separating waste at source in office buildings have been adopted, researchers found that by far the greatest source of energy wastage was the use of hundreds of individual resistance heaters in offices. Recommendations include replacing the energy-inefficient resistance heaters with heat pumps; implementing an online system to monitor energy consumption trends of municipal buildings; fitting controls on air conditioners to limit their operating hours and temperature settings; as well as selecting a flagship building to be retrofitted with a wide spectrum of energy efficiency and renewable energy measures as a pilot facility.



*Fruit and vegetable waste that goes to landfill can be used to produce bioenergy.*

### CSIR study finds that viable bioenergy facility could be established in Tshwane

The CSIR has completed a feasibility study to determine the economic and environmental viability of a bioenergy facility for the City of Tshwane. The Tshwane Economic Development Agency wants to use an anaerobic digester that will use waste from the Tshwane Fresh Produce Market, with supplementation from the Daspoort wastewater treatment work or garden waste, to produce biomethane (fuel gas).

Anaerobic digestion is the breakdown of organic matter in an oxygen-free environment. The process is facilitated by microbes, mainly comprising bacteria and archaea. It is a fairly simple and natural way of converting a variety of complex waste into fuel gas.

Currently, waste goes to landfill, which costs the Tshwane Fresh Produce Market R10 million annually. If the city implements the project, it will divert waste from landfill, reduce the emission of methane into the air and promote sustainable mobility in the city. The gas will be supplied to Tshwane Rapid Transit to power the compressed natural gas buses that operate from the nearby Belle Ombre bus depot.

In addition to the biomethane, carbon dioxide and manure will also be produced. The carbon dioxide could be sold to a supplier such as Afrox, which is the main supplier to industry.

The CSIR recommends that the Tshwane Economic Development Agency begins a pilot research phase to identify and resolve any feedstock and operational problems that may occur, prior to full-scale establishment.



CSIR technology is instrumental in overcoming challenges in the use of waste from tyres in bitumen. To make a bitumen rubber binder (above), pure rubber crumbs (right) are mixed with bitumen.



## RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR THE BUILT ENVIRONMENT

### Overcoming the challenges of using tyre waste as an additive in bitumen

A **CSIR invention** is set to assist asphalt manufacturers overcome challenges in the use of waste from tyres as an additive in bitumen.

Bitumen acts as a glue or binder that keeps the aggregate stones together for asphalt road pavements. Due to the increase in traffic loads and loading times in South Africa, there is a corresponding requirement for an improvement in bitumen performance, which can be attained by modifying the bitumen using various additives.

This presented the industry with an opportunity to utilise waste products, such as used rubber from tyres, as bitumen additives, thus adding an environmental aspect to the modification process. However, a drawback to the waste tyre technology is that the product can only be applied during a very narrow window period under specified conditions of good weather and temperatures. This was problematic, as mechanical breakdowns and poor weather conditions resulted in the narrow window period being surpassed, beyond which, the product

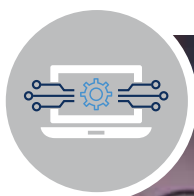
was considered out of specification, technically referred to as 'over-digested'.

The CSIR invention provides a new product evaluation method and a new manufacturing process. It also presents a stiffness inducing reactive polymer that turns the over-digested material into a superior product that outperforms the initial product. This enhanced performance has been proven by testing laboratory road specimens against those of the standard products. The technology was validated by the biggest asphalt producer in the country, Much Asphalt, through laboratory trials. Field trials are ongoing.

The potential benefits of the invention for asphalt manufacturers include the increased reuse of a waste material, ease of handling, ease of blending and energy saving during asphalt processing. The country will benefit significantly from the increase in the recycling of waste material, such as waste tyres for better performing roads.



## CONDUCT HIGH-QUALITY RESEARCH TO FOSTER SCIENTIFIC DEVELOPMENT



Above: The CSIR team of (front, from left) CSIR engineers Keletso Molefe, Mhlali Tapi and Kshir Ramruthan. (Back, from left) CSIR principal engineer Tobias Van Reenen, engineer Angus Steele and principal engineer Danny Naicker. (Right) The CSIR-developed electronic device that monitors indoor carbon dioxide levels and generates an alarm when corrective action is needed.

*The prevalence of tuberculosis in South Africa is among the highest in the world. The CSIR has addressed this public health challenge by developing a real-time airborne infection risk monitor and alarm.*

### RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR THE **BUILT ENVIRONMENT**

## New smart sensor monitors indoor airborne infection risk in real time

**The CSIR has developed** novel technology for a tool to monitor and manage real-time airborne infection control. Together with its online backend, it offers a new platform for indoor environmental quality research. It brings an increased awareness of transmission risks in congregate spaces to South African health care and could help drive behavioural changes that can reduce the rates of airborne transmission and the cost to health care.

The prevalence of tuberculosis (TB) in South Africa is among the highest in the world and a major contributor to morbidity and mortality. Of particular concern is the public health threat posed by increasing rates of drug-resistant infection.

TB spreads from person to person through the air. Exposure risk is a function of exposure duration and indoor air quality, which, in turn, is dependent on the building ventilation rate and occupancy.

High risk settings are typically found in congregate social facilities, such as hospital and clinic waiting rooms and correctional centres. The CSIR has addressed this public health challenge by developing a real-time airborne infection risk monitor and alarm. The novelty of the technology lies in the use of a proxy to determine airborne transmission risks in conjunction with applied limits of disease transmission models.

The technology has been developed with the support of the USAID TB South Africa Project and the Centers for Disease Control and Prevention. It is being piloted in public hospitals and peri-urban homes in South Africa, with key partners such as the United States-based National Institute of Communicable Diseases and University Research Council. Its validation and successful roll-out in social infrastructure, and specifically in the health care sector, could contribute to the containment of tuberculosis transmission and other airborne diseases.



Above: The locomotive condition monitoring system in a ruggedised enclosure with the roof-mounted antenna. (Right) The system's integrated battery backup system.

## RESEARCH, DEVELOPMENT AND IMPLEMENTATION FOR THE **BUILT ENVIRONMENT**

### New system to help Transnet monitor the condition of its locomotives

**CSIR and Transnet engineers** are developing the first 13 units of a system that monitors the condition of Transnet's locomotives, following the earlier successful deployment of two prototypes. The system will enable Transnet to implement predictive maintenance and detect rail infrastructure defects.

Transnet Freight Rail requires the ability to track and trace its fleet of locomotives and determine its condition. Currently, the staff offload data from some of the systems on board the locomotives manually.

The newly developed locomotive condition monitoring system provides an alternative, automated solution, which gathers sensor and fault data through a real-time mechanism, which is then sent to the Transnet servers automatically for evaluation. The system has been

designed and tested on all applicable rail standards. It has a unique communications module that integrates GPRS/3G, WiFi, satellite and ultra-high frequency radio into a single module, allowing communication even in adverse conditions. An integrated battery back-up system allows the device to function for at least one hour in the event of a power failure.

The platform has been designed to allow easy expansion of both hardware and software capabilities and there are plans to implement on-board real-time data analysis. Through machine learning and computer vision algorithms, the system is used to implement predictive maintenance, as well as detect rail infrastructure defects.

Transnet aims to deploy the locomotive condition monitoring systems on all locomotives in its fleet.

Through **machine learning** and **computer vision algorithms**, the system is used to **implement predictive maintenance**, as well as **detect rail infrastructure defects**.

## CONDUCT HIGH-QUALITY RESEARCH TO FOSTER SCIENTIFIC DEVELOPMENT



RESEARCH, DEVELOPMENT AND  
IMPLEMENTATION FOR THE  
**BUILT ENVIRONMENT**

### Creating sustainable human settlements and reducing the impact of disasters on vulnerable communities

**The CSIR is leading the development** of two sets of complementing guidelines that address some of the challenges faced by South African settlements. *The Green Book* provides information on how existing and future South African settlements can adapt to deal with the risks associated with climatic changes. The second guideline, an updated version of *The Red Book*, provides planning and design guidance in support of the creation of sustainable human settlements.

The CSIR is working with the National Disaster Management Centre, the African Institute for Inclusive Growth, universities, government departments and other peer groups to give clear recommendations on how developing and developed urban areas in South Africa should adapt for projected climate change and its impacts to safeguard vulnerable communities. *The Green Book* addresses a wide range of spatial planning and land use management principles relevant to climate change adaptation.

The updated version of *The Red Book*, known as *The Neighbourhood Planning and Design Guide*, developed for the Department of Human Settlements, defines the desired qualities of South African settlements. It provides built environment practitioners with practical planning and design guidance in support of the development of more liveable neighbourhoods. The guide encourages integrated settlement planning, promotes sound urban design principles and assists in improving the efficiency of engineering services and infrastructure.

### Sensor technologies to benefit trucking industry once commercialised

**Two technology demonstrators** developed by CSIR vehicle dynamics experts are set to transform local and international freight and logistics industries. They both address important sensing challenges for articulated trucks, helping to pave the way for new safety and automation systems.

An articulated truck is a large vehicle made up of two separate sections, a tractor and a trailer, connected by a pivoted bar. The first of the two innovations to benefit such trucks is a camera-based articulation angle sensor, which solves the problem of accurate, flexible, robust and independent measurement of the articulation angle between a tractor and trailer. The sensor has been developed for combinations, including tractor semi-trailers and rigid truck and trailer combinations, but the concept can be applied to any type of articulated vehicle.

The second is a stereo camera-based sensor for measuring trailer off-tracking, also called 'cut-in', in an articulated heavy goods vehicle combination. Off-tracking refers to the different paths that the front and rear wheels of such vehicles take when cornering.

The rear or trailer wheels will take a shorter path around the curve, corner or turn. It affects the manoeuvrability and accessibility of heavy goods vehicles and its measurement is crucial for modern trailer steering systems, which minimise this off-tracking. Previous methods of estimating off-tracking have been limited to on-highway use and have required a number of sensors and assumptions to estimate off-tracking in an impractical manner. The current solution is independent of road conditions and does not require any other sensors.

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Two **technology demonstrators** address important **sensing challenges** for articulated trucks, helping to pave the way for new **safety and automation systems**.



Above: Wind turbines in South Africa's Eastern Cape province. Right: CSIR principal engineer Crescent Mushwana (left), and Dominic Milazi, who heads CSIR research into energy policy, discuss the development of best-practice guidelines for energy regulators in the Southern African Development Community.



## PARTNERING FOR AFRICAN RESEARCH, DEVELOPMENT AND IMPLEMENTATION

### African regional collaboration on energy matters

**CSIR energy researchers** are collaborating with their counterparts in Africa on a range of energy-related projects.

The CSIR and the Botswana Institute of Technology Research and Innovation are jointly assessing the value of renewable energy in Botswana's energy system. The collaboration between the two countries follows earlier similar work conducted by the CSIR for South Africa, and the work on the draft integrated resource plan in 2016. The current collaboration project paves the way for future research work around integrated resource planning and grid studies for Botswana.

CSIR researchers, in collaboration with the International Renewable Energy Agency, are also developing best-

practice guidelines for energy regulators to assist them in their oversight role of national power planning entities in the Southern African Development Community region.

The guidelines pay close attention to methodologies that support the development of renewable generation resources in planning processes. The project examines the costs associated with integrated resource planning, facilitates stakeholder workshops with relevant decision-makers and provides guidance on how to implement sound governance structures.

Researchers have provided planning oversight recommendations and customised guidelines to build capacity in Namibia and Zimbabwe.

CSIR energy researchers are **collaborating** with their **counterparts in Africa** on a range of **energy-related projects**.



## CONDUCT HIGH-QUALITY RESEARCH TO FOSTER SCIENTIFIC DEVELOPMENT



Above: Stampede, a next-generation supercomputer from the Texas Advanced Computing Center. (Right) CSIR staff of the Centre for High Performance Computing visiting Ghana are Bryan Johnston, Zintle Sanda and Israel Tshililo.



*The CHPC is sourcing and repurposing high-performance computing systems that are out of production elsewhere in the world and channelling them to African partner countries.*

### PARTNERING FOR AFRICAN RESEARCH, DEVELOPMENT AND IMPLEMENTATION

## Equipping African SKA partner countries with high-performance computing capabilities

**The Centre for High Performance Computing (CHPC)** transferred skills and capabilities in high-performance computing to African countries that will be hosting antennas as part of the Square Kilometre Array (SKA).

The SKA is an international project to build the world's largest radio telescope, made up of a collection of various types of antennas, spread over long distances.

By sourcing and repurposing high-performance computing systems that are out of production elsewhere in the world and channelling them to African partner countries, the CHPC is enabling host nations to process the enormous datasets that will be received via the antennas.

The eight African partner countries that make up the Very Long Baseline Interferometry network are Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique, Namibia and Zambia. The project is funded by the Department of International Relations and Cooperation through the African Renaissance Fund.

The countries have received high-performance computing systems from three supercomputers, namely Ranger from the Texas Advanced Computing Center in the United States of America; the Cambridge Supercomputer from the University of Cambridge in the United Kingdom and Tsesebe from the CSIR in South Africa. Additionally, in early 2018, the CHPC began distributing Stampede, a next-generation supercomputer also from the Texas Advanced Computing Center, which will expose the partner countries to different types of high-performance computing technologies. The CHPC ran a series of training sessions and workshops to help technicians and researchers of the partner countries to use the technology received efficiently. The centre also partnered with the Development in Africa with Radio Astronomy project and conducted Linux/Python programming training.

The CHPC is one of the three pillars of South Africa's National Cyber Infrastructure Initiative System and one of its objectives is to position South Africa to take part in, host and lead large-scale global research and science projects.

## Helping to bridge the road research and knowledge gap in Africa and Asia

The CSIR is leading the establishment of road research centres in various countries in Africa and Asia to help close the research and knowledge gap on roads and road construction.

The Research for Community Partnership (ReCAP), a programme funded by the UK government, through the Department for International Development, identified road research capacity, and addressing constraints associated with rural access in these countries, as priorities.

The CSIR was commissioned to help achieve the aim of promoting safe and sustainable rural access in Africa and Asia through research and knowledge sharing among participating countries and the wider community.

The ReCAP programme has two components, namely the Africa Community Access Partnership (AfCAP) and the Asia Community Access Partnership (AsCAP). The CSIR was able to assist Malawi and Tanzania through AfCAP. Furthermore, through its knowledge and track record in road research, the CSIR also assisted Namibia with the establishment of research capacity within the Road Authority of Namibia, independently of AfCAP. In Asia, the CSIR has developed business plans for the establishment of road research centres in Bangladesh, Myanmar and Nepal, through AsCAP.



The CSIR assisted Namibia with its road research capacity.



## Assessing the environmental and social impact of a wind farm in Ghana

The CSIR has conducted a detailed environmental assessment for a proposed wind energy facility in the Greater Accra Region of Ghana. The study was done in collaboration with a local Ghanaian company on behalf of the Volta River Authority, Ghana's main power generation, distribution and transmission utility.

In accordance with the requirements of the environmental assessment regulations of Ghana, the construction of wind energy facilities exceeding an installed capacity of 15 MW falls into the category for which a full scoping, environmental and social impact assessment study is required. The assessment takes a holistic view of the potential impacts of the proposed wind farm on the biophysical, social and economic context for the project. Based on the findings of the study, the Ghana Environmental Protection Agency decides whether or not the project should go ahead.

The Volta River Authority has set a 5- to 10-year renewable energy generation capacity target for Ghana. Part of the plan is the development of a 152 MW wind energy facility in the Greater Accra Region. If approved, the facility will be the first wind farm of this scale in the country.

The study considered a wide range of specialist areas, including birds, cultural heritage, wetlands, aviation and noise impacts of the turbines on nearby communities. The team used the studies to determine the impacts that would likely occur as a result of the project, as well as recommended mitigation measures on how to avoid or minimise these impacts.

## CONDUCT HIGH-QUALITY RESEARCH TO FOSTER SCIENTIFIC DEVELOPMENT



Above (right): The SANBio team (back from left) Kelebohile Sedieane, Charity Maloma, Markku Pekonen, Nokwanda Ncube, (front from left) Dr Sechaba Bareetseng, Zvikomborero Tangawamira and Marja-Reetta Paaso. The network is managed by Dr Ereck Chakauya. Nontobeko Zulu was not present for the picture.

*The project is one of 13 intercountry collaborative projects on health and nutrition in the Southern African Development Community region.*

### PARTNERING FOR AFRICAN RESEARCH, DEVELOPMENT AND IMPLEMENTATION

## Clinical trials for antiretroviral drug-dosing tool underway

**Researchers from Africa** have jointly developed the GeneDose biomedical tool to help HIV-positive patients take safe doses of the common antiretroviral (ARV) drug, Efavirenz.

The project is one of 13 intercountry collaborative projects on health and nutrition in the Southern African Development Community region, supported by the Southern Africa Network for Biosciences (SANBio) under the New Partnership for Africa's Development (NEPAD), the technical body of the African Union, with funding from the BioFISA II Programme (a Finnish – Southern African Partnership Programme to support the SANBio network).

GeneDose uses genetic tests to identify and reduce the harmful side effects of antiretrovirals and makes personalised medicine a reality in Africa. It is the result of a Southern African collaboration between researchers at the African Institute of Biomedical Science and Technology

(AiBST) and the University of Cape Town. The team started conducting clinical trials in Harare, Zimbabwe, at the end of February 2018, where they have been testing the effectiveness of the GeneDose tool.

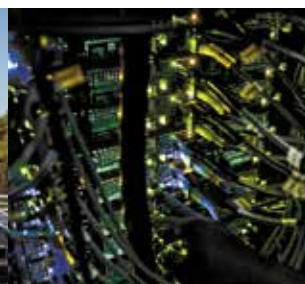
During the clinical trials, the GeneDose system was used to determine personalised ARV doses and compare side effects with those in patients who have been treated with a standard dose.

ARV treatment for HIV can have variable side effects for different patients and the difference lies in a few important genes. There are many other drugs that are dependent on the genetics of the individual and the AiBST team wants to develop similar tests for these other drugs.

The SANBio network, established in 2005, under NEPAD, comprises 13 Southern Africa Development Community member states. The regional hub is at the CSIR, in South Africa.

**ARV treatment** for HIV can have **variable side effects** for different patients and the **difference** lies in a few **important genes**.





## INFRASTRUCTURE RENEWAL AND DEVELOPMENT



The role of infrastructure in innovating and expanding the knowledge base, as well as supporting South African industry in the quest to become more competitive, is undeniable. For the CSIR to undertake the research and development it is mandated to, it needs modern and appropriate facilities and scientific infrastructure.

As part of focused efforts to support industry development needs, in the past five years – with support from government – the CSIR has embarked on the development of research and development facilities that provide capability for industrial innovation initiatives, such as prototyping, upscaling, pilot manufacture and testing that allow science to be translated into market-ready products. Government support manifested through the Industry Innovation Partnership of the Department of Science and Technology, which is specifically aimed at improving industry competitiveness.



## INFRASTRUCTURE

### RENEWAL AND DEVELOPMENT



## Growing South Africa's photonics innovation landscape: The photonics prototyping facility

**Two seed projects** got underway at a new CSIR-based facility that acts as a photonics technology accelerator. The photonics prototyping facility will help bolster South Africa's ability to assist in creating a vibrant photonics industry. Currently, South Africa has a small market share of the global photonics industry.

Drawing on CSIR photonics expertise, one of the two technologies under development focuses on extracting internal (sub-dermal) and external (surface) fingerprints, using optical coherence tomography. The technology, which also offers a non-contact approach, can potentially be used in banks, mortuaries and forensic service facilities.

The second project involves the development of a laser range-finder to be included in a fully automated bow-sight unit for the archery industry. The automation function of the bow-sight unit offers a time-reduction and ease of adjustment for the archer. The facility affords its clients access to first-class infrastructure, technical skills, business skills and a network of stakeholder contacts. In the past year, the facility attracted 18 applications and has four projects in the pipeline.

To further expand the photonics innovation pipeline, the facility is promoting the benefits of access to its expertise and specialised equipment at conferences, exhibits and other events.



*The Photonics Prototyping Facility hosts state-of-the-art electronic and optical equipment in three 1 000 clean rooms. The clean room above is one of three which can be used by technology concept providers for product development.*

## New facility launched to address biomass waste challenges, boost industry competitiveness

**A R37.5 million biorefinery industry development facility** has been established at the CSIR in Durban to help ensure that maximum value is extracted from biomass waste.

The facility, launched by the Minister of Science and Technology, Ms Mmamoloko Kubayi-Ngubane, resulted from the Department of Science and Technology's Industry Innovation Partnership Fund and will support innovation in a range of biomass-based industries, including forestry and agro-processing, among others.

The initial focus of the facility is the forestry sector, which is under strain globally. Biorefinery in South Africa's pulp and paper industry is practiced on a very limited scale. Wood, pulp and paper waste ends up in landfill sites or is burnt, stockpiled or even pumped out to sea. The potential to extract value from it is not realised, resulting in lost opportunities for the country's economy. Furthermore, the country is running out of landfill space.

High-value speciality chemicals can be extracted from sawmill and dust shavings, while mill sludge can be converted into nanocrystalline cellulose, biopolymers and biogas.

The facility holds potential for other sectors and waste streams, such as exploring the use of chicken feathers in high-value products. Small quantities of waste chicken feathers are processed into feed for livestock, but the majority of the waste is traditionally disposed of by burning or landfilling. However, this facility is already demonstrating that keratin can be extracted successfully from the poultry by-product and used in high-value applications, such as nanostructured materials for biomedical applications.

The new facility is accessible to large industry and small, medium and micro enterprises for research and development, analytical and pilot scale testing, evaluation, processing and development of technologies for processing biomass.





*The CSIR completed the installation of a photovoltaic facility on the rooftop of one of the buildings on its Pretoria campus.*

## Investigating alternative energy options in the quest for an energy-autonomous campus

**The CSIR aims to transform its campus** in Pretoria into one where energy is supplied from renewable energy sources, complementing grid-based power with local energy sources and energy storage.

In addition to looking into solar, wind and biogas as renewable energy options, aspects considered include the use of electric and hydrogen-driven vehicles on campus; the implementation of demand-side management; the application of power-to-liquid and power-to-gas processes and the adoption of energy-efficient measures.

Other CSIR campuses across the country will gradually become part of the programme, where in the long term, supply and demand will virtually be balanced to form a virtual power plant.

For the period under review, an energy audit was conducted on the Pretoria campus to quantify the electrical energy load and identify areas of possible

energy conservation and optimisation. The organisation completed the installation of a photovoltaic facility on the rooftop of one of the campus buildings (250kW). The levelised cost of energy of the plant is 0.87 R/kWh, resulting in cost savings when compared to the price of energy purchased from the national grid.

An environmental impact assessment and a feasibility study for the development of a biogas power plant have commenced, while a wind data collection initiative produced energy production calculations and cost estimates from different wind turbine manufacturers. This information was utilised in a pre-feasibility study.

The energy-autonomous campus programme serves as a real-world research platform for designing and operating a primarily renewables-based energy system. The platform will be used to demonstrate, in a real-world setting of significant size, how a future energy system that is based on fluctuating and dispatchable renewables can be designed and operated in a cost-efficient manner.

## INFRASTRUCTURE RENEWAL AND DEVELOPMENT



Lengau, Africa's fastest supercomputer and number 165 on the Top500 list of supercomputers.



*The CSIR-hosted South African Research Network increased the network's total broadband capacity to 3 292 terabits per second.*

## High-performance computing, data-intensive research and high-speed network capacity for scientific and industrial development

**The National Integrated Cyberinfrastructure System** continues to promote scientific and industrial development by providing high-performance computing, high-speed network capacity and national research data infrastructure.

Highlights in high-performance computing included the rating of the new petaflop cluster system of the Centre for High Performance Computing (CHPC) as number one in Africa. This rating was announced at the International Supercomputing Conference in Germany, where South Africa also took second prize in the prestigious International Student Cluster Competition. South Africa is an annual participant, represented by six undergraduate students who receive rigorous training as part of the drive to continually develop critical high-performance computing skills nationally. The CHPC also participated in the launch of the first African Square Kilometre Array antenna in Ghana. The CHPC donated and deployed a supercomputer to Ghana in preparation for the vast amount of data to be received.

In its mission to ensure high-speed networking for the higher education research community, the CSIR-hosted

South African Research Network (SANReN) increased the network's total available broadband capacity to 3 292 terabits per second. SANReN and the Tertiary Education and Research Network of South Africa also completed the implementation of the first 10 gigabits per second pathfinder connection of the Global Research and Education Network on the undersea West Africa Cable System from Cape Town to London. It is envisioned that the channel will be used to transport all science data from South Africa's MeerKAT radio telescope and the European Organization for Nuclear Research at a fraction of the current costs.

The Data Intensive Research Initiative of South Africa (DIRISA) deployed a production version of the data management planning tool, which has been adopted by the National Research Foundation and the persistent identifier allocation service. The latter service forms part of the Department of Telecommunication and Postal Services' national digital object architecture. DIRISA also developed and submitted a draft national strategy focusing on big data for research to the Department of Science and Technology.





*Above: The CSIR outdoor testing system is used for research on solar system design and optimisation in realistic outdoor environmental conditions. Right: The performance of the system is correlated to meteorological readings derived from a weather monitoring system.*



## Advanced outdoor solar energy research and testing facility supports local industry

**The CSIR has constructed** an advanced outdoor solar energy research and testing facility to support the domestic solar photovoltaic (PV) industry with industrial development, research, quality assurance, knowledge-generation and human capital development.

At this new facility, which was completed in December 2017, new products can be designed, built and tested in parallel, shortening the time it takes South African solar components to reach the market.

The facility makes it possible to study the performance of locally and internationally manufactured PV components in real-world South African climates. It is also key in improving accuracy and optimising on-site battery storage.

A weather monitoring system forms an integral part of the outdoor testing facility, enabling the readings from

the PV modules to be compared to different weather readings. Data derived from the weather system are integrated into the Southern African Universities Radiometric Network for anyone to download.

The completion of a new indoor reliability lab will strengthen the research done at the outdoor facility. Here, accelerated stress tests will be conducted to obtain results that would normally take years to occur naturally in the field. Quality and reliability test protocols will also be designed in the indoor lab.

The test facility will assist a standard body, such as the South African Bureau of Standards, with the development of local standards.



## INFRASTRUCTURE RENEWAL AND DEVELOPMENT



Above (left): Graphic illustration of the CSIR Campus of the future. (Right) A proposed public engagement facility, the Gateway to Science and Innovation Centre.



*The Campus Master Plan serves as a blueprint that will guide the development and capital investment in the next 10 years.*

## Towards a campus of the future

**In addition to human capability**, technological advancement and innovation are largely attributed to the quality of research infrastructure. Research infrastructure is recognised as a key element for boosting scientific knowledge generation, accelerating technology development, enhancing both technological and social innovation and providing advanced scientific training for new generations of researchers.

In order to support its scientific and industrial development mandate, the CSIR needs to develop and maintain a world-class research and built infrastructure. At over 70 years old, some of the infrastructure needs to be updated in order to keep up with the technological and innovation advancements required of world-class research institutions.

The Scientia campus is exceptionally beautiful and emphasises the CSIR's long history of excellence. However, the CSIR has not been significantly re-capitalised in the past three decades (some existing infrastructure was developed in the early 1980s, although major infrastructure development was as far back as the 1960s), therefore some of the campuses, particularly Scientia, have aging and outdated infrastructure. While annual investments in property, plant and equipment address the most critical items, it is necessary for a more concerted effort to modernise the CSIR facilities.

The Campus Master Plan (CMP) is a long-term plan, designed to help the CSIR make thoughtful, well-informed choices – over the next several decades – for the renewal and evolution of its facilities and physical environment, based on a continuously refreshed understanding of the organisation's research and community priorities. The plan has been approved by the CSIR Board, and will require investment and funding through public/private partnerships and significant government support.

The plan serves as a blueprint that will guide the development and capital investment in the next 10 years. It envisages the development of a sustainable, modern, forward-thinking research campus where the natural, built, social and institutional environments are integrated in a visually transforming image of the CSIR, where heritage is preserved and future growth is encouraged and accommodated.

In order for the CMP to be realised, the following objectives have been set:

- Facilitate a smooth transition from the current to the research campus of the future;
- Enable a knowledge economy and acknowledge the importance of knowledge clusters;



*CSIR Campus of the future*

- Support open innovation where external knowledge is absorbed and a meeting place is created for talented researchers; and
- Develop a growth strategy to anticipate the need for new research areas.

An implementation plan to ensure that the CMP is realised has been formulated. The plan includes a roadmap that details the different catalytic phases and precincts to be targeted during different phases of implementation. In addition, a number of projects have been recommended for funding in the short to medium term.

The plan will be implemented in two phases. Phase 1 of the programme, estimated to be implemented over a 10-year period and costing in excess of R2 billion, will include:

- The construction of a pilot manufacturing facility that can house various pilot projects;
- The establishment of public engagement facilities to improve science awareness and public understanding

of science. This will include a Gateway to Science and Innovation Centre, aimed at demonstrating South African science achievements, CSIR technologies, and fostering the commercialisation of research;

- The refurbishment of existing buildings to modern standards in terms of interior finishes and space utilisation; and
- The development of a smart and sustainable campus that is energy-autonomous, waterwise and vehicle-free.

A campus planning and development office has been established to oversee the implementation of the CMP. A robust project appraisal and development process is underway to test the viability of the priority projects.

The next steps include continued mobilisation of stakeholders and partner institutions; development and implementation of the capital fundraising strategy and development of the business and operational plan.





# FINANCIAL SUSTAINABILITY AND **GOVERNANCE**



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# CORPORATE GOVERNANCE

## FRAMEWORK

Corporate governance is formally concerned with the organisational arrangements that have been put in place to provide an appropriate set of checks and balances within which the stewards of the organisation operate. The objective is to ensure that those whom the stakeholders entrust with the direction and success of the organisation act in the best interest of these stakeholders. It is about leading with integrity, responsibility, accountability and transparency.

The CSIR is committed to adhering to principles and practices that provide its stakeholders with the assurance that the organisation is soundly and ethically managed. A management model that governs and provides guidance for the way that all employees interact with various stakeholder groups has been established to provide this assurance.

The underpinning principles of the Group's corporate governance rest on the three cornerstones of an effective and efficient organisation, namely a long-term strategic planning process, day-to-day management processes and effective change management processes. These processes are supported by people and systems that plan, execute, monitor and control the strategic and operational domains of the organisation. The supporting infrastructure and its evolution are documented in the management model, which is reviewed and updated constantly to align with organisational changes.

In accordance with the Scientific Research Council Act, 1988 (Act 46 of 1988), as amended by Act 71 of 1990, the appointment of the CSIR Board is by the Executive Authority (the Minister of Science and Technology). The Board provides oversight strategic direction and leadership, determines the goals and objectives of the CSIR and approves key policies. The Board has adopted formal Terms of Reference that are in line with the Scientific Research Council Act, the Public Finance Management Act (PFMA), 1999 (Act 1 of 1999), as amended by Act 29 of 1999 and best practice.

The CSIR Board and the Executive Management Committee believe that the organisation has complied with the relevant principles incorporated in the Code of Corporate Practices and Conduct, as set out in the King Report.

## SHAREHOLDER'S COMPACT

In terms of Treasury Regulations issued in accordance with the PFMA, the CSIR must, in consultation with the Executive Authority, agree on its key performance objectives, measures and indicators annually. These are included in the shareholder's performance agreement (Shareholder's Compact) between the CSIR Board and the Executive Authority.

The Shareholder's Compact promotes good governance practices in the CSIR by clarifying the roles and responsibilities of the Board and the Executive Authority, as well as ensuring agreement on the CSIR's mandate and key objectives. The Chairperson of the Board and the Executive Management Committee hold bilateral meetings with the Executive Authority to ensure that performance is in line with the Shareholder's Compact.

## FINANCIAL STATEMENTS

The Board and the CSIR Executive Management Committee confirm that they are responsible for preparing financial statements that fairly present the state of affairs of the Group as at the end of the financial year and the results and cash flows for that period. The financial statements are prepared in accordance with International Financial Reporting Standards (IFRS). In addition, the Board is satisfied that adequate accounting records have been maintained.

The Auditor-General independently audits and reports on whether or not the financial statements are fairly presented in accordance with IFRS. The Auditor-General's Terms of Reference do not allow for any non-audit related work to be performed.

## ENTERPRISE RISK MANAGEMENT

The Board is responsible for ensuring that a comprehensive and effective risk management process is in place.

Enterprise risk management in the CSIR is an ongoing process that focuses on identifying, assessing, managing and monitoring all known forms of risks across all operations and Group companies. This has been in place for the year under review and up to the date of approval of the annual financial statements.



# CORPORATE GOVERNANCE

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A structured process of enterprise risk management ensures that the goals and objectives of the CSIR are attained. This takes cognisance of the fact that the risks identified are often interlinked and cannot be managed in isolation. CSIR systems review aspects of economy, efficiency and effectiveness. The management of risk is assigned at appropriate levels to ensure adequate responses.

Documented and tested processes allow the CSIR to continue its critical business operations, in the event of interruptions that could possibly impact on its activities. Based on the internal audit, the organisational results achieved, the audit report on the annual financial statements and the management report of the Auditor-General, the Board is satisfied that the system of risk management has been effective during the year under review.

The CSIR has defined three broad risk categories, namely systemic, strategic and operational.

## Systemic risks

Systemic risks originate from macro-economic and national challenges affecting the National System of Innovation and National Government Business Enterprise space in which the CSIR operates.

Continued evaluation of macro-economic influences and ongoing assessment and engagement with stakeholders remain key in directing research activities towards achieving the CSIR's mandate.

## Strategic risks

The organisation has effective mechanisms in place for identifying and monitoring strategic risks that impact the CSIR's ability to deliver on its mandate. The procedures for implementing a risk management process include a focus on human capital assessment and development, research impact areas, technological development and business continuity.

## Operational risks

The CSIR endeavours to minimise operating risk by ensuring that the appropriate infrastructure, controls, systems and people are in place throughout the Group. Key processes employed in managing operating risk include research

ethics and good research practices, segregation of duties, transaction approval frameworks, financial and management reporting, as well as the monitoring of metrics that are designed to highlight positive and/or negative performance across a broad range of Key Results Areas. The Operations Committee, which comprises members of the Executive Management Committee, Operating Unit Executive Directors, Centre Managers and Group Managers, oversee operational matters.

## SUSTAINABILITY

The Board has reviewed the Group's financial budgets for the period 1 April 2018 to 31 March 2019 and is satisfied that, although the CSIR is budgeting for a break-even, adequate resources exist to continue as a going concern for the foreseeable future. The income streams of the CSIR are detailed in the notes to the annual financial statements.

## INTERNAL AUDIT

The Group has an internal audit function that reviews its operations. The Audit and Risk Committee approves the internal audit charter, the annual audit plan and budget of the CSIR internal audit to maintain its independence.

The annual audit plan is based on the key risks to the organisation, the outcome of the enterprise risk assessment conducted by management, as well as specific areas highlighted by internal audit and the Audit and Risk Committee. In addition, areas highlighted in the internal control reviews conducted by the external auditors are incorporated into the internal audit plan for follow up.

The annual audit plan is flexible to ensure that it is responsive to changes in the risk landscape. A comprehensive report on internal audit findings is presented to management regularly and to the Audit and Risk Committee quarterly.

The internal audit function operates according to International Standards of the Professional Practice of Internal Auditing of the Institute of Internal Auditors.

## INTERNAL CONTROL AND COMBINED ASSURANCE

The ultimate responsibility for the system of internal controls designed to identify, evaluate, manage, and mitigate

# CORPORATE GOVERNANCE

risks, as well as provide reasonable assurance against misstatements and losses lies with the Board.

The system comprises self-monitoring mechanisms to allow for actions to be taken to correct deficiencies as they are identified. A combined assurance approach is in place to assist with addressing key enterprise risks.

Executive Management and the Enterprise Risk Management Office identify controls that are necessary to mitigate risks. Internal Audit is the third line of defence and provides assurance on the effectiveness of risk management and the system of internal control.

For the year under review, the internal financial controls have been assessed and deemed adequate and effective.

## AUDIT

External auditors are responsible for the independent audit and reporting on the annual financial statements. The statements comply with International Financial Reporting Standards (IFRS).

In line with the requirements of the PFMA and good governance, the internal audit function provides assurance to the Audit and Risk Committee and management on the adequacy and effectiveness of internal controls. Information is derived from an independent evaluation of risk management, governance processes and internal controls. Where applicable, corrective action is identified and improved controls are recommended.

## APPROVAL FRAMEWORK AND POLICIES

The approval framework governs the authorisation processes in the CSIR. It deals with the construction of strategic plans, development of operational plans and budgets, appointment of staff, approval of salaries, intellectual property management and investment in and disposal of property, plant and equipment, among others. It also defines authority levels in relation to organisational positions.

Appropriate controls to ensure compliance with the above framework are in place. There is a comprehensive set of procedures to provide the necessary checks and balances for the economical, efficient and effective use of resources. The essence of this framework is that it is comprehensive, clear and unambiguous, as well as easy to assimilate and internalise.

Other policies that are in support of the CSIR mandate and strategic priorities cover the following key areas: building and transforming human capital; governance and financial sustainability; transferring technology and human capital; strengthening the science and technology base and performing relevant research and development.

All subsidiary companies are under the control of a duly appointed Board of Directors.

As part of ongoing risk management, a Policy Review and Development Committee has been established to review all the policies of the organisation.

The Board reserves all matters with the potential to have material impact on the operations and reputation of the CSIR to itself.

## CODE OF BUSINESS ETHICS AND ORGANISATIONAL VALUES

The Board and the CSIR Executive Management Committee have approved and adopted a code of ethics that reflects their commitment to a policy of fair dealing and integrity in conducting their operations. The code is closely aligned to the CSIR set of values, compliance to laws and regulations and requires all employees to maintain the highest ethical standards, ensuring that business practices are conducted in a manner that is beyond reproach. Monitoring ethical behaviour is devolved to operating unit level and transgressions are addressed through procedures detailed in the CSIR Conditions of Service and the PFMA.

An Ethics Hotline has been established to facilitate anonymous reporting of ethical transgressions. During the period under review, training sessions were conducted to educate employees about how to use the Ethics Hotline.

## EMPLOYEE PARTICIPATION

The CSIR strongly encourages effective and modern workplace practices and relationships to foster employee participation and work process involvement as a key practice at all levels in the organisation. Some examples of employee participation are the Transformation and Employment Equity Committee, leadership engagement sessions, formal induction programmes, technical and strategic focus groups and task teams.

# GOVERNANCE STRUCTURE

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## THE CSIR BOARD

The responsibilities of the Board are stipulated in the Scientific Research Council Act and the PFMA. The Board approves the strategy, goals, operating policies and priorities for the organisation and monitors compliance with policies, applicable legislation and achievement against objectives.

With the exception of the CEO of the CSIR, all members of the Board are non-executive. Board members are actively involved in and bring independent judgement to bear on the Board's deliberations and decisions.

The Board, whose current number of members adheres to the statutory minimum requirements, meets quarterly. For the year under review, the Board met four times.

The Board meetings were held on 29 June 2017, 21 September 2017, 10 November 2017 and 15 February 2018. A Board strategic session was held on 25 and 26 October 2017. The annual financial statements for the 2017/18 financial year were approved on 17 July 2018.

The Board has three sub-committees, namely the Audit and Risk Committee, the Human Resources and Remuneration Committee, as well as the Research, Development and Innovation Committee (see page 83 and 84). These committees are selected according to the skills sets required for the committees to fulfil their functions.

The Board has adopted formal Terms of Reference, which are reflected in the Board Charter.

## Board Members

CSIR BOARD MEMBERS (1 APRIL 2017 TO 31 MARCH 2018)



**PROF. THOKOZANI MAJOZI**

**Chairperson of the CSIR Board**

*NRF/DST Chair: Sustainable Process Engineering, University of the Witwatersrand*

*PhD (Process Integration), University of Manchester Institute of Science and Technology*

*MSc (Engineering), University of Natal*



**DR THULANI DLAMINI**

**Chief Executive Officer, CSIR**

*PhD (Chemistry), University of the Witwatersrand*  
*MBL, University of South Africa*



**ADV GHANDI BADELA**

**Advocate, Duma Nokwe Group**

*MSc (Electromechanical Engineering), Leningrad Polytechnic Institute*  
*MBA, Gordon Institute of Business Science*



**MS PHINDILE BALENI**

**Director-General, Gauteng Premier's Office**

*B.Proc LLB, University of the Witwatersrand*



**DR PHILIP GOYNS**

**Senior Climate Change Advisor, Promethium Carbon**

*PhD (Energy Studies), University of the Witwatersrand*

*MSc (Mechanical Engineering), University of the Witwatersrand*



**DR ANTONIO LLOBELL**

**Chief Executive Officer, BioGold International**

*PhD (Biology), University of Sevilla*

*MSc (Biological Sciences), University of Sevilla*



**DR RAMATSEMELA MASANGO**

**Executive Director, Mzansi Energy Solutions and Innovations (Pty) Ltd**

*PhD (Nuclear Engineering), Pennsylvania State University*

*MSc (Nuclear Engineering), Pennsylvania State University*



**MS MOKGADI MASEKO**

**Director, Leruo Corporate Consulting**

*B.Compt (Hons), University of South Africa*  
*CA(SA)*



**MR JOEL NETSHITENZHE**

**Executive Director and Board Vice-Chairperson, Mapungubwe Institute for Strategic Reflection**

*MSc (Financial Economics), University of London*

*Post-graduate Diploma (Economic Principles), University of London*



**MS AYANDA NOAH**

**Group Executive: Customer Services, Eskom**

*BSc (Electrical Engineering), University of Cape Town*

*MBA International Management Centre*



**PROF. MAMOKGETHI PHAKENG\***

**Vice-Chancellor (Research and Internationalisation), University of Cape Town**

*PhD (Mathematics Education), University of the Witwatersrand*

*M Ed (Mathematics Education), University of the Witwatersrand*

\* Resigned from the Board in September 2017



# GOVERNANCE STRUCTURE

## SCHEDULE OF ATTENDANCE OF THE CSIR BOARD AND CSIR COMMITTEE MEETINGS

(1 April 2017 to 31 March 2018)

Board member	Board meetings	Audit and Risk Committee	Human Resources and Remuneration Committee	Research, Development and Innovation Committee	Combined Board Committee Meeting (Audit and HR)
T Majozi (Chair)	4				1
T Dlamini*	4	4	4	4	1
G Badela	2	4	4		1
P Baleni	3	1	2		
P Goyns	4		4	4	1
A Llobell	1			2	
R Masango	3		1	4	
M Maseko	2	4			1
J Netshitenzhe	4			3	
A Noah	2	4			
M Phakeng**	1		2	2	

\* Attends in capacity as CEO

\*\* Resigned from the Board in September 2017

## Executive Management Committee

The Executive Management Committee has executive responsibility for the CSIR and consists of the following Executive members:



**DR THULANI DLAMINI**

**Chief Executive Officer, CSIR**

*PhD (Chemistry),  
University of the Witwatersrand  
MBL, University of South Africa*



**MS ZANELE NGWEPE**

**Chief Financial Officer**

*BCom (Hons) in Accounting,  
University of Natal  
CA(SA)*



**DR MOLEFI MOTUKU**

**Group Executive for Research,  
Development and Innovation**

*PhD (Materials Engineering),  
University of Alabama,  
Birmingham*

*MSc (Materials Engineering),  
University of Alabama,  
Birmingham*



**MS SITHEMBILE BHENGU**

**Group Executive: Human  
Capital**

*MBL, University of South Africa  
BSc (Hons) Social Science,  
University of South Africa*



**DR RACHEL CHIKWAMBA**

**Acting Group Executive: Legal,  
Compliance and Business  
Enablement**

*PhD (Genetics),  
Iowa State University*

*MBA, Gordon Institute of  
Business Science*



**MR CHRIS STURDY**

**Chief Financial Officer  
(Until end of August 2017)**

*BCom (Hons)  
Accounting Science,  
University of Pretoria*

*CA(SA)*



**MR RAYNOLD ZONDO**

**Group Executive:  
Shared Services  
(Until end of December 2017)**

*MSc (Project Management),  
University of Pretoria*

*MTech (Biotechnology), Durban  
University of Technology*



**MR LAURENS CLOETE**

**Group Executive: Operations  
(Until end of December 2017)**

*MEng (Electronics),  
University of Pretoria*

*BEng (Electronics),  
University of Pretoria*



**MS AMANDA  
VAN TONDER**

**Acting Chief Financial Officer  
(1 September 2017 to  
30 November 2017)**

*BCom (Hons) Accounting,  
University of South Africa  
CA(SA)*

All Executives are employed  
on a contract, up to 5 years.

# GOVERNANCE STRUCTURE

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## CSIR LEADERSHIP TEAM

The CSIR management is responsible for strategy implementation and managing the day-to-day affairs of the CSIR and its operating units in accordance with the policies and objectives approved by the CSIR Board.

This leadership team comprises the members of the CSIR Executive Management Committee, Operating Unit Executive Directors and Centre Managers.

Other internal structures that contribute to governance include the Executive and Operations and Strategic Research Ethics Committees, the Strategic Research and the Research Advisory Panels.

## BOARD OF DIRECTORS AND GROUP COMPANIES

The CSIR Executive appoints the boards of the various subsidiary companies.

## BOARD AND EXECUTIVE MANAGEMENT REMUNERATION

Details about the Board are set out on pages 78 and 79 of the Corporate Governance Report. The membership and Terms of Reference of each Board Committee are further described on pages 83 and 84.

Remuneration of Board members and the Executive Management is set out in note 18 of the annual financial statements.

Remuneration of Executive Management is in accordance with the remuneration policy that has been approved by the Board.

## GENERAL

The CSIR acknowledges that systems of corporate governance should be reviewed continuously to ensure that they are sound and consistent with world-class standards relevant to the operations of the Group.

The CSIR will continue to comply with all major recommendations of the Code of Corporate Practices and Conduct on Corporate Governance as set out in the King Report.

## PUBLIC FINANCE MANAGEMENT ACT

The PFMA came into effect on 1 April 2000 and has had an impact on governance matters regarding the regulation of financial management in the public sector. For the financial period reported, the CSIR has complied with the PFMA requirements, except on the issues stated in the materiality framework.

## MATERIALITY FRAMEWORK

The materiality framework for reporting losses through criminal conduct and irregular, fruitless and wasteful expenditure, as well as for significant transactions envisaged per section 5.2 of the PFMA, has been finalised and incorporated into the Shareholder's Compact. As per the National Treasury Guideline on Irregular Expenditure dated April 2015 (paragraph 25 (a), (b) and (c)), irregular expenditure of R30.07 million was incurred. However it did not result in any losses or damages to the organisation as the relevant value was obtained from the transactions.

# CSIR BOARD COMMITTEES

## AUDIT AND RISK COMMITTEE

1 April 2017 to 31 March 2018

**Chairperson:** Ms A Noah

**Members:** Adv G Badela  
Ms P Baleni  
Ms M Maseko

**Meetings:** 26 June 2017, 5 September 2017,  
7 November 2017, 13 February 2018

A special combined Audit and Risk Committee and Human Resources and Remuneration Committee meeting was held on 18 July 2017.

### Purpose:

- To deal with all matters prescribed by the regulations issued regarding the PFMA and the Scientific Research Council Act;
- To perform the final review of the key risk matters affecting the organisation;
- To agree on the scope and review the annual external audit plan and the work of the CSIR internal auditors (including the internal audit charter); and
- To act in an unfettered way to understand the dynamics and performance of the organisation without restrictions.

The Audit and Risk Committee has adopted formal Terms of Reference and is satisfied that it has complied with its responsibilities as set out therein.

## HUMAN RESOURCES AND REMUNERATION COMMITTEE

1 April 2017 to 31 March 2018

**Chairperson:** Adv G Badela

**Members:** Ms P Baleni  
Dr P Goyns  
Dr R Masango (from 2018)  
Prof. M Phakeng  
(resigned September 2017)

**Meetings:** 22 June 2017, 5 September 2017,  
31 October 2017, 6 February 2018

A special combined Audit and Risk Committee and Human Resources and Remuneration Committee meeting was held on 18 July 2017.

### Purpose:

- To influence and advise on human resources and remuneration matters in the organisation;
- To approve remuneration changes and bonus payments; and
- To review the remuneration of the Executive Management.

The Human Resources and Remuneration Committee has adopted formal Terms of Reference and is satisfied that it has complied with its responsibilities as set out therein.



# CSIR BOARD COMMITTEES

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## RESEARCH, DEVELOPMENT AND INNOVATION COMMITTEE

1 April 2017 to 31 March 2018

**Chairperson:** Prof. M Phakeng  
(resigned September 2017)

**Members:** Dr P Goyns (Chair from October 2017)  
Dr A Llobell  
Dr R Masango  
Mr J Netshitenzhe  
*Co-opted members*  
Mr R Heydenrich  
Mr T Mtshali

**Meetings:** 15 June 2017, 31 August 2017,  
6 November 2017, 8 February 2018

**Purpose:**

- To provide guidance and advice on the long-term trajectory and composition of the CSIR's science and technology portfolio in the context of the needs of the country;
- To ensure that key innovation and research processes are conducted effectively and benchmarked against international best practice; and
- To ensure that research outputs, organisational climate and credibility remain congruent with the role and objectives of the institution.

The Research, Development and Innovation Committee has adopted formal Terms of Reference and is satisfied that it has complied with its responsibilities as set out therein.

# BOARD AND COMMITTEE MEETING ATTENDANCE

## BOARD MEETINGS

(1 April 2017 to 31 March 2018)

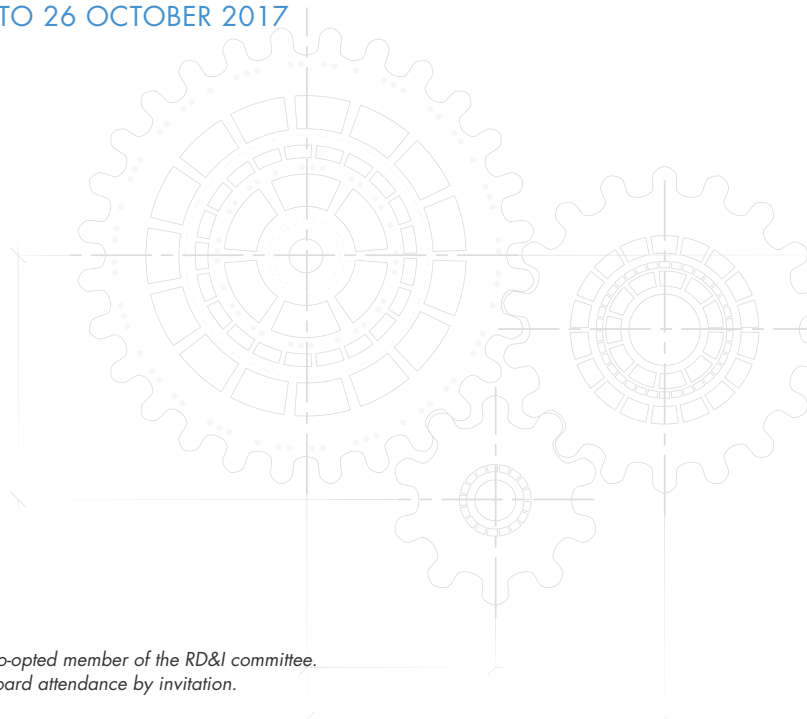
Board meetings	29/06/2017	21/09/2017	10/11/2017	15/02/2018
T Majozi (Chair)	Present	Present	Present	Present
T Dlamini	Present	Present	Present	Present
G Badela	Apology	Present	Present	Apology
P Baleni	Present	Present	Apology	Present
P Goyns	Present	Present	Present	Present
A Llobell	Apology	Apology	Present	Apology
R Masango	Present	Apology	Present	Present
M Maseko	Present	Apology	Apology	Present
J Netshitenzhe	Present	Present	Present	Present
A Noah	Apology	Present	Apology	Present
M Phakeng*	Present	n/a	n/a	n/a

\* Resigned in September 2017

## BOARD STRATEGIC SESSION HELD FROM 25 TO 26 OCTOBER 2017

Board members	Attendance
T Majozi (Chair)	Present
T Dlamini	Present
G Badela	Present
P Baleni	Present
P Goyns	Present
R Heydenrich*	Present
A Llobell	Present
R Masango	Present
M Maseko	Present
T Mtshali*	Present
J Netshitenzhe	Present
A Noah	Present

\* Co-opted member of the RD&I committee.  
Board attendance by invitation.



# BOARD AND COMMITTEE MEETING ATTENDANCE

## AUDIT AND RISK COMMITTEE MEETINGS

Committee members	26/06/2017	18/07/2017*	05/09/2017	07/11/2017	13/02/2018
A Noah (Chair)	Present	Apology	Present	Present	Present
G Badela	Present	Present	Apology	Present	Present
P Baleni	Apology	Apology	Present	Apology	Apology
T Majosi	n/a	Present	n/a	n/a	n/a
M Maseko	Present	Present	Present	Apology	Present

\* Special combined ARC and HR Committee meeting held on 18 July 2017

## HUMAN RESOURCES AND REMUNERATION COMMITTEE MEETINGS

Committee members	22/06/2017	18/07/2017*	05/09/2017	31/10/2017	06/02/2018
G Badela (Chair)	Apology	Present	Present	Present	Present
P Baleni	Present	Apology	Present	Apology	Apology
P Goyns	Present (Chair)	Present	Present	Present	Present
T Majosi	n/a	Present	n/a	n/a	n/a
R Masango	n/a	Apology	n/a	n/a	Present
M Phakeng**	Present	Apology	Present	n/a	n/a

\* Special combined ARC and HR Committee Meeting held on 18 July 2017

\*\* Resigned in September 2017

## RESEARCH, DEVELOPMENT AND INNOVATION COMMITTEE MEETINGS

Committee members	15/06/2017	31/08/2017	06/11/2017	08/02/2018
M Phakeng (Chair)*	Present	Present	n/a	n/a
P Goyns (Chair from October 2017)	Present	Present	Present	Present
R Heydenrich**	Present	Present	Present	Present
A Llobell	Present	Apology	Present	Apology
R Masango	Present	Present	Present	Present
T Mtshali**	Present	Present	Present	Present
J Netshitenzhe	Present	Apology	Present	Present

\* Resigned in September 2017

\*\* Co-opted member of the RD&I committee. Board attendance by invitation.

Committee meetings are open to all Board members.

# REPORT OF THE AUDIT AND RISK COMMITTEE

FOR THE YEAR ENDED 31 MARCH 2018

The committee is pleased to present its report for the financial year ended on 31 March 2018.

## THE COMMITTEE'S RESPONSIBILITY

The committee has adopted formal Terms of Reference approved by the Board. Accordingly, the committee has conducted its affairs in compliance with its Terms of Reference and has discharged its responsibilities contained therein.

## COMMITTEE MEMBERS AND ATTENDANCE

The committee consists of the members as stated on page 83 of this report. In accordance with its approved Terms of Reference, the committee met quarterly during the year under review, on 26 June 2017, 5 September 2017, 7 November 2017 and 13 February 2018. The schedule of attendance is shown on page 86 of this report.

## THE EFFECTIVENESS OF INTERNAL CONTROL

The system of internal control that the CSIR applies over financial risk management is effective, efficient and transparent. In line with the PFMA and King IV, the internal audit provides the committee and management with assurance that the internal controls are appropriate and effective. This is achieved by means of the risk management process, as well as the identification of mitigating measures and an on-going assessment thereof.

From the quarterly reports of the internal audit, the audit report on the annual financial statements and the management report of the Auditor-General of South Africa, it was noted that no matters that include any material deficiencies in the system of internal control or any deviations therefrom were reported. Accordingly, the committee can report that the system of risk management and internal control over financial reporting for the period under review was efficient and effective.

## INTERNAL AUDIT

The Group has an internal audit function that reports directly to the committee. Its charter and audit plans are approved by the committee to ensure that it operates independently.

The committee is satisfied that the internal audit function is operating effectively and has addressed the risks pertinent to the CSIR through its audits.

## RISK MANAGEMENT

The committee is satisfied that the CSIR has a risk management process focused on identifying, assessing, managing and monitoring significant risks across all operations and Group companies. This has been in place for the year under review and up to the date of approval of the annual financial statements.

## EVALUATION OF FINANCIAL STATEMENTS

The committee has evaluated the annual financial statements of the CSIR Group for the year ended on 31 March 2018 and, based on the information provided, the committee considers that it complies, in all material respects, with the requirements of the various acts governing disclosure and reporting on the annual financial statements. The committee concurs with the Executive Management that the adoption of the going concern premise in the preparation of the annual financial statements is appropriate. Therefore, in its meeting held on 17 July 2018, the committee recommended that the CSIR Board adopts the annual financial statements.



**Ayanda Noah**

*Chairperson of the Audit and Risk Committee*  
18 July 2018



# REPORT OF THE AUDITOR-GENERAL

FOR THE YEAR ENDED 31 MARCH 2018

## Report of the auditor-general to Parliament on the Council for Scientific and Industrial Research

### REPORT ON THE AUDIT OF THE CONSOLIDATED AND SEPARATE FINANCIAL STATEMENTS

#### Opinion

I have audited the consolidated and separate financial statements of the Council for Scientific and Industrial Research and its subsidiaries set out on pages 104 to 151, which comprise the consolidated and separate statement of financial position as at 31 March 2018, the consolidated and separate statement of profit or loss and other comprehensive income, statement of changes in equity and statement of cash flows for the year then ended, as well as the notes to the consolidated and separate financial statements, including a summary of significant accounting policies.

In my opinion, the consolidated and separate financial statements present fairly, in all material respects, the consolidated and separate financial position of the group as at 31 March 2018, and their financial performance and cash flows for the year then ended in accordance with International Financial Reporting Standards (IFRS) and the requirements of the Public Finance Management Act of South Africa, 1999 (Act No. 1 of 1999) (PFMA).

#### Basis for opinion

I conducted my audit in accordance with the International Standards on Auditing (ISAs). My responsibilities under those standards are further described in the auditor-general's responsibilities for the audit of the consolidated and separate financial statements section of this auditor's report.

I am independent of the group in accordance with the International Ethics Standards Board for Accountants' Code of ethics for professional accountants (IESBA code) and the ethical requirements that are relevant to my audit in South Africa. I have fulfilled my other ethical responsibilities in accordance with these requirements and the IESBA code.

I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my opinion.

#### Responsibilities of the accounting authority for the financial statements

The board of directors, which constitutes the accounting authority is responsible for the preparation and fair presentation of the consolidated and separate financial statements in accordance with IFRS and the requirements of the PFMA, and for such internal control as the accounting authority determines is necessary to enable the preparation of consolidated and separate financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the consolidated and separate financial statements, the accounting authority is responsible for assessing the group's ability to continue as a going concern, disclosing, as applicable, matters relating to going concern and using the going concern basis of accounting unless the accounting authority either intends to liquidate the group or to cease operations, or has no realistic alternative but to do so.

#### Auditor-general's responsibilities for the audit of the consolidated and separate financial statements

My objectives are to obtain reasonable assurance about whether the consolidated and separate financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes my opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with the ISAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these consolidated and separate financial statements.

A further description of my responsibilities for the audit of the consolidated and separate financial statements is included in the annexure to the auditor's report.

# REPORT OF THE AUDITOR-GENERAL

FOR THE YEAR ENDED 31 MARCH 2018

## Report of the auditor-general to Parliament on the Council for Scientific and Industrial Research

### REPORT ON THE AUDIT OF THE ANNUAL PERFORMANCE REPORT

#### Introduction and scope

In accordance with the Public Audit Act of South Africa, 2004 (Act No. 25 of 2004) (PAA) and the general notice issued in terms thereof, I have a responsibility to report material findings on the reported performance information against predetermined objectives for selected objectives presented in the annual performance report. I performed procedures to identify findings but not to gather evidence to express assurance.

My procedures address the reported performance information, which must be based on the approved performance planning documents of the entity. I have not evaluated the completeness and appropriateness of the performance indicators included in the planning documents. My procedures also did not extend to any disclosures or assertions relating to planned performance strategies and information in respect of future periods that may be included as part of the reported performance information. Accordingly, my findings do not extend to these matters.

I evaluated the usefulness and reliability of the reported performance information in accordance with the criteria developed from the performance management and reporting framework, as defined in the general notice, for the following selected objectives presented in the annual performance report of the entity for the year ended 31 March 2018:

Objectives	Pages in the annual performance report
Objective 1 – scientific and technical	96 to 97

I performed procedures to determine whether the reported performance information was properly presented and whether performance was consistent with the approved performance planning documents.

I performed further procedures to determine whether the indicators and related targets were measurable and relevant, and assessed the reliability of the reported performance information to determine whether it was valid, accurate and complete.

I did not raise any material findings on the usefulness and reliability of the reported performance information for the following objectives:

- Scientific and technical

### REPORT ON THE AUDIT OF COMPLIANCE WITH LEGISLATION

#### Introduction and scope

In accordance with the PAA and the general notice issued in terms thereof, I have a responsibility to report material findings on the compliance of the entity with specific matters in key legislation. I performed procedures to identify findings but not to gather evidence to express assurance.

I did not raise material findings on compliance with the specific matters in key legislation set out in the general notice issued in terms of the PAA.

#### OTHER INFORMATION

The accounting authority is responsible for the other information. The other information comprises the information included in the annual report. The other information does not include the consolidated and separate financial statements, the auditor's report and those selected objectives presented in the annual performance report that have been specifically reported in this auditor's report.

My opinion on the financial statements and findings on the reported performance information and compliance with legislation do not cover the other information and I do not express an audit opinion or any form of assurance conclusion thereon.

# REPORT OF THE AUDITOR-GENERAL

FOR THE YEAR ENDED 31 MARCH 2018

## Report of the auditor-general to Parliament on the Council for Scientific and Industrial Research

### OTHER INFORMATION

In connection with my audit, my responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the consolidated and separate financial statements and the selected objectives presented in the annual performance report, or my knowledge obtained in the audit, or otherwise appears to be materially misstated.

I did not receive the other information prior to the date of this auditor's report. After I receive and read this information, and if I conclude that there is a material misstatement, I am required to communicate the matter to those charged with governance and request that the other information be corrected. If the other information is not corrected, I may have to retract this auditor's report and re-issue an amended report as appropriate. However, if it is corrected this will not be necessary.

### INTERNAL CONTROL DEFICIENCIES

I considered internal control relevant to my audit of the consolidated and separate financial statements, reported performance information and compliance with applicable legislation; however, my objective was not to express any form of assurance on it. I did not identify any significant deficiencies in internal control

*Auditor-General*

Pretoria  
31 July 2018





# EXECUTIVE REPORT



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# EXECUTIVE REPORT

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## INTRODUCTION

On behalf of the CSIR Board, we take pleasure in submitting our Annual Report and the audited annual financial statements of the CSIR Group for the financial year ended 31 March 2018 to Parliament, through the Minister of Science and Technology.

In the opinion of the CSIR Board, the financial statements fairly present the financial position of the CSIR Group as at 31 March 2018 and the results of its operations for that year.

### Statutory basis

As a statutory research council established by government, the CSIR is governed by the Scientific Research Council Act, 1988 (Act 46 of 1988). The organisation is listed as a Public Business Enterprise in terms of the Public Finance Management Act (PFMA), 1999 (Act 1 of 1999).

### The CSIR mandate

The CSIR's mandate is as stipulated in the Scientific Research Council Act, 1988 (Act 46 of 1988):

*The objects of the CSIR are, through directed and particularly multidisciplinary 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.*

*Extract from Scientific Research Council Act 46 of 1988*

The existence of a vibrant economy and a capable state is a pre-requisite for any sustainable solution to South Africa's developmental priorities. The CSIR conducts

research and development (R&D) work that is aimed at supporting industrial development, as well as enhancing the capabilities of government in the areas of service delivery, policy development and information management.

Scientific R&D plays a critical role in supporting the short-, medium- and long-term growth of the country's economy. In the short term, we need to conduct research for the developing and deploying of technologies that improve the efficiency and competitiveness of our existing enterprises. In the medium to long term we need to develop the industries and sectors, based, for example, on the use of new technologies or the beneficiation of local natural resources, that will grow the economy, as well as understand and mitigate the risks to long-term growth due to climate change and the mismanagement of our natural resources.

While sustained economic growth will most certainly address the issues of unemployment and poverty, dealing with the threat of inequality will require a strong and capable state. The CSIR sees its role as that of providing the scientific and technological innovations that will improve the ability of the state to efficiently deliver basic services, such as health, education, social security, access to energy and shelter, to all South Africans. Hence, combating material inequality, as well as the inequality of access to basic services remain crucial objectives to pursue.

### Income sources

The CSIR is funded through a combination of baseline and ring-fenced Parliamentary Grants (PG) that are channelled through the Department of Science and Technology (DST) and earns contract R&D income from both the public and private sectors, locally and internationally.

PG funding is invested in research programmes, research infrastructure, as well as R&D skills development. There are a number of policies and programmes that underpin the effective utilisation of PG funding.

# EXECUTIVE REPORT

## Strategic overview

The CSIR is mandated to utilise research and technological innovation to foster scientific and industrial development to contribute to the improved quality of life of the people of South Africa. Meeting this mandate requires that the CSIR responds to the triple challenge of unemployment, inequality and poverty that South Africa is faced with. The national government aims to address these challenges through a broad range of programmes, guided by the National Development Plan (NDP) and further articulated through Government's Programme of Action, including the 9-Point Plan and sector-specific initiatives. The CSIR aligns its strategy and R&D programme with these national plans, strategies and initiatives.

A key component of our work is to support, through technological innovation, the short, medium and long-term development of the South African economy. We will accomplish this by collaborating with industrial

partners, state-owned enterprises and other institutional stakeholders to identify opportunities to improve the efficiency and competitiveness of our existing industries, and to invest in the development of technologies that will underpin the industries of the future. To this end, the CSIR in 2017 started a strategic internal initiative called Project Synapse to define the CSIR's industrial development strategy. This strategy will drive the organisation's focus on industrial development initiatives to enhance the performance of the South African economy.

The CSIR's strategy is structured around a framework aligning organisational inputs, activities and outputs with this role and the mandate, as schematically laid out in Figure 1. The CSIR's role is further defined by organisational competences and capabilities, reinforced through an effective network of local and international research partnerships and collaborations.

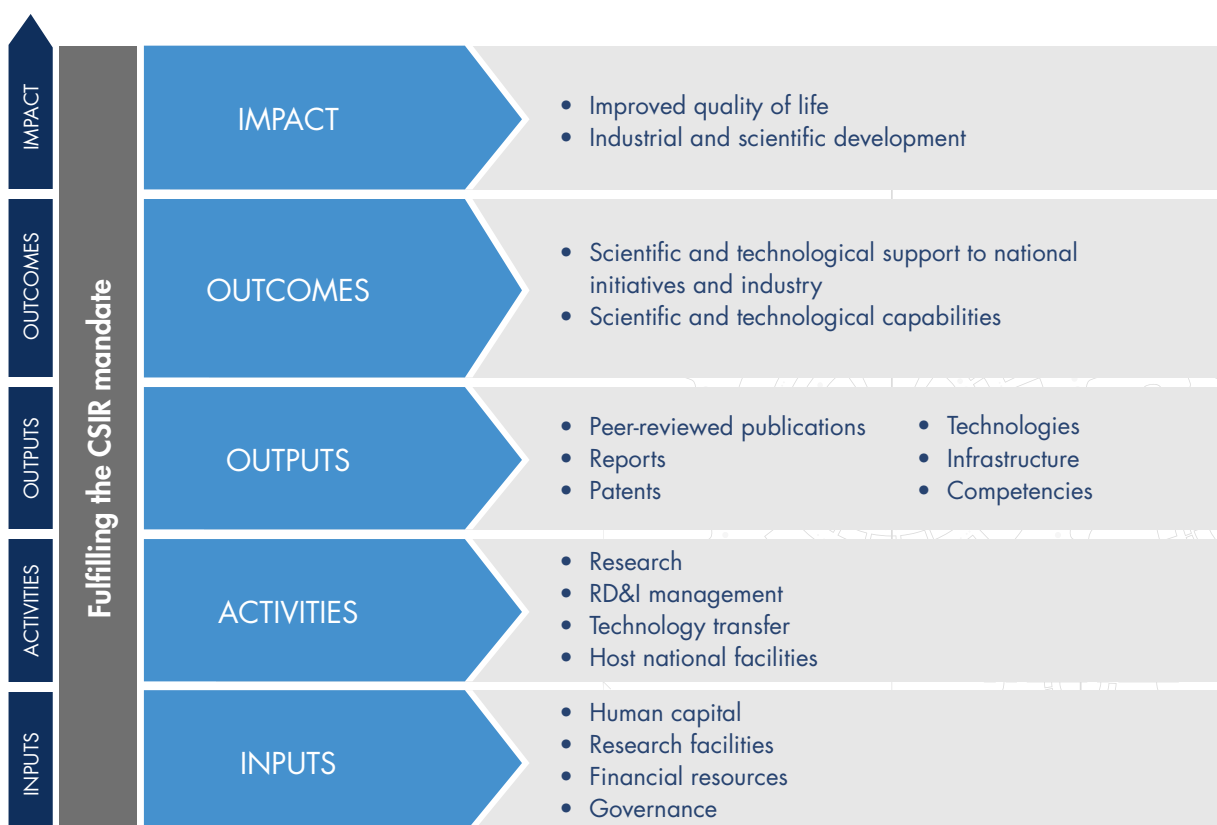


Figure 1: The CSIR's framework for fulfilling its mandate

# EXECUTIVE REPORT

The CSIR's Strategic Framework sets out the logical steps through which we take our inputs (people, processes and facilities) and undertake a set of activities (research and research management) to produce outputs (academic publications, reports and technologies). These outputs will then lead to a series of outcomes (scientific and technological development) that will ultimately result in an improved quality of life for all South Africans.

The CSIR has set the following three high-level strategic objectives in order to meet its mandate:

**Strategic objective 1: Conduct high-quality and relevant research and technological innovation to foster industrial and scientific development.** This strategic objective is achieved through the selection and implementation of a range of R&D programmes.

**Strategic objective 2: Build and transform human capital.** The CSIR's scientific and technical contributions are only possible through the skills and capabilities of our scientific staff, whom we refer to as our science, engineering and technology (SET) base. Therefore, the ongoing development, renewal and transformation of the SET base is of critical importance for the organisation. In addition, the CSIR is an important part of the National System of Innovation and contributes to the national imperative to develop human capital and the ongoing transformation of our society, through the development and training of our scientific base.

**Strategic objective 3: Maintain a financially sustainable and well-governed organisation.** Without a financially sustainable and well-governed organisation, our ability to contribute to national development through our scientific and technological work, over the long term, would be severely compromised. Therefore, the CSIR is committed to maintaining our record of good governance and continuing to operate in a sustainable manner.

The CSIR's R&D programme speaks to seven of the focus areas identified in the NDP:

- Economy and employment;
- Building a capable state;
- Economic and social infrastructure;

- Transition to a low-carbon economy;
- Building safer communities;
- Improving health; and
- Transforming human settlements.

## Economy and employment

The CSIR is well-positioned to play a key role in the national effort towards re-industrialisation, through a range of key capabilities that are aligned to national priorities, ranging from the beneficiation of key strategic minerals of abundance, through to the aerospace and defence sectors. The CSIR's responses range from the immediate (improving the efficiency of production processes, supporting local economic development through localisation programmes) to the medium term (the development of automation solutions for industrial processes, technologies for the beneficiation of local mineral resources, nanomanufacturing and agro-processing technologies), as well as interventions that may only pay off in the longer term (the development of large-scale engineering capabilities, industries based on bio-therapeutic manufacture and the development of enterprises using digital media technologies).

## Building a capable state

Our interventions in this area have focused on service delivery and its associated issues. The main problems we are attempting to address are:

- The lack of organisational capacity to support service delivery. This lack of capacity may take various forms, including the absence of coordinating or implementing agencies, or the shortage of specific technical or programme management skills.
- The absence of an integrated decision-support capability at all levels of government responsible for service delivery. This absence may lead to poor decisions with respect to the planning of service delivery interventions.
- The poor diffusion and uptake of potential technology-based service-delivery solutions. There are instances where potentially appropriate and effective technical solutions to service delivery problems have been developed by the CSIR, but are not being implemented.

# EXECUTIVE REPORT

## Economic and social infrastructure

To achieve sustainable and inclusive growth by 2030, South Africa needs to invest in a strong network of economic infrastructure designed to support the country's medium- and long-term objectives. There is a need to maintain and upgrade our existing infrastructure and to develop the technologies that will form the basis for the infrastructure of the future. South Africa's economic growth and its ability to provide basic services to its people will be undermined if there is no concerted effort to maintain and re-build our transport, water, energy, as well as information and communication technology infrastructure.

Our interventions in support of economic and social infrastructure take two forms – the development of policies and the design of technological solutions.

## Transition to a low-carbon economy

Our long-term goal is to support South Africa's transition into a low-carbon and resilient economy. The CSIR is working on improving the measurement and management of our natural resources; our ability to understand the long-term effects of climate change; therefore, assisting the government with the formulation of mitigation and adaptation strategies. The CSIR is also supporting the development of a green economy and renewable energy technologies, as well as their integration into the national energy system.

## Building safer communities

The CSIR's interventions focus on supporting the acquisition and integration of technology by our security forces; the development of systems for the effective sharing of information across different components of the security forces; the continuous improvement of South African Air Force's air capability; the protection of air and naval assets against guided weapons; the support of specialised, highly mobile combat ready forces; the development of national surveillance capabilities and protection against cyber-security threats.

## Improving health

The CSIR's work in support of health ranges from technical support to the National Health Insurance initiative, particularly with respect to the security, use and transfer of health-related data; the development of interconnected and interoperable point-of-care devices; the use of technology in support of diagnostic functions; the development of vaccines using bio-therapeutic manufacturing methods and the development of new methods to understand, manage and diagnose disease mechanisms at the cellular and molecular level.

## Transforming human settlements

The CSIR is supporting metropolitan areas and municipalities with spatial planning, as well as the management of infrastructure and the long-term transition to greener and smarter economies.

Fast-growing cities are not performing optimally, often due to ineffective spatial layout and management. In addition, there is a lack of capability and tools in government, as well as evidence-based decision-making support, resulting in poor planning, design and management, decision-making and spatial prioritisation of interventions (i.e. housing, infrastructure investment, risk mitigation, social support, economic development interventions, etc.). There is a major need to plan and prioritise infrastructure investment timeously with an understanding of impact on development priorities and long-term implications. In addition, the performance of the built environment system in South Africa is suboptimal due to a number of factors, including the legacy of apartheid.

The R&D work of the CSIR is supported by a number of enabling conditions and processes. These include support for technology transfer, strategic partnerships with state-owned enterprises, developmental agencies, the private sector and other research and technology organisations.



# EXECUTIVE REPORT

## OVERVIEW OF 2017/18 PERFORMANCE

### Key performance indicators and performance reporting

The CSIR enters into a Shareholder's Compact agreement with the DST on an annual basis. The Compact contains a long-term strategic plan and a detailed operational plan with specific Key Performance Indicators (KPIs). The setting of KPI targets is supported by ongoing benchmarking against similar research organisations and trend analyses. Quarterly reports to the DST are the main forms by which the performance against these indicators is monitored.

The CSIR's KPIs provide a high-level basket of measures that reflect progress towards the attainment of the strategic objectives of the organisation. These strategic objectives can be summarised as follows:

- 1. Scientific and technical:** These KPIs are a measure of the extent to which we conduct research and technological innovation to foster industrial and scientific development. The KPIs that are linked to this strategic objective measure the annual aggregated outputs that are produced by our research programmes. These are research publications, patents, technology demonstrators, the income earned from R&D performed on behalf of other parties and the income earned from royalties or the licensing of CSIR technologies.
- 2. Learning and growth:** These KPIs measure the extent to which we are able to build and transform human capital. The CSIR's scientific and technical contributions are only possible through the skills and capabilities of our scientific staff – our science, engineering and technology (SET) base. Therefore, the ongoing development, renewal and transformation of the SET base is of critical importance for the organisation. The KPIs that are linked to this strategic objective include the overall size of the SET base, the number and percentage of that base with doctoral level qualifications and the number and percentage of the SET base that are black and female South Africans, respectively. In addition to these are KPIs that include the number and percentage of that base that are Chief Researchers and Principal Researchers respectively.

- 3. Finance and governance:** Without a well-run and financially sustainable organisation, our ability to contribute to national development through our scientific and technological work would be severely compromised. The KPIs linked to this strategic objective include the total income earned by the organisation and the net profit that we are able to generate, the level of investment we make to maintain our infrastructure, our Broad-Based Black Economic Empowerment (B-BBEE) status and our safety record.

During the 2017/18 financial year, the CSIR met or exceeded the targets for 13 of its 28 KPIs. In particular, the CSIR met 67% (4/6) of the indicators that measure our scientific and technical outputs; 41% (7/17) of indicators that measure growth, transformation and the skills profile of our SET staff and 40% (2/5) of the indicators that measure our financial and governance performance.

### Scientific and technical

The CSIR met or exceeded the annual targets for four of the six indicators in this category.

**Table 1: CSIR performance – scientific and technical**

Indicator	2017/18 Target	2017/18 Actual
Publication equivalents	≥500	546
Journal articles	≥310	317
New technology demonstrators	≥ 40	60
New patents granted	≥ 15	19
Contract income	R2 128 m	R1 771 m
Royalty and licence income	≥ R5.17 m	R4.6 m

# EXECUTIVE REPORT

The CSIR continues to place emphasis on the quality and quantity of our research outputs in the form of peer-reviewed publications, such as journal articles and conference papers, technology demonstrators and patents. The CSIR produced 546 publication equivalents (of which 317 are journal articles), exceeding our target of 500 publication equivalents.

Technology demonstrators are a lead indicator of technology transfer and the excellent performance in exceeding our target of 40 further illustrates the continued efforts that the CSIR is making in this area.

The CSIR was granted 19 international patents, exceeding our target of 15. The CSIR will continue to grow its technology inventory and transfer to the market in order to derive royalty income.

The decline in public sector income due to an apparent shift in priorities and changes in procurement requirements, imposed very late by National Treasury on SOEs and government departments, have had a detrimental impact on the contract income derived by the CSIR from these governmental sources. The CSIR generated R1 771 million in contract income, which is significantly lower than the target of R2 128 million.

## Learning and growth

The CSIR met or exceeded the annual targets for seven of the 17 indicators in this category and missed the targets for the number of SET staff, black SET staff, female SET staff, SET staff with PhDs, total number of Chief Researchers, the total number of Principal Researchers, and the number of Principal Researchers who are female.

**Table 2: CSIR performance – learning and growth**

Indicator	2017/18 Target	2017/18 Actual
Total size of SET base	2 100	1 850
Number of black South Africans in SET base	1 280	1 139
Percentage of SET base who are black South Africans	61	59
Number of female South Africans in SET base	785	674
Percentage of SET base who are female South Africans	≥ 37	35
Number of SET base with Doctorates	411	339
Percentage of SET base with Doctorates	20	17
Total Chief Researchers	22	21
Number of Chief Researchers who are black	2	2
Percentage of Chief Researchers who are black	9.09	9.52
Number of Chief Researchers who are female	4	4
Percentage of Chief Researchers who are female	18	19
Total Principal Researcher	240	202
Number of Principal Researchers who are black	53	53
Percentage of Principal Researchers who are black	22	26
Number of Principal Researchers who are female	45	38
Percentage of Principal Researchers who are female	19	19

# EXECUTIVE REPORT

The CSIR staff headcount has been consistently on the decline since the beginning of the 2017/18 financial year, resulting in the 2017/18 targets for SET staff, black SET staff and female SET staff not being achieved. This is a result of the general decline in the economic outlook in the country and the subsequent decline in income for the CSIR. Therefore, the recruitment and appointment of new staff were constrained considerably in the last two quarters of the year, which had an impact on all learning and growth targets for the year. Of particular importance is also the fact that in this financial year, the number of involuntary exits is significantly higher, at 44.7% of the total exits, as a result of the restructuring of the CSIR Biosciences Unit.

The CSIR, like many organisations, has had challenges with transformation in its female staff complement for many years, particularly female SET staff. The total number of female staff who are South African in general has decreased over the past year to 1 163 (44% of total staff), a decline of 2% compared to the number of female (South African) staff of 1 187 at the end of the previous financial year (31 March 2017). The number of female SET staff who are South African decreased over the past year from 702 to 674, making it 111 below the target of 785 (37% of total SET staff) for 2017/18.

It should be noted that a significant portion of the CSIR workforce is young and thus may be more amenable to enticements to explore other work experiences outside of the CSIR or further career opportunities in industry. Through the Human Capital Portfolio, the CSIR has begun working on a retention strategy to mitigate against the loss of staff

and ensure talent development across all levels. To that effect, there is a concerted effort across the organisation to invest in mentorship and coaching programmes to bolster scientific and technical leadership that assist in capability development and retention of institutional knowledge.

## Financial and governance

The CSIR met or exceeded its targets for two of the five indicators in this category. The indicators for which the targets were not achieved were as follows:

- Total income for the period amounted to R2 504 million and is R359 million below target due to an apparent shift in government priorities and changes in procurement requirements imposed by National Treasury on SOEs and government departments, which have had a detrimental effect on the CSIR's financial position.
- A net loss of R14 million was recorded against a profit target of R64 million.
- The CSIR only managed to achieve a Level 3 B-BBEE status against a Level 2 target. Additional measures to ensure that we regain the Level 2 status in future have been put in place. The organisation is due for a B-BBEE audit later in the 2018/19 financial year.

It is evident that certain areas of the CSIR are no longer financially sustainable and this is a result of fundamental strategic and/or operational deficiencies that have been left unattended for a long time. The areas of the CSIR that are not sustainable have been, and are still, receiving urgent attention.

**Table 3: CSIR performance – financial and governance**

Indicator	2017/18 Target	2017/18 Actual
Total income	R2 863 m	R2 504 m
Investment in property, plant and equipment	≥R108 m	R108 m
Net profit/(loss)	R64 m	(R14 m)
B-BBEE rating	Level 2 contributor	Level 3 contributor
Disabling injury frequency rate	<0.2	0.11

# EXECUTIVE REPORT

## HUMAN RESOURCES OVERVIEW

At the end of the 2017/18 financial year, the CSIR had a staff complement of 2 618 employees<sup>1</sup>. Table 4 shows the distribution of employees across the different occupational levels.

The majority (82%) of CSIR employees are employed in the professional and skilled categories. The CSIR is committed to the demographic transformation of its workforce. The composition of our workforce by gender, race and nationality is illustrated in Table 5.

Approximately 5% (136 employees) of our workforce comprises non-South Africans, the majority of whom are employed as technical professionals. Black South Africans account for 68% (1 771 employees) of all employees, with black male South Africans accounting for 35% and black female South Africans accounting for 33% of all employees.

**Table 4: CSIR employees by occupational level – March 2018**

Occupational level	Total
A. Top	11
B. Senior	99
C. Professional	1 223
D. Skilled	916
E. Semi-skilled	338
F. Unskilled	31
<b>Total</b>	<b>2 618</b>

**Table 5: CSIR employee demographics by gender, race and nationality – March 2018**

Occupational level	Male					Female				
	A	C	I	W	N-SA	A	C	I	W	N-SA
A. Top	4	0	0	1	1	3	0	0	0	2
B. Senior	20	5	12	31	10	6	1	2	11	1
C. Professional	235	31	74	347	84	171	19	44	188	30
D. Skilled	287	15	32	34	3	387	31	34	88	5
E. Semi-skilled	152	17	2	3	0	133	20	3	8	0
F. Unskilled	15	2	0	0	0	14	0	0	0	0
<b>Total</b>	<b>713</b>	<b>70</b>	<b>120</b>	<b>416</b>	<b>98</b>	<b>714</b>	<b>71</b>	<b>83</b>	<b>295</b>	<b>38</b>

A – African C – Coloured I – Indian W – White N-SA – Non-South African

<sup>1</sup> Employees include permanent and contract employees but exclude vacation students



# EXECUTIVE REPORT

## Staff qualification profile

Three hundred and forty-eight (348) CSIR employees have doctoral qualifications and 631 have Master's-level qualifications. In the 2016/17 financial year, the corresponding values were 359 and 637, respectively.

Table 6 shows the distribution of these qualifications according to some key demographic groups. The proportion of doctorates that are black or female

South Africans is relatively low (38% and 25%, respectively) and the CSIR is committed to the long-term efforts needed to improve this situation. The corresponding figures for master's-level qualifications are more positive – 41% of employees at this level are female South Africans and 55% are black South Africans. The comparative figures for the 2016/17 financial year are 40% and 53%, respectively.

**Table 6: CSIR staff qualification – March 2018**

Qualification	Doctorate	Master's	Master's/Doctorate
<b>Total</b>	<b>348</b>	<b>631</b>	<b>979</b>
SA female	88	258	346
<i>Percentage of all</i>	<i>25</i>	<i>41</i>	<i>35</i>
SA male	183	328	511
<i>Percentage of all</i>	<i>53</i>	<i>52</i>	<i>52</i>
SA black	131	350	481
<i>Percentage of all</i>	<i>38</i>	<i>55</i>	<i>49</i>

## Ongoing qualifications

The CSIR is committed to supporting the academic development and transformation of its staff. Table 7 shows the number and distribution of staff studying for higher (Master's or doctoral) degrees. At the end of the 2017/18

financial year, 385 employees were enrolled for higher degrees (2016/17: 438); 52% of these were female South Africans (2016/17: 48%) and 75% were black South Africans (2016/17: 72%).

**Table 7: CSIR staff studying for higher degrees – 2018**

Staff enrolled for	Doctorate	Master's	Master's/Doctorate
<b>Total</b>	<b>157</b>	<b>228</b>	<b>385</b>
SA female	90	109	199
<i>Percentage of all enrolled</i>	<i>57</i>	<i>48</i>	<i>52</i>
SA male	67	119	186
<i>Percentage of all enrolled</i>	<i>43</i>	<i>52</i>	<i>48</i>
SA black	109	179	288
<i>Percentage of all enrolled</i>	<i>69</i>	<i>79</i>	<i>75</i>

# EXECUTIVE REPORT

## FINANCIAL PERFORMANCE OVERVIEW

This has been a particularly challenging year for the CSIR from a financial sustainability perspective and consequently we have not achieved three of the five targets relating to financial sustainability and governance.

The total operating income of the CSIR amounted to R2.5 billion (2016/17: R2.7 billion). The PG recognised as income in 2017/18 amounted to R722.4 million, an increase of 1.2% from the prior year's amount of R714.1 million.

The CSIR's total contract income amounted to R1.77 billion (2016/17: R1.93 billion). This includes a R71 million (2016/17: R70.9 million) ring-fenced allocation from the DST. Significant investments in grant-funded property, plant and equipment were made in the 2017/18 financial year. The revenue for these investments is included in the CSIR's contract income. The decrease in contract income,

excluding the revenue for investments in grant-funded property, plant and equipment of R20.7 million (2016/17: R71.8 million), amounts to 6%.

The continued investment in scientific infrastructure and equipment remains a priority to ensure that world-class facilities and equipment are acquired and maintained. Over the past five financial years, R904.3 million has been invested in property, plant and equipment, with R108.1 million invested in the 2017/18 financial year.

The net loss for the CSIR amounts to R13.8 million (2016/17: R77.2 million profit).

CSIR cash and cash equivalents were at R1.094 billion at the end of March 2018, compared to R1.099 billion as at the end of March 2017. The current ratio is greater than one, with current assets exceeding current liabilities.

## Five-year review of income and expense indicators

	2018 R'000	2017 R'000 restated	2016 R'000	2015 R'000	2014 R'000
<b>Total income</b>	<b>2 542 617</b>	<b>2 735 473</b>	<b>2 736 550</b>	<b>2 442 590</b>	<b>2 202 595</b>
Parliamentary Grant recognised as income	722 373	714 105	680 485	675 340	618 849
Contract income, royalty income, other income and net finance income	<b>1 820 244</b>	<b>2 021 368</b>	<b>2 056 065</b>	<b>1 767 250</b>	<b>1 583 746</b>
Local private and international sectors	371 724	348 462	320 950	348 388	361 353
Local public sector	1 399 783	1 583 293	1 645 798	1 331 042	1 134 470
Royalties and other income	10 255	45 996	49 347	30 202	38 766
Net finance income	38 482	43 617	39 970	57 618	49 157
<b>Total expenditure</b>	<b>2 557 161</b>	<b>2 659 155</b>	<b>2 677 568</b>	<b>2 390 203</b>	<b>2 151 664</b>
Employees' remuneration	1 538 913	1 487 899	1 468 155	1 339 345	1 229 566
Operating expenses	953 158	1 109 512	1 154 910	1 002 234	874 885
Depreciation	65 090	61 744	54 503	48 624	47 213

# EXECUTIVE REPORT

## Five-year ratio analysis

	2018	2017 Restated	2016	2015	2014
<b>Operating expenses</b>					
Remuneration as a percentage of total income (excluding finance income)	61.5%	55.3%	54.4%	56.2%	57.1%
Remuneration as a percentage of total operating expenditure	60.2%	56.0%	54.8%	56.0%	57.1%
<b>Asset management</b>					
Investment in property, plant and equipment (Rm)	108.1	143.8	308.0	209.7	134.7
Investment in property, plant and equipment as a percentage of revenue	4.3%	5.4%	11.6%	8.9%	6.3%
Net asset turn	2.5	2.7	2.9	2.8	2.7
Current ratio	1.2	1.2	1.1	1.1	1.1
<b>Cash flow</b>					
Net cash from operating activities (R'000)	80 846	96 642	138 869	41 407	137 626
Cash and cash equivalents at end of year (including long-term fixed deposits) (R'000)	1 093 595	1 099 124	1 005 241	975 952	1 043 427

## Definitions

*Net asset turn:* Total revenue (including finance income) divided by net assets

*Current ratio:* Current assets divided by current liabilities

The post-retirement medical benefit expense and liability and the effects of the adoption of IFRS, IAS39:

Financial instruments – recognition and measurement have been excluded for the comparison of financial indicators.



# ANNUAL FINANCIAL STATEMENTS



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# Statements of profit or loss and other comprehensive income

FOR THE YEAR ENDED 31 MARCH 2018

	Notes	GROUP		CSIR	
		2018	2017	2018	2017
		R'000	Restated R'000	R'000	Restated R'000
Revenue	2	2 498 486	2 651 163	2 498 486	2 651 305
Other income		5 677	40 559	5 649	40 551
<b>Total operating income</b>		<b>2 504 163</b>	<b>2 691 722</b>	<b>2 504 135</b>	<b>2 691 856</b>
<b>Expenditure</b>					
Employees' remuneration		1 538 913	1 487 899	1 538 913	1 487 899
Depreciation	6	65 091	61 745	65 090	61 744
Operating expenses		950 083	1 108 042	953 158	1 109 512
<b>Total operating expenditure</b>		<b>2 554 087</b>	<b>2 657 686</b>	<b>2 557 161</b>	<b>2 659 155</b>
Finance income	4	38 955	53 166	38 483	52 578
Finance expense	4	(1)	(8 961)	(1)	(8 961)
Share of loss of joint ventures and associates	8	(3 110)	(1 833)	–	–
<b>(Loss)/profit before income tax</b>	3	<b>(14 080)</b>	<b>76 408</b>	<b>(14 544)</b>	<b>76 318</b>
Income tax expense	5	–	(41)	–	–
<b>(Loss)/profit for the year</b>		<b>(14 080)</b>	<b>76 367</b>	<b>(14 544)</b>	<b>76 318</b>
<b>Other comprehensive income</b>					
Not subsequently reclassified to profit or loss:					
Remeasurement of post-retirement medical benefit obligation	17.3	738	926	738	926
<b>Other comprehensive income for the year</b>		<b>738</b>	<b>926</b>	<b>738</b>	<b>926</b>
<b>Total comprehensive (loss)/income for the year</b>		<b>(13 342)</b>	<b>77 293</b>	<b>(13 806)</b>	<b>77 244</b>
<b>(Loss)/profit attributable to:</b>					
Stakeholders of the parent		(14 080)	76 367	(14 544)	76 318
<b>Total comprehensive (loss)/income attributable to:</b>					
Stakeholders of the parent		(13 342)	77 293	(13 806)	77 244

# Statements of financial position

AS AT 31 MARCH 2018

		GROUP		CSIR	
		2018	2017	2018	2017
			Restated		Restated
Notes		R'000	R'000	R'000	R'000
<b>ASSETS</b>					
<b>Non-current assets</b>		<b>795 762</b>	789 219	<b>800 474</b>	794 654
Property, plant and equipment	6	<b>784 364</b>	762 908	<b>784 364</b>	762 907
Interest in joint ventures and associates	8	<b>9 105</b>	20 216	<b>9 105</b>	20 216
Interest in subsidiaries	9	<b>–</b>	–	<b>4 712</b>	5 436
Trade and other receivables	11	<b>2 293</b>	6 095	<b>2 293</b>	6 095
<b>Current assets</b>		<b>1 436 638</b>	1 467 661	<b>1 429 538</b>	1 460 260
Trade and other receivables	11	<b>222 377</b>	275 828	<b>222 291</b>	275 777
Inventory and contracts in progress	12	<b>113 652</b>	85 359	<b>113 652</b>	85 359
Cash and cash equivalents	23	<b>1 100 609</b>	1 106 474	<b>1 093 595</b>	1 099 124
<b>TOTAL ASSETS</b>		<b>2 232 400</b>	2 256 880	<b>2 230 012</b>	2 254 914
<b>EQUITY AND LIABILITIES</b>					
<b>Reserves</b>		<b>994 458</b>	1 007 800	<b>992 070</b>	1 005 876
Retained earnings		<b>994 458</b>	1 007 800	<b>992 070</b>	1 005 876
<b>Non-current liabilities</b>		<b>10 963</b>	10 764	<b>10 963</b>	10 764
Post-retirement medical benefits	17.3	<b>10 963</b>	10 764	<b>10 963</b>	10 764
<b>Current liabilities</b>		<b>1 226 979</b>	1 238 316	<b>1 226 979</b>	1 238 274
Advances received	14	<b>849 477</b>	791 607	<b>849 477</b>	791 607
Trade and other payables	15	<b>377 502</b>	446 709	<b>377 502</b>	446 667
<b>TOTAL EQUITY AND LIABILITIES</b>		<b>2 232 400</b>	2 256 880	<b>2 230 012</b>	2 254 914

# Statements of changes in equity

FOR THE YEAR ENDED 31 MARCH 2018

	Retained earnings R'000	Total R'000
<b>GROUP</b>		
<b>Balance at 31 March 2016</b>	930 507	<b>930 507</b>
Total comprehensive income (restated)	77 293	<b>77 293</b>
Profit for the year (restated)	76 367	<b>76 367</b>
Other comprehensive income for the year:		
Remeasurement of post-retirement medical benefit obligation	926	<b>926</b>
<b>Balance at 31 March 2017 (restated)</b>	1 007 800	<b>1 007 800</b>
Total comprehensive loss	(13 342)	<b>(13 342)</b>
Loss for the year	(14 080)	<b>(14 080)</b>
Other comprehensive income for the year:		
Remeasurement of post-retirement medical benefit obligation	738	<b>738</b>
<b>Balance at 31 March 2018</b>	<b>994 458</b>	<b>994 458</b>
<b>CSIR</b>		
<b>Balance at 31 March 2016</b>	928 632	<b>928 632</b>
Total comprehensive income (restated)	77 244	<b>77 244</b>
Profit for the year (restated)	76 318	<b>76 318</b>
Other comprehensive income for the year:		
Remeasurement of post-retirement medical benefit obligation	926	<b>926</b>
<b>Balance at 31 March 2017 (restated)</b>	1 005 876	<b>1 005 876</b>
Total comprehensive loss	(13 806)	<b>(13 806)</b>
Loss for the year	(14 544)	<b>(14 544)</b>
Other comprehensive income for the year:		
Remeasurement of post-retirement medical benefit obligation	738	<b>738</b>
<b>Balance at 31 March 2018</b>	<b>992 070</b>	<b>992 070</b>

# Statements of cash flows

FOR THE YEAR ENDED 31 MARCH 2018

		GROUP		CSIR	
		2018	2017	2018	2017
	Notes	R'000	Restated R'000	R'000	Restated R'000
<b>Cash flows from operating activities</b>					
Cash receipts from external customers		1 837 205	1 981 437	1 825 922	1 963 409
Parliamentary Grant received		729 359	694 827	729 359	694 827
Cash paid to suppliers and employees		(2 529 110)	(2 617 452)	(2 508 160)	(2 607 625)
<b>Cash generated from operating activities</b>	22	<b>37 454</b>	58 812	<b>47 121</b>	50 611
Finance income received	4	<b>43 737</b>	55 538	<b>33 726</b>	54 992
Finance expense paid	4	(1)	(8 961)	(1)	(8 961)
Income taxes paid	5	–	(45)	–	–
<b>Net cash from operating activities</b>		<b>81 190</b>	105 344	<b>80 846</b>	96 642
<b>Cash flows from investing activities</b>					
Acquisition of property, plant and equipment	6	(87 380)	(71 987)	(87 380)	(71 987)
Proceeds on disposal of property, plant and equipment		<b>3 347</b>	67 043	<b>3 347</b>	67 033
Decrease in subsidiary loans		–	–	<b>680</b>	9 000
Increase in interest in joint ventures and associates		(3 608)	(9 085)	(3 608)	(9 085)
Increase in available-for-sale financial asset	10	–	(4 861)	–	(4 861)
<b>Net cash utilised in investing activities</b>		<b>(87 641)</b>	(18 890)	<b>(86 961)</b>	(9 900)
<b>Cash flows from financing activities</b>					
<b>Net cash utilised in financing activities</b>		–	–	–	–
<b>Unrealised exchange gains/(losses) on foreign cash balances</b>		<b>586</b>	7 141	<b>586</b>	7 141
<b>Net (decrease)/increase in cash and cash equivalents</b>		<b>(5 865)</b>	93 595	<b>(5 529)</b>	93 883
<b>Cash and cash equivalents at beginning of the year</b>		<b>1 106 474</b>	1 012 879	<b>1 099 124</b>	1 005 241
<b>Cash and cash equivalents at end of the year</b>	23	<b>1 100 609</b>	1 106 474	<b>1 093 595</b>	1 099 124



# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 1 PRINCIPAL ACCOUNTING POLICIES

The CSIR is a national government business enterprise (enacted by The Scientific Research Council Act, Act 46 of 1988) domiciled in the Republic of South Africa. The address of the CSIR's principal place of business is Meiring Naudé Road, Brummeria, Pretoria. The CSIR undertakes 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.

The consolidated annual financial statements of the Group as at and for the year ended 31 March 2018 comprise the company and its subsidiaries (together referred to as the Group) and the Group's interest in associates and jointly controlled entities.

### 1.1 Basis of presentation

The consolidated annual financial statements have been prepared in accordance with International Financial Reporting Standards (IFRS) as issued by the International Accounting Standards Board (IASB) and the Public Finance Management Act, 1999 (Act 1 of 1999) as amended by Act 29 of 1999.

The policies set out as follows have been consistently applied to all the years presented.

The preparation of financial statements requires management to make judgements, estimates and assumptions that affect the application of policies and reported amounts of assets and liabilities, income and expenses. The estimates and associated assumptions are based on historical experience and various other factors that are believed to be reasonable under the circumstances, the result of which forms the basis of making judgements about carrying values of assets and liabilities that are not readily apparent from other sources. Actual results may differ from these estimates.

Estimates and underlying assumptions are reviewed on an ongoing basis. Revisions to accounting estimates are recognised in the period in which the estimate is revised and in any future periods affected.

The consolidated annual financial statements are presented in South African rand (R), which is the

CSIR's functional currency, and are rounded off to the nearest thousand.

### 1.2 Basis of consolidation

#### Subsidiaries

Subsidiaries are all entities (including structured entities) over which the Group has control. The Group controls an entity when the Group is exposed to, or has rights to, variable returns from its involvement with the entity and has the ability to affect those returns through its power over the entity. Subsidiaries are fully consolidated from the date on which control is transferred to the Group. They are deconsolidated from the date that control ceases.

The Group applies the acquisition method to account for business combinations. The consideration transferred for the acquisition of a subsidiary is the fair values of the assets transferred, the liabilities incurred to the former owners of the acquiree and the equity interests issued by the Group. The consideration transferred includes the fair value of any asset or liability resulting from a contingent consideration arrangement. Identifiable assets acquired and liabilities and contingent liabilities assumed in a business combination are measured initially at their fair values at the acquisition date. The Group recognises any non-controlling interest in the acquiree on an acquisition-by-acquisition basis, either at fair value or at the non-controlling interest's proportionate share of the recognised amounts of the acquiree's identifiable net assets.

Acquisition-related costs are expensed as incurred.

If the business combination is achieved in stages, the acquisition date carrying value of the acquirer's previously held equity interest in the acquiree is re-measured to fair value at the acquisition date; any gains or losses arising from such re-measurement are recognised in profit or loss.

Any contingent consideration to be transferred by the Group is recognised at fair value at the acquisition date. Subsequent changes to the fair value of the contingent consideration that is deemed to be an asset or liability is recognised in accordance with IAS 39 either in profit or loss or as a change to other comprehensive income. Contingent consideration

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

### **Subsidiaries (continued)**

that is classified as equity is not re-measured, and its subsequent settlement is accounted for within equity.

The excess of the consideration transferred, the amount of any non-controlling interest in the acquiree and the acquisition-date fair value of any previous equity interest in the acquiree over the fair value of the identifiable net assets acquired is recorded as goodwill. If the total of consideration transferred, non-controlling interest recognised and previously held interest measured is less than the fair value of the net assets of the subsidiary acquired in the case of a bargain purchase, the difference is recognised directly in profit or loss.

Inter-company transactions, balances and unrealised gains on transactions between group companies are eliminated. Unrealised losses are also eliminated. When necessary, amounts reported by subsidiaries have been adjusted to conform with the Group's accounting policies.

Investments in subsidiaries are measured at cost less accumulated impairment losses in the CSIR's annual financial statements.

### **Changes in ownership interests in subsidiaries without change of control**

Transactions with non-controlling interests that do not result in loss of control are accounted for as equity transactions – that is, as transactions with the owners in their capacity as owners. The difference between fair value of any consideration paid and the relevant share acquired of the carrying value of net assets of the subsidiary is recorded in equity. Gains or losses on disposals to non-controlling interests are also recorded in equity.

### **Disposal of subsidiaries**

When the Group ceases to have control, any retained interest in the entity is remeasured to its fair value at the date when control is lost, with the change in carrying amount recognised in profit or loss. The fair value is the initial carrying amount for the purposes of subsequently accounting for the retained interest as an associate, joint venture or financial asset. In addition, any amounts previously recognised in other comprehensive income in respect of that entity are accounted for as if the Group had directly disposed

of the related assets or liabilities. This may mean that amounts previously recognised in other comprehensive income are reclassified to profit or loss.

### **Associates**

Associates are all entities over which the Group has significant influence but not control, generally accompanying a shareholding of between 20% and 50% of the voting rights. Investments in associates are accounted for using the equity method of accounting. Under the equity method, the investment is initially recognised at cost, and the carrying amount is increased or decreased to recognise the investor's share of the profit or loss of the investee after the date of acquisition. The Group's investment in associates includes goodwill identified on acquisition.

If the ownership interest in an associate is reduced but significant influence is retained, only a proportionate share of the amounts previously recognised in other comprehensive income is reclassified to profit or loss where appropriate.

The Group's share of post-acquisition profit or loss is recognised in profit or loss, and its share of post-acquisition movements in other comprehensive income is recognised in other comprehensive income with a corresponding adjustment to the carrying amount of the investment. When the Group's share of losses in an associate equals or exceeds its interest in the associate, including any other unsecured receivables, the Group does not recognise further losses, unless it has incurred legal or constructive obligations or made payments on behalf of the associate.

The Group determines at each reporting date whether or not there is any objective evidence that the investment in the associate is impaired. If this is the case, the Group calculates the amount of impairment as the difference between the recoverable amount of the associate and its carrying value and recognises the amount adjacent to share of profit/loss of associates in profit or loss.

Profits and losses resulting from upstream and downstream transactions between the Group and its associate are recognised in the Group's financial statements only to the extent of unrelated investor's interests in the associates. Unrealised losses are

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

### **Associates (continued)**

eliminated unless the transaction provides evidence of an impairment of the asset transferred. Accounting policies of associates have been changed where necessary to ensure consistency with the policies adopted by the Group.

Dilution gains and losses arising in investments in associates are recognised in profit or loss.

Investments in associates are measured at cost less accumulated impairment losses in the CSIR's annual financial statements.

### **Joint arrangements**

Under IFRS 11 investments in joint arrangements are classified as either joint operations or joint ventures depending on the contractual rights and obligations of each investor. The CSIR Group has assessed the nature of its joint arrangements and determined them to be joint ventures. Joint ventures are accounted for using the equity method.

Under the equity method of accounting, interests in joint ventures are initially recognised at cost and adjusted thereafter to recognise the Group's share of the post-acquisition profits or losses and movements in other comprehensive income. When the Group's share of losses in a joint venture equals or exceeds its interests in the joint ventures (which includes any long-term interests that, in substance, form part of the Group's net investment in the joint ventures), the Group does not recognise further losses, unless it has incurred obligations or made payments on behalf of the joint ventures.

Unrealised gains on transactions between the Group and its joint ventures are eliminated to the extent of the Group's interest in the joint ventures. Unrealised losses are also eliminated unless the transaction provides evidence of an impairment of the asset transferred. Accounting policies of the joint ventures have been changed where necessary to ensure consistency with the policies adopted by the Group.

Investments in joint ventures are measured at cost less accumulated impairment losses in the CSIR's annual financial statements.

## 1.3 Foreign currencies

### **Foreign operations**

All foreign subsidiaries of the CSIR are foreign operations. There are no foreign subsidiaries in the period covered by this set of annual financial statements.

The financial statements of foreign subsidiaries are translated into South African rand as follows:

- Assets and liabilities, including goodwill and fair value adjustments on acquisition, at rates of exchange ruling at the reporting date.
- Revenue, expenditure and cash flow items at the average rates of exchange during the relevant financial year (the average rates approximate exchange rates at the various dates).

Differences arising on translation are recognised in other comprehensive income and presented in equity as non-distributable reserves called a foreign currency translation reserve (FCTR). When a foreign operation is disposed of, in part or in full, the relevant amount in the FCTR is transferred to profit or loss.

Foreign exchange gains and losses arising from a monetary item receivable from or payable to a foreign operation, the settlement of which is neither planned nor likely in the foreseeable future, are considered to form part of a net investment in a foreign operation and are recognised directly in other comprehensive income and presented in equity in the FCTR.

### **Foreign currency transactions and balances**

Transactions in foreign currencies are converted to South African rand at the rate of exchange ruling at the date of the transactions. Monetary assets and liabilities denominated in foreign currencies are translated into South African rand using the rates of exchange ruling at the reporting date. The resulting exchange differences are recognised in profit or loss. Non-monetary assets and liabilities measured at fair value are translated at foreign exchange rates ruling at the date the fair value was determined.

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

### 1.4 Property, plant and equipment

#### **Owned assets**

Land is stated at cost less accumulated impairment losses. Buildings, equipment and vehicles are stated at cost less accumulated depreciation and accumulated impairment losses. Cost includes expenditure directly attributable to acquisition.

The cost of self-constructed assets includes the cost of materials, direct labour, the initial estimate, where relevant, of the costs of dismantling and removing the items and restoring the site on which these are located and an appropriate proportion of production overheads.

Where parts of an item of property, plant and equipment have different useful lives, these are accounted for as separate items (major components) of property, plant and equipment.

Gains and losses on disposal of an item of property, plant and equipment are determined by comparing proceeds from disposal with the carrying amount of property, plant and equipment and are recognised in profit or loss.

#### **Subsequent costs**

The Group recognises in the carrying amount of an item of property, plant and equipment, the cost of replacing a part of such an item when that cost is incurred, if it is probable that the future economic benefits embodied in the item will flow to the Group and the cost of the item can be measured reliably. The carrying amount of the replaced part is derecognised. The costs of the day-to-day servicing of property, plant and equipment are recognised in profit or loss as incurred.

#### **Depreciation**

Depreciation is based on cost less residual value and is calculated on the straight-line method from the day the assets are available for use, at rates considered appropriate to write off carrying values over the estimated useful lives of the assets, except for assets specifically acquired for a contract, which are depreciated over the life of the contract. Land is not depreciated.

The estimated lives of the main categories of property, plant and equipment for the current and comparative period are as follows:

- Land: Indefinite
- Buildings: 90 years
- Equipment: 3 to 20 years
- Vehicles: 10 years

Depreciation methods, useful lives and current residual values, if not insignificant, are reassessed annually.

### 1.5 Intangible assets

#### **Research and development**

Expenditure on research activities, undertaken with the prospect of gaining new scientific or technical knowledge and understanding, is recognised in profit or loss when incurred.

Development activities involve a plan or design for the production of new or substantially improved products and processes. Development expenditure is capitalised only if development costs can be measured reliably, the product or process is technically and commercially feasible, future economic benefits are probable, and the Group intends to and has sufficient resources to complete development and to use or sell the asset. The expenditure capitalised includes the cost of materials, direct labour and overhead costs that are directly attributable to preparing the asset for its intended use. Other development expenditure is recognised in profit or loss when incurred.

Capitalised development expenditure is measured at cost less accumulated amortisation and accumulated impairment losses.

#### **Subsequent costs**

Subsequent expenditure on capitalised intangible assets is capitalised only when it increases the future economic benefits embodied in the specific asset to which it relates. All other expenditure, including expenditure on internally generated goodwill and brands, is expensed as incurred.



# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

### Amortisation

Amortisation is based on cost and calculated on the straight-line method at rates considered appropriate to write off carrying values over the estimated useful lives of the intangible assets with definite useful lives. Intangible assets are amortised from the day they are available for use.

The estimated lives of intangible assets with definite useful lives are as follows:

- Investment in technology: 3 to 10 years

Amortisation methods, useful lives and residual values are reviewed at each reporting date and adjusted if appropriate.

## 1.6 Impairment

### Financial assets

A financial asset not classified at fair value through profit or loss is assessed at each reporting date to determine whether there is any objective evidence that it is impaired. A financial asset is considered to be impaired if objective evidence indicates that one or more events have had a negative effect on the estimated future cash flows of that asset.

An impairment loss in respect of a financial asset measured at amortised cost is calculated as the difference between its carrying amount, and the present value of the estimated future cash flows discounted at the original effective interest rate.

Individually-significant financial assets and those that have been identified as impaired are tested for impairment on an individual basis. The remaining financial assets are assessed collectively in groups that share similar credit risk characteristics.

All impairment losses are recognised in profit or loss.

An impairment loss is reversed if the reversal can be related objectively to an event occurring after the impairment loss was recognised. For financial assets measured at amortised cost the reversal is recognised in profit or loss.

### Non-financial assets

The carrying amounts of the Group's non-financial assets, other than inventories and deferred tax assets, are reviewed at each reporting date to determine

whether there is any indication of impairment. If any such indication exists then the asset's recoverable amount is estimated. For goodwill arising from the acquisition of subsidiaries and intangible assets that have indefinite lives or that are not yet available for use, the recoverable amount is estimated at each reporting date.

An impairment loss is recognised if the carrying amount of an asset or its cash-generating unit exceeds its recoverable amount. A cash-generating unit is the smallest identifiable asset group that generates cash flows that are largely independent from other assets and groups. Impairment losses are recognised in profit or loss. Impairment losses recognised in respect of cash-generating units are allocated first to reduce the carrying amount of any goodwill allocated to the units and then to reduce the carrying amount of the other assets in the unit (group of units) on a pro rata basis.

The recoverable amount of an asset or cash-generating unit is the greater of its value in use and its fair value less costs of disposal. In assessing value in use, the estimated future cash flows are discounted to their present value using a pre-tax discount rate that reflects current market assessments of the time value of money and the risks specific to the asset.

An impairment loss in respect of goodwill is not reversed. In respect of other assets, impairment losses recognised in prior periods are assessed at each reporting date for any indications that the loss has decreased or no longer exists. An impairment loss is reversed if there has been a change in the estimates used to determine the recoverable amount. An impairment loss is reversed only to the extent that the asset's carrying amount does not exceed the carrying amount that would have been determined, net of depreciation or amortisation, if no impairment loss had been recognised.

## 1.7 Short-term employee benefits

Short-term employee benefit obligations are measured on an undiscounted basis and are expensed as the related service is provided. A liability is recognised for the amount expected to be paid under short-term cash bonus if the Group has a present legal or constructive obligation to pay this amount as a result of past service provided by the employee, and the obligation can be estimated reliably.

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

### 1.8 Retirement benefits

#### Pension fund

The Group operates a defined contribution plan, the assets of which are held in a separate trustee-administered fund. The benefits payable by the fund in the future, due to retirements and withdrawals from the fund, are contributions to the fund together with fund interest at a rate determined by the valuator with the consent of the trustees. The rate is so determined that the value of the total of the fund shall not exceed the value of the total assets of the fund.

#### Post-retirement benefits other than pensions

The Group provides post-retirement medical benefits to qualifying employees, which is deemed to be a defined benefit plan. The expected costs of these benefits are determined using the projected unit credit method, with actuarial valuations being carried out at each reporting date. Contributions are made to the relevant funds over the expected service lives of the employees entitled to those funds. The estimated cost of providing such benefits is charged to profit or loss on a systematic basis over the employees' working lives within the Group.

Actuarial gains and losses are recognised in other comprehensive income in the year when actuarially determined. The amount recognised in the statement of financial position represents the present value of the post-retirement medical fund benefit obligation. Any asset resulting from this calculation is limited to actuarial losses and the present value of available refunds and reductions in future contributions to the plan.

### 1.9 Inventory and contracts in progress

Inventory is measured at the lower of cost and net realisable value. Cost of inventory is determined by the weighted average method. In the case of work in progress, cost includes an appropriate share of production overheads based on normal operating capacity. Net realisable value represents the estimated selling price less all estimated costs to completion and costs to be incurred in selling.

Contracts in progress are stated as a percentage of the sales value of work completed, after provision for losses relating to the stage of completion and any foreseeable losses to completion of the contract, less progress billings.

### 1.10 Income tax

The CSIR is exempt from South African income tax. The income tax expense of subsidiary companies is reflected on Group level.

Income tax expense comprises current and deferred tax. The current tax charge is based on the profit or loss for the year as adjusted for items that are non-taxable or disallowed. It is calculated using tax rates that have been enacted or substantially enacted at the reporting date. Income tax expense is recognised in profit or loss except to the extent that it relates to items recognised directly in other comprehensive income or equity, in which case it is recognised in other comprehensive income or equity.

Deferred tax is recognised in respect of temporary differences arising from differences between the carrying amounts of assets and liabilities in the financial statements and the corresponding tax basis used in the computation of the taxable profit.

Where the tax effects of temporary differences, including those arising from tax losses, give rise to a deferred tax asset, the asset is recognised only if it is probable that future taxable profits will be sufficient to allow the tax benefit of the loss to be realised. Deferred tax assets are reviewed at each reporting date and are reduced to the extent that it is no longer probable that the related tax benefit will be realised. Deferred tax is not recognised for the following temporary differences: the initial recognition of assets or liabilities in a transaction that is not a business combination and that affects neither profit or loss, and differences relating to investments in subsidiaries, associates and jointly controlled entities to the extent that it is probable that they will not reverse in the foreseeable future.

Deferred tax assets and liabilities are offset when there is a legally enforceable right and when these relate to income taxes levied by the same taxation authority and the Group intends to settle its current tax assets and liabilities on a net basis.

### 1.11 Provisions

Provisions are recognised when the Group has a present legal or constructive obligation as a result of past events, for which it is probable that an outflow of economic benefits will be required to settle the

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

### 1.11 Provisions (continued)

obligation, and a reliable estimate can be made of the amount of the obligation. Provisions are measured at the present value of the expenditures expected to be required to settle the obligation using a pre-tax rate that reflects current market assessments of the time value of money and the risks specific to the obligation. The increase in the provision due to passage of time is recognised as interest expense.

A provision for onerous contracts is recognised when the expected benefits to be derived by the Group from a contract are lower than the unavoidable cost of meeting its obligations under the contract. The provision is measured at the present value of the lower of the expected cost of terminating the contract and the expected net cost of continuing with the contract. Before a provision is established, the Group recognises any impairment loss on the assets associated with that contract.

### 1.12 Government grants

Government grants that compensate the Group for expenses incurred are recognised as income on a systematic basis over periods necessary to match the assistance with the related expenses it is intended to compensate.

Grants that compensate the Group for the cost of an asset are deducted in arriving at the carrying amount of the acquired asset.

### 1.13 Revenue recognition

Revenue from the sale of goods is measured at the fair value of the consideration received or receivable, net of returns and allowances, trade discounts and volume rebates. Revenue is recognised when the significant risks and rewards of ownership have been transferred to the buyer, recovery of the consideration is probable, the associated costs and possible return of goods can be estimated reliably and there is no continuing management involvement with the goods, and the amount of revenue can be measured reliably.

Revenue from services rendered is recognised in profit or loss in proportion to the stage of completion of the transaction at the reporting date. The stage of completion is assessed by reference to work performed as at the reporting date.

Contract revenue includes the initial amount agreed in the contract plus any variations in contract work, claims and incentive payments to the extent that it is probable that these will result in revenue and can be measured reliably. As soon as the outcome of a contract can be estimated reliably, contract revenue and expenses are recognised in profit or loss in proportion to the stage of completion of the contract.

The stage of completion is assessed by reference to work performed as at reporting date. When the outcome of a contract cannot be estimated reliably, contract revenue is recognised only to the extent of contract costs incurred that are likely to be recoverable. An expected loss on a contract is recognised immediately in profit or loss.

Royalties are accrued based on the stipulations of the applicable contracts.

### 1.14 Finance income/expense

Finance income/expense comprises interest receivable on funds invested, interest receivable on trade and other receivables, fair value adjustments on investments and interest payable on borrowings. Interest income is recognised in profit or loss as it accrues, using the effective interest rate method.

Dividend income is recognised in profit or loss on the date that the entity's right to receive payments is established (which is when the dividend is declared). There was no dividend income earned in the period covered by this set of annual financial statements.

Interest payable on borrowings is calculated using the effective interest rate method.

### 1.15 Expenses

#### Operating lease payments

Leases in which a significant portion of the risks and rewards of ownership are retained by the lessor are classified as operating leases. Payments made under operating leases are recognised in profit or loss on a straight-line basis over the term of the lease. Lease incentives received are recognised in profit or loss as an integral part of the total lease expense, over the term of the lease.

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

### 1.15 Expenses (continued)

#### **Finance lease payments**

Leases of property, plant and equipment where the Group has substantially all the risks and rewards of ownership are classified as finance leases. Minimum lease payments are apportioned between the finance charge and the reduction of the outstanding liability. The finance charge is allocated to each period during the lease term so as to produce a constant periodic rate of interest on the remaining balance of the liability.

### 1.16 Financial instruments

Financial instruments are initially measured at fair value plus, for instruments not at fair value through profit or loss, any directly attributable transaction costs, when the Group has become a party to contractual provision of the instrument. Subsequent to initial recognition, these instruments are measured as set out as follows:

#### **Loans and receivables**

##### ***Trade and other receivables***

Trade receivables are subsequently measured at amortised cost using the effective interest method less any impairment losses, which approximate the fair value of these due to the short-term nature thereof.

##### ***Loans***

Loans are measured at amortised cost using the effective interest method less any impairment losses if they have a fixed maturity, or at cost if there is no fixed maturity.

##### ***Cash and cash equivalents***

Cash and cash equivalents are measured at amortised cost, which is their fair value. Cash and cash equivalents comprise fixed deposits, call deposits, bank balances, cash on hand and cash deposits.

#### **Financial assets at fair value through profit or loss**

##### ***Forward exchange contracts***

Forward exchange contracts are fair valued and gains and losses are recognised in profit or loss. Hedge accounting is not applied.

##### ***Available-for-sale financial assets***

Available-for-sale financial assets are subsequently carried at fair value. Changes in the fair value of available-for-sale financial assets are recognised in other comprehensive income. When available-for-sale

financial assets are sold or impaired, the accumulated fair value adjustments recognised in equity are included in profit or loss.

#### **Financial liabilities at amortised cost**

##### ***Trade and other payables and advances received***

Trade and other payables and advances received are stated at amortised cost, which approximates the fair value of these due to the short-term nature thereof.

#### **De-recognition**

Financial assets (or a portion thereof) are de-recognised when the Group realises the rights to the benefits specified in the contract, the rights expire or the Group surrenders or otherwise loses control and does not retain substantially all risks and rewards of the asset. On de-recognition, the difference between the carrying amount of the financial asset and proceeds receivable is included in profit or loss.

Financial liabilities (or a portion thereof) are de-recognised when the obligation specified in the contract is discharged, cancelled or expires.

On de-recognition, the difference between the carrying amount of the financial liability and the amount paid for it is included in profit or loss.

### 1.17 Related parties

The Group operates in an economic environment currently dominated by entities directly or indirectly owned by the South African government. As a result of the constitutional independence of all three spheres of government in South Africa, only parties within the national sphere of government will be considered to be related parties.

Key management is defined as being individuals with the authority and responsibility for planning, directing and controlling the activities of the entity. All individuals from the level of Group Executive up to the Board of Directors are regarded as key management.

Close family members of key management are considered to be those family members who may be expected to influence, or be influenced by key management individuals or other parties related to the entity.



# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

### 1.18 Standards and interpretations issued, not yet effective

At the date of authorisation of the financial statements of the Group for the year ended 31 March 2018, the following standards and interpretations were in issue but not yet effective:

Standard/ Interpretation	Description	Effective date
<b>Amendments to IFRS 2, 'Share based payments', on clarifying how to account for certain types of share-based payment transactions</b>	<p>'This amendment clarifies the measurement basis for cash-settled, share-based payments and the accounting for modifications that change an award from cash-settled to equity-settled. It also introduces an exception to the principles in IFRS 2 that will require an award to be treated as if it was wholly equity-settled, where an employer is obliged to withhold an amount for the employee's tax obligation associated with a share-based payment and pay that amount to the tax authority.</p> <p>This amendment is not expected to affect the Group's results.</p>	<p>Annual periods beginning on or after 1 January 2018</p> <p>The CSIR will adopt for the 2019 financial year</p>
<b>IFRS 9 'Financial instruments'</b>	<p>This standard replaces the guidance in IAS 39. It includes requirements on the classification and measurement of financial assets and liabilities; it also includes an expected credit losses model that replaces the current incurred loss impairment model.</p> <p>The impact of this standard on the Group's results cannot be determined at this stage.</p>	<p>Annual periods beginning on or after 1 January 2018</p> <p>The CSIR will adopt for the 2019 financial year</p>
<b>Amendment to IFRS 9, 'Financial instruments', on prepayment features with negative compensation</b>	<p>'This amendment confirms that when a financial liability measured at amortised cost is modified without this resulting in de-recognition, a gain or loss should be recognised immediately in profit or loss. The gain or loss is calculated as the difference between the original contractual cash flows and the modified cash flows discounted at the original effective interest rate. This means that the difference cannot be spread over the remaining life of the instrument which may be a change in practice from IAS 39.</p> <p>The impact of this amendment on the Group's results cannot be determined at this stage.</p>	<p>Annual periods beginning on or after 1 January 2019</p>

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

### 1.18 Standards and interpretations issued, not yet effective (continued)

Standard/ Interpretation	Description	Effective date
<b>Amendments to IFRS 4, 'Insurance contracts' regarding the implementation of IFRS 9, 'Financial instruments'</b>	<p>'These amendments introduce two approaches: an overlay approach and a deferral approach. The amended standard will:</p> <ul style="list-style-type: none"> <li>• give all companies that issue insurance contracts the option to recognise in other comprehensive income, rather than profit or loss, the volatility that could arise when IFRS 9 is applied before the new insurance contracts standard is issued; and</li> <li>• give companies whose activities are predominantly connected with insurance an optional temporary exemption from applying IFRS 9 until 2021. The entities that defer the application of IFRS 9 will continue to apply the existing financial instruments standard – IAS 39.</li> </ul> <p>These amendments are not expected to affect the Group's results.</p>	Annual periods beginning on or after 1 January 2018
<b>IFRS 15 – 'Revenue from contracts with customers'</b>	<p>'IFRS 15, 'Revenue from contracts with customers' is a converged standard from the IASB and FASB on revenue recognition. The standard will improve the financial reporting of revenue and improve comparability of the top line in financial statements globally.</p> <p>The impact of this standard on the Group's results cannot be determined at this stage.</p>	<p>Annual periods beginning on or after 1 January 2018</p> <p>The CSIR will adopt for the 2019 financial year</p>
<b>Amendment to IFRS 15, 'Revenue from contracts with customers'</b>	<p>'These amendments comprise clarifications of the guidance on identifying performance obligations, accounting for licences of intellectual property and the principal versus agent assessment (gross versus net revenue presentation). New and amended illustrative examples have been added for each of those areas of guidance. The IASB has also included additional practical expedients related to transition to the new revenue standard.</p> <p>The impact of these amendments on the Group's results cannot be determined at this stage.</p>	<p>Annual periods beginning on or after 1 January 2018</p> <p>The CSIR will adopt for the 2019 financial year</p>

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

### 1.18 Standards and interpretations issued, not yet effective (continued)

Standard/ Interpretation	Description	Effective date
<b>IFRS 16 – ‘Leases’</b>	<p>This standard replaces the current guidance in IAS 17. Under IAS 17, lessees were required to make a distinction between a finance lease and an operating lease. IFRS 16 now requires lessees to recognise a lease liability reflecting future lease payment and a ‘right-of-use asset’ for virtually all lease contracts. There is an optional exemption for certain short-term leases and leases of low-value assets which can be applied by lessees. Lessors will be affected by the new standard as the guidance on the definition of a lease has been updated.</p> <p>The impact of this standard on the Group’s results cannot be determined at this stage.</p>	Annual periods beginning on or after 1 January 2019 with earlier application permitted if IFRS 15, ‘Revenue from Contracts with Customers’, is also applied
<b>Amendment to IAS 40, ‘Investment property’ relating to transfers of investment property</b>	<p>These amendments clarify that to transfer to, or from, investment properties there must be a change in use. To conclude if a property has changed use there should be an assessment of whether the property meets the definition. This change must be supported by evidence.</p> <p>These amendments are not expected to affect the Group’s results.</p>	Annual periods beginning on or after 1 January 2018
<b>Annual improvements 2014–2016</b>	<p>These amendments impact two standards:</p> <ul style="list-style-type: none"> <li>• IFRS 1, ‘First-time adoption of IFRS’, regarding the deletion of short-term exemptions for first-time adopters regarding IFRS 7, IAS 19, and IFRS 10 effective 1 January 2018.</li> <li>• IAS 28, ‘Investments in associates and joint ventures’ regarding measuring an associate or joint venture at fair value effective 1 January 2018.</li> </ul> <p>The impact of these amendments on the Group’s results cannot be determined at this stage.</p>	Annual periods beginning on or after 1 January 2018

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

### 1.18 Standards and interpretations issued, not yet effective (continued)

Standard/ Interpretation	Description	Effective date
<b>Annual improvements 2015–2017</b>	<p>These amendments include minor changes to:</p> <ul style="list-style-type: none"> <li>• IFRS 3, 'Business combinations', – a company remeasures its previously held interest in a joint operation when it obtains control of the business.</li> <li>• IFRS 11, 'Joint arrangements', – a company does not remeasure its previously held interest in a joint operation when it obtains joint control of the business.</li> <li>• IAS 12, 'Income taxes' – a company accounts for all income tax consequences of dividend payments in the same way.</li> <li>• IAS 23, 'Borrowing costs' – a company treats as part of general borrowings any borrowing originally made to develop an asset when the asset is ready for its intended use or sale.</li> </ul> <p>The impact of these amendments on the Group's results cannot be determined at this stage.</p>	Annual periods beginning on or after 1 January 2019
<b>Amendments to IAS 28 'Investments in associates', on long term interests in associates and joint ventures</b>	<p>These amendments clarify that companies account for long-term interests in an associate or joint venture to which the equity method is not applied using IFRS 9.</p> <p>The impact of these amendments on the Group's results cannot be determined at this stage.</p>	Annual periods beginning on or after 1 January 2019
<b>Amendments to IAS 19, 'Employee benefits' on plan amendment, curtailment or settlement'</b>	<p>These amendments require an entity to:</p> <ul style="list-style-type: none"> <li>• use updated assumptions to determine current service cost and net interest for the remainder of the period after a plan amendment, curtailment or settlement; and</li> <li>• recognise in profit or loss as part of past service cost, or a gain or loss on settlement, any reduction in a surplus, even if that surplus was not previously recognised because of the impact of the asset ceiling.</li> </ul> <p>These amendments are not expected to affect the Group's results.</p>	Annual periods beginning on or after 1 January 2019



# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

### 1.18 Standards and interpretations issued, not yet effective (continued)

Standard/ Interpretation	Description	Effective date
<b>IFRS 17, 'Insurance contracts'</b>	<ul style="list-style-type: none"> <li>This standard replaces IFRS 4, which currently permits a wide variety of practices in accounting for insurance contracts. IFRS 17 will fundamentally change the accounting by all entities that issue insurance contracts and investment contracts with discretionary participation features.</li> </ul> <p>This standard is not expected to affect the Group's results.</p>	Annual periods beginning on or after 1 January 2021
<b>IFRIC 22, 'Foreign currency transactions and advance consideration'</b>	<p>This IFRIC addresses foreign currency transactions or parts of transactions where there is consideration that is denominated or priced in a foreign currency. The interpretation provides guidance for when a single payment/receipt is made, as well as for situations where multiple payments/receipts are made. The guidance aims to reduce diversity in practice.</p> <p>The impact of this IFRIC on the Group's results cannot be determined at this stage.</p>	Annual periods beginning on or after 1 January 2018
<b>IFRIC 23, 'Uncertainty over income tax treatments'</b>	<p>This IFRIC clarifies how the recognition and measurement requirements of IAS 12 'Income taxes', are applied where there is uncertainty over income tax treatments. The IFRS IC had clarified previously that IAS 12, not IAS 37 'Provisions, contingent liabilities and contingent assets', applies to accounting for uncertain income tax treatments. IFRIC 23 explains how to recognise and measure deferred and current income tax assets and liabilities where there is uncertainty over a tax treatment. An uncertain tax treatment is any tax treatment applied by an entity where there is uncertainty over whether that treatment will be accepted by the tax authority. For example, a decision to claim a deduction for a specific expense or not to include a specific item of income in a tax return is an uncertain tax treatment if its acceptability is uncertain under tax law. IFRIC 23 applies to all aspects of income tax accounting where there is an uncertainty regarding the treatment of an item, including taxable profit or loss, the tax bases of assets and liabilities, tax losses and credits and tax rates.</p> <p>The impact of this IFRIC on the Group's results cannot be determined at this stage.</p>	Annual periods beginning on or after 1 January 2019

The Group has not early-adopted any of the above guidance.

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 2 REVENUE

### Parliamentary Grant

Parliamentary Grant received

Less:

Grant received for projects started before year-end but not completed

Add:

Grant received in prior year for projects completed in this year

### Contract income

Local private sector

Local public sector

International sector (including Africa)

### Royalties

GROUP				CSIR			
2018		2017		2018		2017	
R'000		Restated R'000		R'000		Restated R'000	
	%		%		%		%
<b>Parliamentary Grant</b>							
Parliamentary Grant received	722 373	29	714 105	27	722 373	29	714 105
Less:							
Grant received for projects started before year-end but not completed	729 359	29	694 827	26	729 359	29	694 827
Add:							
Grant received in prior year for projects completed in this year	(11 234)	–	(4 248)	–	(11 234)	–	(4 248)
	4 248	–	23 526	1	4 248	–	23 526
<b>Contract income</b>							
Local private sector	1 771 507	71	1 931 613	73	1 771 507	71	1 931 755
Local public sector	189 579	8	186 487	7	189 579	8	186 487
International sector (including Africa)	1 399 783	56	1 583 151	60	1 399 783	56	1 583 293
	182 145	7	161 975	6	182 145	7	161 975
<b>Royalties</b>							
	4 606	–	5 445	–	4 606	–	5 445
	2 498 486	100	2 651 163	100	2 498 486	100	2 651 305

For the 2016/17 financial year, contract income is disclosed after taking into account the effect of the time value of money (the value of discounting) in terms of SAICA's Circular 9 of 2006: Transactions giving rise to adjustments to revenue/purchases. The value is R16,25 million and is included in finance income (note 4). SAICA's Circular 9 of 2006 has been replaced by SAICA's Circular 2 of 2017.

Included in public sector contract income is R71 million (2017: R70,95 million) ring-fenced allocation from the Department of Science and Technology for specific initiatives managed through memorandums of agreement.

Included in contract income is rental income amounting to R48,50 million (2017: R46,57 million) and revenue of R34,30 million (2017: R39,27 million) earned by the CSIR International Convention Centre.

Estimates on Parliamentary Grant recognition are based on cost to completion, budgets and percentage of completion.

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

GROUP		CSIR	
2018	2017	2018	2017
	Restated		Restated
R'000	R'000	R'000	R'000

## 3 (LOSS)/PROFIT BEFORE INCOME TAX

(Loss)/profit before income tax is arrived at after taking the following items into account:

Audit fees	5 700	5 099	5 700	5 099
Fees for services	17 228	12 225	17 228	12 096
Patent costs	11 425	11 507	11 425	11 378
Legal costs	5 803	718	5 803	718
Operating leases	8 184	6 891	8 184	6 891
Buildings	4 328	2 609	4 328	2 609
Equipment	2 652	2 982	2 652	2 982
Vehicles	1 204	1 300	1 204	1 300
Net realised foreign exchange loss	5 977	13 165	5 977	13 165
Net unrealised foreign exchange gain	(519)	(1 996)	(519)	(1 996)
Board members' and Executive Management's remuneration (note 18)	19 896	23 922	19 896	23 922
Impairments/(reversals of impairments)	19 514	(16 923)	22 668	(15 282)
Impairment/(reversal of impairment) on subsidiaries, joint ventures and associates	11 609	(489)	14 763	1 152
Impairment/(reversal of impairment) on trade receivables	7 905	(16 434)	7 905	(16 434)
Bad debt written off	1 448	3 480	1 448	3 480
Profit on disposal and write-off of property, plant and equipment*	(2 514)	(38 422)	(2 514)	(38 422)
Lost and/or stolen equipment and vehicles**	473	1 028	473	1 028
Losses incurred	473	1 237	473	1 237
Losses recovered	–	(209)	–	(209)

\* Refer to note 7

\*\* These are losses incurred in the normal course of the CSIR's business and are covered by the CSIR's insurance policy. The net losses incurred on these are included in the profit on disposal and write-off of property, plant and equipment amounts.

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 4 FINANCE INCOME/EXPENSE

	GROUP		CSIR	
	2018	2017 Restated	2018	2017 Restated
	R'000	R'000	R'000	R'000
Finance income	38 955	53 166	38 483	52 578
Interest on bank balances and investments	38 016	36 454	37 544	35 866
Interest on trade and other receivables	939	461	939	461
Adjustment on initial recognition of contract income*	–	16 251	–	16 251
Finance expense	(1)	(8 961)	(1)	(8 961)
Interest paid on liabilities	(1)	–	(1)	–
Adjustment on initial recognition of operating expenses*	–	(8 961)	–	(8 961)
	38 954	44 205	38 482	43 617

\* These adjustments (for the 2016/17 financial year) are due to the effect of the time value of money (the value of discounting) in terms of SAICA's Circular 9 of 2006: Transactions giving rise to adjustments to revenue/purchases. SAICA's Circular 9 of 2006 has been replaced by SAICA's Circular 2 of 2017.

## 5 INCOME TAX EXPENSE

The CSIR is exempt from South African income tax in terms of section 10 (1) (t) (i) of the Income Tax Act, 1962 (Act No 58 of 1962).

South African normal taxation due by subsidiaries	–	41
Current taxation	–	41
	–	41
	%	%
South African normal rate of taxation	28%	28%
(Loss)/profit attributable to tax exempt entities	(23%)	(28%)
Assessed loss (refer note 13)	1%	0%
Share of loss of joint ventures and associates	(6%)	0%
Non-taxable portion of capital gain on sale of associate	0%	0%
Current and deferred taxation – effective rate	0%	0%

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 6 PROPERTY, PLANT AND EQUIPMENT

Group	2018			2017		
	Cost	Accumulated depreciation	Carrying value	Cost	Accumulated depreciation	Carrying value
	R'000	R'000	R'000	R'000	R'000	R'000
Land	125 435	–	125 435	125 435	–	125 435
Buildings	491 642	74 492	417 150	472 960	69 302	403 658
Equipment	516 523	341 579	174 944	478 145	313 643	164 502
ICT equipment	196 552	136 531	60 021	180 394	117 993	62 401
Furniture and fittings	15 624	10 730	4 894	14 950	10 084	4 866
Vehicles	8 080	6 160	1 920	8 014	5 968	2 046
	<b>1 353 856</b>	<b>569 492</b>	<b>784 364</b>	<b>1 279 898</b>	<b>516 990</b>	<b>762 908</b>
<b>CSIR</b>						
Land	125 435	–	125 435	125 435	–	125 435
Buildings	491 642	74 492	417 150	472 960	69 302	403 658
Equipment	516 523	341 579	174 944	478 145	313 643	164 502
ICT equipment	196 547	136 526	60 021	180 389	117 989	62 400
Furniture and fittings	15 624	10 730	4 894	14 950	10 084	4 866
Vehicles	8 080	6 160	1 920	8 014	5 968	2 046
	<b>1 353 851</b>	<b>569 487</b>	<b>784 364</b>	<b>1 279 893</b>	<b>516 986</b>	<b>762 907</b>



# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 6 PROPERTY, PLANT AND EQUIPMENT (CONTINUED)

	Land R'000	Buildings R'000	Equipment R'000	ICT Equipment R'000	Furniture and fittings R'000	Vehicles R'000	Total R'000
<b>Group</b>							
Carrying value 31 March 2016	125 435	394 946	160 887	65 356	5 172	1 941	<b>753 737</b>
Additions	–	13 730	36 877	19 876	826	678	<b>71 987</b>
Disposals and write-offs	–	(7)	(405)	(506)	(21)	(132)	<b>(1 071)</b>
Depreciation	–	(5 011)	(32 857)	(22 325)	(1 111)	(441)	<b>(61 745)</b>
Carrying value 31 March 2017	125 435	403 658	164 502	62 401	4 866	2 046	<b>762 908</b>
Additions	–	18 682	42 793	24 477	1 138	290	<b>87 380</b>
Disposals and write-offs	–	–	(168)	(652)	(13)	–	<b>(833)</b>
Depreciation	–	(5 190)	(32 183)	(26 205)	(1 097)	(416)	<b>(65 091)</b>
<b>Carrying value 31 March 2018</b>	<b>125 435</b>	<b>417 150</b>	<b>174 944</b>	<b>60 021</b>	<b>4 894</b>	<b>1 920</b>	<b>784 364</b>
<b>CSIR</b>							
Carrying value 31 March 2016	125 435	394 946	160 887	65 344	5 172	1 941	<b>753 725</b>
Additions	–	13 730	36 877	19 876	826	678	<b>71 987</b>
Disposals and write-offs	–	(7)	(405)	(496)	(21)	(132)	<b>(1 061)</b>
Depreciation	–	(5 011)	(32 857)	(22 324)	(1 111)	(441)	<b>(61 744)</b>
Carrying value 31 March 2017	125 435	403 658	164 502	62 400	4 866	2 046	<b>762 907</b>
Additions	–	18 682	42 793	24 477	1 138	290	<b>87 380</b>
Disposals and write-offs	–	–	(168)	(652)	(13)	–	<b>(833)</b>
Depreciation	–	(5 190)	(32 183)	(26 204)	(1 097)	(416)	<b>(65 090)</b>
<b>Carrying value 31 March 2018</b>	<b>125 435</b>	<b>417 150</b>	<b>174 944</b>	<b>60 021</b>	<b>4 894</b>	<b>1 920</b>	<b>784 364</b>

Land and buildings are unencumbered and full details of the titles are available at the registered office of the CSIR.

A change in the depreciation estimate due to a change in the useful lives of equipment, ICT equipment, furniture and fittings and vehicles resulted in a R5,7 million (2017: R5 million) decrease in the depreciation amount for the current financial year. In the prior financial year the useful life of buildings was re-assessed from 40 years to 90 years and resulted in an increase of R4,8 million in the depreciation amount.

During the current financial year, assets to the value of R20,7 million (2017: R71,8 million) were purchased with government grant funds. At year-end the cumulative value of assets purchased with government grant funds and shown at a nil cost is R701,2 million (2017: R732,3 million).

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 7 NON-CURRENT ASSETS HELD FOR SALE

In the 2015/16 financial year, property, plant and equipment transferred to non-current assets classified as held for sale amounted to R27,6 million (carrying value) and related to land, buildings, equipment, ICT equipment and vehicles. The property, plant and equipment was presented as held for sale following the events detailed below.

The CSIR and Nelson Mandela Metropolitan University (NMMU) were finalising an agreement to transfer Erf 1281 Summerstrand to NMMU. The transfer was finalised in the prior financial year and the net profit of R36,8 million is included in other income for 2016/17.

The CSIR reached an agreement to sell certain laboratory assets in the 2015/16 financial year. The contract of sale was approved and concluded with the effective date being in the prior financial year. The net profit of R1,9 million is included in other income for 2016/17.

## 8 INTEREST IN JOINT VENTURES AND ASSOCIATES

	GROUP		CSIR	
	2018 R'000	2017 R'000	2018 R'000	2017 R'000
Cost of investments less impairment losses	23 188	19 580	24 258	20 650
Loans to joint ventures and associates	27 937	27 937	27 937	27 937
Share of post-acquisition losses of joint ventures	(23 339)	(23 362)	–	–
Share of post-acquisition losses of associates	(5 036)	(1 903)	–	–
	22 750	22 252	52 195	48 587
Impairment of joint ventures and associates	(13 645)	(2 036)	(43 090)	(28 371)
	9 105	20 216	9 105	20 216

The loans to joint ventures and associates are interest free, unsecured and have no fixed terms of repayment. In substance, they form part of the Group's net investment in joint ventures and associates.

Agreements have been entered into between the CSIR and certain joint ventures and associates to subordinate the loans made to those joint ventures and associates. The subordination agreements will remain in force for as long as the liabilities of the relevant joint ventures or associates exceed their assets, fairly valued.

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 8 INTEREST IN JOINT VENTURES AND ASSOCIATES (CONTINUED)

Details of the joint ventures and associate at 31 March 2018 are as follows:

Name of joint venture/associate	Place of incorporation	Portion of ownership interest	Portion of voting power held	Principal activity	Carrying value		Financial year-end
					2018 R'000	2017 R'000	
Joint ventures							
Sera (Pty) Ltd	South Africa	50%	50%	Commercialisation and licensing of patents	3 023	3 062	31 March
Ellipsoid Technology (Pty) Ltd	South Africa	50%	50%	Commercialisation of encapsulation technology	1 576	1 514	31 March
Associates							
Persomics AB	Sweden	33,69%	33,69%	Commercialisation of novel printing technology	18 151	17 676	31 December
					22 750	22 252	

The following are details of the significant joint ventures' and associates' assets, liabilities, income and expenses:

	JOINT VENTURES GROUP		ASSOCIATES GROUP	
	2018 R'000	2017 R'000	2018 R'000	2017 R'000
Current assets	7 582	7 785	1 793	4 578
Non-current assets	33 665	33 665	6 833	7 144
Current liabilities	53 329	53 597	1 310	1 256
Non-current liabilities	36 232	36 232	6 114	6 910
Income	378	432	339	5 346
Expenses	332	293	10 955	12 377

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 9 INTEREST IN SUBSIDIARIES

Shares at cost less impairment losses

Indebtedness

– by subsidiaries

– impairment of loans

CSIR	
2018	2017
R'000	R'000

4 650	4 650
62	786
8 023	8 703
(7 961)	(7 917)
4 712	5 436

Details disclosed in Addendum A.

The loans to subsidiaries are interest free, unsecured and have no fixed terms of repayment.

Agreements have been entered into between the CSIR and certain subsidiaries to subordinate the loans made to those subsidiaries. The subordination agreements will remain in force for as long as the liabilities of the relevant subsidiaries exceed their assets, fairly valued.

## 10 AVAILABLE-FOR-SALE FINANCIAL ASSET

In the 2015/16 financial year the CSIR Group's investment in Persomics AB was classified as an available-for-sale financial asset. The percentage held in Persomics AB as at 31 March 2016 was 12.53% and the related value amounted to R6,177 million. In the prior financial year the CSIR invested an additional R4,861 million in Persomics AB which then became an associate. Further investments were made subsequent to Persomics AB becoming an associate. Refer to note 8 for more detail.

## 11 TRADE AND OTHER RECEIVABLES

	GROUP		CSIR	
	2018	2017	2018	2017
	R'000	R'000	R'000	R'000
Trade receivables	183 461	234 207	183 447	234 202
Prepaid expenditure	34 376	38 023	34 376	38 011
Other receivables*	6 833	9 693	6 761	9 659
	224 670	281 923	224 584	281 872
Less non current portion: other receivables*	(2 293)	(6 095)	(2 293)	(6 095)
Current portion	222 377	275 828	222 291	275 777

Trade receivables are shown net of impairment losses. Refer to note 21 for more details on trade receivables.

\* Included in other receivables is an amount of R1,17 million (2017: R1,75 million) relating to the sale of an associate in the 2015/16 financial year. The initial payment of R10 million was received in April 2016 with the balance of R1,75 million being payable by 30 June 2019. Also included in other receivables is an amount of R4,85 million (2017: R7,52 million) for the sale of Erf 1281 Summerstrand (refer to note 7).

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

GROUP		CSIR	
2018	2017	2018	2017
R'000	R'000	R'000	R'000

## 12 INVENTORY AND CONTRACTS IN PROGRESS

	Restated		Restated	
Contracts in progress less provision for losses	112 217	83 936	112 217	83 936
Raw materials and consumables	1 435	1 423	1 435	1 423
	113 652	85 359	113 652	85 359

Estimates on contract in progress recognition are based on cost to completion, budgets and percentage of completion. The cost of inventories recognised as an expense amounted to R10,78 million (2017: R12,03 million).

## 13 DEFERRED TAX

A subsidiary in the Group is in an assessed loss position and no deferred tax asset was raised for the assessed loss due to the uncertainty of the recoverability in future periods in respect of the carry forward of unused tax losses.

Opening balance	7 317	7 453
Assessed tax loss utilised for the year	(424)	(136)
Assessed tax loss carried forward	6 893	7 317

## 14 ADVANCES RECEIVED

	Restated		Restated	
Advances on contracts received from clients and stakeholders	849 477	791 607	849 477	791 607

## 15 TRADE AND OTHER PAYABLES

	Restated		Restated	
Accounts payable and accruals	324 415	384 529	324 415	384 487
Salary related accruals	53 087	62 180	53 087	62 180
	377 502	446 709	377 502	446 667



# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

GROUP		CSIR	
2018	2017	2018	2017
R'000	R'000	R'000	R'000

## 16 OPERATING LEASE COMMITMENTS

Financial commitments under non-cancellable operating leases will result in the following payments falling due:

Within one year:	<b>4 560</b>	4 787	<b>4 560</b>	4 787
Land and buildings	<b>3 197</b>	3 939	<b>3 197</b>	3 939
Vehicles	<b>1 363</b>	848	<b>1 363</b>	848
Within two to five years:	<b>13 810</b>	12 786	<b>13 810</b>	12 786
Land and buildings	<b>11 871</b>	11 576	<b>11 871</b>	11 576
Vehicles	<b>1 939</b>	1 210	<b>1 939</b>	1 210
More than 5 years:	<b>10 635</b>	12 764	<b>10 635</b>	12 764
Land and buildings	<b>10 635</b>	12 764	<b>10 635</b>	12 764

Agreements relating to operating lease payments for vehicles vary from three to five years and payments are fixed for the term of the agreements.

The CSIR leases buildings under operating leases. The lease periods vary from one to 10 years. The leases have varying terms, escalation clauses and renewal rights. On renewal, the terms of the leases are renegotiated. Not included in the above commitments are rental payment amounts which are contingent on market rates.

The CSIR leases a number of properties at nominal rental amounts. The lease periods vary from 25 to 99 years.

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 17 RETIREMENT BENEFITS OF EMPLOYEES

### 17.1 CSIR Pension Fund

The fund is registered in terms of the Pension Funds Act, 1956 (Act 24 of 1956), and is a defined contribution plan.

The CSIR's liability to the fund was limited to paying the employer contributions up until 29 February 2016. The impact of the tax reform effective from 1 March 2016 is that the CSIR package structure was changed to reflect all retirement fund contributions as employee contributions. All permanent CSIR employees are members of the fund.

Employee contributions of R190,2 million (2017: R180 million) were expensed during the year.

### 17.2 Associated Institutions Pension Fund (AIPF)

The fund is a defined benefit plan. The formula used to determine pensions is based on the pensionable earnings of the final year, and the aggregate period of uninterrupted membership.

The CSIR has one employee (2017: one employee) who is a member of the AIPF as at 31 March 2018. The fund is controlled by the state, which has assumed responsibility for the unfunded portion of this fund.

Employee contributions of R13 045 (2017: R12 201) were expensed during the year.

### 17.3 Post-retirement medical benefits

The CSIR has a post-retirement medical benefit obligation to certain qualifying retired CSIR employees (pensioners) who joined the CSIR prior to 30 September 1996. An offer was made to qualifying pensioners in December 2005 to accept an annuity, payable from an independent source, equivalent to the value of their medical subsidy. The pensioners who accepted the offer are no longer entitled to a subsidy from the CSIR.

The accumulated benefit obligation and the annual cost of accrual of benefits are assessed by independent, qualified actuaries using the projected unit credit method. The estimated present value of the anticipated expenditure for the remaining 18 continuation members (2017: 18 continuation members) was recalculated by the actuaries as at 31 March 2018 and will be funded through cash and cash equivalents. These cash and cash equivalents have not been set aside specifically for this benefit.

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

GROUP		CSIR	
2018	2017	2018	2017
R'000	R'000	R'000	R'000

## 17 RETIREMENT BENEFITS OF EMPLOYEES (CONTINUED)

### 17.3 Post-retirement medical benefits (continued)

The amount included in the statement of financial position arising from the CSIR's obligation in respect of post-retirement medical benefits is as follows:

Present value of obligations	10 963	10 764	10 963	10 764
Net liability on statement of financial position	10 963	10 764	10 963	10 764

Amounts recognised in the statement of comprehensive income in respect of the scheme are as follows:

Interest cost	937	995	937	995
Actuarial gain recognised during the year	(738)	(926)	(738)	(926)
	199	69	199	69

Movement in the net liability recognised in the statement of financial position is as follows:

Net liability at the beginning of the year	10 764	10 695	10 764	10 695
Movement for the year	199	69	199	69
Net expense recognised in the statement of comprehensive income	199	69	199	69
Net liability at the end of the year	10 963	10 764	10 963	10 764

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

GROUP		CSIR	
2018	2017	2018	2017
R'000	R'000	R'000	R'000

## 17 RETIREMENT BENEFITS OF EMPLOYEES (CONTINUED)

### 17.3 Post-retirement medical benefits (continued)

Principal actuarial assumptions at the reporting date:

Discount rate at 31 March	8.00%	8.70%	8.00%	8.70%
Medical inflation costs	6.10%	7.20%	6.10%	7.20%

The above results are sensitive to changes in the assumed future rate of medical inflation.

The effect of a one percent increase in the assumed future rate of medical inflation would have the following effects:

Effect on defined benefit obligation	637	660	637	660
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The effect of a one percent decrease in the assumed future rate of medical inflation would have the following effects:

Effect on defined benefit obligation	(582)	(601)	(582)	(601)
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The above sensitivity analyses are based on a change in an assumption while all other assumptions are assumed to remain unchanged. This may not always be realistic as some of the assumptions tend to be correlated. When calculating the sensitivity of the defined benefit obligation to significant actuarial assumptions the same method (present value of the defined benefit obligation calculated with the projected unit credit method at the end of the reporting period) has been applied as when calculating the liability recognised within the statement of financial position.

Historical information (R'000):	2018	2017	2016	2015	2014
Present value of the defined benefit obligation	10 963	10 764	10 695	10 614	9 772
Deficit in the plan	10 963	10 764	10 695	10 614	9 772

The average term (undiscounted) of the defined benefit obligation is 8.7 years (2017: 9.6 years) and the average duration (discounted) of the defined benefit obligation is 6.1 years (2017: 6.5 years).

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 18 BOARD MEMBERS, DIRECTORS AND EXECUTIVE MANAGEMENT'S REMUNERATION

2018						
	Entity	Fees for services as director	Managerial Services			Total
			Basic salary	Bonuses and performance-related payments	Accrued leave*	
			R'000	R'000	R'000	
<b>Board members and Executive Directors</b>						
Dr TH Dlamini	CSIR	–	4 432	–	–	4 432
<b>Non-executive Board members</b>						
Adv. G Badela	CSIR	118	–	–	–	118
Ms P Baleni	CSIR	–	–	–	–	–
Dr PH Goyns	CSIR	188	–	–	–	188
Dr A Llobell	CSIR	77	–	–	–	77
Prof. T Majosi	CSIR	237	–	–	–	237
Dr R Masango	CSIR	111	–	–	–	111
Ms M Maseko	CSIR	89	–	–	–	89
Mr J Netshitenzhe	CSIR	87	–	–	–	87
Ms A Noah	CSIR	115	–	–	–	115
Prof. M Phakeng (until September 2017)	CSIR	63	–	–	–	63
<b>Executive Management</b>						
Ms SM Bhengu (from September 2017)	CSIR	–	1 588	–	–	1 588
Dr RK Chikwamba	CSIR	–	2 693	47	–	2 740
Mr JPL Cloete (until December 2017)	CSIR	–	2 075	45	206	2 326
Dr M Motuku	CSIR	–	2 966	57	–	3 023
Ms ZL Ngwepe (from December 2017)	CSIR	–	879	–	–	879
Mr CR Sturdy (until August 2017)	CSIR	–	1 190	55	51	1 296
Ms A Van Tonder (acting CFO from September 2017 to November 2017)	CSIR	–	414	–	–	414
Mr RM Zondo (until December 2017)	CSIR	–	2 021	50	42	2 113
<b>2018</b>		<b>1 085</b>	<b>18 258</b>	<b>254</b>	<b>299</b>	<b>19 896</b>



# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 18 BOARD MEMBERS, DIRECTORS AND EXECUTIVE MANAGEMENT'S REMUNERATION

2017						
Entity	Fees for services as director	Managerial Services			Total	
		Basic salary	Bonuses and performance-related payments	Accrued leave*		
		R'000	R'000	R'000		R'000
<b>Board members and Executive Directors</b>						
Dr TH Dlamini (from February 2017)	CSIR	–	728	–	–	<b>728</b>
Dr SP Sibisi (until September 2016)	CSIR	–	2 459	1 752	254	<b>4 465</b>
<b>Non-executive Board members</b>						
Adv. G Badela	CSIR	115	–	–	–	<b>115</b>
Ms P Baleni	CSIR	–	–	–	–	<b>–</b>
Dr PH Goyns	CSIR	174	–	–	–	<b>174</b>
Dr A Llobell	CSIR	90	–	–	–	<b>90</b>
Prof. T Majosi	CSIR	308	–	–	–	<b>308</b>
Dr R Masango	CSIR	128	–	–	–	<b>128</b>
Ms M Maseko	CSIR	92	–	–	–	<b>92</b>
Mr J Netshitenzhe	CSIR	131	–	–	–	<b>131</b>
Ms A Noah	CSIR	63	–	–	–	<b>63</b>
Prof. M Phakeng	CSIR	150	–	–	–	<b>150</b>
<b>Executive Management</b>						
Dr RK Chikwamba	CSIR	–	2 534	788	–	<b>3 322</b>
Mr JPL Cloete	CSIR	–	2 696	835	–	<b>3 531</b>
Dr M Motuku**	CSIR	–	2 815	835	–	<b>3 650</b>
Mr CR Sturdy	CSIR	–	2 750	867	–	<b>3 617</b>
Mr RM Zondo	CSIR	–	2 563	795	–	<b>3 358</b>
<b>2017</b>		<b>1 251</b>	<b>16 545</b>	<b>5 872</b>	<b>254</b>	<b>23 922</b>

\* Accrued leave paid out at end of contract.

\*\* Acting CEO for the period October 2016 to January 2017

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

GROUP		CSIR	
2018	2017	2018	2017
R'000	R'000	R'000	R'000

## 19 CONTINGENT LIABILITIES AND FACILITIES

Local and foreign payment and performance guarantees issued as at 31 March

26 035	26 416	26 035	26 416
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The CSIR has a borrowing plan approved by the Minister of Finance to issue performance bonds, local and foreign advance payment guarantees and carnets.

### Legal costs and litigation

In the nature of the CSIR's business, agreements with complex deliverables may be entered into. All necessary steps are taken to manage the risks inherent to these transactions. If and when it is evident that there is a reasonable probability that a dispute on a transaction could lead to costs against the CSIR, such costs will be disclosed.

## 20 CAPITAL COMMITMENTS

Property, plant and equipment

23 882	36 332	23 882	36 332
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This capital expenditure is to be financed from internal sources.

## 21 FINANCIAL INSTRUMENTS

The Group has exposure to the following risks from its use of financial instruments:

- market risk
- credit risk
- liquidity risk.

This note presents information about the Group's exposure to each of the above risks and the Group's objectives, policies and processes for measuring and managing risk. Further quantitative disclosures are included throughout these consolidated financial statements.

The Board has overall responsibility for the establishment and oversight of the Group's risk management framework.

The Group's risk management policies are established to identify and analyse the risks faced by the Group, to set appropriate risk limits and controls, and to monitor risks and adherence to limits. Risk management policies and systems are reviewed regularly to reflect changes in market conditions and the Group's activities. The Group, through its training and management standards and procedures, aims to develop a disciplined and constructive control environment in which all employees understand their roles and obligations.

The Audit and Risk Committee oversees how management monitors compliance with the Group's risk management policies and procedures and reviews the adequacy of the risk management framework in relation to the risks faced by the Group. The Group Audit and Risk Committee is assisted in its oversight role by Internal Audit. Internal Audit undertakes both regular and ad hoc reviews of risk management controls and procedures, the results of which are reported to the Audit and Risk Committee.

The estimated net fair values, as at the reporting date, have been determined using available market information and appropriate valuation methodologies as outlined below. This value is not necessarily indicative of the amounts that the group could realise in the normal course of business. The fair values of the financial assets and financial liabilities are sensitive to exchange rate movements. A sensitivity analysis of a 10% increase/decrease in exchange rate fluctuation on the bank balances held in foreign currency bank accounts as at 31 March 2018 is performed. The fair value of receivables, bank balances, repurchase agreements and other liquid funds, payables and accruals, approximate their carrying amount due to the short-term maturities of these instruments.

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 21 FINANCIAL INSTRUMENTS (CONTINUED)

### 21.1 Market risk

Market risk is the risk that changes in market prices, such as foreign exchange rates and interest rates will affect the Group's income or the value of its holdings of financial instruments. The objective of market risk management is to manage and control market risk exposures within acceptable parameters, while optimising the return.

#### Foreign currency risk

The Group is exposed to currency risk on sales and purchases that are denominated in a currency other than the respective functional currency of the Group entities.

The Group enters into forward exchange contracts to buy specified amounts of foreign currencies in the future at a predetermined exchange rate.

Forward exchange contracts are entered into mainly to cover import orders. The Group has no policy to enter into forward exchange contracts for anticipated foreign receipts. The Group does not use derivative financial instruments for speculative purposes.

The Group's exposure to foreign currency risk was as follows:

	31 MARCH 2018					
	Total R'000	ZAR R'000	EURO R'000	USD R'000	GBP R'000	Other R'000
Trade receivables	183 461	161 843	1 507	15 917	3 039	1 155
Bank accounts	102 842	55 648	6 439	27 375	6 902	6 478
Trade and other payables	(377 502)	(373 437)	(3 392)	(564)	(109)	–
Gross statement of financial position exposure	(91 199)	(155 946)	4 554	42 728	9 832	7 633
Net exposure	(91 199)	(155 946)	4 554	42 728	9 832	7 633

	31 MARCH 2017					
	Total R'000	ZAR R'000	EURO R'000	USD R'000	GBP R'000	Other R'000
Trade receivables	234 207	195 472	1 716	32 851	2 831	1 337
Bank accounts	205 736	41 420	7 326	140 611	11 952	4 427
Trade and other payables (restated)	(446 709)	(443 502)	(119)	(1 721)	–	(1 367)
Gross statement of financial position exposure	(6 766)	(206 610)	8 923	171 741	14 783	4 397
Net exposure	(6 766)	(206 610)	8 923	171 741	14 783	4 397

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

GROUP	
2018	2017

## 21 FINANCIAL INSTRUMENTS (CONTINUED)

### 21.1 Market risk (continued)

#### Foreign currency risk (continued)

The following significant exchange rates applied during the year:

	R	R
Year-end spot rate:		
Euro	14.5733	14.3275
USD	11.8254	13.4123
GBP	16.5709	16.7489

#### Sensitivity analysis

A 10% strengthening of the rand against the following currencies at 31 March would have decreased profit or loss by the amounts shown below. This analysis assumes that all other variables remain constant. The analysis is performed on the same basis for 2017.

	R'000	R'000
Euro	(455)	(892)
USD	(4 273)	(17 174)
GBP	(983)	(1 478)
Other	(763)	(440)

A 10% weakening of the rand against the above currencies at 31 March would have had the equal but opposite effect on the above currencies to the amounts shown above, on the basis that all other variables remain constant.

#### Interest rate risk

Interest rate exposure and investment strategies are evaluated by management on a regular basis. Interest-bearing investments are held with several reputable banks in order to minimise exposure.

At the reporting date the interest rate profile of the Group's interest-bearing financial instruments was as follows:

#### Fixed rate instruments: carrying amount

	R'000	R'000
Financial assets: Fixed deposits	887 503	848 620

The Group does not account for any fixed rate financial assets and liabilities at fair value through profit or loss, and the Group does not designate derivatives as hedging instruments under a fair value hedge accounting model. Therefore, a change in interest rates at the reporting date would not affect profit or loss.

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

GROUP	
2018	2017
R'000	R'000

## 21 FINANCIAL INSTRUMENTS (CONTINUED)

### 21.1 Market risk (continued)

#### Interest rate risk (continued)

##### Variable rate instruments: carrying amount

Financial assets: Call deposits	105 000	52 000
Financial assets: Bank balances	102 842	205 736
	<b>207 842</b>	<b>257 736</b>

#### Sensitivity analysis

An increase of 100 basis points in interest rates at the reporting date would have increased equity and profit and loss by the amounts shown below. This analysis assumes that all other variables, in particular foreign currency rates, remain constant. The analysis is performed on the same basis for 2017.

Variable rate instruments	<b>2 078</b>	2 577
---------------------------	--------------	-------

A decrease of 100 basis points would have had the equal but opposite effect to the amounts shown above.

### 21.2 Credit risk

Credit risk is the risk of financial loss to the Group if a customer or counterparty to a financial instrument fails to meet its contractual obligations, and arises principally from the Group's bank balances and deposits, trade and other receivables and loans to joint ventures, associates and subsidiaries.

#### Trade and other receivables and loans to joint ventures, associates and subsidiaries

Trade and other receivables and loans to joint ventures, associates and subsidiaries are presented net of impairment losses. Credit risk with respect to trade receivables is limited due to the large number of customers comprising the Group's customer base and their dispersion across different industries and geographical areas.

#### Bank balances and deposits

The Group's bank balances and cash are placed with high credit, quality financial institutions with no significant exposure to any one financial institution.

#### Guarantees

Refer to note 19 for details on bank guarantees issued with respect to facilities.



# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

GROUP	
2018	2017
R'000	R'000

## 21 FINANCIAL INSTRUMENTS (CONTINUED)

### 21.2 Credit risk (continued)

#### Exposure to credit risk

The carrying amount of financial assets represents the maximum credit exposure.

The maximum exposure to credit risk at the reporting date was:

Current fixed deposits	887 503	848 620
Call deposits	105 000	52 000
Bank balances	102 842	205 736
Cash on hand and cash deposits	5 264	118
Trade and other receivables	224 670	281 923
Contracts in progress less provision for losses (2017 restated)	112 217	83 936
	<b>1 437 496</b>	<b>1 472 333</b>

The maximum exposure to credit risk for trade receivables at the reporting date by type of customer was:

Local public sector	110 338	143 065
Local private sector	51 180	52 551
International sector	21 943	38 591
	<b>183 461</b>	<b>234 207</b>

The Group's most significant customers are various local public sector customers.

The aging of the Group's trade receivables at the reporting date was:

	2018		2017	
	Gross R'000	Impairment R'000	Gross R'000	Impairment R'000
The aging of the Group's trade receivables at the reporting date was:				
Not past due	115 473	78	149 485	706
Past due 0 – 30 days	33 781	195	32 342	12
Past due 31 – 120 days	20 984	2 115	23 385	1 030
Past due more than 120 days	30 475	14 864	38 342	7 599
	<b>200 713</b>	<b>17 252</b>	<b>243 554</b>	<b>9 347</b>

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 21 FINANCIAL INSTRUMENTS (CONTINUED)

### 21.2 Credit risk (continued)

#### Exposure to credit risk (continued)

The movement in the allowance for impairment in respect of trade receivables during the year was as follows:

	GROUP	
	2018	2017
	R'000	R'000
Balance at 1 April	9 347	25 781
Movement for the year	7 905	(16 434)
Recoveries	(2 651)	(12 151)
Utilisation	(1 987)	(8 811)
New impairment allowances	12 543	4 528
Balance at 31 March	17 252	9 347

The allowance account in respect of trade receivables is used to record impairment losses unless the Group is satisfied that no recovery of the amount owing is possible; at that point the amount considered irrecoverable is written off against the financial asset directly.

The fully performing trade receivables are considered to be of high credit quality.

### 21.3 Liquidity risk

Liquidity risk is the risk that the Group will not be able to meet its financial obligations as these fall due. The Group's approach to managing liquidity is to ensure, as far as possible, that it will always have sufficient liquidity to meet its liabilities when due, under both normal and stressed conditions, without incurring unacceptable losses or risking damage to the Group's reputation.

The Group monitors its cash flow on a daily basis. Typically, the Group ensures that it has sufficient cash on demand to meet expected operational expenses for a period of 60 days, including the servicing of financial obligations; this excludes the potential impact of extreme circumstances that cannot be predicted reasonably, such as natural disasters.

The following are the contractual maturities of financial liabilities, including interest payments but excluding the impact of netting agreements for the Group:

	2018			2017		
	Carrying amount	Contractual cash flows		Carrying amount	Contractual cash flows	
		6 months or less	6–12 months		6 months or less	6–12 months
	R'000	R'000	R'000	R'000	R'000	R'000
<b>Non-derivative financial liabilities</b>						
Trade and other payables (2017 restated)	(377 502)	(377 502)	–	(446 709)	(446 709)	–
	(377 502)	(377 502)	–	(446 709)	(446 709)	–

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 21 FINANCIAL INSTRUMENTS (CONTINUED)

### 21.4 Fair values

At 31 March 2018 the carrying amount of bank balances and cash, deposits, trade and other receivables, contracts in progress and trade and other payables approximated their fair values due to the short-term maturities of these assets and liabilities.

#### **Basis for determining fair values**

##### ***Trade and other receivables and trade and other payables***

The fair value of trade and other receivables and trade and other payables is calculated based on the present value of future cash flows, discounted at the average return on investment rate at the reporting date.

##### ***Forward exchange contracts***

The fair value of forward exchange contracts is determined using forward exchange rates at the Statement of Financial Position date, with the resulting value discounted back to present value.

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

GROUP		CSIR	
2018	2017	2018	2017
	Restated		Restated
R'000	R'000	R'000	R'000

## 22 RECONCILIATION OF OPERATING PROFIT TO CASH GENERATED FROM OPERATING ACTIVITIES

<b>Operating profit for the year before taxation</b>	<b>(14 080)</b>	76 408	<b>(14 544)</b>	76 318
Adjusted for:				
Depreciation	<b>65 091</b>	61 745	<b>65 090</b>	61 744
Net unrealised foreign exchange gain	<b>(519)</b>	(1 996)	<b>(519)</b>	(1 996)
Net finance income	<b>(38 954)</b>	(44 205)	<b>(38 482)</b>	(43 617)
Post-retirement medical benefits	<b>937</b>	995	<b>937</b>	995
Straight-lining adjustment of operating leases	<b>(1)</b>	5	<b>(1)</b>	5
Leave accrual	<b>4 188</b>	14 111	<b>4 188</b>	14 111
Impairments/(reversals of impairments)	<b>19 514</b>	(16 923)	<b>22 668</b>	(15 282)
Profit on disposal and write-off of property, plant and equipment	<b>(2 514)</b>	(38 422)	<b>(2 514)</b>	(38 422)
Share of loss of joint ventures and associates	<b>3 110</b>	1 833	<b>–</b>	–
Bad debt written off	<b>1 502</b>	3 645	<b>1 502</b>	3 645
<b>Operating profit before changes in working capital</b>	<b>38 274</b>	57 196	<b>38 325</b>	57 501
Decrease/(increase) in trade and other receivables	<b>42 521</b>	(19 247)	<b>49 459</b>	(27 535)
(Increase)/decrease in inventory and contracts in progress	<b>(29 378)</b>	18 584	<b>(29 961)</b>	18 584
Increase/(decrease) in advances received	<b>59 315</b>	(11 517)	<b>59 315</b>	(11 517)
(Decrease)/increase in trade and other payables	<b>(73 278)</b>	13 796	<b>(70 017)</b>	13 578
<b>Net working capital changes</b>	<b>(820)</b>	1 616	<b>8 796</b>	(6 890)
<b>Cash generated from operating activities</b>	<b>37 454</b>	58 812	<b>47 121</b>	50 611

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## 23 CASH AND CASH EQUIVALENTS

	GROUP		CSIR	
	2018	2017 Restated	2018	2017 Restated
	R'000	R'000	R'000	R'000
Fixed deposits	887 503	848 620	883 000	844 394
Call deposits	105 000	52 000	103 000	50 000
Bank balances	102 842	205 736	102 331	204 612
Cash on hand and cash deposits	5 264	118	5 264	118
	<b>1 100 609</b>	<b>1 106 474</b>	<b>1 093 595</b>	<b>1 099 124</b>

## 24 RELATED PARTY TRANSACTIONS

The CSIR is a schedule 3B National Government Business Enterprise in terms of the Public Finance Management Act, (Act 1 of 1999) as amended by Act 29 of 1999, and therefore falls within the national sphere of government.

As a consequence, the CSIR has a significant number of related parties, being entities that fall within the national and provincial sphere of government. Amounts due from/to these entities are subject to the same terms and conditions as normal trade receivables and trade payables. For detail on individually significant transactions refer to notes 2 and 3.

In addition, the CSIR has a related party relationship with its subsidiaries (see Addendum A) and joint ventures and associates (see note 8). Unless specifically disclosed, these transactions are concluded at arm's length and the Group is able to transact with any entity.

### 24.1 Transactions with related parties

The following is a summary of transactions with related parties during the year and balances due at year-end:

	GROUP		CSIR	
	2018	2017 Restated	2018	2017 Restated
	R'000	R'000	R'000	R'000
<b>Constitutional institutions</b>				
Services rendered	2 712	–	2 712	–
Services received	116	–	116	–
Amount due to	(20)	–	(20)	–
<b>Major public entities</b>				
Services rendered	323 815	369 041	323 815	369 041
Services received	30 922	32 604	30 922	32 604
Amount due from	36 974	37 009	36 974	37 009
<b>National public entities</b>				
Services rendered	119 581	118 209	119 581	118 209
Services received	16 556	7 537	16 556	7 537
Amount due from	19 070	22 095	19 070	22 095



# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

GROUP		CSIR	
2018	2017	2018	2017
R'000	Restated R'000	R'000	Restated R'000

## 24 RELATED PARTY TRANSACTIONS (CONTINUED)

### 24.1 Transactions with related parties (continued)

#### National government business enterprises

Services rendered	4 701	6 275	4 701	6 275
Services received	629	1 488	629	1 488
Amount due from	965	664	965	664

#### Provincial public entities

Services rendered	4 079	4 800	4 079	4 800
Amount due from	7 563	1 457	7 563	1 457

#### Provincial government business enterprises

Services received	8	22	8	22
Amount due (to)/from	–	(16)	–	(16)

#### Government departments

Services rendered	1 605 648	1 791 895	1 605 648	1 791 895
Services received	7 428	256	7 428	256
Amount due from	25 879	74 993	25 879	74 993

#### Subsidiaries

Services rendered	–	–	–	142
Services received	–	–	–	13
Amount due (to)/from	–	–	(13)	(13)

#### Joint ventures and associates

Services rendered	356	205	327	197
Services received	–	–	–	–
Amount due from	12	3	–	–

### 24.2 Transactions with key management

Total remuneration of key management is included in employees' remuneration (refer to note 18 for Executive Management's remuneration).

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

GROUP		CSIR	
2018	2017 Restated	2018	2017 Restated
R'000	R'000	R'000	R'000

## 25 IRREGULAR AND FRUITLESS AND WASTEFUL EXPENDITURE

### 25.1 Irregular expenditure

Opening balance	920	–	920	–
Irregular expenditure relating to the 2017/18 financial year:				
– Non-compliance to PPPFA and/or PFMA *	2 980	–	2 980	–
Irregular expenditure relating to prior financial years:				
– Non-compliance to PPPFA and/or PFMA *	4 440	–	4 440	–
Irregular expenditure relating to the 2015/16 financial year:				
– Payment prior to signing of contract **	–	920	–	920
Amounts condoned	(920)	–	(920)	–
Irregular expenditure awaiting condonation	7 420	920	7 420	920

\* No loss was incurred by the CSIR.

\*\* Contract was subsequently signed and no loss was incurred by the CSIR.

### 25.2 Fruitless and wasteful expenditure

Fruitless and wasteful expenditure of R42 526 (due to a cancellation fee and interest paid) and R36 416 (due to two suppliers being appointed and paid for the same project) was incurred in the 2017/18 financial year.

Fruitless and wasteful expenditure of R6 997 was incurred in the 2016/17 financial year due to a customs penalty levied.

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

GROUP	
2018	2017
R'000	R'000

## 26 AGRÉMENT SOUTH AFRICA

Agrément South Africa has been established as a separate entity. All activities of Agrément South Africa are to be transferred to the new entity with effect from 1 April 2018. All assets and liabilities will transfer on 1 April 2018.

**Profit attributable to Agrément South Africa is as follows:**

Revenue	13 969	15 140
Employees' remuneration	(7 927)	(7 866)
Operating expenses	(5 855)	(6 699)
<b>Profit for the year</b>	<b>187</b>	<b>575</b>

**Assets and liabilities attributable to Agrément South Africa are as follows:**

### Assets

#### Non-current assets

Property, plant and equipment

#### Current assets

Trade and other receivables

Inventory and contracts in progress

Bank balances and cash on hand

#### Total assets

### Equity and liabilities

#### Reserves

Retained earnings

#### Current liabilities

Advances received

Trade and other payables

#### Total equity and liabilities

250	471
250	471
5 464	4 959
2	173
102	–
5 360	4 786
5 714	5 430
1 606	1 419
1 606	1 419
4 108	4 011
3 452	3 131
656	880
5 714	5 430

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

GROUP	
2018	2017
	Restated
R'000	R'000

## 27 DEREGISTRATION OF SUBSIDIARY

### Accredited Spatial Knowledge Network (Pty) Ltd

The Group held 100% of the issued share capital in Accredited Spatial Knowledge Network (Pty) Ltd. The company was deregistered on 21 July 2016.

The net assets of Accredited Spatial Knowledge Network (Pty) Ltd on deregistration were as follows:

Net asset value disposed	—
<b>Total consideration</b>	—
<b>Net cash outflow arising on deregistration of interest in subsidiary</b>	
Bank balance and cash disposed	—

## 28 CORRECTION OF PRIOR PERIOD ERRORS

The CSIR entered into two agreements with a local public sector customer in prior financial years. During the latter part of the 2017 financial year, communication was received from the customer indicating funding constraints with regards to the continuation of these contracts. The CSIR took the view that these constraints would be temporary and continued executing work and recognising the related revenue. In the current financial year it became clear that the funding constraints could not be resolved by the customer and that the CSIR would not be compensated for the work performed in the 2017 financial year from October 2016 onwards.

As a consequence, local public sector revenue for the 2017 financial year has been overstated. The related contracts in progress and advances received balances have been overstated and understated respectively. Expenses and the related liabilities have also been overstated.

The errors have been corrected by restating each of the affected financial statement line items for the prior period.

The following tables summarise the impact on the Group's consolidated financial statements.

# Notes to the annual financial statements

FOR THE YEAR ENDED 31 MARCH 2018

## Consolidated statement of financial position (extract)

Inventory and contracts in progress

### Current assets

### Total assets

Retained earnings

Reserves

Advances received

Trade and other payables

Current liabilities

### Total equity and liabilities

## Consolidated statement of profit or loss and other comprehensive income (extract)

Revenue

Operating expenses

### Profit for the year

### Total comprehensive income for the year

GROUP		
Impact of correction of errors		
As previously reported	Adjustments	As restated
R'000	R'000	R'000
As at 31 March 2017		
100 564	(15 205)	<b>85 359</b>
1 482 866	(15 205)	<b>1 467 661</b>
<b>2 272 085</b>	<b>(15 205)</b>	<b>2 256 880</b>
1 026 090	(18 290)	<b>1 007 800</b>
1 026 090	(18 290)	<b>1 007 800</b>
786 620	4 987	<b>791 607</b>
448 611	(1 902)	<b>446 709</b>
1 235 231	3 085	<b>1 238 316</b>
<b>2 272 085</b>	<b>(15 205)</b>	<b>2 256 880</b>
For the year ended 31 March 2017		
2 671 497	(20 192)	<b>2 651 305</b>
1 109 944	(1 902)	<b>1 108 042</b>
<b>94 657</b>	<b>(18 290)</b>	<b>76 367</b>
<b>95 583</b>	<b>(18 290)</b>	<b>77 293</b>

There is no impact on the total operating, investing or financing cash flows for the years ended 31 March 2017.



ADDENDUM A:

## Interest in subsidiaries

31 MARCH 2018

Consolidated subsidiaries	Country of incorporation	Issued capital	Interests of the CSIR				
			Effective holding		Financial year-end	Shares at cost less accumulated impairment losses	
			2018 %	2017 %		2018 R'000	2017 R'000
Direct investments							
Technology Finance Corporation SOC Ltd (Technifin)	South Africa	5 200	100	100	31 March	4 650	4 650
Technovent SOC Ltd	South Africa	5 000	100	100	31 March	–	–
						4 650	4 650

ADDENDUM A:

# Interest in subsidiaries

31 MARCH 2018

Interests of the CSIR				
Net indebtedness less accumulated impairment losses by subsidiaries		Net investment		General nature of business
2018 R'000	2017 R'000	2018 R'000	2017 R'000	
–	–	4 650	4 650	The commercialisation of patents, which are being developed at the CSIR, and on which royalties are earned based on the utilisation of the rights by external companies, either local or international.
62	786	62	786	The provision of financial administration services to the CSIR subsidiaries and joint ventures.
62	786	4 712	5 436	



# KNOWLEDGE DISSEMINATION

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Books and book chapters.....	180
International patents granted .....	186

## Highlights of CSIR knowledge dissemination (2017)

The organisation has progressed well on its scientific performance indicators. CSIR researchers have conducted significant research over the past year with a number of high-impact journal articles (Top 10 given in Table 1), conference papers (selected examples in Table 2) and reference works (books and book chapters). The organisation has also reached its performance targets for publication equivalents and journal articles.

**Table 1: Top 10 Journal articles for 2017 (based on impact factor of journal)**

	Title	Journal	Impact factor	Lead institute	CSIR Authors
1	Review on the current practices and efforts towards pilot-scale production of metal-organic frameworks (MOFs)	Coordination Chemistry Reviews	13.3	CSIR	Ren, Jianwei; Dyosiba, Xoliswa L; Musyoka, Nicholas M; Langmi, Henrietta W; Mathe, Mahlanyane K
1	Structural defects in metal-organic frameworks (MOFs): Formation, detection and control towards practices of interests	Coordination Chemistry Reviews	13.3	CSIR	Ren, Jianwei; Ledwaba, Mpho V; Musyoka, Nicholas M; Langmi, Henrietta W; Mathe, Mahlanyane
2	Enhancer-derived lncRNAs regulate genome architecture: fact or fiction?	Trends in Genetics	10.8	CSIR	Fanucchi, Stephani; Mhlanga, Musa M
3	An efficient selective reduction of nitroarenes catalyzed by reusable silver-adsorbed waste nanocomposite	Applied Catalysis B: Environmental	9.4	UNISA	Van der Westhuyzen, Christiaan W; Maity, Arjun
4	No evidence for extensions to the standard cosmological model	Physical Review Letters	8.5	Imperial College, London	Kroon, Steve
5	Empirical parameter identification for a hybrid thermal model of a high-speed permanent magnet synchronous machine	IEEE Transactions on Industrial Electronics	7.2	North-West University	Holm, Stanley R
6	Highly efficient inactivation of bacteria found in drinking water using chitosan-bentonite composites: Modelling and breakthrough curve analysis	Water Research	6.9	CSIR	Motshekga, Sarah; Sinha Ray, Suprakas
7	Structure-activity relationships of carbon-supported platinum-bismuth and platinum-antimony oxidation catalysts	Journal of Catalysis	6.8	Tshwane University of Technology	Kesavan Pillai, Sreejarani

# HIGHLIGHTS OF CSIR KNOWLEDGE DISSEMINATION

**Table 1: Top 10 Journal articles for 2017 (based on impact factor of journal)**

	Title	Journal	Impact factor	Lead institute	CSIR Authors
8	Coating effect of LiFePO <sub>4</sub> and Al <sub>2</sub> O <sub>3</sub> on Li <sub>1.2</sub> Mn <sub>0.54</sub> Ni <sub>0.13</sub> Co <sub>0.13</sub> O <sub>2</sub> cathode surface for lithium ion batteries	Journal of Power Sources	6.4	CSIR	Seteni, Bonan; Rapulenyane, Nomasonto; Luo, Hongze
9	Remote sensing of species diversity using Landsat 8 spectral variables	ISPRS Journal of Photogrammetry and Remote Sensing	6.4	CSIR	Madonsela, Sabelo; Cho, Moses; Ramoelo, Abel

**Table 2: Selected high-impact conference proceedings**

Title	Conference	Description
Progressing the South African SAR technology base through the development of a dual-band, fully polarised, airborne SAR sensor	Geoscience and Remote Sensing Symposium, USA	Describes the development of a dual-band, fully polarised SAR sensor demonstrator for airborne platforms as part of a programme aimed at establishing a local SAR technology base in South Africa.
Hybrid paper-based potentiostat for low-cost point-of-need diagnostics	The 21st International Conference on Miniaturized Systems for Chemistry and Life Sciences, USA	Manufacturing of a low-cost hybrid paper-based potentiostat. Potentiostats exhibit high sensitivity, and can be used for a variety of applications. The development of a portable, low-cost, disposable potentiostat can assist in a variety of fields including environmental monitoring, wearables and healthcare.
Driver drowsiness detection using behavioural measures and machine learning techniques: A review of state-of-art techniques	PRASA-RobMech International Conference, South Africa	There are many facial features that can be extracted from the face to infer the level of drowsiness. The recent rise of deep learning requires that these algorithms be revisited to evaluate their accuracy in detection of drowsiness. The analysis reveals that support vector machine technique is the most commonly used technique to detect drowsiness, but convolutional neural networks performed better than the other two techniques.



**Table 2: Selected high-impact conference proceedings**

Title	Conference	Description
The development of an African atmospheric science network	NACA Conference, South Africa	Atmospheric science research can have large impact on key societal issues for the continent (e.g. air quality, human health, agriculture, climate change). An African working group on atmospheric science has been proposed that would provide the following: a formal organisation through which African atmospheric scientists can develop a cohesive community to enhance collaboration regionally and internationally; improve uptake and impact of African scientists' research; contribute to bridge the gap of missing knowledge and foster the next generation of African atmospheric science researchers.
IoT devices and applications based on LoRa/LoRaWAN	IEEE Industrial Electronics Society, China	Internet of Things (IoT) has revolutionised the traditional Internet where only human-centric services were offered. IoT has several applications such as smart water management systems. However, they require high energy-efficient sensor nodes that are able to communicate across long distance. This motivates the development of many Low-Power Wide Area Networks (LPWAN) technologies, such as LoRa. The objective is to contribute toward the realisation of LoRa as a viable communication technology for applications that need long-range links and deployed in a distributed manner.
Towards a distributed control system for software defined wireless sensor networks	IEEE Industrial Electronics Society, China	Software Defined Networking (SDN) is a developing networking paradigm that advocates a complete overhaul of conventional networking. Software Defined Wireless Sensor Networks (SDWSN) is also an emerging network paradigm that infuses the SDN model into Wireless Sensor Networks (WSNs). The application of SDN model in WSN is set to cultivate the potential of WSNs in modern communication and to bring about the efficiency that the WSNs have not yet achieved due to their inherent constraints. This paper investigates the viability of a distributed control system for SDWSN.

# HIGHLIGHTS OF CSIR KNOWLEDGE DISSEMINATION

**Table 2: Selected high-impact conference proceedings**

Title	Conference	Description
From TV white space / spectrum sharing trials and geolocation spectrum database towards 5G	Progress In Electromagnetics Research Symposium, Russia	The presentation overviews the progress made in South Africa in research, development and implementation of a novel approach to intelligently reuse ultra-high frequency (UHF) television (TV) broadcasting spectrum for telecommunication needs, and, based on the experience with several technologies, argues on the filtering requirements, and future use of technology in the 5th generation communications (5G).
Fingerprint minutiae extraction using deep learning	International Joint Conference on Biometrics, USA	The high variability of fingerprint data makes the task of minutiae extraction challenging. We pose minutiae extraction as a machine learning problem and propose a deep neural network – MENet, for Minutiae Extraction Network – to learn a data-driven representation of minutiae points. We show that MENet performs favourably in comparison against existing minutiae extractors.
Enhanced biometric access control for mobile devices	Southern Africa Telecommunication Networks and Applications Conference, Spain	In the new Digital Economy, mobile devices are increasingly being used for tasks that involve sensitive and/or financial data. Hitherto, security on smartphones has not been a priority and furthermore, users tend to ignore the security features in favour of more rapid access to the device. We propose an authentication system that can provide enhanced security by utilising multi-modal biometrics from a single image containing unique face and iris data. The proposed system outperforms the related studies and shows promising advancements to at-a-distance iris recognition on mobile devices.
Standing posture control for a low-cost commercially available hexapod robot	IEEE/RSJ International Conference on Intelligent Robots and Systems, Canada	Posture control is one of the fundamental requirements for legged robots to achieve mobility on uneven terrain. This paper presents the implementation of a standing posture control system on a low-cost, commercially available hexapod robot platform. The controller was experimentally tested on level and uneven terrain, as well as on a dynamic balance board. Results compared favourably to those obtained on more expensive, custom-designed platforms.



Review on the current practices and efforts towards pilot-scale production of metal-organic frameworks (MOFs).

*Jianwei Ren, Xoliswa Dyosiba, Nicholas M. Musyoka, Henrietta W. Langmi, Mkhulu Mathe, Shijun Liao*

Metal-organic frameworks (MOFs) have been under development over the past 20 years. Similar to other technologies, research on MOFs in the upcoming 30 years will move towards the direction where MOF materials can deliver societal benefits by solving real-world problems. Taking technology from laboratory to applications is always a challenge. Analysis of the current MOFs research efforts indicates that the high cost, limited availability of MOF products and the knowledge gap for cost-effective production technologies account for the slow progression towards the development of envisioned MOF products at pilot-scale level. This short review brings together the scattered literature that addresses pilot-scale production of MOF materials. An additional aspect focuses on the progress on the development of pilot-scale synthetic strategies with green and sustainable features for MOF materials, which is an imperative to promote MOF-enabled products into the real world.



Structure-activity relationships of carbon-supported platinum-bismuth and platinum-antimony oxidation catalysts.

*Mabuatsela V. Maphoru, Sreejarani Kesavan Pillai, Josef Heveling*

Compositional and morphological studies on supported platinum are important for the improvement and expanded use of catalysts for oxidative coupling reactions. Nanocomposites consisting of 5% Pt supported on activated carbon and promoted with 5% Bi or Sb were prepared by electroless deposition and microwave-assisted (MW) methods. Addition of promoters significantly increases the dispersion of Pt. Bismuth reacts with residual phosphorus of the support to form various phases of BiPO<sub>4</sub>, while Sb cannot be detected by XRD. However, samples prepared by the MW method are unique in that they contain crystalline PtBi or PtSb alloys as part of the phase matrix. The thermal stability of the samples in air and the TOFs for the oxidation of 2-methyl-1-naphthol correlate with the metal dispersion. Since the oxidation reaction is understood to take place on the surface of metals with high standard electrode potentials, sufficient Pt exposure is one of the key performance parameters.



## Highly efficient inactivation of bacteria found in drinking water using chitosan-bentonite composites: Modelling and breakthrough curve analysis.

*Sarah C. Motshekga, Suprakas Sinha Ray*

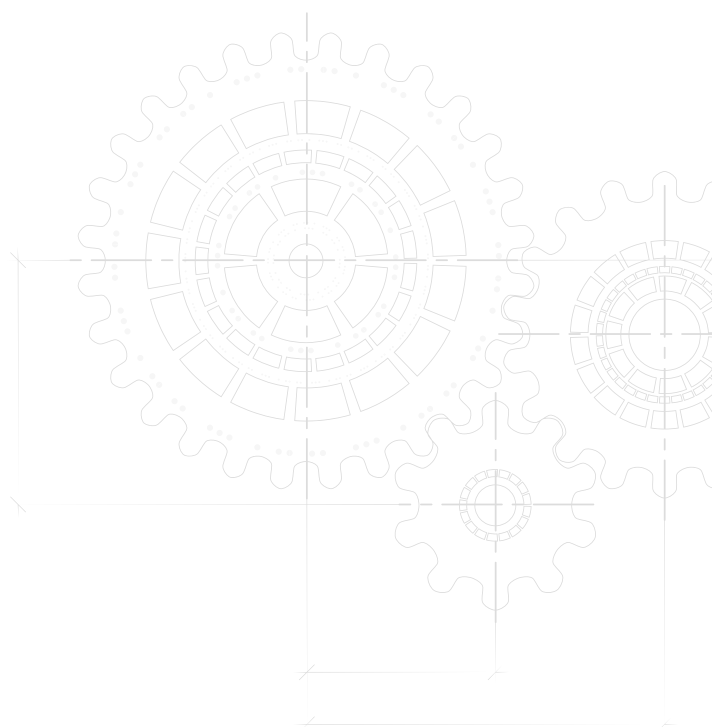
Disinfection of bacterially-contaminated drinking water requires a robust and effective technique and can be achieved by using an appropriate disinfectant material. The advanced use of nanomaterials is observed as an alternative and effective way for the disinfection process and water treatment as a whole. Hence, the inactivation of *Escherichia coli* (*E. coli*) using chitosan-Bentonite (Cts-Bent) composites was studied in a fixed bed column. Cts-Bent composites were synthesized using in situ cross-linking method using Bent-supported silver and zinc oxide nanoparticles. These composites were characterized by Fourier transform infrared spectroscopy, X-ray diffraction, scanning electron microscopy, and energy dispersive spectroscopy. The effect of the composite bed mass, initial concentration of bacteria, and flow rate on the bacterial inactivation was investigated. The characterization results revealed that the composites were successfully prepared and confirmed the presence of both silver and zinc oxide nanoparticles in the chitosan matrix. The growth curves of *E. coli* were expressed as breakthrough curves, based on the logistic, Gompertz, and Boltzmann models. The breakthrough time and processed volume of treated water at breakthrough were used as performance indicators, which revealed that the composites performed best at low bacterial concentration and flow rate and with substantial bed mass. The chitosan composites were found to be highly effective, which was demonstrated when no bacteria were observed in the effluent sample within the first 27 h of analysing river water. All the models were suitable for adequately describing and reproducing the experimental data with a sigmoidal pattern. Therefore, the prepared composite is showing potential to work as a disinfectant and provide an alternative solution for water disinfection; hence this study should propel further research of the same or similar materials.



## An efficient selective reduction of nitroarenes catalyzed by reusable silver-adsorbed waste nanocomposite.

*Somnath Giri, Raghunath Das, Chris van der Westhuyzen, Arjun Maity*

Silver nanocomposites (AgNCs) were produced by adsorption onto an electron-rich polypyrrole-mercaptopropionic acid (PPy-MAA) composite, known to be a highly efficient adsorbent for the removal of  $\text{Ag}^+$  ions from aqueous media in the remediation of metal-contaminated water sources. In situ reduction of  $\text{Ag}^+$  cations to  $\text{Ag}^0$  nanoparticles (NPs) was achieved in the absence of an additional reducing agent, and the AgNCs formed were characterized by FE-SEM, EDAX, HR-TEM, STEM, XRD, ATR-FTIR, and XPS. An investigation into the potential application of these AgNCs, effectively a waste product for further processing, as a catalyst for the reduction of variously substituted nitroarenes in water was undertaken in an effort to benefit the materials and determine the reaction's specificity. One composite having  $11.14 \pm 0.05$  wt% Ag content was particularly active in these reductions, with aniline derivatives being prepared in 71–94% yields. The kinetics of the reaction was examined using 4-nitrophenol, a common water-soluble pollutant; pseudo-first-order kinetics was observed with predicted activation energy of 68.3 kJ/mol for this system. Furthermore, this AgNC displayed superior stability over 10 reaction cycles without loss of catalytic activity. A mechanism was elucidated based on these findings. The mild, economical, and efficient reduction method using a reusable “waste” material may prove a promising alternative for further industrial application.







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### Paradigms and Theories Influencing Policies in the South African and International Water Sectors: A Framework for Policy Analysis

*Richard Meissner*

This book presents a new way of looking at and analysing policies, programs and/or plans in which research scientists have used their knowledge to develop mechanisms such as South Africa's National Water Resource Strategy, Second Edition; Australian and South African climate change adaptation strategies for government entities and the UNDP's Water and Ocean Governance focus area. It critically assesses how science can be used in the service of society and how researchers and practitioners can bridge the gaps that arise as a result of incomplete thinking. Presenting a bird's-eye view of how thinking and understanding operate in the policy context, it offers a valuable contribution to fields of inquiry such as research methods, comparative analyses, political science, international relations and the natural and social sciences in general. This book fills a market gap, providing real-world solutions to the practical application of science, paradigms and theories.

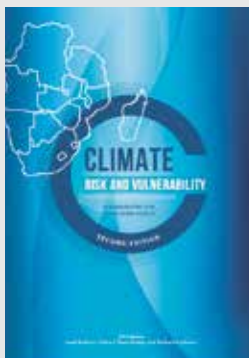


### The Green Building Handbook, Volume 11

*Llewellyn Van Wyk, Louiza Duncker, Pierre Du Plessis, Jeremy Gibberd, Mokonyama Mathetha, Muzi Nkosi.*

Edited by Llewellyn van Wyk and packed with contributions from South Africa's leading industry experts and researchers, The Green Building Handbook provides readers with practical insights into green building designs, technologies, materials and solutions relevant in the South African context and the effect each has on the environmental impact of buildings. In this issue CSIR researchers made multiple contributions including alternative and supplementary water conservation management options (using Cape Town as a case study), proposals on how buildings may be adapted to climate change and an evaluation of the strengths and limitations of the Green Star South Africa's rating scheme in respect of its transport environment category.

## BOOKS AND BOOK CHAPTERS



### Climate Risk and Vulnerability: A Handbook for Southern Africa (2nd edition)

*Claire Davis*

The handbook was conceived and designed with the intent to provide decision-makers with up-to-date information, appropriate for country planning, on the impacts and risks of climate change and variability. Reliable and accessible climate information is an important tool in responding to the impacts of climate change and the development of robust mitigation and adaptation strategies. The handbook translates the latest climate change information in a manner that is relevant to decision makers to build knowledge in the region. The handbook also serves as a reference guide for practitioners within the SADC member states who are currently engaged in impacts research and development of both mitigation and adaption policies and strategies. The content has been produced by a team that comprises climate scientists, social scientists with experience in impacts, vulnerability and adaptation, as well as communications experts.



### South African Risk and Vulnerability Atlas: Understanding the Social and Environmental Implications of Global Change. 2nd edition

*Julia Mambo, Miriam Murambadoro, Alize Le Roux, Gerbrand Mans, Elsona Van Huyssteen, Cornelia Van Niekerk, Claire Davis, Francois Engelbrecht, Emma Archer, Rebecca Garland, Tirusha Thambiran, Yerdashin Padayachi.*

The success of the first edition of the South African Risk and Vulnerability Atlas (SARVA), both as a publication and at COP17 (17th meeting of the 'Conference of the Parties' of the international treaty known as the United Nations Framework Convention on Climate Change), as shown by the feedback received, has prompted the production of this second edition with more chapters based on themes and case studies. While this publication still targets local government, it has been designed to appeal to other users including academia. We do however, acknowledge that more integration is needed in terms of balancing between the social and the physical impacts of climate and global change. CSIR contributions include: Municipal vulnerability to climate change; Profiling the vulnerabilities and risks of South African settlements; Disaster management and risk reduction in South Africa; Future climate change over Southern Africa; Human health; Risk and vulnerability to global and climate change in South Africa and Air quality.

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# INTERNATIONAL PATENTS GRANTED

Patent title	Patent number	Country
A field effect transistor and a gas detector including a plurality of field effect transistors	ZL 201480031221.3	China
A field effect transistor and a gas detector including a plurality of field effect transistors	9,683, 957	United States of America
A method and apparatus for assessing the integrity of a rock mass	2704671	Canada
A system for monitoring the condition of structural elements and a method of developing such a system	6167407	Japan
A method of calibrating a camera and a system therefor	2926543	European Patent Office
A method of calibrating a helmet and a system therefor	13008	Thailand
Compounds and compositions having activity against the enzyme HIV-1 reverse transcriptase	292792	India
Flame-proofed artefact and a method of manufacture thereof	9,796,167	United States of America
Integrated sensing device for assessing integrity of a rock mass and corresponding method	2014202050	Australia
Integrated sensing device for assessing integrity of a rock mass and corresponding method	2754975	Canada
Material analysis system (Cellnostics 3)	ZL 201280068912.1	China
Process for the production of crystalline titanium powder	2844411	European Patent Office
Process for the production of crystalline titanium powder	2635587	Russia Federation
Process for the production of crystalline titanium powder	115784	Ukraine
Production of crystalline titanium powder	31933	Kazakhstan
Production of crystalline titanium powder	9,567,690	United States of America
System for monitoring the condition of structural elements and a method of developing such a system	9,797,869	United States of America
Upgrading of titanium nitride	2,820,161	Canada
Water treatment using a cryptocrystalline magnesite-bentonite clay composite	2015395597	Australia

The CSIR acknowledges the support from the National IP Management Office's Intellectual Property Support Fund towards maintaining the CSIR patent portfolio.

# ABBREVIATIONS

<b>2D</b>	Two-dimensional
<b>3D</b>	Three-dimensional
<b>3G</b>	Third Generation
<b>5G</b>	5th Generation
<b>AfCAP</b>	Africa Community Access Partnership
<b>AiBST</b>	African Institute of Biomedical Science and Technology
<b>AIPF</b>	Associated Institutions Pension Fund
<b>AISI</b>	Aerospace Industry Support Initiative
<b>ARV</b>	Antiretroviral
<b>AsCAP</b>	Asia Community Access Partnership
<b>B-BBEE</b>	Broad-Based Black Economic Empowerment
<b>BIDF</b>	Biorefinery Industry Development Facility
<b>BRICS</b>	Brazil, Russia, India, China and South Africa
<b>CHPC</b>	Centre for High Performance Computing
<b>CSIR</b>	Council for Scientific and Industrial Research
<b>DEA</b>	Department of Environmental Affairs
<b>DIRISA</b>	Data Intensive Research Initiative of South Africa
<b>DST</b>	Department of Science and Technology
<b>EPO</b>	European Patent Office
<b>FCTR</b>	Foreign currency translation reserve
<b>GBP</b>	Great British Pound
<b>GDP</b>	Gross domestic product
<b>GEOSS</b>	Global Earth Observation System of Systems
<b>GPRS</b>	General Packet Radio Service
<b>HCD</b>	Human Capital Development
<b>HIV</b>	Human Immunodeficiency Virus
<b>IASB</b>	International Accounting Standards Board
<b>ICASA</b>	Independent Communications Authority of South Africa

<b>ICT</b>	Information and Communications Technology
<b>IEE</b>	Industry Energy Efficiency
<b>IFRS</b>	International Financial Reporting Standards
<b>IIP</b>	Industry Innovation Partnership
<b>IPBES</b>	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
<b>iPSC</b>	induced Pluripotent Stem Cell
<b>IPAP</b>	Industrial Policy Action Plan
<b>KPI</b>	Key Performance Indicator
<b>kW</b>	Kilowatt
<b>merSETA</b>	Manufacturing, Engineering and Related Services Sector Education and Training Authority
<b>MICT</b>	Media, Information and Communication Technologies
<b>MOFs</b>	Metal-Organic Frameworks
<b>MW</b>	Mega Watt
<b>NDP</b>	National Development Plan
<b>NEPAD</b>	New Partnership for Africa Development
<b>NMISA</b>	National Metrology Institute of South Africa
<b>NSI</b>	National System of Innovation
<b>NRF</b>	National Research Foundation
<b>PCR</b>	Polymerase Chain Reaction
<b>PFMA</b>	Public Finance Management Act
<b>PhD</b>	Doctor of Philosophy
<b>PLM</b>	Product Lifecycle Management
<b>PV</b>	Photovoltaic
<b>R&amp;D</b>	Research and Development
<b>RDI</b>	(also RD&I) Research, Development and Innovation
<b>REC</b>	Research Ethics Committee
<b>ReCAP</b>	Research for Community Partnership
<b>SADC</b>	South African Development Community



# ABBREVIATIONS

<b>SAICA</b>	South African Institute of Chartered Accountants
<b>SANBio</b>	Southern Africa Network for Biosciences
<b>SANDF</b>	South African National Defence Force
<b>SANReN</b>	South African National Research Network
<b>SAR</b>	Satellite Aperture Radar
<b>SARVA</b>	South African Risk and Vulnerability Atlas
<b>SDN</b>	Software Defined Networking
<b>SDWSN</b>	Software Defined Wireless Sensor Networks
<b>SET</b>	Science, engineering and technology
<b>SETA</b>	Sector Education and Training Authority
<b>SKA</b>	Square Kilometre Array
<b>SMME</b>	Small, Medium and Micro Enterprise

<b>SOE</b>	State-owned enterprise
<b>TB</b>	Tuberculosis
<b>TLIU</b>	Technology Localisation Implementation Unit
<b>TV</b>	Television
<b>UAV</b>	Unmanned Aerial Vehicle
<b>UHF</b>	Ultra-high frequency
<b>UK</b>	United Kingdom
<b>UNDP</b>	United Nations Development Programme
<b>USD</b>	United States Dollar
<b>WHO</b>	World Health Organization
<b>WRC</b>	Water Research Commission
<b>WSNs</b>	Wireless Sensor Networks







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ISBN-13 978-0-7988-5638-6