ANNUAL REPORT 2018/19

science & technology
Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

CSIR
our future through science

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

(Scientific Research Council Act 46 of 1988, as amended by Act 27 of 2014)

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THE CSIR AT A GLANCE

2 342
TOTAL STAFF BASE

1 608
*SET BASE

1 610
BLACK SOUTH AFRICANS

1 041
FEMALE SOUTH AFRICANS

**Science, engineering and technology figures as at 31 March 2019*


320
STAFF WITH DOCTORAL QUALIFICATIONS
586
STAFF WITH MASTER'S-LEVEL QUALIFICATIONS
536
PUBLICATION EQUIVALENTS
319
JOURNAL ARTICLES
±R126 m
TOTAL INVESTMENT IN HCD
22
NEW PATENTS
50
NEW TECHNOLOGY DEMONSTRATORS

ABOUT THE CSIR

The Council for Scientific and Industrial Research (CSIR) is a leading scientific and technology research organisation that undertakes directed multidisciplinary research and technological innovation that contribute to the improved quality of 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. 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 Johannesburg, Durban, Cape Town and Stellenbosch – in proximity to applicable industries across the country.

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.

Impact is at the core of the organisation's business and the objectives have been crafted to ensure that we achieve this.

BUILD AND TRANSFORM HUMAN CAPITAL

2 342 CSIR total staff headcount

1 608 Science, engineering and technology staff (62% are black and 36% are female)

82.5% Employees are employed in the professional and skilled categories

320 Employees have doctoral qualifications

586 Employees have master's-level qualifications

CONDUCT HIGH-QUALITY RESEARCH TO FOSTER SCIENTIFIC DEVELOPMENT

- In total, **45%** of CSIR articles were published in journals with an **impact factor (IF) of 2 – 4.99** (in the top 10% of journals) and **9%** of CSIR articles were published in journals with an **IF of five or higher** (i.e. in the top 6% of journals)
- At the end of 2018/19, the CSIR generated **R1.746 billion** in contract **R&D income**

CONDUCT RELEVANT RESEARCH TO FOSTER INDUSTRIAL DEVELOPMENT

50 Technology demonstrators. These are a lead indicator of technology transfer

R5.42 m Royalty and licence income

INFRASTRUCTURE RENEWAL AND DEVELOPMENT

- **Exceeded** the annual target of ≥ **R61 million** and **invested R74 million** in property, plant and equipment

FINANCIAL SUSTAINABILITY AND GOVERNANCE

R7.7 m Net profit in 2018/19

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 consist of scientists, engineers and technologists who share a passion for shaping a better future through science and technology innovation. Our innovations are made possible through our state-of-the-art research infrastructure and some of the brightest minds who call the CSIR home.

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.

MINISTER'S FOREWORD

Dr Blade Nzimande
Minister of Higher Education, Science and Technology

In the period since democracy, the Council for Scientific and Industrial Research (CSIR), has built an impressive portfolio of research and innovation capabilities that has positioned the organisation as a pioneering innovation leader on the continent, with a global impact.

The CSIR has a critical role to play in addressing issues plaguing our economic advancement, particularly the triple challenges of poverty, unemployment and inequality.

This role is embedded in its mandate to foster scientific and industrial development to improve the quality of life of all South Africans, particularly the youth, women and people with disabilities.

It is undeniable that South Africa's investment in research and development (R&D) has been constrained in recent years. However, the CSIR demonstrated through its innovative outputs that investment in R&D is critical for our country's overall development and prosperity.

THE CSIR IS ENCOURAGED TO IMPLEMENT MORE LONG-TERM SUSTAINABLE ENGAGEMENT PROGRAMMES.

THE CSIR HAS STEADILY BUILT A STRONG REPUTATION FOR EXCELLENCE AND TRANSFORMATION.

As a public entity, reporting to the Department of Science and Technology (DST), the CSIR remains critical for government to realise the National Development Plan (vision 2030) and the Nine-Point-Plan, guided by our White Paper.

I therefore congratulate the CSIR for embarking on a strategy to realign its role to become more effective in driving innovation-led research and development in response to the massive developmental challenges of our economy and society. If this strategy is executed correctly, it could position the CSIR in the forefront of the drive to build a national innovation system that is central to the strategic goals of the White Paper on Science, Technology and Innovation (March, 2019).

The fact that the new CSIR strategy is rooted in technologies for the future, bodes well for South Africa's readiness for the era of the fourth industrial revolution (4IR) and its many contradictory opportunities and challenges.

The CSIR has also ensured that it builds and transforms its human capital base to better reflect the demography and strategic needs of our country. Out of a total staff headcount of 2 342, 1 608 make up the science, engineering and technology base. Of these, 62% are black and 36% are female.

Some 82.5% which makes up the majority of the CSIR employees are employed in the professional and skilled categories; 320 have doctoral qualifications and 586 have master's level qualifications.

I am pleased to note the overall progress and achievements of the organisation in the year under review, especially on projects and research interventions that government is directly funding.

The outputs of the Biomanufacturing Industry Development Centre are commendable. The centre supports small, medium and micro enterprises (SMMEs) by giving them access to world-class biomanufacturing facilities and research expertise.

To date, the Centre has supported 31 enterprises; has 89 products that are either in market evaluation stage or transferred to SMMEs and has also signed 14 licences.

Over a period of four years, 183 new permanent jobs have been created with 87 interns supported and equipped with vocational skills.

As a Department, we will be closely monitoring the CSIR-hosted Titanium Centre of Competence because of its potential direct benefits to industry and our economy.

The recent progress in the production of pure grade titanium at the centre's pilot plant is a significant milestone in the Centre's research activities.

Through the Waste Research Development and Innovation Roadmap, we now have analyses of the state of waste management in Africa, its impact on the continent and proposed solutions for improved waste management in the region.

The CSIR has been active in various outreach programmes initiated based on the priorities set out by the DST. The CSIR has been taking part in various career days and exhibitions to promote science through participation. This is a positive contribution to Government's support for social ('grassroots') innovation to emerge from within communities using the tools of science, engineering and technology to solving problems.

In order to see these innovations come to fruition, the CSIR is encouraged to implement more long-term sustainable engagement programmes, which span over multiple years, in order to make a real impact in the communities that we serve.

In order to contribute to a transformed, stronger and efficient National System of Innovation, as a Department, part of our responsibility is to fund students and researchers to ensure that we have sufficient pipeline of researchers who also reflect the demographic landscape of our country.

We therefore remain committed to ensuring that we promote diversity and employment equity across organisations under our mandate.

We appointed the CSIR to manage the funding of postgraduate bursaries through the DST/CSIR Interbursary Support Programme for key strategic areas as identified by the department and which also align to the CSIR's research activities.

To date, the programme has supported 839 students; and 348 in the last financial year alone.

These research areas include aerospace, modelling and digital sciences, titanium (manufacturing elements), photonics, biotechnology, as well as information and communications technology.

Indeed, the CSIR has steadily built a strong reputation for excellence and transformation not only in South Africa, but across the entire African continent. We believe that this reputation is only possible to the extent that it anchors its mandate at the heart of the nation's developmental agenda.

Amongst its notable achievements, the CSIR has generated R1.746 billion in contract R&D income and a total of 45% of the CSIR articles were published in the top 10% journals with an **impact factor (IF) of 2-4.99** and 9% published in journals with an **IF of five or higher** (i.e. in the top 6% of journals).

With all these achievements, I would like to thank the Board, executive leadership and staff of the CSIR for their dedication.

Dr BE Nzimande
Minister of Higher Education, Science and Technology

ISANDULELO SIKANGQONGOSHE

Kusukela kwaqala isikhathi sombuso wentando yabantu i-Council for Scientific and Industrial Research (i-CSIR) isiyenze umsebenzi oncomekayo ekucwaningeni nasekuqhamukeni namasu amasha osekuyenze yaba yinhlangano eyivulandlela ezwenikazini namagalelo ezwakalayo emhlabeni.

I-CSIR inomsebenzi omqoka ekulungiseni izinkinga ezikhinyabeza ukudlondlobala komnotho wethu, ikakhulukazi izinselelo ezintathu zobubha, ukusweleka komsebenzi nokungalingani.

Leli qhaza lisegunyeni lalo lokuqhuba intuthuko kwezesayensi nezimboni ukuphucula izinga lempilo yabo bonke abantu baseNingizimu Afrika, ikakhulukazi intsha, abantu besifazane nabantu abakhubazekile.

Akungatshazwa ukuthi ukutshala kweNingizimu Afrika ocwaningweni nentuthuko kunqindekile eminyakeni embalwa edlule. Kepha, i-CSIR ikhombise ngomsebenzi wayo onobuchule ukuthi ukutshala ocwaningweni nasentuthukweni kumqoka kangakanani entuthukweni nasekuchumeni kwezwe lethu.

I-CSIR IKHUTHAZWA UKUTHI ILANDELE IZINHLELO ZESIKHATHI ESIDE, EZITHATHA IMINYAKA EMININGI, UKUZE ZIBE NEGALELO ELIZWAKALAYO EMIPHAKATHINI EYISEBENZELAYO.

IMPELA I-CSIR ISIZAKHELE IGAMA ELIHLE.

Njengenkampani kahulumeni, engaphansi komNyango wezeSayensi nezokuQamba (phecelezi Innovation), i-CSIR imqoka kuhulumeni ukuthi ufeze uHlelo lweNtuthuko kaZwelonke (umbono wezi-2030) noHlelo olumaPhuzu ayisiShiyagalombili.

Yingakho ngihalalisela i-CSIR ngokulandela isu lokubuyekeza umsebenzi wayo ukuthi ikwazi ukuqhuba umsebenzi wayo wocwaningo nentuthuko ukubhekana nezinselelo ezinkulu zentuthuko ezithinta umnotho wethu nomphakathi. Uma lolu hlelo lulandelwa ngendlela efanele, loku kuzobeka i-CSIR ekhaleni lokwenza uhlelo lukazwelonke lokuqamba izinto ezintsha eliyisisekelo ezinhlosweni ze-White Paper on Science, Technology and Innovation (langoNdasa wangowezi-2019).

Ukuthi isu le-CSIR elisha liyeme ebuchwephesheni bangomuso, kuyizindaba ezinhle ngokulungela uGuquko lobuChwepheshe obuSha namathuba nezinselelo eziningi oluza nazo.

I-CSIR iphinde yaqinisekisa ukuthi yakha futhi ishintsha umthombo wabasebenzi bayo ngokuthi kubonakale ukuthi yiluphi uhlanga nobulili obuningi ezweni lakithi nangokwezidingo zezwe lethu. Esibalweni sabasebenzi abayizi-2 342, kwezesayensi, ezobunjiniyela nezobuchwepheshe abayizi-1 608, ezingamaphesenti abangama-62, bamnyama kuthi kubona abangamaphesenti angama-36 kube ngabesifazane.

Amaphesenti angama-82.5, okuyiwona ayiningi labasebenzi be-CSIR, aabasemikhakheni yalabo abafundele imisebenzi yabo nabaqeqeshiwe, abangama-320 baneziqu zobudokotela emikhakheni yabo, kuthi abangama-586 babe neziqu ze-Master's.

Kuyangithokosizisa ukubona indima esikhathuliwe nezinto ezenziwe yile nhlangano ngalo nyaka esiwubuyekezayo, ikakhulukazi imisebenzi nocwaningo ezixhashwe uhulumeni ngemali.

Imikhiqizo ye-Biomanufacturing Industry Development Centre iyancomeka. Lesi sikhungo seseka izinkampani ezincane ngokuthi zikwazi ukusebenzisa izinto zomkhiqizo wemvelo, nezingayicekeli phansi futhi nezongayo kanye nobuchule bocwaningo.

Kumanje, isiKhungo sinike umsebenzi izinkampani ezingama-31, sinemikhiqizo engama-89 ehlolelwa ukudayiswa noma ukudluliselwa ezinkampanini ezincane kanti futhi sesisayine izimvume, noma amalayisensi, ayi-14.

Eminyakeni emine, kudaleke imisebenzi egcwele eyi-183, kwesekwa amathwasa emisebenzi angama-87 ngamakhono emisebenzi yezandla.

SiwumNyango, sibheke ngeso lokhozi i-Titanium Centre of Competence ese-CSIR ngenxa yalokho engakwenzela imboni nomnotho wethu.

Ukukhiqizwa okusanda kwenzeka kwe-titanium yohlobo oluphambili yingqophamlando enkulu emsebenzini wocwaningo walesi siKhungo.

Nge-Waste Research Development and Innovation Roadmap, sesikwazi ukucwaninga isimo sokuphathwa kwezibi e-Afrika, umphumela wayo ezwenikazini neziphakamiso ngokuthi izibi zingaphathwa kanjani esifundeni.

Kuningi ekwenzile i-CSIR ezinhlelweni ngokwemisebenzi eseqhulwini ngokohlelo lomNyango. I-CSIR ibibambe iqhaza ngezinsuku zokufundisa abafundi ngemisebenzi nangemibukiso yokugqugquzela isayensi ngokwenza. Ukuphosa esivivaneni okuhle lokhu emsebenzini kahulumeni wokweseka umphakathi ('emazingeni aphansi') wokuqamba okuvela emiphakathini isebenzisa izinto zesayensi, ubunjiniyela nobuchwepheshe ukuxazulula izinkinga.

Ukuze lezi zinto ezintsha zithele izithelo, i-CSIR ikhuthazwa ukuthi ilandele izinhlelo zesikhathi eside, ezithatha iminyaka eminingi, ukuze zibe negalelo elizwakalayo emiphakathini eyisebenzelayo.

Ukuphosa esivivaneni sohlelo loguquko nolusebenzayo i-National System of Innovation siwumNyango, omunye umsebenzi wethu wukuxhasa izitshudeni nabacwaningi ukuqinisekisa ukuthi sinabacwaningi abenele bakusasa, kubonakale nokuthi ngabaluphi uhlanga nobulili obuningi ezweni lethu.

Ngakho, sizibophezele ekuqinisekiseni ukuthi sigqugquzela ukumeleleka kwazo zonke izinhlanga, izilimi, amasiko nobulili namathuba omsebenzi kuzo zonke izinhlangano ezingaphansi kwesandla sethu.

Sigunyaze i-CSIR ukuthi yengamele imifundaze yezitshudeni ezenza izifundo zobudokotela emikhakheni yazo nge-DST/CSIR Interbursary Support Programme emikhakheni emqoka ngokweso lomNyango nehambisana nomsebenzi wocwaningo we-CSIR.

Kuze kube manje, lolu hlelo seluxhase izitshudeni ezingama-839, nezingama-348 ngonyaka wezimali odlule.

Kule mikhakha sibala ezejubane emafini, isayensi yezobuchwepheshe bolwazi, ubuchwepheshe bombani wokukhanya, ubuchwepheshe bezinto ezikhiqizwe ngemvelo nobuchwepheshe bolwazi nokuxhumana.

Impela i-CSIR isizakhele igama elihle nangoguquko hhayi eNingizimu Afrika kuphela, kepha nasezwenikazini i-Afrika yonke. Sikholwa wukuthi leli gama elihle lingenxa yomsebenzi omuhle wokuthuthukisa isizwe.

Phakathi kwezinto ezinhle ezenziwe yi-CSIR singabala ukungenisa kwayo u-R1.746 billion ngocwaningo nezentuthuko namaphepha ocwaningo e-CSIR angama-45% ashicilelwe emabhukwini ocwaningo avelele angamaphesenti ayishumi **anomphumela owu-2-4.99** nawu-9% ane-**IF yokuhlanu noma ngaphezulu** (okungama-6% amabhuku ocwaningo avelele).

Ngawo wonke lo msebenzi, ngifisa ukubonga iBhodi, abaphathi abakhulu nabasebenzi be-CSIR ngokuzinikela kwabo.

Ngu-Dkt BE Nzimande
UNgqongoshe wezeMfundo ePhakeme ezeSayensi nezobuChwepheshe

KETAPELEKAKANYWA YA TONA

Khansele ya Dinyakišišo tša Saense le Intasteri (CSIR), mo nakong ya go tloga ga go thoma ga temokrasi e bile le potfolio ya go kgahliša ya dinyakišišo le mabokgoni a tšweletšopele ao a dirilego mokgatlo ketapele ye mpsha ya tšweletšopele mo kontinenteng, ka khuetšo ya lefase.

CSIR e na le karolo ye bohlokwa yeo e e kgathago go šogana le ditaba tšeo di tšhošetšago kaonafalo ya ekonomi ya rena, kudu ditlhohlo tše tharo tša bohloki, tlhokego ya mešomo le go se lekalekane.

Karolo ye e akareditšwe ka taolelong go godiša tšweletšopele ya saense le intasteri go kaonafatša boleng bja bophelo bja Maafrika Borwa ka moka, kudu bafsa, basadi le batho ba go phela ka bogolofadi.

Ke nnete gore peeletšo ya Afrika Borwa go dinyakišišo le tšweletšopele (R&D) e kwešitšwe bohloko mo mengwageng ya kgauswanyana. Le ge go le bjalo, CSIR e bontšhitše ka tšweletšo ya yona ye mpsha gore peeletšo ka R&D e bohlokwa go tšweletšopele ka kakaretšo le katlego ya naga ye rena.

BJALO KA KGORO, KAROLO YA MAIKARABELO A RENA KE GO THEKGA BAITHUTI LE BANYAKIŠIŠI.

CSIR E NA LE KAROLO YE BOHLOKWA GO KAONAFALO YA EKONOMI YA RENA.

Bjalo ka lekala la setšhaba, leo le begago go Kgoro ya Saense le Mpshafatšo (DST), CSIR e dula e le bohlokwa go mmušo go lemoga Leano la Tšweletšopele la Setšhaba (pono ya 2030) le Leano la Dintlha tše Senyane.

Ka gona ke lebogiša CSIR ka go tla ka mokgwa wa go beakanya lefsa mošomo wa yona wa go kgona go feta wa go eta pele dinyakišišo tša tšweletšopele le kaonafatšo go arabela ditlhohlo tše dikgolo tša phetogo tša ekonomi le setšhaba sa rena. Ge mokgwa wo o ka dirwa gabotse, o ka bea CSIR pele go maitapišo a go aga mokgwa wa mpshafatšo wa setšhaba woo o lego gare ga dinepo tša peakanyo ya White Paper ka ga Saense le Theknolotši le Mpshafatšo (Hlakola, 2019).

Ntlha ya gore mokgwa wo mofsa wa CSIR o theilwe go ditheknolotši tša ka moso, o bontšha gabotse go lokela ga Afrika Borwa mo nakong ya Phetogo ya Intasteri ya Bone (4IR) le dibaka tša yona tša go thulana le ditlhohlo.

CSIR e kgonthišitše gape gore e aga le go fetoša motheo wa letlotlo la yona la batho la go bontšha temokrafi le dinyakwa tše di beakantšwego tša naga ya rena. Godimo ga palomoka ya palomoka ya badirišani ya 2 342 ge o bala ka o tee ka o tee, badirišani ba 1608 ba Saense, boentšenere le theknolotši, bao ba dirago 62%, ke bathobaso moo 36% ya bona e le basadi.

82.5 % yeo e dirago bontši bja bašomi ba CSIR ba thwetšwe magorong a profešene le a bokgoni; 320 ba na le dithuto tša bongaka gomme ba 586 ba na le legato la dithuto la mastase.

Ke thabetše go lemoga tšwelopele ka kakaretšo le dikatlego tša mokgatlo mo ngwageng wa tshekatsheko, kudu mo diprotšekeng le ditsenogareng tša dinyakišišo tšeo di thekgwago thwii ke mmušo.

Ditšweletšo tša Senthara ya Tšweletšopele ya Intasteri ya Tšweletšo ya Diphedi e a retega. Senthara e thekga borakgwebo/mmakgwebopotlana, ba magareng le ba bannyane (SMMEs) ka go dira gore ba fihlelele dinolofatši tša tšweletšo ya diphedi tšeo di šomišwago lefaseng ka moka le bokgoni bja dinyakišišo.

Go fihla lehono, Senthara e file borakgwebo/mmakgwebo ba 31; e na le ditšweletšwa tše 89 tšeo di lego legatong la tekolo ya mmaraka goba di fetišditšwe go SMMEs gomme e saenne gape dilaesense tše 14.

Mo nakong ya mengwaga ye mene, go hlotšwe mešomo ye mefsa ya go ya go ile ye 183 le baithutelamošomo ba 87 bao ba thekgilwego le go matlafatšwa ka mabokgoni a mošomo.

Bjalo ka Kgoro, re tla be re lekola ka go tsenelela Senthara ya Bokgoni ya Thaethaniamo yeo CSIR e lego monggae ka lebaka la dikholego tša thwii tša bokgoni go intasteri le ekonomi ya rena.

Tšweletšo ya kgauswanyana ya thaethaniamo ya legato la go hlweka mo semeleng sa teko sa senthara ke phihlelelo ye kgolo kudu mo mešongwaneng ya dinyakišišo ya Senthara.

Ka Tšweletšopele ya Dinyakišišo ya Dilahlwa le Peakanyo ya Mpshafatšo, gonabjale re na le tshekatsheko ya maemo a taolo ya dilahlwa ka Afrika, khuetšo ya yona le ditharollo tšeo di akantšwego tša taolo ya dilahlwa yeo e kaonafaditšwego mo seleteng.

CSIR e dutše e kgatha tema go mananeo a go fihlelela batho a go fapana ao a thomilwego go lebeletšwe dilo tše bohlokwa tšeo di beilwego ke DST. CSIR e dutše e kgatha tema matšatšing a mošomo a go fapana le dipontšho go godiša saense ka go kgatha tema. Se ke go kgatha tema ga mohola go thekgo ya mmušo ya mpshafatšo ya leago "setšhaba') go thoma mo ditšhabeng go šomišwa sedirišwa sa saense, boentšenere le theknolotši go rarolla mathata.

Gore go bonwe dimpshafatšo tše ka phihlelelo ya bona, CSIR e hlohleletšwa go phethagatša mananeo a go kgatha tema a go swarelela a nako ye telele, ao a katološetšwago go mengwaga ye mentši, gore a dire khuetšo ye bohlokwa go ditšhaba tšeo re di šomelago.

Gore re kgone go kgatha tema go Mokgwa wa Setšhaba wa Mpshafatšo, bjalo ka Kgoro, karolo ya maikarabelo a rena ke go thekga baithuti le banyakišiši go kgonthiša gore re na le mohlwaela wa banyakišiši bao le bona ba bontšhago tikologo ya temokrafi ya naga ya rena.

Ka gona re dula re ikgafile go kgonthiša gore re godiša phapano le tekatekano ya mošomo go phatlalala le mekgatlo ka fase ga taolelo ya rena.

Re thwetše CSIR go laola thekgo ya dipasari tša dialogadigolwane ka Lenaneo la Thekgo la Pasari ya Tirišano ya DST/CSIR la dikarolo tša mokgwa wa motheo bjalo ka ge go boletšwe ke kgoro gape e bapetšwago le mešongwana ya dinyakišišo tša CSIR.

Go fihla lehono, lenaneo le thekgile baithuti ba 839; le 348 mo ngwageng wa ditšhelete wa feta fela.

Dikarolo tše tša dinyakišišo, di akaretša sekgoba sa lefaufau, sebopego le disaense tša titšitale, thaithaniamo (dielemente tša tšweletši), difotoniki, payotheknolotši, gammogo le theknolotši ya tshedimošo le dikgokagano.

Ka nnete, CSIR e aga ka go latelana maemo a maatla a bokgoni le phetogo e sego fela ka Afrika Borwa, eupša go phatlalala le kontinente ya Afrika. Re tshepa gore maemo a kgonega fela go fihla moo e tsebišago taolelo mo gare ga lenaneo la tšweletšopele ya naga.

Gare ga dikatlego tša yona tše bohlokwa, CSIR e dirile R1.746 bilione ka tumelelano le letseno la R&D gomme palomoka ya 45% ya diathekele tša CSIR di phatlaladitšwe mo dijenaleng tša godimo tša 10% tša **ntlha ya khuetšo ya 2-4.99** gomme 9% e phatlaladitšwe ka dijenaleng tša **IF ya hlano goba go feta** (seo se ra gore mo go 6% ya dijanale tša godimo).

Ka dikatlego tše ka moka, ke rata go leboga Boto, boetapelephithiši le badirišani ba CSIR ka boikgafo bja bona.

Ngaka BE Nzimande
Tona ya Thuto ya Godimo, Saense le Theknolotši

CHAIRMAN'S OVERVIEW

Prof. Thokozani Majozi
CSIR Board Chairperson

On behalf of the Board, it gives me pleasure to present to you the 2018/19 Annual Report of the Council for Scientific and Industrial Research (CSIR).

At the CSIR, our mandate seeks to foster industrial and scientific development through directed multidisciplinary research and technological innovation to improve the quality of life of South Africans. The work we do is always underpinned by this mandate, as well as a renewed focus on securing the long-term growth, impact, sustainability and relevance of our organisation. Thus, as the Board we have been working closely with the organisation to provide an informed and objective oversight of the application of the CSIR mandate to improve the quality of life of our citizens.

In the year under review, the organisation embarked on a project to develop a new strategy. This key turnaround strategy seeks to leverage our science, engineering, innovation and technology strengths and opportunities that will contribute to industrial and societal development to improve competitiveness and contribute positively to our economy. The strategy process culminated in a new vision, mission, objectives, values and a reconfigured research and development focus that is relevant to the needs of industry.

MAINTAINING A HEALTHY AND SAFE ORGANISATION IS A PRIORITY FOR THE BOARD.

THE BOARD IS FULLY SUPPORTIVE OF THE ORGANISATION'S NEW STRATEGIC REPOSITIONING.

We believe that by enhancing our collaboration with the public and private sector, especially industries, we will be able to offer solutions that will result in the creation of more jobs and the growth of our economy. In his address at the Job Summit, President Cyril Ramaphosa said, "Unemployment is the greatest challenge facing our country at this moment in its history. In the National Development Plan, we said that if we are to effectively and sustainably tackle the triple challenge of poverty, unemployment and inequality, we should aim to reduce unemployment to at least 6% by 2030. We need to acknowledge that we will not be able to reach that target, unless we do something extraordinary".

I am thus convinced, now more than ever, that as the CSIR, we are on the right path in pursuing the new strategy. From the beginning, the CSIR Board has been engaged in and fully supportive of the organisation's

THE BOARD REMAINS COMMITTED TO UPHOLDING SOLID CORPORATE GOVERNANCE PRINCIPLES THAT ARE UNDERPINNED BY THE APPLICATION OF TRANSPARENCY, ETHICAL CONDUCT AND EQUITY.

new strategic repositioning. We are of the view that the CSIR has a unique set of competences and capabilities within the science, engineering, and technology (SET) base and therefore has a lot to offer in response to and in addressing the challenges we face as a country.

The Board remains committed to upholding solid corporate governance principles that are underpinned by the application of transparency, ethical conduct and equity.

In 2018/19, we continued to ensure that a comprehensive and effective risk management process is in place. We also approved a number of policies to guide ethical practices in the organisation.

One of the key policies that was approved was the Safety, Health, Environment and Quality Policy. In order for us to attain zero harm, zero disabling injuries and zero fatalities, we need to continue to cultivate a culture of health and safety within the organisation. Maintaining a healthy and safe organisation is a priority for the Board.

We continue to operate in challenging times, but our strong SET and innovation capability, and governance foundation provide us with the flexibility to adapt to external influences.

I am pleased with the overall performance of the organisation, especially with the measures that were put in place to ensure a financially sustainable organisation. Of course, this is still work in progress and there is still a lot that needs to be done to perform well in all of our strategic objectives. I am confident that as we continue to diligently apply ourselves, showcase our capabilities to our stakeholders, especially industry, and curb wasteful and fruitless expenditure, we will continue to strengthen our financial position.

In the latter part of the financial year, the former Minister of Science and Technology, Mrs Mmamoloko Kubayi-Ngubane, appointed a new Board on a four-year term, effective January 2019. I am pleased and honoured that I will be continuing in my role as Chairperson. As the Board, we are committed to use our combined skills, diversity and experience to guide the organisation to much greater heights. We also look forward to working with the new Ministry of Higher Education, Science and Technology under the leadership of Dr Blade Nzimande.

The Board would like to use this opportunity to congratulate the CEO, Dr Thulani Dlamini, on his appointment as the member of the Presidential Commission on the fourth industrial revolution (4IR). This is great news for the organisation and it is a testimonial to the confidence that President Cyril Ramaphosa has in our CEO. This appointment is even more significant now that the World Economic Forum, the Department of Science and Technology, and the CSIR are in discussions about establishing a Centre for the fourth industrial revolution in Africa to be based at the CSIR.

On behalf of the Board, I would like to thank the Department of Science and Technology for their continued support, the CSIR executives, as well as our dedicated employees for their hard work and commitment. We look forward to continued collaboration as we implement the new CSIR strategy.

Prof. Thokozani Majozi
CSIR Board Chairperson

ELIJIKAYO LIKASIHLALO

Egameni leBhodi, kuyintokozo enkulu kimi ukunethulela umBiko woNyaka wangowezi-2018/19 we-Council for Scientific and Industrial Research (i-CSIR). E-CSIR, umongo womsebenzi wethu ukusabalalisa intuthuko yezezimboni neyezesayensi ngocwaningo olunemixhantela eminingi nokuqamba izinto ezintsha zobuchwepheshe ukuphucula impilo yabantu baseNingizimu Afrika. Umsebenzi esiwenzayo uhlale usekelwe kuloku kanye nokujonga okusha intuthuko yesikhathi esizayo, umsizila, ukukhula nokuthi inhlangano yethu ihlale inesidingo ebantwini. Yingakho siyiBhodi besisebenzisana kakhulu ne-CSIR ukuthi siyeluse ngendlela efanele ekwenzeni umsebenzi wayo ewubekelwe ukuphucula impilo yezakhamuzi zakithi.

Ngonyaka obuyekezwayo, inhlangano iqale umbhidlango wokuqhamuka nesu elisha. Inhloso yaleli su elimqoka ukugxilisa amagalelo esayensi, ubunjiniyela, ukuqamba nobuchwepheshe ekuthuthukiseni izimboni nomphakathi wakithi ukuze kube nokuphucuka nokuphosa esivivaneni ngendlela enhle emnothweni wethu. Lolu hlelo lokubuyekeza isu luholele embonweni, kwingqubomgomo, emigomweni emisha, nendlela entsha yokwenza ucwaningo oluhambisana nezidingo zemboni.

Sikholwa ukuthi ngokuqinisa ukubambisana kwethu nomkhakha kahulumeni nozimele, ikakhulukazi izimboni, sizokwazi ukuba nezisombululo ezizokwandisa umsebenzi, zikhulise umnotho wethu. Enkulumweni yakhe eNgqungqutheleni yemiSebenzi, uMengameli Cyril Ramaphosa wathi: "Ukusweleka kwemisebenzi yiyona nselelo enkulukazi ekhona ezweni lethu ngalesi sikhathi. OHlelweni lweNtuthuko lukaZwelonke, sathi ukuze sikwazi ukubhekana ngempumelelo nenselelo yezihlava ezintathu okuwububha, ukusweleka komsebenzi nokungalingani, kufanele sigxile ekunciphiseni ukusweleka komsebenzi kufinyelele okungenani kumaphesenti ayisithupha ngonyaka wezi-2030. Kudingeka ukuthi sivume ukuthi ngeke sifinyelele kulowo mgomo, ngaphandle kokuthi senze umlingo."

Yingakho ngikholwa ukuthi manje, kunakuqala, siyi-CSIR sisendaweni enhle yokulandela leli su elisha. Kusukela ekuqaleni, iBhodi ye-CSIR ibimatasa futhi yeseka isu elisha

IBHODI ISAZIBOPHEZELE EKULANDELWENI KWEMIGOMO YOKUPHATHA INHLANGANO NGENDLELA EFANELE OKUSEKELWE EKUNGAFIHLINI IZINTO, UBUQOTHO NOKULINGANA.

lenkampani. Sikholwa ukuthi i-CSIR inamakhono namandla angafani nawabanye endimeni yezesayensi, ubunjiniyela nebuchwepheshe, ngakho kuningi engakwenza ukubhekana nezinselelo esibhekene nazo siyizwe.

IBhodi isazibophezele ekulandelweni kwemigomo yokuphatha inhlangano ngendlela efanele okusekelwe ekungafihlini izinto, ubuqotho nokulingana.

Ngonyaka wezi-2018/19, siqhubekile nokuqinisekisa indlela ephelele nesebenzayo yokugada ubungozi. Sivumelane ngezinqubo eziningi ezizolandelwa ukuze kusetshenzwe ngobuqotho enkampanini.

Enye yezinqubo ezivunyiwe eyezokuphepha, ezempilo, ezemvelo nokubheka izinga, i-Safety, Health, Environment and Quality Policy. Ukuze sifinyelele ekutheni kungabi nakulimala, nakukhubazeka nakufa kwabantu, kudingeka ukuthi siqhubeka nokufaka isiko lezempilo nezokuphepha enhlanganweni yethu. Kumqoka kwiBhodi ukuthi inhlangano ihlale inokuphila nokuphepha.

Siyaqhubeka nokusebenza ngaphansi kwezimo ezinzima kodwa ukuba namandla kwethu esisekelweni sesayensi, ubunjiniyela nobuchwepheshe, ukuqamba izinto ezintsha nokuphatha kusenza sikwazi ukubhekana nezinto zangaphandle ezisithintayo.

Ngithakasile ngomsebenzi wenhlangano uwonke, ikakhulukazi imizamo esiyenzile ukuqinisekisa ukuthi inhlangano iyachuma ngokwezimali. Yebo, umsebenzi osaqhubeka lona futhi kuningi okusadinga ukwenziwa ukuze sifinyelele emgomweni esizibekele wona. Ngiyakholwa wukuthi ngenkathi siqhubeka sisebenza ngokuzikhandla, sigabisa ngamakhono ethu kubalingani bethu bangaphandle, ikakhulukazi izimboni, sinciphisa ukumosa nokusebenzisa imali ngendlela engenasidingo sizokwazi ukuphucula isimo sethu sezimali.

Ngasemaphethelweni onyaka wezimali odlule, uNgqongqoshe omdala wezeSayensi nezoBuchwepheshe uNkk Mmamoloko Kubayi-Ngubane waqoka iBhodi entsha ezoba khona iminyaka emine, kusukela ngoMasingana wangowezi-2019. Kuyangithokozisa futhi ngizizwa ngihloniphekile ukuthi ngizoqhubeka nomsebenzi wami wokuba ngusiHlalo. SiyiBhodi, sizibophezele ekusebenziseni amakhono ethu ehlangene namava ukuthi siphumelelise inhlangano. Sinentshisekelo yokusebenzisana neHhovisi lobuNgqongqoshe beMfundo ePhakeme, ezeSayensi nezoBuchwepheshe elisha eliholwa uDkt Blade Nzimande.

IBhodi ifisa ukuthatha leli thuba ukuhalalisela isiKhulu esiPhezulu uDkt uThulani Dlamini ngokuqokwa ukuba abe yilungu le-Presidential Commission on the fourth industrial revolution. Yizindaba ezimnandi lezi enhlanganweni kanti ziwubufakazi bokuthi uMengameli u-Cyril Ramaphosa usethemba kangakanani isiKhulu esiPhezulu sethu. Lesi sikhundla simqoka kabi uma kubhekwa ukuthi i-World Economic Forum, umNyango wezeSayensi noBuchwepheshe ne-CSIR baphezu kwezingxoxo zokusungula i-Centre for the fourth industrial revolution in Africa ezoba se-CSIR.

Egameni leBhodi, ngifisa ukubonga umNyango wezeSayensi noBuchwepheshe ngokuhlale useseka, izikhulu ze-CSIR nabasebenzi bethu ngokuzikhandla nokuzinikela. Sikubheke ngamehlo abomvu ukuqhubeka nokusebenzisana silandela isu elisha le-CSIR.

USolwazi uThokozani Majozi
USihlalo weBhodi yase-CSIR

KAKARETŠO YA MODULASETULO

Legatong la Boto, ke thabela go le abela Pego ya Ngwaga le Ngwaga ya 2018/19 ya Khansele ya Dinyakišišo tša Saense le Intasteri (CSIR).

Mo CSIR, taolelo ya rena e godiša tšweletšopele ya intasteri le saense ka dinyakišišo tša taetšo gape tša dikarolontši le mpshafatšo ya theknolotši go kaonafatša boleng bja bophelo bja Maafrika Borwa. Mošomo woo re o dirago nako le nako o thekgwa ke taolelo ye, gammogo le nepišo yeo e mpshafaditšwego ya go boloka kgolo ya nako ye telele, khuetšo, tshwarelelo le maleba tša mokgatlo wa rena. Ka gona, bjalo ka Boto re dutše re šoma gabotse le mokgatlo go fa taolo ya tsebo le nepo ya tirišo ya taolelo ya CSIR go kaonafatša boleng bja bophelo bja badudi ba rena.

Ka ngwaga wa tshekatsheko, mokgatlo o thoma protšeke go godiša mokgwa wo mofsa. Mokgwa wo wa kaonafatšo ye kgolo o nyaka go huetša maatla le dibaka tša saense, boenetšenere, mpshafatšo le theknolotši tšeo di tla kgathago tema go tšwelotšopele ya intasteri le setšhaba go kaonafatša bokgoni le go kgatha tema gabotse go ekonomi ya rena. Tshepetšo ya mokgwa e phethilwe ka pono ye mpsha, maikemišetšo, dinepo, mehola le dinyakišišo tšeo di beakantšwego lefsa le nepišo ya tšwelotšopele yeo e lego maleba go dinyakwa tša intasteri.

GO ŠIRELETŠA MAPHELO LE POLOKEGO KE SELO SEO SE TLAGO PELE MO GO BOTO.

BOTO YA CSIR E THEKGA KA BOTLALO GO DIRA PEAKANYO LEFSA YA MOKGATLO.

Re kgolwa gore ka go kaonafatša tirišano ya rena ka makala a setšhaba le a praebete, kudu diintasteri, re tla kgona go aba ditharollo tšeo di tla dirago dikgoba tša mešomo ye mentši le kgolo ya ekonomi ya rena. Mo polelong ya gagwe ya Samiti ya Mešomo, Mopresidente Cyril Ramaphosa o rile, "Tlhokego ya mešomo ke tlhohlo ye kgolo yeo naga ya rena e lebanego le yona ka nako ye mo historing ya yona. Mo Leanong la Tšweletšopele ya Setšhaba, re boletše gore re nyaka go lwantšhana ka katlego le ka go swarelela ditlhohlo tše tharo tša tlhokego ya mešomo, bohloki le go se lekalekane, re swanetše go ikemišetša go fokotša tlhokego ya mešomo go fihla go bonnyane 6% ka 2030. Re rata go amogela gore re ka se kgone go fihlelela selebanywa seo, ntle le ge re ka dira se sengwe sa go se tlwaelege".

BOTO E DULA E IKGAFILE GO THEKGA MAITSHWARO A TAOLO YA TIRIŠANO YEO E TIILEGO AO A THEKGWAGO KE TIRIŠO YA GO SE FIHLE SELO, BOITSHWARO BJO BOBOTSE LE GO LEKALEKANA.

Ka gona ke a kgotsofala, go feta le peleng, gore bjalo ka CSIR re mo tseleng ya maleba go latela mokgwa wo mofsa. Go tloga mathomong, Boto ya CSIR e be e dutše e kgatha tema gape e thekga ka botlalo go dira peakanyo lefsa ya mokgatlo. Re na le pono ya gore CSiR e na le sehlopa sa moswananoši sa mabokgoni le maitemogelo ka motheong wa saense, boenetšenere, le theknolotši (SET) ka gona e na le tše dintši tšeo e ka di abago go arabela le go šogana le ditlhohlo tšeo re lebanego le tšona bjalo ka naga.

Boto e dula e ikgafile go thekga maitshwaro a taolo ya tirišano yeo e tiilego ao a thekgwago ke tirišo ya go se fihle selo, boitshwaro bjo bobotse le go lekalekana.

Ka 2018/19, re tšwela pele go kgonthiša gore go na le tshepetšo ya taolo ya kotsi ya katlego gape ye kgolo. Re dumeletše gape dipholisi tše mmalwa go hlahla tirišo ya maitshwaro ka mokgatlong.

Ye nngwe ya dipholisi tše dikgolo tšeo di dumeletšwego e bile Polokego, Maphelo, Tikologo le Boleng. Gore re se be le kgobalo le e tee, go se be le dikgobalo le gatee, le go se be le mahu le gatee, re hloka go tšwela pele go godiša setšo sa maphelo le tšhireletšo ka mokgatlong. Go šireletša maphelo le polokego ke selo seo se tlago pele mo go Boto.

Re tšwela pele go šoma ka fase ga dinako tša ditlhohlo, eupša SET ya rena ye maatla le bokgoni bja mpshafatšo, motheo wa taolo o dira gore re kgone go fetogafetoga go itlwaetša dikhuetšo tša ka ntle. Ke thabile ka mošomo wa mokgatlo ka kakaretšo, kudu ka mekgwa yeo e dirišwago go kgonthiša mokgatlo wo o swarelelago ka ditšhelete. Ke nnete se e sa le mošomo woo o tšwelago pele gomme go sa na le tše dintši tšeo di swanetšwego go dirwa go šoma gabotse go dinepo ka moka tša dipeakanyo tša rena. Ke a kgotsofala ge re tšwela pele go šoma ka tlhokomelo, re bontšha mabokgoni a rena go bakgathatema ba rena, kudu diintasteri, le go laola ditshenyagelo tša tshenyo le go hloka mohola, re tla tšwela pele go matlafatša maemo a rena a ditshelete.

Mo karolong ya mafelelo ya ngwaga wa ditšhelete, Tona ya maloba ya Saense le Theknolotši Mdi Mamoloko Kubayi-Ngubane o thwetše Boto ye mpsha ya go tšea mengwaga ye mene go tloga ka Pherekgong 2019. Ke thabile gape ke hlomphilwe gore ke tla be ke tšwela pele ka mošomo wa ka bjalo ka Modulasetulo. Bjalo ka Boto, re ikagafile go šomiša mabokgoni a rena ao a kopantšwego, phapano le maitemogelo go hlahla mokgatlo go ya maemong a godimo. Re lebeletše gape go šoma le ofise ye mpsha ya tona ya Kgoro ya Thuto ya Godimo, Saense le Theknolotši ka fase ga boetapele bja Ngaka Blade Nzimande.

Boto e rata go šomiša sebaka go lebogiša CEO, Ngaka Thulani Dlamini, ka go thwalwa ga gagwe bjalo ka leloko la Khomišene ya Mopresidenete ka go Phetogo ya Intasteri ya Bone (4IR). Tše ke ditaba tše dibotse go mokgatlo gape ke tlhompho go tshepo yeo Mopresidente Cyril Ramaphosa a nago le yona go CEO ya rena. Thwalo ye e bohlokwa kudu gonabjale ka gore Foramo ya Ekonomi ya Lefase, Kgoro ya Saense le Theknolotši, le CSIR ba boledišana ka go thoma Senthara ya Phetogo ya Instasteri ya Bone ka Afrika yeo e tlogo ba ka CSIR.

Legatong la Boto, ke rata go leboga Kgoro ya Saense le Theknolotši ka thekgo ya bona yeo e tšwelago pele, taolophethiši ya CSIR, gammogo le bašomi ba rena bao ba ikgafilego ka go šoma ka maatla ga bona le boikgafo. Re lebeletše go tšwela pele go dirišana ge re phethagatša mokgwa wo mofsa wa CSIR.

Prof. Thokozani Majozi
Modulasetulo wa Boto ya CSIR

CEO'S MESSAGE

Dr Thulani Dlamini
CSIR CEO

The 2018/19 financial year will be one of the most memorable and significant for the CSIR in recent years. During this financial year, the CSIR Board approved a new CSIR strategy. The new strategy sets out a new strategic direction for the CSIR to make a greater impact in industry and on the economy, thereby ultimately improving the quality of life of our people, as our mandate intends.

The new strategy boldly responds to the mandate of the CSIR, which is to foster industrial and scientific development that improves the quality of life of our people, through directed and multidisciplinary research. The strategy development process was extensive and included inputs from various engagements with stakeholders – internally and externally – and most importantly, through the requisite environmental scanning.

One of the key outcomes of the strategy development process was the new vision of the organisation, namely

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

This vision is supported by a new mission, objectives and values for the organisation.

The strategy is underpinned by four pillars, which will guide us in our pursuit to conduct research to enable a capable state. These four pillars are growth, sustainability, impact and relevance. They bring alignment between responding to our mandate and addressing internal organisational imperatives. For instance, growth means that the CSIR will use its capabilities, i.e. skilled human resources, infrastructure and intellectual property to assist in growing the South African economy, contributing to alleviating poverty, and addressing unemployment and inequality. Additionally, the two-pronged role of a scientific and industrial development focus inherently means that the CSIR will also grow, not only financially, but with regard to human capital, infrastructure and other competencies to keep us as a world-class organisation.

The pillar on sustainability refers to the CSIR developing technologies that lead to an increased competitive advantage of South African enterprises, and thus ensuring that they remain sustainable. This also speaks to the financial sustainability of the organisation in a resource-constrained environment.

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

The last pillar, relevance, addresses the CSIR's role in leading innovation to contribute to industrial development and our ability to deliver on our mandate.

Another key outcome of the new strategy is the appropriate operating model to effect it.

As part of the strategy formulation process, the previous operating model underwent a thorough assessment, which identified gaps including the representation of R&D at executive level, customer centricity and being marketing facing. The new model brings changes to address these gaps. One key change is the introduction of three research divisions consisting of synergistic clusters to allow for better integration and collaboration in research.

Refining the strategy and communicating it to stakeholders, especially internally, made up a significant percentage of the work that was done in the year under review, and Team CSIR proved to be equal to the task. Therefore, moving forward, we will continue to focus on the new organisational strategy to optimise our operations, unlock potential and opportunities, and serve our stakeholders better.

As we reflect on the achievements of the past year, it is important to recognise the work that has already been achieved, while also noting areas for growth and improvement.

In this annual report, we highlight our advances in R&D, novel technologies and innovative interventions across our research spectrum and their impact on government, industry, society and the continent. A select number of projects are highlighted in our research section from page 26.

The CSIR is serious about the impact of the fourth industrial revolution (4IR) on South Africa's competitiveness. In this regard, the new CSIR strategy is underpinned by relevant 4IR technologies, such big data analytics, the Internet of Things, robotics, artificial intelligence and others.

In June last year, the founder and Executive Chairman of the World Economic Forum (WEF), Prof. Klaus Schwab, visited the CSIR and also delivered a keynote address at the CSIR Emerging Researchers Symposium. This was a significant moment for us, and now the WEF, the Department of Science and Technology and the CSIR are in discussions about establishing an affiliate centre for the fourth industrial revolution in Africa to be based here at the CSIR.

CSIR employees are essential to our success and we have been working towards creating a diverse workplace where everyone feels recognised and valued. The Excellence Awards are one of the ways in which we do that. In November 2018, we recognised the stellar performance of individuals and teams in their respective roles and truly demonstrated our EPIC values of pursuing Excellence, celebrating People, personifying Integrity and welcoming Collaboration.

Receiving the Top Employer certification for the ninth consecutive year; and receiving two Universum awards for being an employer of choice in the natural sciences and engineering/technology categories, as voted for by students and professionals, is a testament to and evidence of our commitment to building and transforming human capital. You can read more about the academic and research achievements of our researchers who distinguished themselves in their work and received various national and international acknowledgements on pages 32, 33 and 95.

I am pleased with the progress that we have made with regard to our finances. The net profit for the CSIR amounts to R7.7 million, a substantial increase and turnaround in our financial performance when compared to the previous year's R13.8 million net loss. This is a reflection of the commitment of CSIR employees to the financial sustainability of the organisation, the effectiveness of measures that we put in place and the disciplined application of the cost management strategies that we implemented to strengthen our finances, in order to remain financially sustainable in our operations.

None of the achievements of this past year would have been possible without the calibre of our employees. Therefore, I would like to thank our leadership and all our employees for their hard work, passion and commitment towards fulfilling the mandate of the CSIR, as well as their support as we implement the new strategy.

The three-year term of the new Board came into effect on 1 January 2019 and I am confident that its composition and combined skills sets have the ability to steer this organisation forward.

We are grateful for the financial and strategic support that we receive from the Department of Science and Technology. It goes a long way in assisting us to fulfil our mandate.

I would also like to extend a warm CSIR welcome to the Minister of Higher Education, Science and Technology, Dr Blade Nzimande and his deputy, Mr Buti Manamela. We look forward to a progressive working relationship to respond to the triple challenge of unemployment, poverty and inequality.

Dr Thulani Dlamini

CSIR Chief Executive Officer

UMYALEZO WESIKHULU ESIPHEZULU

Unyaka wezimali wangowezi-2018/19 uzoba ngomunye weyohlale ikhunjulwa nemqoka kwi-CSIR eminyakeni ezayo. Ngalo nyaka wezimali, iBhodi ye-CSIR ivumelane nesu elisha le-CSIR. Leli su licaba indlela entsha okufanele i-CSIR iyilandele ukuze ibe negalelo elizwakalayo emnothweni, elizokwenza ukuthi ithuthukise izinga lempilo yabantu bakithi, njengoba kuwumsebenzi wethu esiwujutshelwe.

"Isu elisha lithinta umsebenzi we-CSIR ngqo, okuwukutshala intuthuko kwezezimboni nezesayensi ephucula izinga lempilo yabantu bakithi ngocwaningo oluhleliwe noluhlanganisa imikhakha ehlukene kodwa exhumene. Indlela yokwenza leli su ibisabalele nemibono yabalingani, bangaphakathi nabangaphandle, kanti okumqoka kakhulu ukuthi kwenzekile nokuhlola umphumela wayo esimweni semvelo.

Omunye wemiphumela yokwenziwa kwaleli su kube wumbono omusha wenhlangano, othi,

"Singomasheshisa bokuchuma kwezenhlalo nezomnotho eNingizimu Afrika ngokuba ngabaholi bokuqamba izinto ezintsha".

Lo mbono wesekwa yinqubomgomo nemigomo emisha yenhlangano.

Leli su lisekelwe ezinsikeni ezine, ezizosihola ekwenzeni kwethu ucwaningo lokusiza uhulumeni. Lezi zinsika wukukhula, intuthuko yesikhathi esizayo, igalelo nokuthi inhlangano yethu ihlale inesidingo ebantwini. Zihlanganisa umsebenzi wethu nokubhekana nezidingo zangaphakathi zenhlangano. Isibonelo nje, ukukhula kusho ukuthi i-CSIR izosebenzisa amandla ayo, okusho abasebenzi bayo abanamakhono, ingqalasizinda nobunikazi bobuchopho ukulekelela umnotho waseNingizimu Afrika, ukusiza ukuqeda ububha nokusweleka komsebenzi nokungalingani. Ngaphezu kwalokho, leli qhaza elimbaxambili lokugxila kwisayensi nezezimboni kuyazisho ukuthi lisho ukuthi i-CSIR ngeke igcine ngokusimama ngokwezimali kuphela kepha futhi nangokwezisebenzi nangamanye amakhono ukuze sihlale siyinkampani esezingeni lomhlaba.

Insika ngekusasa isho ukuthi i-CSIR yenza ubuchwepheshe obenza ukuthi izinkampani zaseNingizimu Afrika zibe namandla amaningi okuqhudelana, ukuqinisekisa ukuthi ziyachuma. Lokhu kusho ukusimama kwenhlangano ngokwezimali esimweni somnotho esintengayo.

Ukuba negalelo kusho ukukwazi ukwenza ubuchwepheshe nemikhiqizo yethu kudayiseke ezimbonini nokuthi ukuthekela ubuchwepheshe nolwazi kusize uhulumeni akwazi ukwenza umsebenzi wakhe. Insika yokugcina, okungukuba nesidingo ebantwini, isho iqhaza le-CSIR ekuholeni ukuqamba izinto ezintsha ukuphosa esivivaneni sentuthuko nokukwazi kwethu ukufeza umsebenzi esiwujutshelwe. Omunye umphumela omqoka ngaleli su elisha yindlela ekahle yokulisebenzisa. Njengengxenye yokuqhamuka nesu elisha, indlela yokusebenza endala yabuyekezwa, kwabonakala izici zayo okubalwa kuzo ukuvela kocwaningo nentuthuko ezingeni lezikhulu eziphethe, ekugxileni emakhasimendeni nokubheka ekukhangiseni. Le ndlela entsha iza nezinguquko ezilungisa lezo zici. Olunye ushintsho ukuqalwa kwezigaba zocwaningo ezintathu ezinamaqoqo asebenzisanayo ukuze zididiyeleke kahle izinto kube nokubambisana ocwaningweni.

Ukulungisa isu nokwazisa abalingani ngalo, ikakhulukazi ngaphakathi enhlanganweni, kube yingxenye enkulu yomsebenzi esiwenze ngonyaka obuyekezwayo, kwathi ithimba lase-CSIR lakhipha unyawo. Ngakho-ke uma sibheka phambili, sizoqhubeka nokugxila eqhingeni elisha lenhlangano ukuphumelelisa umsebenzi wethu, sisebenzise amathuba akhona, sisebenzele abalingani bethu kangcono.

Uma sibheka izinto esizizuze ngonyaka odlule, kumqoka ukubona umsebenzi osuwenzekile, siphinde sibheke izindawo esingenza kangcono kuzona. Kulo mbiko wonyaka, sibheka amazwibela omsebenzi wethu ocwaningweni nentuthuko, ubuchwepheshe obusha nezindlela ezintsha zokwenza izinto kuwo wonke umsebenzi wethu wocwaningo negalelo lawo kuhulumeni, ezimbonini, emphakathini nasezwenikazini. Amazwibela eminye imisebenzi ekhethekile akhona esigabeni socwaningo ekhasini lama-26.

I-CSIR izimisele ngegalelo lokusetshenziswa kobuchwepheshe kuzo zonke izinto ukuze iNingizimu Afrika ikwazi ukuqhudelana namanye amazwe. Ngenxa yalokhu, isu elisha le-CSIR leyeme ebuchwephesheni obufanele njengokucubungula i-data enkulu, i-Internet of Things, ezamarobhothi, ubuchwepheshe obufana nezingqondo zabantu nokunye.

NgoNhlangulana wangonyaka odlule, umsunguli noSihlalo oMkhulu we-World Economic Forum (e-WEF), uSolwazi u-Klaus Schwab, wavakashela i-CSIR, wethula inkulumo enohlonze kwi-CSIR Emerging Researchers Symposium. Kwaba yinto enkulu loko kithi, yingakho manje i-WEF, umNyango wezeSayensi nezoBuchwepheshe ne-CSIR benezingxoxo ngokusungula isizinda se-fourth industrial revolution in Africa okomkhulu laso lizoba la e-CSIR.

Abasebenzi be-CSIR bawumgogodla wempumelelo yethu kanti besimatasa senza ukuthi indawo yokusebenza ibe nalo lonke uhlobo lwabantu lapho wonke umuntu ezizwa eyigugu khona. Ama-Excellence Awards ngenye yezindlela esihlonipha ngayo abasebenzi bethu. NgoLwezi lwangowezi-2018, saklomelisa abantu namathimba abo ngomsebenzi wabo omuhle emisebenzini abayenzayo, kwagqama inqubomgomo yethu ye-EPIC (Excellence, People, Integrity ne-Collaboration). Ukuthola isitifiketi sokuba wumQashi oVelele iminyaka eyisishiyagalolunye ilandelana, ukuthola imiklomelo ye-Universum ngokuba wumqashi ofiswa abasebenzi eminxeni yezesayensi, ubunjiniyela nobuchwepheshe – ngokuvotelwa yizitshudeni nabasebenzi abakulo mkhakha – kuwubufakazi bokuzibophezela kwethu ekwakheni nasekushintsheni amakhono abantu. Ungafunda kabanzi ngokuzuzwe ngabacwaningi bethu abazibonakalise ngomsebenzi wabo ngokuthola uxhaxha lwemiklomelo kazwelonke nasemhlabeni emakhasini ama-32, 33 nama-95.

Ngijabulile ngendima esiyikhathulile kwezezimali. Inzuzo esiyenzile ingakabanjwa intela ibe yizigidi zamarandi eziyi-7.7, okusho ukuthi ikhuphuke kakhulu kunaphambilini nokusho ukwenza kangcono kunangonyaka odlule lapho salahlekelwa khona yizigidi zamarandi eziyi-13.8. Loku kuwubufakazi bokuzinikela kwabasebenzi be-CSIR ekusimameni ngokwezimali kwenhlangano, ukusebenza kwemizamo yethu nokugada imali ngeso lokhozi esikuqalile ukuze sisimame ngokwezimali emsebenzini wethu.

Yonke impumelelo yangonyaka odlule ibingenzeke ngaphandle kohlobo lwabasebenzi esinabo. Ngakho-ke, ngifisa ukubonga abaholi bethu bethu ngokuzikhandla kwabo, uthando nokuzinikela emsebenzini ewunikiwe i-CSIR kanye nokuseseka kwabo ngenkathi silandela isu elisha.

Sibonga ukwesekwa ngezimali nangamasu umNyango wezeSayensi nezoBuchwepheshe. Kusisiza kakhulu ekwenzeni umsebenzi wethu.

Ngifisa ukwamukela uNgqongqoshe wezeMfundo ePhakeme i-Sayensi noBuchwepheshe uDkt Blade Nzimande nephini lakhe uMnu Buti Manamela e-CSIR. Silangazelela ubudlelwano obuhle ukubhekana nenselelo yezihlava ezintathu zokusweleka komsebenzi, ububha nokungalingani.

UDkt Thulani Dlamini
ISikhulu esiPhezulu se-CSIR

MOLAETŠA WA MOHLANKEDIMOGOLOPHETHIŠI

Ngwaga wa ditšhelete wa 2018/19 e tla ba wo mongwe woo o tla gopolwago kudu gape wo bohlokwa go CSIR mo mengwageng ya kgauswanyana. Nakong ya ngwaga wo wa ditšhelete, Boto ya CSIR e dumeletše tsela ye mpšha yeo CSIR e tlo go e tšeya go thoma ngwageng wo. Tsela ye ye mpšha e laetša taetšo ya peakanyo ye mpšha ya CSIR go dira khuetšo ye kgolo mo intastering le go ekonomi, ka gona mafelelong wa kaonafatša boleng bja bophelo bja batho ba rena ka ge taoleeo ya rena e bolela.

Mokgwa wa rena o arabela ka boikgantšho go taolelo ya CSIR, yeo e lego go godiša tšweletšopele ya instasteri le saense yeo e kaonafatšago boleng bja bophelo bja batho ba rena, ka dinyakišišo tša taetšo gape tša dikarolontši. Tshepetšo ya tšweletšopele ya peakanyo e bile ye kgolo gape e akareditše dikgopolo go tšwa go dipoledišano le bakgathatema – ka gare le ka ntle – gape se bohlokwa, ka tekolo ye bohlokwa ya tikologo. Ye nngwe ya dipoelo tše bohlokwa tša tshepetšo ya tšweletšopele ya mokgwa e bile pono ye mpsha ya mokgatlo, e lego

"Re ba akgofiši ba letlotlo la ekonomi ya leago la Afrika Borwa ka go eta pele mpshafatšo".

Pono ye e thekgwa ke maikemišetšo, dinepo le mehola tša mokgatlo.

Mokgwa o tiišwa ke diketapele tše nne, tšeo di tla re hlahlago mo maikemišetšong a rena a go dira dinyakišišo go dumelela mmušo wa bokgoni. Diketapele tše tše nne ke kgolo, tshwarelelo, khuetšo le maleba. Di tliša peakanyo gare ga go arabela taolelo ya rena le go šogana le dinyakwa tša mokgatlo tša ka gare. Mohlala, kgolo e ra gore CSIR e tla šomiša mabokgoni a yona, seo se ra gore methopo ya batho ya go ba le mabokgoni, infrastraktšha le thoto ya bokgoni go thuša go godiša ekonomi ya Afrika Borwa, go kgatha tema go fokotša bohloki, go šogana le tlhokego ya mešomo le go se lekalekane. Go tlaleletša, mohola wo o arotšwego gabedi wa nepo ya tšweletšopele ya saense le intasteri o nepiša bohlokwa o ra gore CSIR le yona e tla gola, e sego fela ka ditšhelete, gape le malebana le letlotlo la batho, infrastraktšha le mabokgoni a mangwe go re dira mokgatlo wa bokgoni lefaseng ka moka.

Ketapele ka tshwarelelo e ra ditheknolotši tšeo di golago tša CSIR tšeo di dirago kholego tše dibotse tšeo di oketšegago tša dikgwebo tša Afrika Borwa, ka gona tša kgonthiša gore di dula di swareletše. Se se bolela gape ka tshwarelelo ya mokgatlo ka ditšhelete mo tikologong yeo e se nago methopo.

Khuetšo e nepiša kgwebišano ya ditheknolotši tša rena le dimpshafatšo tša tšweletšopele ya instasteri, gammogo le phetišetšo ya theknolotši le tsebo yeo e dumelelago mmušo wa bokgoni. Ketapele ya mafelelo, maleba, e šogana le mošomo wa CSIR go eta pele mpshafatšo go kgatha tema go tšweletšopele ya intasteri le bokgoni bja rena go tšweletša taolelo ya rena. Poelo ye nngwe ye kgolo ya mokgwa wo mofsa, ke mmotlolo wo o šomišwago wa maleba go e huetša. Bjalo ka karolo ya tshepetšo ya go dira mokgwa, mmotlolo wa go feta woo o dirišwago o lekotšwe, seo se utolla mafokodi go akaretšwa kabo ya R&D mo legatong la bolaodiphethiši, maitemogelo a mabotse a modirelwa gape le go lemoga papatšo. Mmotlolo wo mofsa o tliša diphetogo go šogana le mafokodi a. Phetogo ye nngwe ye kgolo ke tsebišo ya dikarolo tše tharo tša dinyakišišo tšeo di nago le dihlopha tša tirišano go dumelela tsenelano ye kaone le tirišano mo dinyakišišong.

Go kaonafatša mokgwa le go o tsebiša bakgathatema, kudu ka gare, go dira phesente ye kgolo ya mošomo

woo o dirilwego mo ngwageng wa tshekatsheko, gomme Sehlopha sa CSIR se itaeditše go ba se lekane mošomo. Ka gona, go ya pele, re tla tšwela pele go nepiša go mokgwa wo mofsa wa mokgatlo go kaonafatša ditshepedišo tša rena, go lokolla bokgoni le dibaka, le go šomela bakgathatema ba rena gabotse.

Ge re bontšha dikatlego tša rena tša ngwaga wa go feta, go bohlokwa go lemoga mošomo wo o šetšego o atlegile, mola re lemoga dikarolo tša kgolo le kaonafatšo. Ka pego ye ya ngwaga le ngwaga, re bontšha tšwelopele ya rena ka R&D, ditheknolotši tša go fapana le ditsenogare tša mpshafatšo go phatlalala le mohlwaela wa dinyakišišo tša rena le khuetšo ya tšona go mmušo, intasteri, setšhaba le kontinente. Diprotšeke tše di kgethilwego tše mmalwa di gateletšwe mo karolong ya dinyakišišo tša rena go tloga letlakaleg la 26.

CSIR e hlokometše kudu khuetšo ya phetogo ya intasteri ya bone (4IR) go bokgoni bja Afrika Borwa. Ka go realo, mokgwa wo mofsa wa CSIR o thekgwa ke ditheknolotši tša 4IR tša maleba, go swana le tshekatsheko ya data ye kgolo, Inthanete ya Dilo (Internet of Things), dirobothiki, bokgoni bja maitirelo le tše dingwe. Ka Phupu ngwaga wa go feta mothomi le Modulasetulophethiši wa Foramo ya Ekonomi ya Lefase (WEF), Prof. Klaus Schwab, o etetše CSIR gape o file polelokgolo mo Simposiamong sa Banyakišiši bao ba sa Golago. Se e bile nako ye bohlokwa kudu go rena, le gape WEF, Kgoro ya Saense le Theknolotši le CSIR ba boledišana ka go thoma senthara ya tirišano ya Phetogo ya Instasteri ya Bone ka Afrika yeo e tla bago mo CSIR.

Bašomi ba CSIR ba bohlokwa mo katlegong ya rena gape re dutše re šomela go hlola lefelo la mošomo la go fapana moo mang le mang a ikwago a lemogwa gape a na le mohola. Difoka tša Bokgoni ke tsela ye nngwe yeo re dirago seo. Ka Dibatsela 2018, re lemogile go šoma gabotse kudu ga batho le dihlopha mo mešomong ya bona ya go fapana gape e bontšhitše mehola ya rena ya go KGAHLIŠA KUDU ya go tšwetša pele Bokgoni, ya go keteka Batho, ya go emela Tshepagalo le go amogela Tirišano. Go amogela setifikeiti sa Mothwadi wa Godimo mo mengwageng ye senyane ya go latelana, le go amogela difoka tše pedi tša Universam tša go ba mothwadi wa kgetho ka disaense tša tlhago le magoro a boentšenere/theknolotši, bjale ka ge re kgethilwe ke baithuti le diprofešenale, ke kgonthišo go bohlatse bja boikgafo bja rena go aga le go fetoša letlotlo la batho. O ka bala tše dintši ka dikatlego tša thuto le dinyakišišo tša banyakišiši ba rena bao ba bontšhitšego bokgoni mešomong ya bona gomme ba amogetše dikamogelo tša go fapana tša gae le tša ditšhabatšhaba mo matlakaleng a 32, 33 le 95.

Ke thabile ka kaonafalo yeo re e dirilego malebana le ditšhelete tša rena. Poelo ye e šetšego ya CSIR e fihlelela R7,7 milione, koketšego ye kgolo le kaonafalo ya go šomišwa ga ditšhelete tša rena ge go bapetšwa le tahlegelo ya go šala ya R13.8 milione ya ngwaga wa go feta. Se ke taetšo ya boikgafo bja bašomi ba CSIR go swarelela ditšhelete tša mokgatlo, go šoma gabotse ga mekgwa yeo re e šomišago le tirišo ya maikarabelo ya mekgwa ya taolo ya ditshenyagelo yeo re e dirišitšego go matlafatša ditšhelete tša rena, gore re dule re swareletše ka ditšhelete mo ditshepetšong tša rena.

Ga go na ye tee ya dikatlego tše tša ngwaga wa go feta e ka bego e kgonagetše ntle le bokgoni bja bašomi ba rena. Ka gona, ke rata go leboga boetapele bja rena le bašomi ba rena ka moka ka go šoma ka maatla ga bona, lerato le boikgafo go fihlelela taolelo ya CSIR, gammogo le thekgo ya bona ge re phethagatša mokgwa wo mofsa.

Nako ya mengwaga ye meraro ya Boto e thomile ka la 1 Pherekgong 2019 gomme ke na le tshepo gore sebopego sa yona le mabokgoni a yona ao a kopantšwego a na le bokgoni bja go iša mokgatlo wo pele.

Re a leboga ka thekgo ya ditšhelete le peakanyo yeo re e amogetšego go tšwa go Kgoro ya Saense le Theknolotši. E ikgafile go re thuša go fihlelela taolelo ya rena.

Ke rata gape go fetišetša kamogelo ye borutho ya CSIR go Tona ya Thuto ya Godimo, Saense le Theknolotši, Ngaka Blade Nzimande le motlatši wa gagwe Mna Buti Manamela. Re lebeletše kamano ya mošomo yeo e tšwelago pele go arabela ditlhohlo tše tharo tša tlhokego ya mešomo, bohloki le go se lekalekane.

Ngaka Thulani Dlamini

Mohlankedimogolophethiši wa CSIR

ORGANISATIONAL HIGHLIGHTS

The CSIR mandate commits the organisation to fostering scientific and industrial development to help improve the lives of South Africa's people. The starting point for this is our human capital – the quality of our science, engineering and technology base and those who support them. In this section, we share a few highlights from our investment in human capital and the dividends on this investment. We also share a selection of highlights on the research, development and innovation undertaken to benefit the country in the areas of health, industry, energy, defence and security, as well as the built and natural environments.

YOUNG RESEARCHERS SHOW THEIR METTLE

The CSIR prides itself on creating an environment in which young researchers are exposed to projects that add value to their studies and allow them to gain insight from world-class supervisors. By applying their skills in solving complex challenges on home soil, a new generation of researchers is making a difference in South African industry and society.

THE PROMISING ROLE OF MACHINE LEARNING IN MODELLING STREAM FLOW IN RIVERS

CSIR researcher Melise Steyn received the Stellenbosch University's Medal for the Top Magister Student (Science) in 2018.

Steyn's Master's degree focused on accurate river stream flow forecasting, which will assist in managing the consequences of droughts or floods. The use of time-series records relies on continuous, uninterrupted observations, but gaps in the data are often unavoidable. She proposed using machine-learning techniques to address these challenges.

Steyn first focused on short-term stream flow forecasting at a single river station. Support vector regression and neural network models were trained on historical stream flow and precipitation data, to forecast with a lead time of up to seven days. She investigated the ability of models to infill incomplete stream flow records, using data from upstream stations and rain gauges. Results highlighted the promising role of machine learning in the modelling of stream flow in rivers.

Steyn is part of the CSIR's advanced mathematical modelling team that is developing the Winetech Analysis Tool to mine and analyse large volumes of South African weather data, multispectral images of wine farms, and sensory and chemical wine properties to support viticultural decision-making by agricultural users and researchers.

She is a former CSIR bursar who obtained her BSc in mathematical science, her BSc (Hons) in applied mathematics – for which she received the Dean's medal at the Stellenbosch University's Science Faculty – before going on to complete her MSc in applied mathematics through a CSIR studentship.

STEYN BECAME ONE OF **586** CSIR EMPLOYEES WITH MASTER'S DEGREES.

364 CSIR EMPLOYEES WERE ENROLLED FOR HIGHER DEGREES AT THE END OF 2018/19.

Rector and Vice-Chancellor of South Africa's Stellenbosch University, Professor Wim de Villiers, handing CSIR researcher Melise Steyn the medal for Top Magister Student (Science).

IN PURSUIT OF SUPER-SENSITIVE GAS SENSORS

Zamaswazi Tshabalala received the Frank Nabarro Prize for Outstanding Oral Presentation in the category for condensed matter physics at the 63rd Annual Conference of the South African Institute of Physics in 2018.

Tshabalala studies smart materials that can be used to enhance gas-sensing properties such as sensitivity and selectivity. Gas sensors have broad application areas that can affect all aspects of life, such as detecting and monitoring gases in our living and working environments. They can be used for medical diagnosis or monitoring, such as the CSIR-developed breathalyser; in the automotive and aerospace sectors for air-quality control and the monitoring of carbon emissions; in the defence and security sector to detect bombs; to monitor industrial processes in mining; and for food spoilage in food processing, transportation and storage.

Tshabalala focuses on improving the fabrication of semiconducting metal oxide's hierarchical nanostructures with enhanced gas-sensing properties. The contribution of the study lies in the potential increase of the sensitivity and selectivity of gas sensors at room temperature, and an increased understanding of the relevant surface chemistry that contributes to the sensing mechanism in order to achieve a reliable sensing device. She draws on nanoscience and nanotechnology to manipulate and enhance the properties of the material suitable for the application.

CSIR student and PhD candidate Zamaswazi Tshabalala.

Tshabalala is at the CSIR on a PhD studentship. She has a BSc (Hons) in applied physics and mathematics from the University of KwaZulu-Natal and an MSc in physics from the University of the Free State.

CLOSER SYNERGY BETWEEN COMMUNICATION AND COMPUTING MODELS

Dr Hlabishi Kobo's PhD research on software-defined wireless sensor networks hit the mark when the Institute of Electrical and Electronics Engineers (IEEE) rated a paper based on his research as one of the top five cited papers published in 2017.

Two months after its publication, the paper, titled 'A Survey on Software-Defined Wireless Sensor Networks: Challenges and Design Requirements' was one of the top 100 popular papers in the IEEE's Xplore digital library with its 4 million papers. The paper was co-authored by the CSIR's Dr Adnan Abu Mahfouz.

CSIR senior researcher Dr Hlabishi Kobo.

Software-defined networking (SDN) is an emerging network paradigm which has disrupted the status quo in networking and computing. SDN introduces flexibility, innovation, simplicity, and better management. Wireless sensor networks have always been used for monitoring physical and environmental factors such as temperature, humidity, vibrations, motions and seismic events. Software-defined wireless sensor networks are a new network model formed by applying SDN to wireless sensor networks to address their inherent challenges. The controller in software-defined wireless sensor networks is vital as it holds the intelligence and control of the whole network. The centralisation of the controller rouses many challenges such as security, reliability, scalability and performance.

Kobo's paper looks at the efficient distribution method for the control system of the software-defined wireless sensor network using the concept of fragmentation. The evaluation showed that distributing the control system of the network is not only ideal, but necessary. The fragmentation model is envisaged to enhance the participation of such networks in Internet of Things and the broader fourth industrial revolution.

Kobo has a BSc, BSc (Hons) and MSc in computer science, all from the University of the Western Cape. He joined the CSIR on a PhD studentship and has since obtained his PhD in computer engineering from the University of Pretoria.

YOUNG SOUTH AFRICAN STUDENTS CARVE OUT AN INTERNATIONAL TRACK RECORD IN SUPERCOMPUTING


2013


2014


2015


2016


2017


2018


2019

South African undergraduate students have placed in the top three positions of the international Student Cluster Competition every year since they first competed in 2013.

The South African teams, made up of undergraduate computer science and engineering students took the top honours in 2013, 2014, 2016 and 2019, and came second in 2015 and 2017. In 2018 the team came third.

High-performance computing is a relatively new field in South Africa and the CSIR-managed Centre for High Performance Computing (CHPC) in Cape Town boasts one of the largest processing clusters on the continent – a collection of networked processors that provide the computing power needed to solve complex computing problems. The CHPC assists South African researchers to study complex climate models or sift through genomics data. The centre also assists industry in a variety of other fields.

It all began in 2011, when the team from CHPC, whilst attending the International Supercomputing Conference in Germany, realised the potential of the Student Cluster Competition as an opportunity to create awareness for high-performance computing as a career and to develop the high-performance computing pipeline in the country. The team started planning a national competition that would culminate in a team of six who would represent South Africa on the international stage.

Getting started: Selecting teams for participation in the South African round

The team selection phase is designed to impart critical knowledge for building a cluster, which includes using Linux systems, the basic software stack of a cluster, and considerations which should be taken into account when choosing hardware. Universities around the country are invited to send teams of four and the CSIR ensures that teams are entered from as many universities as possible, so that students from all backgrounds are given a chance to learn and compete. Team selection concludes with an assignment which requires each team to build a prototype cluster in the cloud. The teams selected from this round proceed to the national round of the Student Cluster Competition.

Getting to Team South Africa: Competing nationally

In the national CHPC Student Cluster Competition, participants build small high-performance clusters out of hardware provided by the CHPC and its industrial partners. The contest takes place at the annual CHPC National Conference. The participants are given a selection of applications to optimise and run on their cluster to demonstrate the performance of their design.

Each team is assigned a budget and a parts list from one of the CHPC's industry partners. With this budget and parts list, the team must design a cluster taking into consideration the set of applications which will be used to benchmark the cluster. Once the cluster's design is finalised, the hardware specification is submitted to the CHPC's partners for manufacturing.

The hardware, as specified in the cluster design, is delivered to the CHPC National Conference, where the teams construct their cluster, install the software stack and perform benchmarks. The teams are judged on a combination of the performance of the applications and the design of the cluster.

South African team representatives go through extensive training after winning the national round, including travelling to the Dell headquarters and the Texas Advanced Computing Centre in the United States of America, where they receive training from experienced administrators of supercomputing clusters on the design and administration of supercomputers.

Taking on the world's best: The Student Cluster Competition

The winning team from the national competition, with two additional individuals selected from the other teams by the judges, is entered into the Student Cluster Competition, held annually at the International Supercomputing Conference in Germany. Competitors typically include China, the United States of America, Germany and the United Kingdom.

Building the local pool of skills in high-performance computing

The competition receives significant media attention and, as a result, some team members have been approached by South African industry organisations for internships and other opportunities.

The CHPC National Conference also serves as a platform where member states of the Southern African Development Community (SADC) gather to discuss the implementation of the cyber infrastructure framework of the region. The SADC Cyber Infrastructure Forum has expressed interest to send observers to the Student Cluster Competition in the hopes to establish a regional competition to advance high-performance computing in Southern Africa.

THE CHPC WINTER SCHOOL IS THE CENTRE'S FLAGSHIP COURSE IN HIGH-PERFORMANCE COMPUTING.

Students from across South Africa at the annual CHPC winter school.

ASSISTING THE DST TO FUND NEW GRADUATES IN PRIORITY THEMATIC RESEARCH AREAS

The Department of Science and Technology has appointed the CSIR to manage the funding of postgraduate bursaries in key strategic areas as identified by the department, and that also align with CSIR research activities.

The DST-CSIR Inter-Bursary Support Programme funds postgraduate students who are pursuing their Honours, Master's and PhD degrees in research areas deemed important for the country and in which the country has a scarcity of skills. Students are supported to study fulltime at any of the public universities. The programme supports mainly South African students (87%), however, a small percentage of international students are also supported.

A CSIR technical review panel selects students based on the alignment of their study field with the identified priority thematic research areas, their academic performance, as well as demographic requirements.

The thematic research areas are aerospace, composites, modelling and digital sciences, microsystems technology, titanium (manufacturing elements), photonics, biotechnology, as well as information and communications technology.

In 2018, the CSIR expanded the support provided to the students in order to better equip them with skills that will contribute to a well-rounded science, engineering, technology and innovation pipeline. This support includes a travel grant to support PhD students to present their work at an approved conference; training on research skills focusing on aspects such as how to do research, technical reporting or dissertation writing; attending high-level national conferences for Master's and PhD students; experiential learning through part-time or vacation work at a research and development institute, as well as covering costs related to their thesis or dissertation.

BRINGING SCIENCE, ENGINEERING AND TECHNOLOGY TO THE PUBLIC

The CSIR undertakes engagement activities such as career days at schools and universities, exhibitions, as well as outreach programmes to raise awareness about science, engineering and technology in general, and the organisation's work and career opportunities specifically.

The CSIR's science engagement is informed by the vision of the Department of Science and Technology (DST) to promote science through participation and the involvement of citizens, particularly the youth.

Science engagement in the CSIR context refers to all the organisation's efforts to engage or interact with the public about its research, development and innovation. It includes programmes to attract the youth to enrol in the fields of science, technology, engineering, and mathematics, sharing of knowledge and expertise between CSIR researchers and other African scientists or organisations, as well as outreach and awareness activities. The CSIR takes guidance in respect of thematic interventions and national initiatives from the DST and the South African Agency for Science and Technology Advancement.

CSIR participation at the Parliamentary Budget Vote at the Iziko Museum in Cape Town (left) and at Scifest Africa in Grahamstown.

Science engagement for a younger audience

The CSIR hosts career days that focus on Grade 10-12 students. CSIR researchers showcase their work and share their experiences with students and their teachers at tailored exhibitions and visits to laboratories.

Grooming young scientists in communicating their research

The CSIR's emerging researchers symposium is a platform for young researchers to showcase their research to peers and potential collaborators. The researchers also participate in other science events across the country.

10 000

THE ESTIMATED NUMBER OF STUDENTS REACHED THROUGH THE CSIR'S PUBLIC ENGAGEMENT ACTIVITIES IN 2018/19.

CSIR student Zelldra Schutte with learners visiting the CSIR. Schutte is pursuing her Doctor of Philosophy in trauma biomechanics.

Exhibition participation

Bio-Africa Convention, Durban, KwaZulu-Natal

Scifest Africa – South Africa's National Science Festival, Makhanda, Eastern Cape

Sasol TechnoX Science, Maths and Technology Exhibition, Sasolburg, Free State

Eding International Science Festival, Polokwane, Limpopo and Klerksdorp, North West

Parliamentary exhibit following State of the Nation address, Cape Town, Western Cape

National Science Week Launch, Mpumalanga

Africa Aerospace and Defence Expo, Pretoria, Gauteng

Science Forum South Africa, Pretoria, Gauteng

Gauteng Youth Expo, Johannesburg, Gauteng

South African Local Government Association Municipal Managers Forum, Mbombela, Mpumalanga

CSIR-hosted events

Black Science, Technology and Engineering Professionals student chapter visit, Pretoria, Gauteng

Emerging Researchers Symposium, Pretoria, Gauteng

Career Day, Pretoria, Gauteng

Outreach activities

Science Beyond Borders, Thohoyandou, Limpopo and Kimberley, Northern Cape

Soshanguve Crossing Centre, Pretoria, Gauteng

Father Smangaliso Mkhatshwa Centre, Pretoria, Gauteng

The CSIR hosted a Career Day for Grade 10-12 students at its International Convention Centre in 2018.

THE CLASS OF 2018

The CSIR is committed to supporting the academic development and transformation of its staff, both in the science, engineering and technology and support bases. In line with the organisation's values, the organisation pursues excellence and celebrates its people.

Below are some of the employees who obtained doctoral or master's-level qualifications in 2018.

Dr Sindisiwe Buthelezi,
CSIR researcher
PhD (Biochemistry and Cell Biology), University of the Witwatersrand

Dr Varsha Chhiba,
CSIR senior researcher
PhD (Chemistry), University of the Witwatersrand

Dr Jacques Cilliers,
CSIR principal researcher
PhD (Electronic Engineering), University College London

Dr Pranitha Dawlal,
CSIR researcher
PhD (Microbiology), University of Pretoria

Dr Christoper de Saxe,
CSIR senior engineer
PhD (Engineering), Cambridge University

Precilla Dimpe,
CSIR systems administrator
MTech (Information Technology), Tshwane University of Technology

Babalo Dlulane,
CSIR financial administrative officer, MTech (Cost and Management Accounting), Tshwane University of Technology

Zimbini Faniso,
CSIR engineer
MSc (Physics), University of Fort Hare

Marlene Jivan,
CSIR senior project coordinator
MCom (Programme and Project Management), Cranefield College

Dr Hlabishi Kobo,
CSIR senior researcher
PhD (Computer Engineering), University of Pretoria

Tichaona Kumirai,
CSIR senior technician
MSc (Applied Science: Mechanical Engineering), University of Pretoria

Lehlo Ledwaba,
Candidate engineer
MSc (Applied Science), University of Pretoria

Qualifications obtained but not available for a photograph:
Amos Akande, Kirodh Boodhraj, Johnny Botha, OJ Botlhoko, Nwabisa Budaza, Gawie Croeser, Steve Dima, Ross Holder, Gugu Khalala, Thokozani Khwela, Dimakatso Makwakwa, Prettier Maleka, Ipfi Matoho, Lindokuhle Mdletshe, Rory Meyer, Tladi Mofokeng,

Dr Gugulethu Mabuza-Hocquet,
CSIR engineer
DPhil (Electrical and Electronic Engineering), University of Johannesburg

Dr Sabelo Madonsela,
CSIR postdoctorate
PhD (Geography), University of KwaZulu-Natal

Washington Makoana,
CSIR researcher
MEng (Mechanical Engineering), Central University of Technology

Victor Manavhela,
Regional Manager: National Cleaner Production Centre
MSc (Environmental Management), University of the Free State

Nthabiseng Mokoena,
CSIR engineer
MSc (Computer and Electrical Engineering), North-West University

Vuyelwa Mvandaba,
CSIR candidate researcher
MSc (Hydrology), Rhodes University

Dr Suliman Ridhwaan,
CSIR senior researcher
PhD (Applied Mathematics), University of Cambridge

Dr Delphia Skosana,
Project Management Manager
D (Philosophy), University of South Africa

Dr Andrew Smith,
CSIR senior researcher
PhD (Computer Science), University of South Africa

Mr Oscar Sono,
CSIR technician
MEng (Mechanical Engineering), University of the Witwatersrand

Mayur Tikam,
CSIR engineer
MEng (Mechanical Engineering), University of Pretoria

Sibongile Tshabalala,
Studentship
MSc (Medicine), University of the Witwatersrand

Christo Fourie,
CSIR research group leader
MEng (Engineering Management)
University of Pretoria

Dr Laven Naidoo,
CSIR senior researcher
PhD (Geoinformatics), University of Pretoria

Mahlatse Ratsoma,
CSIR engineer
MSc (Computer and Electronic Engineering), North-West University

Dr Elsona van Huyssteen,
CSIR principal researcher
PhD (Town and Regional Planning), University of Pretoria

Dr Lara van Niekerk,
CSIR senior researcher
PhD (Botany), Nelson Mandela University

Madumetja Moselakgomo, Nilesh Moti, Abesach Motlatle, Sibongile Mtimka, Nthambeleni Mukwevho, Gculisile Mvelase, Laven Naidoo, Andre Page, Treshan Pillay, Nomasonto Rapulenyane, Colin Schwegmann, Stanley Semelane, Justice Shaku, Hester Van Greuning, Corney Van Rooyen, Nqobile Xaba

RDI FOR INDUSTRY

GROWING THE BIOMANUFACTURING SECTOR BY BRIDGING THE TECHNOLOGY TRANSLATION GAP

Some 89 products that rely on biomanufacturing have been developed and transferred to enterprises at the CSIR-hosted and managed Biomanufacturing Industry Development Centre (BIDC) in the last five years.

Seven more products are currently under product and process development for new and existing small, medium and micro enterprises (SMMEs).

This industry-focused programme, championed by the CSIR, focuses its efforts on building a critical mass of bioprocess and product development skills and infrastructure and making these available and accessible to industry and SMMEs. This enables the translation of research and development to market-ready products and technologies, thereby creating sustainable jobs in the South African biomanufacturing sector.

Since its inception, the BIDC has provided support to 31 enterprises. Of these, 22 are black-owned enterprises and 14 are led by black females.

Through the dedicated engagement with enterprises over the past five years, several growth limiting issues were identified, including access to networks in the manufacturing industry, access to funding to support the set-up of large-scale manufacturing facilities, and business development support. In an effort to mitigate these challenges, the BIDC has linked enterprises with manufacturers to support the large-scale production of products and partnered with business incubators (OneBio, Biopark) to provide SMMEs with business development support. Furthermore, quarterly networking events were held to provide SMMEs with the opportunity to interact with their peers, as well as with facilitators who are successful entrepreneurs or experts in a variety of sectors. Opportunities have also been created for funders to present on initiatives for funding support at the events.

The centre has supported and contributed to follow-on funding proposals for business establishment to the Department of Science and Technology, the Department of Trade and Industry and the Small Enterprise Development Agency through specification of large-scale equipment, facilities layout and, in some cases, techno-economic feasibility studies.

31
ENTERPRISES CONTRACTED SINCE INCEPTION

89
PRODUCTS IN MARKET EVALUATION STAGE, IN THE MARKET OR TRANSFERRED TO SMMEs

183
NEW **PERMANENT JOBS** RECORDED OVER FOUR YEARS

87
INTERNS SUPPORTED SINCE INCEPTION AND EQUIPPED WITH VOCATIONAL SKILLS

14
LICENCES SIGNED

CSIR senior process engineer Prisha Naicker with locally manufactured chemical oxygen demand (COD) test kits, developed for a client. Industry and municipalities are required to adhere to water discharge specifications for COD, and currently imported COD test kits are widely used.

RDI FOR INDUSTRY

DEVELOPING AN ESSENTIAL OIL-BASED ANTIMICROBIAL PACKAGING TO CONTROL POST-HARVEST DISEASES IN AVOCADOS

The CSIR and the Tshwane University of Technology (TUT) pooled their respective skills in polymer and crop science to develop active packaging materials to help control post-harvest diseases in avocados.

South Africa produces prime quality export avocados. However, the shelf life of avocados is relatively short. Their quality and marketability are also considerably affected by the common post-harvest diseases anthracnose and stem-end rot.

The synthetic fungicide Prochloraz is used as a postharvest control measure for anthracnose in South Africa, Australia and New Zealand. Copper oxychloride is sprayed at pre-harvest stage to control anthracnose, but repeated applications throughout the season can cause the accumulation of copper residues on the fruit and in the soil. Due to the development of fungicide resistant strains, post-harvest fungicide applications are not considered a long-term solution for the fruit industry. The rising consumer demand for chemical-free food and the strict regulations enforced by the importing countries demand an alternatively safe and eco-friendly approach.

The CSIR and TUT investigated the application of essential oil in combination with polyolefins to develop active packaging materials as an alternative to synthetic fungicide treatment.

The CSIR produced active essential oil-based polymer pellets, which were screened for anti-fungal activity and anthracnose disease reduction performance in avocados at the TUT crop science lab. After receiving positive feedback on its efficacy, the CSIR scaled up the material and produced 1 000 sachets of the essential oil pellets. Testing was done on harvested and naturally infected Hass cultivars of avocados.

The research and development has led to industry interest for similar solutions to other avocado varieties.

45%
OF SOUTH AFRICAN PRODUCED AVOCADOS WERE EXPORTED IN 2016.
Source: www.nda.agric.za

Above: CSIR principal researcher Dr Sreejarani Pillai prepares a sachet with small polymer pellets that has been infused with essential oil.

Left: In laboratory tests undertaken by the Tshwane University of Technology, newly developed packaging pellets inhibited post-harvest fungus development.

Left: The CSIR's Lesley Mapoko feeds an essential oil-polymer mix into a twin-screw extruder.

DRIEKOP ESSENTIAL OILS PROJECT HANDED OVER TO LOCAL COOPERATIVE

In March 2019, the CSIR officially handed over the Driekop Essential Oils project to the Temothuo Cooperative, five years after it was launched by the Department of Rural Development and Land Reform.

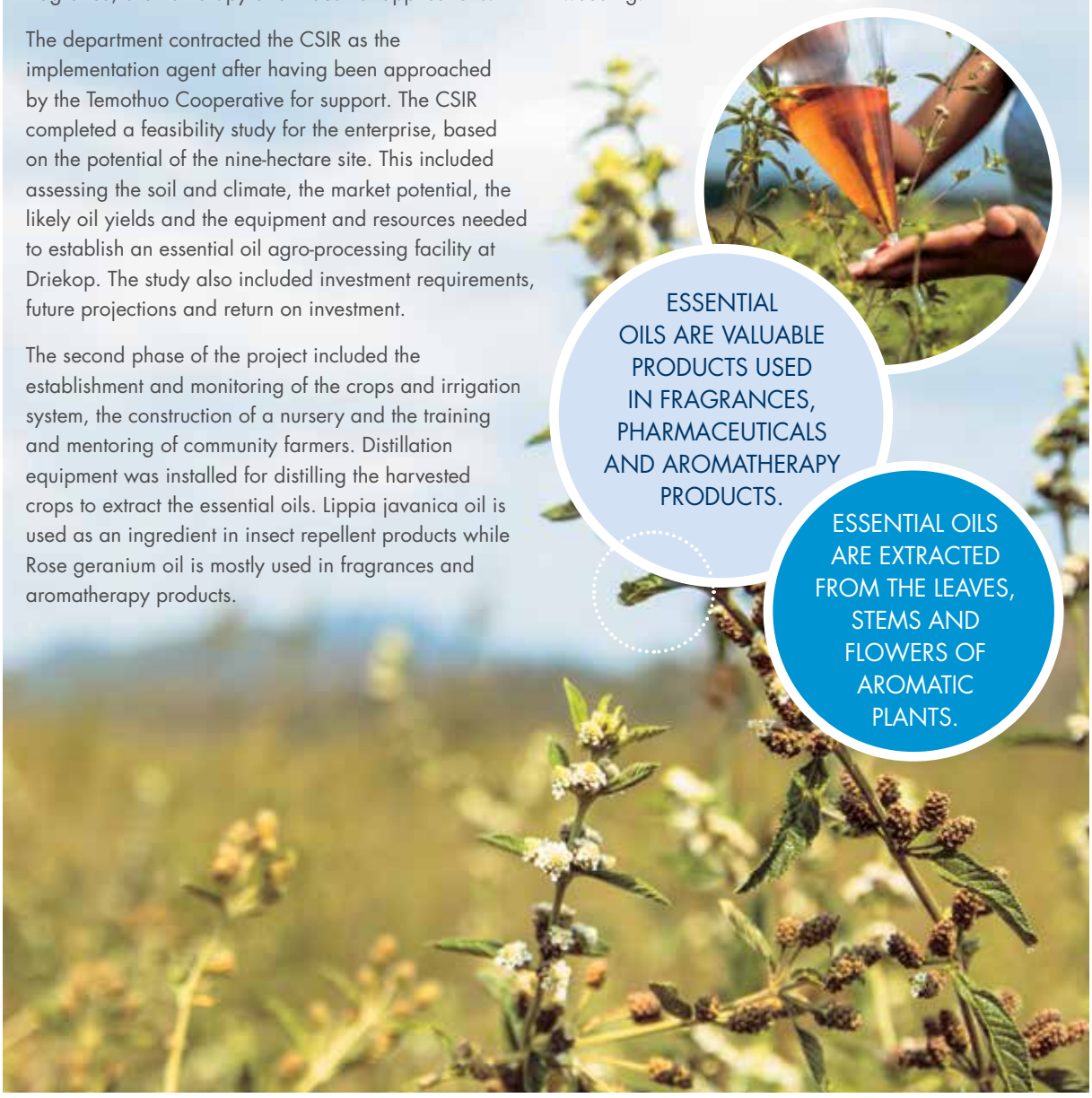
The department lauded the CSIR for providing support to the community of Driekop in Burgersfort, Limpopo, to establish an essential oils agro-processing facility. Essential oils are extracted from plants by a process of steam distillation and are widely used in flavour, fragrance, aromatherapy and industrial applications.

The department contracted the CSIR as the implementation agent after having been approached by the Temothuo Cooperative for support. The CSIR completed a feasibility study for the enterprise, based on the potential of the nine-hectare site. This included assessing the soil and climate, the market potential, the likely oil yields and the equipment and resources needed to establish an essential oil agro-processing facility at Driekop. The study also included investment requirements, future projections and return on investment.

The second phase of the project included the establishment and monitoring of the crops and irrigation system, the construction of a nursery and the training and mentoring of community farmers. Distillation equipment was installed for distilling the harvested crops to extract the essential oils. Lippia javanica oil is used as an ingredient in insect repellent products while Rose geranium oil is mostly used in fragrances and aromatherapy products.

The CSIR supported Temothuo in determining the quality of the produced oils by means of chemical analyses for purposes of marketability. The cooperative was introduced to various potential essential oil buyers and the essential oils produced were successfully positioned in the local market place.

The cooperative has 10 full-time staff members from the local community and employs additional staff members on a seasonal basis during periods of harvesting and weeding.



Essential oil crops cultivated at Driekop in Limpopo.

RDI FOR INDUSTRY

MSc student Nwabisa Jafta in the technology demonstration laboratory.

TECHNOLOGY FOR NEW REAGENTS USED IN GENOME ENGINEERING LICENCED TO CAPEBIO

The CSIR has developed manufacturing technologies for the local production of molecular biology enzyme reagents that had been isolated from South Africa's indigenous biodiversity using metagenomic techniques.

The technologies related to these new reagents have been licensed to CapeBio Pty Ltd, a new black-owned small, medium and micro enterprise for commercialisation.

Biotechnology research and development activities rely heavily on the use of proteins and enzymes as reagents and these reagents are widely used by laboratories globally. Access to novel and newly developed research reagents is a major driver of improved competitiveness and productivity in the biotechnology research and innovation value chain.

In the earlier stages of the research, the CSIR team extracted microbial genes from the soil in the Kogelberg Biosphere Reserve, one of the world's most biodiverse areas. The CSIR specifically targeted molecular enzymes which are used to cut DNA, in some instances to make more DNA and also to join molecules. Several processes for the manufacture of these enzymes were then developed for translation into functional product prototypes. Licensee CapeBio will use the new reagents for their own applications in the laboratory and will commercialise the technologies, creating value from the country's biodiversity.

EIGHT AEROSPACE TECHNOLOGY ROADMAPS COMPLETED

The CSIR-hosted Aerospace Industry Support Initiative (AISI) has developed technology roadmaps for eight companies in the aerospace industry, seven of which are small, medium and micro enterprises (SMMEs).

A technology roadmap is a visual document that communicates the plan for technology initiatives in an organisation, looking at what technology solutions will be implemented at which stage to help the organisation move forward.

The intervention assisted the companies to identify relevant technology support projects in line with their long-term technology planning needs. The tool assists industry with long-term technology planning and prioritisation which mitigate the risk of over-reliance on a small number of customers, creating growth and sustainability.

The companies supported were Aerosud Aviation, LambdaG, Lantern Engineering, Shrike Marine, Thata Ubeke Manufacturing, Cybicom Atlas Defence, Trax Interconnect and Jonker Sailplanes.

The projects implemented included the use of additive manufacturing on 3D-printed microwave sub-assemblies at LambdaG; localising software-defined radio technology at Lantern Engineering; developing a resin via-filling capability for highly complex circuit boards at TraX Interconnect; designing, developing and manufacturing a 24 m wingspan sailplane to upgrade the current JS1 Revelation model at Jonker Sailplanes; and developing a rotational moulding supplier that will produce the sacrificial thermoplastic cores used by Aerosud in the production of complex integral aerostructures from carbon fibre material.

Jonker Sailplanes is developing a new 24 m wingspan sailplane with support from the Aerospace Industry Support Initiative, an initiative funded by the Department of Trade and Industry.

INTERVENTION BRINGS NEW BUSINESS AND CREATES NEW JOBS AT LOCAL FOUNDRY

A quality improvement intervention by the National Foundry Technology Network (NFTN) at Matt Cast Suppliers, a Johannesburg-based foundry, has resulted in new business from the railway sector, as well as the creation of six new jobs.

The NFTN, an initiative of the Department of Trade and Industry (**the dti**) hosted by the CSIR, helped Matt Cast Suppliers to obtain ISO 9001 Quality Management System certification, a key international standard that sets out the requirements for a quality management system. It enables businesses and organisations to be more efficient and improve customer satisfaction, while, at the same time, increasing their prospects of supplying the local and international markets.

Matt Cast Suppliers is one of a few foundries in South Africa that produces high chrome white cast iron. The foundry also casts materials such as alloy steel, mild steel, stainless steel and nonferrous metal alloys.

Besides the increased production, as a result of the intervention, the company now has the ability to maintain and monitor the quality of its castings, while also improving on its turnaround times. Being ISO 9001 QMS certified has led to increased confidence from the company's existing customers, especially in the export market. As a result, they have secured business from the railway industry, which created employment for six people.

Areas of improvement were first identified by NFTN technical advisors during a gap analysis process. This led to the appointment of industrial engineers to review the company's production processes and efficiency, as well as ergonomics, through the layout and process optimisation intervention at the foundry.

South Africa's foundries employ about 15 000 workers.

Matt Cast Suppliers employees with the ISO 9001 certificate. ISO 9001 compliance has increased prospects for the company to supply to international markets.

RDI FOR INDUSTRY

COMMERCIALLY PURE GRADE TITANIUM POWDER TARGETED AT OPTIMISED PILOT PLANT

Research and development to establish a process to produce primary titanium metal powder continues, with a milestone being achieved when an optimised facility for pilot-batch production was commissioned and batches of relatively pure titanium sponge was produced.

An analysis of the morphology of the titanium product indicated a mix of a finer powder component and bulk sponge-type product. Chemical analysis revealed a relatively pure product with some iron contamination from the reactor vessel construction materials and a notably low oxygen content. This was achieved without any post-processing of the product to improve purity.

Future production campaigns will refine the process conditions to enable the synthesis of a bulk powder product of commercially pure quality.

South Africa aims to establish a titanium industry to add value to its significant ilmenite mineral resource. Currently, this is mainly exported or used in low-value added pig-iron manufacture. The titanium-rich slag by-product of the pig-iron process represents a valuable source of titanium but is also exported for use in titanium dioxide pigment and titanium tetrachloride manufacture. Titanium metal in billet, milled product or powder form offers lucrative value-adding opportunities where local mineral resources can be processed into titanium metal which would provide the primary feedstock to a South African titanium manufacturing industry.

The CSIR-hosted Titanium Centre of Competence is funded by the Department of Science and Technology.

INTERNET OF THINGS SOLUTION IMPROVES OVERALL SITUATIONAL AWARENESS IN A PLATINUM MINE

The CSIR, as part of an international consortium, partnered with a South African platinum mine in a Norwegian-funded collaboration to test various Internet-of-Things technologies developed to improve the safety of miners.

As part of the Wireless Mine Safety project, the technologies were installed at the mine's underground training panel to test research and development efforts on positioning technology, gas monitoring, airflow monitoring, noise monitoring and micro-seismicity. The multiple sensors were all interconnected on a single wireless network based on the ISA 100.11a wireless networking technology standard and the data visualised in a manner suitable for improving the situational awareness on the surface. This potentially empowers mine managers to take decisions with economic and safety benefits.

A CSIR engineer installs a wireless sensor in a platinum mine stope.

The collaborators included SINTEF, one of Europe's largest contract research organisations; GasSecure, a Dräger company specialising in innovative gas detection; Etion, a local technology company; and the University of Pretoria. Further development and commercialisation options for some of the technologies are being considered by the partners.

SUPPORTING LOCAL VALVE AND PUMP MANUFACTURERS

The CSIR-hosted Technology Localisation Implementation Unit (TLIU) is supporting the development of nine local manufacturers – five valve and four pump manufacturers – that have been shortlisted to provide nuclear components to Eskom's Koeberg power plant.

This intervention aims to assist local manufacturers, particularly those linked to designated sectors, such as Eskom's major infrastructure build programme, to be globally competitive, while increasing local content in these capital programmes. The Department of Trade and Industry's designation procurement policy stipulates that 75% of valves and pumps that are procured by the public sector or state-owned entities must be locally sourced. This is done to improve manufacturing, industrialisation and economic growth in South Africa.

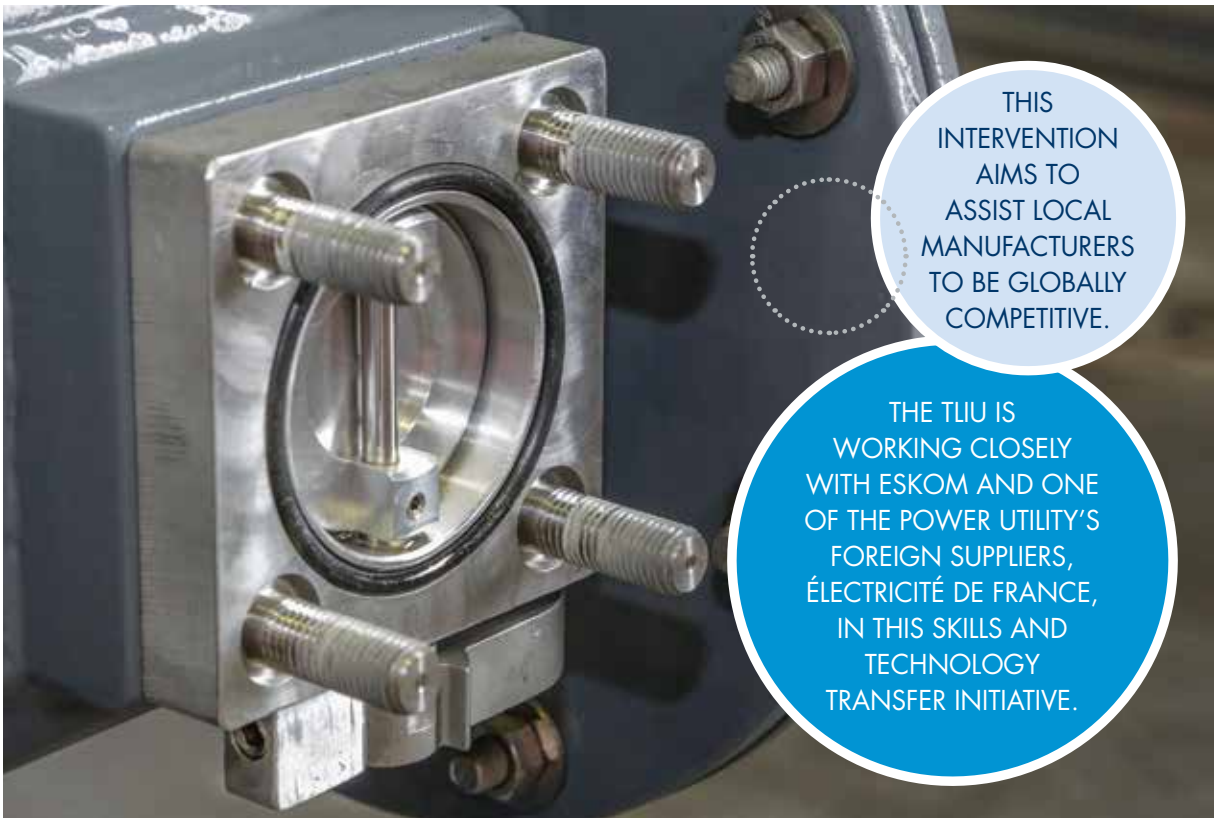
The TLIU is working closely with Eskom and one of the power utility's foreign suppliers, Électricité de France (EDF) in this skills and technology transfer initiative.

The intervention was informed by earlier supplier development audits that were conducted by the TLIU, Eskom and EDF, which helped to determine the level of current manufacturing capabilities, including quality management systems and manufacturing skills.

Gaps identified related to design capacity and capability, a lack of adherence to the international quality management standard for welding, as well as manufacturing standards and codes of practice.

A dedicated training and support programme was developed to help address these gaps. Suppliers were also granted an opportunity to have their prototypes assessed and confirmed by Eskom, which gives them hands-on experience in designing, verifying, manufacturing and testing nuclear compliant components.

The programme not only assists Eskom to comply with its designation requirements in terms of local procurement, but also facilitates the transfer of nuclear capability technology to the local suppliers.



Valves like this 80 mm aluminium radiator isolating valve used to be imported at a huge cost to Eskom. The valve has been designed, simulated and manufactured with the assistance of the Technology Localisation Implementation Unit and the CSIR to comply with the specifications of the original equipment manufacturers.

RDI FOR INDUSTRY

CSIR principal researcher and expert in spectrum innovation, Dr Luzango Mfupe, left, and a low-cost spectrum management device, right.

EDGING TOWARDS THE EFFICIENT USE OF SPECTRUM FREQUENCY IN SOUTH AFRICA

The CSIR continued to play a key role in providing evidence-based information to South African decision-makers on matters pertaining to spectrum in South Africa. Spectrum is the medium over which all wireless communications devices such as television, mobile phones and radio, communicate. Decisions around spectrum allocation, management and regulation need to be informed and taken with care, as it is a finite, but highly-in-demand, resource. The CSIR has extensive experience and a solid skills base in the field of radio frequency spectrum engineering.

Commissioned study on Wireless Open Access Network approved

In August 2018, the South African Cabinet approved the outcome of a study conducted by the CSIR to determine the amount of spectrum required for open access and licensing to the industry. The study confirmed that spectrum can be licensed to both the Wireless Open Access Network and the telecommunications industry and still achieve the national policy obligations of lowering the cost of communication. This will remove the entry barriers for small and medium companies while sustaining current investments. The study, commissioned by the Department of Telecommunications and Postal Services, served as part of the discussion document in Government Gazette number 41935, notice number 1003 of September 2018, which aims to elicit comments to be considered for a policy direction on the matter.

Sharing development in spectrum innovation with SADC communication regulatory authorities

CSIR researchers facilitated and delivered a tutorial on the Spectrum Innovation and Dynamic Spectrum Sharing Regulatory Framework to the Communications Regulatory Authority of Southern Africa. The tutorial session was attended by 23 participants from eight countries in the Southern African Development Community.

The tutorial outlined the need for dynamic spectrum sharing and provided a detailed description of the needed technology regulatory frameworks to allow dynamic spectrum sharing. Earlier CSIR research resulted in spectrum innovation that enables the efficient use of national spectrum resources and accelerates the development of network technologies to bridge the broadband divide between rural and urban areas in the SADC region, with potential for roll-out to continental Africa.

The CSIR continued to collaborate with the Independent Communications Authority of South Africa (ICASA), academia and the industry on research, development and innovation in the field of smart spectrum management techniques. This will assist South Africa and other African countries to create a techno-regulatory ecosystem and value chain that is necessary for deriving the maximum industrial benefit from new and future wireless technologies such as 5G and beyond.

Reference geolocation spectrum database ready for use

The CSIR completed the development of the Reference geolocation spectrum database system for ICASA. This database is used to efficiently allocate usable spectrum, which makes it possible to use television white spaces without interfering in adjacent primary licensed services. The developed system was demonstrated and commissioned for live use on 15 March 2019.
The CSIR also completed a complementary development of secondary geolocation spectrum databases through funding support from the Technology Innovation Agency. These developments open up the industrialisation opportunities of the TV white space technology ecosystem in the country for the information and communications technology sector.

INVESTING IN CONTEXT-AWARE REAL-TIME ACTION AND OBJECT RECOGNITION FOR SMART FACTORIES

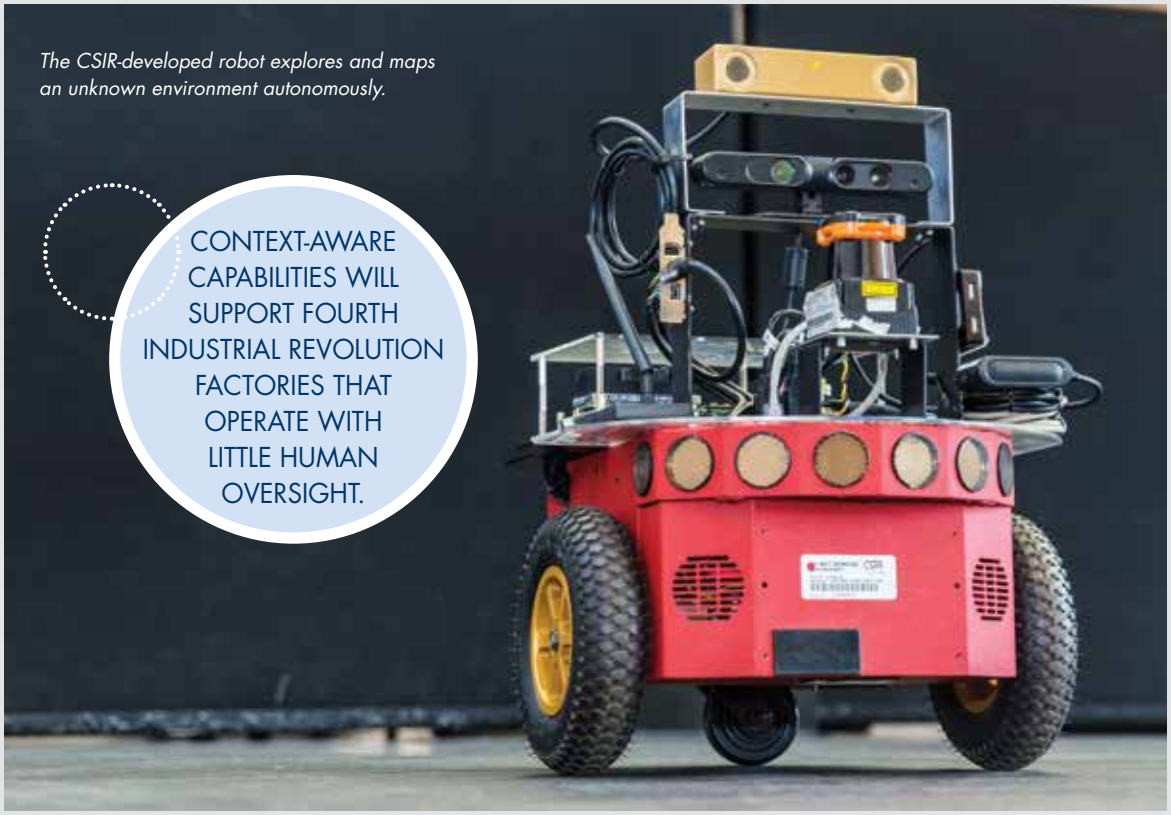
The CSIR is developing a mobile, autonomous robotic demonstrator that uses real-time object recognition and context-aware decision making.

Real-time object recognition based on computer vision and machine learning has a multitude of potential uses. It lends itself to context-aware decision-making applications, including those involving mobile robotic platforms, where it adds a key vision component and the potential to significantly enhance autonomous operation. It is particularly relevant in the context of the fourth industrial revolution, which is introducing smart factories, operating with little human oversight and autonomously managing product and supply.

The CSIR-developed robot explores and maps an unknown environment autonomously and when it recognises an object from a pre-selected object class, it approaches the object and takes inspection-style images from multiple angles. These images are then sent to a custom anomaly detector for automated inspection analysis.

The demonstrator robot showcases relevant CSIR skillsets in data science, information security, mathematical modelling and mobile autonomous systems.

Key features of the robot include a stereo-vision camera (the gold coloured sensor at the top) for 3D imaging, and a low-power, mobile graphics processing unit (mounted at the back of the robot) for real-time image analysis.



The CSIR-developed robot explores and maps an unknown environment autonomously.

CONTEXT-AWARE CAPABILITIES WILL SUPPORT FOURTH INDUSTRIAL REVOLUTION FACTORIES THAT OPERATE WITH LITTLE HUMAN OVERSIGHT.

RDI FOR INDUSTRY

ADVANCES IN HUMAN LANGUAGE TECHNOLOGY

Commercialisation of local text-to-speech voices gains momentum

The CSIR has seen an upward trend in the use of its text-to-speech offering, Qfrency, over the past year. The technology is currently available in the form of end-user licences, site licences, software development kit licences and software-as-a-service. End-user licences are available on the Windows and Android platforms and are mainly used for assistive technology and hands-free applications. Site licences are bulk purchases of voices for implementation at a single site, such as a school's computer centre. The current main market sector for site licences remains in education. Software development kits are being used for the integration of the text-to-speech engine and voices into a client's existing software stack. Software-as-a-service is suitable for use in cases which require ad hoc access to text-to-speech, mainly for dynamic content.

In addition to the Qfrency engine enhancements, the Qfrency voice suite was also extended through the addition of a boy voice. The story about the boy voice was featured on the television show, Carte Blanche. The boy voice is also available on the Google Play Store.

CSIR develops technology for creating augmented ebooks

The CSIR has made progress with the setting up of collaboration agreements with publishers to work on the development of an augmented ebook system, using the ePub3 standard and the CSIR's local South African text-to-speech technology, Qfrency. CSIR researchers in human language technology are using select titles from collaborating publishers to develop the novel technology.

As a developing country with a vision towards an equal, inclusive society for its citizens, South Africa needs to solve systemic problems such as poverty, lack of education and unemployment. One of the role players in the solutions is the publishing industry, which provides a literary service to its education market segment. Reading is one of the prerequisites for learning, hence it forms an important part of the equation towards a better education. In turn, education prepares citizens for, and opens doors to, employment opportunities, ultimately breaking the poverty cycle.

The CSIR aims to commercialise the augmented ebook system with a vision to fuel the re-industrialisation of the local publishing industry by enabling digital reading offerings which source ebook conversion from within the South African economy.

ABOUT HUMAN LANGUAGE TECHNOLOGY

Human language technology combines electronic engineering, computer science, computational linguistics and linguistics to programme a computer to process human language. It broadly involves text processing technology and speech processing technology.

Text technology is concerned with natural language processing and results in offerings such as spell checkers, machine translation systems, and translation memory systems where translators can store documents that they have already translated, aligned at sentence or phrase level, for use at a later stage.

Speech technology is concerned with automatically recognising human speech and converting it to text, as well as reproducing human speech by synthesising text into audio. Text emanating from speech recognition systems can be further analysed through data analytics and keyword spotting systems. Computer-generated audio can be used to provide access to information in a wide range of applications, including ebooks augmented with audio.

The CSIR's Devashen Govender.

RDI FOR HEALTH

DOPPLER ULTRASOUND DEVICE FOR THE EARLY DETECTION OF CARDIOVASCULAR DISEASE

The CSIR has developed a device that can identify individuals at risk of cardiovascular disease by using a Doppler ultrasound probe.

The device, called Cardiflo, is a diagnostic tool which uses ultrasound technology to assess blood flow in the carotid arteries. It measures the speed of the blood flow and estimates the diameter of a blood vessel and the amount of obstruction present.

Cardiovascular diseases are the leading causes of death and disability in the world. It is estimated that 17.5 million people died from these diseases in 2012, representing 31% of all global deaths. In South Africa, approximately 200 people die each day due to cardiovascular diseases. Both locally and internationally, health-care costs are rising as more people begin to suffer from chronic diseases, such as obesity, diabetes and cardiovascular diseases.

The main advantage of the Doppler-based screening device is its ability to extract risk screening information from a Doppler signal alone, without the need for imaging. Other benefits of the device include its simplified hardware and user-friendliness, eliminating the need for highly skilled primary-care level operators to perform critical measurements. The system is cost-effective and reliable. Clinical trials of the device are expected to take place in 2019.

The device aims to make ultrasound-based risk evaluation for cardiovascular disease available to a much wider population than was previously possible, thereby helping to alleviate the significant burden of cardiovascular diseases. It addresses the need to determine and manage the risk of heart disease by informing people to change their lifestyles.

CARDIFLO IS A DIAGNOSTIC TOOL WHICH USES ULTRASOUND TECHNOLOGY TO ASSESS BLOOD FLOW IN THE CAROTID ARTERIES.

CARDIOVASCULAR DISEASES ARE THE LEADING CAUSES OF DEATH AND DISABILITY IN THE WORLD.

The user interface of Cardiflow showing the blood flow in the carotid arteries.

RDI FOR HEALTH

PARTNERING WITH RIGHT ePHARMACY FOR LOCALISATION OF A MEDICINE DISPENSING ROBOT

The CSIR was contracted by Right ePharmacy to design and develop a robotic pharmaceutical dispensing unit that consists of electronic and robotic technology to support the dispensing of medication to patients.

Current robotic dispensing systems do not support the handling of medicine sachets. Right ePharmacy, a leading pharmaceutical product developer focusing on optimising the pharmaceutical supply chain, was in search of an innovative, easy-access medicine dispensing solution with quality controls and measures that support the pharmaceutical staff and improve quality and control around medicine dispensing.

The dispensing robot can apply labels to medicine sachets, ready for patient consumption. It scans and verifies each product before dispensing. Right ePharmacy currently supports 18 medicine dispensing locations at five shopping centres in South Africa.

The current prototype dispensing robot will be incubated in the CSIR Industry 4.0 Product Life Cycle Management Centre of Technologies to focus on the localisation and manufacturing of the technology.

30%
OF MEDICINES IN SA, AND **80%** IN AFRICA, ARE **DISPENSED IN MEDICINE SACHETS**

THE ROBOT **SCANS AND VERIFIES** EACH PRODUCT IN
0.4s

900
SACHETS PER HOUR – THE DISPENSING ROBOT'S PICKING SPEED

The user interface of the AVA dispensing robot.

CSIR KEY IN CORE TECHNOLOGY FOR THE NATIONAL HEALTH INSURANCE INFORMATION SYSTEMS

The CSIR continues to assist the National Department of Health with the development of information systems for the National Health Insurance (NHI).

The Department of Health contracted the CSIR for the development and operation of the core technology systems required for the NHI, such as the beneficiary, provider and facility registries. The work also includes the development of standards-based interoperability between the NHI core registries and external health databases. Earlier, the CSIR had developed a patient registration system. Close to 42 million patients country-wide have been registered on the system.

The CSIR and the department also developed a web-based tool that visualises key information related to primary healthcare facilities across the country. Using this tool, the public can select a particular facility and view facility-related information including location, services offered and contact details of the facility manager. The public can also follow up on the implementation status of projects such as the Health Patient Registration System, which identifies patients and issues each a unique health identifier that links their medical records to ensure continuity of care and an integrated healthcare service; Ideal Clinic, a web-based tool that is used to determine the status of a clinic; and MomConnect, an initiative that aims to support maternal health through the use of cellphone-based technologies.

Four of the project team members, from left, the CSIR's Preia Motheeram, Surél Aucamp, Yeshalen Naicker and Lelethu Zazaza.

TECHNOLOGY FOR TB AND HIV POINT-OF-CARE TESTING NAMED ONE OF AFRICA'S TOP 30 TECHNOLOGY SOLUTIONS

CSIR researchers have found a way to simultaneously detect the presence of tuberculosis (TB) and HIV in blood in a non-invasive, quick and cost-efficient manner.

The technology is much needed, given the high number of TB and HIV/Aids-related deaths. Acknowledged by the World Health Organization (WHO) as one of Africa's top 30 technology solutions, the CSIR-developed technology will allow health-care practitioners to go into remote areas and diagnose HIV and TB without having to send blood samples to a laboratory.

The technology is in the form of a diagnostic assay on a microarray slide, measuring 2.5 x 7.5 cm, containing fixed HIV and Mycobacterium Tuberculosis (M.tb) antigens, and a portable battery-powered fluorescence reader to detect the presence of HIV and M.tb antibodies in the blood.

Preliminary results have been achieved for this ongoing scientific research project and the team is now proceeding to the proof-of-concept phase.

43%

OF THE GLOBAL TOTAL OF NEW HIV INFECTIONS IN 2016, WERE IN SOUTHERN AND EAST AFRICA.

Source: www.avert.org

In February 2019, the project was presented and selected as one of Africa's top 30 technology solutions at the WHO Innovation Challenge.

RDI FOR ENERGY

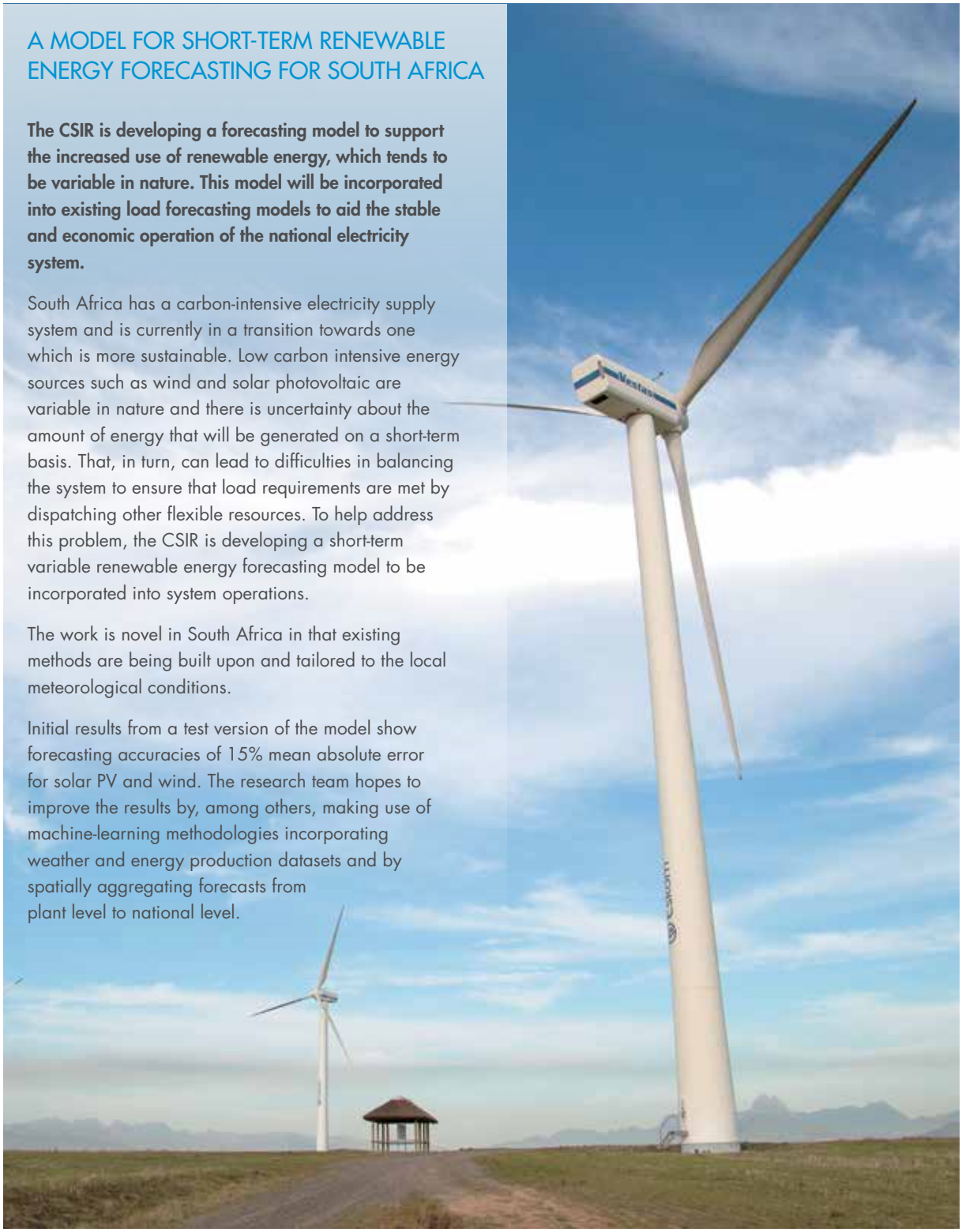
A MODEL FOR SHORT-TERM RENEWABLE ENERGY FORECASTING FOR SOUTH AFRICA

The CSIR is developing a forecasting model to support the increased use of renewable energy, which tends to be variable in nature. This model will be incorporated into existing load forecasting models to aid the stable and economic operation of the national electricity system.

South Africa has a carbon-intensive electricity supply system and is currently in a transition towards one which is more sustainable. Low carbon intensive energy sources such as wind and solar photovoltaic are variable in nature and there is uncertainty about the amount of energy that will be generated on a short-term basis. That, in turn, can lead to difficulties in balancing the system to ensure that load requirements are met by dispatching other flexible resources. To help address this problem, the CSIR is developing a short-term variable renewable energy forecasting model to be incorporated into system operations.

The work is novel in South Africa in that existing methods are being built upon and tailored to the local meteorological conditions.

Initial results from a test version of the model show forecasting accuracies of 15% mean absolute error for solar PV and wind. The research team hopes to improve the results by, among others, making use of machine-learning methodologies incorporating weather and energy production datasets and by spatially aggregating forecasts from plant level to national level.



ADVANCED SOLAR ENERGY QUALITY AND RELIABILITY TESTING FACILITY SUPPORTS LOCAL INDUSTRY

To support the growing South African photovoltaic (PV) industry, the CSIR has established an advanced solar PV quality and reliability facility for conducting indoor accelerated stress testing.

Accelerated stress tests provide quantitative results regarding the reliability of PV modules that would normally take years to collect naturally in the field. These results are used regularly in the global PV industry to inform contractual agreements among plant developers, owners and financiers. The facility was developed to support the domestic solar PV industry with industrial development, research, quality and reliability assurance, knowledge-generation and human capital development. With the addition of an ultra-violet light soaking chamber, the indoor facility is ready to offer the full scope covered in standard reliability test protocols.

The facility supports the renewable energy industry, specifically on PV module quality, reliability, design, system modelling, operations, maintenance and monitoring. In one qualification project using the new facility, 50% of the PV modules destined for a rooftop PV plant were found to have a serious safety defect related to manufacturing. The problem was resolved before the plant commissioning, minimising the risk of future safety and performance issues with the plant.

The indoor facility complements the CSIR outdoor testing facility that was completed in March 2019. The combined indoor and outdoor facility makes it possible to optimise the performance of locally and internationally manufactured PV components in real-world South African climates. The combined test facility will also assist the South African Bureau of Standards with the development and implementation of local standards.

A weather monitoring system against which the performance of the outdoor testing system is correlated. An indoor testing facility has now also been completed.

RDI FOR SAFETY AND SECURITY

CSIR-DEVELOPED SURVEILLANCE SYSTEM HELPS CURB RHINO POACHING

A CSIR-developed wide area surveillance system, designed to detect, track and support the apprehension of rhino poachers at poaching hotspots in the Kruger National Park, is proving highly effective.

The system, called Meerkat, had been deployed at different locations in the Kruger National Park for the past 27 months, with significant success.

The system is credited by rangers as directly contributing to the decrease in rhino poaching by more than 80% within the deployed area. In addition, its presence in a section is a huge deterrent factor, causing rhino poachers to avoid the area and resulting in effectively stabilising areas of high rhino poaching density. Its effectiveness was recognised when the CSIR team received the SANParks Kudu Innovation Award in 2018.

Meerkat utilises a Reutech Radar Systems surveillance radar and a CSIR-developed long-range camera system to detect and localise poachers, as well as discriminate them from animals. The system is optimised to operate in the undulating bush savannah environment, in any weather, during day or night. It has been integrated with existing capabilities, staff, and procedures in the park since 2017.

DURING THE 27-MONTH DEPLOYMENT, MEERKAT:

CONTRIBUTED TO THE SUCCESSFUL ARREST OR DISRUPTION OF MORE THAN

70%

OF ALL POACHING GROUPS DETECTED

EFFECTIVELY PREVENTED A FURTHER

11%

OF POACHERS DETECTED, FROM SHOOTING RHINO

DISRUPTED A TOTAL OF

77%

OF ALL POACHERS DETECTED

DETECTED

90%

OF POACHERS WHO ENTERED THE AREA

The CSIR-developed wide-area surveillance system is self-sufficient and can be used continuously for months at a time at unprepared and unattended sites. This enables maximum continuous coverage over poaching ingress routes.

RDI FOR SAFETY AND SECURITY

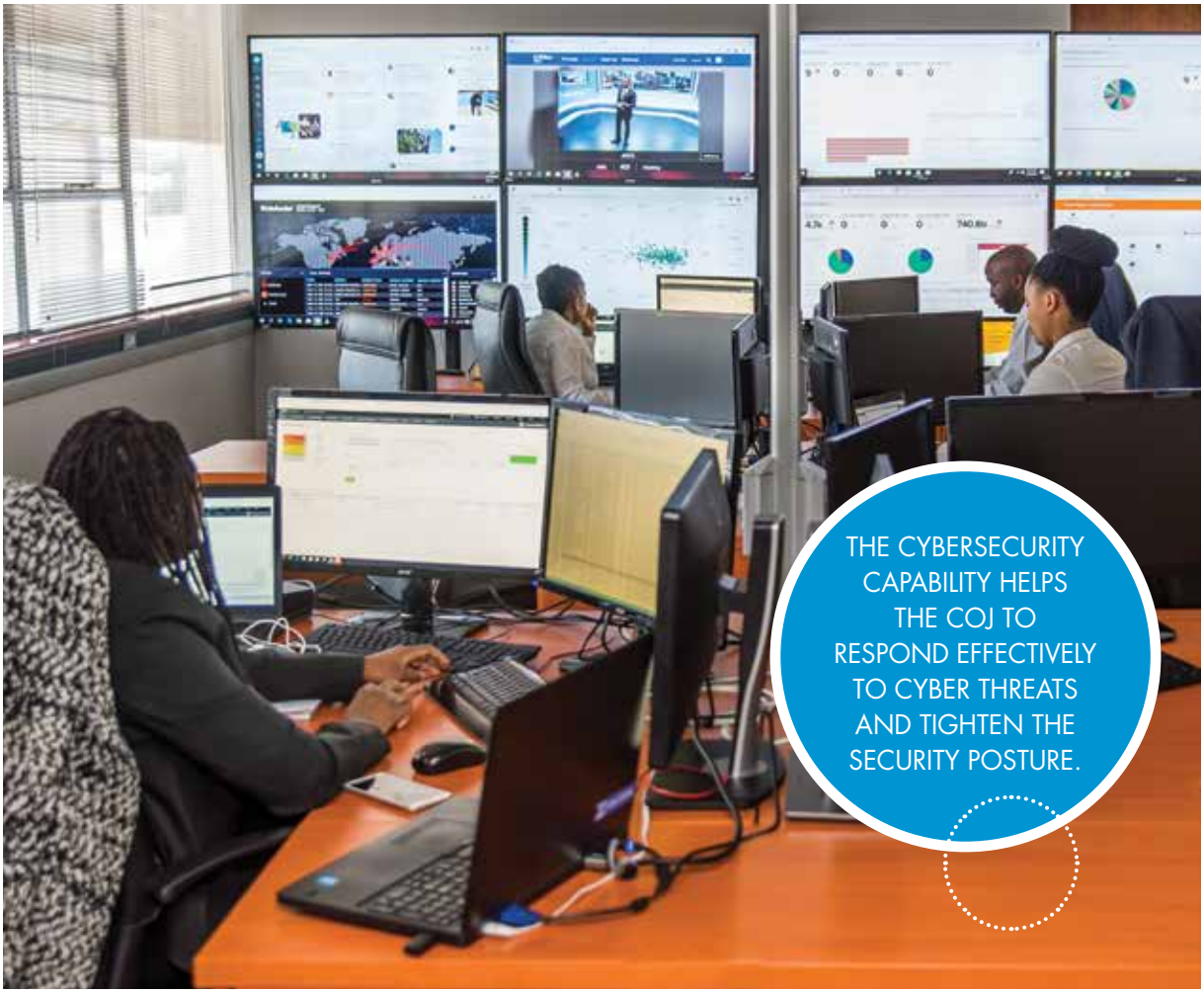
A CYBERSECURITY CENTRE FOR THE CITY OF JOHANNESBURG

The CSIR has helped establish a cybersecurity capability for the City of Johannesburg (CoJ). This capability enables the CoJ to respond effectively to cyber threats and tighten the security posture. In addition to establishing the cybersecurity centre, the CSIR facilitated cyber awareness training for CoJ employees at all levels and developed related cyber governance in the CoJ.

The centre's main functions are to detect any possible cyber threats to the CoJ, to respond to any possible incidents, and to recover from any loss resulting from cyber-attacks. The centre also provides cyber threat intelligence and self-assessment on a continuous basis.

Various CSIR technologies were used in setting up the centre, including a social media analysis tool which is part of the threat intelligence component; a virtualised environment for training on incident response; and an online training platform for cyber awareness.

Since the establishment of the centre, the city has been able to detect thousands of malicious activities on its infrastructure and networks, ranging from malicious login attempts to deliberate attacks. The centre has been able to successfully investigate various cases at the request of the city.



The City of Johannesburg cybersecurity centre.

VASTLY IMPROVED CAPABILITIES FOR CSIR-DEVELOPED UNMANNED AERIAL VEHICLE

The CSIR has upgraded its two-metre wingspan unmanned aerial vehicle to a full unmanned aircraft system, fitted with both day and night observation capabilities and linked to a new ground control station.

The airframe can fly for over an hour, quietly, for distances of up to 10 km, powered only by its new lithium battery pack. Payloads of up to 500 g can be accommodated in its modular payload bay. A custom-designed, retractable pan-and-tilt camera gimbal system was developed specifically for this system to accommodate both a daylight zoom camera and a night vision camera. It has a new dolly launch system and, due to a number of upgrades to its sensors and avionics, it is now also capable of autonomous landings.

The system is stored in and deployed from a portable travel case. The removable wing is manufactured in three parts for ease of packaging with all the airframe's electrical systems and flight controls connecting automatically upon assembly.

The ground-based equipment includes a laptop with a tripod-mounted antenna extending the range and improving the communication quality of the video and data links. A number of the subsystems have been manufactured, tested and delivered to a client along with the required training.

The Indiza system can be used in surveillance activities such as close-in military and civilian reconnaissance missions. This includes public order policing, border management and infrastructure monitoring.

EQUIPPING THE NAVY WITH NEXT-GENERATION SONAR SYSTEMS

The CSIR is working closely with the South African Navy to improve the operational efficiency of an underwater drone through a new broadband underwater data communication system that can transmit data and sonar images fast and reliably at long ranges together with an ultra-high resolution imaging synthetic aperture sonar system.

The CSIR's sonar group has worked with the Navy over the years in developing, localising, manufacturing and maintaining the SA Navy's wet-end sonar systems on operational vessels by conducting research for next-generation sonar systems. In the recent past, the team has mainly focused its research and development efforts on ultra-wide bandwidth sonar technologies.

The use of autonomous underwater vehicles has significantly increased in the last decade, almost completely replacing the expensive dedicated vessels for some applications such as detection and classification of dangerous objects, seafloor mapping, infrastructure inspection, bathymetric surveys and securing seaways using side-scan and synthetic aperture sonars. This led to major advancements of such underwater vehicles and their associated technical capabilities. Despite this, there are still some limiting factors such as power requirements, long-distance underwater communication and the time it takes to recover data.

The research team is working on integrating the broadband underwater data communication and synthetic aperture sonar systems. Presently, there is no means to transfer the data wirelessly underwater to the support ship while the vehicle performs the operation. By integrating the two systems, the images can be processed underwater, close to the array on the vehicle and transmitted acoustically in near real time. These images will be available in real time. The various parts of a sea-going technology demonstrator will be tested soon.

RDI FOR THE BUILT ENVIRONMENT

ARMING MUNICIPALITIES FOR CLIMATE CHANGE: THE GREEN BOOK

A new online tool supports local government with the planning and design of climate-resilient settlements. The depths and scale of information provided via the tool is unprecedented in South Africa.

Co-funded by the Canadian International Development Research Centre and the CSIR, The Green Book online tool is the result of a three-year initiative in which the CSIR collaborated with South Africa's National Disaster Management Centre and a number of stakeholders and reviewers. The tool will contribute to resilient, sustainable and liveable South African settlements through climate change adaptation.

Key research findings incorporated into the tool include the most detailed projections (at 8x8 km^2 resolution) of future climate change ever available for the country; new models to quantify the exposure of South African settlements to various hazards, including drought, wildfires, inland floods and coastal flooding; a vulnerability assessment framework for all 213 local municipalities and 1 637 settlements across South Africa; a population potential growth model to forecast settlement growth across South Africa; and a menu of adaptation actions.

Climate change will continue to present a number of risks to South Africa's water resources. The Green Book analyses the impacts of climate change on ground and surface water and translates them into the risks that municipalities will face to provide water.

The website is structured into three components. The first is a series of interactive national story maps that provide information about the research methodology, findings and recommendations for 11 components of the project. The second component is a municipal risk profile tool that assists municipalities to assess their current and future climate risks, socioeconomic and other vulnerabilities, population growth pressure, and the impact of climate change on hydro-meteorological hazards and key resources. A municipal adaptation action tool provides a range of planning and design actions for municipalities to adapt their settlements and environments to the likely impacts of climate change.

The tool can be found at www.greenbook.co.za

8x8 km^2
RESOLUTION OF FUTURE CLIMATE CHANGE

1x1 km^2
FORECAST OF SETTLEMENT GROWTH

213
LOCAL MUNICIPALITIES COVERED

1637
SETTLEMENTS COVERED

83
ADAPTATION ACTIONS

The driving force behind The Green Book, from left, CSIR senior researcher Alize le Roux, researcher Amy Pieterse and senior researcher Willemien van Niekerk.

A CSIR-developed tool helps local government to quantify the exposure of South African settlements such as this one, to hazards such as floods.

RDI FOR THE BUILT ENVIRONMENT

REVISED GUIDE EASES THE PLANNING AND DESIGNING OF SERVICES AND INFRASTRUCTURE FOR NEIGHBOURHOOD DEVELOPMENT PROJECTS

The CSIR was instrumental in the revision of a neighbourhood planning and design guide that takes into account issues of climate change as they relate to the built environment, as well as local realities such as poverty, inequality, rapid urbanisation and informality, current theoretical approaches to settlement making, and the latest research as reflected in various government policies, programmes, frameworks and strategies.

The Neighbourhood Planning and Design Guide replaces its predecessor, *Guidelines for Human Settlement Planning and Design*, commonly known as the *Red Book*. The Department of Human Settlements appointed the CSIR to manage the process of developing the guide, to coordinate the various contributions, and to prepare the final document.

The purpose of the guide is to provide practical information related to the planning and design of the range of services and infrastructure typically provided as part of a neighbourhood development project. It addresses a range of aspects including neighbourhood layout, water supply, sanitation, stormwater management, electrical energy, roads, transport, public open spaces, housing, and crime prevention through environmental design.

The *Red Book* provides decision-making support to built environment professionals and practitioners, including public and private sector engineers, town planners, urban designers, architects and landscape architects, as well as community groups involved in people-driven housing developments. It also contains useful information for students, lecturers and decision-makers such as local government councillors. The application of the guidelines should ultimately result in the delivery of infrastructure and services that are effective and efficient and that contribute to the creation of vibrant, safe, integrated and inclusive neighbourhoods, towns and cities.

The new *Red Book* will assist in transforming the South African human settlement landscape over time to reflect the qualities and objectives outlined in, for instance, the National Development Plan and the Integrated Urban Development Framework. It will also play a role in supporting the global Sustainable Development Goals and will ultimately contribute to improving the living conditions of all South Africans.

The *Red Book* is available electronically and as a printed document.

DETERMINING THE TRANSPORT PATTERNS OF HOUSEHOLDS IN GAUTENG

The CSIR has partnered with the Gauteng Department of Roads and Transport to determine the transport patterns of households in the province.

About 37 000 households are participating in this survey, which aims to assist government to plan for future investments in transport infrastructure in the province. The survey will provide updated information from the previous survey, undertaken in 2014, in which survey datasets from metropolitans and district municipalities were consolidated.

The results will be used for transport planning and to measure progress in solving transport challenges. Understanding travel patterns in this mostly urban region is critical in assisting with an enhanced understanding of travel behaviour in the province.

Travel surveys will continue to be one of the most important ways of scientifically obtaining the critical information needed for transportation planning and decision-making.

RDI FOR THE NATURAL ENVIRONMENT

CSIR KEY CONTRIBUTOR IN SPECIAL REPORT ON GLOBAL WARMING OF 1.5° C

The CSIR was a key contributor to an Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5° C, which was released in October 2018.

The IPCC is the leading world body for assessing the science related to climate change, its impacts and potential future risks, and possible response options. The CSIR led the sections in the special report on tropical cyclones, ocean circulation, and regional climate change impacts, including climate change hot spots, regional tipping points in the climate system and the impacts of climate change on regional economic growth.

Scientists estimate that human activities have caused approximately 1.0° C of global warming above pre-industrial levels. Global warming is likely to reach 1.5° C between 2030 and 2052 if it continues to increase at the current rate. The new report highlights that limiting global warming to 1.5° C compared to 2° C will greatly reduce the risk to marine biodiversity, ecosystems, food security, water supply, health and livelihoods. It highlights that every bit of warming matters, especially since the warming of 1.5° C or higher increases the risk associated with long-lasting or irreversible changes, such as the loss of some ecosystems.

The CSIR was represented at the launch of the report in Korea, addressing the audience on the impacts of global warming on tropical cyclone intensities. CSIR research on the development of an African-based earth system model contributed numerous peer-reviewed papers that are referenced in the special report. These include papers on the drastic rate of warming in Southern Africa; the impacts of rising temperatures on human health in Africa; and a paper on land falling tropical cyclones over Southern Africa under different degrees of global warming.

The full title of the report is *Global Warming of 1.5° C, an IPCC special report on the impacts of global warming of 1.5° C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty (SR15)*. The report was requested by governments on adoption of the Paris Agreement in December 2015 at the 21st Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC).

The IPCC Special report on Global Warming of 1.5° C was approved by the UNFCCC governments in October 2018. The report outlines plausible pathways through which global warming can be restricted to 1.5° C.

RDI FOR THE NATURAL ENVIRONMENT

SUPPORTING THE DEPARTMENT OF ENVIRONMENTAL AFFAIRS WITH ADVANCES IN ENVIRONMENTAL ASSESSMENT

Collaboration between the CSIR and the Department of Environmental Affairs in the field of environmental assessment has resulted in new decision-making tools and legislative interventions that will be routinely used in this field.

The CSIR was instrumental in the development of a report framework to be used in the application for environmental approval for new electricity transmission and distribution infrastructure. The Generic Environmental Management Programme report template was published by the Minister of Environmental Affairs in the Government Gazette in March 2019. Co-generated by the CSIR, the Department of Environmental Affairs (DEA), the South African National Biodiversity Institute (SANBI), the Department of Water and Sanitation and Eskom, the purpose of the template is to improve efficiency when the applicant prepares the documents and to assist the authorisation process by DEA. The template was one of the outcomes of an earlier strategic environmental assessment for electricity grid infrastructure that the CSIR conducted for DEA and Eskom.

In another example of how the CSIR is supporting efficient and responsible decision-making, the Integrated Environmental Management Plan for the Phase 1 Square Kilometre Array (SKA) radio telescope was published by the Minister of Environmental Affairs in the Government Gazette on 22 March 2019. The plan presents a new and innovative approach to environmental planning and authorisation for large-scale projects, such as the spatially extensive array of telescopes in the SKA project.

The CSIR furthermore supported DEA in the development of protocols and a national online environmental screening tool. This tool collates spatial environmental sensitivity data that was developed through strategic environmental assessments conducted by the CSIR over the past five years, through collaboration between DEA, the CSIR and SANBI. The protocols prescribe minimum assessment and reporting requirements for conducting specialist studies for different environmental themes as part of environmental impact assessments. The screening tool went live in mid-2018 and the Minister gazetted the draft protocols for public comment in May 2019.

The CSIR has previously collaborated with the Department of Environmental Affairs and the South African National Biodiversity Institute to conduct strategic environmental assessments for the rollout of wind and solar photovoltaic energy which resulted in the identification of eight renewable energy development zones and five power corridors.

CSIR INFORMS WATER REQUIREMENTS OF SA'S MULTI-BILLION RAND DECIDUOUS FRUIT INDUSTRY

To support South Africa's apple growers in a country saddled with water challenges, a research team determined the water requirements of fruit trees with a particular focus on apple trees, from planting to full bearing age.

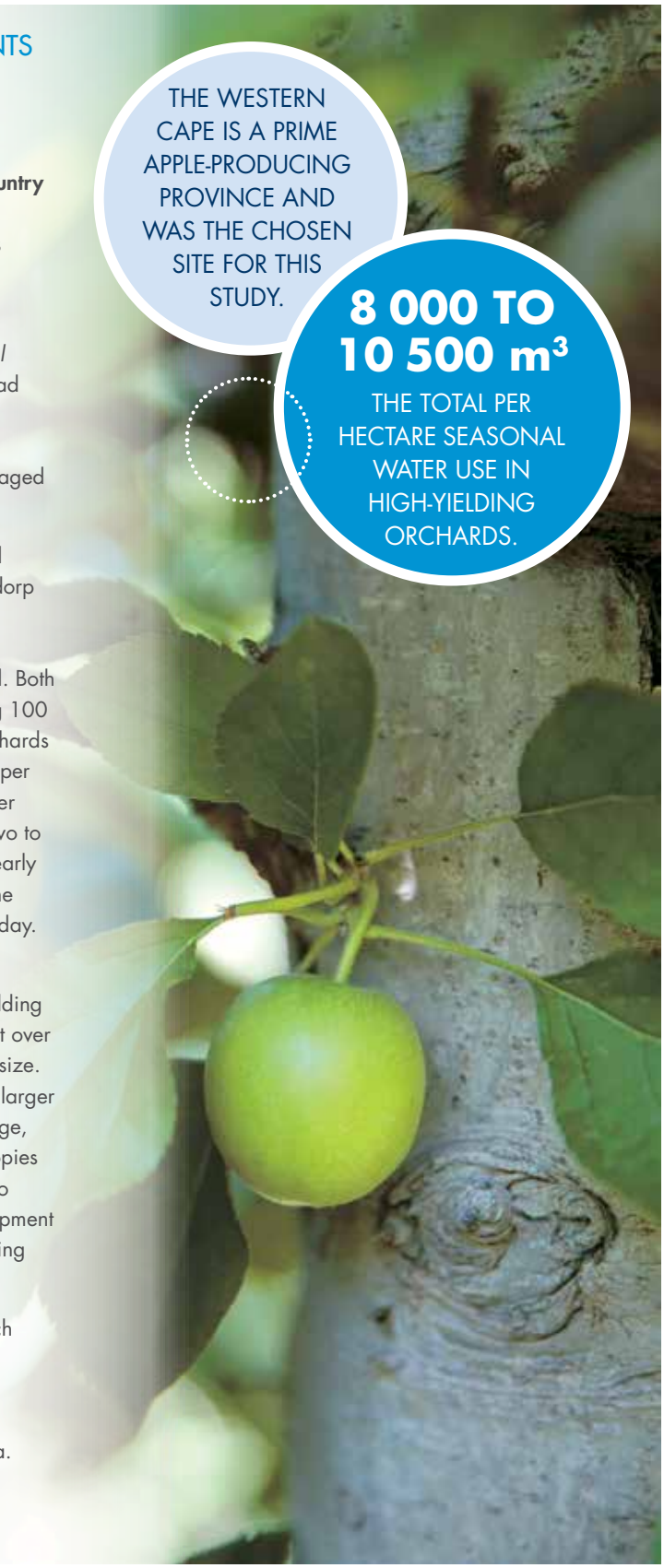
The four-year study, published in the *Agricultural Water Management Journal*, found that crop load has a very low impact on the orchard's water requirements. Instead, canopy size is the major driver of water use and how the canopy is managed is extremely important.

The study was conducted in the Koue Bokkeveld and the Elgin/Grabouw/Vyeboom and Villiersdorp regions of the Western Cape – a prime apple producing region. The widely planted Golden Delicious and the blushed cultivars were studied. Both are high-yielding cultivars with yields exceeding 100 tons per hectare becoming common. All the orchards were irrigated using one micro-sprinkler system per tree, delivering between 30-35 litres of water per hour. The frequency of irrigation ranged from two to three times per week, lasting one to two hours early in the season. During the hot summer months, the frequency increased to daily or several times a day.

The study showed that the maximum unstressed seasonal total orchard water use in the high-yielding orchards ranges from a little under 8 000 to just over 10 500 m^3 per hectare, depending on canopy size. Golden Delicious orchards, which tend to have larger canopies to protect the fruit from sunburn damage, used the most water. However, the smaller canopies of the red cultivars, normally maintained open to improve light penetration to promote the development of the red fruit colour, had significant water saving benefits.

The study collaborators were the Water Research Commission, the Agricultural Research Council, the South African Apple and Pear Producers Association represented by Hortgro Science, and the Universities of Stellenbosch and Pretoria.

High apple yields can be produced sustainably without using excessive amounts of water, provided the canopy is managed optimally.



RDI FOR THE NATURAL ENVIRONMENT

TESTS VALIDATE CSIR BIODEGRADABLE PLASTIC BAGS

CSIR-developed biodegradable plastic materials, made from agricultural waste by-products and biopolymers, have been tested and validated at an industrial facility for bioplastic carry bags. Bags made using the CSIR-developed material meet the biodegradability and compostability claims as per international norms and standards requirements.

In recent years, rapid industrialisation and economic development have led to an increase in plastic production and consumption world-wide. As a result, plastic waste pollution is threatening ecosystems. Adoption of bio-based biodegradable technology could help reduce the plastic waste pollution 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 is in discussion with industry players to utilise the bioplastic technology for different end-use applications such as carrier, kitchen and garbage bags, mulch films and others.

Senior researcher Dr Goitse Perry with a biodegradable plastic bag produced at the CSIR.

CSIR TAKES THE LEAD IN PUBLISHING A GREEN ECONOMY GUIDELINE

The first guideline on planning and implementing green economy projects in the agricultural sector has been developed by CSIR sustainability experts.

Green Economy Implementation in the Agriculture Sector: Moving from Theory to Practice is published by Springer Publishing and bridges the gap between the volumes of theory and practical implementation challenges that may be encountered at the project level.

Key to the book is a step-by-step process assisting the user to translate abstract green economy principles into tangible practicalities on the ground. The book provides a useful analysis of the green economy implementation context and a practical framework for implementing green economy projects focusing on vegetable crop production. The team engaged several farmers in the Limpopo province who were unaware of the concept of a green economy.
The ideals of a green economy are the efficient use of resources, keeping costs low and achieving social equity, thereby making the concept relevant to small-scale farmers. The authors combined information from desktop reviews and field research on vegetable production in a green economy context in South Africa. The book is authored by CSIR researchers Dr Constansia Musvoto, Karen Nortje, Anton Nahman and Dr William Stafford.

CSIR SCIENTISTS CONTRIBUTE TO MAJOR ASSESSMENT OF THE FORESTS-WATER-CLIMATE-PEOPLE LINK

CSIR scientists contributed to a global report on forests and water. The report, titled *The Forest and Water on a Changing Planet: Vulnerability, Adaptation and Governance Opportunities*, compiled by over 50 scientists from 20 countries, responded to questions regarding what people can do for and with forests to sustain the quality and quantity of water to support the health and wellbeing of forests and people.

More than seven billion humans share the earth with approximately three trillion trees, and both need water. With increasing water scarcity challenges globally, the role of trees and forests in the water cycle is at least as important as their role in the carbon cycle in the face of global change.

Several experts from the CSIR were involved in the development of the assessment report, which was launched during the United Nations High-level Political Forum on Sustainable Development in New York in July 2018.

CSIR contributions covered topics such as forest hydrology, climate and land use change, governance-related aspects, as well as multiple benefits and synergies in trade-offs.

An important issue in South Africa is that one requires a government-issued licence to undertake stream flow reduction activities (solely represented by plantations of introduced tree species), as mandated by the National Water Act, 1998 (Act 36 of 1998). The licence was introduced to control large-scale commercial afforestation activities and their downstream impacts (streamflow reductions). In the report, the CSIR highlights the South African science behind this unique policy, as well as the benefits and challenges that have arisen as a result.

PARTNERING FOR AFRICAN RESEARCH, DEVELOPMENT AND INNOVATION

FIRST WASTE MANAGEMENT OUTLOOK FOR AFRICA PUBLISHED

The CSIR, through the Waste Research Development and Innovation Roadmap, played a leading role in the publication of the first Africa Waste Management Outlook in 2018.

The publication presents waste evidence for the continent and highlights emerging social and technological waste innovations in Africa. The research was funded by the Department of Science and Technology, in partnership with the United Nations Environment Programme (UNEP) and the International Environmental Technology Centre (IETC).

The publication is the result of contributions by experts and researchers from across the African continent. It provides an analysis of the state of waste management in Africa, its impact on the continent and proposed solutions for improved waste management in the region.

The regional outlook is the latest in a series of waste management outlooks, which began with the Global Waste Management Outlook in 2015, published by UNEP, through the IETC, in partnership with the International Solid Waste Association. The CSIR's Prof. Linda Godfrey was the lead author and coordinator of the publication.

Among other things, the study found that, while an estimated 70-80% of the 125 million tons of municipal solid waste generated across Africa is recyclable, only 4% of the waste generated is recycled. That 4% is largely recycled by the activities of informal waste pickers, rather than by public and private sector design. Driven by poverty, unemployment and social need, informal waste pickers play a huge role in recovering valuable resources from waste.

More than 90% of the waste generated in Africa is disposed of at uncontrolled dumpsites and landfills – 19 of the world's biggest dumpsites are located in Africa, specifically in sub-Saharan Africa.

125 MILLION TONS OF MUNICIPAL SOLID WASTE GENERATED ACROSS AFRICA IS RECYCLABLE, BUT ONLY 4% IS RECYCLED.

MORE THAN 90% OF THE WASTE GENERATED IN AFRICA IS DISPOSED OF AT UNCONTROLLED DUMPSITES AND LANDFILLS.

SMARTER ROADS FOR SUB-SAHARAN AFRICA

The CSIR is helping to secure the welfare and adaptive capacity of vulnerable rural communities in sub-Saharan Africa, through design interventions that mitigate current and future climate impacts on low-volume roads. These roads are the lifeblood of rural communities, as they ensure access to markets and services.

Low-volume roads make up the bulk of road networks across Africa. They have not been designed for future climatic conditions, making them vulnerable to degradation, with many already impassable in the rainy seasons. The CSIR is engaged in projects in six African countries, including Ghana, Malawi and Mozambique.

In Ghana, the CSIR investigated alternative surfacing for steep slopes on low-volume roads. Concrete, bituminous and cobble surfaces were used in alternative surfacing options. In addition, various erosion control treatments and alternative drainage structures to kerbs were identified.

In Mozambique, the CSIR completed four demonstration sections on a 50 km stretch of road on the Mohambe-Maqueze road in the Gaza province of Mozambique. Solutions for soil erosion due to rainfall on the plains; soil erosion at the interface of concrete crossings and gravel roads; and water damage to roads, culverts and protection works were developed and demonstrated. The CSIR also demonstrated how well-constructed unpaved roads can be made climate resilient by raising their level, applying a better wearing course and improving side drainage.

The CSIR, in collaboration with the Transport Technology Transfer Centre, assisted Malawi with the institutional set-up for road research and the development of a strategic plan for the implementation of road research. The CSIR was contracted by the Research for Community Access Partnership, a programme of UKaid, to provide in-service training to transport sector practitioners to build the required capacity.

The CSIR is involved in design interventions for rural African roads, such as this one in Mozambique.

PARTNERING FOR AFRICAN RESEARCH, DEVELOPMENT AND INNOVATION

NEPAD SANBIO COLLABORATION:

15
UNIVERSITIES

6
RESEARCH AND TECHNOLOGY ORGANISATIONS

10
PRIVATE COMPANIES

13
SADC COUNTRIES

NEPAD SANBIO HELPS ADDRESS BURDEN OF DISEASE, FOOD AND NUTRITION INSECURITIES IN THE SADC REGION

During the past five years, the Southern African Network for Biosciences (SANBio) has supported 15 collaborative projects in food and health. It also produced 148 MSc degrees, 71 PhDs and 22 Postdocs across institutions of higher learning and training in the Southern African Development Community (SADC) region, as well as 2 000 vocational trainees.

SANBio is a programme of NEPAD – the New Partnership for Africa's Development. It is a shared biosciences research, development and innovation platform for working collaboratively to address some of Southern Africa's key biosciences issues in health, nutrition and health-related intervention areas such as agriculture and the environment. Hosted by the CSIR, NEPAD SANBio is growing the region's capacity in this field, creating networks and commercialising university research and development with private sector companies from the SADC region.

The 15 collaborative projects undertaken resulted in six start-up companies while seven products have been transferred to users or consumers. Some 26 industry-academia collaborations were generated, creating 40 non-permanent jobs and 50 permanent jobs.

The team are, front, from left, Zwikomborero Tangawamira, Markku Pekonen, Kelebohile Sedieane and Thiru Naidoo-Swettenham. Back, from left, are, Nontobeko Zulu, Dr Sechaba Bareetseng, Marja-Reetta Paaso. Not present are Nokwanda Ncube and SANBio Network Manager, Dr Ereck Chakauya.

DEVELOPING A PORTABLE DEVICE TO DETERMINE HIV VIRAL LOAD USING LASER TECHNOLOGY

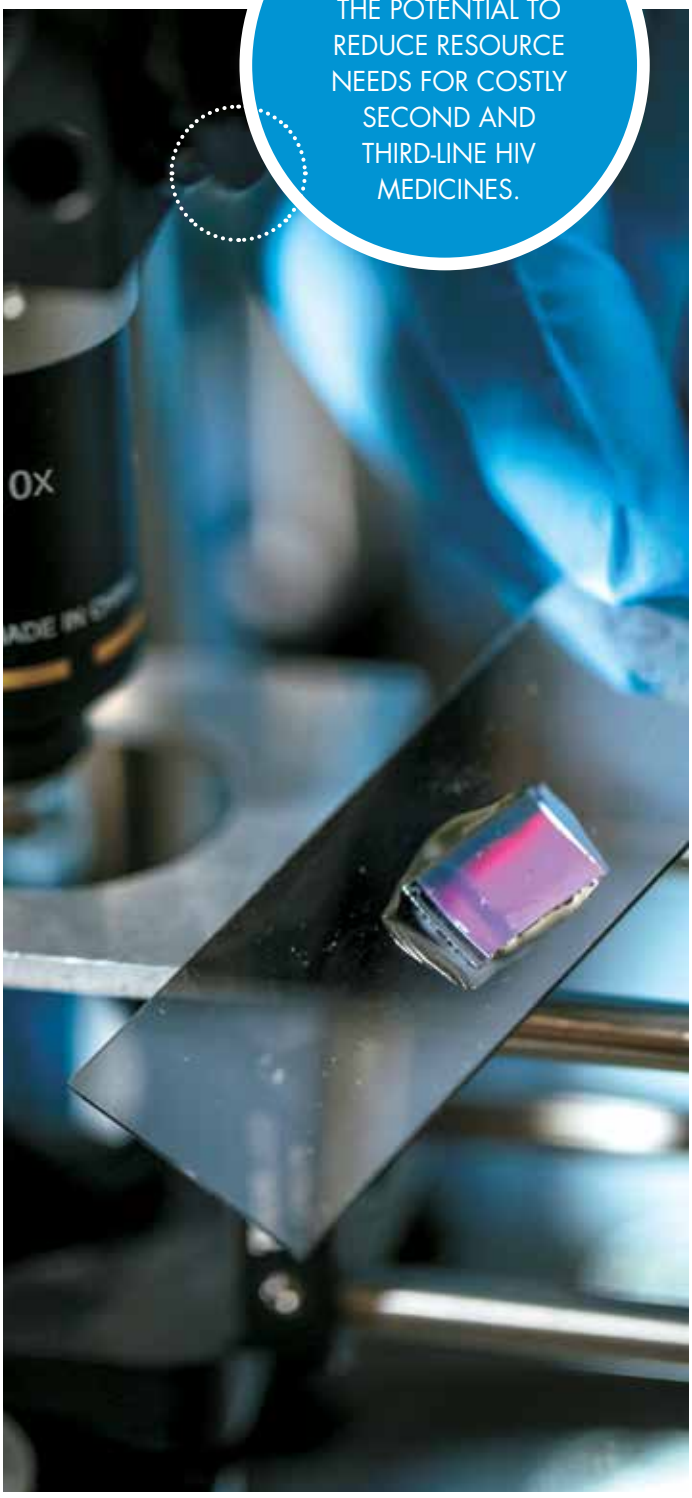
The CSIR and Cairo University in Egypt are jointly developing a point-of-care photonic crystal biosensor for HIV detection and viral load quantification. The collaboration is made possible through an African Laser Centre grant.

The researchers aim to develop a laser-based photonic crystal that can detect and quantify HIV particles with higher sensitivity. Currently, there are no point-of-care diagnostics available for viral load detection in resource-limited settings. In many cases, there is a severe lack of systems and clinical capacity to get viral load test results. Information about viral load is important to the patient and the doctor.

The accessibility of the device, particularly in low-resourced areas, has the potential to improve the quality of treatment and the life expectancy of people living with HIV. It also has the potential to reduce resource needs for costly second and third-line HIV medicines.

CSIR senior researcher Dr Sello Manoto with an in-house built reflectance spectroscopy platform for HIV detection and viral load quantification.

THE DEVICE HAS THE POTENTIAL TO REDUCE RESOURCE NEEDS FOR COSTLY SECOND AND THIRD-LINE HIV MEDICINES.



A photonic crystal reflecting a brilliant colour due to the resonant reflection from the periodic nanostructure.

FINANCIAL SUSTAINABILITY AND GOVERNANCE

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 to whom the stakeholders entrust 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 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 to align with organisational changes.

In accordance with the Scientific Research Council Act 1988 (Act 46 of 1988), as amended by Act 27 of 2014, 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 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 King IV Report on Corporate Governance for South Africa 2016 (King IV).

SHAREHOLDER'S COMPACT

In terms of Treasury Regulations issued in accordance with the PFMA, the CSIR must, in consultation with the Executive Authority, annually agree on its key performance objectives, measures and indicators. These are included in the shareholder's performance agreement (Shareholder's Compact) concluded 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 compliance with IFRS. The Auditor-General's Terms of Reference do not allow for any non-audit work to be performed.

CORPORATE GOVERNANCE

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.

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 inter-linked 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 reports, 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 risks, strategic risks and operational risks.

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, 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 areas such as: human capital assessment and development, research impact areas, technological development and business continuity.

Operational risks

These risks include financial, legal and compliance risks and are those risks affecting the systems, people and processes through which the CSIR operates.

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 and 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, Cluster Executive 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 adequate resources exist to continue as a going concern for the foreseeable future. The Board confirms that it has assessed key sustainability risks and there is no reason to believe that the business will not be a going concern in the year ahead.

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 by the external auditors are incorporated into the internal audit plan for follow up.

The annual audit plan is flexible in ensuring 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 the International Standards of the Professional Practice of Internal Auditing of the Institute of Internal Auditors.

INTERNAL CONTROL AND COMBINED ASSURANCE

The Board has ultimate responsibility for the system of internal control designed to identify, evaluate, manage, and mitigate risks, and provide reasonable assurance against misstatements and losses.

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 in 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 as adequate and effective.

AUDIT

External auditors are responsible for the independent audit and to report on the annual financial statements. The statements comply with International Financial Reporting Standards.

In line with the requirements of the PFMA and good governance, the internal audit function provides assurance to the Audit and Risk Committee and Executive 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 are in place to ensure the compliance with the above framework. A comprehensive set of procedures exists 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 building and transforming human capital; governance and financial sustainability; transferring technology and human capital and 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, the Policy Review and Development Committee has been established to review all the policies of the organisation. To date, a number of policies have been reviewed and approved by the Board.

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

CORPORATE GOVERNANCE

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. Employee participation takes place through activities such as leadership engagement sessions, formal induction programmes, technical and strategic focus groups and task teams.

GOVERNANCE STRUCTURE

THE CSIR BOARD

The responsibilities of the Board are governed by 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 and the meetings were held on 19 April 2018, 17 July 2018, 18 October 2018 and 19 February 2019. A Board strategic session was held on 23 and 24 August 2018. The annual financial statements for the 2018/19 financial year were approved on 18 July 2019.

The Board comprises three sub-committees, namely; the Audit and Risk Committee, the Human Resources and Remuneration Committee and the Research, Development and Innovation Committee (see pages 78-79). 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 reflected in the Board Charter. The Board committees complied with their respective Charters.

CSIR BOARD MEMBERS

The term of the Board appointed on 1 January 2015 came to an end on 31 December 2018. A new Board was appointed with effect from 1 January 2019 for a four-year term, ending on 31 December 2022. All new Board members have a diverse set of skills to effectively discharge their duties.

The collective Board was formally inducted on 25 January 2019.

All Board members were welcomed by the Minister of Science and Technology during an inaugural meeting held on 19 February 2019. The occasion provided the policy context and contribution expected from the Board.

CSIR Board Members

(1 APRIL 2018 TO 31 DECEMBER 2018)

PROF. THOKOZANI MAJOZI
Chairperson of the CSIR Board
NRF/DST Chair: Sustainable Process Engineering, University of the Witwatersrand

DR THULANI DLAMINI
Chief Executive Officer, CSIR

ADV GHANDI BADELA
Advocate, Duma Nokwe Group

MS PHINDILE BALENI
Director-General, Gauteng Premier's Office

DR PHILIP GOYNS
Senior Climate Change Advisor, Promethium Carbon

DR ANTONIO LLOBELL
Chief Executive Officer, BioGold International

DR RAMATSEMELA MASANGO
Executive Director, Mzansi Energy Solutions and Innovations (Pty) Ltd

MS MOKGADI MASEKO
Director, Leruo Corporate Consulting

MR JOEL NETSHITENZHE
Executive Director and Board Vice-Chairperson, Mapungubwe Institute for Strategic Reflection

MS AYANDA NOAH
Group Executive: Customer Services, Eskom

New CSIR Board members

(1 JANUARY 2019 TO 31 MARCH 2019)

PROF. THOKOZANI MAJOZI

Chairperson of the CSIR Board

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

DR THULANI DLAMINI

Chief Executive Officer, CSIR

MS PHINDILE BALENI

Director-General, Gauteng Premier's Office

MS AMBER-ROBYN CHILDS

Senior Lecturer at Rhodes University

DR RAMATSEMELA MASANGO

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

MR STAFFORD MASIE

Non-Executive Director and Shares, Thumbzup (South Africa, Australia/ AsiaPac, London and USA)

MS TINY MOKHABUKI

Chief Financial Officer, MICT SETA

DR VUYO MTHETHWA

Senior Human Resources Director, Durban University of Technology

MR JOEL NETSHITENZHE

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

DR CHRISTINE RENDER

Independent Consultant

MR CASSIM SHARIFF

Executive Director at SDB GAS and Lirazest

CSIR Board Members

(1 APRIL 2018 TO 31 DECEMBER 2018)

SCHEDULE OF ATTENDANCE OF THE CSIR BOARD AND CSIR COMMITTEE MEETINGS

(1 April 2018 to 31 December 2018)

Board members	Board meetings	Audit and Risk Committee	Human Resources and Remuneration Committee	Research, Development and Innovation Committee
T Majozi (Chair)	3	–	–	–
T Dlamini (CEO)	3	3	3	3
G Badela	3	2	3	–
P Baleni	2	2	1	–
P Goyns	3	–	3	3
A Llobell	1	–	–	1
R Masango	2	–	3	3
M Maseko	1	2	–	–
J Netshitenzhe	3	–	–	3
A Noah	2	3	–	–

CSIR Board Members

(1 JANUARY 2019 TO 31 MARCH 2019)

SCHEDULE OF ATTENDANCE OF THE CSIR BOARD AND CSIR COMMITTEE MEETINGS

(1 January 2019 to 31 March 2019)

Board members	Board meetings	Audit and Risk Committee	Human Resources and Remuneration Committee	Research, Development and Innovation Committee
T Majozi	1	–	–	–
T Dlamini	1	1	1	1
P Baleni	1	0	0	–
A Childs	1	–	–	1
R Masango	1	–	1	1
S Masie	1	1	–	0
T Mokhabuki	1	1	–	–
V Mthethwa	1	1	1	–
J Netshitenzhe	1	–	–	1
C Render	0	1	–	0
C Shariff	1	–	1	1

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

MS ZANELE NGWEPE
Chief Financial Officer

DR MOLEFI MOTUKU
Group Executive for Research, Development and Innovation
(Resigned on 31 December 2018)

MS SITHEMBILE BHENGU
Group Executive: Human Capital

ADVOCATE ESMÉ KENNEDY
Group Executive: Legal, Compliance and Business Enablement
(Appointed on 1 August 2018)

MS KHUNGEKA NJOBE
Group Executive: Business Excellence and Integration
(Appointed on 1 March 2019)

DR RACHEL CHIKWAMBA
Executive: Project Synapse
Acting Group Executive: Chemicals, Agriculture, Food and Health

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

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, Cluster Executive Managers and portfolio and support functions Group 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 71 to 73 of the Corporate Governance Report. The membership and Terms of Reference of each Board Committee are further described on pages 78 and 79.

Remuneration of Board members and the Executive Management is set out in note 13 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 these 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 as set out in the King Report on Corporate Governance.

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.

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. No material losses through criminal conduct and irregular, fruitless and wasteful expenditure were incurred during the year.

CSIR BOARD COMMITTEES

AUDIT AND RISK COMMITTEE

1 April 2018 to 31 December 2018

Chairperson: Ms A Noah

Members: Adv G Badela
Ms P Baleni
Ms M Maseko

Meetings: 10 May 2018
10 July 2018
9 October 2018

1 January 2019 to 31 March 2019

Chairperson: Ms T Mokhabuki

Members: Ms P Baleni
Mr S Masie
Dr V Mthethwa
Dr C Render

Meeting: 5 February 2019

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 2018 to 31 December 2018

Chairperson: Adv G Badela

Members: Ms P Baleni
Dr P Goyns
Dr R Masango
(joined committee in 2018)

Meetings: 17 April 2018
10 July 2018
9 October 2018

1 January 2019 to 31 March 2019

Chairperson: Dr V Mthethwa

Members: Ms P Baleni
Dr R Masango
Mr C Shariff

Meeting: 5 February 2019

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.

RESEARCH, DEVELOPMENT AND INNOVATION COMMITTEE

1 April 2018 to 31 December 2018

Chairperson: Dr P Goyns

Members:
Mr R Heydenrich
Dr A Llobell
Dr R Masango
Mr T Mtshali
Mr J Netshitenzhe

Meetings:
10 April 2018
3 July 2018
10 October 2018

1 January 2019 to 31 March 2019

Chairperson: Dr C Render

Members:
Dr A Childs
Dr R Masango
Mr S Masie
Mr J Netshitenzhe
Mr C Shariff

Meeting: 12 February 2019

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; and
- To ensure that key innovation and research processes are conducted effectively and benchmarked against international best practice, and that research outputs, organisational climate and credibility remain congruent with the role and objectives of the institution.

The Research and 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

(1 APRIL 2018 TO 31 DECEMBER 2018)

BOARD MEETINGS

Board members	19 April 2018	17 July 2018	18 October 2018
T Majozi (Chair)	Present	Present	Present
T Dlamini (CEO)	Present	Present	Present
G Badela	Present	Present	Present
P Baleni	Present	Present	Apology
P Goyns	Present	Present	Present
A Llobell	Present	Apology	Apology
R Masango	Present	Present	Apology
M Maseko	Apology	Present	Apology
J Netshitenzhe	Present	Present	Present
A Noah	Apology	Present	Present

BOARD STRATEGIC SESSION HELD ON 23 AND 24 AUGUST 2018

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

* *Attended only one day*

AUDIT AND RISK COMMITTEE MEETINGS

Committee members	10 May 2018	10 July 2018	9 October 2018
A Noah (Chair)	Present	Present	Present
G Badela	Apology	Present	Present
P Baleni	Present	Present	Apology
T Dlamini	Present	Present	Present
M Maseko	Apology	Present	Present

HUMAN RESOURCES AND REMUNERATION COMMITTEE MEETINGS

Committee members	17 April 2018	10 July 2018	9 October 2018
G Badela (Chair)	Present	Present	Present
P Baleni	Apology	Present	Apology
T Dlamini	Present	Present	Present
P Goyns	Present	Present	Present
R Masango	Present	Present	Present

RESEARCH, DEVELOPMENT AND INNOVATION COMMITTEE MEETINGS

Committee members	10 April 2018	3 July 2018	10 October 2018
P Goyns (Chair)	Present	Present	Present
T Dlamini	Present	Present	Present
R Heydenrich (co-opted member)	Present	Apology	Present
A Llobell	Present	Apology	Apology
R Masango	Present	Present	Present
T Mtshali (co-opted member)	Present	Apology	Apology
J Netshitenzhe	Present	Present	Present

Board and committee meeting attendance

(1 JANUARY 2019 TO 31 MARCH 2019)

BOARD MEETING

Board members	19 February 2019
T Majozi (Chair)	Present
T Dlamini (CEO)	Present
P Baleni	Present
A Childs	Present
R Masango	Present
S Masie	Present
T Mokhabuki	Present
V Mthethwa	Present
J Netshitenzhe	Present
C Render	Apology
C Shariff	Present

AUDIT AND RISK COMMITTEE MEETING

Committee members	5 February 2019
P Baleni	Apology
S Masie	Present
T Mokhabuki (Chair)	Present
V Mthethwa	Present
C Render	Present

HUMAN RESOURCES AND REMUNERATION COMMITTEE MEETING

Committee members	5 February 2019
P Baleni	Apology
R Masango	Present
V Mthethwa (Chair)	Present
C Shariff	Present

RESEARCH, DEVELOPMENT AND INNOVATION COMMITTEE MEETING

Committee members	12 February 2019
A Childs	Present
R Masango	Present
S Masie	Apology
J Netshitenzhe	Present
C Render (Chair)	Absent
C Shariff	Present

REPORT OF THE AUDIT AND RISK COMMITTEE

FOR THE YEAR ENDED **31 MARCH 2019**

The committee is pleased to present its report for the financial year ended 31 March 2019.

THE COMMITTEE'S RESPONSIBILITY

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

COMMITTEE MEMBERS AND ATTENDANCE

The committee consists of the members as stated on page 78 of this report. The newly elected members assumed duty from 1 January 2019. In accordance with its approved Terms of Reference, the committee met quarterly during the year under review, on 10 May 2018, 10 July 2018, 9 October 2018 and 5 February 2019. The schedule of attendance is shown on pages 81 and 82 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 31 March 2019 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. The committee further concurs and accepts the conclusions of the Auditor-General on the audited annual financial statements, and is of the opinion that the audited annual financial statements be accepted and read together with the report of the Auditor-General.

In its meeting held on 9 July 2019, the committee recommended that the CSIR Board adopts the annual financial statements.

Tiny Mokhabuki
Chairperson of the Audit and Risk Committee
23 July 2019

REPORT OF THE AUDITOR-GENERAL

FOR THE YEAR ENDED **31 MARCH 2019**

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 102 to 147, which comprise the consolidated and separate statement of financial position as at 31 March 2019, 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 2019, 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 sections 290 and 291 of the International Ethics Standards Board for Accountants' *Code of ethics for professional accountants* (IESBA code), parts 1 and 3 of the International Ethics Standards Board for Accountants' *International Code of Ethics for Professional Accountants (including International Independence Standards)* 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 codes.

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 this auditor's report.

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 2019:

Objectives	Pages in the annual performance report
SO2 – Conduct high quality research to foster scientific development	96
SO3 – Conduct relevant research to foster industrial development	96

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 these objectives.

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.

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 the auditor's report. After I receive and read this information, and if I conclude that there is 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 2019

AUDITOR-GENERAL SOUTH AFRICA
Auditing to build public confidence

REPORT OF THE AUDITOR-GENERAL

FOR THE YEAR ENDED **31 MARCH 2019**

ANNEXURE – AUDITOR-GENERAL'S RESPONSIBILITY FOR THE AUDIT

As part of an audit in accordance with the ISAs, I exercise professional judgement and maintain professional scepticism throughout my audit of the consolidated and separate financial statements, and the procedures performed on reported performance information for selected objectives and on the entity's compliance with respect to the selected subject matters.

Financial statements

In addition to my responsibility for the audit of the consolidated and separate financial statements as described in this auditor's report, I also:

- Identify and assess the risks of material misstatement of the consolidated and separate financial statements whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for my opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by the board of directors, which constitutes the accounting authority.
- Conclude on the appropriateness of the board of directors, which constitutes the accounting authority use of the going concern basis of accounting in the preparation of the financial statements. I also conclude, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the Council for Scientific and Industrial Research and its subsidiaries ability to continue as a going concern. If I conclude that a material uncertainty exists, I am required to draw attention in my auditor's report to the related disclosures in the financial statements about the material uncertainty or, if such disclosures are inadequate, to modify the opinion on the financial statements. My conclusions are based on the information available to me at the date of this auditor's report. However, future events or conditions may cause a entity to cease continuing as a going concern.
- Evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.
- Obtain sufficient appropriate audit evidence regarding the financial information of the entities or business activities within the group to express an opinion on the consolidated financial statements. I am responsible for the direction, supervision and performance of the group audit. I remain solely responsible for my audit opinion.

Communication with those charged with governance

I communicate with the accounting authority regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that I identify during my audit.

I also confirm to the accounting authority that I have complied with relevant ethical requirements regarding independence, and communicate all relationships and other matters that may reasonably be thought to have a bearing on my independence and, where applicable, related safeguards.

EXECUTIVE REPORT

82.5%
CSIR EMPLOYEES IN PROFESSIONAL AND SKILLED CATEGORIES

586
HAVE MASTER'S-LEVEL QUALIFICATIONS

320
HAVE DOCTORAL QUALIFICATIONS

EXECUTIVE REPORT

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 2019 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 2019 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), as amended by Act 27 of 2014. 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), as amended by Act 27 of 2014:

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 the Scientific Research Council Act, 1988 (Act 46 of 1988), as amended by Act 27 of 2014.

Scientific and industrial research, development and innovation (RDI) play 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 developing and deploying 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.

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.

Strategic overview

Meeting our 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. In particular the CSIR strategy speaks to seven of the focus areas identified in the NDP.

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. Through this last financial year we have refocused our efforts towards key industrial sectors for the country. 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 next generation technological 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. Again, in the past year we have re-strategised our efforts in this area, concentrating on implementing new structures to better support the state and industry in terms of the enabling environment required for economic growth (energy, water, smart institutions, digital transformation, logistics). The main problems we are attempting to address are:

- The lack of organisational capacity to support service delivery;
- The absence of an integrated decision support capability at all levels of government responsible for service delivery; and
- The poor diffusion and uptake of potential technology-based service-delivery solutions.

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. We are working on improving the measurement and management of our natural resources and ability to understand the long-term effects of climate change (and assisting the government with the formulation of mitigation and adaptation strategies). We are 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

Our 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 the 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 cybersecurity 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. During this financial year we also started investigating new diagnostics and pharmaceutical manufacturing technologies that, together with our existing offerings would form the basis of next generation health solutions.

Transforming human settlements

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. There is a major need to plan and prioritise infrastructure investment timeously with an understanding of the impact on development priorities and long-term implications. 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. Increasingly we have been incorporating new digital technologies to assist in these activities.

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. The RDI work of the CSIR is further supported by a number of enabling conditions and processes. These include support for technology transfer, strategic partnerships with state-owned entities (SOEs), developmental agencies, the private sector and other research and technology organisations.

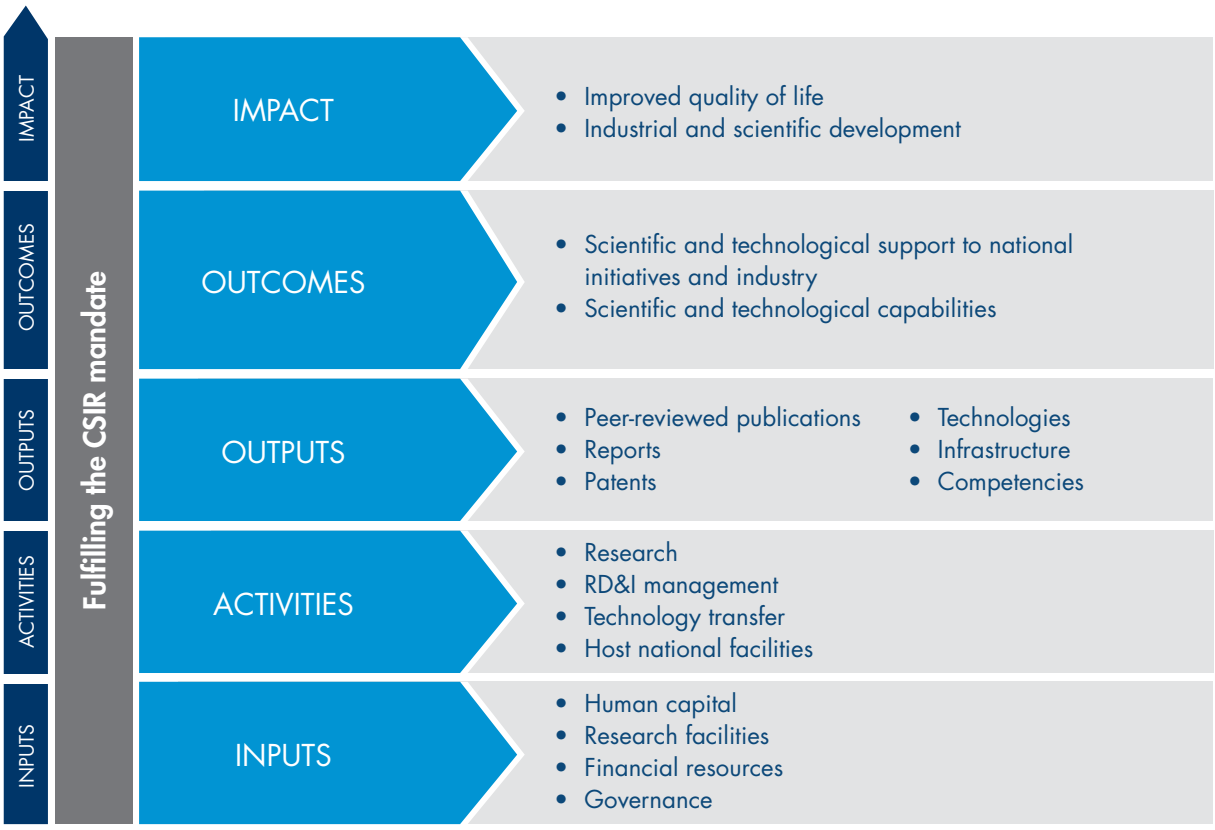


Figure 1: The CSIR's framework for fulfilling its mandate

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 five high-level strategic objectives in order to meet its mandate:

Strategic objective 1: Build and Transform Human Capital

The CSIR will grow and develop the human capital required to support and perform the necessary research, development and innovation activities to fulfil its mandate.

Strategic objective 2: Conduct High-quality Research to Foster Scientific Development

The CSIR identifies and invests in relevant areas of research to develop new capability and ultimately develop relevant solutions for the public and private sector.

Strategic objective 3: Conduct Relevant Research to Foster Industrial Development

In partnership with both the public and private sector, the CSIR will identify opportunities to improve the efficiency and competitiveness of our existing industry, and invest in the development of technologies that will underpin the industries of the future.

Strategic objective 4: Infrastructure Renewal and Development

The CSIR will develop and maintain world-class research and built infrastructure.

Strategic objective 5: Financial Sustainability and Governance

The CSIR is committed to maintaining its record of good governance and to continue to operate in a safe and sustainable manner (financially and environmentally).

OVERVIEW OF THE 2018/19 PERFORMANCE

Key performance indicators and performance reporting

The CSIR enters into a Shareholder's Compact agreement with the DST on an annual basis. The Shareholder's 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. Progress against the five strategic objectives for the 2018/19 financial year is described below.

SO1: Build and Transform Human Capital

The CSIR's research base contributions are only possible through the skills and capabilities of our research and support staff. The ongoing development, renewal and transformation of our staff is therefore of critical importance for the organisation. In addition, the CSIR is an important part of the national system of innovation, and through the development and training of our scientific base contributes to the national imperative to develop human capital and to the ongoing transformation of our society. 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 who 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.

The CSIR met or exceeded the annual targets for seven of the seventeen indicators in this category and missed the targets for the total number of SET staff, number of black SET staff, number of female SET staff, number of SET staff with PhDs, total number of chief researchers, number and percentage of chief researchers who are black, number of chief researchers who are female, total number of principal researchers, and the number of principal researchers who are female.

Table 1: CSIR performance – Build and Transform Human Capital

Indicator	2018/19 Target	2018/19 Actual
Total size of SET base	1 860	1 608
Number of black South Africans in SET base	1 160	998
Percentage of SET base who are black South Africans	62	62.08
Number of female South Africans in SET base	687	578
Percentage of SET base who are female South Africans	≥ 37	35.95
Number of SET base with Doctorates	369	313
Percentage of SET base with Doctorates	20	19.47
Total chief researchers	23	14
Number of chief researchers who are black	3	1
Percentage of chief researchers who are black	13	7.14
Number of chief researchers who are female	3	2
Percentage of chief researchers who are female	13	14.29
Total principal researchers	210	190
Number of chief researchers who are black	57	52
Percentage of principal researchers who are black	27	27.37
Number of principal researchers who are female	41	32
Percentage of principal researchers who are female	20	16.84

Although the total number of SET staff was reduced, the profile and transformation of the SET staff was maintained and targets for percentage black, female and Doctorate were achieved. The total number of chief researchers, especially the number of black chief researchers, remains a concern. We will continue to address this challenge through the Accelerated Researcher Development Programme (introduced in 2017/18) aimed at providing directed support towards the pipeline development of principal and chief researchers in line with the transformation goals of the CSIR.

The CSIR total staff headcount at the end of the 2018/19 financial year was 2 342 compared to 2 618 as at 31 March 2018, a decline of 10.54% in the total number of staff at the CSIR. The CSIR headcount at the end of the 2018/19 financial year includes 1 608 (68.66%) science, engineering and technology (SET) employees and 734 (31.34%) support professionals. This is as a result of the moratorium on appointments as part of cost-containment measures, which only allowed for the recruitment of critical staff; voluntary separations related to the repositioning and restructuring process; general staff turnover due to contracts ending; retirements; and resignations. Table 2 shows the distribution of employees across the different occupational levels.

Table 2: CSIR employees by occupational level – March 2019

Occupational level	Total
A. Top	13
B. Senior	88
C. Professional	1 144
D. Skilled	788
E. Semi-skilled	280
F. Unskilled	29
Total	**2 342**

Table 3: CSIR employee demographics by gender, race and nationality – March 2019

Occupational level	Male					Female				
	A	C	I	W	N-SA	A	C	I	W	N-SA
A. Top	4	0	0	1	1	4	0	0	1	2
B. Senior	19	3	10	27	9	7	1	2	9	1
C. Professional	234	29	71	304	77	185	16	38	167	23
D. Skilled	252	13	23	29	5	348	27	25	63	3
E. Semi-skilled	125	16	2	2	1	106	19	2	7	0
F. Unskilled	14	1	0	0	0	14	0	0	0	0
Total	**648**	**62**	**106**	**363**	**93**	**664**	**63**	**67**	**247**	**29**

A – African C – Coloured I – Indian W – White N-SA – Non-South African

The majority (82.5%) 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 3.

Approximately 5% (122 employees) of our workforce comprises non-South Africans, the majority of whom are employed as technical professionals. Black South Africans account for 66% (1 610 employees) of all employees, with black male South Africans accounting for 35% and black female South Africans accounting for 34% of all employees.

Staff qualification profile

Three hundred and twenty (320) CSIR employees have doctoral qualifications and 586 have master's-level qualifications. In the 2017/18 financial year, the corresponding values were 348 and 631, respectively.

Table 4 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 (41% and 27%, 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 59% are black South Africans. The comparative figures for the 2018/19 financial year are 41% and 55%, respectively.

Table 4: CSIR staff qualification – March 2018

Qualification	Doctorate	Master's	Master's/Doctorate
Total	**320**	**586**	**906**
SA female	87	239	326
Percentage of all	*27*	*41*	*36*
SA male	165	309	474
Percentage of all	*52*	*53*	*52*
SA black	130	344	474
Percentage of all	*41*	*59*	*52*

Ongoing qualifications

The CSIR is committed to supporting the academic development and transformation of its staff. Table 5 shows the number and distribution of staff studying for higher (master's or doctoral) degrees. At the end of the 2018/19 financial year, 364 employees were enrolled for higher degrees (2017/18: 397); 51% of these were female South Africans (2017/18: 50%) and 75% were black South Africans (2017/18: 73%).

Table 5: CSIR staff studying for higher degrees – 2019

Staff enrolled for	Doctorate	Master's	Master's/Doctorate
Total	**168**	**196**	**364**
SA female	86	100	186
Percentage of all enrolled	*51*	*51*	*51*
SA male	74	88	162
Percentage of all enrolled	*44*	*45*	*45*
SA black	121	151	272
Percentage of all enrolled	*72*	*77*	*75*

Key highlights

Appointments and awards

- Board Chairperson, Prof. Thokozani Majozi was awarded the National Order of Mapungubwe (Bronze) for his outstanding contribution to science, particularly the development of a novel mathematical technique for near-zero-effluent batch chemical facilities, which enables the re-use of wastewater.
- Robbie Van Heerden was appointed to the Eskom Technical Review Team. He is one of the specialists tasked with acutely monitoring operations and maintenance within Eskom power stations.
- Chris Burger was appointed as a Non-executive Director to the Board of the Air Traffic Navigation Services.
- Dr Lucia Steenkamp was a joint winner of the Research and Innovation Award in the Distinguished Women Scientists category at the South African Women in Science Awards.
- Dr Bonex Mwakikunga won an Excellence in Innovation Award at the Future of Education Summit.

Recruitment and learning

- The CSIR is embarking on a drive to increase the effectiveness of its recruitment process and improve CSIR brand awareness through the LinkedIn platform. The envisaged benefit is the reduction of recruitment and marketing costs. Training sessions were provided by LinkedIn to the recruitment team and the Marketing and Communications department. The system licences were allocated to the recruiters in early January 2019 and they are now able to source candidates via the LinkedIn platform. Approved content has been published on the CSIR live page.
- The CSIR entered into an agreement with merSETA to support various human capital development programmes as shown in Table 10 below. The amount of the contract is over R68 million for a period of 4 years.

Restructuring

- A CCMA-facilitated consultation process commenced in January 2019. The process was initiated to address operational areas that were not sustainable and improve operational efficiency.
- The outcome of this process required the promotion and demotion of a number of employees to be appointed in positions as per the approved and optimised organisational structure. Guidelines have been established as to how demotions and salary deductions will be implemented in a phased-approach to ease the impact on staff members who were accommodated in alternate, but lower-paying positions.
- On 28 March 2019, employees who could not be placed in alternate positions within the CSIR were issued with notice of termination and a termination agreement setting forth the restructuring package they qualify for in terms of the CSIR's Retrenchment Policy. The statistics of the restructuring process are shown in Table 6 below.

Table 6: Statistics of the restructuring process

Placement	Resignation	Retirement	VSP*	Retrenchment	Incapacity Health	Total
178	19	2	45	28	1	273

* *Voluntary Separation Package*

SO2: Conduct High-quality Research to Foster Scientific Development

The CSIR contributes to scientific development by identifying, and investing in relevant areas of research. The outputs of these interventions will include the production of a range of high-quality technical outputs (including peer-reviewed journal articles and patents) and the generation of contract research and development (R&D) income through the provision of research services. The KPIs linked to this strategic objective include research publications, patents and the income earned from R&D performed on behalf of other parties.

The CSIR met or exceeded the annual targets for three of the four indicators in this category and missed the targets for contract R&D income.

The CSIR produced 536 publication equivalents, of which 319 are journal articles, exceeding the annual target of 480 and 310, respectively. In total, 45% of CSIR articles were published in journals with an impact factor (IF – a putative marker of journal quality) of 2 – 4.99 (in the top 10% of journals by IF) and 9% of CSIR articles were published in journals with an IF of five or higher (i.e. in the top 6% of journals by IF). The CSIR was granted 22 international patents exceeding the annual target of 15.

At the end of the 2018/19 financial year, the CSIR generated R1.746 billion in Contract R&D income against a target of R1.970 billion. The gap can be mainly attributed to the delays in securing and finalising a number of planned contracts; the tender process requirements of National Treasury; changes in the funding landscape; models of key funders that require the CSIR to increase co-funding on various initiatives; and the general global economic decline that has resulted in budget cuts and non-renewal of contracts with key customers.

Table 7: CSIR performance – Conduct High-quality Research to Foster Scientific Development

Indicator	2018/19 Target	2018/19 Actual
Publication equivalents	≥ 480	536
Journal articles	≥ 310	319
New patents granted	≥ 15	22
Contract income (Rm)	1 970	1 746

SO3: Conduct Relevant Research to Foster Industrial Development

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 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. The KPIs linked to this strategic objective include technology demonstrators and the income earned from royalties or the licensing of CSIR technologies.

The CSIR met or exceeded the annual targets for two indicators in this category. Technology demonstrators are a lead indicator of technology transfer. Meeting our target of 50 illustrates the continued efforts that the CSIR is making to ensure that our technologies are developed to a level of maturity at which they can be transferred, leading to impact, adoption in the market and royalty income.

Table 8: CSIR performance – Conduct Relevant Research to foster Industrial Development

Indicator	2018/19 Target	2018/19 Actual
New technology demonstrators	≥ 50	50
Royalty and licence income	≥ R 4 m	R5.42 m

SO4: Infrastructure Renewal and Development

In order to support its scientific and industrial development mission, the CSIR needs to develop and maintain a world-class research and built infrastructure. The KPI linked to this strategic objective includes the level of investment we make in Property, Plant and Equipment (PPE) to maintain our infrastructure.

The CSIR exceeded the annual target of ≥ R61 million and invested R74 million in PPE. This indicator provides a measure of the CSIR's investment to develop and maintain world-class facilities and equipment to provide the quality of RDI that is expected of it.

Table 9: CSIR performance – Infrastructure Renewal and Development

Indicator	2018/19 Target	2018/19 Actual
Investment in property, plant and equipment (Rm)	≥ 61	74

SO5: Financial Sustainability and Governance

Without a financially sustainable and well-governed organisation our ability to, over the long-term, contribute to national development through our scientific and technological work would be severely compromised. The CSIR is therefore committed to maintaining our record of good governance and to continue to operate in a safe and sustainable manner. 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, our Broad-Based Black Economic Empowerment (B-BBEE) status and our safety record.

The CSIR exceeded the annual targets for one of the four indicators in this category. The CSIR generated a profit of R7.7 million, exceeding the annual target of R0 million. The indicators for which the targets were not achieved are as follows:

- Total income for the period amounted to R2 555 billion and this is R218 million below target. The shortfall in total income is attributable to constrained financial performance in the operating units;
- The CSIR only managed to achieve a Level 3 B-BBEE status against a Level 2 target. Additional measures, such as greater focus on attracting and/or developing enterprises with credible B-BBEE credentials and promote, manage and enhance the role that people with disabilities play within the organisation, have been initiated to ensure that we regain our Level 2 status when the current certificate expires in August 2019; and
- The CSIR did not achieve the annual target of ≤ 0.2 on the Disabling Frequency Rate due to seven disabling injuries suffered during the year. The organisation is continuously monitoring its health and safety (H&S) risks and implementing appropriate response measures to address undesirable trends as and when identified. This includes numerous management safety walkabouts, H&S articles published on our Intraweb and safety tips communicated with Secretariats of SHE Committees in the Operating Units, Centres, Portfolios and Regional Sites to raise awareness on the number of disabling injuries that occurred during the year, the lessons learned, near misses, the risk of fatigue and pressure of financial year-end leading to incidents.

Table 10: CSIR performance – financial sustainability and governance

Indicator	2018/19 Target	2018/19 Actual
Total income (Rm)	2 740	2 555
Net profit/(loss) (Rm)	0	7.7
B-BBEE rating	Level 2 contributor	Level 3 contributor
Disabling injury frequency rate	≤ 0.2	0.28

The total operating income of the CSIR amounted to R2.5 billion (2017/18: R2.5 billion). The PG recognised as income in 2018/19 amounted to R752 million, an increase of 3.2% from the prior year's amount of R722 million.

The CSIR's total contract income amounted to R1.75 billion (2017/18: R1.77 billion). This includes a R78 million (2017/18: R71 million) ring-fenced allocation from the DST. Significant investments in grant-funded PPE were made in the 2018/19 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 R34 million (2017/18: R20.7 million), amounts to 6.1%.

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, R840 million has been invested in PPE, with R74 million invested in the 2018/19 financial year alone.

The net profit for the CSIR amounts to R7.7 million (2017/18: R13.8 million loss).

CSIR cash and cash equivalents were at R1.234 billion at the end of March 2019, compared to R1.094 billion at the end of March 2018. The current ratio is greater than one, with current assets exceeding current liabilities.

FINANCIAL PERFORMANCE OVERVIEW

Five-year review of income and expense indicators

	2019 R'000	2018 R'000 Restated	2017 R'000 Restated	2016 R'000	2015 R'000
Total income	**2 554 593**	**2 542 617**	**2 735 473**	**2 736 550**	**2 442 590**
Parliamentary Grant recognised as income	752 149	722 373	714 105	680 485	675 340
Contract income, royalty income, other income and net finance income	**1 802 444**	**1 820 244**	**2 021 368**	**2 056 065**	**1 767 250**
Local private and international sectors	292 386	371 724	348 462	320 950	348 388
Local public sector	1 453 826	1 399 783	1 583 293	1 645 798	1 331 042
Royalties and other income	8 402	10 255	45 996	49 347	30 202
Net finance income	47 830	38 482	43 617	39 970	57 618
Total expenditure	**2 547 761**	**2 557 161**	**2 659 155**	**2 677 568**	**2 390 203**
Employees' remuneration	1 586 816	1 538 913	1 487 899	1 468 155	1 339 345
Operating expenses	895 824	953 158	1 109 512	1 154 910	1 002 234
Depreciation	65 121	65 090	61 744	54 503	48 624

Five-year ratio analysis

	2019	2018 Restated	2017 Restated	2016	2015
Operating expenses					
Remuneration as a percentage of total income (excluding finance income)	**63.3%**	61.5%	55.3%	54.4%	56.2%
Remuneration as a percentage of total operating expenditure	**62.3%**	60.2%	56.0%	54.8%	56.0%
Asset management					
Investment in property, plant and equipment (Rm)	**74.1**	108.1	143.8	308.0	209.7
Investment in property, plant and equipment as a percentage of revenue	**3.0%**	4.3%	5.4%	11.6%	8.9%
Net asset turnover	**2.3**	2.5	2.7	2.9	2.8
Current ratio	**1.2**	1.2	1.2	1.1	1.1
Cash flow					
Net cash from operating activities (R'000)	**180 211**	80 836	96 642	138 869	41 407
Cash and cash equivalents at end of year (including long-term fixed deposits) (R'000)	**1 241 468**	1 093 586	1 099 124	1 005 241	975 952

Definitions

Net asset turnover: 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 9. Financial instruments – recognition and measurement have been excluded for the comparison of financial indicators.

CONSOLIDATED FINANCIAL STATEMENTS

R7.7 m

PROFIT FOR 2018/19

R2.5 bn

REVENUE FOR 2018/19

Consolidated statements of profit or loss and other comprehensive income

FOR THE YEAR ENDED **31 MARCH 2019**

	Notes	GROUP 2019 R'000	GROUP 2018 R'000	CSIR 2019 R'000	CSIR 2018 R'000
Revenue	2	**2 503 783**	2 498 486	**2 503 783**	2 498 486
Other income		**2 990**	5 679	**2 980**	5 650
Total operating income		**2 506 773**	2 504 165	**2 506 763**	2 504 136
Expenses					
Employees' remuneration		**(1 586 816)**	(1 538 912)	**(1 586 816)**	(1 538 912)
Depreciation		**(65 121)**	(65 092)	**(65 121)**	(65 091)
Operating expenses		**(895 551)**	(950 083)	**(895 824)**	(953 159)
Operating (loss) profit	3	**(40 715)**	(49 922)	**(40 998)**	(53 026)
Finance income	4	**48 286**	38 955	**47 830**	38 483
Finance expense		**–**	(1)	**–**	(1)
Share of loss of joint ventures and associates		**(312)**	(3 110)	**–**	–
Profit (loss) for the year		**7 259**	(14 078)	**6 832**	(14 544)
Other comprehensive income:					
Items that will not be reclassified to profit or loss:					
Remeasurement of post-retirement medical benefit obligation		**934**	738	**934**	738
Other comprehensive income for the year net of taxation	27	**934**	738	**934**	738
Total comprehensive income (loss) for the year		**8 193**	(13 340)	**7 766**	(13 806)

Consolidated statements of financial position

AS AT **31 MARCH 2019**

	Notes	GROUP 2019 R'000	GROUP 2018 R'000	CSIR 2019 R'000	CSIR 2018 R'000
ASSETS					
Non-current assets					
Property, plant and equipment	6	**758 672**	784 363	**758 672**	784 363
Investments in subsidiaries	8	**–**	–	**4 650**	4 711
Investments in joint ventures and associates	7	**5 081**	9 105	**5 083**	9 106
Trade and other receivables	9	**292**	2 293	**292**	2 293
		764 045	795 761	**768 697**	800 473
Current assets					
Inventories	22	**1 384**	1 435	**1 384**	1 435
Other receivables from contracts with customers	23	**116 470**	112 217	**116 470**	112 217
Trade and other receivables	9	**195 708**	222 376	**195 688**	222 291
Contract assets	24	**6 918**	–	**6 918**	–
Cash and cash equivalents	17	**1 241 468**	1 100 609	**1 234 024**	1 093 595
		1 561 948	1 436 637	**1 554 484**	1 429 538
TOTAL ASSETS		**2 325 993**	2 232 398	**2 323 181**	2 230 011
EQUITY AND LIABILITIES					
Equity					
Retained income		**1 002 472**	994 460	**999 650**	992 070
Liabilities					
Non-current liabilities					
Retirement benefit obligation	12	**10 906**	10 963	**10 906**	10 963
Current liabilities					
Trade and other payables	10	**384 976**	377 498	**384 986**	377 501
Advances on contracts with customers	26	**916 452**	849 477	**916 452**	849 477
Provisions	25	**11 187**	–	**11 187**	–
		1 312 615	1 226 975	**1 312 625**	1 226 978
Total liabilities		**1 323 521**	1 237 938	**1 323 531**	1 237 941
TOTAL EQUITY AND LIABILITIES		**2 325 993**	2 232 398	**2 323 181**	2 230 011

Consolidated statements of changes in equity

FOR THE YEAR ENDED **31 MARCH 2019**

	Retained income R'000	Total equity R'000
GROUP		
Balance at 1 April 2017	1 007 800	1 007 800
Loss for the year	(14 078)	(14 078)
Other comprehensive income	738	738
Total comprehensive loss for the year	**(13 340)**	**(13 340)**
Opening balance as previously reported	994 458	994 458
Adjustments		
Prior year adjustments	(179)	(179)
Balance at 1 April 2018 as restated	**994 279**	**994 279**
Profit for the year	7 259	7 259
Other comprehensive income	934	934
Total comprehensive income for the year	**8 193**	**8 193**
Balance at 31 March 2019	**1 002 472**	**1 002 472**
Note(s)	27	
CSIR		
Balance at 1 April 2017	1 005 876	1 005 876
Loss for the year	(14 544)	(14 544)
Other comprehensive income	738	738
Total comprehensive loss for the year	**(13 806)**	**(13 806)**
Opening balance as previously reported	992 070	992 070
Adjustments		
Prior year adjustments	(186)	(186)
Balance at 1 April 2018 as restated	**991 884**	**991 884**
Profit for the year	6 832	6 832
Other comprehensive income	934	934
Total comprehensive income for the year	**7 766**	**7 766**
Balance at 31 March 2019	**999 650**	**999 650**
Note(s)	27	

Consolidated statements of cash flows

FOR THE YEAR ENDED **31 MARCH 2019**

	Notes	GROUP 2019 R'000	GROUP 2018 R'000	CSIR 2019 R'000	CSIR 2018 R'000
Cash flows from operating activities					
Cash receipts from external customers		**1 761 700**	1 837 205	**1 761 690**	1 825 922
Parliamentary Grant received		**760 092**	729 359	**760 092**	729 359
Cash paid to suppliers and employees		**(2 391 265)**	(2 529 120)	**(2 391 411)**	(2 508 170)
Cash generated from operations	16	**130 527**	37 444	**130 371**	47 111
Finance income received		**49 684**	43 737	**49 363**	33 726
Finance expense		**–**	(1)	**–**	(1)
Net cash from operating activities		**180 211**	81 180	**179 734**	80 836
Cash flows from investing activities					
Purchase of property, plant and equipment	6	**(40 172)**	(87 379)	**(40 172)**	(87 379)
Sale of property, plant and equipment	6	**686**	3 347	**686**	3 347
Movement in investments (incl subs, JVs & Assoc)		**(2 067)**	(3 608)	**(2 067)**	(3 608)
Loans to Group companies repaid		**–**	–	**47**	680
Proceeds from liquidation of Ellipsoid		**1 150**	–	**1 150**	–
Net cash from investing activities		**(40 403)**	(87 640)	**(40 356)**	(86 960)
Unrealised exchange gains/(losses) on foreign cash balances		**1 051**	586	**1 051**	586
Total cash movement for the year		**140 859**	(5 874)	**140 429**	(5 538)
Cash at the beginning of the year		**1 100 609**	1 106 474	**1 093 595**	1 099 124
Total cash at end of the year	**17**	**1 241 468**	1 100 600	**1 234 024**	1 093 586

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

Entity information

The CSIR is a national government business enterprise (enacted by The Scientific Research Council Act, 1988 (Act 46 of 1988, as amended by Act 27 of 2014) 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 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.

The consolidated annual financial statements of the Group as at and for the year ended 31 March 2019 comprise the entity and its subsidiaries (together referred to as the Group) and the Group's interest in associates and jointly controlled entities.

1 SIGNIFICANT ACCOUNTING POLICIES

The principal accounting policies applied in the preparation of these consolidated and separate financial statements are set out below.

1.1 Basis of preparation

The consolidated and separate financial statements have been prepared on the going concern basis in accordance with, and in compliance with, International Financial Reporting Standards (IFRS) and International Financial Reporting Interpretations Committee (IFRIC) interpretations issued and effective at the time of preparing these financial statements and the Public Finance Management Act, 1999 (Act 1 of 1999) as amended by Act 29 of 1999.

These consolidated financial statements comply with the requirements of the South African Institute of Chartered Accountants' Financial Reporting Guides as issued by the Accounting Practices Committee; and the Financial Reporting Pronouncements as issued by the Financial Reporting Standards Council.

The consolidated statements have been prepared on the historic cost convention, unless otherwise stated in the accounting policies which follow and incorporate the principal accounting policies set out below. They are presented in rands, which is the Group and entity's functional currency.

These accounting policies are consistent with the previous period, except for policies discussed under changes in accounting policy note.

1.2 Consolidation

Basis of consolidation

The consolidated financial statements incorporate the financial statements of the CSIR and all subsidiaries. Subsidiaries are entities (including structured entities) which are controlled by the Group.

The Group has control of an entity when it is exposed to or has rights to variable returns from involvement with the entity and it has the ability to affect those returns through the use of its power over the entity.

The results of subsidiaries are included in the consolidated financial statements from the effective date of acquisition to the effective date of disposal.

All inter-company transactions, balances and unrealised gains on transactions between Group companies are eliminated in full on consolidation. Unrealised losses are also eliminated, unless the transaction provides evidence of an impairment of the asset transferred.

Investments in subsidiaries in the separate financial statements

In the CSIR's separate financial statements, investments in subsidiaries are carried at cost, less any accumulated impairment losses.

1.3 Joint arrangements

A joint arrangement is an arrangement where two or more parties have joint control. Joint control is the contractually agreed sharing of control of an arrangement, which exists only when decisions about the relevant activities require the unanimous consent of the parties sharing control. A joint arrangement is either a joint operation or a joint venture.

A joint operation is a joint arrangement whereby the parties that have joint control of the arrangement have rights to the assets, and obligations for the liabilities, relating to the arrangement. A joint venture is a joint arrangement whereby the parties that have joint control of the arrangement have rights to the net assets of the arrangement. The Group has assessed the nature of its joint arrangements and determined them to be joint ventures.

Joint ventures

An interest in a joint venture is accounted for using the equity method. Under the equity method, interests in

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

1 SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

Joint ventures (continued)

joint ventures are carried in the statement of financial position at cost adjusted for post-acquisition changes in the CSIR's share of net assets of the joint venture, less any impairment losses.

The Group's share of post-acquisition profit or loss is recognised in profit or loss, and its share of movements in other comprehensive income is recognised in other comprehensive income, with a corresponding adjustment to the carrying amount of the investment. Losses in a joint venture in excess of the Group's interest in that joint venture, including any other unsecured receivables, are recognised only to the extent that the Group has incurred a legal or constructive obligation to make payments on behalf of the joint venture.

Profits or losses on transactions between the Group and a joint venture are eliminated to the extent of the Group's interest therein. Unrealised losses are eliminated unless the transaction provides evidence of an impairment of the asset transferred. Accounting policies of joint ventures have been changed where necessary to ensure consistency with the policies adopted by the Group.

Investments in joint ventures in the separate financial statements

In the CSIR's separate financial statements, investments in joint ventures are carried at cost, less any accumulated impairment losses.

1.4 Investments in associates

An associate is an entity over which the Group has significant influence and which is neither a subsidiary nor a joint arrangement. Significant influence is the power to participate in the financial and operating policy decisions of the investee but has no control or joint control over those policies. It generally accompanies a shareholding of between 20% and 50% of the voting rights.

Investments in associates are accounted for using the equity method. Under the equity method, investments in associates are carried in the Statement of Financial Position at cost adjusted for post-acquisition changes in the Group's share of net assets of the associate, less any impairment losses.

The Group's share of post-acquisition profit or loss is recognised in profit or loss, and its share of movements in other comprehensive income is recognised in other comprehensive income with a corresponding adjustment to the carrying amount of the investment. Losses in an associate in excess of the Group's interest in that associate, including any other unsecured receivables, are recognised only to the extent that the Group has incurred a legal or constructive obligation to make payments on behalf of the associate.

Profits or losses on transactions between the Group and an associate are eliminated to the extent of the Group's interest therein. Unrealised losses are 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.

1.5 Significant judgements and sources of estimation uncertainty

The preparation of financial statements in conformity with IFRS requires management, from time to time, to make judgements, estimates and assumptions that affect the application of policies and reported amounts of assets, liabilities, income and expenses. These estimates and associated assumptions are based on experience and various other factors that are believed to be reasonable under the circumstances. Actual results may differ from these estimates. The estimates and underlying assumptions are reviewed on an ongoing basis. Revisions to accounting estimates are recognised in the period in which the estimates are revised and in any future periods affected.

Critical judgements in applying accounting policies

The critical judgements made by management in applying accounting policies, apart from those involving estimations, that have the most significant effect on the amounts recognised in the financial statements, are outlined as follows:

Lease classification

The Group is party to leasing arrangements, both as a lessee and as a lessor. The treatment of leasing transactions in the financial statements is mainly determined by whether the lease is considered to be an operating lease or a finance lease.

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

1 SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

1.5 Significant judgements and sources of estimation uncertainty (continued)

Critical judgements in applying accounting policies (continued)

Lease classification (continued)

In making this assessment, management considers the substance of the lease, as well as the legal form, and makes a judgement about whether substantially all of the risks and rewards of ownership are transferred. Arrangements which do not take the legal form of a lease but that nevertheless convey the right to use an asset are also covered by such assessments.

Revenue recognition

The nature of CSIR's business is varied, in that there are contracts with customers which give rise to single performance obligations, and others which give rise to multiple performance obligations. Judgement is applied in the determination of distinct performance obligations, as well as to when transfer of control of the identified performance obligations is satisfied.

In identifying distinct performance obligations, judgement was applied in assessing whether certain deliverables are separately identifiable from other items to be transferred to the customer in terms of the contract.

Key sources of estimation uncertainty

Impairment of financial assets

As at 31 March 2019, the Group had R25 million (2018: R17million) in allowance for doubtful accounts for trade and other receivables. The allowance for doubtful accounts is based on assumptions about risk of default and expected loss rates. The Group uses judgement in making these assumptions and selecting the inputs to the calculation of the allowance for doubtful accounts, based on the expected credit model (used in IFRS 9).

Impairment testing

Impairment of property, plant and equipment

Property, plant and equipment in use are assessed for impairment when there is a triggering event that provides evidence that an asset may be impaired. To assess whether any impairment exists, estimates of expected future cash flows are used. Actual outcomes could vary significantly from such estimates. Factors such as changes in discount rates, the planned use of buildings, machinery or equipment or closure of facilities and technical obsolescence could lead to shorter useful lives or impairment.

Useful lives of property, plant and equipment

Management assess the appropriateness of the useful lives of property, plant and equipment at the end of each reporting period. The useful lives of motor vehicles, furniture and computer equipment are determined based on the Group's replacement policies for the various assets.

When the estimated useful life of an asset differs from previous estimates, the change is applied prospectively in the determination of the depreciation charge.

Provisions

Provisions are inherently based on assumptions and estimates using the best information available. Additional disclosure of these estimates of provisions are included in note 25.

Estimates of employee benefit liabilities

An updated actuarial valuation is carried out at the end of each financial year for the post-employment liabilities of the Group. Key assumptions used to determine the net assets and liabilities of these obligations and their sensitivities are set out in note 12.

1.6 Property, plant and equipment

Property, plant and equipment are tangible assets which the Group holds for its own use, or for rental to others and which are expected to be used for more than one year.

An item of property, plant and equipment is recognised as an asset when it is probable that future economic benefits associated with the item will flow to the Group, and the cost of the item can be measured reliably.

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

1 SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

1.6 Property, plant and equipment (continued)

Property, plant and equipment is initially measured at cost. Cost includes all of the expenditure which is directly attributable to the acquisition or construction of the asset, including the capitalisation of borrowing costs on qualifying assets and adjustments in respect of hedge accounting, where appropriate.

Expenditure incurred subsequently for major services, additions to or replacements of parts of property, plant and equipment are capitalised if it is probable that future economic benefits associated with the expenditure will flow to the Group and the cost can be measured reliably. Day to day servicing costs are included in profit or loss in the year in which they are incurred.

Major inspection costs which are a condition of continuing use of an item of property, plant and equipment and which meet the recognition criteria are included as a replacement in the cost of the item of property, plant and equipment. Any remaining inspection costs from the previous inspection are derecognised.

Major spare parts and stand by equipment which are expected to be used for more than one year are included in property, plant and equipment.

Property, plant and equipment is subsequently stated at cost less accumulated depreciation and any accumulated impairment losses, except for land which is stated at cost, less any accumulated impairment losses.

Depreciation of an asset commences when the asset is available for use as intended by management. Depreciation is charged to write off the asset's carrying amount over its estimated useful life to its estimated residual value, using a method that best reflects the pattern in which the asset's economic benefits are consumed by the Group. Leased assets are depreciated in a consistent manner over the shorter of their expected useful lives and the lease term. Depreciation is not charged to an asset if its estimated residual value exceeds or is equal to its carrying amount. Depreciation of an asset ceases at the earlier of the date that the asset is classified as held for sale or derecognised.

The useful lives of items of property, plant and equipment have been assessed as follows:

Item	Depreciation method	Average useful life
Buildings	Straight line	90 years
Furniture and fixtures	Straight line	3 to 20 years
Motor vehicles	Straight line	10 years
Office equipment	Straight line	3 to 20 years
IT equipment	Straight line	3 to 5 years
Land	Straight line	Indefinite

The residual value, useful life and depreciation method of each asset are reviewed at the end of each reporting year. If the expectations differ from previous estimates, the change is accounted for prospectively as a change in accounting estimate.

Each part of an item of property, plant and equipment with a cost that is significant in relation to the total cost of the item is depreciated separately.

The depreciation charge for each year is recognised in profit or loss, unless it is included in the carrying amount of another asset.

Impairment tests are performed on property, plant and equipment when there is an indicator that they may be impaired. When the carrying amount of an item of property, plant and equipment is assessed to be higher than the estimated recoverable amount, an impairment loss is recognised immediately in profit or loss to bring the carrying amount in line with the recoverable amount.

An item of property, plant and equipment is derecognised upon disposal or when no future economic benefits are expected from its continued use or disposal. Any gain or loss arising from the derecognition of an item of property, plant and equipment, determined as the difference between the net disposal proceeds, if any, and the carrying amount of the item, is included in profit or loss when the item is derecognised.

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

1 SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

1.7 Financial instruments

Financial instruments held by the Group are classified in accordance with the provisions of IFRS 9 Financial Instruments. Broadly, the applicable classification possibilities, which are adopted by the Group, are as follows:

Financial assets which are debt instruments:

- Amortised cost (This category applies only when the contractual terms of the instrument give rise, on specified dates, to cash flows that are solely payments of principal and interest on principal, and where the instrument is held under a business model whose objective is met by holding the instrument to collect contractual cash flows).

Financial liabilities:

- Amortised cost
  Note 15 Financial instruments and risk management present the financial instruments held by the Group based on their specific classifications.

All regular way purchases or sales of financial assets are recognised and derecognised on a trade date basis. Regular way purchases or sales are purchases or sales of financial assets that require the delivery of assets within the timeframe established by regulation or convention in the marketplace.

The specific accounting policies for the classification, recognition and measurement of each type of financial instrument held by the Group are presented below:

Trade and other receivables

Classification

Trade and other receivables, excluding, when applicable, VAT and prepayments, are classified as financial assets subsequently measured at amortised cost (note 9).

They have been classified in this manner because their contractual terms give rise, on specified dates to cash flows that are solely payments of principal and interest on the principal outstanding. The Group's business model is to collect the contractual cash flows on trade and other receivables.

Recognition and measurement

Trade and other receivables are recognised when the Group becomes a party to the contractual provisions of the receivables. They are measured at initial recognition and at fair value plus transaction costs, if any.

They are subsequently measured at amortised cost.

The amortised cost is the amount recognised on the receivable initially, minus principal repayments, plus cumulative amortisation (interest) using the effective interest method of any difference between the initial amount and the maturity amount, adjusted for any loss allowance.

Impairment

The Group recognises a loss allowance for expected credit losses on trade and other receivables, excluding VAT and prepayments. The amount of expected credit losses is updated at each reporting date.

The Group measures the loss allowance for trade and other receivables at an amount equal to lifetime expected credit losses (lifetime ECL), which represents the expected credit losses that will result from all possible default events over the expected life of the receivable.

Measurement and recognition of expected credit losses

The Group makes use of a provision matrix as a practical expedient to the determination of expected credit losses on trade and other receivables. The provision matrix is based on historic credit loss experience, adjusted for factors that are specific to the debtors, general economic conditions and an assessment of both the current and forecast direction of conditions at the reporting date, including the time value of money, where appropriate.

The customer base is widespread and does not show significantly different loss patterns for different customer segments. The loss allowance is calculated on a collective basis for all trade and other receivables in totality. Details of the provision matrix are presented in note 9.

An impairment gain or loss is recognised in profit or loss with a corresponding adjustment to the carrying amount of trade and other receivables, through the use of a loss allowance account. The impairment loss is included in operating expenses in profit or loss as a movement in credit loss allowance (note 3).

Write-off policy

The Group writes off a receivable when there is information indicating that the counterparty is in

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

1 SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

1.7 Financial instruments (continued)

Trade and other receivables (continued)

Write-off policy (continued)

severe financial difficulty and there is no realistic prospect of recovery, e.g. when the counterparty has been placed under liquidation or has entered into bankruptcy proceedings. Receivables written off may still be subject to enforcement activities under the Group's recovery procedures, taking into account legal advice where appropriate. Any recoveries made are recognised in profit or loss.

Credit risk

Details of credit risk are included in the trade and other receivables note (note 9) and the financial instruments and risk management note (note 15).

Derecognition

Refer to the derecognition section of the accounting policy for the policies and processes related to derecognition.

Trade and other payables

Classification

Trade and other payables (note 10), excluding VAT and amounts received in advance, are classified as financial liabilities subsequently measured at amortised cost.

Recognition and measurement

They are recognised when the Group becomes a party to the contractual provisions, and are measured at initial recognition at fair value plus transaction costs, if any.

Trade and other payables expose the Group to liquidity risk and possibly to interest rate risk. Refer to note 15 for details of risk exposure and management thereof.

Trade and other payables denominated in foreign currencies

When trade payables are denominated in a foreign currency, the carrying amount of the payables are determined in the foreign currency. The carrying amount is then translated to the Rand equivalent using the spot rate at the end of each reporting period. Any resulting foreign exchange gains or losses are recognised in profit or loss in the other operating gains (losses) (note 3).

Details of foreign currency risk exposure and the management thereof are provided in the financial instruments and risk management note (note 15).

Derecognition

Refer to the "derecognition" section of the accounting policy for the policies and processes related to derecognition.

Financial guarantee contracts

A financial guarantee contract is a contract that requires the issuer to make specified payments to reimburse the holder for a loss it incurs because a specified debtor fails to make payments when due in accordance with the terms of a debt instrument.

Financial guarantee contracts issued by the Group are initially measured at their fair values and, if not designated as at fair value through profit and loss, and do not arise from a transfer of a financial asset, are subsequently measured at the higher of:

- The amount of the loss allowance determined in accordance with IFRS 9; and
- The amount initially recognised less, where appropriate, cumulative amount of income recognised in accordance with the revenue recognition policies.

Refer to note 29 for details of financial guarantee contracts.

Cash and cash equivalents

Cash and cash equivalents are stated at carrying amount, which is deemed to be fair value.

Derecognition

Financial assets

The Group derecognises a financial asset only when the contractual rights to the cash flows from the asset expire, or when it transfers the financial asset and substantially all the risks and rewards of ownership of the asset to another party. If the Group neither transfers nor retains substantially all the risks and rewards of ownership and continues to control the

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

1 SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

1.7 Financial instruments (continued)

Derecognition (continued)

Financial assets (continued)

transferred asset, the Group recognises its retained interest in the asset and an associated liability for amounts it may have to pay. If the Group retains substantially all the risks and rewards of ownership of a transferred financial asset, the Group continues to recognise the financial asset and also recognises a collateralised borrowing for the proceeds received.

Financial liabilities

The Group derecognises financial liabilities when, and only when, the Group obligations are discharged, cancelled or they expire. The difference between the carrying amount of the financial liability derecognised and the consideration paid and payable, including any non-cash assets transferred or liabilities assumed, is recognised in profit or loss.

1.8 Tax

Income tax

The CSIR is exempt from South African income tax.

1.9 Leases

A lease is classified as a finance lease if it transfers substantially all the risks and rewards incidental to ownership. A lease is classified as an operating lease if it does not transfer substantially all the risks and rewards incidental to ownership.

Operating leases – lessor

Operating lease income is recognised as an income on a straight-line basis over the lease term.

Initial direct costs incurred in negotiating and arranging operating leases are added to the carrying amount of the leased asset and recognised as an expense over the lease term on the same basis as the lease income.

Income for leases is disclosed under revenue in profit or loss.

Operating leases – lessee

Operating lease payments are recognised as an expense on a straight-line basis over the lease term. The difference between the amounts recognised as an expense and the contractual payments are recognised as an operating lease asset. This liability is not discounted.

Any contingent rents are expensed in the period they are incurred.

1.10 Inventories

Inventories are measured at the lower of cost and net realisable value on the weighted average method.

Net realisable value is the estimated selling price in the ordinary course of business less the estimated costs of completion and the estimated costs necessary to make the sale.

The cost of inventories comprises of all costs of purchase, costs of conversion and other costs incurred in bringing the inventories to their present location and condition.

1.11 Other receivables from contracts with customers

This accounting policy needs to be read in conjuction with the accounting policies for revenue from contracts with customers, contract assets and advances on contracts with customers. The Group presents as an asset the gross amount due from customers for contract work for all contracts in progress for which costs incurred plus recognised profits (less recognised losses) exceed progress billings. These are included in other receivables from contracts with customers under current assets. Progress billings that are invoiced, but not yet paid by customers are included in trade and other receivables.

1.12 Impairment of assets

The Group assesses at each end of the reporting period whether there is any indication that an asset may be impaired. If any such indication exists, the Group estimates the recoverable amount of the asset.

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

1 SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

1.12 Impairment of assets (continued)

Irrespective of whether or not there is any indication of impairment, the Group also:

- Tests intangible assets with an indefinite useful life or intangible assets not yet available for use for impairment annually by comparing its carrying amount with its recoverable amount. This impairment test is performed during the annual period and at the same time every period.
- Tests goodwill acquired in a business combination for impairment annually.

If there is any indication that an asset may be impaired, the recoverable amount is estimated for the individual asset. If it is not possible to estimate the recoverable amount of the individual asset, the recoverable amount of the cash-generating unit to which the asset belongs is determined.

The recoverable amount of an asset or a cash-generating unit is the higher of its fair value less costs to sell and its value in use.

If the recoverable amount of an asset is less than its carrying amount, the carrying amount of the asset is reduced to its recoverable amount. That reduction is an impairment loss.

An impairment loss of assets carried at cost less any accumulated depreciation or amortisation is recognised immediately in profit or loss.

An entity assesses at each reporting date whether there is any indication that an impairment loss recognised in prior periods for assets other than goodwill may no longer exist or may have decreased. If any such indication exists, the recoverable amounts of those assets are estimated.

The increased carrying amount of an asset other than goodwill attributable to a reversal of an impairment loss does not exceed the carrying amount that would have been determined had no impairment loss been recognised for the asset in prior periods.

A reversal of an impairment loss of assets carried at cost less accumulated depreciation or amortisation other than goodwill is recognised immediately in profit or loss. Any reversal of an impairment loss of a revalued asset is treated as a revaluation increase.

1.13 Employee benefits

Short-term employee benefits

The cost of short-term employee benefits, (those payable within 12 months after the service is rendered, such as paid vacation leave and sick leave, bonuses, and non-monetary benefits such as medical care), are recognised in the period in which the service is rendered and are not discounted.

The expected cost of compensated absences is recognised as an expense as the employees render services that increase their entitlement or, in the case of non-accumulating absences, when the absence occurs.

Defined contribution plans

Payments to defined contribution retirement benefit plans are charged as an expense as they fall due.

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.

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

1 SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

1.13 Employee benefits (continued)

Post-retirement benefits other than pensions (continued)

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.

1.14 Provisions and contingencies

Provisions are recognised when:

- The Group has a present obligation as a result of a past event;
- It is probable that an outflow of resources embodying economic benefits will be required to settle the obligation; and
- A reliable estimate can be made of the obligation.

  The amount of a provision is the present value of the expenditure expected to be required to settle the obligation. A constructive obligation to restructure arises only when an entity:
- Has a detailed formal plan for the restructuring, identifying at least:
  - The business or part of a business concerned,
  - The principal locations affected,
  - The location, function, and approximate number of employees who will be compensated for terminating their services,
  - The expenditures that will be undertaken; and
  - When the plan will be implemented.
- Has raised a valid expectation in those affected that it will carry out the restructuring by starting to implement that plan or announcing its main features to those affected by it.

Contingent assets and contingent liabilities are not recognised. Contingencies are disclosed in note 14.

1.15 Government grants

Government grants are recognised when there is reasonable assurance that:

- The Group will comply with the conditions attached to them; and
- The grants will be received.

Government grants are recognised as income over the periods necessary to match them with the related costs that they are intended to compensate.

A government grant that becomes receivable as compensation for expenses or losses already incurred or for the purpose of giving immediate financial support to the entity with no future related costs is recognised as income of the period in which it becomes receivable.

Government grants related to assets, including non-monetary grants at fair value, are presented in the statement of financial position by deducting the grant to arrive at the carrying amount of the asset.

Grants related to income are presented as a credit in the profit or loss (separately).

1.16 Revenue from contracts with customers

The Group derives revenue from contracts with customers for the following:

- Contract income, including CSIR International Convention Centre revenue;
- Operating leases; and
- Royalty income.

The Group measures and accounts for revenue based on the specifications of each individual contract with a customer, excluding any amounts received on behalf of third parties, and based on the contractual obligations either accounts for the revenue at a specific point in time or over time as control of the goods or services are transferred to the customer.

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

1 SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

1.16 Revenue from contracts with customers (continued)

The Group recognises revenue over time if a customer simultaneously receives and consumes all of the benefits provided by the Group. The Group recognises revenue at a point in time if the over time criteria is not met. Revenue is recognised when control is transferred to the customer which is usually when legal title passes to the customer and the business has the right to payment. Refer below for further explanation of the different products and services and when control is transferred to the customer and when the Group has right to payment.

Contract income (including CSIR International Convention Centre revenue)

Contract income comprises the consideration received or receivable on contracts entered into with customers in the ordinary course of the CSIR's activities. Revenue is the shown net of amounts collected on behalf of third parties (e.g. VAT). Revenue is recognised at the amount of the transaction price that is allocated to each performance obligation, determined at an amount that depicts the consideration to which CSIR expects to be entitled in exchange for transferring the goods and services promised to the customer.

Where a contract contains multiple performance obligations, the transaction price is allocated to each performance obligation based on their relative stand-alone selling prices.

Contract income is recognised when the transfer of control of the identified performance obligation(s) has been satisfied. In term contracts, where milestones and invoicing dates are not aligned, revenue is recognised according to the stage of completion. Stage of completion is measured based on costs incurred as a percentage of total estimated costs required to satisfy the performance obligation.

Operating leases

Contract income from operating leases is recognised on a straight-line basis over the lease term.

Royalty income

Royalty income is recognised when the underlying transactions triggering their payment occurs. Royalty income is measured at the rate per customer contract.

1.17 Contract assets and advances on contracts with customers

The accounting policy for contract assests needs to be read in conjuction with the accounting policy for revenue from contract with customers. Contract assets arise on the basis that costs are incurred to satisfy performance obligations, the related payment timing is determined based on each individual contract. These costs include costs to fulfil a contract and includes costs such as direct labour, materials, professional/consulting services and allocation of overhead cost which relate directly to satisfy performance obligations of the contract.

Contract assets are recovered from the customer when the relevant performance obligations are completed and payment can be obtained from the customer. If costs are incurred on a contract without a corresponding payment received it is shown as contract asset at the reporting period.

If the customer has paid in advance for performance obligations to satisfied it is shown as an advance on contract with customers within current liabilities. The Group presents as a liability the gross amount due to customers for contract work for all contracts in progress for which progress billings exceed costs incurred plus recognised profits (less recognised losses).

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

	GROUP		CSIR	
	2019	2018	**2019**	2018
	R'000	R'000	**R'000**	R'000
2 REVENUE				
Revenue from contracts with customers				
Parliamentary Grant	**752 149**	722 373	**752 149**	722 373
Contract income	**1 535 620**	1 771 507	**1 535 620**	1 771 507
Royalty income	**5 422**	4 606	**5 422**	4 606
Other government grants	**210 592**	–	**210 592**	–
	2 503 783	2 498 486	**2 503 783**	2 498 486
The Group disaggregates revenue from customers as follows:				
Parliamentary Grant				
Parliamentary Grant received	**760 092**	729 359	**760 092**	729 359
Less:				
Grant received for projects started before year-end but not completed	**(19 177)**	(11 234)	**(19 177)**	(11 234)
Add:				
Grant received in prior year for projects completed in this year	**11 234**	4 248	**11 234**	4 248
	752 149	722 373	**752 149**	722 373
Contract income				
Local private sector	**188 695**	189 579	**188 695**	189 579
Local public sector	**1 243 234**	1 399 783	**1 243 234**	1 399 783
International sector (including Africa)	**103 691**	182 145	**103 691**	182 145
	1 535 620	1 771 507	**1 535 620**	1 771 507
Royalty income				
Royalty income	**5 422**	4 606	**5 422**	4 606
Other government grants				
Other government grants	**210 592**	–	**210 592**	–
Total revenue from contracts with customers	**2 503 783**	2 498 486	**2 503 783**	2 498 486

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

	GROUP		CSIR	
	2019 R'000	2018 R'000	**2019 R'000**	2018 R'000
2 REVENUE (CONTINUED)				
Parliamentary Grant				
Parliamentary Grant received	**30%**	29%	**30%**	29%
Grant received for projects started before year-end but not completed	**–%**	–%	**–%**	–%
Contract income				
Local private sector	**8%**	8%	**8%**	8%
Local public sector	**49%**	56%	**49%**	56%
International sector (including Africa)	**4%**	7%	**4%**	7%
Other government grants				
Other government grants	**9%**	–%	**9%**	–%
	100%	100%	**100%**	100%

Included in public sector contract income is R78 million (2018: R71 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 R54 million (2018: R48,50 million) and revenue of R35,8 million (2018: R34,30 million) earned by the CSIR International Convention Centre.

Estimates on Parliamentary Grant recognition are based on cost to completion, budgets and percentage of completion.

Other government grants relate to income from contracts with government that impose specified performance conditions on the CSIR.

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

	GROUP		CSIR	
	2019	2018	**2019**	2018
	R'000	R'000	**R'000**	R'000

3 OPERATING PROFIT (LOSS)

Operating (loss) profit for the year is stated after charging (crediting) the following, among others:

Auditors' remuneration – external auditors	**4 853**	5 700	**4 853**	5 700
Fees for services				
Legal costs	**3 511**	5 803	**3 511**	5 803
Patent costs	**4 834**	11 425	**4 834**	11 425
Operating leases				
Equipment	**4 395**	2 652	**4 395**	2 652
Buildings	**3 437**	4 328	**3 437**	4 328
Vehicles	**1 375**	1 204	**1 375**	1 204
Net realised foreign exchange (gain)/loss	**(11 495)**	5 977	**(11 495)**	5 977
Net unrealised foreign exchange gain	**(8 063)**	(519)	**(8 063)**	(519)
Board members' and Executive Management's remuneration	**18 567**	19 896	**18 567**	19 896
Impairments/(reversals of impairments)				
Impairment/(reversal of impairment) on subsidiaries, joint ventures and associates	**4 620**	11 609	**4 954**	14 763
Impairment/(reversal of impairment) on trade receivables	**7 750**	7 905	**7 750**	7 905
Bad debts	**1 722**	1 448	**1 722**	1 448
Loss/(Profit) on disposal and write-off of property, plant and equipment	**57**	(2 514)	**57**	(2 514)
Lost and/or stolen equipment and vehicles				
Losses incurred	**–**	473	**–**	473
	35 563	75 387	**35 897**	78 541

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

	GROUP		CSIR	
	2019	2018	**2019**	2018
	R'000	R'000	**R'000**	R'000

4 FINANCE INCOME

Interest income

Investments in financial assets:

Interest on bank balances and investments	**48 286**	38 955	**47 830**	38 483
Finance income/expense				
Interest on bank balances and investments	**47 955**	38 016	**47 499**	37 544
Interest on trade and other receivables	**331**	939	**331**	939
Finance income	**48 286**	38 955	**47 830**	38 483
Interest paid on liabilities	**–**	1	**–**	1
Finance expense	**–**	1	**–**	1
Total amounts	**48 286**	38 954	**47 830**	38 482

5 INCOME TAX EXPENSE

Major components of the tax expense

Reconciliation of the 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 58 of 1962).

Applicable tax rate	**28%**	28%
Exempt income	**(23%)**	(23%)
Tax loss used	**1%**	1%
Other	**(6%)**	(6%)
	–%	–%

A subsidiary in the Group is in an assessed loss position and no deferred tax asset was raised for the assessed loss due to uncertainty of the recoverability in future periods in respect of the carry forward of unused tax losses. The estimated tax loss available for set off against future taxable income is R6 463 (2018: R6 893).

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

6 PROPERTY, PLANT AND EQUIPMENT

	2019			2018		
	Cost or revaluation R'000	**Accumulated depreciation R'000**	**Carrying value R'000**	Cost or revaluation R'000	Accumulated depreciation R'000	Carrying value R'000
Group						
Land	**125 435**	**–**	**125 435**	125 435	–	125 435
Buildings	**502 059**	**(79 951)**	**422 108**	491 642	(74 492)	417 150
Furniture and fixtures	**15 807**	**(11 449)**	**4 358**	15 624	(10 730)	4 894
Motor vehicles	**8 549**	**(6 410)**	**2 139**	8 080	(6 160)	1 920
Office equipment	**528 030**	**(368 168)**	**159 862**	516 523	(341 579)	174 944
IT equipment	**197 095**	**(152 325)**	**44 770**	196 546	(136 526)	60 020
	1 376 975	**(618 303)**	**758 672**	1 353 850	(569 487)	784 363
CSIR						
Land	**125 435**	**–**	**125 435**	125 435	–	125 435
Buildings	**502 059**	**(79 951)**	**422 108**	491 642	(74 492)	417 150
Furniture and fixtures	**15 807**	**(11 449)**	**4 358**	15 624	(10 730)	4 894
Motor vehicles	**8 549**	**(6 410)**	**2 139**	8 080	(6 160)	1 920
Office equipment	**528 030**	**(368 168)**	**159 862**	516 523	(341 579)	174 944
IT equipment	**197 095**	**(152 325)**	**44 770**	196 546	(136 526)	60 020
	1 376 975	**(618 303)**	**758 672**	1 353 850	(569 487)	784 363

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

6 PROPERTY, PLANT AND EQUIPMENT (CONTINUED)

Reconciliation of property, plant and equipment – Group – 2019

	Opening balance	Additions	Disposals	Depreciation	Total
	R'000	R'000	R'000	R'000	R'000
Land	**125 435**	**–**	**–**	**–**	**125 435**
Buildings	**417 150**	**10 417**	**–**	**(5 459)**	**422 108**
Furniture and fixtures	**4 894**	**559**	**(15)**	**(1 080)**	**4 358**
Motor vehicles	**1 920**	**552**	**–**	**(333)**	**2 139**
Office equipment	**174 944**	**20 220**	**(313)**	**(34 989)**	**159 862**
IT equipment	**60 020**	**8 424**	**(414)**	**(23 260)**	**44 770**
	784 363	**40 172**	**(742)**	**(65 121)**	**758 672**

Reconciliation of property, plant and equipment – Group – 2018

	Opening balance	Additions	Disposals	Depreciation	Total
	R'000	R'000	R'000	R'000	R'000
Land	125 435	–	–	–	**125 435**
Buildings	403 659	18 682	–	(5 191)	**417 150**
Furniture and fixtures	4 866	1 138	(13)	(1 097)	**4 894**
Motor vehicles	2 046	290	–	(416)	**1 920**
Office equipment	164 502	42 792	(168)	(32 182)	**174 944**
IT equipment	62 401	24 477	(652)	(26 206)	**60 020**
	762 909	**87 379**	**(833)**	**(65 092)**	**784 363**

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

6 PROPERTY, PLANT AND EQUIPMENT (CONTINUED)

Reconciliation of property, plant and equipment – CSIR – 2019

	Opening balance	Additions	Disposals	Depreciation	Total
	R'000	R'000	R'000	R'000	R'000
Land	**125 435**	**–**	**–**	**–**	**125 435**
Buildings	**417 150**	**10 417**	**–**	**(5 459)**	**422 108**
Furniture and fixtures	**4 894**	**560**	**(15)**	**(1 081)**	**4 358**
Motor vehicles	**1 920**	**552**	**–**	**(333)**	**2 139**
Office equipment	**174 944**	**20 220**	**(313)**	**(34 989)**	**159 862**
IT equipment	**60 020**	**8 423**	**(414)**	**(23 259)**	**44 770**
	784 363	**40 172**	**(742)**	**(65 121)**	**758 672**

Reconciliation of property, plant and equipment – CSIR – 2018

	Opening balance	Additions	Disposals	Depreciation	Total
	R'000	R'000	R'000	R'000	R'000
Land	125 435	–	–	–	**125 435**
Buildings	403 658	18 682	–	(5 190)	**417 150**
Furniture and fixtures	4 866	1 138	(13)	(1 097)	**4 894**
Motor vehicles	2 046	290	–	(416)	**1 920**
Office equipment	164 502	42 792	(168)	(32 182)	**174 944**
IT equipment	62 401	24 477	(652)	(26 206)	**60 020**
	762 908	**87 379**	**(833)**	**(65 091)**	**784 363**

Details of properties

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 R4,7 million (2018: R5,7 million) decrease in the depreciation amount for the current financial year.

During the current financial year, assets to the value of R34,1 million (2018: R20,7 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 R728,6 million (2018: R701,2 million).

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

	GROUP		CSIR	
	2019 R'000	2018 R'000	**2019 R'000**	2018 R'000

7 INTEREST IN JOINT VENTURES AND ASSOCIATES

Joint operations

The following joint operations are material to the Group:

Cost of investments	**25 254**	23 188	**26 325**	24 258
Loans to joint ventures and associates	**18 116**	27 937	**18 116**	27 937
Share of post-acquisition losses of joint ventures	**(14 993)**	(23 339)	**–**	–
Share of post-acquisition losses of associates	**(5 455)**	(5 036)	**–**	–
Subtotal	**22 922**	22 750	**44 441**	52 195
Impairment of joint ventures and associates	**(17 839)**	(13 645)	**(39 358)**	(43 090)
	5 083	9 105	**5 083**	9 105

The loans to joint ventures and associates are interest free, unsecured and have no fixed terms of repayment. In essence, they form part of the Group's net investment in joint ventures and associates.

On 11 April 2018, liquidation of the Group's joint venture with Ellipsoid (Pty) Ltd, was completed. CSIR had 50% ownership interest in the joint venture. A liquidation dividend of R1,15 million was received. The loss on liquidation of R0,43 million was recognised in other expenses.

Joint ventures

The following table lists all the joint ventures in the Group:

Group

Name of company	Place of incorporation	Principal activity	Financial year-end	Portion of ownership interest	Portion of voting power held	Carrying amount **2019 R'000**	Carrying amount 2018 R'000
Joint ventures							
Sera (Pty) Ltd – South Africa	South Africa	Commercialisation and licensing of patents	31 March	50%	50%	**3 123**	3 023
Ellipsoid Technology (Pty) Ltd	South Africa	Commercialisation of encapsulation technology	31 March	50%	50%	**–**	1 576
Associates							
Persomics AB	Sweden	Commercialisation of novel printing technology		38,02%	38,02%	**19 799**	18 151
						22 922	22 750

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

7 INTEREST IN JOINT VENTURES AND ASSOCIATES (CONTINUED)

The following are details of the significant joint ventures' and associates' assets, liabilities, income and expenses:

	JOINT VENTURES GROUP		ASSOCIATES GROUP	
	2019 R'000	2018 R'000	**2019 R'000**	2018 R'000
Current assets	**4 638**	7 582	**218**	1 793
Non-current assets	**33 665**	33 665	**22 901**	6 833
Current liabilities	**33 693**	53 329	**840**	1 310
Non-current liabilities	**36 232**	36 232	**6 521**	6 114
Income	**225**	378	**–**	339
Expenses	**24**	332	**1 149**	10 955

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

	CSIR	
	2019	2018
	R'000	R'000

8 INTERESTS IN SUBSIDIARIES, INCLUDING CONSOLIDATED STRUCTURED ENTITIES

Shares at cost less impairment losses	**4 650**	4 650
Indebtedness		
– by subsidiaries	**7 976**	8 023
– impairment of loans	**(7 976)**	(7 962)
	4 650	4 711

Indebtedness

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.

The following table lists the entities that are controlled directly by the CSIR, and the carrying amounts of the investments in the CSIR's separate financial statements.

CSIR

Name of company	Held by	% voting power 2019	% voting power 2018	% holding 2019	% holding 2018	Net investment 2019	Net investment 2018
Technology Finance Corporation SOC Ltd	CSIR	**100%**	100%	**100%**	100%	**4 650**	4 650
Technovent SOC Ltd		**100%**	100%	**100%**	100%	**–**	61
						4 650	4 711

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

	GROUP		CSIR	
	2019	2018	**2019**	2018
	R'000	R'000	**R'000**	R'000
9 TRADE AND OTHER RECEIVABLES				
Financial instruments:				
Trade receivables	**178 407**	200 712	**178 399**	200 699
Accrued income	**12**	39	**–**	–
Loss allowance	**(25 006)**	(17 252)	**(25 006)**	(17 252)
Trade receivables at amortised cost	**153 413**	183 499	**153 393**	183 447
Other receivables	**10 192**	6 761	**10 192**	6 761
Non-financial instruments:				
VAT	**–**	33	**–**	–
Prepayments	**32 395**	34 376	**32 395**	34 376
Total trade and other receivables	**196 000**	224 669	**195 980**	224 584
Split between non-current and current portions				
Non-current assets	**292**	2 293	**292**	2 293
Current assets	**195 708**	222 376	**195 688**	222 291
	196 000	224 669	**195 980**	224 584

Trade receivables are shown as the net of impairment losses. Refer to note 15 for more details on trade receivables. Included in other receivables is an amount of R0,87 million (2018: R1,17 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. During the current year the repayment terms were renegotiated, the outstanding balance is now repayable by 29 September 2020. Also included in other receivables, is an amount of R1,72 million (2018: R4,85 million) for the sale of Erf 1281 Summerstrand. The CSIR and Nelson Mandela Metropolitan University (NMMU) entered into an agreement to transfer Erf 1281 Summerstrand to NMMU in the 2016/17 financial year.

10 TRADE AND OTHER PAYABLES				
Financial instruments:				
Trade payables	**295 641**	303 401	**295 651**	303 404
Salary related payables	**49 572**	53 087	**49 572**	53 087
Non-financial instruments:				
VAT	**39 763**	21 010	**39 763**	21 010
	384 976	377 498	**384 986**	377 501

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	GROUP		CSIR	
	2019	2018	**2019**	2018
	R'000	R'000	**R'000**	R'000

11 OPERATING LEASE COMMITMENTS

Authorised capital expenditure

Financial commitments under non-cancellable operating leases will result in the following payments falling due:

Minimum lease payments due within one year				
Land and buildings	**3 144**	3 197	**3 144**	3 197
Vehicles	**1 012**	1 363	**1 012**	1 363
	4 156	4 560	**4 156**	4 560
Minimum lease payments due within 2 to 5 years				
Land and buildings	**12 574**	11 871	**12 574**	11 871
Vehicles	**1 038**	1 939	**1 038**	1 939
	13 612	13 810	**13 612**	13 810
Minimum lease payments due in more than 5 years				
Land and buildings	**8 121**	10 635	**8 121**	10 635

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.

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FOR THE YEAR ENDED **31 MARCH 2019**

12 RETIREMENT BENEFITS OF EMPLOYEES

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 R191,4 million (2018: R190,2 million) were expensed during the year.

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 (2018: one employee) who is a member of the AIPF as at 31 March 2019. The fund is controlled by the state, which has assumed responsibility for the unfunded portion of this fund.

Employee contributions of R13 855 (2018: R13 045) were expensed during the year.

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 (2018: 18 continuation members) was recalculated by the actuaries as at 31 March 2019 and will be funded through cash and cash equivalents. These cash and cash equivalents have not been set aside specifically for this benefit.

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:

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FOR THE YEAR ENDED **31 MARCH 2019**

	GROUP		CSIR	
	2019	2018	**2019**	2018
	R'000	R'000	**R'000**	R'000

12 RETIREMENT BENEFITS OF EMPLOYEES (CONTINUED)

Carrying value

Present value of the defined benefit obligation-wholly unfunded	**(10 906)**	(10 963)	**(10 906)**	(10 963)

Amounts recognised in the statement of profit or loss and other comprehensive income in respect of the scheme are as follows:

Net expense recognised

Interest cost – recognised in profit or loss	**877**	937	**877**	937
Actuarial gain – recognised in other comprehensive income	**(934)**	(738)	**(934)**	(738)
	(57)	199	**(57)**	199

Movements for the year

Opening balance	**10 963**	10 764	**10 963**	10 764
Net expense recognised in profit or loss	**(57)**	199	**(57)**	199
Net liability at the end of the year	**10 906**	10 963	**10 906**	10 963

Key assumptions used

Principal actuarial assumptions at the reporting date				
Discount rates used	**8%**	8%	**8%**	8%
Expected rate of return on assets	**5,8%**	6,1%	**5,8%**	6,1%

The above results are sensitive to changes in the assumed future rate of medical inflation.

Defined contribution plan

The effect of a one percent increase in the assumed future rate of medical inflation would have the following effects:

The total Group contribution to such schemes	**694**	637	**694**	637

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	**(526)**	(582)	**(526)**	(582)

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):	**2019**	2018	2017	2016	2015
Present value of the defined benefit obligation	**10 906**	10 963	10 764	10 695	10 614

The average term (undiscounted) of the defined benefit obligation is 8.2 years (2018: 8.7 years) and the average duration (discounted) of the defined benefit obligation is 5.7 years (2018: 6.1 years).

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13 BOARD MEMBERS, DIRECTORS AND EXECUTIVE MANAGEMENT'S REMUNERATION

	2019			
	Basic salary R'000	Accrued leave* R'000	Directors' fees R'000	Total R'000
Board members and Executive Directors				
Dr TH Dlamini	4 675	–	–	**4 675**
Non-executive Board members				
Adv G Badela	–	–	94	**94**
Ms P Baleni	–	–	–	**–**
Dr AR Childs	–	–	35	**35**
Dr PH Goyns	–	–	176	**176**
Dr A Llobell	–	–	47	**47**
Prof T Majozi	–	–	475	**475**
Dr R Masango	–	–	187	**187**
Ms M Maseko	–	–	35	**35**
Mr S Masie	–	–	35	**35**
Ms T Mokhabuki	–	–	35	**35**
Dr V Mthethwa	–	–	47	**47**
Mr J Netshitenzhe	–	–	132	**132**
Ms A Noah	–	–	94	**94**
Dr C Render	–	–	23	**23**
Mr CE Shariff	–	–	47	**47**
Executive Management				
Ms SM Bhengu	2 794	–	–	**2 794**
Dr RK Chikwamba	2 840	–	–	**2 840**
Dr M Motuku	2 413	87	–	**2 500**
Ms ZL Ngwepe	2 398	–	–	**2 398**
Ms K Njobe (from 1 March 2019)	212	–	–	**212**
Adv E Kennedy (from 1 August 2018)	1 686	–	–	**1 686**
	17 018	**87**	**1 462**	**18 567**

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13 BOARD MEMBERS, DIRECTORS AND EXECUTIVE MANAGEMENT'S REMUNERATION

2018

	Basic salary	Bonuses and performance related payments	Accrued leave*	Directors' fees	Total
	R'000	R'000	R'000	R'000	R'000
Board members and Executive Directors					
Dr TH Dlamini	4 432	–	–	–	**4 432**
Non-executive Board members					
Adv G Badela	–	–	–	118	**118**
Ms P Baleni	–	–	–	–	**–**
Dr PH Goyns	–	–	–	188	**188**
Dr A Llobell	–	–	–	77	**77**
Prof. T Majozi	–	–	–	237	**237**
Dr R Masango	–	–	–	111	**111**
Ms M Maseko	–	–	–	89	**89**
Mr J Netshitenzhe	–	–	–	87	**87**
Ms A Noah	–	–	–	115	**115**
Prof. M Phakeng	–	–	–	63	**63**
Executive Management					
Ms SM Bhengu	1 588	–	–	–	**1 588**
Dr RK Chikwamba	2 693	47	–	–	**2 740**
Mr JPL Cloete	2 075	45	206	–	**2 326**
Dr M Motuku	2 966	57	–	–	**3 023**
Ms ZL Ngwepe	879	–	–	–	**879**
Mr CR Sturdy	1 190	55	51	–	**1 296**
Ms A Van Tonder (acting CFO from September 2017 to December 2017	414	–	–	–	**414**
Mr RM Zondo	2 021	50	42	–	**2 113**
	18 258	**254**	**299**	**1 085**	**19 896**

* Accrued leave paid out at end of contract.

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

14 CONTINGENCIES

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. Refer to note 29 for financial guarantees issued by the CSIR.

15 FINANCIAL INSTRUMENTS AND RISK MANAGEMENT

Financial risk management

Overview

The Group is exposed to the following risks from its use of financial instruments:

- Credit risk;
- Liquidity risk; and
- Market risk (currency risk, interest rate risk and price 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 2019 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 consolidated annual financial statements

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15 FINANCIAL INSTRUMENTS AND RISK MANAGEMENT (CONTINUED)

15.1 Market risk

Market risk is the risk that changes in market prices, such as foreign exchange rates and interest rates which 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 2019	ZAR R'000	EURO R'000	USD R'000	GBP R'000	Other R'000	Total R'000
Trade receivables	137 170	3 518	9 807	2 239	679	**153 413**
Bank accounts	93 986	1 030	26 299	5 964	733	**128 012**
Trade and other payables	(383 199)	(413)	(938)	(419)	–	**(384 969)**
Gross statement of financial position exposure	(152 043)	4 135	35 168	7 784	1 412	**(103 544)**
Net exposure	**(152 043)**	**4 135**	**35 168**	**7 784**	**1 412**	(103 544)

31 March 2018	ZAR R'000	EURO R'000	USD R'000	GBP R'000	Other R'000	Total R'000
Trade receivables	161 843	1 507	15 917	3 039	1 155	**183 461**
Bank accounts	55 648	6 439	27 375	6 902	6 478	**102 842**
Trade and other payables	(373 437)	(3 392)	(564)	(109)	–	**(377 502)**
Gross statement of financial position exposure	161 843	161 843	161 843	161 843	161 843	**(91 199)**
Net exposure	**(155 946)**	**4 554**	**42 728**	**9 832**	**7 633**	(91 199)

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	GROUP	
	2019	2018

15 FINANCIAL INSTRUMENTS AND RISK MANAGEMENT (CONTINUED)

15.1 Market risk (continued)

Foreign currency risk (continued)

The following closing exchange rates were applied at reporting date:

	R	R
Rand per unit of foreign currency:		
USD	**14,213**	11,825
Euro	**15,919**	14,573
GBP	**18,438**	16,571

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 2018.

	R'000	R'000
Euro	**(141)**	(455)
USD	**(3 517)**	(4 273)
GBP	**(778)**	(983)
Other	**(141)**	(763)

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	**1 072 842**	887 503

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 consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

	GROUP	
	2019	2018
	R'000	R'000

15 FINANCIAL INSTRUMENTS AND RISK MANAGEMENT (CONTINUED)

15.1 Market risk (continued)

Interest rate risk (continued)

Variable rate instruments: Carrying amount

Financial assets: Call deposits	**40 500**	105 000
Financial assets: Bank balances	**128 012**	102 842
	168 512	207 842

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 2018.

Variable rate instruments	**1 685**	2 078

A decrease of 100 basis points would have had the equal but opposite effect to the amounts shown above.

15.2 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 29 for details on bank guarantees issued with respect to facilities.

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FOR THE YEAR ENDED **31 MARCH 2019**

	GROUP	
	2019	2018
	R'000	R'000

15 FINANCIAL INSTRUMENTS AND RISK MANAGEMENT (CONTINUED)

15.2 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	**1 072 842**	887 503
Call deposits	**40 500**	105 000
Bank balances	**128 012**	102 842
Cash on hand and cash deposits	**114**	5 264
Trade and other receivables	**196 000**	224 670
Contracts in progress less provision for losses	**116 470**	112 217
	1 553 938	1 437 496

The maximum exposure to credit risk for trade receivables at the reporting date by type of customer was:

Local public sector	**84 588**	110 338
Local private sector	**53 278**	51 180
International sector	**15 215**	21 943
	153 081	183 461

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:

	2019		2018	
	Gross	**Impairment**	Gross	Impairment
	R'000	**R'000**	R'000	R'000
The aging of the Group's trade receivables at the reporting date was:				
Not past due	**95 876**	**–**	115 473	78
Past due 0 – 30 days	**31 977**	**111**	33 781	195
Past due 31 – 120 days	**12 782**	**1 280**	20 984	2 115
Past due more than 120 days	**37 418**	**23 623**	30 475	14 864
	178 053	**25 014**	200 713	17 252

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15 FINANCIAL INSTRUMENTS AND RISK MANAGEMENT (CONTINUED)

15.2 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	
	2019	2018
	R'000	R'000
Balance at 1 April	**17 252**	9 347
Movement for the year		
Recoveries	**(4 601)**	(2 651)
Utilisation	**12 217**	(1 987)
New impairment allowances	**138**	12 543
Balance at 31 March	**25 006**	17 252

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.

15.3 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:

	2019			2018		
	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
Non-derivative financial liabilities						
Trade and other payables	**(384 975)**	**(384 975)**	**–**	(377 502)	(377 502)	–

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15 FINANCIAL INSTRUMENTS AND RISK MANAGEMENT (CONTINUED)

15.4 Fair values

As at 31 March 2019, 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.

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	GROUP		CSIR	
	2019	2018	**2019**	2018
	R'000	R'000	**R'000**	R'000
16 RECONCILIATION OF OPERATING PROFIT TO CASH GENERATED FROM OPERATING ACTIVITIES				
Profit (loss) before taxation	**7 259**	(14 080)	**6 832**	(14 544)
Adjustments for:				
Depreciation and amortisation	**65 121**	65 092	**65 121**	65 091
(Profit)/losses on disposal and write-off of property, plant and equipment	**57**	(2 514)	**57**	(2 514)
Gains on foreign exchange	**(8 063)**	(519)	**(8 063)**	(519)
Bad debt written off	**1 665**	1 502	**1 665**	1 502
Interest income	**(48 286)**	(38 954)	**(47 830)**	(38 482)
Finance expense	**–**	1	**–**	1
Impairments (reversal of impairments)	**12 370**	19 514	**12 708**	22 668
Movements in retirement benefit assets and liabilities	**877**	**937**	**877**	**937**
Movements in provisions	**11 187**	–	**11 187**	–
Leave accrual	**5 119**	4 188	**5 119**	4 188
Share of losses from joint venture and associate	**312**	3 110	**–**	–
Changes in working capital				
Inventories	**51**	(12)	**51**	(12)
Trade and other receivables	**15 991**	42 521	**15 782**	49 459
Contract assets	**(6 918)**	–	**(6 918)**	–
Other receivables from contracts with customers	**1 117**	(29 378)	**1 117**	(29 961)
Trade and other payables	**4 073**	(73 278)	**4 071**	(70 017)
Advances on contracts with customers	**68 595**	59 315	**68 595**	59 315
	130 527	37 444	**130 371**	47 111

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	GROUP		CSIR	
	2019	2018	**2019**	2018
	R'000	R'000	**R'000**	R'000

17 CASH AND CASH EQUIVALENTS

Cash and cash equivalents consist of:				
Cash on hand	**114**	5 264	**114**	5 264
Bank balances	**128 012**	102 842	**127 410**	102 331
Short-term deposits	**1 113 342**	992 503	**1 106 500**	986 000
	1 241 468	1 100 609	**1 234 024**	1 093 595

Cash on hand includes petty cash of R0,1 million (2018: R0,1 million) and cash deposits made by the CSIR of R5,7 million (2018: R5,1 million).

18 RELATED PARTIES

Relationships

The CSIR is a schedule 3B National Government Business Enterprise in terms of the Public Finance Management Act, 1999 (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.

In addition, the CSIR has a related party relationship with its subsidiaries 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.

Transactions with related parties

Constitutional institutions				
Services rendered	**1 955**	2 712	**1 955**	2 712
Services received	**–**	116	**–**	116
Amount due (to) from	**1 700**	(20)	**1 700**	(20)
Major public entities				
Services rendered	**277 863**	323 815	**277 863**	323 815
Services received	**92 958**	30 922	**92 958**	30 922
Amount due from	**30 495**	36 974	**30 495**	36 974

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	GROUP		CSIR	
	2019	2018	**2019**	2018
	R'000	R'000	**R'000**	R'000
18 RELATED PARTIES (CONTINUED)				
Transactions with related parties (continued)				
National public entities				
Services rendered	**134 296**	119 581	**134 296**	119 581
Services received	**24 819**	16 556	**24 819**	16 556
Amount due from	**21 904**	19 070	**21 904**	19 070
National government business enterprises				
Services rendered	**3 226**	4 701	**3 226**	4 701
Services received	**423**	629	**423**	629
Amount due from	**271**	965	**271**	965
Provincial public entities				
Services rendered	**7 439**	4 079	**7 439**	4 079
Amount due from	**1 154**	7 563	**1 154**	7 563
Provincial government business enterprises				
Services received	**410**	8	**410**	8
Government departments				
Services rendered	**1 743 005**	1 605 648	**1 743 005**	1 605 648
Services received	**6 229**	7 428	**6 229**	7 428
Amount due from	**26 342**	25 879	**26 342**	25 879
Subsidiaries				
Amount due (to)/from	**–**	–	**(13)**	(13)
Joint ventures and associates				
Services rendered	**–**	356	**–**	327
Amount due from	**–**	12	**–**	–

The above is a summary of transactions with related parties during the year and balances due at year-end.

Transactions with key management

Total remuneration of key management is included in employees' remuneration (refer to note 13 for Executive Management's remuneration).

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

	GROUP		CSIR	
	2019	2018	**2019**	2018
	R'000	R'000	**R'000**	R'000

19 IRREGULAR AND FRUITLESS AND WASTEFUL EXPENDITURE

Irregular expenditure				
Opening balance	**7 420**	920	**7 420**	920
Irregular expenditure relating to the 2018/19 financial year:				
– Non-compliance with PPPFA and/or PFMA*	**5 704**	2 980	**5 704**	2 980
Irregular expenditure relating to prior financial years:				
– Non-compliance with PPPFA and/or PFMA*	**620**	4 440	**620**	4 440
Amounts condoned	**(5 839)**	(920)	**(5 839)**	(920)
	7 905	7 420	**7 905**	7 420

Included in the balance of R7,9 million above is a total of R6,6 million's worth of transgressions that the CSIR Board has requested National Treasury to condone. At the time of preparation of these financial statements the CSIR was waiting for confirmation of condonation.

* No loss was incurred by the CSIR.

Corrective actions taken by the CSIR:

- There were nine transgressions that constituted the total amount of irregular expenditure reported in the 2017/18 annual financial statements. Of the nine offences, seven occurred in years prior and were detected during the 2017/18 financial year.
- Disciplinary action has been taken against employees that committed or were involved in two offences. Warnings (verbal and/or written) were given to employees involved on other five transgressions, while for two instances, the employees had already left the employ of the CSIR and no action was taken because no loss was incurred by the public entity.
- During the 2018/19 financial year, training on procurement processes and special emphasis on compliance with the PPPFA and National Treasury Instruction Notes relating to procurement of goods and services was provided to staff.
- During the 2018/19 financial year, 10 transgressions that constitute irregular expenditure were detected. Procurement training and awareness have been provided to the employees relating to eight of the offences, while no action was taken for the two instances because the employees had left the employ of the CSIR and no loss was suffered by the public entity.

Amount incurred in current year	**95**	79	**95**	79

Fruitless and wasteful expenditure of R72 960 (due to settlement of an employee's liability for recruitment fee towards a recruitment agent in lieu of retaining the employee as a key resource to the organisation) and R22 127 (unnecessary service rendered to the CSIR due to lack of consultation of line manager by an employee) was incurred in the 2018/19 financial year.

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.

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

20 CHANGES IN ACCOUNTING POLICY

The consolidated financial statements have been prepared in accordance with IFRS on a basis consistent with the prior year, except for the adoption of the following new or revised standards.

In the 2018/19 financial year, the Group implemented the following new standards, including any consequential amendments to other standards, with a date of initial application of 1 January 2018:

- IFRS 9 Financial Instruments; and
- IFRS 15 Revenue from Contracts with Customers.

None of the new standards, revised standards, amended standards or interpretations have a material impact on the Group's overall results and financial position. The nature and effects of the changes most relevant to the Group's financial statements are given below.

Application of IFRS 9 Financial Instruments

In the current year, the Group has applied IFRS 9 Financial Instruments (as revised in July 2014) and the related consequential amendments to other IFRSs. The IFRS 9 replaces the International Accounting Standard 39: Financial Instruments and introduces new requirements for the classification and measurement of financial assets and financial liabilities; impairment for financial assets; and general hedge accounting. Details of these new requirements, as well as their impact on the Group's financial statements are described below.

The Group has applied IFRS 9 in accordance with the transition provisions set out in IFRS 9.

Impairment of financial assets

On 1 April 2018, the Group changed the methodology of assessing impairment of its financial assets from the incurred loss model (used in IAS 39) to the expected credit loss model (used in IFRS 9). In accordance with the transitional provisions of IFRS 9, the Group has not restated prior periods, but it has reassessed the impairment allowances under the new approach as of 1 April 2018.

Transition approach

The Group has applied the exemption from full retrospective application for the classification and measurement requirements, including impairment, meaning that the comparative 2017/18 results have not been restated. Accordingly, the information presented for 2017/18 does not generally reflect the requirements of IFRS 9 but rather those of IAS 39.

Application of IFRS 15 Revenue from contracts with customers

The Group has implemented IFRS 15 'Revenue from Contracts with Customers', effective 1 April 2018. The new standard replaces IAS 18 'Revenue' and IAS 11 'Construction Contracts'. The IFRS 15 establishes a comprehensive framework for determining how much and when revenue is recognised, and also contains new requirements related to presentation. The core principle in the framework is that revenue should be recognised depending on the transfer of promised goods or services to the customer for an amount that reflects the consideration which should be received in exchange for those goods or services. The objective of the standard is to provide a five-step approach to revenue recognition that includes identifying contracts with customers, identifying performance obligations, determining transaction prices, allocating transaction prices to performance obligations, and recognising revenue when or as performance obligations are satisfied. Judgement needs to be applied, including making estimates and assumptions, for multiple-element contracts in identifying performance obligations, in constraining estimates of variable consideration and in allocating the transaction price to each performance obligation and to lease components (if any).

In the comparative period, revenue was measured at the fair value of the consideration received or receivable. Revenue from the sale of goods was recognised when the significant risks and rewards of ownership had been transferred to the customer; recovery of the consideration was probable; the associated costs and possible return of goods could be estimated reliably; there was no continuing management involvement with the goods; and the amount of revenue could be measured reliably. Revenue from rendering of services was recognised in proportion to the stage of completion of the work performed at the reporting date, which was determined by reference to work performed as at the reporting date.

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

20 CHANGES IN ACCOUNTING POLICY (CONTINUED)

The new standard provides additional requirements and guidance that are relevant to the Group, notably on the following area:

- Contract income: There is no material impact from these changes as revenue continues to be recognised over the contract term.

Transition approach and use of practical expedients

The Group has applied the exemption from full retrospective application for the adoption of IFRS 15. However, there are no adjustments required to opening retained earnings owing to there being no changes upon adoption of IFRS 15.

21 NEW STANDARDS AND INTERPRETATIONS

21.1 Standards and interpretations not yet effective

The Group has decided against the early adoption of the following standards and interpretations, which have been published and are mandatory for the Group's accounting periods beginning on or after 1 April 2019 or later periods:

Standard/interpretation:	Effective date: years beginning on or after	Expected impact:
• Plan Amendment, Curtailment or Settlement – Amendments to IAS 19	1 January 2019	Unlikely there will be a material impact
• Prepayment Features with Negative Compensation – Amendment to IFRS 9	1 January 2019	Unlikely there will be a material impact
• Amendments to IAS 12 Income Taxes: Annual Improvements to IFRS 2015 – 2017 cycle	1 January 2019	Unlikely there will be a material impact
• Uncertainty over Income Tax Treatments	1 January 2019	Unlikely there will be a material impact
• IFRS 16 Leases	1 January 2019	Unable to reliably estimate the impact because we are currently unable to determine the appropriate discount rate

	GROUP		CSIR	
	2019	2018	**2019**	2018
	R'000	R'000	**R'000**	R'000
22 INVENTORIES				
Finished goods	**1 384**	1 435	**1 384**	1 435
23 OTHER RECEIVABLES FROM CONTRACTS WITH CUSTOMERS				
Contracts in progress at the end of the reporting period				
Other receivables from contracts with customers	**116 470**	112 217	**116 470**	112 217

Other receivables from contracts with customers arise as a result of the time lag between customer billing and revenue recognition. Contract assets (refer to note 24) constitute capitalised costs on point in time contracts with customers. Advances received in excess of work completed are included in advances on contracts with customers under current liabilities.

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

	GROUP		CSIR	
	2019 R'000	2018 R'000	**2019 R'000**	2018 R'000

24 CONTRACT ASSETS

Contract assets	**6 918**	–	**6 918**	–

Exposure to credit risk

Contract assets inherently expose the Group to credit risk, being the risk that the Group will incur financial loss if customers fail to make payments as they fall due.

25 PROVISIONS

Reconciliation of provisions – Group – 2019

	Opening balance	Additions	Total
Restructuring	–	11 187	11 187

Reconciliation of provisions – Company – 2019

	Opening balance	Additions	Total
Restructuring	–	11 187	11 187

The restructuring provision relates to redundancy costs incurred as a result of the reorganisation that took place at the CSIR. On 13 April 2018 the Board approved a targeted intervention that focused on the aspects of the CSIR's operations that were not sustainable. As at Sunday, 31 March 2019, approximately 4% of the staff had been retrenched.

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

26 ADVANCES ON CONTRACTS WITH CUSTOMERS

Advances from customers constitute income received from customers in advance.

27 OTHER COMPREHENSIVE INCOME

Components of other comprehensive income – Group – 2019	Gross	Tax	Net
Items that will not be reclassified to profit (loss)			
Remeasurements on net defined benefit liability/asset			
Remeasurement of post-retirement medical	934	–	934

Components of other comprehensive income – Group – 2018	Gross	Tax	Net
Items that will not be reclassified to profit (loss)			
Remeasurements on net defined benefit liability/asset			
Remeasurement of post-retirement medical	738	–	738

Components of other comprehensive income – CSIR – 2019	Gross	Tax	Net
Items that will not be reclassified to profit (loss)			
Remeasurements on net defined benefit liability/asset			
Remeasurement of post-retirement medical	934	–	934

Components of other comprehensive income – CSIR – 2018	Gross	Tax	Net
Items that will not be reclassified to profit (loss)			
Remeasurements on net defined benefit liability/asset			
Remeasurement of post-retirement medical	738	–	738

Notes to the consolidated annual financial statements

FOR THE YEAR ENDED **31 MARCH 2019**

	GROUP		CSIR	
	2019	2018	**2019**	2018
	R'000	R'000	**R'000**	R'000
28 CAPITAL COMMITMENTS				
Property, plant and equipment	**21 140**	23 882	**21 140**	23 882
29 FINANCIAL GUARANTEES				
Local and foreign payments and performance guarantees issued as at 31 March	**32 889**	26 035	**32 889**	26 035

KNOWLEDGE DISSEMINATION

536
PUBLICATION EQUIVALENTS

319
JOURNAL ARTICLES

22
PATENTS

149 Journal articles
169 Books and book chapters
174 International patents granted

JOURNAL ARTICLES

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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	6473444	Japan
A method for identification of anti-HIV human miRNA mimics and miRNA inhibitors and anti-HIV pharmaceutical compounds	3178943	European Patent Office
A method for identification of anti-HIV human miRNA mimics and miRNA inhibitors and anti-HIV pharmaceutical compounds	10,214,779	United States of America
A method of calibrating a camera and a system therefor	228659	Israel
A method of calibrating a camera and a system therefor	10-1857472	South Korea
A method of calibrating a camera and a system therefor	CN 105308627	China
Accelerated pavement testing	2017222407	Australia
Apparatus, methods and systems for measuring and detecting electrical discharge	9,910,083	United States of America
Apparatus, methods and systems for measuring and detecting electrical discharge	CN 105283741	China
Apparatus, methods and systems for measuring and detecting electrical discharge	2661976	Russian Federation
Apparatus, methods and systems for measuring and detecting electrical discharge	2972148	European Patent Office
Apparatus, methods and systems for measuring and detecting electrical discharge	6393285	Japan
Controllable laser amplifier apparatus and method	10,079,469	United States of America
Laser apparatus and method having plural excitation sources with associated beam splitting arrangements for adaptive control	10,084,279	United States of America
Management and treatment of benign prostatic hyperplasia	2214688	European Patent Office
Method and device for detection of whole organism bacteria	2628677	Spain
miRNA inhibitors of pathogenic infection	3084008	European Patent Office
Molten salt electrolysis apparatus and process	3033443	European Patent Office
Pathogenic control of apoptosis	10,143,691	United States of America
Process for the production of crystalline titanium powder	CN 104736273	China
Production of a cathode material	6316812	Japan
Site-specific nuclease single-cell assay targeting gene regulatory elements to silence gene expression	10,167,466	United States of America

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ABBREVIATIONS

2D	Two-dimensional
3D	Three-dimensional
3G	Third Generation
4IR	Fourth industrial revolution
5G	5th Generation
AfCAP	Africa Community Access Partnership
AiBST	African Institute of Biomedical Science and Technology
AIPF	Associated Institutions Pension Fund
AISI	Aerospace Industry Support Initiative
ARV	Antiretroviral
AsCAP	Asia Community Access Partnership
B-BBEE	Broad-based Black Economic Empowerment
BIDC	Biomanufacturing Industry Development Centre
BIDF	Biorefinery Industry Development Facility
BRICS	Brazil, Russia, India, China and South Africa
CCMA	Commission for Conciliation, Mediation and Arbitration
CHPC	Centre for High Performance Computing
COD	Chemical Oxygen Demand
CoJ	City of Johannesburg
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DIRISA	Data Intensive Research Initiative of South Africa
DST	Department of Science and Technology
ECL	Expected credit losses
EDF	Électricité de France
EPO	European Patent Office
FCTR	Foreign currency translation reserve
GBP	Great British Pound
GDP	Gross domestic product
GEOSS	Global Earth Observation System of Systems
GPRS	General Packet Radio Service
HCD	Human Capital Development
HIV	Human Immunodeficiency Virus
IASB	International Accounting Standards Board
ICASA	Independent Communications Authority of South Africa
ICT	Information and Communications Technology
IEE	Industry Energy Efficiency
IEEE	Institute of Electrical and Electronics Engineers
IESBA	International Ethics Standards Board for Accountants
IETC	International Environmental Technology Centre
IF	Impact Factor
IFRS	International Financial Reporting Standards
IIP	Industry Innovation Partnership
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
iPSC	induced Pluripotent Stem Cell
IPAP	Industrial Policy Action Plan
ISAs	International Standards on Auditing
KPI	Key Performance Indicator
KW	Kilowatt

ABBREVIATIONS

merSETA	Manufacturing, Engineering and Related Services Sector Education and Training Authority
MICT	Media, Information and Communication Technologies
MOFs	Metal-Organic Frameworks
MW	Mega Watt
NDP	National Development Plan
NEPAD	New Partnership for Africa Development
NFTN	National Foundry Technology Network
NHI	National Health Insurance
NIPMO	National Intellectual Property Management Office's
NMISA	National Metrology Institute of South Africa
NSI	National System of Innovation
NRF	National Research Foundation
PAA	Public Audit Act
PCR	Polymerase Chain Reaction
PFMA	Public Finance Management Act
PhD	Doctor of Philosophy
PLM	Product Lifecycle Management
PV	Photovoltaic
R&D	Research and Development
RDI (also RD&I)	Research, Development and Innovation
REC	Research Ethics Committee
ReCAP	Research for Community Partnership
SADC	South African Development Community
SAICA	South African Institute of Chartered Accountants
SANBI	South African National Biodiversity Institute
SANBio	Southern Africa Network for Biosciences
SANDF	South African National Defence Force
SANReN	South African National Research Network
SAR	Satellite Aperture Radar
SARVA	South African Risk and Vulnerability Atlas
SDN	Software-Defined Networking
SDWSN	Software Defined Wireless Sensor Networks
SET	Science, engineering and technology
SETA	Sector Education and Training Authority
SKA	Square Kilometre Array
SMME	Small, Medium and Micro Enterprise
SOE	State-owned enterprise
TB	Tuberculosis
TLIU	Technology Localisation Implementation Unit
TUT	Tshwane University of Technology
TV	Television
UAV	Unmanned Aerial Vehicle
UHF	Ultra-high frequency
UK	United Kingdom
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
WEF	World Economic Forum
WHO	World Health Organization
WRC	Water Research Commission
WSNs	Wireless Sensor Networks

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