Strategic Plan 2020-2025

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

NACI
NATIONAL ADVISORY COUNCIL ON INNOVATION

NATIONAL ADVISORY COUNCIL ON INNOVATION

STRATEGIC PLAN 2020-2025
AND
ANNUAL PERFORMANCE PLAN 2020-2021

INNOVATION
FOR A BETTER FUTURE

FOREWORD

On behalf of the National Advisory Council on Innovation (NACI), and in the context of policy reflection and renewal in South Africa, I am honoured to present NACI's 2020-2021 Annual Performance Plan (APP). Government has been reviewing what it has achieved and not achieved since 1994, with the aim of guiding the enhancement of policy to address the persistent challenges of unemployment, inequality and poverty.

The 2020-2025 Strategic Plan identifies strategic outcome-oriented goals to contribute to the realisation of the National Development Plan (Vision 2030) and the 2019 White Paper on Science Technology and Innovation (STI). Recently, the Council completed a review of the 1996 White Paper on Science and Technology, including a performance analysis of the national system of innovation (NSI) over a 20-year period, and submitted this as input into the draft new White Paper on STI. It also conducted foresight exercise whose outputs will inform the development of new decadal plan for STI. The Council continues to review the 2002 National Research and Development Strategy (NRDS) and Ten-Year Innovation Plan.

NACI will continue to improve the quality, relevance and efficacy of its advice to the Minister of Higher Education, Science and Technology and, through the Minister, to the Cabinet. It generates advice proactively or at the behest of the Minister of Science and Technology. In thinking about advice, the Council recognises that it is important to focus on both the foundations of STI (disciplines or knowledge domains, infrastructure and human resources) and the role of STI in addressing the challenges of education, health, food security and global change in a sluggish economy. The Council sees access to good quality data, analytical capability, strong partnerships and healthy relationships with recipients of advice as critical. Some of NACI's strengths include the ability to mobilise NSI stakeholders and access local and international experts to complement its limited resources.

NACI will build on its previous efforts to strengthen planning, monitoring and evaluation capability in the national system of innovation (NSI). Working with partners, the Council will improve phase 1 and develop phase 2 of the National STI Information Portal, and will continue to develop a monitoring and evaluation framework and system for the NSI. The latter will take into consideration the new White Paper on STI, the new decadal plan, the reviews of the National Research and Development Strategy and Ten-Year Innovation Plan, and the foresight exercise.

The Council values the importance of good corporate governance, communication and international engagement, and we are confident that NSI role players and South African citizens will benefit from the work NACI has planned for the 2020/21 financial year.

ISANDULELO

Esikhundleni se National Advisory Council on Innovation (NACI), kanye nomongo wenqubomgomo yokubuyekeza nokuvuselela eMzansi Afrikha, kuyintokozo kimina ukunethulela i-Annual Performance Plan (APP) yeNACI yonyaka ka2020 kuya ku2021. Uhulumeni ubelokhu ebuyekeza lokhu asekuzuzile nalokhu angakuzu-zanga kusuka ngo-1994, ngenhloso yokuqondisa ukuthuthukiswa kwenqubomgo-mo ukubhekana nezinqinamba eziphikelelayo zokungasebenzi, ukungalingani kanye nobubha.

Uhlelo lwamasu lonyaka ka2020 kuya ku2025 luveze imigomo egxile emiphumelweni ukunikela kukuqonda kweNational Development Plan (umbono ka2030) kanye neWhite paper on Science Technology and Innovation (STI) ka2019. Kamumva, umkhandlu uqedele ukubuyekeza iWhite Paper on Science and Technology yonyaka ka1996, kufakwa phakathi ukuhlaziywa komsebenzi weNational system of innovation ngaphezu kwesikhathi seminyaka engu-20, wase uhambisa lokhu njengegalelo lombhalo omusha weWhite Paper on STI. Ubuye wenza ukuvivinywa kokubona ngaphambili umphumelo ozokwazisa ukuthuthukis-wa kwecebo leminyaka elishumi leSTI. Umkhandlu uyaqhubeka ukubuyekeza iNa-tional Research and Development Strategy (NRDS) kanye neTen-Year Innovation Plan.

INACI izoqhubeka nokuthuthukisa izinga, ukuhambisana kanye nokusebenza kahle kwezeluleko zayo kunqonqoshe wesayensi nobuchwepheshe nangale kunqonqoshe kuya kwiKhabinethi. Isungula izeluleko ezisebenzayo okanye kubuholi bukanqonqoshe wesayensi nobuchwepheshe. Ngokucabanga ngezaluleko, umkhandlu ubone ukuthi kubalulekile ukugxila esisekelweni seSTI (isizinda seziyalelo nolwazi, ingqalasizinda kanye nezinsizakusebenza) kanye nendima yeSTI ekubhekeni izinqinamba zezemfundo, ezempilo, ukuphepha kwezokudla kanye noshintsho emhlabeni jikelele emnothweni ovilaphayo. Umkhandlu ubona ukufinyelela olwazini olusezingeni elihle, ukuhlaziywa okunamandla, ukubambisana okuqinile, kanye nobudlelwane obunempilo nabamukeli bezaluleko ezibalulekile. Amanye amandla eNACI afaka phakathi ikhono lokuhlanganisa ababambiqhaza beNSI kanye nokufinyelela kochwepheshe bendawo nabasezweni lonke ukuphelelisa imithombo yayo elinganisiwe.

INACI izokwakha emandleni ayo andlule okuqinisa ukuhlela, ukuqapha kanye nokuhlola amandla kunational system of innovation (NSI). Ngokusebenzisana nabalingani, umkhandlu uzothuthukisa isigaba sokuqala bese ukhulisa isigaba sesibili seNational STI Information Portal, bese iqhubeka nokukhulisa uhlaka lokuqapha nokuhlola indlela yokwenza yeNSI. Isakamuva sizobhekisisa iWhite Paper on STI entsha, icebo Elisha leminyaka elishumi, ukubuyekezwa kwe Nation-al Research and Development Strategy kanye neTen-Year Innovation Plan, kanye nesivivinyo sokubonela phambili.

Umkhandlu uyakwazisa ukubaluleka kokuphatha kukahulumeni okuhle, ukuxhumana kanye nokuzimbandakanya kwamazwe omhlaba, kanti futhi siyaqinisekisa ukuthi ababambe iqhaza kuNSI kanye nezakhamuzi zaseNingizimu Afrikha bazozuza emsebenzini weNACI ewuhlelele unyaka wezimali ka2020/21.

OFFICIAL SIGN-OFF

It is hereby certified that this Annual Performance Plan (APP) was developed by the management of the National Advisory Council on Innovation (NACI) under the guidance of the Acting Chief Executive Officer of NACI; prepared in line with NACI's 2020-2025 Strategic Plan; and accurately reflects the performance targets which NACI will endeavour to achieve, given the resources made available in the budget for 2020/21.

Dr Shadrack Moephuli
Interim NACI Chairperson

Signature ……

Ms Pretty Makukule
Chief Financial Officer (DSI)

Signature ……..

Dr Mlungisi Cele
Acting CEO (NACI)

Signature ……

Dr Phil Mjwara
Accounting Officer

Signature……

Approved by

Minister Dr Blade Nzimande:
Executive Authority

Signature ……

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2020-2025

PART A: OUR MANDATE

1. Constitutional mandate

There are no specific constitutional provisions for NACI.

2. Legislative mandate

The National Council on Innovation Act, 1997 (Act No. 55 of 1997), provides the mandate for NACI (2015). The Act mandates NACI to advise the Minister for Higher Education, Science and Technology and, through the Minister, Cabinet, on the role and contribution of science, mathematics, innovation and technology, including indigenous technologies, in promoting and achieving national objectives, namely, to improve and sustain the quality of life of all South Africans, develop human resources for science and technology, build the economy, and strengthen the country's competitiveness in the international arena.

3. Policy mandates

3.1 The relationship between the NDP and the National System of Innovation (NSI)

The 2011 National Development Plan (NDP) highlights the centrality of science, technology and innovation (STI) in creating sustainable socio-economic development and addressing societal challenges such as education, health, food security, water scarcity and climate change. The difference between countries that are able to tackle poverty effectively by growing and developing their economies, and those that cannot, is the extent of their ability to grasp and apply insights from STI and use them creatively (NDP, 2011).

The NDP acknowledges that economic development is a longer-term project and that innovation should grow in importance over time. In the first phase (2012-2017), the focus was to be on "intensifying research and development spending, emphasising opportunities linked to existing industries". In the second phase (2018-2023), the "country should lay the foundations for more intensive improvements in productivity", and "innovation across state, business and social sectors should start to become pervasive". As the country approaches 2030, "the emphasis should be on consolidating the gains of the second phase, with greater emphasis on innovation, improved productivity, more intensive pursuit

of a knowledge economy and better utilisation of comparative and competitive advantages in an integrated continent".

The NDP is clear that achieving a competitive and sustainable economy will require a strong and effective national system of innovation (NSI), which must contribute to transformation. It views the NSI as the principal tool for creating new knowledge, applying knowledge in production processes, and disseminating knowledge through teaching and research collaboration. The NDP further acknowledges that advances in technological innovation and the production of new knowledge are critical to growth and development.

Having identified the potential contribution of the NSI to socio-economic development, the NDP proposes two actions for the NSI. First, a common overarching framework should be created to address pressing challenges in the NSI (involving the higher and further education systems, state-owned enterprises and private industries). The NSI should function in a coordinated manner with objectives that are aligned to national priorities. Second, the size and effectiveness of the NSI should be increased.

3.2 Medium-Term Strategic Framework (MTSF) 2020-2025

During the State of the Nation on the 20 June 2019, President Ramaphosa said that within the next decade, South Africa would have made progress in tackling poverty, inequality and unemployment, where: (a) no person in South Africa will go hungry; (b) the economy will grow at a much faster rate than our population; (c) two million more young people will be in employment; (d) the schools will have better educational outcomes and every 10-year-old will be able to read for meaning; (e) violent crime will be halved.

In pursuit of these goals, the President outlined seven priorities that will guide government over the next medium-term strategic framework (2020-25). These are:

- Priority 1: Capable, Ethical and Developmental State
- Priority 2: Economic Transformation and Job Creation
- Priority 3: Education, Skills and Health
- Priority 4: Consolidating the Social Wage through Reliable and Basic Services
- Priority 5: Spatial Development, Human Settlements and Local Government
- Priority 6: Social Cohesion and Safe Communities
- Priority 7: A better Africa and World

The achievement of these priorities will require improved coordination both vertical and horizontal, alignment between various policies (including STI), leadership, resources (human and financial), infrastructure and so forth. The key challenge will be to align the implementation of MTSF with other policies including the National Development Plan (NDP), the Re-imagined Industrial Strategy, the 2019 White Paper on STI and post-school education policy.

3.3 Science technology and innovation policy mix

The post-apartheid STI policy (from the 1996 White Paper on Science and Technology to the 2019 White paper on STI) serve as an instrument of transformation of the human conditions in order to ensure that all South Africans enjoy freedom, social justice, equality, peace, and sustainable shared prosperity and improved quality of life and well-being. To this extent, the concepts of NSI and innovation were introduced and have become the subject of much of discussion and reviews. Questions are raised about the existence, coordination, resourcing and broader understanding and awareness of the NSI beyond the Department of Science and Innovation and whether innovation has always been understood as an all-encompassing of different elements including the non-technological. Most importantly, the major weakness of the pre-1994 exclusionary and racialised science and technology system and the NSI, is the persistent misalignment between the STI policy and 'needs of the majority', the poor, working class and black women. This is the fundamental issue that should feature prominently in the country's STI agenda for the next five-years or so. The 2019 White Paper on STI acknowledges the problem and promotes the transformation, inclusion and coherence as important underlying principles of the new STI agenda and ambition. Namely, that STI should contribute towards the creation of the sustainable and inclusive socioeconomic development. To the extent that the 2019 White Paper on STI put strong emphasis on the outcomes and impact of STI on society, environment and economy.

The 2019 White Paper is premised on the view that the South Africa's national system of innovation is relatively productive considering the challenges (which include its size, funding and governance, its racial, age and gender-skewed human resources, and its bias towards technological innovation).

The 2019 White Paper also recognises that South Africa is part of a world in transition. Some of the features of this transition include growing unemployment, inequality, poverty, climate change, the hollowing of nation states through excessive contracting, a multipolar distribution of power in the world, new wars, megacities, growing migration, the ongoing

effects of the 2008 global economic crisis (with another predicted in the near future), the post-truth approach and the rise of chauvinistic nationalism. The Sustainable Development Goals (SDG) are a global agreement to address these challenges.

In South Africa, particular challenges include the legacy of colonialism and apartheid (including the land question), the burden of disease (such as HIV/Aids), youth unemployment, a sluggish economy, the erosion of agricultural land, water scarcity, the mismatch between education investments and outcomes.

4. Institutional policies and strategies governing the five-year planning period

The 2019 White Paper on STI has number of implications for the system and its actors. It proposes a number of actions in relation to NACI. Namely,

- NACI will be reconfigured to act as the national STI M&E institution, charged with analysing STI information and undertaking work to inform government planning on STI. NACI will convene a high-level forum to develop a framework of indicators to monitor South Africa's NSI performance.
- To support the Ministerial STI Structure in carrying out its mandate, government recognises that, in addition to the STI Plenary discussed above, there is a need for ongoing stakeholder engagement. NACI will be strengthened to facilitate such engagement, for example, by following up on matters discussed at the STI Plenary. Policy advice from relevant NSI institutions and think-tanks, for instance the Academy of Science of South Africa (ASSAf), the HSRC and the Centres of Excellence, will also be used.
- Furthermore, the Ministerial STI Structure will require expert studies and up-to-date performance and environmental information to support its decisions. To advise the Ministerial STI Structure, a strengthened NACI will undertake such studies.
- Implement knowledge management systems to enhance the analysis of NSI performance and support evaluation work that informs strategies. In this, NACI will draw on the work of existing specialist centres that collect STI-related information. Existing institutional arrangements for data collection (e.g. innovation and R&D surveys) will be maintained and strengthened and, where necessary, expanded.

- The DSI, working with NACI, will develop a public STI investment framework to support the commitment of public resources for STI by the Ministerial STI Structure. NACI's role will be to undertake foresight studies and provide an independent STI M&E function (including regular analysis of public STI spending). The framework will be based on an analysis of STI funding requirements in line with strategic and sovereign priorities, as well as consultation across government through an interdepartmental STI Budget Committee at the level of Director-General, including national and provincial governments with significant STI mandates. NACI to work with DST, the DPME and the National Treasury to ensure that the framework delivers actionable and comparable information that can inform the management and funding of the NSI initiatives.

Appropriate links will also be established between NACI and the DPME to help integrate STI into transversal government planning by the DPME, and to support funding prioritisation by the DPME and National Treasury (e.g. via the annual Budget Mandate Paper). For instance, based on its new M&E function and on regular environmental scanning, NACI will prepare reports on the implications of geopolitical and demographic shifts, technological changes, environmental sustainability imperatives and other megatrends for government STI planning.

In order to give effect to the above proposals, a process will be initiated to amend the NACI legislation.

5. Relevant court rulings

None.

PART B: OUR STRATEGIC FOCUS

6. Vision

A leading advisory body to government on science, technology and innovation, in a well-coordinated, responsive and functioning national system of innovation.

7. Mission

To provide evidence-based advice to the Minister of Higher Education, Science and Technology and, through the Minister, Cabinet on science, technology and innovation matters, through the research expertise and engagement with stakeholders.

8. Values

a) Professionalism.

b) Integrity.

c) Innovation and knowledge sharing.

d) Transparency and accountability.

9. Situational analysis

This section is not intended to be a comprehensive assessment of the situation, but to identify key trends and challenges confronting all science systems in general, and the South African NSI in particular. Although deeper analysis may be required to provide a better understanding of some trends, the available information has been used to reflect on NACI's current work and possible future work, and to develop this Strategic Plan and APP.

9.1. External environment analysis

9.1.1 Global macro trends

Global social inequality – as expressed in the growing gap between rich and poor – is one of humanity's most remarkable and enduring legacies. It is a social relic that, so far, has stubbornly defied the passage of time, holding its place as a constant across both ancient and modern worlds, with such pronounced and obscene visibility that, despite spectacular feats of science and technology by our species over the centuries, remains

to this day one of humanity's stunning acts of misachievement (NACI, 2019).

Contemporary South Africa is a stunning exemplar of this striking historical phenomenon – this, despite the passage of over 25 years of democratic governance, one of the most progressive constitutions in the modern world, the Bill of Rights and numerous efforts to reconstruct the economy. Many, particularly poor black communities, feel left behind, excluded and treated as unimportant, like the counterparts in many other parts of the world, as Ángel Gurría argued, "at the mercy of big impersonal forces of globalisation, technological change, large corporations and financial institutions". Yet the forces are recognisable, definite and historical, the product of human imagination and social power (NACI, 2019). The message is clear: the world we live in is characterised by unbalance, inadequate and uneven development, and growing demands for a better life.

For its part, the United Nations have recognised and framed the societal challenges as actionable 17 SDGs as shown in Fig 1. The SDGs ought to be addressed and achieved in an integrated fashion. To this extent, the emphasis should therefore be on interlinkages, collective actions, coordination and collaboration between different nations, institutions and policies.

FIGURE 1: SUSTAINABLE DEVELOPMENT GOALS

Without discussing these SDGs or societal challenges in details, in the next section, we discuss selected global macro trends, which have bearing on the developing countries including South Africa.

9.1.1.1 Growing social inequality and instability

Barring major global catastrophes, and despite slowing global growth rates, the world is very likely to be a much richer place by mid-century. World GDP is expected to more than triple by 2060, per capita incomes are also set to rise rapidly, and wealth accumulation is anticipated to continue apace. However, whether this will also be a better world depends very much on how incomes and wealth will be distributed across the globe and within countries.

At present, the prosperity gulf between developed and developing economies is wide. But the future promises convergence. Over the next half century, disparities in GDP per capita are expected to narrow across countries; per capita income levels of the currently poorest economies will more than quadruple (in 2005 purchasing power parity terms), whereas they will only double in the richest economies; China and India will experience more than a sevenfold increase of their income per capita by 2060. Nonetheless, significant gaps in living standards will remain between advanced and emerging economies as well as between them and the least developed countries.

Inequalities within countries will pose major political, social and economic risks in the coming years. Over two-thirds of emerging and poor countries, encompassing 86% of the population of the developing world, will experience growing inequalities. For many, the prospects of long-term help are particularly gloomy: by 2030, some two-thirds of the world's poor could be living in "fragile" states – in other words, in countries where there is no government that could effectively constitute a counterpart for foreign aid agencies.[1]

Rising wealth and income in the developing economies of the world is progressing hand in hand with the emergence of a global middle class. By current projections, the global economy's middle class is expected to more than double between 2009 and 2030, from 1.8 billion to almost 5.0 billion, accounting for about 60% of the world population. Some two-thirds of those middle-class citizens are expected to be found in Asia.[2] Of course, the number of people in the middle class does not properly capture its spending power. Given the broad range of expenditures that fall within the middle-class definition, some countries have more affluent middle classes than others. Today's middle class in Europe

[1] ESPAS (European Strategy and Policy Analysis System) (2015), Global Trends to 2030: Can the EU Meet the Challenges Ahead?, ESPAS, Brussels.
[2] Gros, D. and C. Alcidi (eds.) (2013), The Global Economy in 2030: Trends and Strategies for Europe, ESPAS, Brussels.

and North America make up just over half of the global total in terms of number of people, but they account for almost two-thirds of total spending by the world's middle class. This is about to change. Asia's share of global middle-class expenditure is expected to climb from around one-quarter today to almost 60% in 2030, bringing about a huge shift from spending on necessities such as food and clothing to choice-based spending on categories such as household appliances and restaurants.[3]

Growing income and wealth inequalities are not the preserve of the developing world. In the vast majority of advanced countries, the gap between rich and poor has reached its highest level for three decades. Today, the richest 10% of the population in the OECD area earn nearly 10 times the income of the poorest 10%, up from 7 times in the 1980s. However, the ratio does vary widely across OECD countries. In Nordic and many Continental European countries, the ratio is significantly lower than the average, but in Italy, Japan, Korea, Portugal and the United Kingdom it is closer to 10 to 1, between 13 and 16 to 1 in Greece, Israel, Turkey and the United States, and as high as between 27 and 30 to 1 in Mexico and Chile.[4]

Importantly, however, the rise in overall income inequality in OECD countries is not only about the top income bracket. The evidence suggests that what matters most is the gap between low-income households and the rest of the population. Indeed, over the last 30 years, incomes at the low end of the scale often grew much more slowly during the prosperous years and decreased during downturns. Unsurprisingly perhaps, for the vast majority of developed countries for which data are available, poverty rates increased from the mid-1990s to the 2010s, pushing up rates for the OECD area as a whole by 1.5 percentage points. Over the last couple of decades the risk of poverty has shifted markedly away from the elderly towards families with children. Hence, large families with three or more children also tend to have higher levels of poverty risk. Moreover, child poverty is seen to be increasing in almost all OECD and EU countries. On average across the OECD, the child poverty rate increased from 12.2% in 2000 to 13.2% in 2010.[5]

Also at risk are young adults, who make up an increasing share of the poor. The increase in youth poverty is to be found particularly among youngsters not in education, employment or training who run a greater than average chance of unemployment, lower wages, poorer health and therefore a greater risk of long-term "scarring". In many countries, migrant

[3] Kharas, H. and G. Gertz (2010), "The new global middle class: A cross-over from west to east", draft version of chapter in China's Emerging Middle Class: Beyond Transformation, C. Li, (ed.), Brookings Institution Press, Washington, DC.

[4] OECD (2013), OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth, OECD Publishing, Paris, http://dx.doi.org/10.1787/sti_scoreboard-2013-en.

[5] OECD (2013), OECD Income Distribution Database, www.oecd.org/social/income-distribution-database.htm.

families and their children are also at risk. Within Europe, this is particularly true of non-EU immigrant families and their offspring.[6] And finally, there are those families facing persistent poverty. These are most likely to be older people, single people (especially women both with and without children) and jobless households.

9.1.1.2 Food sustainability: Local and global food security

It is estimated that 60% more food will be required to feed 9 billion people on Earth by 2050.[7] Furthermore, changing diets, driven by a growing middle class, will lead to additional demand for more resource-intensive types of food, such as meat. Presently most countries are largely self-supporting with respect to food, but there are major challenges, where war, poor governance and extreme events lead to major humanitarian crises, especially in some African countries. In developing countries population growth is still the most important factor driving the need for food. Yet in many countries demand for food is driven more by affluence than by population growth. Increasing calorific intake and livestock consumption linked to an expanding global middle class is emerging as a future source of increasing demand.[8]

Food and nutritional insecurity will persist in many, predominantly poor, regions.[9] An increasing number of regions will face water scarcity, and the competition for scarce water resources could lead to internal and international conflict.[10] Soil degradation will affect the amount of land available for productive agriculture: around half of the world's agricultural land is already affected by moderate to severe degradation and around 12 million hectares of productive land become barren annually due to desertification and drought. If no significant improvements are achieved in production practices, the loss of yield may be as high as 50% in some African countries by 2050.[11] The situation in most OECD and BRICS countries is less severe, as continuing yield improvements will lead to more efficient use of land. Instead of agricultural land expansion, land abandonment is planned in many countries, which will allow ecosystems to partially recover and regenerate.[12]

[6] Jokinen, K. and M. Kuronen (2011), "Research on families and family policies in Europe: Major trends", in Wellbeing of Families in Future Europe: Challenges for Research and Policy, FAMILYPLATFORM – Families in Europe Volume 1, Uhlendorff, U., M. Rupp and M. Euteneuer (eds.), FAMILYPLATFORM, Brussels.

[7] OECD (2013), Global Food Security: Challenges for the Food and Agricultural System, OECD Publishing, Paris.

[8] http://ufm.dk/en/publications/2016/files/an-oecd-horizon-scan-of-megatrends-and-technology-trends-in-the-context-of-future-research-policy.pdf

[9] FAO (Food and Agriculture Organization of the United Nations) and WWC (World Water Council) (2015), Towards a Water and Food Secure Future: Critical Perspectives for Policy-makers, FAO/WWC, Rome/Marseille.

[10] WWAP (United Nations World Water Assessment Programme) (2015), The United Nations World Water Development Report 2015: Water for a Sustainable World, UNESCO, Paris.

[11] UNCCD (United Nations Convention to Combat Desertification) (2014), Desertification: The Invisible Frontline, UNCCD, Bonn.

[12] OECD (2012), Environmental Outlook to 2050: The Consequences of Inaction, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264122246-en.

Food production and consumption have a major impact on both health and environment, including regional planning and land use. If food is need to be made more sustainable, food production (farming systems) and consumption (change in food choices) as well as processing and waste issues need to be addressed. The need for environmental sustainability and food security both globally and locally combined with the patterns of global population growth generates particular sets of future challenges and opportunities the world.

At present, most agricultural resources (land, water and nutrients) go to feed animals rather than humans and the current challenge is as much for 'feed security' as it is 'food security'. The production of meat and dairy, require large inputs of resources like energy, land, nutrients and water, and result in emissions both from animals (greenhouse gases) and manures (nitrogen, phosphorus). Some 80% of global agricultural plant harvest (expressed as nitrogen) goes to feed livestock.[13] Although smaller in their absolute impact, there are also significant environmental effects of vegetables, vegetable oils, coffee, tea and alcoholic beverages.

Rapidly increasing meat and dairy consumption in developing countries is increasing environmental degradation, especially as markets and citizens shift towards western diets. Even small changes in diets can affect resource use and have important environmental and/or health impacts. Different kinds of alternatives to meat emerge in supermarkets (crockets, quorn, tahoe, etc.) or are currently under research. One example of laboratory grown meat is the so-called 'stem cell burger'.[14] The impact of such artificial foods on health and the environment remains to be ascertained.

A major driver for change is the health risks from inappropriate diets, resulting, for example, from excess meat and dairy consumption.[15] Dietary risks represent the largest factor, especially for cardio and circulatory diseases as well as by cancer. Reducing meat and dairy consumption offers the double benefit of improved health and improved environment.

A rapidly developing narrative concerns the opportunity to optimize human diets, to provide appetizing and nutritious food that not only meets calorific needs, but minimizes the health and environmental risks associated with overconsumption, waste and farming

[13] Our Nutrient World' (2013): http://www.gpa.unep.org/index.php/global-partnership-on-nutrient-management/publications-and-resources/global-partnership-on-nutrient-management-gpnm/21-nutrient-management-key-messages-for-rio20-summit/file

[14] http://www.bbc.co.uk/news/science-environment-23576143

[15] http://www.forbes.com/sites/alicegwalton/2014/03/04/the-protein-puzzle-meat-and-dairy-may-significantly-increase-cancer-risk/

practices. There are emerging signals of reducing meat and dairy consumption in developed countries, including rapidly developing narratives on vegan, vegetarian and demitarian (halving meat intake) lifestyles, including the possible health benefits. Changing diets affect the opportunity space for urban farming, with its own opportunities and risks. Reducing excess intake of resource-intensive food types (such as meat and dairy products) also reduces the need to use arable land for the production of livestock feeds. This can potentially free up land for carbon sequestration, supporting climate change mitigation, bio-based products replacing fossil inputs, as well as helping to meet bioenergy goals. Similar challenges apply in fisheries and aquaculture, with rates of fish consumption increasing substantially. Meanwhile, land limitations push for improved methods to conduct agriculture in salt rich environments.

Agriculture and food face global challenges linked to sustainable rural economies, global warming, plant and animal diseases, deforestation, erosion, soil depletion, eutrophication, diversity loss and desertification. Other factors threatening the sustainability of the food system are rising global demand for food, feed and biomass for bio-based products and energy, rapid urbanisation, dramatic decreases in rural habitation, and decreasing land available for food production, all pushing system resilience to its limits. There is a growing recognition of the need to optimize food production and consumption in relation to environmental challenges. Direct impacts of agriculture pose environmental threats affecting from water, air and soil quality, to climate, stratospheric ozone and biodiversity. These are caused by a wide range of material flows and their potential environmental load, such as greenhouse gases, nitrogen and phosphorus pollution, as well as heavy metal and pesticide residues.

Around 10% of world's food production is exported. This figure might increase in the coming decades due to large differences in terms of food supply and demand in various countries. Countries like China and India have not enough agricultural land of sufficient quality to satisfy their increasing demands for both feed and food. This will affect global food transport and might turn some regions into new feed and food exporters. Transportation of food forms additional energy cost and additional environmental impacts from energy supply and use.

At the same time, we are living through an age of hitherto unprecedented and spectacular advances in the techno-sciences whose effects are beginning to permeate virtually every sphere of human and planetary life. This includes major advances in information and communications technology (ICT), biotechnology, nanotechnology, the Internet of Things (IOT), robotics, artificial intelligence (IA), machine learning, blockchain, 3D-printing,

amongst many others, all of which are elements of a new production revolution or fourth industrial revolution (4IR) that transforms production processes and products; markets, services and trading systems; entire industries and entire economies (NACI, 2019).

The societal challenges are systemic in nature. They require longer-term planning and policy actions across technological, economic and social structures and boundaries, and across national borders. While they can be seen as offering opportunities to the global community, turning these challenges into opportunities for sustainable and inclusive growth is not straightforward (OECD, 2015). Firstly, the societal challenges maybe interlinked or have unexpected knock-on effects. For example, ageing societies can lead to a reduced labour force, increases in health care costs, and a reduction in the tax base. Secondly, some challenges have a global dimension, such as climate change, which means that national policies alone are insufficient to solve them. Current government policy structures and policies, including research and development (R&D) and STI policy, are ill-adapted to tackle such complex challenges (OECD, 2015).

In the context of the above set of global societal challenges, South Africa has identified and seeks to find solutions towards the triple challenge of inequality, unemployment and poverty.

9.1.1.3 Innovation for socio-economic development

Innovation has always been a foundation for economic growth. From the invention of the wheel to the Industrial Revolution, the invention of medicines to air transport and the Internet, innovation leads to change and progress. In today's world, beset by financial, social and environmental challenges, and looking for new, stronger, more inclusive and sustainable ways forward, innovation is more important than ever, and policies to foster it, leading to the creation and diffusion of new products, processes and methods, are vital.

Innovation can be measured in several aspects of a country's growth. First, there is technological progress embodied in tangible, physical capital, such as better machinery, smarter equipment or greener buildings. Second, there is intangible, knowledge-based, capital, such as software, data, research and development (R&D), design, intellectual property, and firm-specific skills.

Third, there is the smarter, more efficient use of labour and capital to generate so-called multifactor productivity growth (also referred to as total factor productivity). Fourth, there is the role that innovation plays in strengthening the dynamics of an economy, with new

innovative firms entering the market, replacing other slower, less innovative ones in a process known as creative destruction. Together, these four dimensions account for as much as half of GDP growth.

Innovation is also about what humankind needs. It is critical for addressing profound social and global challenges (such as climate change, health, food security, poverty and access to clean water) in an affordable and timely manner. At the same time, innovation can contribute to inequality, which is why it needs to be accompanied by appropriate labour and social policies (OECD, 2015).

9.1.1.4 Climate change and energy

Ongoing climate change and its adverse effects on human and energy security

Global land and ocean surface temperature data show an averaged combined warming of 0.85°C over the period 1880 to 2012. The greatest warming over the past century has occurred at high latitudes, with a large portion of the Arctic having experienced warming of more than 2°C. The last 30 years were likely the warmest of the last 1,400 years in the northern hemisphere. Anthropogenic greenhouse gas (GHG) emissions are extremely likely to have been the dominant cause of the observed warming since the mid-20th century. Atmospheric concentrations of carbon dioxide (CO_2), methane and nitrous oxide are unprecedented in at least the last 800 000 years.[16] CO_2 emissions account for around 75% of global GHG emissions, with most coming from energy production – fossil fuel combustion represents two-thirds of global CO_2 emissions.[17] Around half of the anthropogenic CO_2 emissions since 1,750 have occurred in the last 40 years. Agriculture is a major emitter of the more powerful greenhouse gases of methane and nitrous oxide.

There is a strong, consistent, almost linear relationship between cumulative CO_2 emissions and projected global temperature change during the 21st century. Further warming over the next few decades is now inevitable, based on recent rises in atmospheric CO_2 levels, and the global mean surface temperature change for the period 2016-35 relative to 1986-2005 will likely be in the range 0.3°C to 0.7°C. Heat waves will likely occur more often and last longer, while extreme precipitation events will become more intense and frequent in many regions. Rainfall will most likely increase in the tropics and higher latitudes, but decrease in drier areas.

[16] Data from the following reference throughout the section unless otherwise indicated: IPCC (Intergovernmental Panel on Climate Change) (2014), Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC, Geneva.

[17] OECD (2012), Environmental Outlook to 2050: The Consequences of Inaction, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264122246-en.

The oceans will continue to warm and acidify, strongly affecting marine ecosystems. The global mean sea level will continue to rise at an even higher rate than during the last four decades. The Arctic region will continue to warm more rapidly than the global mean, leading to further glacier melt and permafrost thawing. However, while the Atlantic Meridional Overturning Circulation will most likely weaken over the 21st century, an abrupt transition or collapse is not expected.

Reducing and managing the risks of climate change will require a mixed strategy of mitigation and adaptation. The extent of mitigation efforts will determine levels of future GHG emissions: without additional efforts beyond those already in place today, warming by the end of the 21st century will lead to a high risk of severe, widespread and irreversible impacts globally, even with adaptation. The IEA's New Policies Scenario is consistent with a long-term temperature rise of 4°C.

In many respects, this is already an ambitious scenario that requires significant changes in policy and technologies, but will still lead to dangerous levels of climate change. A more stringent mitigation scenario that leads to CO_2-equivalent concentrations of about 450 parts per million in 2100 would meet the 2°C targets agreed at the recent Paris climate conference. This 2°C Scenario (2DS) is characterized by 40-70% reductions in global GHG emissions by 2050 compared with 2010. It will mean increasing the share of low-carbon electricity supply from the current share of approximately 30% to more than 80% by 2050.

Developing and poorest countries in the world are expected to be much more influenced by climate change, largely due to the lack of financial resources to mitigate the adverse effects.[18] There are greater risks for agriculture and food security as well as increasing pressures for health and social care systems, which may result in hunger and diseases.[19] In the period from 2030 to 2050, climate change may cause 250,000 additional deaths per year, mainly due to malnutrition, malaria and heat stroke.[20] Furthermore, the rises in the sea level and storm surges over the next years to come will have significant impacts on coastal cities, especially in Asia's most densely populated cities.

[18] Roland Berger (2014) Trend Compendium 2030 //. — 2014. URL: http://www.rolandberger.com/expertise/trend_compendium_2030/Climate_change_and_ecosystem_at_risk.html

[19] World Bank (2014) Climate Change and Poverty: An Analytical Framework. Policy Research Working Paper;No. 7126. World Bank Group, Washington, DC. URL: https://openknowledge.worldbank.org/handle/10986/20639

[20] http://www.who.int/mediacentre/factsheets/fs266/en/

9.1.1.5 *Increasing demand for primary energy driven by population and economic growth*

Global demand for resources has grown significantly since the beginning of the 20th century, which was a combined result of structural economic change as well as the transition from agricultural to industrial economies. The population of the world has increased fourfold, whereas the production volume went far beyond with 25-fold.[21] Technological advances that led to the economic industrialisation provided significantly greater variability in the use of natural resources, particularly to generate energy to run the whole system. Global primary energy demand is set to increase further by 37% between 2012 and 2040. Most of this demand will be due to economic growth in developing countries, which will account for around 60% of global energy consumption. Meanwhile, growth in global demand is expected to slow down from 2% per year in the last two decades to 1% per year after 2025. This is a result of price and policy effects, as well as structural shifts in the global economy towards services and lighter industrial sectors.[22]

Industry will remain the largest consumer of energy in 2040, by which time its energy demand is expected to have risen by about 40%. Manufacturing in the OECD has gradually shifted away from coal and oil over recent decades, a trend that is projected to continue: while in 1990, coal and oil accounted for nearly half of heavy industry's fuel, they are expected to decline to just 15% of the fuel mix by 2040. China's fuel mix will also "lighten-up" by this time. This will lead to a fall in the average amount of industrial energy demand per unit of economic output worldwide. Future energy demand growth varies by industry sub-sector, however, with the chemical sector seeing the largest growth as the demand for plastics and other chemicals increases.[23]

Transportation will be the second largest consumer of energy in 2040. While car numbers are projected to expand with a growing global middle class, fuel efficiency improvements mean energy demand from cars will rise only slightly. Hybrid vehicles could account for nearly 50% of new-car sales by 2040, compared with just 1% in 2010.[24] This effect will be especially noticeable in Europe, where liquid fuels consumption is expected to decline.[25] Commercial transport – including airplanes, shipping, trains and trucks – will account for

[21] EEA (2016) Global megatrends// European Environment Agency. — 2016. URL: http://www.eea.europa.eu/soer-2015/global/competition http://www.eea.europa.eu/soer-2015/global/competition

[22] Barreneche, A., Keenan, M., Saritas, O. et al. (2016). An OECD Horizon Scan of Megatrends and Technology Trends in the Context of Future Research Policy, A report prepared by the OECD Directorate for Science, Technology and Innovation, commissioned by Danish Agency for Science, Technology and Innovation (DASTI), Copenhagen (Available at: http://ufm.dk/en/publications/2016/files/an-oecd-horizon-scan-of-megatrends-and-technology-trends-in-the-context-of-future-research-policy.pdf)

[23] [35] ExxonMobil (2015), The Outlook for Energy: A View to 2040, Exxon Mobil Corporation, Irving, Texas.

[24]

[25] http://www.eia.gov/outlooks/aeo/pdf/0383(2014).pdf

virtually all of the growth in energy demand from transportation. Most of this demand growth will be met by oil.

The third largest consumer of energy in 2040 will be commercial and residential buildings. Worldwide, households will increasingly shift towards cleaner fuels and will rely more on electricity than primary fuels as domestic appliances and electronics become more widely available. Nearly 1 billion people will newly gain access to electricity by 2040, but more than half a billion will remain without it.[26]

9.1.1.6 Urbanisation and megacities: Move towards smarter and sustainable cities

By 2050, the urban population is expected to reach 6 billion up from less than 1 billion in 1950. By 2100, it is likely to reach somewhere around 9 billion, which may represent the 85% of the projected global population. Almost all the growth will occur in the cities of developing countries, with nearly 90% occurring in Asia and Africa. In a few countries like Japan and the Russian Federation, the urban population will decrease in line with falling overall population numbers. The number of "megacities" of 10 million or more inhabitants has almost tripled over the last 25 years, and they now account for 12% of the world's urban population. Forty or so such cities will exist by 2030.[27]

High fertility rates combined with limited job prospects in many rural areas are important drivers of urbanisation, as cities typically offer better jobs and educational opportunities. Indeed, urbanisation can be an important dynamo of economic growth: cities generally provide easier access to modern and efficient infrastructure – for example, public transportation, housing, electricity, water and sanitation – for large numbers of people in an economically efficient manner[28, 29]. In emerging economies such as China, cities have been the main sources of domestic demand, through higher consumption of a growing affluent middle class and very high spending on infrastructure, a dynamic that is expected to continue.[30]

Building on advances in sensors and their connectivity through high-performance computing – the so-called Internet of Things – urban areas in more advanced economies will increasingly become "smart cities". Various utility and transport networks and systems

[26] IEA (2014), World Energy Outlook 2014, OECD/IEA, Paris, http://dx.doi.org/10.1787/weo-2014-en

[27] Barreneche, A., Keenan, M., Saritas, O. et al. (2016). An OECD Horizon Scan of Megatrends and Technology Trends in the Context of Future Research Policy, A report prepared by the OECD Directorate for Science, Technology and Innovation, commissioned by Danish Agency for Science, Technology and Innovation (DASTI), Copenhagen (Available at: http://ufm.dk/en/publications/2016/files/an-oecd-horizon-scan-of-megatrends-and-technology-trends-in-the-context-of-future-research-policy.pdf)

[28] OECD (2012b), Environmental Outlook to 2050: The Consequences of Inaction, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264122246-en.

[29] UN (2014), World Urbanization Prospects: The 2014 Revision, Highlights, UN Department of Economic and Social Affairs, Population Division, New York.

[30] EUISS and ESPAS (2012), Global Trends 2030: Citizens in an Interconnected and Polycentric World, EUISS and ESPAS, Paris.

will become progressively interconnected, thereby supporting more sustainable use and management of resources.[31]

While cities will make it easier to provide modern energy and water infrastructures to a growing number of people, air pollution and unmanaged waste will be major concerns for public health in many urban areas.[32] Climate change will see storm surges and rising sea levels increase over the next decades, which will have major impacts on low-lying coastal cities, especially in Asia, where so much of the world's urban population lives. Extreme weather events will also disrupt complex urban systems and will have major impacts on the insurance industry in developed countries.

The economic benefits of urbanisation seen in countries such as China may not materialise in other parts of the world, particularly in sub-Saharan Africa and some parts of Asia. Inadequate education and physical infrastructure, combined with poor governance, have so far constrained the efficient use of productive resources and the industrial development that might have come with it.[33] A growing proportion of low-income groups will become urbanized over the next decades so that in some regions, urban growth will become virtually synonymous with slum formation. Urban slums suffer from substandard housing and inadequate water, sanitation and waste management services, all of which have negative consequences for human health and the environment.[34] Such areas are also more likely prone to conflict and social unrest.[35]

Improving health in cities has emerged as an important issue. In high-income countries, the burden of non-communicable diseases, including cardiovascular and respiratory diseases, cancer is projected to rise from some 86% in 2005 to 89% in 2030 in terms of DALYs.[36] Air pollution, noise and temperature account for a considerable proportion of these non-communicable diseases. Ambient particulate air pollution was ranked ninth as a determinant of disease in the ranking of the Global Burden of Disease estimates in 2010 and is estimated to reduce life expectancy by almost 9 months on average in Europe.[37]

[31] EC (European Commission) (2014a), Preparing the Commission for Future Opportunities: Foresight Network Fiches 2030, working document, https://ec.europa.eu/digital-agenda/en/news/european-commission-foresight-fiches-global-trends-2030.

[32] OECD (2012b), Environmental Outlook to 2050: The Consequences of Inaction, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264122246-en.

[33] OECD (2015a), The Metropolitan Century: Understanding Urbanisation and Its Consequences, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264228733-en.

[34] OECD (2012b), Environmental Outlook to 2050: The Consequences of Inaction, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264122246-en.

[35] UK Ministry of Defence (2014), Global Strategic Trends – Out to 2045, Strategic Trends Programme, Fifth Edition, Ministry of Defence, Swindon.

[36] Busse R., et al. (2009). Managing Chronic Disease in Europe, Department of Health Care Management, Berlin University of Technology.

[37] http://www.aphekom.org/web/aphekom.org/home;jsessionid=F72B04D8770C600FD1311ABF499C250D

In many cities, there is scope for improvement in environmental quality and health through targeted policies. There is considerable variation in levels of environmental exposures, such as air pollution, noise, temperature and lack of green space within cities, which are associated with a range of preventable adverse health effects. Emerging evidence suggests that multiple factors explain exposure variability. These include: urban and transport planning indicators, such as road network, distance to major roads, and traffic density, household density, industry and natural and green space, personal behaviors and lifestyles. The urban environment is a complex and interlinked system; for instance circular economy, urban farming, the need to reduce worker displacements, favor proximity production, address possible pollution sources in cities pose complex challenges.

These challenges require a holistic approach as social, economic, cultural and political issues are interwoven with urban planning, environmental, transport, energy, food and water issues. Making cities 'green and healthy' goes far beyond simply reducing CO_2 emissions. Environmental interventions at the community level, such as urban and transport planning have been shown to be more cost-effective than interventions at the individual level.[38]

A sustainable and healthy city should have attractive open public spaces and promote sustainable, inclusive and healthy mobility. Some potential policies, such as a reduction of car use by increasing the attractiveness of public and active transportation, combined with more cycling lanes and green spaces may have joint effects in that they may not only reduce environmental exposures such as air pollution, noise, and temperature (i.e. heat islands), but also increase physical activity, UV exposure (Vitamin D), social contacts and thereby reduce stress, morbidity and premature mortality. Moreover, a green and active lifestyle may create co-benefits such as a reduction in CO_2 emissions and traffic congestion. Urban farming may increase biodiversity and quality of life. However, knowledge is still lacking despite a wide variety of experiments taking place in cities. Sharing about such experiments is also necessary as decision-makers need better data to reduce the complexity of factors in urban planning, transport, environmental exposures, social processes and behavior affecting human health: they need enhanced understanding of such issues to know at which level and where to target their actions in an efficient and cost effective way.

[38]Chokshi DA, Farley TA. Cost-effectiveness of environmental approaches to disease prevention. New Eng J Med 2012; 367: 295-7

New research tools, methods and paradigms are under development. Geographical information systems, smartphones, GPS devices, and remote sensors can be used to produce location-based data and measure environmental exposures and mobility. The Exposome (i.e. totality of environmental exposures)[39], smart cities paradigm, citizen observatories and other related areas of science and technology can provide the information needed. Further action needs to be taken for better visions and concerted research and action involving all stakeholders to provide more holistic solutions. It requires further collaboration between both researchers and practitioners in the field, and more input from many sectors including, urban and transport planning, energy, the bioeconomy, environment, health and well-being and social and behavioral sciences.[40]

9.1.1.7 Social cohesion, safety and security

Demographic change and the growth of international migration

The world's population is expected to grow during the 21st century, though at a slower rate than in the recent past. According to the UN's 2015 medium-variant projection, the global population will reach 8.5 billion by 2030 and 9.7 billion by 2050. Growth will take place almost entirely in less developed countries – for example, Africa will account for more than half the increase in global population between now and 2050 – while population size in much of the developed world will stabilize or even fall. While today, 60% of the global population lives in Asia (4.4 billion), 16% in Africa (1.2 billion), and 10% in Europe (738 million), by 2050, Asia's share will fall to 54% (5.3 billion), Africa's will increase to 26% (2.5 billion) and Europe's will decline to 7% (707 million). Africa is projected to be the only region still experiencing substantial population growth after 2050, so that by 2100, it is expected to account for 39% (4.4 billion) of the world's population.[41]

Regarding the distribution of the age groups, the number of youth aged 15-24 years is growing rapidly in Africa, increasing 42% by 2030 and more than doubling by 2055.[42] A second group of youthful countries is projected to persist in the Middle East. A high proportion of working-age adults could offer these countries an economic boost; on the other hand, these countries are typically among the poorest and already struggle to

[39] http://www.mdpi.com/1660-4601/11/8/7805

[40] Vercruysse, N., Stahel, W.R., Saritas, O. et al. (2015). The Junction of Health, Environment and the Bioeconomy: Foresight and Implications for European Research and Innovation Policies, A report prepared for Directorate-General for Research and Innovation, European Commission, Brussels.

[41] UN (2015), World Population Prospects: The 2015 Revision, Key Findings and Advance Tables, UN Department of Economic and Social Affairs, Population Division, New York.

[42] UN (2015), Youth population trends and sustainable development, Population Facts, No. 2015/1, UN Department of Economic and Social Affairs, Population Division, New York.

provide educational and employment opportunities for their young people. A reservoir of disaffected young people with low education and few job opportunities may lead to greater political and social instability.

Meanwhile, the developed and developing parts of the world experience aging populations. Low fertility rates across much of the developed and, increasingly, developing world will result in population decline in many countries. For some, notably Japan and much of Central and Eastern Europe, populations are expected to fall by more than 15% by 2050. At the same time, life expectancy is projected to reach 83 years in more developed countries by mid-century and 75 years in the less developed regions. The combination of low fertility rates and longer life spans will lead to future ageing in all major regions of the world, so that by 2050, there will be almost complete global parity between the number of over-60s and the number of children. This is a significant change from the past and present: while there are around 900 million over-60s in the world today, their number is projected to increase to 1.4 billion by 2030 and 2.1 billion by 2050, and could rise to 3.2 billion by 2100. Europe has the largest proportion of over-60s (24% in 2015), a share that is projected to reach 34% in 2050. But rapid ageing will occur in other parts of the world as well, particular in Asia, where the over-60s are expected to make up 25% of the population in 2050.70 Almost 80% of the world's older population will live in less developed regions: China will have about 330 million citizens aged 65 or more, India about 230 million, Brazil and Indonesia over 50 million.[43]

The size of the working-age population (15-64) is currently at an historical peak and will very soon begin to diminish. This means the size of the dependent population (i.e. children under 15 and persons over 65 years of age) relative to the working-age population that provides social and economic support will increase. Without international migration, the working-age population in more developed regions would decline by 77million or 11% by 2050; the situation in Europe is even more severe, where the size of the working population would decline by 20% (Royal Society, 2012). Old-age dependency ratios are expected to reach very high levels indeed in some OECD countries – 70 per 100 in Japan and over 60 in Italy, Korea, Portugal and Spain by 2050.[44]

Ageing implies changes in lifestyle and consumption patterns, and this will have significant implications for the types of products and services in demand. At the same time, the prevalence of non-communicable diseases and increased disability among the elderly will place considerable burdens on healthcare and other services, where a more-than-

[43]UN (2011), World Population Prospects: The 2010 Revision, UN Department of Economic and Social Affairs, Population Division, New York.
[44]UN (2011), World Population Prospects: The 2010 Revision, UN Department of Economic and Social Affairs, Population Division, New York.

proportional increase in demand can be expected. High old-age dependency ratios will lead to fiscal pressures that raise the risks of inter-generational conflict. In response, governments will likely seek to reduce beneficiaries and benefits, increase workers' contributions, and extend the required number of working years.[45]

While the ability of elderly citizens to remain active and continue working beyond official retirement age is set to increase, this alone is expected to be insufficient to meet workforce shortages. The central scenario in the OECD's long-term growth projection assumes that inflows of migrant workers will be an important factor to mitigate ageing in most OECD economies[46], heralding a new age of international migration. It is difficult to measure and estimate reliably future changes in levels of international migration – the movement of people across international boundaries, which is often a response to changing socio-economic, political and environmental forces, is subject to significant volatility.[47] Looking back over the period 1960-2010, international migration stocks grew both in real numbers and as a percentage of the world's population (from 2% in 1960 to 3.1% in 2010). Even if the stock of international migrants is assumed to remain at around 3% of the world's population, this implies a growth to around 250 million by 2030.[48] Other estimates put the flow of international migrants from developing to developed countries at 96 million during 2010-50, with the US, Canada, the UK and Australia the largest net receivers.[49] However, developing Asia, particularly China, could become a major area of destination by 2050, and a growing number of migrants will probably move between and within Asia and Africa as countries in these regions develop economically.

Estimations of future workforce shortages should consider technological change as an important determining factor, particularly the impacts of robotics and artificial intelligence, which may reduce the demand for migrant workers' labor and skills. Technologies such as these and others (e.g. neurotechnologies) may also enhance physical and cognitive capacities, allowing people to work longer in their lives. Nevertheless, on the supply side, youth bulges in some parts of the developing world are creating conditions ripe for outward migration: a likely lack of employment opportunities and growing risks of internal conflict will force many to seek better lives and safety elsewhere. Climate change may also have more of an influence on future international migration flows.[50] And existing

[45] US National Intelligence Council (2012), Global Trends 2030: Alternative Worlds, NIC, Washington, DC.

[46] Westmore, B. (2014), "International Migration: The relationship with economic and policy factors in the home and destination country", OECD Economics Department Working Papers, No. 1140, OECD Publishing, Paris, http://dx.doi.org/10.1787/5jz123h8nd7l-en.

[47] UN (2012), World Urbanization Prospects 2011, UN Department of Economic and Social Affairs, Population Division, New York.

[48] UK Foresight (2011), Migration and Global Environmental Change: Final Project Report, The Government Office for Science, London.

[49] UK Ministry of Defence (2014), Global Strategic Trends – Out to 2045, Strategic Trends Programme, Fifth Edition, Ministry of Defence, Swindon.

[50] European Environment Agency (2015) The European Environment: State and Outlook 2015 – Assessment of Global Megatrends, European Environment Agency, Copenhagen.

diasporas in developed countries will continue to facilitate migration and settlement of friends and family from the less developed world.[51]

International migration, while potentially solving anticipated labor and skills shortages in receiving countries, will see the size and importance of ethnic minority communities grow. Some of these may be poorly integrated and economically disadvantaged, which may lead to tensions and instability.[52] This may make it more difficult for governments to win support for more open and forward-looking immigration policies.[53] Immigration will also be challenged by inequalities: in societies with a shrinking middle class, openness is likely to be perceived as a threat to well-being and job security. Rising populism could also see governments use migrants as scapegoats for existing social problems.[54]

A key, much more significant factor driving globalisation is migratory flows. There are roughly 230 million migrants in the world today, moving in search of better lives and better jobs, fleeing from wars and civil strife, and/or reuniting with their families. Migratory movements show no sign of slacking, as the long drawn-out conflicts among other places in North and sub-Saharan Africa and the Middle East drive people to seek safe havens in Europe, and income and wealth disparities across the globe continue to attract people from poorer to more prosperous countries. Many, of course, bring qualifications and skills with them. In the decade to 2010/11, for example, the number of tertiary educated immigrants in the OECD increased by 70%, to reach 27 million.[55] All the signs point to a further strengthening of factors pushing and pulling migratory flows in the decades to come.

9.1.1.8 Towards holistic health: Prevention and treatment of diseases and pandemics

The healthcare systems of the future will have to face a growing spectrum of challenges. Progress has been made in the battle against some infectious diseases such as tuberculosis (TB), HIV/AIDS and malaria. HIV/AIDS mortality has fallen quite dramatically in recent years, and deaths from TB (95% of which occur in low- and middle-income countries) are declining, albeit very slowly.[56] Approximately half of the world's population is at risk of malaria (with 90% of malaria deaths occurring in Africa). However, between 2000 and 2013, an expansion of malaria interventions helped to reduce malaria incidence

[51] EUISS and ESPAS (2012), Global Trends 2030: Citizens in an Interconnected and Polycentric World, EUISS and ESPAS, Paris.

[52] UK Ministry of Defence (2014), Global Strategic Trends – Out to 2045, Strategic Trends Programme, Fifth Edition, Ministry of Defence, Swindon.

[53] ESPAS (European Strategy and Policy Analysis System) (2015), Global Trends to 2030: Can the EU Meet the Challenges Ahead?, ESPAS, Brussels.

[54] EUISS (European Union Institute for Security Studies) (2010), Global Governance 2025: At a Critical Juncture, EUISS, Paris.

55 OECD (2013), Regions at a Glance 2013, OECD Publishing, Paris, http://dx.doi.org/10.1787/reg_glance-2013-en.

56 WHO (2014), Global Tuberculosis Report 2014, WHO, Geneva.

by 30% globally, and by 34% in Africa. During the same period, malaria mortality rates decreased by an estimated 47% worldwide and by 54% in Africa.[57] However, trends are at work in society that suggest that future progress in countering infectious diseases may become harder to achieve. Urbanisation is continuing to gather pace in the developing world; climate change is influencing geographic patterns of human and animal infections (e.g. malaria); international tourism is growing; global migration levels are unlikely to abate; and excessive current use of antibiotics is set to reduce the future effectiveness of drugs against some communicable diseases (e.g. TB).

While the annual number of deaths due to infectious disease is projected to decline, the total annual number of deaths from non-communicable diseases (NCDs) is projected to increase from 38 million in 2012 to 52 million by 2030. This epidemic of NCDs is being driven by powerful forces such as demographic ageing, rapid unplanned urbanisation, and the globalisation of unhealthy lifestyles. While many chronic conditions develop only slowly, changes in lifestyles and behaviors are occurring rapidly and pervasively. The leading causes of NCD deaths in 2012 were cardiovascular diseases, cancers, respiratory diseases and diabetes. These four major NCDs were responsible for 82% of NCD deaths. Going forward, annual cardiovascular disease mortality is projected to increase from 17.5 million in 2012 to 22.2 million in 2030, and annual cancer deaths from 8.2 million to 12.6 million.[58] The prevalence of diabetes has been increasing globally in recent decades, and WHO projects that it will be the seventh-leading cause of death in 2030. NCDs already disproportionately affect low- and middle-income countries, and current projections indicate that by 2020 the largest increases in NCD mortality will occur in Africa and other low- and middle-income countries.[59]

Cases of neurological disease, spurred in particular by rising longevity and the anticipated rapid ageing of societies in the coming decades, are expected to multiply. Alzheimer's Disease International (ADI), for example, estimates that 46.8 million people worldwide are living with dementia in 2015, and that the number will almost double every 20 years, reaching 74.7 million in 2030 and 131.5 million in 2050.

Fifty-eight percent of all people with dementia live in countries currently classified by the World Bank as low- or middle-income countries. This proportion is estimated to increase to 63% in 2030 and 68% in 2050. Between 2015 and 2050, the number of older people living in high-income countries is forecast to increase by 56%, compared with 138% in

57 WHO (2015), Malaria Fact sheet N°94 Reviewed April 2015, http://www.who.int/mediacentre/factsheets/fs094/en/.

58 WHO (2014b), Global Status Report on Noncommunicable Diseases 2014, WHO, Geneva.

59 WHO (2011), Global Status Report on Noncommunicable Diseases 2010, WHO, Geneva.

upper-middle-income countries, 185% in lower-middle-income countries, and by 239% in low-income countries.[60]

Use of antibacterial drugs has become widespread over several decades (although equitable access to antibacterial drugs is far from being available worldwide). These drugs have been extensively misused in both humans and food-producing animals in ways that favor the selection and spread of resistant bacteria. Consequently, antibacterial drugs have become less effective or even ineffective, resulting in an accelerating global health security emergency that is rapidly outpacing available treatment options.[61]

The global health challenges for the next decades are immense. But the very scale of those challenges across the developing world and the advanced economies offers vast opportunities for established and novel medical procedures, specialized treatments, new medicines and technological solutions, as well as for the development and implementation of innovative systems of health provision and care co-ordination and management. Unfortunately, at the present time the resources devoted to preventing, mitigating and curing disease, as well as to people's access to those resources, are also unevenly distributed. Evidence to date indicates that access to good health care correlates quite strongly with income level, educational level and access to knowledge.

On the positive side as incomes and educational levels rise across much of the globe, even in poorer countries, and the middle classes in emerging and developing economies gain ground, the prospects for sustainable health markets in those parts of the world are expected to brighten considerably. The quest for longevity continues at pace, with a great deal of effort being put into finding the substances, interventions and habits that can keep people live longer and healthier lives, for example by revolutionising the treatment for a massive range of degenerative conditions.[62] For a meaningful long life, the elderly will need to have sufficient mental capital and retain better cognitive abilities and living standards. As people work to an older age, there is a chance that they will de facto be mentally stimulated for longer.[63] Quality of life is expected to increase with healthy food, meaningful work, safe workplaces, social security as well as recreational activities in local and global resorts.

Better diets, lower air pollution and chemical exposure levels, healthier living environments and more active lifestyle will lead to a reduction in NCDs (outdoor air pollution is

[60]ADI (2015), World Alzheimer Report 2015: The Global Impact of Dementia – An Analysis of Prevalence, Incidence, Cost and Trends, ADI, London.
[61]WHO (2014c), Antimicrobial Resistance: Global Report on Surveillance, WHO, Geneva.
[62]http://www.gizmag.com/gdf11-protein-aging-mice-harvard/31929/
[63]http://www.pewinternet.org/2014/08/06/future-of-jobs/

responsible for nearly 500,000 premature deaths in Europe alone.[64] More holistic approaches are needed. Hazard identification and risk assessment require modern approaches taking individual and population characteristics into account. The latter are currently developed in adverse outcome pathway focus in toxicology and creation of follow-up studies of suitable cohorts e.g. family and birth cohorts.

New approaches are needed for health and social care, building both on public engagement and technology, developing and supporting networks within different communities, and engaging people in disease prevention and the provision of healthcare and social services. New social paradigms are emerging, many of which are triggered by contradictions in the urbanisation process and new technologies. Social cohesion is an important determinant of health. Social and socio-ecological cohesion, including the urbanisation of nature and its socio-environmentally enabling and disabling conditions are key processes in healthy longevity.[65]

Intervention and guidance towards healthy behavior targeting communities as well as individuals are however needed. New cross-cutting methods could help to take cross sectoral approaches including socio-economic and behavioral aspects, the impact of climate change and increased urbanisation into account. Human biomonitoring (HBM), sensoring and health surveys can be used as tools for increasing health awareness and promotion, as well as assessing human exposure to environmental agents and their adverse and beneficial effects. Biomarkers are used to measure indicators of changes and events in biological systems with the analysis of specimens of human tissues such as blood, urine, hair, adipose tissue and teeth. Sensors can be used to measure lifestyle, mobility, behavior and exposure patterns in order to suggest and promote healthier patterns.

Thanks in particular to green technologies which allow focusing on safe production and products, we could hope that by 2030, the burden on young generations will be less, resulting in reduction of neurobehavioral and reproductive problems along with improved immune resistance and mental health. The use of nature/green space to treat and relieve diseases such as obesity, COPD (please define), attention deficit hyperactivity disorder (ADHD), allergies, dementia and depression should be considered to ensure sustainable and resilient lifestyles through a balance between humans and nature.

[64] Air Quality in Europe – 2014 report http://www.eea.europa.eu/publications/air-quality-in-europe-2014

[65] http://www.sed.manchester.ac.uk/geography/staff/documents/Cities_social_cohesion_and_environment.pdf
http://intl-usj.sagepub.com/content/49/9/1959.abstract

The efficient shift from treatment to prevention, individual participation and responsibility, while ensuring the health of ageing societies and dealing with threats to treatment such as antimicrobial resistance, remain major challenges. The goal is that healthy life expectancy increases as genetic and environmental causes of disease and possible interactions between the two are better understood and as regulation prevent harmful exposure and promote healthy environments. The enhanced use of Information and Communication Technologies increases the amount of health-related information available and could thus continue improving our ability to turn knowledge into increasing life-expectancy and quality of life. The market for diagnostic tools is likely to continue to flourish which could cause dramatic evolutions (positive or negative) in the field of health.

Cheap mapping of the genome has generated an important potential for early 'diagnosis' (or 'prognosis') for every individual. Mapping of the exposome (and all the other 'omes' like the 'virome') as well as other sensor based indicators and human biomonitoring promises to make health and disease, prevention, diagnosis and treatment amenable to analysis through vast amounts of computer power, offering potentially greatly improved health care and health. Yet, considerations of privacy, as well as of cost, e.g. the cost of research, treatment and health insurance, dampen these possibilities and reduce the speed of developments.[66]

9.1.1.9 Geopolitical instability and changing nature of warfare

The shift from a hegemonic to a multipolar world of economic and political power is of long standing. Indeed, the gradual transition was noted at least as far back as the 1980s.[67] Thirty years on, the dynamics of change are as strong as ever, paving the way for a further significant transformation of the global landscape in the decades ahead.

The next 50 years will see the center of gravity of the world economy shift east and south. By 2030, developing countries are expected to contribute two-thirds of global growth and half of global output, and will be the main destinations of world trade. Simultaneously, considerable changes will take place in the relative size of the world's major economies. Fast growth in China and India will see their combined GDP surpass that of the Group of Seven (G7) economies fairly soon and overtake that of the entire current OECD membership by 2060.[68] The top economies in 2030 are widely expected to be the

[66] Vercruysse, N., Stahel, W.R., Saritas, O. et al. (2015). The Junction of Health, Environment and the Bioeconomy: Foresight and Implications for European Research and Innovation Policies, A report prepared for Directorate-General for Research and Innovation, European Commission, Brussels.

[67] OECD (1987), Interdependence and Co-operation in Tomorrow's World, OECD Publishing, Paris.

[68] Johansson, Å., et al. (2012), "Looking to 2060: Long-term global growth prospects: A Going for Growth report", OECD Economic Policy Papers, No. 3, OECD Publishing, Paris, http://dx.doi.org/10.1787/5k8zxpjsggf0-en.

United States and China, with a race for third place between the European Union and India.[69]

Several new emerging countries will appear on the scene by 2030, since economic progress is accelerating in many states. New large economies in 2030 (measured in total GDP at purchasing power parity [PPP]) will include Mexico, Indonesia, Turkey, Nigeria and Vietnam, their eventual success depending largely on the quality of their governance and of their economic policy, their demographic profile and the level of education they provide to their citizens.[70]

As the new geographic diffusion of power has changed, so too have many of the features of power. A growing list of emerging states will be looking to translate their economic gains into more meaningful global influence. Global governance structures will evolve further as key groupings take on board the growing presence of some of the new vibrant economies, perhaps following the example set by the G7/G8, which scaled up to the G20 as a reflection of those new realities. In so doing, a delicate balance will need to be struck between the necessary engagement of such countries in international economic governance and the challenge of coordinating the growing number and diversity of participants.

Non-state actors such as multinational businesses, non-governmental organisations, sovereign wealth funds, major cities, academic institutions and foundations endowed with global reach are all expected to play increasingly influential roles in the coming decades. In some cases, they may even prove instrumental in the creation of new alliances and coalitions that have the wide public support to tackle some of the global challenges facing the planet – poverty, environment, security, etc.[71]

Cities, and in particular megacities, stand out as one of the increasingly powerful subnational actors. Metropolitan areas are the prime engine of growth. In the OECD area, more than half of economic growth and job creation occurred in the 275 metropolitan areas with over 500 000 inhabitants.[72] Megacities (populations over 10 million) in the developed world and in the emerging economies have until now been very much the center of attention for business and policy makers alike – small wonder, since together

[69]Gros, D. and C. Alcidi (eds.) (2013), The Global Economy in 2030: Trends and Strategies for Europe, ESPAS, Brussels.

[70]ESPAS (2015), Global Trends to 2030: Can the EU Meet the Challenges Ahead?, ESPAS, Brussels.

[71]NIC (2012), Global Trends 2030: Alternative Worlds, US NIC, Washington, DC.

[72]OECD (2013b), Regions at a Glance 2013, OECD Publishing, Paris, http://dx.doi.org/10.1787/reg_glance-2013-en.

they account for more than 70% of world GDP. This looks set to change, however, as interest switches to the growth of medium-sized cities (below 10 million inhabitants) especially in emerging and developing economies.

All these dynamics will certainly bring about new types of frictions and conflicts on the agenda. Looking back, the last two decades have witnessed a gradual decline in the number (and severity) of internal armed conflicts worldwide – from a peak in 1994 when almost a quarter of the world's countries were embroiled in civil conflict, to less than 15% today. This has been much the result of widespread improvements in factors such as levels of education, economic diversification and more favorable demographic developments.[73] The number of interstate conflicts, while fluctuating somewhat, has also been on a declining trajectory[74], thanks mainly to a rising body of global norms against such warfare and the deepening economic and financial linkages among countries.

When it comes to forecasting the longer-term outlook for armed conflict, views diverge. Forecasts indicate that this downward trend will continue, with the share of countries involved in internal armed struggles falling from 15% now to 12% in 2030, and 10% in 2050, and with conflicts concentrated mainly in sub-Saharan Africa and South Asia.108 Others are somewhat less sanguine. The US National Intelligence Council states that the risks of interstate conflict are on the rise owing to changes in the international system, but does not foresee conflict on the level of a world war involving all major powers.[75]

New developments might be expected at the crossroads of intra- and interstate armed conflict, as internal tensions spill across frontiers, generating "internationalized" intrastate conflict. Outstanding features of the recent wave of warfare include the extreme fragmentation of armed groups and the decentralized multiplication of fronts and factions engaged in conflict. For Briscoe (2014), three particular risks stand out for the international community: the intractability of conflict, with trouble tending increasingly to re-emerge in territories that have already been affected by warfare; unpredictable suicide attacks on major cities and infrastructures that lead to vulnerable states backing proxy groups and exacerbating cross-border civil war; and doubts about the capacity of current institutional mechanisms to deal with such fragmented and internationalized internal conflicts.

[73]Hegre, H. and Nygard, H.M. (2014), "Peace on Earth? The future of internal armed conflict", Conflict Trends, 01-2014, Peace Research Institute, Oslo.
[74]Pettersson, T. and P. Wallensteen (2015), "Armed conflicts, 1946-2014", Journal of Peace Research Vol. 52/4.
[75]NIC (2012), Global Trends 2030: Alternative Worlds, US NIC, Washington, DC.

9.1.1.10 Among the most prominent trends in the evolution of warfare, the following ones can be mentioned[76]:

Wars are taking place in closer to the habitation areas of civilians, and military operations are increasingly taking place increasingly in residential areas. There is less tolerance for the loss of the military personnel and civilian lives. With the growing role of media and social networking technologies, societies are more exposed to losses. Therefore, increasing number of death tolls overturn social, and thus political support for armies. Lower or no negative impact on human lives and settlements is becoming a key success factor for military operations.

The security and sustainability of energy sources can be considered as one of the key determinants of success in military operations. Due to the diversity of war environments, concepts and technologies mentioned above, military operations may take place in a wide variety of conditions. This may require military equipment to be suitable for the use of more than one energy source to ensure their viability for an extended period of time.

The meaning and role of leadership in armies is also changing. In the past, leadership referred to 'power', however, in the current war environment, it refers more to 'common wisdom'. Due to the increasing flow of information from a number of sources and growing complexity, it is difficult, if not impossible, for a single leader to make correct decisions in a limited time. It is expected that satellite and sensor systems, artificial intelligence and advanced data analytics will play a greater role as decision support systems. Therefore, new generation leaders in the army will go beyond sole commanders, but towards becoming 'CEOs of the knowledge economy'. Consequently, creative and flexible thinking, collaborative behaviour, skills collective intelligence and the ability to work with Information and Communication Technologies are becoming crucial qualifications for future military leaders.

There are of course important economic implications for both for the countries involved in conflict and for their trading partners. Armed conflict can impact negatively on openness to trade and investment seems intuitively obvious, and yet the matter has attracted little attention from economic research until fairly recently. Major conflicts can indeed reduce trade flows (by up to two-thirds). The impacts tend to be asymmetrical, affecting the

[76]Burmaoglu, S. and Saritas, O. (2016). Changing characteristics of warfare and the future of military R&D, Technological Forecasting & Social Change, Article in press, available online (http://dx.doi.org/10.1016/j.techfore.2016.10.062).

exporter side more than the importer side, and depend to some extent on the nature of the conflict and the number of conflicts a country is involved in.[77] For exporting nations, understanding and anticipating the risks and the nature of these economic impacts will be an important part of conducting business in an increasingly complex geopolitical future.

9.1.1.11 Connected world and cybersecurity

Information and Communication Technologies (ICTs) underpin much of the globalisation phenomenon. Internet penetration helped by mobile broadband has been growing quickly. For the developing world, it is estimated that over the seven-year period from 2014 to 2020, an additional 1.1 billion new individuals will acquire a mobile phone for the first time, or 155 million per year. Moreover, 3G and 4G penetration is expected to double in the developing markets by 2018, with some operators planning to leapfrog 3G technology and launch 4G networks.[78] However, a new digital divide is looming on the horizon. The next phase of Internet development will be marked by a growing number of connected devices. North America, for example, is likely to have almost 12 devices per capita connected by 2019, Western Europe around 8. This will be in stark contrast to Latin America's 2.9 and Africa's 1.4, suggesting big differences in how societies will be utilizing, and benefiting from, the Internet.[79]

Apart from moves by some governments to limit citizens' access to Internet content through controls (the "walled garden" phenomenon), a further obstacle to the global spread of information technology and its multiple applications and connectivity potential could be the lack of local language in Internet use. While it is true that English serves as a common Internet language for millions of people, the flip side is that millions of people have no access because they speak no English. Around 55% of websites around the world use English as the primary language, yet only 5% of the global population (335 million) speaks English as their first language. Chinese on the other hand (including all dialects) is the first language of over 1.1 billion people (17% of the global population), yet only 3% of websites are written in Chinese. This trend continues in many non-English-speaking countries throughout the developing world, where very little Internet content exists in languages such as Arabic, Hindi and Bengali.[112]

77 Kamin, K. (2015), The Impact of Conflict on Trade – Evidence from Panel Data (work-in-progress draft), University of Kiel, www.etsg.org/ETSG2015/Papers/323.pdf.

78 GSMA Intelligence (2014), Local World – Content for the Next Wave of Growth, Analysis, GSMA Intelligence, London.

79 ITU and UNESCO (2015), The State of Broadband 2015: Broadband as Foundation for Sustainable Development, Broadband Commission for Digital Development, Geneva.

Whilst providing opportunities for the society, the penetration of ICTs into all spheres of life gives rise to a number of threats. Factors like the transboundary nature of cyberspace, its dependence on sophisticated information technologies, widespread use of sites and services increase the likelihood and strength of threats. Particularly, the protection of sensitive data from the individual to national and international levels has become a major concern for cybersecurity.

9.1.1.12 Cybercrimes may differ in nature. Broadly three categories can be distinguished:

a) Offences against the confidentiality, integrity and availability of computer systems. These include the following types of crimes: illegal penetration and interference in the computer system, illegal access and use of information, production and distribution of malicious computer programs, breach of confidentiality of personal data

b) Financial cybercrime and crimes causing personal injury. Computer fraud associated with forging signatures, violation of intellectual property rights, carrying out mass mailings, acts causing personal injury

c) Cybercrime associated with the spread of inappropriate content. Actions leading to the incitement of ethnic hatred, production and distribution of child pornography, the acts of international terrorism

The common characteristics of all threats are[80]:

- Cybercrime is widespread in the areas of financial instruments, computer and content in violation of the confidentiality, integrity and availability of computer systems.
- Perceptions of the risks vary considerably for the state, business and individuals.
- Cybercrime is much more common for individual users than for organised groups of users (organisations, groups, and so on.).
- Individual cybercrimes are more common in developing countries and require considerable effort to prevent them.
- The share of the global traffic that violates intellectual property rights is 24%.
- These criminal tools like botnets have become widespread in 2011 they controlled more than 1 million IP addresses.

Around the globe, 82 countries have signed international agreements on the fight against

[80] United Nations Office (2013). Comprehensive Study on Cybercrime. http://www.unodc.org/documents/organized-crime/UNODC_CCPCJ_EG.4_2013/CYBERCRIME_STUDY_210213.pdf

cybercrime. More than 40 countries have become parties to the Convention on Cybercrime of the Council of Europe regulating the most effective tool for the development of regulation in this area.[81] Economic losses from cybercrime in 2014 amounted to more than $ 400 billion.[82] The US is the leading country, which has the highest rank in the Global cybersecurity index (GCI).[83] Whilst the country allocated 0.15% of its GDP for cybersecurity in 2009, the planned amount for 2017 is 0.35% of GDP.[84] This increase investment in information security can be explained, on the one hand, due to the improvement and accessibility of opportunities for cybercrime by hackers, and on the other hand, due to the increase in the share of valuable information to be used in companies and other organisations within networks, which is associated with an increase in the use of ICT technologies in the organisational activities of the companies. Similar to governments, corporations are increasingly investing in cybersecurity in various areas including software and hardware tools, recruitment of staff responsible for information security, special training and staff development programs, the development of professional services, issues on transmission functions on outsourcing.[85]

9.1.2 Domestic macro trends

South Africa is estimated to currently host a population of approximately 58 million people, with approximately 51% (approximately 29,5 million) of the population being female (Stats SA, 2019). By 2018, life expectancy at birth was estimated at 61.1 years for males and 67.3 years for females (Stats SA, 2018). In 2015, the size of the South African economy was estimated at R3,055.2 billion (measured in constant 2010 prices, seasonally adjusted and annualised) (Stats SA, 2016). Figure 13.1 shows how the Gross Domestic Product (GDP) of the country has nearly doubled since the transition from apartheid in 1994 to its current institutional form as a constitutional democracy (NACI, 2016b:32).

[81] United Nations Office (2013). Comprehensive Study on Cybercrime. http://www.unodc.org/documents/organized-crime/UNODC_CCPCJ_EG.4_2013/CYBERCRIME_STUDY_210213.pdf

[82] McAfee Labs (2016). Threats Predictions. http://www.mcafee.com/us/resources/reports/rp-threats-predictions-2016.pdf

[83] ITU (2015). International Telecommunication Union. ABI Research. Global Cybersecurity Index & Cyberwellness./http://www.itu.int/dms_pub/itu-d/opb/str/D-STR-SECU-2015-PDF-E.pdf

[84] Atlantis (2015). Atlantis Council. Risk Nexus. Overcome by cyber risks? Economic benefits and costs of alternate cyber futures./http://publications.atlanticcouncil.org/cyberrisks/

[85] Frost&Sullivan (2015). Global Information Security Workforce Study./https://www.isc2cares.org/uploadedFiles/wwwisc2caresorg/Content/GISWS/FrostSullivan-(ISC)%C2%B2-Global-Information-Security-Workforce-Study-2015.pdf

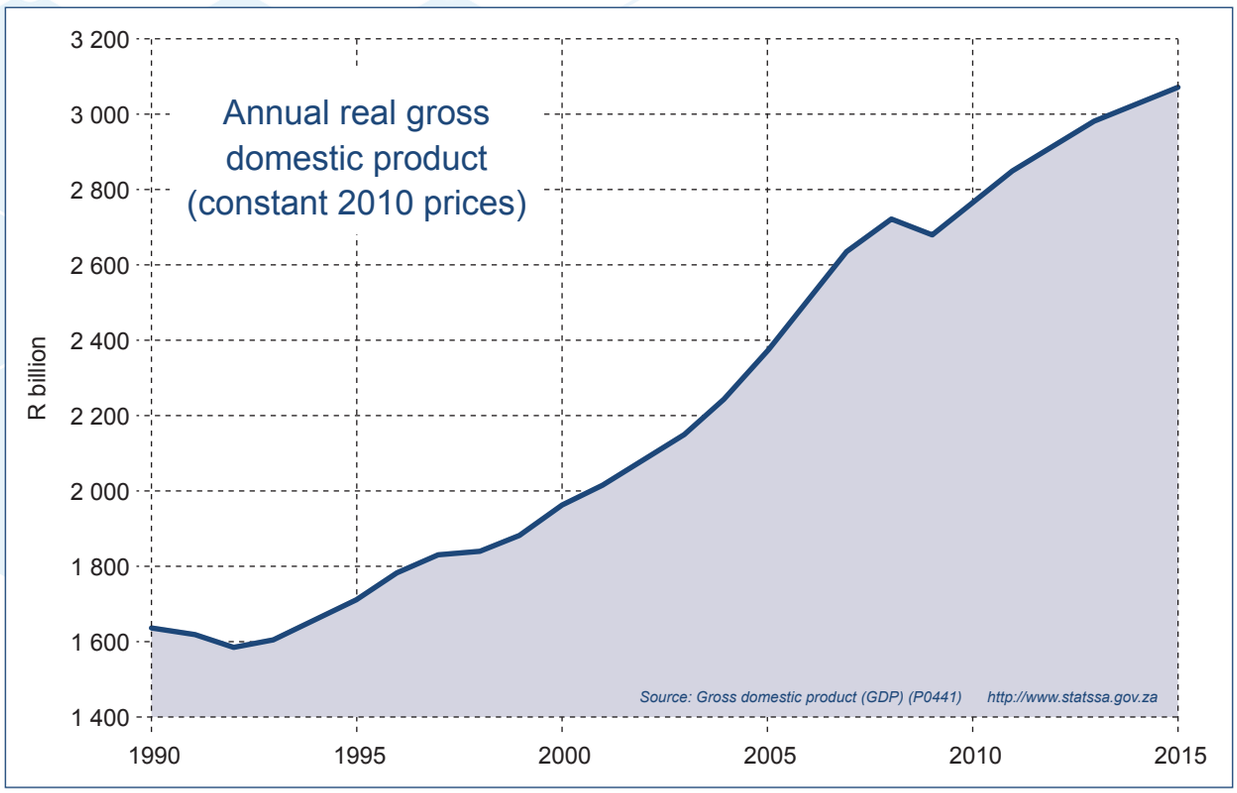

FIGURE 13.1 SOUTH AFRICAN GDP (1990-2015) AT CONSTANT 2010 PRICES

Source: NACI, 2016(b:32)

In the context of world systems, South Africa contributes only 0.46% of the global economy's total output. Emergent in the context of international and intra-national inequalities is the ascension of BRICS as a new geopolitical bloc on the semi-periphery of the world system, comprising Brazil (3.15% of total world output), Russia (2.49% of total world output), India (2.74% of total world output), China (13.9% of total world output) and South Africa. The BRICS countries are home to 42% of the world's population and collectively contributed 22.74% of the world's GDP in 2015. This share is marginally lower than that of the USA alone, which generated 23.32% of world output (NACI 2016b:32).

According to Bhorat (2015, cited in NACI 2016b:33), South Africa is "…one of the most consistently unequal countries in the world". South Africa is home to the most unequal distribution of incomes and wealth, which is consistent with its history and the persistence of market-oriented fundamentalist approaches which continue to exclude the majority of the country's population from access to economic resources.

South Africa's current situation reflects its past and contemporary challenges and obscures progressive possibilities in its emergent future. At the same time, globalisation has brought about an integrated, interdependent, hierarchical and capitalistic international economic order which has done little to address the problems of poverty, underdevelopment, unemployment and inequality that constitute major inherited and embedded structural legacies. The minerals-energy complex which underpinned apartheid has been unbundled and de-concentrated but its impacts include increased ecological constraints and environmental degradation. State capacities and capabilities are displaying evidence of being 'hollowed-out' through the local variation of new public management (NPM) also known as Batho Pele (RSA 1995). This has perversely allowed continuities with the legacy of apartheid (Van Vuuren 2006 cited in NACI 2016b:35).

The current South African economy situation is not growing fast enough to address societal challenges including unemployment, poverty and inequality. Government has identified a number of structural faults of the economy as follows:

- Structure of the South African economy remains insufficiently diversified.
- Inefficient public monopolies imposing high cost structure for network infrastructure such as electricity and transport.
- Disappointing export performance and exports that are concentrated in minerals and metals products.
- Highly concentrated industrial structures, limited competition and high barriers to entry.
- Weak and volatile growth in labour-intensive sectors such as construction, manufacturing and agriculture.
- Skills development not sufficiently linked to the economy's needs and developing capabilities.

At the same time, it is important to understand how growth drivers have changed since 1994 (as shown in Table 1).

TABLE 1 EVOLUTION OF SOUTH AFRICAN GROWTH DRIVERS SINCE 1994 (THE DEPARTMENT OF TRADE AND INDUSTRY, 2019)

Economy inherited in 1994	Growth Drivers 1994 – 2008	Growth Drivers 2008 – 2018
• Emerged from extended recessions. • Highly protected (tariffs, marketing boards and a broad range of State controls). • Inefficient and anti-competitive, largely serving a consumer market of 2-3 million whites.	• Massive opening up of SA economy with substantial growth of trade, especially imports. • Consumer demand grew as we steered the economy to serve all South Africans. • Emergence of China, leading to 'commodity super-cycle' and credit extension fueled SA growth of 4-5% but at cost of severe erosion of SA consumer base. • Financial & business services outgrew 'productive sectors' due to credit extension & house price growth. • Within business services, sub-sectors such as security, cleaning and maintenance services grew as business sought to evade labour regulations by outsourcing and casualising the workforce. • Pockets of mining & manufacturing benefited e.g. platinum, iron-ore and coal. Manufacturing sectors linked to mining such as machinery, basic iron & steel, industrial chemicals grew.	• Global Financial Crisis ended commodity super-cycle. • Global economy on a fundamentally different growth trajectory now. • Emergence of 'economic nationalism'. • WTO under serious threat, protectionism under guise of 'national security'.

Source: Based on Maharajh (2011, p20) with substantial additions and changes by the author

Government has proposed that sustainable growth over the long-run requires:

a) Building a capable state as well as a functional relationship between the state and the private sector.

b) Macro-economic policy in support of growth and employment creation.

c) Building economic confidence with policy predictability and rule of law.

d) Improving educational outcomes throughout individuals' working life.

e) Harnessing the opportunities brought by the fourth industrial revolution and adaptation to climate change.

f) Expanding effective, affordable and integrated public transport systems and prioritising targeted housing and urban development interventions to overcome spatial legacies and support densification.

g) Progressive policies which contribute to equity, social stability and cohesion.

Most importantly, government has identified industrialisation, investment and infrastructure, innovation, integration and inclusion as engines of growth.

9.1.3 Selected STI trends

South Africa's success with the Square Kilometre Array (SKA) is an indication of the country's STI presence in the world. The project brings together a wealth of the world's finest scientists, engineers and policy makers, and has the potential to enhance South Africa's strength in STI international collaboration. The MeerKAT array is to be integrated into SKA Phase 1 (2019-2024) with an additional 133 antennas in the Karoo, making it a 197-dish mid-frequency array.

However, in comparison with other countries, South Africa's NSI is not operating efficiently. In fact, there is evidence that the efficiency of the NSI has been declining.

The best indicator of inefficiencies at the system level is provided by the Global Innovation Index (GII). The GII measures innovation inputs and outputs for 126 countries. The overall score is the simple average of the two. The table below summarises South Africa's 2018 GII ranking.

Category	Rank	Score
Innovation inputs	48	45.36
Innovation outputs	65	24.87
Overall	58	35.13

There is a considerable difference between the input and output scores. The GII calculates the efficiency ratio by measuring the degree to which innovation inputs are transformed into innovation outputs, and in terms of this South Africa comes in at 83 out of 126, with a score of 0.55. Of the 57 countries that have a higher overall GII score than South Africa, only one, the United Arab Emirates, has a lower efficiency ratio.

According to a 2018 study performed by Cornell University, INSEAD and the World Intellectual Property Organisation, South Africa is a significant negative outlier in terms of its overall innovation performance relative to its stage of development – with only four countries faring worse (the United Arab Emirates, Qatar, Kuwait and Brunei).

While South Africa's efficiency in translating innovation inputs into outputs is very low overall, there are significant differences between the science, technology and innovation components of the NSI.

In terms of science, the indicators suggest that the system is working well. Since 2004/05, research output measured in terms of publications and citations has been increasing steadily. As the White Paper notes, although the number of university research staff did

not increase between 1996 and 2014, research output trebled. South Africa grew faster than the world average; the country has increased its global share of publications and citations. While inputs in terms of researchers remained static, outputs have increased significantly, indicating that the efficiency of the science system has been improving.

Of course, there are still challenges. South Africa's world ranking is far higher in social sciences (18) and the arts and humanities (18) than in life sciences (33), physical science (38) and technology (40). Moreover, with the number of researchers increasing very slowly, and growing pressures on teaching in universities as student enrolments grow and many of the most productive researchers reach retirement age, there is no room for complacency. However, the science system has been working well and it is possible to identify several policy measures that have contributed positively to this outcome – the South African Research Chairs Initiative, for example.

In terms of technology, several indicators suggest that the system is not working well. South Africa's share of patents at the United States Patent and Trademark Office (USPTO) has declined significantly against the global total. The country's share of total foreign patents at the USPTO declined by more than 50% between 1996 and 2015, which does not compare well with Brazil, the best comparator country for South Africa.[86] Likewise, South Africa's share of high technology exports does not compare well with Brazil's. The World Bank's development indicators show that South Africa's share stagnated while Brazil's grew significantly, and by 2016, high technology exports as a share of total manufactured exports was almost three times more for Brazil than South Africa.

South Africa's receipts from the sale of intellectual property show an overall trend of decline. In the first half of the 1990s, South Africa's receipts were higher than those of Brazil, but by 2015, Brazil's were more than six times higher than South Africa's. The decline in receipts from the sale of intellectual property between 2013 and 2016 is of particular concern.

In terms of innovation, there is also evidence that the system is not working as required. Measured in terms of the introduction of new products for export and/or new export markets, established firms are becoming less innovative, and there are fewer new firms entering the export market. These two indicators show clearly that innovation outputs are in decline.

[86]Brazil and South Africa have comparable GDP per capita, comparable economic growth rates and comparable rates of growth of manufacturing.

Despite new policies and additional resources, technology and innovation outputs have stagnated or risen only very slowly. There is an urgent need to ensure that policies and resources are used more effectively.

9.1.3.1 Innovation for economic development

The 6th Administration set economic transformation and job creation as key priorities. It promotes broader and cross-cutting role and contribution of innovation. The clearest indicators of the state of innovation in the business sector are derived from the export market. Increasing innovation results in an increase in the number of exporting firms, new export products and new export markets.

In South Africa, very few firms are significant exporters, and entry rates are below those of comparator countries. According to the World Bank's 2014 South Africa Economic Update – Focus on Export Competitiveness "South Africa has one of the lowest new firm entry rates into exporting among its peers". The same report shows that by far the largest share of South Africa's export growth is accounted for by existing firms selling into existing markets.

It is concerning that South Africa's top exporting firms, which are responsible for the overwhelming share of South African exports, are developing and selling fewer products into global markets. Few new firms have entered the export market, and established exporters are developing and selling fewer products into global markets. It is innovative and competitive firms that enable economic growth, diversify the economy and exports, raise productivity and enhance employment. Economic growth and employment creation are the highest priorities of government, but South African firms are becoming less rather than more innovative. The decadal plan should therefore aim to ensure that business sector innovation grows.

In South Africa, one of the critical constraints – and indeed there is some evidence to suggest that it is the binding constraint – lies in the paucity of skills and their deployment. South Africa's lowest GII scores are in education (83) and tertiary education (87), and a 2018 World Bank report identifies the skills constraints in South Africa as a major deterrent to innovation in general, and to the vitality of the manufacturing sector in particular. There should be continuous investment educational and skills development encompassing range of areas including mathematics, science, engineering, data coding and analytics, and robotics, which are critical to technological age necessary to put economy on new trajectory.

9.1.3.2 Innovation in the public sector

Although firms are recognised as being at the core of innovation, continuous improvement is also an imperative for the public sector, particularly in the context of increasing fiscal pressures and rising expectations from all citizens in respect of the improved delivery of public services (including education, health, security, transport infrastructure and access to public spaces). Government therefore needs to accelerate its pace of innovation, particularly as regards taking advantage of technological advances to improve its performance (e-government).

According to the 2019 White Paper on STI, integrating digital technologies into the provision of government services and the management of cities (smart cities) has the potential to transform the scope and efficiency of public services. It suggests a need for public sector to become an enabler for inclusive development through initiatives such as strengthening of ICT applications for e-government, e-learning and e-health. The mode of implementation suggested through this policy document is co-creation and user-led initiatives using socially innovative methods such living labs.

The new co-creation platform that is gaining momentum is the use of Hackathons to solicit the ideas and solutions from a broad range of stakeholders. The first National Public Service Hackathon, aimed at improving public service delivery, took place at the University of Johannesburg in 2018 and it attracted about 200 young innovators[87]. It was organised by the Department of Public Service and Administration. The South African National Roads Agency (Sanral) also hosted the Hackathon in 2018. This Hackathon challenged young participants to use data (Gauteng Freeway Improvement toll gantry data and WhereIsMyTransport public transport related data) and technology to create innovative smart mobility applications, NACI also hosted the Hackathons in 2018 and 2019 as part of the efforts of developing and improving the National STI Information Portal (NSTIIP).

In a study on the scope for innovation in the public sector, the OECD has recommended four core areas in which to raise levels of innovation (OECD 2015, cited in NACI, 2015). These are empowering employees through a focus on skills, culture and values, leadership and engagement; putting knowledge to use through data, openness and learning; working together through partnerships, structures and collaborations; and rethinking the rules through the realistic amendment of regulations and budgeting and project management processes.

[87] https://www.itweb.co.za/content/JN1gPvO1gPgMjL6m

Although this is still a relatively new area of public policy, the pursuit of innovative means to deliver public services has been recognised in South Africa for some time. In 2001 the Centre for Public Service Innovation was launched. This government component, part of the Minister of Public Service and Administration's portfolio, acts as facilitator for the unearthing, development and practical implementation of innovative solutions within and throughout the public service, towards a more effective, efficient and accountable government. The centre makes annual awards for innovative projects within the public sector and facilitate pilot projects aimed at demonstrating the value of innovative solutions.

9.1.3.3 Seize the opportunities of the digital economy and fourth industrial revolution

The country has taken a decisive step in confronting the opportunities and challenges brought by the fourth industrial revolution. This wave of revolution involves convergence of cyber, physical and biological systems to change the means of production, mobility, society and many aspects of life. In 2019, the Presidential Advisory Commission on Fourth Industrial Revolution was established. and this 30-member commission is chaired by the country's president. Its terms of reference include coordination of the development of South Africa's response through a comprehensive action plan to deal with the Fourth Industrial Revolution. As part of that mandate, the Commission would identify and recommend policies, strategies and plans that are needed to position South Africa as one of the leading countries in the evolution and development of Fourth Industrial Revolution.

Fourth Industrial Revolution has a potential to catalyse economic and societal transformation. Today's world is increasingly shaped by the rise of the digital economy. With billions of people using the Internet and mobile communications, knowledge diffusion is accelerating. In countries where literacy remains a challenge, image and voice communications are connecting communities to global networks. The proliferation of massive amounts of data is just a hint of what can be expected from the emergence of ubiquitous data generation and computing, dubbed the "Internet of Things". An open and accessible Internet, where creativity, sharing, entrepreneurship and experimentation can flourish, is essential for innovation in the 21st century. Big data and data analytics have become a driving force in science, product innovation, processes, organisational methods, and services, including healthcare.

The processing and analysis of big data will have important effects on the nature and processes of innovation itself. Big data analysis is proving to be a new addition to the

acquisition of knowledge, in addition to experimental science, theoretical analysis and computer simulation. Big data generates new hypotheses and the potential wherewithal to test these hypotheses.

In addition, the exploitation of big data will be a key element underpinning the competitiveness of firms in almost all sectors, but with particularly strong impacts in health care, retail and trade, manufacturing and public service (Manyika et al., 2011). As an illustration, sensors embedded in manufactured products create innovative after-sales service offerings such as proactive maintenance.

However, policy makers will have to be careful to strike the right balance between the free flow of data and the safeguarding of personal privacy and confidence (OECD, “Better innovation for better lives”, 2015).

9.1.3.4 Big data

The processing and analysis of big data will have important effects on the nature and processes of innovation itself. Big data analysis is proving to be a new addition to the acquisition of knowledge, in addition to experimental science, theoretical analysis and computer simulation. Big data generates new hypotheses and the potential wherewithal to test these hypotheses. Data-intensive analysis is likely to yield new insights and will change the way scientific research is done (NACI, 2015).

In addition, the exploitation of big data will be a key element underpinning the competitiveness of firms in almost all sectors, but with particularly strong impacts in health care, retail and trade, manufacturing and public service (Manyika et al., 2011). As an illustration, sensors embedded in manufactured products create innovative after-sales service offerings such as proactive maintenance. A key issue to confront, therefore, is how South Africa will leverage its capacities in big data, particularly data generated through the Square Kilometre Array project.

9.1.3.5 Water-energy-food nexus

Water, energy and food (WEF) nexus has since become a topical matter particularly in South Africa and the world in general, especially in the face of population and economic growths coupled with climate variability, frequent droughts and erratic rainfall. WEF nexus comprises systems that are increasingly interdependent (see Figure 1), which demand a more holistic view. For instance, water is an essential input for producing agricultural goods and hydropower, while energy is required to produce and distribute water and

food, and to pump water from groundwater or surface water sources, to power tractors and irrigation machinery, and to process and transport agricultural goods.

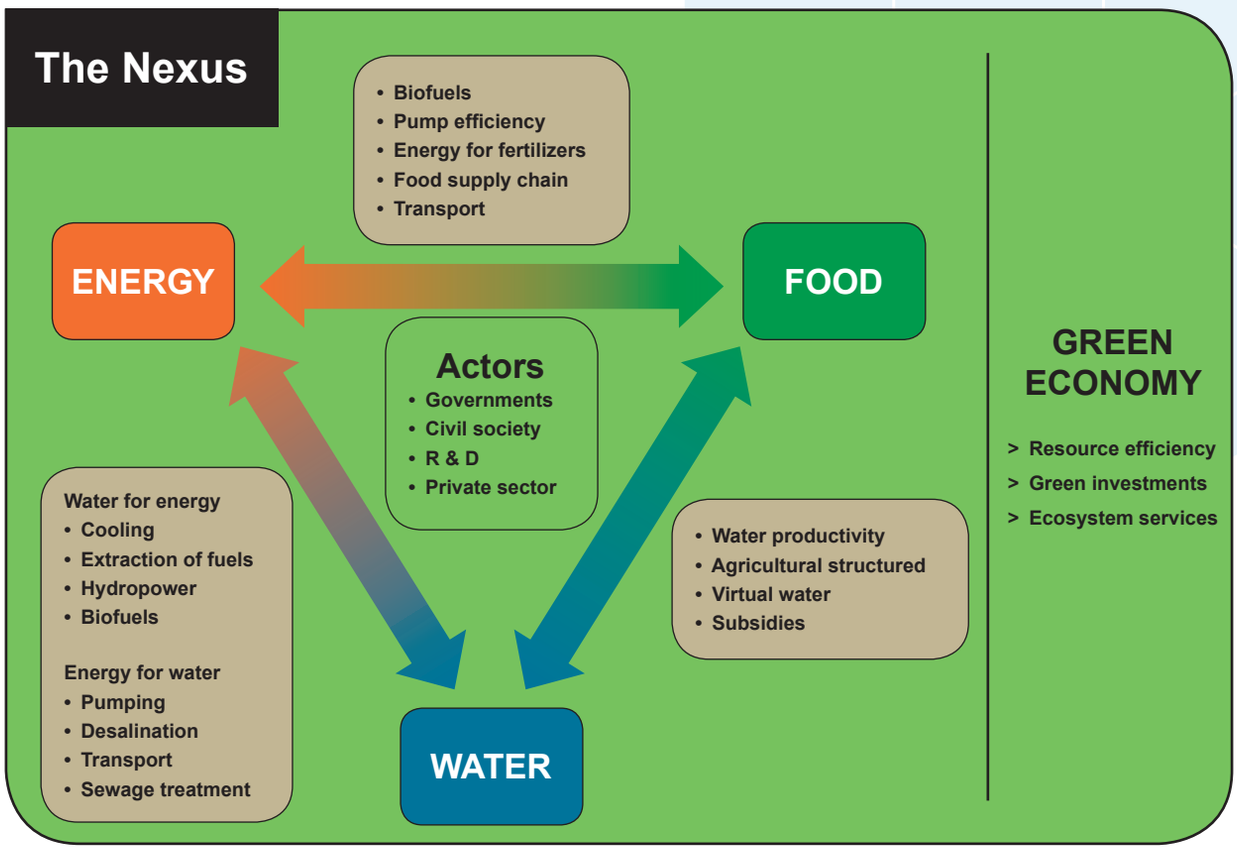

FIGURE 1: INTERDEPENDENCE BETWEEN WATER, ENERGY AND FOOD[88]

Using water to irrigate crops might promote food production, but it can also reduce river flows and hydropower. Growing crops for biofuel under an irrigation system could increase overall water withdrawals at the expense of food security. Converting surface irrigation into high-efficiency pressurised irrigation might save water, but might also result in higher energy use. All these examples suggest that challenges associated with WEF security should be dealt with through the coordinated and coherent efforts of all the relevant stakeholders and policies/strategies (Nasser, 2013). With this, policymakers, researchers and development agencies have an opportunity to integrate water, energy and agricultural sectors to optimise the use of the resource base, maximise synergies and minimise trade-offs and conflicts (WRC, 2018). Therefore, WEF nexus is to be closely aligned with SDGs 2 (zero hunger), 6 (clean water and sanitation) and 7 (affordable and clean energy). The main challenge regarding WEF nexus in South Africa is the unavailability or inaccessibility of data related to the three sectors. The only information available on WEF nexus has a regional SADC focus.

[88]http://www.water-energy-food.org/fotos/charts/01/nexus_en_450_b.jpg

9.1.3.6 Financing of the system and incentives

The Ministerial Review Committee report examined how the various dimensions of South Africa's complex NSI should be resourced to facilitate the further evolution of the South African economy into one in which high-level knowledge and skills are added to the system as new drivers. Some of the constraints identified are the unreliable pipeline of trained and knowledgeable people at all levels, the inadequate investment in existing research teams, not keeping up with infrastructure requirements, and failing to incentivise private investment in innovation, both within and from outside the country. The South African National Survey of Research and Experimental Development 2017/18 shows that the growth of government of R&D has declined in 2017/18.

The 2019 White Paper on Science Technology & Innovation acknowledges that the size, shape and strength of the NSI is directly proportional to the quantum of funding that the NSI receives. The White Paper recognises that the NSI is inadequately funded. Thus, the WP proposes that levels of R&D funding must be increased to 1.1% of GDP and target an aspirational 2% within the subsequent 10 years. In order to achieve this target, the White Paper has made the following suggestions:

- Incentivising collaboration and co-funding between business, universities, and science councils via legislative reform and increased levels of funding by government itself.
- Integration of policies into national development strategies
- Improvement of organisations productivity and competitiveness
- Requesting STI-intensive national department, provincial and local governments to set budget targets for STI activities in collaboration with their line science councils
- Streamlining RDI funding activities of TIA with those of development finance institutions such as the IDC and DBSA
- Increasing FDI by exploring partnerships with the BRICS Development Bank and multinational corporations
- Exploration of extra funding sources such as corporate social investments, crowd funding, non-profit organisations, and venture capital funds.

NACI will develop workstreams aimed at following up on the proposals of the White Paper while at the same time monitoring its implementation.

TABLE 2: AVERAGE NUMBER OF RESEARCHERS (FULL-TIME EQUIVALENT) PER MILLION INHABITANTS

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
									Forecast		
Low-income countries	139	144	150	152	155	157	160	162	167	170	173
Lower middle-income countries	180	184	188	194	206	217	229	238	244	252	261
Upper middle-income countries	813	853	886	939	979	1 018	1 039	1 076	1 122	1 160	1 199
High-income countries	3 648	3 721	3 735	3 825	3 891	3 974	4 076	4 151	4 203	4 276	4 348
South Africa	192	211	217	246	276	283	307	324	344	364	383

Source: UNESCO's Institute for Statistics; NACI's linear forecast

As Table 3 shows, although SET graduations are high as a proportion of all graduations at master's and doctoral levels, at 46.4% and 52.0% respectively in 2017, SET graduations are still low at the undergraduate and honours levels (NACI, 2019).

TABLE 3: PUBLIC UNIVERSITIES' SET GRADUATION RATES

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Undergraduate diploma or certificate	27.2	24.5	22.2	24.1	26.2	27.6	29.3	28.6	27.4	27.0	28.6	29.0	29.5
Bachelor degree	32.3	31.9	32.2	32.4	31.9	31.7	31.5	27.9	26.8	27.7	27.2	26.6	26.0
Bachelor of technology degree	N/A	N/A	N/A	N/A	N/A	N/A	N/A	53.3	49.6	48.5	45.7	43.3	40.9
Postgraduate certificate or diploma	23.3	27.0	25.7	22.1	20.6	16.1	15.5	15.4	9.7	7.0	6.8	4.7	2.6
Honours degree	22.1	22.5	22.1	23.3	24.6	23.9	25.3	25.5	26.9	25.4	26.9	27.5	28.0
Master's degree	40.5	40.4	41.1	42.0	42.2	43.7	43.3	45.7	44.6	46.4	46.7	47.3	48.0
Doctoral degree	48.6	51.0	51.4	54.2	52.4	52.5	50.0	49.9	49.5	52.0	51.1	51.1	51.1
All qualifications	29.4	28.5	27.9	28.7	29.4	29.4	30.0	30.3	29.1	29.2	29.8	29.9	30.0

A large proportion of SET graduates at postgraduate-level is partly driven by a large number of non-South African students. As Table 4 shows, out of a total of 1 239 doctoral graduates in 2017 from the public South African universities, 26.7% of them were non-South Africans. This has raised policy debates regarding whether South Africa is a hub of PhD production for other African countries. Other discussions involve the need to make use of this inward mobility of human capital to improve the national system of innovation.

TABLE 4: NUMBER OF SET DOCTORAL DEGREES AWARDED BY SOUTH AFRICAN UNIVERSITIES ACCORDING TO GENDER AND NATIONALITY

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
											Forecast		
South African total	**386**	**446**	**458**	**536**	**617**	**653**	**676**	**773**	**757**	**908**	**918**	**972**	**1 026**
South African male	210	226	236	269	307	328	355	367	367	425	437	460	484
South African female	176	221	222	267	310	325	321	406	391	484	481	511	542
SADC total	**65**	**86**	**90**	**95**	**147**	**151**	**155**	**165**	**199**	**226**	**231**	**248**	**265**
SADC male	52	64	62	74	107	105	104	112	140	160	159	171	182
SADC female	13	23	28	21	40	46	51	53	59	66	72	78	83
Other Africa total	**69**	**99**	**116**	**148**	**149**	**201**	**221**	**252**	**329**	**N/A**	**352**	**382**	**411**
Other Africa male maamale	54	89	95	114	113	153	176	199	261	N/A	275	298	321
Other Africa female	15	10	21	34	36	48	45	53	68	N/A	77	84	90
Other foreign total	39	61	57	58	52	68	72	71	91	87	91	96	101
Other foreign male	23	34	36	37	34	41	49	38	51	55	55	58	60
Other foreign female	16	27	21	21	18	27	23	33	40	32	36	38	40
No nationality total	**16**	**12**	**10**	**17**	**20**	**3**	**6**	**3**	**8**	**18**	**8**	**8**	**7**
No nationality male	9	11	10	11	19	3	3	2	7	13	6	6	6
No nationality female	7	1	0	6	1	0	3	1	1	5	2	2	1
Grand total	**575**	**704**	**730**	**854**	**985**	**1 076**	**1 130**	**1 263**	**1 384**	**1 239**	**1 600**	**1 705**	**1 809**
Total males	**348**	**423**	**439**	**505**	**580**	**630**	**687**	**717**	**826**	**652**	**933**	**993**	**1 052**
Total females	**227**	**281**	**292**	**349**	**405**	**446**	**443**	**546**	**559**	**587**	**667**	**712**	**757**

Source: Department of Higher Education and Training; NACI's linear forecast

9.1.3.7 *International partnerships*

International partnerships in STI policy and advice represent a growing share of scientific and technical activities worldwide. Often, these offer developing countries opportunities to acquire knowledge and build a science and technology base for local development, as well as to share data and exchange ideas, encouraging greater creativity.[89] The DST is not only entrusted with the overall coordination of the NSI, but is also responsible for facilitating and overseeing South Africa's scientific and technological cooperation with other countries and international organisations.[90] The country has effective science and technology collaborations with, for example, Japan, the European Union, the OECD, BRICS and the African Union.

The DST is also facilitating the creation of an African network of science advice for governments in Africa, which will provide a platform for sharing ideas and experience on the development of sound STI advice. Several of South Africa's science councils, advisory bodies, and publicly funded research and technology organisations have dedicated teams working on international cooperation. The 2013/14 financial year saw the creation of more than 2 000 international cooperation opportunities for the South African NSI.[91]

The benefits of South Africa's involvement in the Africa Union's science and technology activities, including those related to the New Partnership for Africa's Development, have been less obvious, in spite of some successes, such as the African Science and Technology Indicators Initiative.[92] Greater effort is needed to ensure that South Africa derives more from partnerships

9.1.3.8 *Brief reflection on global advisory councils*

NACI is part of global advisory councils. In 2017, it hosted the 3rd Global Forum on National Advisory Councils. The Forum offers members an opportunity to share and learn from each other. The Global Forum of National Advisory Councils affirmed that science technology and innovation (STI) is undoubtedly one of the most influential drivers of sustainable and inclusive socioeconomic development and affects a nation on all levels. Changes are occurring at unprecedented speeds, which sometimes outpace society's ability to adapt and transform. This paradigm compels governments to re-evaluate their policy and redesign national systems to embrace the new era.

[89] Wagner CS. 2006. International collaboration in science and technology. Science and Technology Policy for Development, Dialogues at the Interface, by Louk Box and Rutger Engelhard (eds) (2006) Anthem Press London UK.

[90] http://www.gov.za/about-sa/science-technology

[91] DST (2014). 2013/2014 Annual Report.

[92] DST (2012). Ministerial Review Committee on Science, Technology and Innovation Landscape.

For its part, the Global Forum discussed among others, ways of enhancing efficacy of advice to government, the 4th industrial revolution, climate change, water-energy-food nexus, bid data, financing and human resources for STI, governance, planning, monitoring and evaluation and creating STI ecosystems, STI and SMMEs, innovation and entrepreneurship. The Global Forum also dealt with STI policy developments including dealing with emergent concepts such as systems innovation and transformative change.

Internationally, national advisory councils differ from one country to another and evolve continuously. Internationally, national councils for STI are usually established based on three models, namely –

(a) planning and priority setting (for instance in Japan, Korea, China and Finland, but this function seems to be disappearing);

(b) advisory (in Austria, Canada, Denmark, Germany's Commission of Experts for Research and Innovation, Singapore, Switzerland, the United Kingdom and the United States); and

(c) coordination (sometimes in addition to the advisory model, in Finland, Germany's Innovationsdialog and Wissenschaftsrat, Japan, Korea and China).

National Advisory Councils experience numerous and diverse challenges. According to the Organisation for Economic Co-operation and Development (OECD), the planning and coordination models require "significant commitments of ministers' time by government as well as a willingness across political parties to see research and innovation as permanently central aspects of government policy. It is difficult for politicians to give up some of their autonomy and to participate in such arrangements." The study, National Research and Innovation Councils as an Instrument of Innovation Governance: Characteristics and Challenges (2015), identified a number of other challenges. First, to strike the right balance between independence and credibility on the one hand, and legitimacy or clout on the other hand. Second, stakeholder inclusion and transparency.

Third, demand for coordination and the ability to promote experimentation. The ability of a council to drive policy coordination tends to be limited because coordination does not happen simply by creating a council. Coordination is "often hampered by the fact that people are bounded by their contextual, political or other realities or constraints, not because they are not talking to each other or because they are not aware of the need for coordination". Fourth, effectiveness of advice (to balance advice to maintain credibility and influence), the importance of government's receptiveness to outside advice and the importance of both individuals (in councils, government, ministries, secretariats) and

group dynamics. Finally, “no council, regardless of its composition, is immune to the vagaries of political fickleness. A council’s effectiveness might be impeded by a new Prime Minister or government that might dislike the mandate or composition of a council, simply because it was appointed by its predecessor.”

In addition, National Advisory Councils are confronted with what former South Africa’s Statistician General described as “evolving and tenuous relationship between systems of evidence (quantitative [statistics] and qualitative) and decision systems or politics” (2017).

9.2 Internal environment analysis

As indicated above, NACI derives its mandate from an Act of Parliament, promulgated in 1997 and amended in 2011. The legislation requires NACI to offer advice to government on the role and contribution of STI in meeting national imperatives such as the creation of sustainable quality of life, sustainable development and economic growth, and developing human capital for STI. The Act sets out a number of specific areas in which NACI is expected to provide advice. These include:

a) the coordination and stimulation of the NSI;

b) strategies for the promotion of technology innovation, development, acquisition, transfer and implementation in all sectors;

c) the coordination of science and technology policy and strategies with policies and strategies in other environments;

d) the identification of research and development (R&D) priorities, and their incorporation in the process of government funding of R&D;

e) the promotion of mathematics, the natural sciences and technology in the education sector;

f) the establishment and maintenance of information systems that support the monitoring and evaluation of the management and functioning of the NSI;

g) international liaison and cooperation in STI; and

h) developments in STI that might require new legislation.

The issue of mandate is one of the factors that affect the influence and effectiveness of advisory councils. The areas indicated above span the policy concerns of Cabinet as a whole, as well as the work and jurisdictions of various government departments. This is one of the reasons for repeated questions about whether NACI is able to fulfil its mandate

in its current form and location. Although the Minister of Higher Education, Science and Technology or DSI officials occasionally refer NACI's advice to other government departments to which the advice might be relevant, the 2018 Institutional Review found that NACI's advice was primarily associated with the priorities and jurisdictions of DSI and did not appear to have a Cabinet reach.

NACI's ability to fulfil its mandate and perform some of its functions has been hampered for several reasons. The Ministerial Review Committee on the STI Landscape in South Africa and other experts[93] argue that NACI is "hamstrung by the fact that it report[s] to the DSI and thus ha[s] no structural location that … afford[s] it the authority needed for effective coordination of a national system". There has been a general call for NACI to be established as an independent entity responsible for its own resources, both human and financial. The idea is for the Secretariat to be removed from government and be appointed under terms to be determined by the NACI Council. This has not yet been achieved, although NACI's founding legislation was amended to allow NACI to have its own Chief Executive Officer, where previously the Director-General of Science and Technology was the CEO.

In 2018, NACI completed an institutional review focusing on the period between 2009 and 2018. The review panel considered matters such as the recognition of the importance of NACI as an apex advisory structure for the NSI, and concerns about NACI's structural location and performance. In developing its final report, the review panel worked on the assumption that the new White Paper on STI would contain the changes to NACI proposed in the 2019 White Paper. The Minister and NACI Council will engage and agree on the process and approach to implement both the 2019 White Paper on STI proposals and institutional review recommendations. Part of this engagement will necessitate reflection on international experiences and evolution of NACI type STI advisory mechanisms in response to the changing and increasing demands for relevant and responsive policy advice.

In 2014, the Minister at the time requested that the CEOs of the DST public entities become ex officio members of the NACI Council. He also asked NACI to develop and host the National STI Information Portal. The portal was launched 2017. The NACI Chairperson has been granted direct access to the Minister to improve coordination and the collaboration of diverse stakeholders (such as the DST-National Research Foundation

93 These include the 2007 OECD Review of the South African NSI, and institutional reviews of NACI carried out in 2008 and 2018.

Centre of Excellence in Scientometrics and STI Policy (SciSTIP); the Department of Higher Education and Training; the Higher Education Management Information System; the Research Information Management System; and the Centre for Science, Technology and Innovation Indicators).

NACI recognises the importance of building local and international networks. These networks serve different purposes. These include knowledge sharing, capacity building and skills transfer, deepening knowledge of and understanding of latest trends in STI policy and world in general, evaluation, governance, planning and representation of Africa in general and South Africa in particular. A number of senior international experts have been involved as part of reference groups overseeing high-profile projects (Review of the 1996 White Paper on Science and Technology) and institutional review of NACI.

Some existing networks include the following local and international organisations (each collaboration has its own specific focus):

a) The Organisation for Economic Cooperation and Development – STI policy analysis, evaluation, country reviews, impact assessment, bibliometrics, and data and repository management.

b) The Global Forum on National Advisory Councils on Innovation – experience and knowledge sharing and learning, improving the role and contribution of advisory councils, developing relevant advice, interaction between advisors and policymakers, capacity building and joint projects.

c) The National Research Foundation, Human Sciences Research Council, Academy of Science of South Africa, South African Council for Natural Scientific Professions, Technology Innovation Agency, Accenture, the New Partnership for Africa's Development, the National Science and Technology Forum (NSTF), the Science Policy Research Unit (University of Sussex), and SciSTIP at Stellenbosch University – strengthening the system's monitoring, evaluation and learning capability, developing and operating the National STI Information Portal, and developing the next generation of STI policy analysts.

d) The Institute for Statistical Studies and Economics of Knowledge (Moscow) – planning, such as foresight exercises.

In addition, NACI has been and will continue to play an important in Brazil Russia India China and South Africa (BRICS) STI activities, African Union and Southern African Development Countries STI Office activities. NACI participated and presented at the first meeting of BRICS member countries Finance Ministers, Governors of Central Banks and STI policy makers and experts and training of SADC officials on the development of STI Indicators.

The recently approved new White Paper on Science, Technology and Innovation proposes an expanded mandate and role for NACI, which is to perform advisory, monitoring and evaluation, planning and coordination functions. To carry out this mandate effectively, NACI will have to align its work to broad government priorities, ensure that the Council is representative, and be given enhanced organisational capacity.

PART C: MEASURING OUR PERFORMANCE

10. Institutional performance information

10.1 Measuring our outcomes

Outcomes	Outcome indicators	Baseline	Five-year target
An evidence-based, confidential and timely advice (proactive and reactive) will be generated.	Number of advice generated and submitted to the Minister of Higher Education, Science and Technology.	Two to three advice generated annually	To learn from previous experience to improve efficacy and ensure evidence-based, confidential and timely production of 10 advice to the Minister of Higher Education, Science and Technology and, through the Minister, Cabinet.
Performance monitoring and evaluation of the National System of Innovation (NSI) conducted	Number of NSI monitoring and evaluation reports	Review of the 1996 White Paper on Science and Technology and Performance analysis of NSI. STI Indicators reports produced. Draft monitoring and evaluation framework for the NSI produced.	The NSI monitoring and evaluation framework implemented: • State of STI report generated. • State of innovation in TVET college sector report produced. • Updated SA Innovation Score card framework. Based on the current specifications, we envisage the National STI Information Portal to be functioning optimally.

Outcomes	Outcome indicators	Baseline	Five-year target
Contributions made towards building a well-coordinated, responsive and effective NSI.	Number of analytical reports produced and roundtable discussions held.	South Africa Foresight Exercise for Science Technology and Innovation 2030 completed in 2019. Framework for the development of the new decadal plan for STI produced in 2019.	Institutional Foresight Exercise capability built. Two sectoral/provincial/regional foresight exercises undertaken in partnership with relevant stakeholders.
Building a capable, smart and effective organisation	• An internal organisational capacity[94] to meet predetermined objectives enhanced. • Communication plan implemented. • Improved employee retention and satisfaction	Improved planning, implementation and communication of predetermined objectives.	Achievement of predetermined objectives, thus contributing towards clean audit outcomes.

[94]Including skills development, digitisation, integrated planning, monitoring and resourcing and so forth.

Enablers necessary for the achievement of the outcomes

To learn from previous experience to improve efficacy and ensure evidence-based, confidential and timely policy advice to the Minister of Higher Education, Science and Technology and, through the Minister, Cabinet. Achieving this outcome will require better data and information analysis, more coordination and improved scientific advisory mechanisms. Building internal capability and exploiting new and established external networks will be critical.

To contribute to the building of NSI monitoring, evaluation and learning capability in order to assess the health of the NSI and its contribution to sustainable and inclusive development. This outcome is intended to partly support government to learn from experience and bolster policy performance over time, and help ensure that government action is meets its objectives efficiently at the lowest possible cost (OECD, 2015). To achieve this outcome, NACI will need the capacity to ensure that STI indicators needed for monitoring, evaluation, planning and management (both quantitative and qualitative) are available and analysed (DST, 2012).

To contribute to the building of a well-coordinated, responsive and effective NSI. NACI will be seeking to explore and propose solutions to the long-standing STI policy questions of coordination, prioritisation, financing, size and shape, human resources, and knowledge production and diffusion, among others.

Building a capable, smart and effective organisation. For this outcome to be realised, current internal operational inefficiencies will have to be addressed, the quality and turnaround time for the production of advice enhanced, knowledge management and communication improved, and the benefits of digitisation optimally exploited. Skills, knowledge and competency development will be critical.

27.3 Key risks and mitigations

Outcomes	Key risks	Risk mitigations
An evidence-based, confidential and timely advice (proactive and reactive) will be generated.	Low uptake of advice Appointment of highly capable and competent staff	• Secretariat to undergo training to develop skills relating to drafting and delivering advice promptly • Council to secure Ministerial approval of identified areas prior to the production of advice • Council to give more time and attention to draft advice.
Performance monitoring and evaluation of the National System of Innovation (NSI) conducted	Copyright infringements relating to STI data and information stored on the STI data and information portal. Non-appointment of critical skills	Continue negotiations with the service provider to determine the terms of utilising STI data and information.
Building a capable, smart and effective organisation	Inaccurate, unreliable and incomplete reporting of actual achievements against predetermined objectives as indicated in the APP (Qualified Audit Opinion on non-financial performance). Lack of funding to fill critical and scarce skills	Conduct awareness sessions with all employees on Technical Indicator Descriptive Matrix (A step-by-step training to the user on how to capture the indicator as indicated in the APP using the Technical Indicator Descriptive standard template prescribed by National Treasury). • Implement and monitor quarterly the approved Roles and Responsibilities on Performance Information Reporting Guideline. • Finalise the draft Department of Science and Technology Performance Information Reporting Guidelines.

ANNUAL PERFORMANCE PLAN

2020-2021

11. Annual Performance Plan

By their nature strategic outcome-oriented goals are broad and focused on the long term. Short to medium-term objectives that can be pursued, implemented and tracked are therefore needed. The NACI objectives are articulated in Table 4, which also provides indicators and baselines.

NACI performance indicators and annual targets for 2020/21

TABLE 2: NACI'S PERFORMANCE OUTCOMES, INDICATORS AND TARGETS FOR THE 2020/21 FINANCIAL YEAR

Outcome 1		**To learn from previous experience to improve efficacy and ensure evidence-based, informed, confidential and timely policy advice to the Minister of Higher Education, Science and Technology and through the Minister, to Cabinet**							
Outputs	**Performance indicators**		**Annual targets**						
		Strategic targets	**Audited/actual performance**			**Estimated performance**	**Medium-term targets**		
			2016/17	**2017/18**	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**
Strategic objective 1		**To provide evidence-based advice on science, technology and innovation matters to the Minister of Higher Education, Science and Technology and, through the Minister, to Cabinet, on request or on NACI's initiative**							
STI advice	Number of STI policy advice documents submitted to the Minister of Higher Education, Science and Technology	Nine STI policy advice documents submitted to the Minister of Higher Education, Science and Technology by 31 March 2022	Advice focusing on issues related to venture capital, sustainable use of biomass in South Africa, food security in South Africa, and the development of indicators to monitor the implement-tation of South Africa's Bio-economy Strategy	Three STI policy advice documents submitted to the Minister and Director-General of Higher Education, Science and Technology focusing on the following areas:	Three STI advice documents submitted to the Minister of Higher Education, Science and Technology by 31 March 2019	Three STI2 advice documents submitted to the Minister of Higher Education, Science and Technology by 31 March 2020	Three STI advice documents submitted to the Minister of Higher Education, Science and Technology by 31 March 2021	Three STI advice documents submitted to the Minister of Higher Education, Science and Technology by 31 March 2022	Three STI advice documents submitted to the Minister of Higher Education, Science and Technology by 31 March 2023

Outcome 1		To learn from previous experience to improve efficacy and ensure evidence-based, informed, confidential and timely policy advice to the Minister of Higher Education, Science and Technology and through the Minister, to Cabinet						
Outputs	Performance indicators		Annual targets					
		Strategic targets	Audited/actual performance			Estimated performance	Medium-term targets	
			2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
Strategic objective 1		To provide evidence-based advice on science, technology and innovation matters to the Minister of Higher Education, Science and Technology and, through the Minister, to Cabinet, on request or on NACI's initiative							
				1. Draft White Paper on STI. 2. Analysis of government support programmes for business research and innovation. 3. South African STI Indicators Report. In addition, a draft advice on a biomass assignment model within a bio-based economy was finalised.					

Outcome 2:		To contribute to the building of NSI monitoring, evaluation and learning capability in order to assess the health of the NSI and its contribution to sustainable and inclusive development							
Outputs	Performance indicators	Strategic targets	Audited/actual performance			Estimated performance	Medium-term targets		
			2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
Strategic objective 2		To assess the performance of the NSI							
State of STI reports[96]	Number of state of STI reports produced	Three STI Indicator reports finalised by 31 March 2022	The NSI performance analysis and the situational reports were finalised	The State of STI report was produced before 31 March 2018	STI indicators report finalised by 31 March 2019	STI Indicators report finalised by 31 March 2020	STI Indicators report finalised by 31 March 2021	STI Indicators report finalised by 31 March 2022	STI Indicators report finalised by 31 March 2023
NSI M&E reports	Number of NSI M&E reports produced	Six NSI M&E reports finalised by 31 March 2022	The 2016 STI Indicators report was finalised	A draft progress report on the evaluation of the Sector Innovation Fund Programme was produced. A preliminary draft of an M&E framework for the South African STI system was produced.	Two NSI M&E Reports finalised by 31 March 2019	Two NSI M&E Reports finalised by 31 March 2020	Two NSI M&E Reports finalised by 31 March 2021[97]	Two NSI M&E Reports finalised by 31 March 2022	Two NSI M&E Reports finalised by 31 March 2023

[96]The STI Indicators Report will serve as the "State of STI Report". Discussions are underway with different actors to enhance the framing, content and quality of the STI Indicators Report so that it becomes an authoritative State of STI Report for South Africa. In future, the production of the State of STI Report will be produced biennially.

[97]M&E reports will emerge from studies including state of innovation in the TVET sector, impact of imported technologies, technology diffusion, transformation and absorption of STI human resources, evaluation of maths and physics education performance.

Outcome 2:		To contribute to the building of NSI monitoring, evaluation and learning capability in order to assess the health of the NSI and its contribution to sustainable and inclusive development							
Outputs	Performance indicators	Strategic targets	Audited/actual performance			Estimated performance	Medium-term targets		
			2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
Strategic objective 2		To assess the performance of the NSI							
				An inception report on the costs, benefits and impact (as well as absorption and diffusion) of imported technologies was produced.					

Strategic objective 3		To develop an STI central data and information portal for publicly financed data to provide easy access to knowledge, learning resources, indicators and communities of practice on the design, implementation and evaluation of innovation policies							
Outputs	Performance indicators	Strategic targets	Audited/actual performance			Estimated performance	Medium-term targets		
			2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
Strategic objective 3		STI central data and information portal							
National STI Information Portal (NSTIIP)	Successful implementation of NSTIIP	Fully functional and effective model of NSTIIP by 31 March 2022[98]	NSTIIP was developed	User experience of the NSTIIP was documented A technical forum was established and is functioning well. Potential areas for upscaling the NSTIIP (e.g. communities of practice and a database of researchers) have been identified.	Phase 1 (upscaling of NSTIIP) by 31 March 2019	Phase 2 (full-scale roll-out of the NSTIIP) by 31 March 2020	Ongoing maintenance and implementation of the NSTIIP by 31 March 2021	Ongoing maintenance and implementation of the NSTIIP by 31 March 2022	Ongoing maintenance and implementation of the NSTIIP by 31 March 2023

[98]The NSTIIP has reached the fourth capability maturity level and contributes significantly to NSI planning, monitoring and evaluation. All aspects of the portal are fully developed, accessible and of value to the users.

Outcome 3:		To contribute towards building a well-coordinated, effective and responsive NSI							
Outputs	Performance indicators	Strategic targets	Audited/actual performance			Estimated performance	Medium-term targets		
			2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
Strategic objective 4:		**To contribute towards improving NSI coordination and planning**							
Institutional Foresight exercise capability	Foresight exercise capability institution-alised		No target	No target	Finalisation of foresight exercise by 30 September 2018	High-level framework for STI decadal plan was submitted to the Minister of Higher Education, Science and Technology – 31 July 2019	Institutional foresight exercise capability model conceptual-ized, partner-ships estab-lished and skills develop-ment occurred by 31 March 2021	One sectoral/ provincial/ regional Foresight Exercise conducted in partnership with relevant stakeholders by 31 December 2022	Evaluation of the South Africa Foresight Exercise for STI 2030 by 15 March 2023

Outcome 4		Transforming NACI into a smart, efficient and learning organisation.							
Output	Performance indicator	Strategic target	Audited/actual performance			Estimated performance	Medium-term targets		
			2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/2
Strategic objective 5		To ensure the efficient and effective provision of administrative, financial, technical and professional corporate services, among others, to support the discharge of the core mandate of NACI							
Communication plan	Communication plan updated and implemented	Communication plan updated and implemented by 31 March 2022	One stakeholder engagement on the 2016 South African STI Indicators report Five collaboration and partnership meetings with STI stakeholders: (1) NSTF on 2 Feb. 2017; (2) SciSTIP on 9 Feb. 2017; (3) Technology Innovation Agency on 16 Feb. 2017; (4) Technology Top 100 on 17 Feb. 2017; and (5) Embassy of Switzerland on 17 Feb. 2017	Media coverage of the launch of the South African STI Indicators Report included live broadcast and television interviews. Articles were also published in newspapers on a range of issues related to the Council's work.	Communication plan implemented by 31 March 2019	Communication plan updated and implemented by 31 March 2020	Communication plan updated and implemented by 31 March 2021	Communication plan updated and implemented by 31 March 2022	Communication plan updated and implemented by 31 March 2023

Outcome 4		Transforming NACI into a smart, efficient and learning organisation.							
Output	Performance indicator	Strategic target	Audited/actual performance			Estimated performance	Medium-term targets		
			2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/2
Strategic objective 5		To ensure the efficient and effective provision of administrative, financial, technical and professional corporate services, among others, to support the discharge of the core mandate of NACI							
			Two presentations: (1) Minister of Science and Technology on the NACI Annual Performance Plan on 27 February 2017, and (2) Cluster on the STI Indicators booklet on 1 March 2017						

Outcome 4		Transforming NACI into a smart, efficient and learning organisation.							
Output	Performance indicator	Strategic target	Audited/actual performance			Estimated performance	Medium-term targets		
			2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/2
Strategic objective 5		To ensure the efficient and effective provision of administrative, financial, technical and professional corporate services, among others, to support the discharge of the core mandate of NACI							
			Two international participation events: (1) Innovation and Technology Absorption by South African Firms on 2 March 2017; and (2) Organisation for Economic Co-operation and Development Committee for Scientific and Technological Policy Global Science Forum meeting from 20 Feb. to 4 March 2017						

Outcome 4		Transforming NACI into a smart, efficient and learning organisation.							
Output	Performance indicator	Strategic target	Audited/actual performance			Estimated performance	Medium-term targets		
			2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/2
Strategic objective 5		To ensure the efficient and effective provision of administrative, financial, technical and professional corporate services, among others, to support the discharge of the core mandate of NACI							
Internal corporate governance system	Internal corporate governance system implemented	Internal corporate governance system approved and implemented by 31 March 2022	Corporate governance system developed and approved	The 2016/17 Annual Report and 2018/19 APP were approved by Parliament. The Terms of Reference for the Institutional Review (2009-2018) were finalised. The Institutional Review Panel was established.	Corporate governance system implemented (such as Annual Report, Annual Performance Plans) by 31 March 2019 Institutional review report completed by 30 July 2018	Corporate governance system implemented (2019/20 APP, 2018/19 Annual Report) developed and approved by Minister and submitted to Parliament by 31 March 2020	Corporate governance system implemented system (2021/22 APP, 2020/21 Annual Report) developed and approved by Minister and submitted to Parliament by 31 March 2021	Corporate governance system system implemented (2022/23 APP, 2021/22 Annual Report) developed and approved by Minister and submitted to Parliament by 31 March 2022	Corporate governance system system implemented (2022/23 APP, 2022/23 Annual Report) developed and approved by Minister and submitted to Parliament by 31 March 2023

Outcome 4		Transforming NACI into a smart, efficient and learning organisation.							
Output	Performance indicator	Strategic target	Audited/actual performance			Estimated performance	Medium-term targets		
			2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/2
Strategic objective 5		To ensure the efficient and effective provision of administrative, financial, technical and professional corporate services, among others, to support the discharge of the core mandate of NACI							
Knowledge management system	Knowledge management system implemented	Knowledge management system approved and implemented by 31 March 2021	Draft terms of reference have been developed and sent to the DST's Knowledge, Information and Records Management Unit to assist NACI with sourcing technical advice for training and development of the system.	Knowledge management system implemented through Alfresco system by 30 March 2018	Knowledge management system implemented by 31 March 2019	Knowledge management system implemented by 31 March 2020	Knowledge management system implemented by 31 March 2021	Knowledge management system implemented by 31 March 2022	Knowledge management system implemented by 31 March 2023

Quarterly targets for 2020/21

TABLE 3: NACI'S QUARTERLY TARGETS FOR THE 2020/21 FINANCIAL YEAR.

Outcome 1:		**To learn from previous experience to improve efficacy and ensure evidence-based, informed, confidential and timely policy advice to the Minister of Higher Education, Science and Technology and through the Minister, to Cabinet**				
Performance indicator	**Reporting period**	**Annual target**	**Quarterly targets**			
			1st	**2nd**	**3rd**	**4th**
Strategic objective: 1		**To provide evidence-based advice on science, technology and innovation matters to the Minister of Higher Education, Science and Technology and, through the Minister, to Cabinet, on request or on NACI's initiative.**				
Number of STI policy advice documents submitted to the Minister of Science and Innovation	Annually	Three STI policy advice documents submitted to the Minister of Higher Education, Science and Technology by 31 March 2021	Planning and data analysis by June 2020	Data analysis, consultation and reporting 30 September 2020	One STI advice document by 20 December 2020	Two STI policy advice documents generated by 31 March 2021
Outcome 2:		**To contribute to the building of NSI monitoring, evaluation and learning capability in order to assess the health of the NSI and its contribution to sustainable and inclusive development.**				
Performance indicators	**Reporting period**	**Annual target**	**Quarterly targets**			
			1st	**2nd**	**3rd**	**4th**
Strategic objective 2		**To assess the performance of the NSI.**				
Number of State of STI reports produced	Annually	STI Indicators report finalised by 31 March 2021	No target	No target	No target	Final STI Indicators report finalised by 31 March 2021
Number of NSI M&E reports	Biannually	Two NSI M&E reports finalised by 31 March 2021	No target	No target	Drafting M&E reports 15 December 2020	Two NSI M&E reports finalised by 31 March 2021

Strategic objective 3		To develop an STI central data and information portal for publicly financed data to provide easy access to knowledge, learning resources, indicators and communities of practice on the design, implementation, and evaluation of innovation policies.				
Performance indicators	**Reporting period**	**Annual target**	**Quarterly targets**			
			1st	**2nd**	**3rd**	**4th**
Strategic objective 3		**STI central data and information portal**				
Successful operation of National STI Information Portal NSTIIP)	Bi-annually	Phase 2 (full-scale roll-out of the NSTIIP) by 31 March 2021	No target	Directory of experts from two universities Two active communities of practice on the NSTIIP	No target	Directory of experts from four universities Eight active communities of practice on the NSTIIP
Strategic Outcome-Oriented Goal 4:		**To contribute towards building well-coordinated, effective and responsive NSI**				
Performance indicator	**Reporting period**	**Annual target**	**Quarterly targets**			
			1st	**2nd**	**3rd**	**4th**
Strategic objective: 4		**To contribute towards improving NSI coordination and planning.**				
		High-level framework for NRDS and TYIP submitted to the Minister of Higher Education, Science and Technology by 31 July 2020	High-level framework for NRDS and TYIP submitted to the Minister of Higher Education, Science and Technology by 31 June 2020	No Target	No target	No target

Strategic Outcome-Oriented Goal 5:		Transforming NACI into a smart, efficient and learning organisation				
Performance indicator	Reporting period	Annual target	Quarterly targets			
			1st	2nd	3rd	4th
Strategic objective 5		**To ensure the efficient and effective provision of administrative, financial, technical and professional corporate services, among others, to support the discharge of the core mandate of NACI**				
Communication plan	Half-yearly	Communication plan implemented by 31 March 2021	Communication plan refined and implemented by 30 June 2020	Communication plan implemented by 30 September 2020	Communication plan implemented by 31 December 2020	Communication plan implemented by 31 March 2021
Corporate governance system	Quarterly	Corporate governance system implemented (2020/21 APP, 2019/20 Annual Report) developed and approved by Minister and submitted to Parliament by 31 March 2021	Annual Report highlights submitted to the DSI by 30 May 2020	1. 1st draft of the 2019/20 Annual Report submitted to the DSI by 30 July 2020 2. 1st draft of the 2021/22 Annual Performance Plan submitted to the DSI by 15 October 2020 3. 2nd draft of the 2019/20 Annual Report submitted to the DSI by 30 August 2020 4. 2019/20 Annual Report ready for tabling in Parliament by 30 September 2020		Final draft of the 2021/22 Annual Performance Plan submitted to the DSI by 30 January 2021

Strategic Outcome-Oriented Goal 5:		Transforming NACI into a smart, efficient and learning organisation				
Performance indicator	Reporting period	Annual target	Quarterly targets			
			1st	2nd	3rd	4th
Strategic objective 5		To ensure the efficient and effective provision of administrative, financial, technical and professional corporate services, among others, to support the discharge of the core mandate of NACI				
Knowledge management system	Quarterly	Knowledge management system implemented by 31 March 2020	Knowledge café to be hosted as a platform to create NACI knowledge management strategy by 30 June 2019	Identification of key interviewees (with NACI knowledge) to be finalised by 30 September 2020	All NACI meetings recorded and transcripts stored safely in Alfresco by 30 November 2020 Interviews with selected knowledge holders recorded and stored by 30 November 2020	Knowledge management system implemented by 31 March 2021

12. Resource Considerations

12.1 Human resource requirements

To implement its advisory work programme, the NACI Council is supported by the NACI Secretariat. The Secretariat is comprised of a small team of 11, including the Acting CEO. In the period under review, two people were employed on fixed-term contracts to assist the team with their workload.

12.2 Expenditure estimates

Table 3 below presents a summary of 2020/21 expenditure estimates for the total budget of R16.7 million, comprising compensation of employees (R7,9 million) and goods and services (R8,8 million).

TABLE 4: NACI EXPENDITURE ESTIMATES

Description	Audited outcomes			Adjusted appropriation	Medium-Term Expenditure Estimate		
	2016/17 R'000	2017/18 R'000	2018/19 R'000	2019/20 R'000	2020/21 R'000	2021/22 R'000	2022/23 R'000
Compensation of employees	8,451	8,334	6,883	9,891	7,976	8,228	8,623
Goods and services	5,762	8,730	9,401	9,587	8,816	9,095	9,348
Transfers and subsidies	36	40		26	-	-	-
Payment of capital assets	254	34		-	-	-	-
Total	**14,503**	**17,138**	**16,284**	**19,504**	**16,792**	**17,323**	**17,971**

LINKS TO OTHER PLANS

Listed below are some key public policies and strategies relevant to the National Advisory Council on Innovation's work over the next five years.

White Paper on Science and Technology (2019).

National Development Plan (Vision 2030).

Nine-Point Plan.

New Growth Path.

Re-imagined Industrial Strategy.

Ten-Year Innovation Plan.

National Infrastructure Plan.

Medium Term Strategic Framework (MTSF) (2019-2024).

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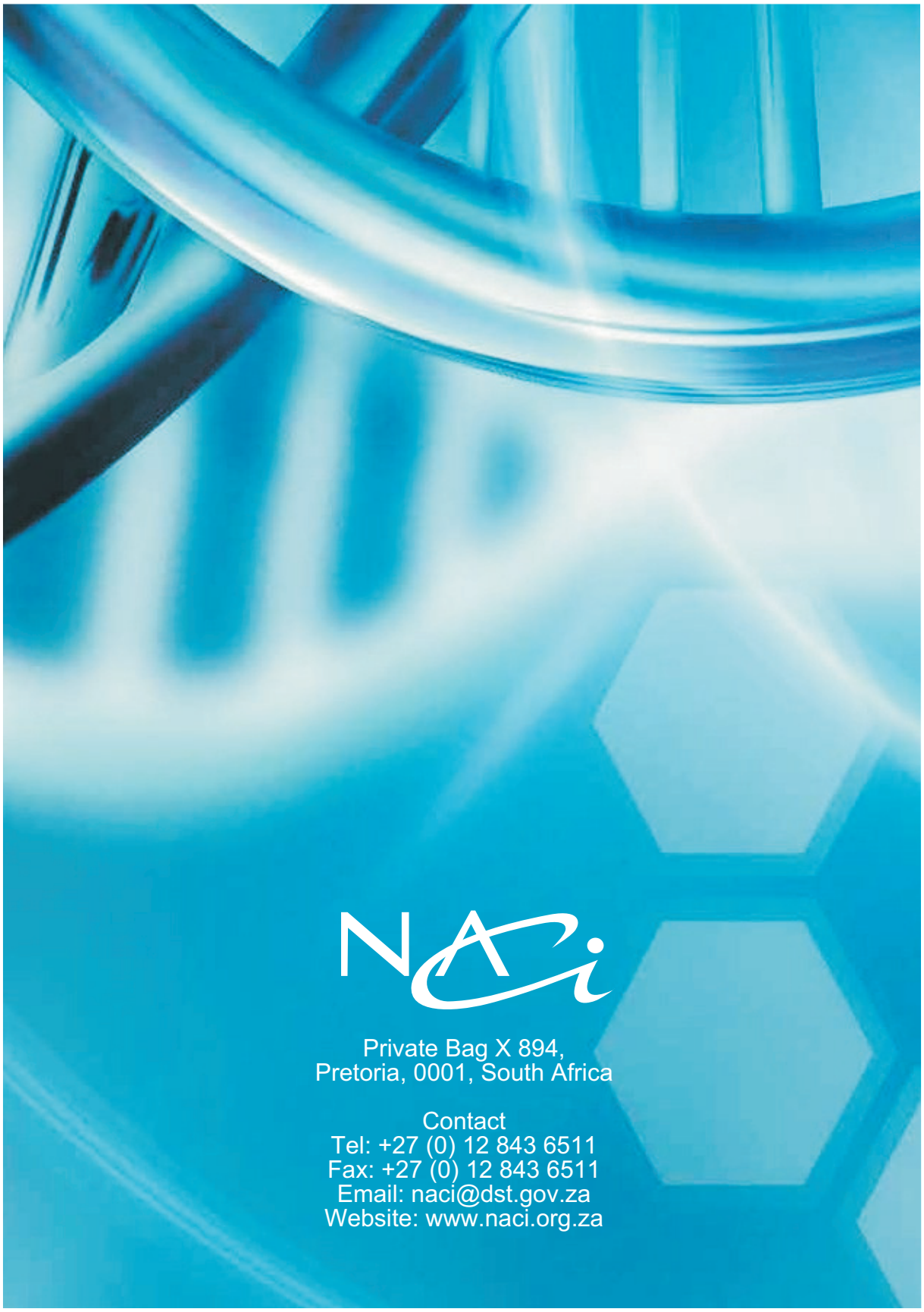
NOTES



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