



# City Of Johannesburg Climate Action Plan

March 2021



a world class African city

Supported by:



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based on a decision of the German Bundestag



# Acknowledgements

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The Climate Action Plan (CAP) was developed under the leadership of Mr. Geoffrey Makhubo, Executive Mayor, and Mr. Mpho Moerane, Member of the Mayoral Committee for the EISD. Sincere thanks are extended to the EISD's Acting Executive Director, Mr. Tiaan Ehlers and the EISD's former Executive Director, Mr. Shuaib Suleman, and the entire Executive Management Team of the City of Johannesburg.

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# Executive Summary

The City of Johannesburg has committed to adopting a Climate Action Plan aligned with the aims and targets of the Paris Agreement. Long before the Paris Agreement was signed, the City was already at the forefront of low-carbon development and resilience planning. The City's long-term strategy, known as the 2040 Growth and Development Strategy (GDS) made provisions for a resilient, liveable, sustainable urban environment, compatible with a healthy natural environment and underpinned by infrastructure supportive of a low-carbon economy.

The Paris Agreement, with its ambition to limit the increase in global average temperatures to 1.5°C, and the subsequently published Special Report of the Intergovernmental Panel on Climate Change (IPCC) on Global Warming of 1.5°C, propelled the City of Johannesburg onto a more ambitious climate change course. This more ambitious course is presented in this Climate Action Plan (CAP), which sets the target of a net-zero emissions and resilient city by 2050. With the 2020 World Economic Forum highlighting climate change as one of the greatest threats facing humanity in the 21<sup>st</sup> century and the devastating COVID-19 pandemic, the CAP could not have come at a better time. The City takes seriously its commitment to net-zero emissions and resilience and in support of this commitment intends to green its municipal infrastructure and create a sustainable urban environment, together with the business community, youth, civil society, academia and research institutions, the provincial and national governments and all other relevant stakeholders.

The City's Climate Change Risk and Vulnerability Assessment and the Green Book produced by the Council for Scientific & Industrial Research (CSIR) provided critical evidence to inform the CAP. Projections indicate that as climate change accelerates, the City of Johannesburg will continue to experience its increasingly harmful impacts, such as droughts and threats to water security, flooding, and heatwaves that pose a risk to human health. Historical records of climatic

conditions demonstrate clear rising trends in temperature as well as rainfall variability and intensity. Average monthly temperatures in Johannesburg will almost certainly increase under all climate change scenarios. The data shows that average daytime temperatures have already increased nearly 1.5°C since 1981, while average night-time temperatures are almost 1°C higher than 40 years ago. This temperature increase constitutes a direct human health risk and also increases the need for additional cooling, which could increase Johannesburg's energy demand.

Johannesburg will experience a significant increase in interannual rainfall variability, resulting in wet or extremely wet years followed by exceptionally dry years. Analyses of climate change impact on extreme rainfall events projected an increase in rainfall intensity in the summer months which will be evident by 2030 and which will increase the frequency of flooding events. The north-eastern, north-western and southern parts of the city are currently the most vulnerable to these impacts of climate change. Particularly vulnerable areas include, among others, Soweto, Alexandra, Ebony Park, Diepsloot, Stretford, Roodepoort, Rabie Ridge, Poortjie, Orange Farm, Mayibuye, Lenasia, Lakeside, Kanana Park, Kaalfontein and Ivory Park.

To enhance climate resilience and adapt to climate change impacts, the City will focus on enhancing water security, creating resilient human settlements, implementing flood and drought management strategies, developing resilient infrastructure and enhancing the health and wellbeing of communities. The CAP forecasts a need for R1.3 billion in capital investment for prioritised adaptation actions until 2050, as well as an annual operations budget amounting to approximately R650 million for the same time period.<sup>1</sup> Some 60% of the required financing can be sourced from the City's existing operational budget, and can be committed by applying a climate lens to critical service provision and resilience building.

<sup>1</sup> See CBA Technical Report for Adaptation.

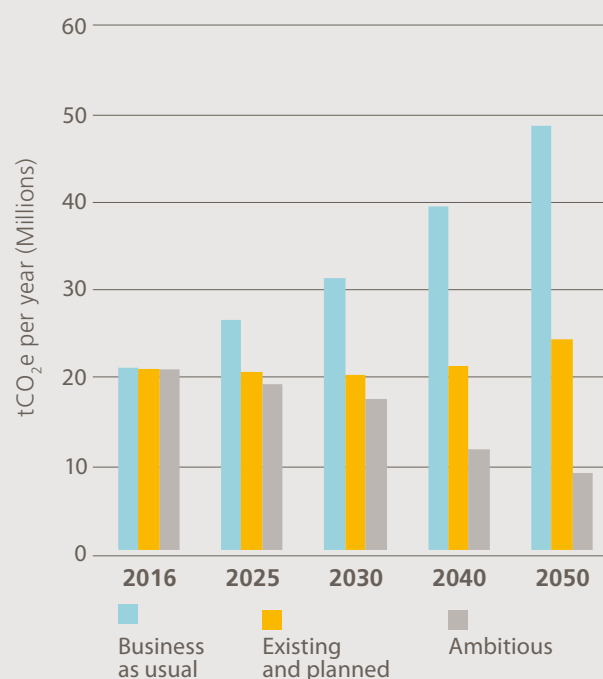


The 2016 Greenhouse Gas Inventory estimated the City of Johannesburg's annual greenhouse gas (GHG) emissions at 20.9 million tonnes of carbon dioxide equivalent (MtCO<sub>2</sub>e). The largest contributor to these emissions is stationary energy use, by buildings and industry, for example, which accounted for 54% of GHG emissions.

These energy-related emissions resulted primarily from electricity use, due to the carbon-intensive nature of South Africa's energy system, which relies predominantly on coal-fired power plants for generation. The transport sector accounted for 35% of emissions, most of which were generated by private vehicles. The waste and wastewater sectors accounted for 11% of emissions. No estimates of emissions for the Industrial Processes and Product Use or Agriculture, Forestry and Other Land Use sectors were included in the inventory due to a lack of data.

Mitigation scenario modelling was conducted to determine possible pathways and targets the City can adopt to achieve its net-zero emissions goal by 2050. Three scenarios were produced: a business as usual (BAU) scenario, an existing and planned actions scenario and an ambitious actions scenario. The BAU scenario assumes no actions are undertaken to reduce GHG emissions. The existing and planned actions scenario was informed by currently existing national, regional and local policies and programmes, as well as market trends, adjusted downwards based on certainty of implementation. The ambitious actions scenario was informed by discussions, iterative follow-up communications and check-ins with relevant departments and other entities to identify an ambitious but realistic set of key actions that can be implemented.

Under the BAU scenario, emissions are projected to grow by 133% by 2050, with the fastest growth in stationary energy, followed by transport. Existing and planned actions will see emission reductions below the 2016 base year of 3% by 2030, followed by a 2% increase in emissions by 2040 and a 17% increase in emissions by 2050. With ambitious yet achievable actions, the City's emissions can be reduced to 43% below the BAU scenario by 2030, 70% by 2040 and 81% by 2050, representing an 57% reduction of total emissions from the 2016 base year (Figure A). CoJ has committed to pursuing the ambitious action scenario and has adopted the following emission reduction targets: 25% by 2030, 75% by 2040 and 100% (net-zero emissions) by 2050, as compared to the 2016 baseline.



**Figure A: Comparison of mitigation scenarios**

In the built environment, key mitigation emissions reduction opportunities are found in energy efficiency (e.g. stricter building standards/codes) and renewables (e.g. grid decarbonisation and rooftop solar PV). Transport emissions can be reduced through a modal shift from private to public transport, the use of cleaner fuels (e.g. electric and hybrid vehicles) and higher vehicle efficiency (e.g. vehicle emissions standards). Emissions from waste can be reduced by diverting solid waste from landfill (e.g. through recycling and composting) and the use of wastewater biogas for energy production.

These actions all form part of the City's plan and will be implemented city-wide to reduce greenhouse gas emissions and transition the city to net-zero emissions. The CAP forecasts a need for R10 billion in capital investment for prioritised mitigation actions until 2050, as well as an annual operations budget of approximately R25 billion for the same time period.

To achieve the CAP's vision of a resilient, sustainable carbon-neutral Johannesburg, the city is committed to collaborating with all stakeholders including the youth, civil society, academia, research institutions, labour, business and all residents of the City of Johannesburg.



# Foreword

## Executive Mayor

Johannesburg, also referred to as the City of Gold, eGoli, is the wealthiest city in South Africa. The city was founded on mining after the discovery of gold on the Witwatersrand, in the late 19<sup>th</sup> century. Since then, the city has grown into the country's financial centre, and has diversified its economic activities from mining, into tertiary and secondary sectors, in the banking and manufacturing sectors. The city is home to the Johannesburg Stock Exchange and offices of major multinational JSE listed companies.

Based on this historical legacy of mining in this city, including a predominantly coal-based energy dependency, air pollution is a big problem in the city, resulting in the increase in greenhouse gas emissions. The impacts have had a negative effect on the health of Joburgers. Locally, the source of energy we use combined with the sprawled nature of the city which reflects an apartheid era planning, has resulted in a very energy inefficient city, resulting in high greenhouse gas emissions, emanating mostly from the transport, and the stationary energy sector, specifically from buildings.

Climate change is one of the greatest risks facing the world in the 21<sup>st</sup> century. The effects are more pronounced in cities like Johannesburg characterized by high urbanization and resource insecurity. Moreover, these effects have been exacerbated by another deadly human risk, the Covid-19 pandemic. This presents a dichotomy of emergencies that has presented a City like ours with an opportunity to build back, greener and better.

In an effort to tackle increasing carbon emissions and reducing energy demand, the City of Johannesburg is taking steps to implementing effective and scalable carbon reduction measures through joint partnerships.

The City notes the key outcome from the 2020 World Economic Forum, which further highlighted climate change as one of the greatest threats facing humanity in the 21<sup>st</sup> century, and underscored that if not addressed, it threatens the very existence of mankind and all other life on Earth.

The City has an Air Quality Management Plan (AQMP), which is intended to guide interventions that help improve the air quality locally. As a response to the Paris Climate Agreement, the City committed to the following C40 Declarations in its efforts to achieve its targets of reducing GHG emissions and improve climate resilience:

- To develop a Paris Compatible Climate Action Plan, by December 2020;
- To achieve Net Zero Carbon Buildings by 2050;
- To advance towards Zero Waste by 2050;
- Achieving an Equitable Low Carbon Transformation, geared towards pro-poor development;
- Just Transition, safe-guarding jobs; and
- Edmonton Declaration, which calls for collaboration with the scientific, technology and innovation community to develop bold climate actions.

This Climate Action Plan (CAP) is a long-term City-wide plan, encompassing the undertaking of climate actions in the City, including by external stakeholders, residents, business, non-governmental organisations, academia, community based organisations, etc. to lead the City towards a low carbon economy and a resilient and adaptive future.

The CAP comes at a critical time for cities that seek to implement the transformative Paris Agreement on climate change. Cities are at the centre of targeted climate change response, as they develop and plan for their budgets. City budgets must now move away from maladaptive, high-carbon intensive investments to investments that are innovative thereby play a role in future-proofing the city. The City has long played a leadership role in providing innovative solutions to climate finance. In this regard, the City of Johannesburg has pioneered a municipal "Green Bond" in South Africa to raise funds to help respond comprehensively to climate change and to ensure the sustainable management of resources. The Green Bond issued by the city in June 2014 was worth R1.5bn (approx. US\$143m) and funded projects across a range of climate change mitigation sectors in the city.

The Paris Agreement and the Sustainable Development Goals are the vehicles chosen by the international community to deliver a safer, less risky and more prosperous world for the many rather than the few. Society and economies need to transform their development paths in line with these aims and ambitions over the short, medium and long terms. The CAP will help the City to realize the goal of its Growth and Development Strategy 2040, aiming to "Provide a resilient, liveable, sustainable urban environment – underpinned by infrastructure supportive of a low-carbon economy".

Our CAP, which focuses on both climate adaptation and climate mitigation actions, when implemented will make our city a cleaner, greener and more liveable city for Joburgers to enjoy. The way we plan our city, the choice of public transport, how we provide basic services (i.e. waste, energy, water etc.) will determine how our people are able to cope with the projected climate change impacts.

I am grateful to C40 Cities Climate Leadership Group for their technical support and contribution in the development of the City's Climate Action Plan. In addition, I would like to express my appreciation for all the stakeholders and experts who have tirelessly made contributions to the development of this publication.

The CAP does not provide a quick fix as it takes a long-term view of transformational ambitious climate actions that are required. However, it is my hope that through a concerted effort; collaboration between a wide range of partners, our City will make inroads towards net-zero emissions and a climate resilient city by 2050.



**Cllr Geoffrey Makhubo,**  
Executive Mayor  
City of Johannesburg



# Message from Mark Watts, C40

As one of the founding cities of C40 in Africa, the City of Johannesburg has a long history of demonstrating leadership and commitment to climate action. Following the ratification of the Paris Agreement in 2016, Johannesburg committed to C40's Deadline 2020 Programme designed to support cities to deliver plans which translate the aspirations of the global climate accord into city-level action.

I would like to congratulate Johannesburg on joining other leading African cities by publishing an ambitious, inclusive, evidenced-based climate action plan. The plan advances the city's developmental aspirations whilst addressing the urgent need to reduce greenhouse gas emissions and adapt to the impacts of climate change. In addition, Johannesburg's plan reflects the city's commitment to climate justice, poverty eradication and social equality by ensuring that the transition towards a carbon-neutral and resilient city prioritises the city's most vulnerable communities and results in an equitable distribution of benefits.

The completion of Johannesburg's climate action plan is timely as the city, together with the global community, looks towards recovering from the tragic loss of human lives and the associated socio-economic impacts of the COVID-19 pandemic. In these trying times, this plan guides a green economic stimulus with the potential to attract investment, create jobs and expand the local economy.

Finally, I would like to recognise Mayor Geoffrey Makhubo's leadership and the contributions his city has made to C40 as an organisation over the years. We look forward to continuing to work with and learn from Johannesburg as you embark on the journey of implementing the actions contained in this plan.

A handwritten signature in dark ink, appearing to read 'Mark Watts'.

**Mark Watts,**  
Executive Director  
C40 Cities Climate Leadership Group





# Foreword

## from the Youth

We are facing an emergency of an urgency, severity and scope never before experienced by humankind. So far, our response hasn't been anywhere close to adequate. But you already know that. You know it in your gut, in your bones. We are each part of the planet's living systems, knitted together with almost 7.7 billion human beings and 1.8 million known species. We can feel the connections between us. We can feel the brokenness and the closing window to heal it. This earth, our home, is telling us that a better way of being must emerge, and fast. The science is clear. According to the Intergovernmental Panel on Climate Change, we need to limit the rise in global temperature to 1.5°C by 2030. We are already experiencing the effects of climate change, with vulnerable communities experiencing the effects more severely. The time to act is now!

Young people all across the world have led a global movement to call for enhanced ambition and immediate climate action. This is in line with the Sustainable Development Goals and the realization of poverty eradication, environmental protection and wellbeing of all people. As South Africa revises its Nationally Determined Contribution, and metropolitan municipalities develop their Climate Action Plans, we, the youth living in the City of Joburg, have compiled this Youth Climate Action Plan. Through this we will emphasise the urgent need for climate action in order to build a climate-resilient Johannesburg. This is in accordance with the Climate Justice Charter, the Bill of Rights, South Africa's National Development Plan, and the National Youth Policy.

This Youth Climate Action Plan is inspired by our lived experiences and our visions of the future. It is our generation, and the generations to come that will bear the brunt of the destructive effects of climate change. It is our generation, and the generations to come that will have to witness their descendants perish due to unbearable living conditions that will arise from a climate change. We are the ones we have been waiting for. As the gatekeepers of tomorrow's world, it is up to us to preserve our tomorrow.





# Introduction



# 1. Introduction

## VISION

Johannesburg – a World Class African City of the Future – a vibrant, equitable African city, strengthened through its diversity; a city that provides real quality of life; a city that provides sustainability for all its citizens; a resilient and adaptive society.<sup>i</sup>

### 1.1 The City of Johannesburg at a glance

The City of Johannesburg Metropolitan Municipality is South Africa's largest and fastest-growing city. It is the capital of Gauteng Province, the smallest and wealthiest of South Africa's nine provinces. It is located on South Africa's eastern plateau, known as Highveld, at an elevation of approximately 1700 meters above sea level (Figure 1).

The City of Johannesburg covers an area of 1,645 km<sup>2</sup>, stretching from Orange Farm in the south to Midrand in the north. It is comprised of two major urban centres,

Johannesburg and Midrand, and several smaller urban centres: Diepsloot, Ennerdale, Ivory Park, Lenasia, Orange Farm, Randburg, Roodepoort, Rosebank, Sandton and Soweto.

The Metropolitan Municipality was formally created in 2000 as the result of a merger of five independent metropolitan local councils. In 2006, the municipality was reorganised into seven administrative regions, shown in Figure 2 on the next page.

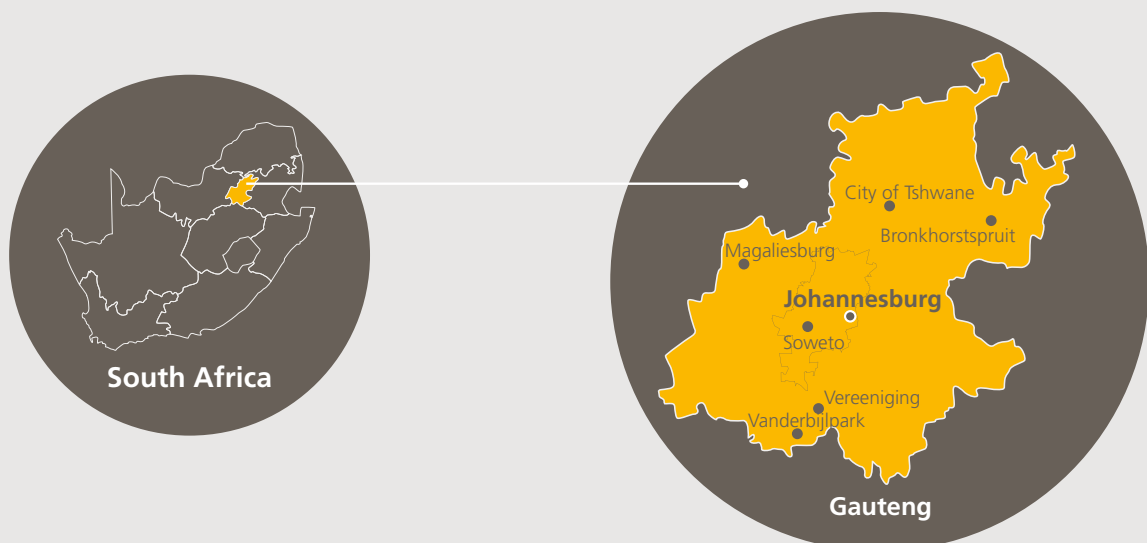


Figure 1: City of Johannesburg location map



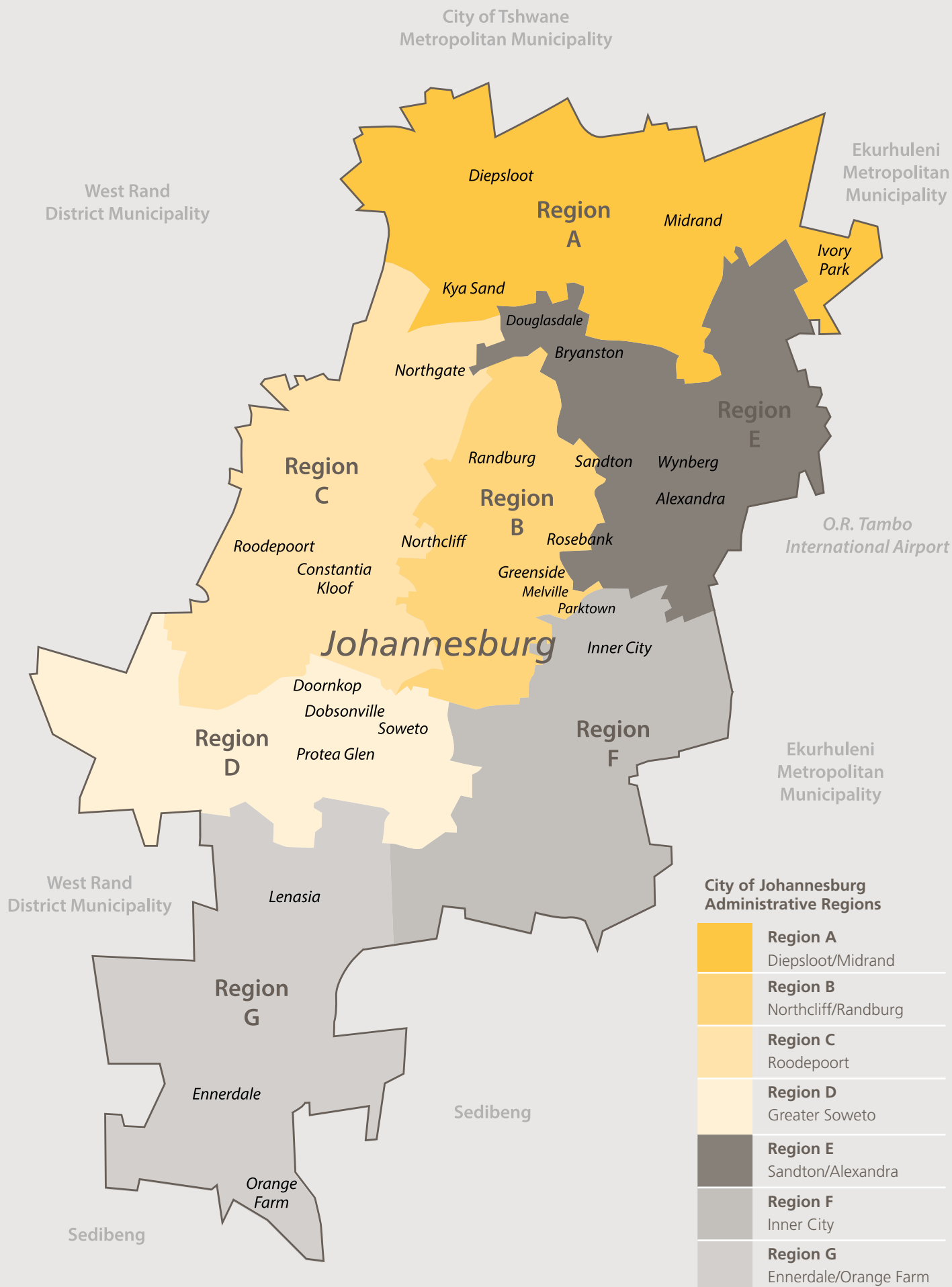


Figure 2: City of Johannesburg administrative regions

Johannesburg was established in 1886, following the discovery of gold on a local farm, and has since become the industrial and financial hub of South Africa and the wider region. Although small in land area, Johannesburg is the most populous city in South Africa, with approximately 5.74 million residents in 2020 and a population density that is 40 times the national average.

**DID YOU KNOW:** **Gauteng**, the name of the province of which the City of Johannesburg is the capital, is a Sesotho/Tswana/Pedi word that means "Place of Gold".

The city is the economic capital of South Africa, contributing an average of 16% to the country's Gross Domestic Product (GDP). The City attracts large numbers of migrants from other parts of South Africa, Africa and the world in search of economic opportunities, access to services or political asylum.

Over the past 10 years, the City has seen an average annual population growth of 3%.<sup>ii</sup> Johannesburg's population has grown by over 100,000 every year 2015, with approximately one-third of this growth attributed to migration.

Though the city's economy was originally heavily dependent on mining, it has since diversified and is now predominantly based on the secondary and tertiary sectors, including finance and business services (over 30% of the economy), community services (21%), wholesale and retail trade (18%) and manufacturing (13%).

Johannesburg contains Sandton, the most affluent and important business and financial district in South Africa. This 'richest square mile in Africa' is home to institutions such as the Johannesburg Stock Exchange and the offices of major multinational companies. The city also hosts the Constitutional Court of South Africa, the second-highest court in the country, and the headquarters of one of the biggest broadcasters in Africa, the South African Broadcasting Corporation (SABC).

The growth of formal employment opportunities in the City has not kept pace with economic growth; in 2020, only 12% of South Africa's formal employment opportunities were located in the City. The low levels of education and low skills base of the City's labour force has proven incompatible with its increasingly tertiary sector-based economy. Of Johannesburg's formally employed, 40% are unskilled or semi-skilled, 45% are classified as skilled and only 15% are highly skilled. The skills deficit in Johannesburg remains a critical challenge.

Section 1.2 presents key information about the City in numbers.

## 1.2 key information about the City in numbers

### Sub-tropical climate

Warm summers, and mild, sunny winters

**25°C**

Average summer temperature

**18°C**

Average winter temperature



GDP

**R11.3 billion**

(City of Johannesburg, 2019)



**15%**

National contribution

**41.58%**

Of total provincial employment

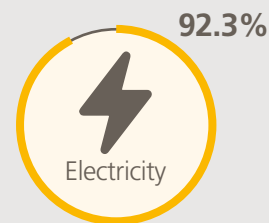
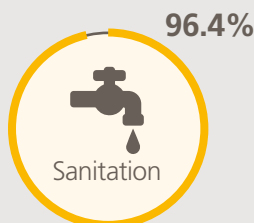
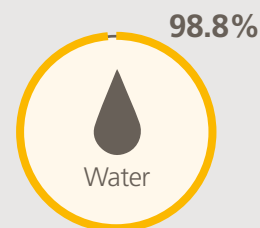
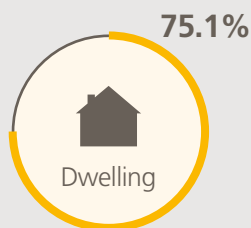
**70%**

Of headquarters of RSA businesses  
(City of Johannesburg, 2018)

## Access to basic services



**1.8 million**  
households



**210+** informal settlements



**6.30**  
Quality of  
life (QoL)  
index



**95%**  
Water quality  
Blue drop  
index



**73pts**  
Customer  
satisfaction  
index



Unemployment  
rate

**31.5%**



Youth  
unemployment  
rate

**41.2%**



Poverty rate  
**45.22%**



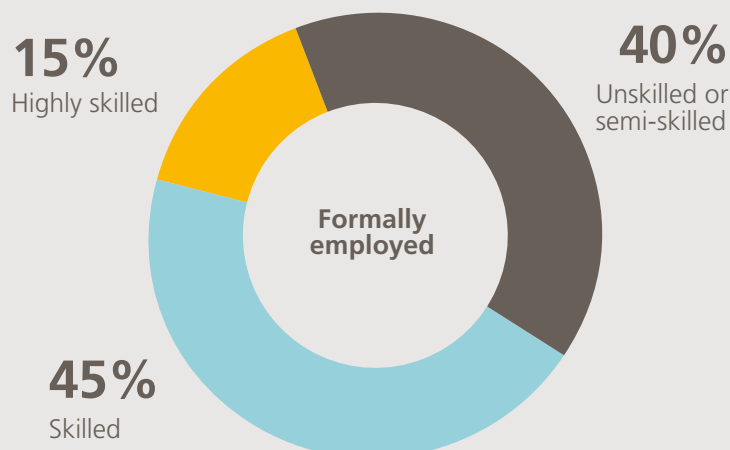
Human  
Development Index  
**0.725**



GINI coefficient  
**0.628**



GVA Growth  
(Average annual growth)  
**1.95%**





### 1.3 Why does Johannesburg need a Climate Action Plan?

**We are ploughing through this planet's finite resources as if there is no tomorrow, causing climate change and biodiversity loss along the way... Frankly, there will be no tomorrow for many people unless we stop.**

**- Joyce Msuya, Acting Executive Director of UN Environment (2019)**

Climate change is one of the greatest threats facing the world in the 21<sup>st</sup> century. If not addressed, it will threaten the survival of entire nations and of life on Earth itself. Taking action to mitigate and adapt to climate change is therefore not optional, but an urgent necessity.

The adoption of the Paris Agreement on Climate Change at the 2015 Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC), and its subsequent signing by nearly 200 countries, marked an historic turning point for climate action.

Under the Paris Agreement, countries have committed to limiting the average global temperature increase to below 2°C above pre-industrial levels, while pursuing efforts to keep the increase to below 1.5°C. The 2018 IPCC Special Report on the implications of a 1.5°C temperature increase<sup>iii</sup> revealed that human activities have already caused approximately 1°C of global warming above pre-industrial levels, and that if warming continues at the present rate, the 1.5°C threshold will likely be reached between 2030 and 2052. While effects of climate change are already being observed, at 1.5°C above pre-industrial levels, its impacts on natural and human





systems will be severe and long-lasting, if not irreversible. These impacts include loss of ecosystems, the melting of the Greenland ice sheet, sea level rise and more frequent droughts and heatwaves, with devastating consequences for health, livelihoods, food security and economic growth.

Climate change already disproportionately affects poor and vulnerable populations. Climate action is therefore not only an environmental issue, but also a social justice imperative, inextricably linked to challenges such as eradicating poverty and enhancing inclusivity. The UN's 17 interlinked Sustainable Development Goals (SDGs)<sup>iv</sup>, adopted in 2015, provide a holistic framework and vision for the world to address these issues. The achievement of each of these goals is inextricably linked to climate action, which is mandated in SDG 13.

Cities are key players in the efforts to achieve all 17 SDGs and C40's member cities, including the City of Johannesburg, have committed to playing their part. Under C40's Deadline 2020 initiative, Johannesburg has made a public commitment to develop and implement an ambitious Climate Action Plan (CAP) founded on science-based targets aligned with the global goal of limiting the average temperature rise to 1.5°C.

In 2020, the COVID-19 pandemic devastated economies worldwide and exposed stark inequalities, as poorer communities were disproportionately affected by the virus itself and its social and economic consequences. The global economic contraction in 2020 has been estimated at over 3%<sup>v</sup>. According to South African Minister of Finance Mr. Tito Mboweni, the South African economy is projected to contract by over 7% in 2020, the most severe depression the country has faced in 90 years<sup>vi</sup>.

Metropolitan municipalities across the country have reported significant drops in revenue collection, which has impacted their services and operations. The South African government has responded by passing one of the largest COVID-19 recovery stimulus packages of the Global South, totalling R500 billion (nearly US\$30 billion).

As the country has begun to chart a path towards recovery, the City of Johannesburg, which has been one of worst-hit cities in the world by the pandemic, has reaffirmed its commitment to pursue a sustainable and just recovery.

The implementation of the CAP will help the City to forge a 'new normal' by addressing systemic risks and pursuing transformation over the longer term, while meeting the immediate needs for the creation of sustainable jobs, the improvement of service delivery and the alleviation of poverty

#### 7 key reasons why the City of Johannesburg requires a Climate Action Plan:

- 1 To signal the City's commitment to address climate change as a social justice imperative, inextricably linked to the challenges of eradicating poverty and enhancing inclusivity;
- 2 To help the City understand and effectively respond to climate change impacts;
- 3 To help the City to transition to a low-carbon, competitive and just economy;
- 4 To help the City to make a meaningful contribution towards national and global climate action targets under the Paris Agreement and the SDGs;
- 5 To position the city to attract international finance for a green economic recovery following the COVID-19 pandemic;
- 6 To demonstrate leadership as responsible global citizens through advocacy, international diplomacy and innovation;
- 7 To ensure that the benefits of climate action are equitably distributed.

and inequality. A COVID-recovery plan that aligns with the CAP is essential to ensure that the benefits of both are maximised.

## 1.4 Benefits of climate action

The benefits of climate action extend far beyond reducing GHG emissions and reducing climate risks, as depicted in Figure 3 below. The City is committed to ensuring that its climate action is pro-poor and inclusive, and that the benefits derived are equitably distributed.



*Figure 3: Benefits of climate action for the City of Johannesburg*

## 1.5 CAP principles

Johannesburg's CAP is underpinned by the following principles, which have informed the design of the CAP development process, form the basis of the document itself and will also guide its implementation.

- intersectionality
- just transition
- transparency
- systemic change
- leadership
- pro-poor
- advocacy
- innovation
- evidenced-based
- sustainability
- resilience
- inclusivity





## 1.6 The climate action journey of the City of Johannesburg

**Twenty-five years ago, people could be excused for not knowing much, or doing much, about climate change. Today we have no excuse. No more can it be dismissed as science fiction; we are already feeling the effects**

**- Archbishop Emeritus Desmond Mpilo Tutu**

Coordinated international efforts to address climate change began in the early 1990s, with the 1992 Rio Earth Summit, where the text of the United Nations Framework Convention on Climate Change (UNFCCC) was opened for signature. The 197 parties to the UNFCCC committed to reducing the atmospheric concentration of greenhouse gases with the goal of "preventing dangerous anthropogenic interference with Earth's climate system".

South Africa ratified the Convention in 1997. The UNFCCC has formed the basis of South Africa's national, provincial and local government climate change policies, strategies and plans. Figure 4 on the next page illustrates the main international, national and provincial developments that informed the City of Johannesburg's CAP.

<b>1992</b>	International United Nations Framework Convention on Climate Change (UNFCCC) adopted
<b>1997</b>	National South Africa ratifying the UNFCCC
<b>2004</b>	National Climate Change Response Strategy launched
<b>2007</b>	National Long-Term Mitigation Scenarios defined
<b>2009</b>	National Greenhouse Gas Emissions Inventory developed
<b>2011</b>	National Climate Change Response White Paper published Provincial Gauteng Over-arching Climate Change Response Strategy (GCCRS) launched
<b>2012</b>	National Development Plan 2030 adopted National Greenhouse Gas Emissions Inventory developed
<b>2013</b>	National Long-Term Adaptation Scenarios developed
<b>2014</b>	National South Africa's Greenhouse Gas Mitigation Potential Analysis conducted
<b>2015</b>	National RSA Nationally Determined Contribution submitted National UN Sustainable Development Goals adopted
<b>2016</b>	International Paris Agreement ratified National Greenhouse Gas Emissions Inventory developed
<b>2017</b>	National Climate Change Response M&E Framework created
<b>2018</b>	International IPCC Special report on 1.5°C Global Warming published
<b>2020</b>	National Launch of CSIR Green Book – Adapting settlements for the future Provincial Gauteng City Region Climate Change Response Strategy and Action Plan launched National Climate Adaptation Strategy for 2020 launched National South Africa's Low Emission Development Strategy published

*Figure 4: Summary of International, National and Provincial climate change developments that informed the City's journey*





South African municipalities began to officially address environmental issues through their State of Environment Reports in the early 1990s. Although these reports did not focus explicitly on climate change, they represented the earliest attempts to address climate change issues at the local government level. The international Cities for Climate Protection programme, launched in 1993, initiated a more focused local climate change response. Sustainable development was brought to the forefront of municipal planning in Johannesburg's first long-term plan, Joburg 2030, launched after the 2000 local government elections which resulted in Johannesburg's merger into a single city. Joburg 2030 ushered in a new era of environmental policy formulation and planning in the city, exemplified by the adoption of the Environmental Management Framework and subsequent Integrated Environmental Management Policy (2005)<sup>vii</sup>.

Johannesburg's role in the international sustainable development space grew during the 2000s, with the ICLEI Africa office hosted by the city during 2001-2006, and Mayor

Amos Masondo holding the ICLEI presidency from 2003-2006. The City of Johannesburg also hosted the 2002 World Summit on Sustainable Development. In the mid-2000s, Johannesburg became a member of C40 and then took a seat on the network's steering committee, a prestigious position both for the country and the African continent.

During his tenure from 2001 until 2011, Mayor Masondo created momentum for climate action through the implementation of large-scale capital projects with clear climate change co-benefits. These included retrofitting city-owned buildings, equipping streetlights with energy efficient bulbs and installing solar water geysers and other 'climate-proofing' solutions in over 700 low-cost houses in Cosmo City. Flagship infrastructure projects included the Rea Vaya Bus Rapid Transport (BRT) system, the Robinson Deep waste to energy project, the Northern Works wastewater to energy project and the Klipriver Klipspruit greening and river rehabilitation project.

In 2006, the City of Johannesburg established a dedicated Environment and Infrastructure Services Department (EISD) to champion environmental issues and shape relevant municipal policy. In addition, the Joburg 2040 Growth and Development Strategy,<sup>viii</sup> also launched in 2011, articulated clear goals for achieving a low-carbon economy and urban resilience. In turn, the city's spatial planning blueprint, the Spatial Development Framework,<sup>ix</sup> further supported the GDS 2040 goals by adopting a radical planning approach to facilitate work towards a compact, connected and transit-oriented city.

The EISD also ensured Johannesburg's increasingly active participation in international networks such as C40 and ICLEI. In 2011, Johannesburg was among the first C40 member cities to report GHG data to the new C40-Carbon Disclosure Project platform.

Leading up to COP 21 in 2015, the City of Johannesburg completed a Climate Change Strategic Framework to mainstream climate change into city planning and policymaking, define adaptation goals and set specific GHG emission reduction targets, thereby meeting an important requirement for compliance with the Compact of Mayors.

The City of Johannesburg has remained in the international climate spotlight, hosting the 2014 C40 Mayors Summit, and winning a 'Finance & Economic Development' award at the C40 Cities Awards of 2015 for its pioneering Green Bonds initiative. Johannesburg joined C40's CAP Africa programme in March 2018, hosted the second CAP Africa Regional

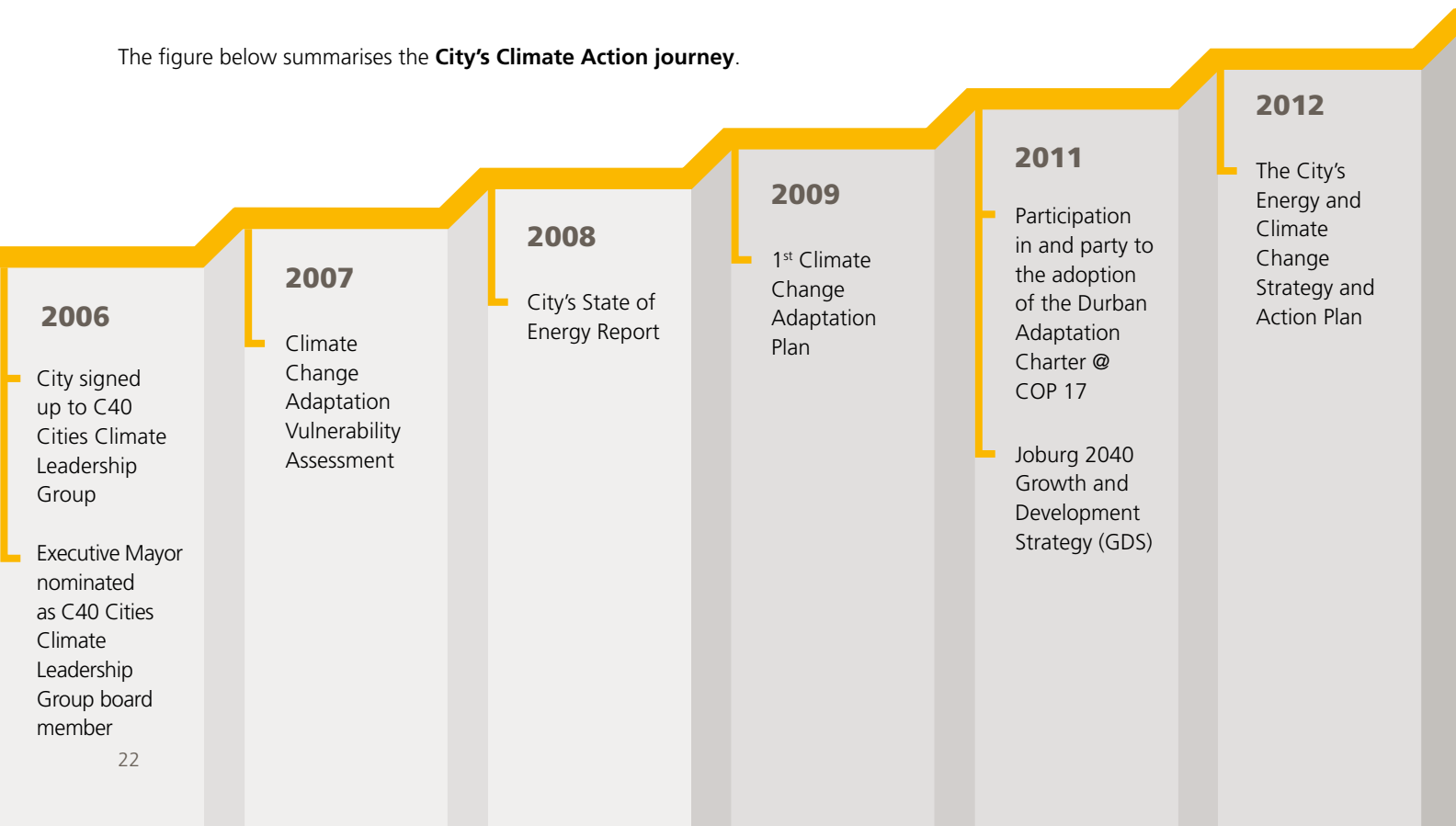
Academy in 2019, and has since undertaken a comprehensive programme of work to engage stakeholders, strengthen the evidence base, consolidate existing programmes and identify new actions to meet the City's commitment of becoming a net-zero emissions, resilient and inclusive city by 2050.

## 1.7 Johannesburg's Climate Action Plan process

The City of Johannesburg adopted an inclusive and participatory approach to the development of the CAP, following a standardized process proposed by C40 and summarised in Figure 5 below. The CAP builds on previous participatory processes, most recently the review of the city's Adaptation Plan. The 'strategic appraisal' undertaken during May 2018 assessed the existing evidence and data, policies, programmes, commitments and strategic priorities at municipal, provincial and national levels. This appraisal was followed by a stage of evidence gathering, quantitative and qualitative assessment and modelling (outlined further in Chapter 3) to build a strong evidence base for action. The City then identified, prioritized, refined and validated climate actions for the final CAP through a series of consultation workshops and technical meetings with relevant stakeholders during 2018-2020. These workshops included:

- CAP introductory workshop (September 2018)
- Mitigation workshop (May 2019)
- Vulnerability assessment workshop (September 2019)
- Adaptation prioritization workshop (June 2020)
- Mitigation prioritization workshop (August 2020)
- CAP validation workshop (October 2020)

The figure below summarises the **City's Climate Action journey**.



## 1.8 The structure of this Climate Action Plan

The rest of this CAP is structured as follows:

- Chapter 2, Climate Change Governance, presents the City's climate-related governance structure.
- Chapter 3, Evidence-based Climate Action, presents the evidence upon which the City's planned climate actions, as presented in Chapter 4, are based. It outlines the baseline data and information on the City's GHG emissions and climate vulnerability. The chapter also presents possible future GHG emission scenarios for the City.
- Chapter 4, Joburg Climate Action Plan, forms the heart of the CAP. It presents the actions required to achieve the City's goals of net-zero emissions and climate resilience.
- Chapter 5, Implementing Climate Actions, addresses the implementation of the CAP, including a high level cost-benefit analysis of proposed actions, financing options, interactions between different actions, and the monitoring, evaluation and reporting framework to be used.
- Chapter 6, Mobilizing Stakeholders, focusses on the mobilization of stakeholders, summarizing activities to facilitate community engagement with the CAP process.
- Chapter 7, Conclusion and Way Forward, draws conclusions from the CAP and presents a way forward for the City.

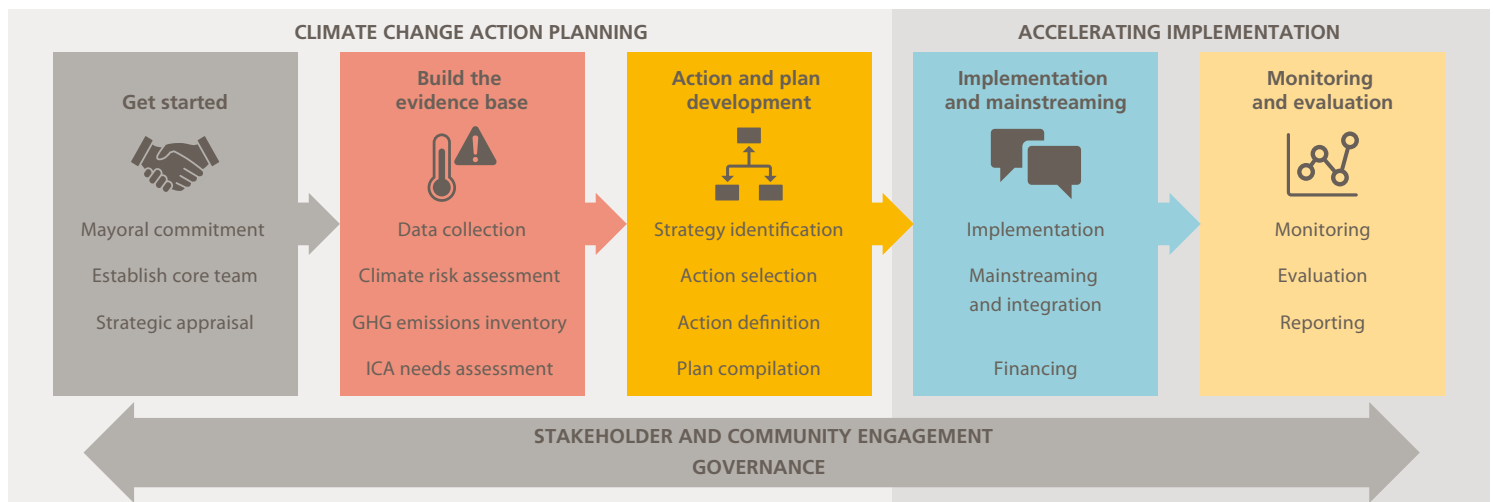
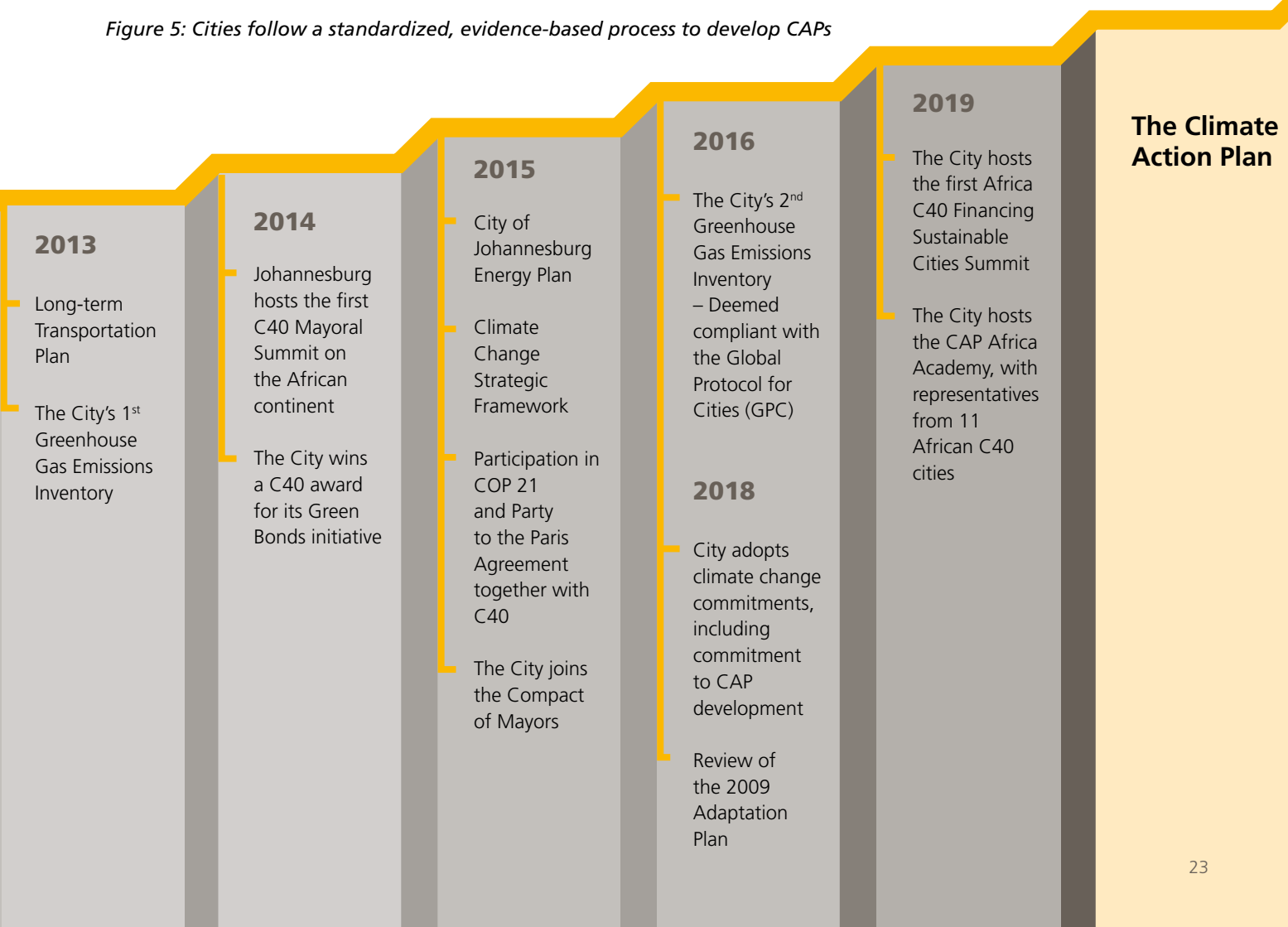


Figure 5: Cities follow a standardized, evidence-based process to develop CAPs







An aerial photograph of the Johannesburg skyline. The M1 Telcel tower is the most prominent feature, standing tall above the city. The city is densely packed with various buildings, including residential and commercial structures. In the foreground, there are green trees and a white building with a red roof. The sky is blue with some clouds. A large white number '2' is overlaid on a green and yellow background in the top right corner.

2

# Climate Change Governance

## 2. Climate Change Governance

The scale of urban transformation required to achieve the City of Johannesburg's goals of climate resilience and net-zero emissions can only be attained by strengthening the City's climate change governance to facilitate a city-wide response. The Environment Department will mobilize and collaborate with other spheres of government, youth, labour, the private sector, non-profit organisations, academia and civil society

and work towards mainstreaming climate-conscious planning and implementation across all city departments and municipal entities.

This chapter describes the City's governance structures in relation to climate change. It concludes with a list of actions to strengthen the City's climate governance across ten themes.

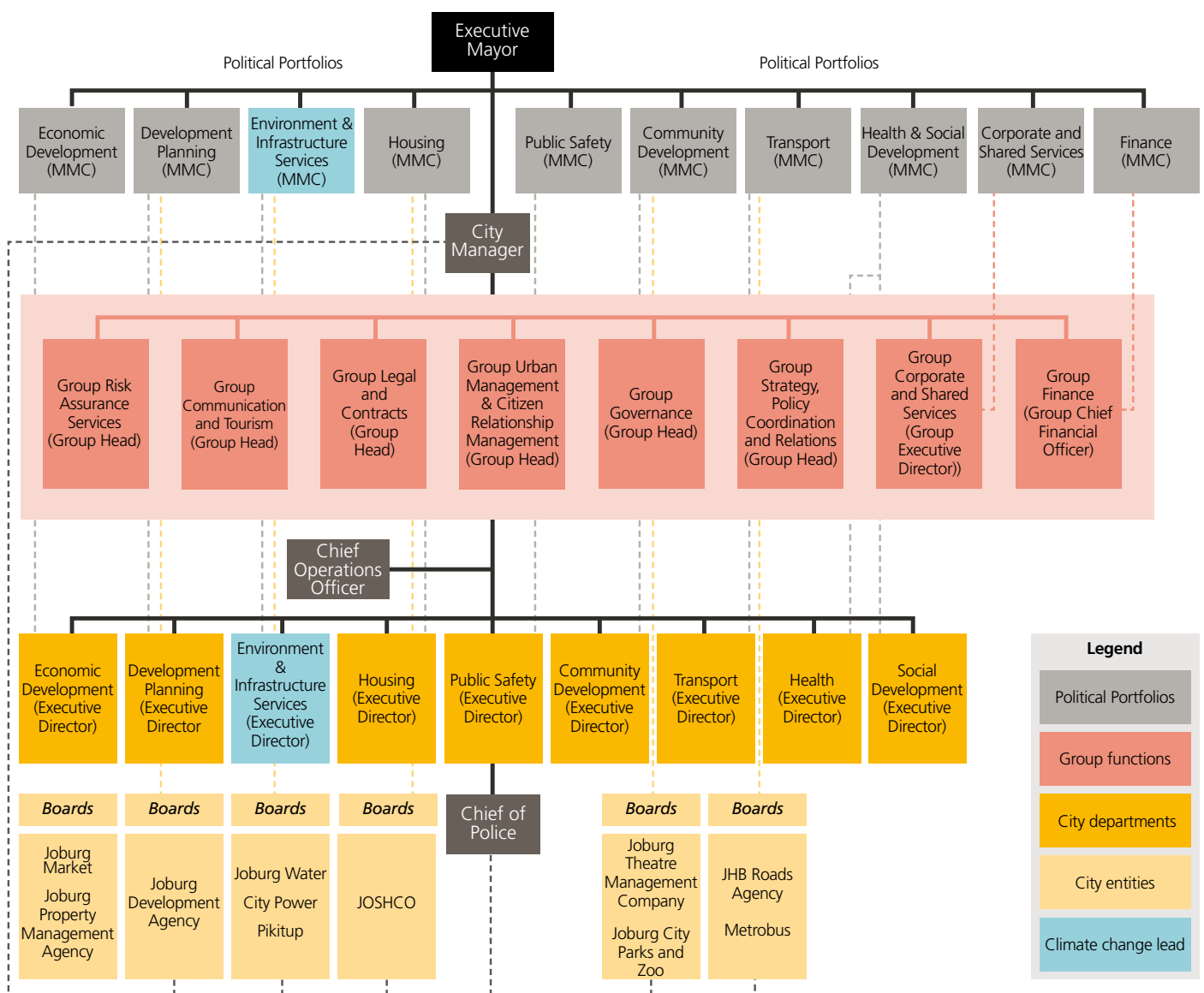


Figure 6: Organogram showing the governance structure for climate change in the City of Johannesburg.



## 2.1 Institutional structures

The City of Johannesburg's municipal government consists of a legislative arm (the Council), an executive arm (the Executive Mayor and the Mayoral Committee) and an administrative arm (headed by the City Manager). Key service delivery functions are fulfilled by municipal agencies and other entities. The organogram in Figure 6 on the previous page depicts the City's governance structure. Every entity depicted has a role to play in the implementation of climate actions.

City departments and municipal entities are grouped into four clusters: Human and Social Development, Economic Growth, Sustainable Services and Governance. Climate change falls within the remit of the Sustainable Services Cluster, which oversees and coordinates the majority of the City's service delivery obligations. The clusters are chaired by Members of the Mayoral Committee and provide political leadership, guidance and oversight for the implementation of the City's Priority Implementation Plans. Consultation and decision-making in the City occur through a number of committees. Their composition and powers are stipulated by the Municipal Structures Act (MSA) [No. 117 of 1998].

### 2.1.1 The climate change function

The Directorate of Air Quality and Climate Change within the Environment and Infrastructure Services Department (EISD) is responsible for coordinating and advancing the City's climate change agenda. The EISD in turn forms part of the Sustainable Services Cluster. As of 2020, the climate change sub-unit employs four full-time staff members. Two further positions have been created but have been vacant for several years (one due to a lack of funding).

The climate change unit is responsible for a wide range of activities. These include:

- Climate change baselines and forecasts: Data collection and compilation of GHG Inventories, Mitigation Scenarios and Climate Risk and Vulnerability Assessments.
- Cross-sectoral engagement: Convening multi-stakeholder meetings and workshops to support climate change mainstreaming.
- Strategic planning: Developing climate change strategies and plans and ensuring that climate change priorities are reflected in all city plans.
- Monitoring and reporting: Monitoring and reporting on climate adaptation and mitigation both internally and internationally.
- Climate change communications and events: Developing communications materials and contributing to city events aimed at building public awareness.

- Climate change financing: Developing and facilitating project proposals to attract financing for climate action.
- Climate change diplomacy: Representing the City of Johannesburg at international climate change conferences.

## 2.2 The Climate Action Forum

The Climate Action Forum (CAF) was established in 2018 with an endorsement from the City's Mayoral Committee. It aims to facilitate cross-sectoral engagement in support of climate change mainstreaming within the City administration. The CAF is chaired by the Director of Air Quality and Climate Change and is open to city staff from all departments and municipal entities. It is convened six times a year and aims to achieve the following:

- To enhance knowledge sharing and data gathering;
- To promote intragovernmental coordination and cooperation;
- To identify research needs to advance the City's climate change agenda;
- To promote policy integration and implementation of climate actions.

The CAF addresses a range of climate change-related topics and serves as a forum for city departments and entities to present their initiatives. The CAF was frequently consulted during the development of the CAP and will play a key role in its implementation.

### 2.2.1 The CAP Steering Committee

The CAP Steering Committee (CAP SC) was established in 2019 to provide strategic guidance related to the authorisation, resourcing and delivery of climate action in the City. It is chaired by the Executive Director of the EISD and comprised of Heads of Departments and Chief Executive Officers of municipal entities, or their representatives. The role of the CAP SC is to make recommendations to the City's most senior administrative committee, the Executive Management Team.

### 2.2.2 Technical working groups

Cross-sectoral technical working groups aim to enhance collaboration between different departments and municipal entities on specific issues or projects relevant to their respective functions. The aim of the working groups is to offer a platform for technical discussions on trade-offs between climate actions and efforts towards the mainstreaming of climate change into programmes and projects. Working groups relevant to climate change include the Flooding Working Group, the City's New Buildings Programme's Steering Committee and the City's Energy Management Committee. Members of the technical working groups are selected based on their position, expertise and interests.

## 2.4 Climate change governance actions

While the City has structures in place to help drive and mainstream climate action, stakeholders engaged during the CAP development process helped to identify a number of key actions to further increase the effectiveness of the City's climate change programmes.

These priority actions are summarised in Figure 7 and described in more detail below, ordered by thematic area following C40's

climate governance categories. This cross-cutting set of actions is to be implemented in the immediate term (2021-2025).

### 2.4.1 Mainstreaming climate policy

- Recommend to the Executive Management Team that all strategies, plans and policies under development or revision should take into consideration opportunities and risks related to climate change;

	<b>Mainstreaming climate policy:</b> Ensure that all strategies, policies, plans and projects developed by the City are compatible with the objectives of the CAP.
	<b>Institutional arrangements:</b> Optimise institutional arrangements to support the CAP's implementation.
	<b>Legal frameworks:</b> Ensure that the city's legal framework is well-aligned with the objectives of the CAP.
	<b>Cross-departmental arrangements and action:</b> Promote multi-sectoral, multi-departmental coordination and collaboration to give effect to the implementation of transformational actions.
	<b>Vertical integration:</b> Partner with provincial and national government to advance efforts towards meeting climate change objectives across all three spheres.
	<b>External governance:</b> Establish structures to promote engagement and collaboration between the City, civil society, academia, private sector and other stakeholders.
	<b>Communications and engagement:</b> Raise public awareness to support the implementation of the CAP.
	<b>Budgetary mainstreaming:</b> To avoid maladaptation and carbon lock-in, ensure that the City's budget prioritisation process is aligned to the CAP's objectives and that priority actions are funded.
	<b>Monitoring and reporting:</b> Establish a system to track progress towards achieving the CAP's targets and ensure transparent reporting.
	<b>Overcoming capacity and resource challenges:</b> Establish partnerships and find innovative solutions to overcome capacity and resource challenges.

Figure 7: Summary of actions to enhance climate change governance in the City of Johannesburg

- Draft a directive for the Council's consideration which requires new iterations of strategies, policies and plans to be aligned with and advance the implementation of the CAP. These include but are not limited to the City's Growth and Development Strategy, Spatial Development Framework, Integrated Development Plan and Service Delivery and Budget Implementation Plan;
- Ensure that Group Risk Assurance Services reflects climate change in the City's Risk Register.

#### **2.4.2 Institutional arrangements**

- Consider the positioning of climate change leadership in relation to offices responsible for long-term strategic planning and coordination, such as Group Strategy, Policy Coordination and Relations, and the Office of the Chief Operations Officer;
- Ensure that existing city structures are utilised to advance the climate change agenda by consulting with and reporting through the City's committees;
- Ensure the effectiveness of the CAF and CAP SC by making sure that their discussions are relevant and their meetings well-attended;
- Convene a special committee on climate change under the leadership of the EISD, with the purpose of supporting fellow Members of the Mayoral Committee through bi-annual meetings.

#### **2.4.3 Legal frameworks to support climate action**

- Make a recommendation to the Executive Management Team that all by-laws under development or revision should take into consideration opportunities and risks related to climate change;
- Engage Group Legal and Contracts to ensure that the City's procurement processes favour climate-friendly approaches and technologies;
- Leverage the opportunities arising from the promulgation of the Carbon Tax, the draft amendments to the Electricity Regulations on New Generation Capacity and the draft Climate Change Bill.

#### **2.4.4 Cross-departmental arrangements and action**

- Utilise the Flooding Working Group to drive the implementation of flooding-related actions;
- Utilise the Energy Management Committee to drive the implementation of energy-related actions;
- Utilise the New Buildings Programme's Steering Committee to drive actions relating to buildings;
- Identify any further needs for cross-departmental working groups for the implementation of climate actions.

#### **2.4.5 Vertical integration**

- Participate in the Intergovernmental Committee on Climate Change, National Committee on Climate Change and the Gauteng Provincial Climate Change Forum;
- Participate in the South Africa's Vertical Integration Working Group, supported by C40;
- Participate in the Cities Resilience Forum spearheaded by the Department of Environment, Forestry & Fisheries (DEFF), and the Cities Support Programme of the National Treasury;
- Contribute to the national and provincial governments' policymaking and legislative processes by providing written inputs and attending workshops when requested.
- Engage with DEFF regarding the Nationally Determined Contribution and the National Climate Change Policy Dialogue;
- Work with adjacent municipalities to reduce emissions from sources that contribute to both air pollution and climate change.

#### **2.4.6 External governance**

- Update the CAP's Integrated Communications and Stakeholder Engagement Plan to reflect stakeholder engagement required to support implementation;
- Reinstate the Johannesburg Business Forum as a platform to actively engage the private sector on a quarterly basis;
- Continue to participate in meetings convened by the Alliance for Climate Action;
- Meet with the Johannesburg Youth Council and other youth organisations on a quarterly basis;
- Establish a forum for engagement with social and environmental non-profit organisations working to advance inclusive climate action;
- Publish annual reports detailing the City's engagement and collaboration with external stakeholders.

#### **2.4.7 Communications and engagement**

- Develop tailored communications campaigns to enhance public awareness of and buy-in for the implementation of specific climate actions;
- Develop an internal communications campaign to encourage city departments and entities to fulfil their roles in delivering the CAP;
- Partner with the Citizen Relationship and Urban Management Department to develop an engagement schedule for public consultations on projects aiming to build climate change resilience in vulnerable communities;
- Ensure International Relations continues to feature climate change activities in the City's newsletter.

#### **2.4.8 Budgetary mainstreaming**

- Ensure that climate change risks are mainstreamed into the City's spatial planning and budget prioritization systems to avoid maladaptive investment;
- Ensure the inclusion of weighted criteria related to climate change adaptation and mitigation in the City's budget prioritisation tool;
- Request written commitments from the relevant entities that implementation of priority CAP actions will commence within the financial year following Council adoption of the CAP;
- Ensure that Executive Management Team members submit quarterly reports to the Group Chief Financial Officer and the City Manager on the amount of funding allocated to the implementation of the CAP;
- Conduct detailed feasibility studies to support the implementation of climate actions, taking into consideration development and adaptation deficits.

#### **2.4.9 Monitoring and transparent reporting**

- Establish a climate change monitoring and evaluation (M&E) framework aligned with the City's overarching M&E system;
- Produce GHG inventories every two years, subject to the provision of external support;
- Update Risk and Vulnerability Assessments every five years;
- Update the Climate Action Plan every five years in line with the Integrated Development Planning cycle;
- Develop a registry to record climate actions implemented in the city, including those led by non-governmental actors, to enhance reporting to provincial and national government;
- Require all departments and municipal entities to align their performance management and reporting processes with CAP indicators and targets.

#### **2.4.10 Capacity and resources**

- To enhance the capacity of the City's climate change leadership, ensure that all vacancies within the climate change sub-unit are filled;
- Evaluate the human resources of the City's climate change leadership to determine the optimal structure and capacity for CAP implementation;
- Strengthen partnerships with universities to help meet research needs;
- Establish a dedicated position for responding to international calls for project proposals in order to secure funding;
- Clarify roles and responsibilities across all departments and municipal entities as they relate to CAP implementation and the development of key climate change deliverables and reports;
- Ensure Group Corporate and Shared Services Human Resources formalize roles and responsibilities by updating job descriptions to reflect responsibilities related to CAP implementation;
- Develop a skills training and development programme to upskill staff in key sectors where skills shortages form a barrier to climate action.





3

# Evidence-based Climate Action

# 3. Evidence-based Climate Action

To be credible and effective, any plan that aims to achieve climate resilience and net-zero emissions must be based on sound baseline data. The CAP process enhanced the City's evidence base, utilising the latest data and information combined with flexible tools, robust methods and models, to boost confidence in the effectiveness of the City's action planning processes and in the potential positive impacts of its climate actions. This chapter presents the evidence that forms the basis of the City's climate change strategy: the GHG emissions inventory, climate change projections, and the city's climate vulnerability and risk assessment.

## 3.1 Johannesburg's current emissions profile

The City of Johannesburg developed a sector-specific GHG emissions inventory for 2016 using the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)<sup>x</sup>. The GPC provides clear requirements and detailed guidance for the estimation of GHG emissions for the following sectors: Stationary Energy; Transportation; Waste & Wastewater; Industrial Processes and Product Use (IPPU); and Agriculture, Forestry and Other Land Use (AFOLU).

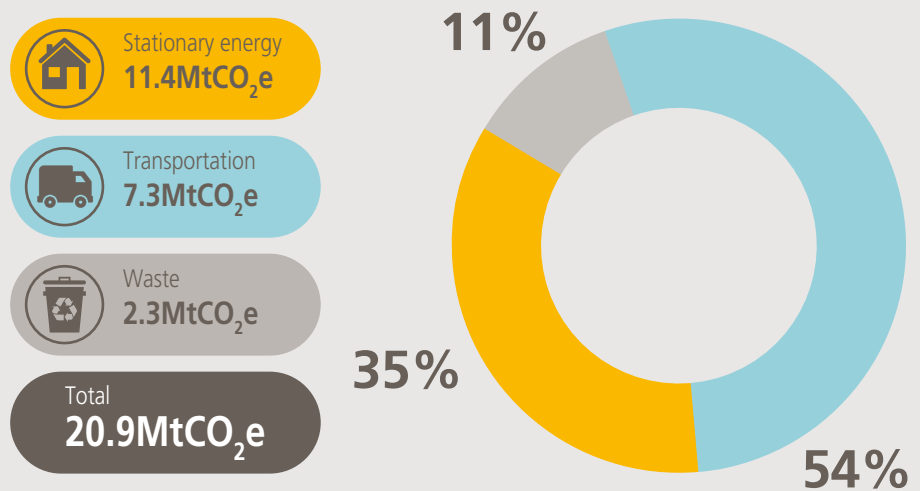


Figure 8: Johannesburg's GHG emissions in 2016

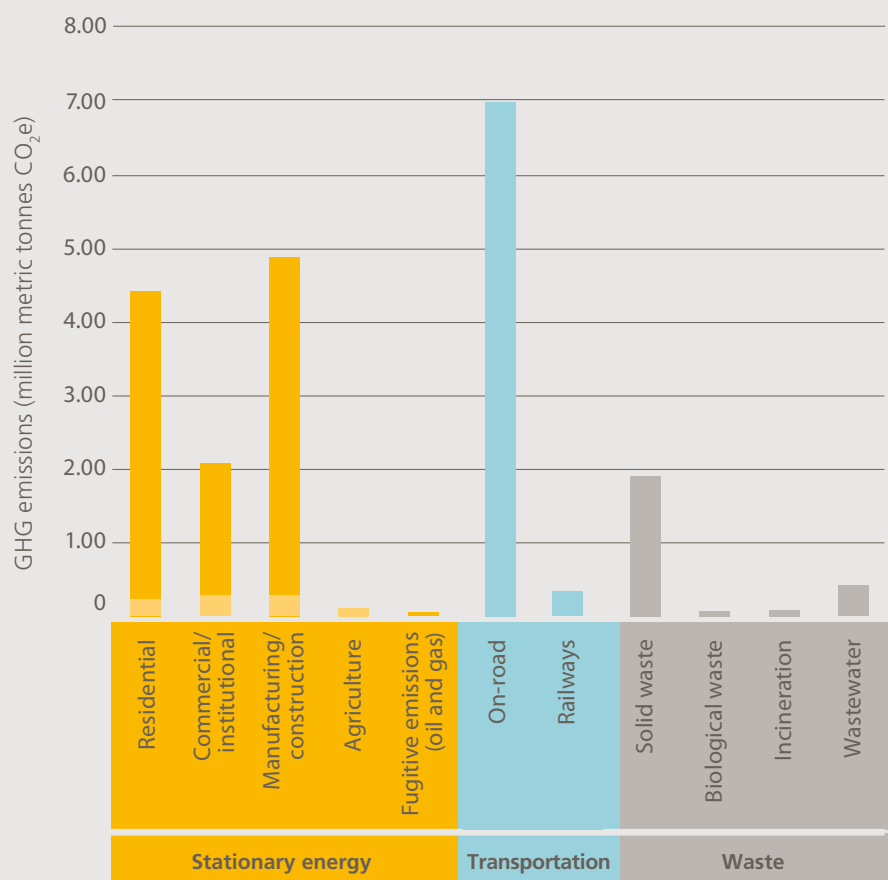


Figure 9: Detailed overview of GHG emissions by sector in Johannesburg, 2016



The 2016 BASIC-level<sup>2</sup> inventory primarily focused on GHG emissions from stationary (e.g. buildings and industry) and mobile (transportation) energy consumption within the city boundaries. It measured emissions generated by direct combustion within city limits (Scope 1), the consumption of grid-supplied electricity, heating and cooling (Scope 2), and the treatment of waste generated in the city. The City of Johannesburg did not report on IPPU and AFOLU due to data limitations. Figure 8 presents the City of Johannesburg's estimated GHG emissions for 2016, totalling 20.9 million tonnes of carbon dioxide equivalent (MtCO<sub>2</sub>e). 11.4 MtCO<sub>2</sub>e (54%) were generated by stationary energy, driven largely by electricity consumption by the manufacturing and construction industries. The transportation sector was responsible for 7.3 MtCO<sub>2</sub>e (35%), and the waste and wastewater sector for 2.3 MtCO<sub>2</sub>e (11%). This pattern is consistent with other cities in South Africa and with most cities globally.

Johannesburg's 2016 emissions amounted to 4.2 tCO<sub>2</sub>e per capita and 442 tCO<sub>2</sub>e per million USD GDP. The City's per capita emissions are slightly lower than the average for all C40 cities (currently 5.59 tCO<sub>2</sub>e) and the other C40 member cities in South Africa, Durban (6.1 tCO<sub>2</sub>e), Tshwane (6.0 tCO<sub>2</sub>e) and Cape Town (5.7 tCO<sub>2</sub>e). They are, however, higher than the average for all African cities (3.27 tCO<sub>2</sub>e).

### 3.2 The City's GHG baseline projections and targets

Along with a transition in the local energy sector, a transition in transport and spatial planning will be instrumental to

enable significant emission reductions and achieve the City's net-zero emissions target.

The baseline for calculating emission reductions is the business-as-usual (BAU) emissions trajectory, a projection of the City's GHG emissions between 2016 and 2050 without any GHG mitigation measures. Different future scenarios were developed and compared to this baseline, including a scenario projecting the impacts of only currently existing and planned actions in the city and nationally and an emissions trajectory consistent with the City achieving the status of an 'early peak city' and reaching its net-zero emissions goal by 2050. The City employed a multi-stakeholder process to gather underlying data, assess options for and validate the results of all future emissions scenarios.

#### 3.2.1 Baseline trajectory

The BAU baseline trajectory was developed based on the City's projected economic and population growth until 2050. Though the City is expected to continue to grow, the rate at which the population grows is projected to decrease after 2025. Table 1 shows the projected BAU baseline emissions for the City of Johannesburg up until 2050, without any further implementation of climate change mitigation interventions (whether already planned or new).

Under the baseline scenario, the City's emissions are projected to increase by 133% from 20.9 MtCO<sub>2</sub>e in 2016 to 48.7 MtCO<sub>2</sub>e by 2050.

Actions	2016	2025	2030	2040	2050
<b>Projected emissions under BAU (MtCO<sub>2</sub>e)</b>	20.9	26.5	31.2	39.4	48.7
<b>% increase compared to 2016</b>	n/a	27%	49%	89%	133%

Table 1: Baseline emission projections

<sup>2</sup> BASIC includes: scope 1 & 2 emissions from stationary energy, scope 1 transportation and scope 1 & 3 emissions from waste

### 3.2.2 Pathway and targets to 2050

In December 2016, C40 published an analysis of the contribution that C40 cities must make to delivering the Paris Agreement objective of limiting global temperature rise to 1.5°C above pre-industrial levels, entitled 'Deadline 2020: How cities will get the job done'. The analysis showed that, as a collective, C40 cities must reach their emissions peak by 2020 and achieve zero net emissions by 2050 at the latest. The study divided cities into different categories based on their historical emissions, economic growth and development status. Johannesburg was classified as an 'early peak city'. Johannesburg's proposed mitigation scenario includes room for some growth in emissions in the short term, but states that the City's GHG emissions should peak by 2030 at no more than 28.9 MtCO<sub>2</sub>e, and then decline towards net-zero emissions by 2050. Figure 10 below shows this future emissions trajectory for the City of Johannesburg.

The City has set targets for emission reductions that are consistent with this trajectory, with deadlines aligned with key strategic documents and commitments.

This trajectory is also, in the short term, consistent with South Africa's national GHG emissions reduction target. The National Climate Change Response White Paper and the first Nationally Determined Contribution under the Paris Agreement both commit the country to a 'peak-plateau-decline' model, with emissions peaking between 2020 and 2025 and then plateauing for ten years before declining.

## Emissions trajectories from 2016 to 2050

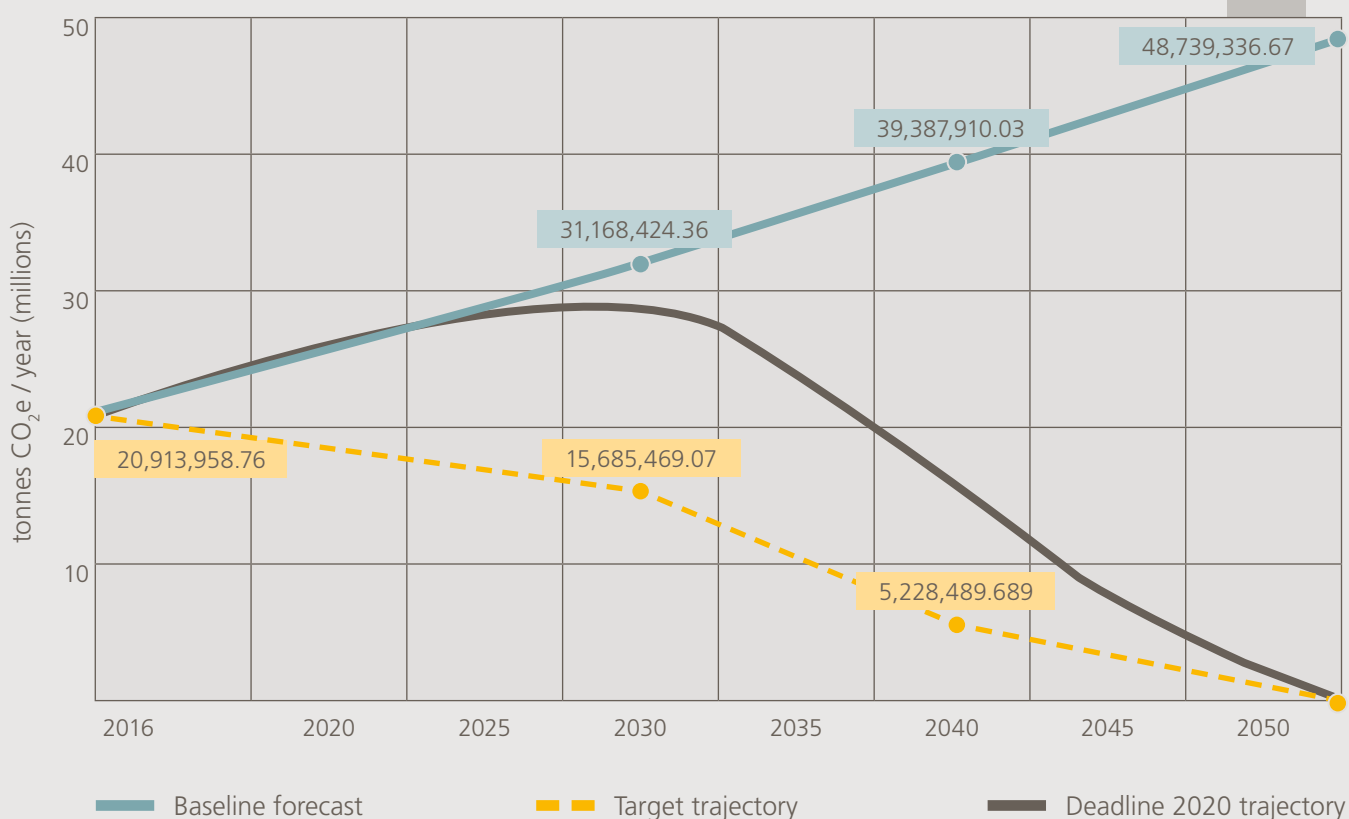


Figure 10: Business-as-usual, Deadline 2020 and target GHG emissions pathways for the City of Johannesburg



## **Carbon Neutral, Climate Neutral, Net Zero, Net Zero Carbon?**

These terms are often used interchangeably, but do they mean the same thing?

They do, mostly. Carbon neutral refers to a net carbon dioxide ( $\text{CO}_2$ ) emissions balance of zero. This may be achieved either by eliminating all  $\text{CO}_2$  emissions, or by balancing  $\text{CO}_2$  emissions with removals (often through carbon offsetting or sequestration by vegetation). This is also termed 'net zero carbon'.

Sometimes confusion occurs when other gases are involved. Technically speaking, a city can be 'carbon neutral' whilst still emitting other greenhouse gases, such as nitrous oxide ( $\text{N}_2\text{O}$ ) from waste disposal, biomass combustion or agriculture. These gases are also emitted alongside  $\text{CO}_2$  in the combustion of fossil fuels. This is why sometimes the terms 'net zero' or 'climate neutral', which more explicitly cover all greenhouse gases, are used instead. Johannesburg interprets 'net zero emissions' as including all greenhouse gases.



### 3.3 The GHG mitigation scenarios

The City worked with stakeholders and experts to assess a range of policies and actions, their likely impacts, interactions, and mitigation potentials, and based on these, developed a set of GHG mitigation scenarios using C40's 'Pathways' model. The aim of the mitigation scenarios is to assess and demonstrate how the City might achieve its interim targets and its 2050 objective of net-zero emissions. This requires identifying planned and existing policies and actions that will impact future emissions and devise additional or scaled-up mitigation actions that will close the gap between the baseline GHG emissions scenario and the target trajectory. The City developed two scenarios to reflect this distinction:

1. Existing and planned scenario;
2. Ambitious scenario.

#### 3.3.1 Existing and planned scenario

The 'Existing and planned scenario' demonstrates the GHG emission reductions that may be achieved through implementation of policies and actions that are already in place. This includes policies and actions initiated by the City, provincial or national administrations that have already been planned or committed to, and that will impact future GHG emissions. Existing and planned actions were identified by consulting information sources including the business plans of relevant City departments and entities, local policies, reports and strategic documents such as the Integrated Development Plan (IDP), and provincial and national plans such as the Integrated Resource Plan.

Figure 11 below shows that existing and planned policies and actions are projected to deliver a reduction in GHG emissions

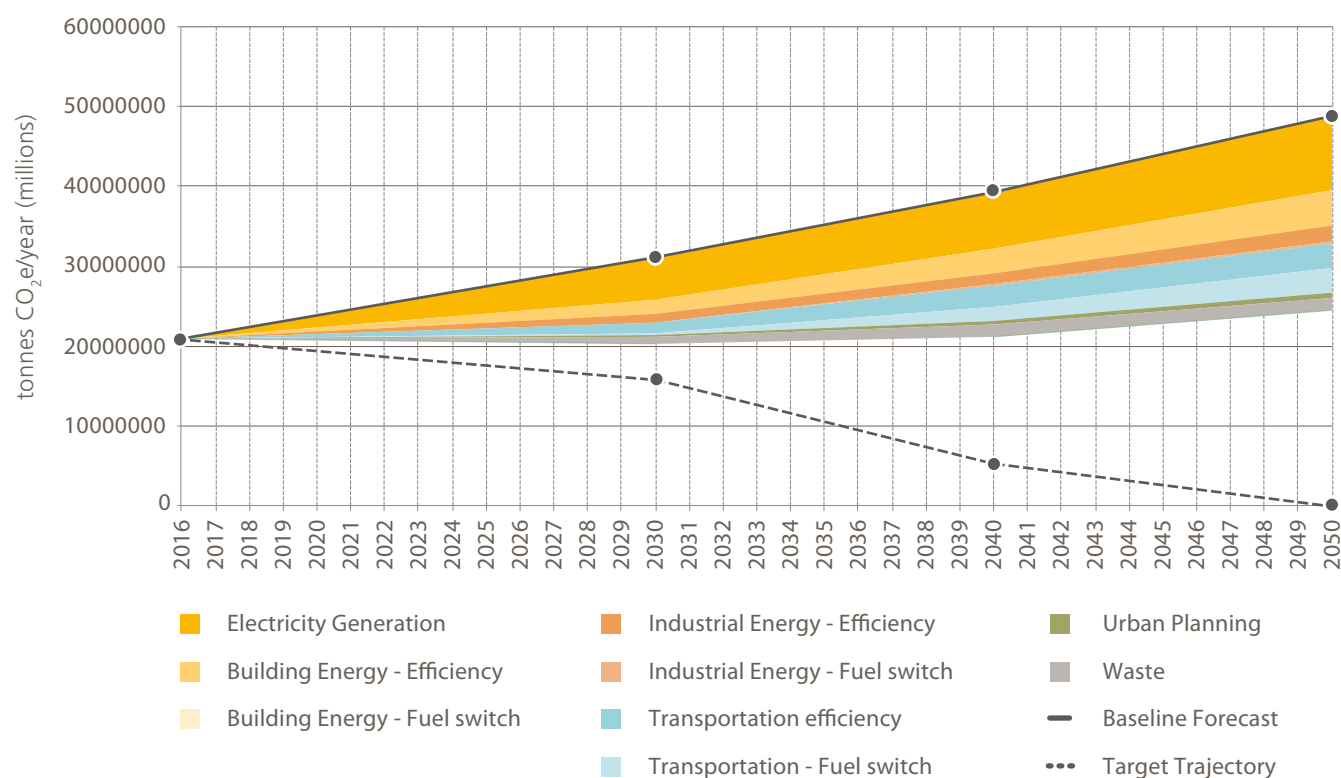


Figure 11: Potential mitigation impact of the existing and planned scenario



of 23% compared to BAU by 2025, 35% by 2030, 46% by 2040 and 50% by 2050. Under this scenario, total emissions in 2050 are estimated to be 17% higher than in the base year, at 24.5 MtCO<sub>2</sub>e. The graph shows that existing plans to decarbonise the electricity supply will have the single largest impact on reducing future emissions, followed by planned actions in the transportation sector, in particular the shift to electric vehicles. This scenario shows that the

City is already on course to achieve a stabilization of total emissions and a significant reduction compared to the BAU emissions scenario. However, many of the policies and actions identified are yet to be implemented or fall outside of the City's jurisdiction, which means that close collaborations and advocacy will be required to ensure they are realised. Furthermore, to achieve the targets the city has set, additional and more ambitious action will be required.

Actions	2025	2030	2040	2050
<b>Electricity generation</b>	<ul style="list-style-type: none"> <li>11.5% of commercial buildings &amp; 5.5% of homes have renewables;</li> <li>18.5% of grid electricity from renewable sources.</li> </ul>	<ul style="list-style-type: none"> <li>15% of commercial buildings &amp; 7.5% of homes have renewables;</li> <li>35% of grid electricity from renewable sources.</li> </ul>	<ul style="list-style-type: none"> <li>20% of commercial buildings &amp; 11.5% of homes have renewables;</li> <li>35% of grid electricity from renewable sources.</li> </ul>	<ul style="list-style-type: none"> <li>20% of commercial buildings &amp; 15% of homes have renewables;</li> <li>35% of grid electricity from renewable sources.</li> </ul>
<b>Building energy</b>	<ul style="list-style-type: none"> <li>5% upgraded to solar thermal;</li> <li>13% LED lighting;</li> <li>7% high-efficiency appliances in commercial buildings.</li> </ul>	<ul style="list-style-type: none"> <li>6% upgraded to solar thermal;</li> <li>21% LED lighting;</li> <li>10% high-efficiency appliances in commercial buildings.</li> </ul>	<ul style="list-style-type: none"> <li>20% upgraded to solar thermal;</li> <li>35% LED lighting;</li> <li>18% high-efficiency appliances in commercial buildings.</li> </ul>	<ul style="list-style-type: none"> <li>25% upgraded to solar thermal;</li> <li>50% LED lighting;</li> <li>25% high-efficiency appliances in commercial buildings.</li> </ul>
<b>Industrial &amp; other stationary</b>	<ul style="list-style-type: none"> <li>Distribution water loss reduced to 40.5%;</li> <li>Industrial energy efficiency improved 15%.</li> </ul>	<ul style="list-style-type: none"> <li>Distribution water loss reduced to 38%;</li> <li>Industrial energy efficiency improved 15%.</li> </ul>	<ul style="list-style-type: none"> <li>Distribution water loss reduced to 33%;</li> <li>Industrial energy efficiency improved 15%.</li> </ul>	<ul style="list-style-type: none"> <li>Distribution water loss reduced to 28%;</li> <li>Industrial energy efficiency improved 15%;</li> <li>Complete phase-out of coal in industry.</li> </ul>
<b>Transportation</b>	<ul style="list-style-type: none"> <li>Private car use reduced to 30% of journeys;</li> <li>2% of journeys by BRT, 26% by minibus, 4% by commuter rail;</li> <li>2.5% of vehicles electric.</li> </ul>	<ul style="list-style-type: none"> <li>Private car use reduced to 29% of journeys;</li> <li>2% of journeys by BRT, 26% by minibus, 4% by commuter rail;</li> <li>4.5% of vehicles electric.</li> </ul>	<ul style="list-style-type: none"> <li>Private car use reduced to 27% of journeys;</li> <li>4% of journeys by BRT, 24% by minibus, 6% by commuter rail;</li> <li>35% of vehicles electric.</li> </ul>	<ul style="list-style-type: none"> <li>Private car use reduced to 26% of journeys;</li> <li>5% of journeys by BRT, 23% by minibus, 7% by commuter rail;</li> <li>55% of vehicles electric.</li> </ul>
<b>Waste</b>	<ul style="list-style-type: none"> <li>24.5% of waste recycled &amp; 74% to landfill;</li> <li>25% of organic waste treated biologically;</li> <li>7% of landfill gas captured.</li> </ul>	<ul style="list-style-type: none"> <li>32% of waste recycled &amp; 66.3% to landfill;</li> <li>32% of organic waste treated biologically;</li> <li>15% of landfill gas captured.</li> </ul>	<ul style="list-style-type: none"> <li>46.5% of waste recycled &amp; 50% to landfill;</li> <li>47% of organic waste treated biologically;</li> <li>15% of landfill gas captured.</li> </ul>	<ul style="list-style-type: none"> <li>46.5% of waste recycled &amp; 50% to landfill;</li> <li>50% of organic waste treated biologically;</li> <li>15% of landfill gas captured.</li> </ul>

**Table 2: Main assumptions and targets included in the existing and planned scenario**

### 3.3.2 Ambitious Scenario

The objective of the 'Ambitious scenario' is to explore opportunities to enhance and scale-up existing programmes and identify additional actions to deliver greater future emissions reductions and help the City move closer to meeting its targets. It represents an ambitious low-carbon development trajectory that generates economic, social and environmental benefits for the City of Johannesburg. This scenario relies on bold, transformative actions within the direct control and/or influence of the City. It considers the City's infrastructural, financial, technological, social, economic, policy and legal conditions and constraints. Shifting Johannesburg onto this pathway is technically achievable and will require strong partnerships, structural, institutional and societal change, political will, bold leadership and significant investment. The scenario was co-developed with stakeholders and rigorously tested in consultations.

The City of Johannesburg will actively pursue achieving this scenario through the implementation of the CAP.

Figure 12 shows the mitigation potential of the ambitious scenario, while Table 3 summarizes information on the main targets that were modelled for the actions in this scenario. The GHG emissions projection for the ambitious scenario shows that with ambitious but achievable action, the City's emissions can be reduced to 28% below the BAU scenario by 2025, 43% by 2030, 70% by 2040 and 81% by 2050, representing an 57% reduction of total emissions from the 2016 base year. The scenario requires increased efforts to reduce emissions across all sectors, but the greatest mitigation potential is found in transportation (through a combination of mode shift to public transit and electrification) and decarbonisation of the electricity supply. The scenario foresees not only greater levels of ambition in the long term but also significant interventions to reduce emissions in the immediate term, by 2025.

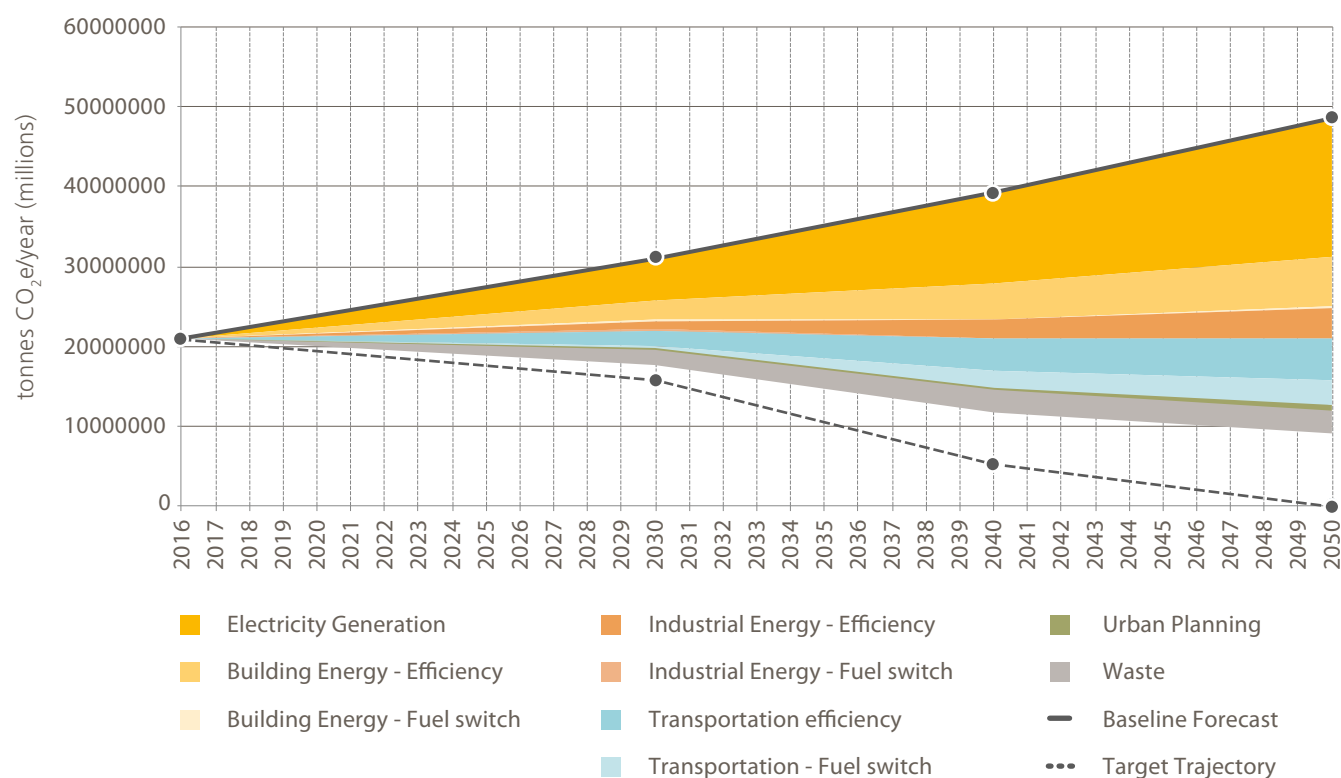


Figure 12: Potential mitigation impact of the ambitious scenario

Actions	2025	2030	2040	2050
<b>Electricity generation</b>	<ul style="list-style-type: none"> <li>11.5% of commercial buildings &amp; 5.5% of homes have renewables;</li> <li>18.5% of grid electricity from renewable sources.</li> </ul>	<ul style="list-style-type: none"> <li>20% of commercial buildings &amp; 7.5% of homes have renewables;</li> <li>35% of grid electricity from renewable sources.</li> </ul>	<ul style="list-style-type: none"> <li>37.5% of commercial buildings &amp; 15% of homes have renewables;</li> <li>57% of grid electricity from renewable sources.</li> </ul>	<ul style="list-style-type: none"> <li>55% of commercial buildings &amp; 22% of homes have renewables;</li> <li>71% of grid electricity from renewable sources.</li> </ul>
<b>Building energy</b>	<ul style="list-style-type: none"> <li>10% upgraded to heat pumps or high-efficiency boilers;</li> <li>15% upgraded to solar thermal;</li> <li>40% LED lighting;</li> <li>30% of coal stoves switched to LPG or wood;</li> <li>20% high-efficiency appliances in commercial buildings.</li> </ul>	<ul style="list-style-type: none"> <li>20% upgraded to heat pumps or high-efficiency boilers;</li> <li>16% upgraded to solar thermal;</li> <li>43% LED lighting;</li> <li>32% of coal stoves switched to LPG or wood;</li> <li>31% high-efficiency appliances in commercial buildings.</li> </ul>	<ul style="list-style-type: none"> <li>60% upgraded to heat pumps or high-efficiency boilers;</li> <li>35% upgraded to solar thermal;</li> <li>85% LED lighting;</li> <li>70% of coal stoves switched to LPG or wood;</li> <li>53% high-efficiency appliances in commercial buildings.</li> </ul>	<ul style="list-style-type: none"> <li>100% upgraded to heat pumps or high-efficiency boilers;</li> <li>50% upgraded to solar thermal;</li> <li>100% LED lighting;</li> <li>100% of coal stoves switched to LPG or wood;</li> <li>75% high-efficiency appliances in commercial buildings.</li> </ul>
<b>Industrial &amp; other energy</b>	<ul style="list-style-type: none"> <li>Distribution water loss reduced to 33%;</li> <li>Industrial energy efficiency improved 15%.</li> </ul>	<ul style="list-style-type: none"> <li>Distribution water loss reduced to 15%;</li> <li>Industrial energy efficiency improved 16%.</li> </ul>	<ul style="list-style-type: none"> <li>Distribution water loss reduced to 10%;</li> <li>Industrial energy efficiency improved 24%.</li> </ul>	<ul style="list-style-type: none"> <li>Distribution water loss reduced to 10%;</li> <li>Industrial energy efficiency improved 30%;</li> <li>Complete phase-out of coal in industry.</li> </ul>
<b>Transportation</b>	<ul style="list-style-type: none"> <li>Private car use reduced to 27% of journeys;</li> <li>4% of journeys by BRT, 25% by minibus, 5% by commuter rail;</li> <li>5% of vehicles electric.</li> </ul>	<ul style="list-style-type: none"> <li>Private car use reduced to 26% of journeys;</li> <li>5% of journeys by BRT, 24% by minibus, 6% by commuter rail;</li> <li>7.5% of vehicles electric.</li> </ul>	<ul style="list-style-type: none"> <li>Private car use reduced to 18% of journeys;</li> <li>10% of journeys by BRT, 21% by minibus, 11% by commuter rail;</li> <li>40% of vehicles electric.</li> </ul>	<ul style="list-style-type: none"> <li>Private car use reduced to 12% of journeys;</li> <li>14% of journeys by BRT, 16% by minibus, 18% by commuter rail;</li> <li>60% of vehicles electric.</li> </ul>
<b>Waste</b>	<ul style="list-style-type: none"> <li>49% of waste recycled &amp; 48% to landfill;</li> <li>49% of organic waste treated biologically;</li> <li>20% of landfill gas captured.</li> </ul>	<ul style="list-style-type: none"> <li>64% of waste recycled &amp; 32% to landfill;</li> <li>64% of organic waste treated biologically;</li> <li>35% of landfill gas captured.</li> </ul>	<ul style="list-style-type: none"> <li>93% of waste recycled &amp; zero waste to landfill;</li> <li>93% of organic waste treated biologically;</li> <li>55% of landfill gas captured.</li> </ul>	<ul style="list-style-type: none"> <li>93% of waste recycled &amp; zero waste to landfill;</li> <li>100% of organic waste treated biologically;</li> <li>75% of landfill gas captured.</li> </ul>

**Table 3: Main assumptions and targets included in the ambitious scenario**

### 3.3.3 Residual emissions

Whilst the ambitious action scenario has the potential to deliver significant emission reductions, it does not achieve net-zero emissions for the City of Johannesburg. Total emissions are still projected at around 9 MtCO<sub>2</sub>e in 2050, with most residual emissions generated by the road transport sector, direct combustion of fuel in buildings, and the wastewater system (see Figure 13 below). The City will need to identify additional actions or technologies to mitigate these residual emissions and achieve its net-zero emissions goal. The City also must ensure continued monitoring of current, projected and future residual emissions and update the plan to include new options as they emerge.

### 3.3.4 Air quality implications

The City of Johannesburg strives to improve air quality through the initiatives detailed in its Air Quality Management Plan. Most of the identified climate change mitigation actions will also improve air quality in the city, in particular by significantly reducing concentrations of PM<sub>2.5</sub> (fine particulate matter). In South Africa, exposure to ambient PM<sub>2.5</sub> causes more than 24,000 premature deaths each year<sup>xi</sup> and in the City of Johannesburg reported PM<sub>2.5</sub> concentration levels that exceed the national standard for acceptable air quality of 20ug/m<sup>3</sup>.<sup>xii</sup> The actions included in the existing and planned scenario are projected to reduce the concentrations of PM<sub>2.5</sub> generated within the city limits by 31% by 2050 (see Figure 14).

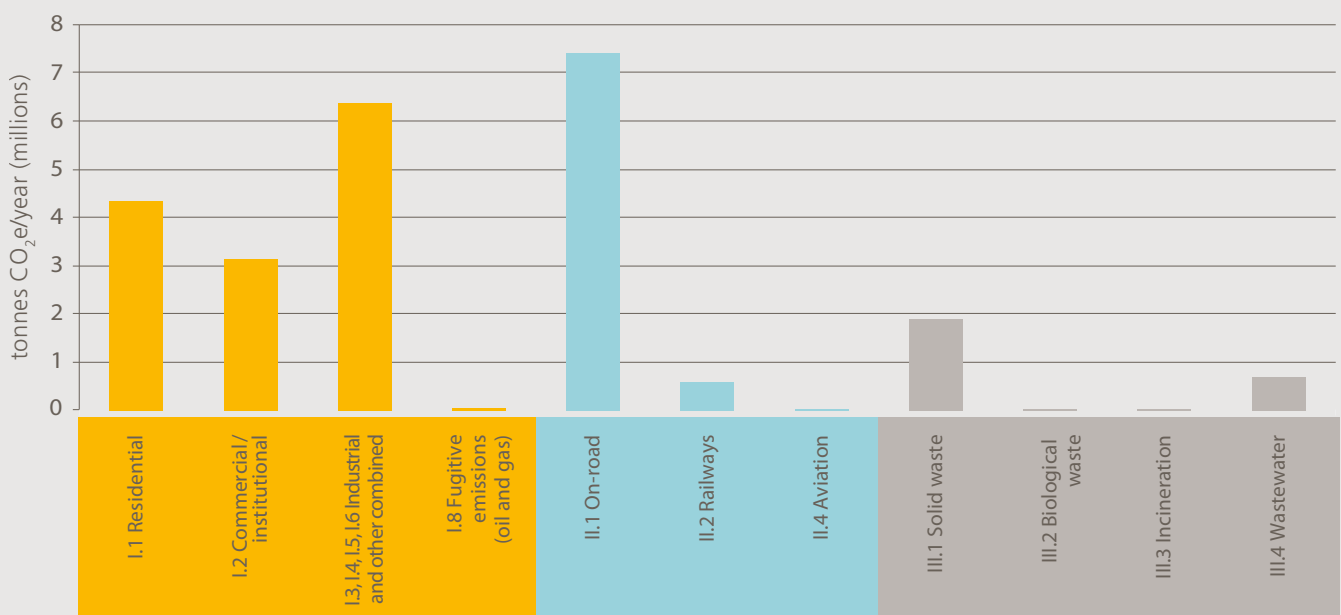


Figure 13: Residual emissions in 2050 (ambitious scenario)

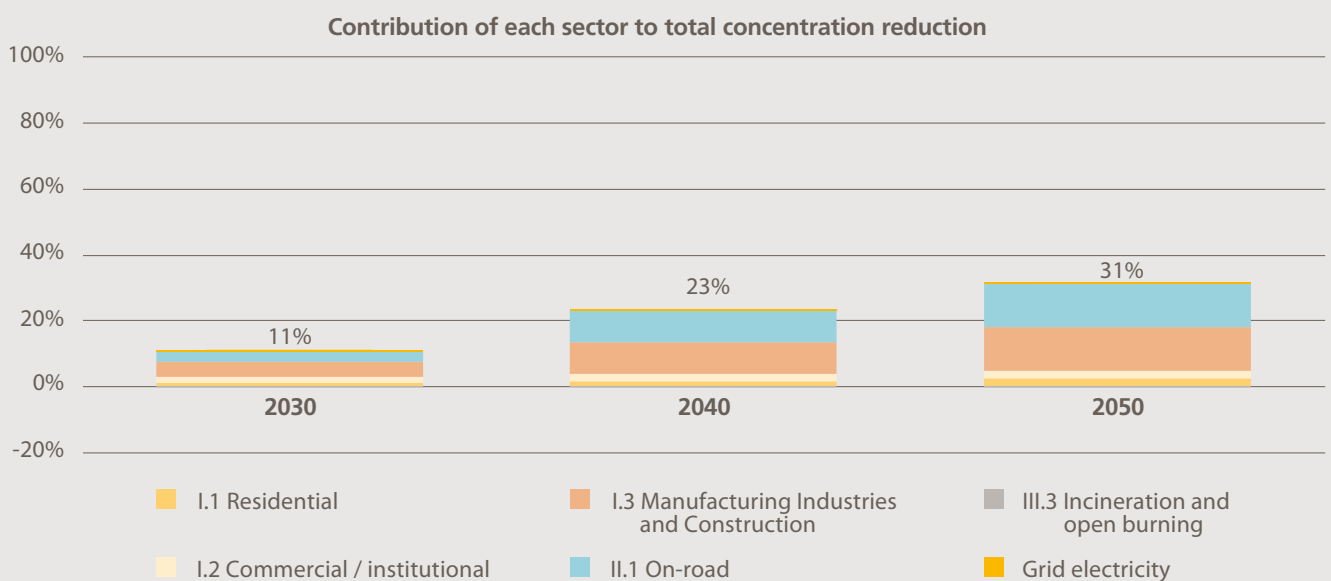
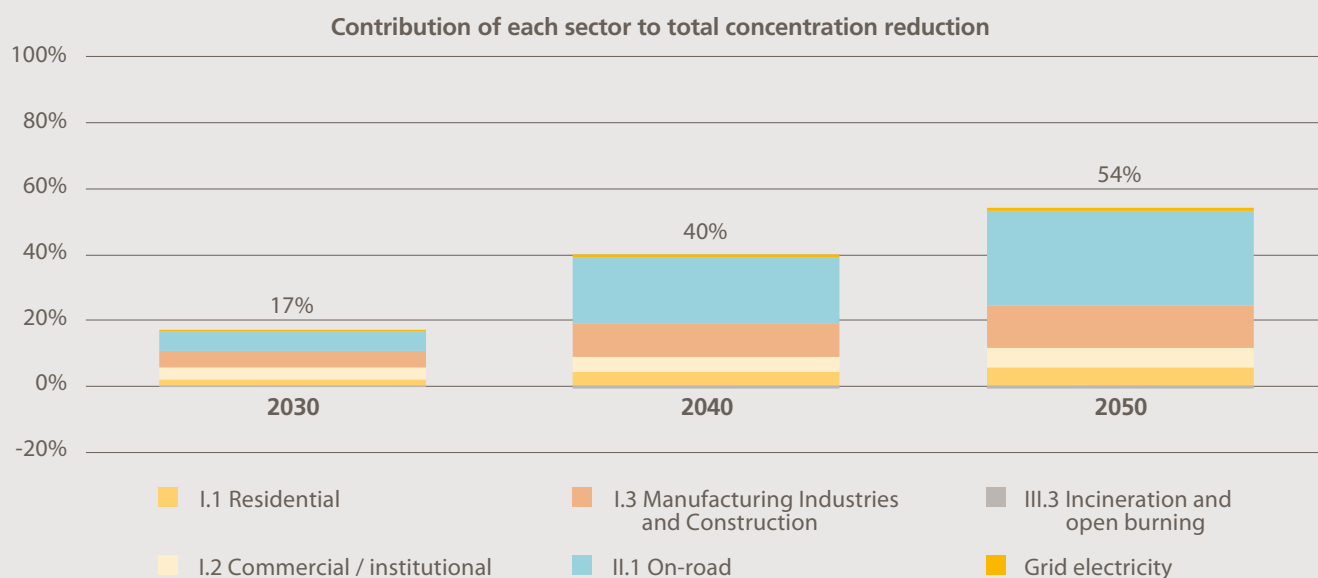


Figure 14: Projected reduction in PM<sub>2.5</sub> concentrations under the existing and planned actions scenario.



Implementing the actions included in the ambitious scenario would reduce the concentrations of  $PM_{2.5}$  generated within city limits by 54% by 2050 (see Figure 15). The largest reductions in  $PM_{2.5}$  concentrations are expected to be delivered by actions related to the manufacturing and construction sectors, as well as on-road transport.<sup>3</sup>



**Figure 15: Projected reduction in  $PM_{2.5}$  concentrations under the ambitious scenario.**

<sup>3</sup> Note that the graph presents only the reductions in  $PM_{2.5}$  emissions due to decarbonization of grid electricity generation that affect air quality within the city boundaries. As most power generation facilities supplying the city are located outside the city boundaries, this is only a small part of the total air pollution produced in the process of generating the grid electricity used in the city. The remainder of the pollution affects areas near the power generation facilities and the larger airshed.

### 3.4 Climate risks and vulnerabilities relevant to Johannesburg

To identify and prioritise actions to enhance the City of Johannesburg's climate resilience, it is necessary to understand the key risks and vulnerabilities of all parts of the city.

#### 3.4.1 Observed climate trends

Johannesburg has always experienced significant interannual rainfall variability, driven primarily by the El Niño/La Niña phenomenon. Increases in temperature, rainfall variability and rainfall intensity due to climate change have already been observed – see Figure 16. Climate change models project that these upward trends will continue and accelerate in the coming decades.



No clear annual precipitation trends as a result of climate change have been observed. The central and southern parts of the city have experienced an increase in rainfall in recent decades, whereas the opposite trend is evident in the northern part.



The amount of precipitation Johannesburg receives varies greatly year-to-year. The city receives on average 713 mm of rainfall per year.



The frequency of meteorological events is likely to become less predictable.

Figure 16: Observed rainfall and temperature trends in Johannesburg



### 3.4.2 Historical and current vulnerability

The north-eastern, north-western and southern parts of the City are currently the most vulnerable to impacts of climate change. Particularly vulnerable areas include Soweto, Alexandra, Ebony Park, Diepsloot, Stretford, Roodepoort, Rabie Ridge, Poortjie, Orange Farm, Mayibuye, Lenasia, Lakeside, Kanana Park, Kaalfontein, and Ivory Park.

**Vulnerability:** The degree to which the City is “susceptible to and unable to cope with adverse effects of climate change, including climate variability and extremes.”<sup>xiii</sup>



The average daily temperature in the City of Johannesburg is 25°C.



Average mid-day and midnight temperatures have steadily increased over the last four decades in all parts of the city. Average mid-day temperatures have increased nearly 1.5°C and average night-time temperatures almost 1°C since 1981.



Colder days and nights are becoming less frequent while hotter days and nights are becoming more frequent.

### 3.4.3 Future Climate Change Scenarios

Future climate change scenarios are based on possible trajectories of atmospheric greenhouse gas concentrations (not emissions) developed by IPCC. These are known as Relative Concentration Pathways (RCPs). Which pathway will be taken depends on to what extent GHG emissions are reduced in the years to come. The RCPs are labelled with the radiative forcing value projected for each pathway for the year 2100, namely 2.4, 4.5, 6 and 8.5 W/m<sup>2</sup>. Because atmospheric greenhouse gas concentrations will not respond immediately even to ambitious emissions reduction efforts, the pathways are likely to diverge only after the mid-century. For the purposes of this report, climate change impact on temperatures and rainfall in the City of Johannesburg by 2050 (10<sup>th</sup> to 90<sup>th</sup> percentile) was projected using the latest downscaled climate change scenarios,<sup>xiv</sup> focusing on RCP4.5 (a pathway that would require ambitious global climate action) and RCP8.5 (a pathway that would result without ambitious climate action). Figure 17 shows the projected change in the single day extreme heat value for the City of Johannesburg under these two scenarios.

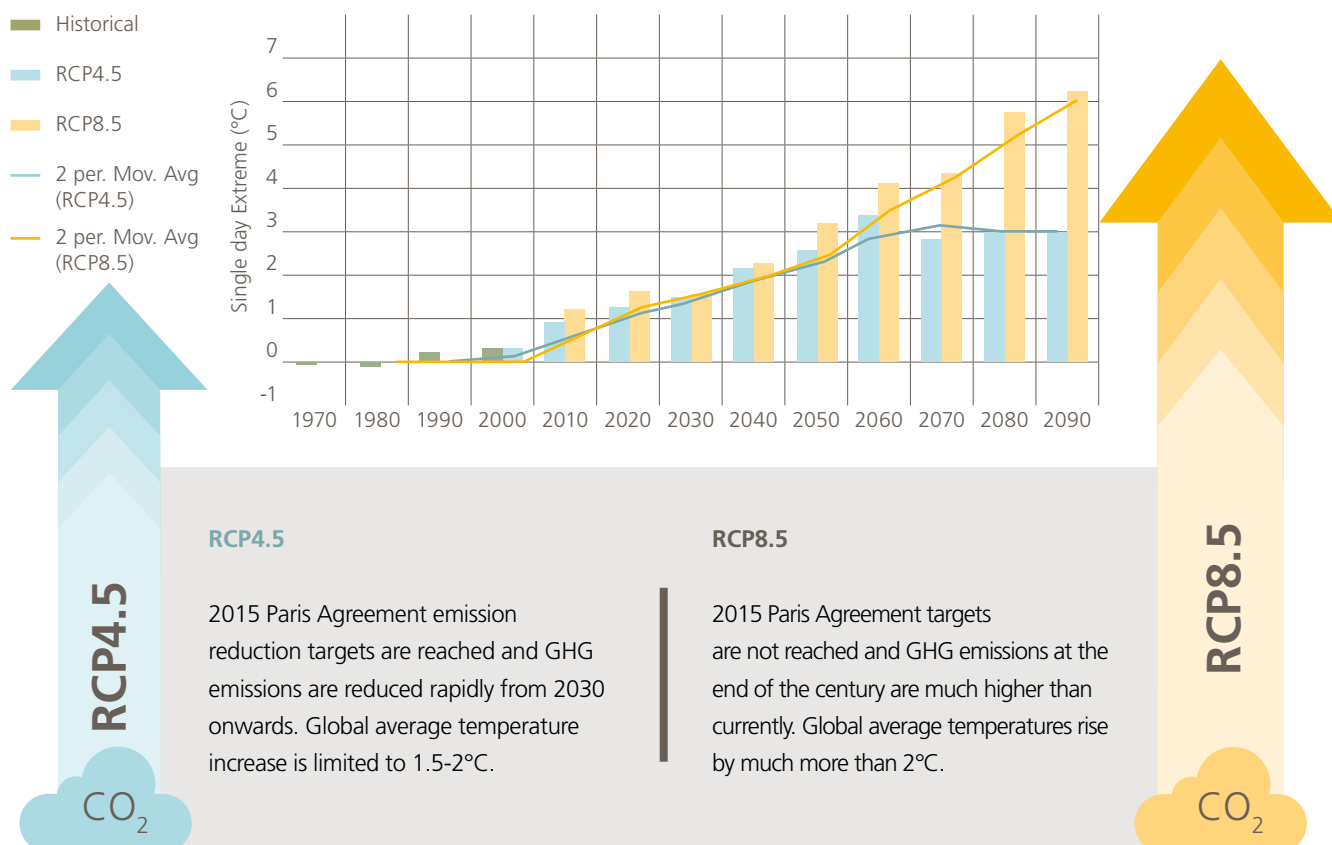






Figure 17: Projected climate change impacts in Johannesburg's based on RCP4.5 and RCP8.5

	Average temperature	+2.20°C to 2.79°C	+2.74°C to +3.08°C
	Very hot days	+0.28 days to 15.34 days per year	+0.56 days to +18.14days per year
	Average rainfall	+10.49 mm - 88.98 mm	+60.20 mm - 113.17 mm
	Extreme rainfall days	+0.50 days to +2.56 days per year	+0.88 days to +2.30 days per year



### 3.4.4 Baseline Sensitivity, Adaptive Capacity, and Vulnerability to Climate Change

A vulnerability assessment was undertaken for the CAP using GIS spatial analysis and statistical analysis of timeseries data on current and projected climate trends. The assessment was conducted in two parts. First, a baseline vulnerability assessment was undertaken to establish the current vulnerability of the different wards that constitute the City of Johannesburg. Sensitivity (i.e. how exposed a certain area is to a certain hazard) and adaptive capacity (i.e. how well a certain area is able to respond to a certain hazard) indicators were constructed using data on aspects of quality of life such as types of dwellings,

access to services like clean water, and household income. Each ward received a high, medium, or low score for each of these aspects and these scores were consolidated into sensitivity and adaptive capacity scores. A ward's sensitivity combined with its adaptive capacity gives its overall vulnerability, which was also expressed as a score. Climate change projections were applied to this baseline to estimate the extent to which future climate change may exacerbate vulnerability.

The baseline sensitivity, adaptive capacity and vulnerability scores for the different parts of Johannesburg are shown in Figure 18.

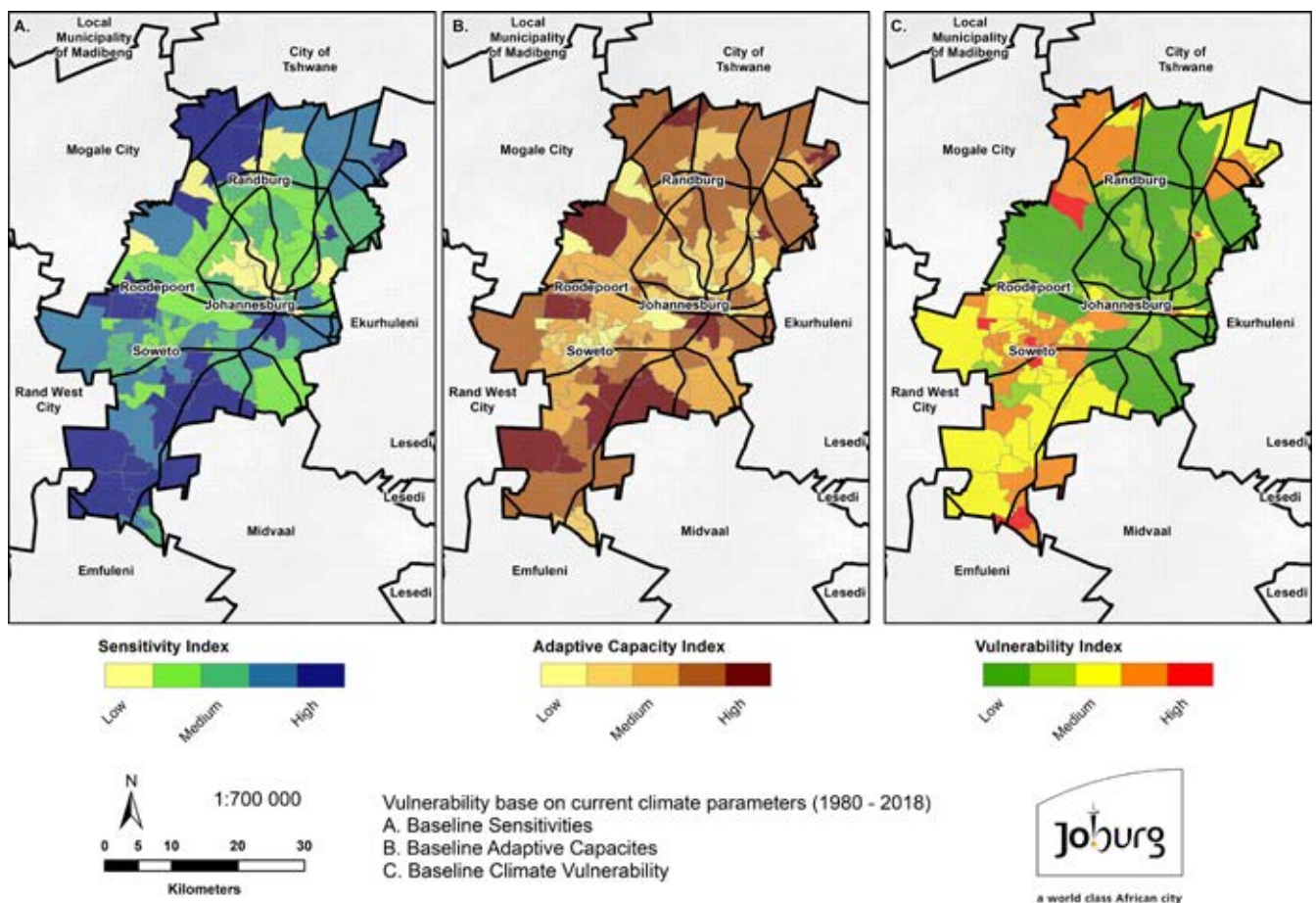


Figure 18: Baseline sensitivity, adaptive capacity and climate vulnerability map of the City of Johannesburg

### 3.4.5 Future climate, risks and vulnerability

The climate risks projected to impact Johannesburg most severely in the future will be the result of changes in interannual rainfall variability, changes in rainfall intensity and increasing temperatures resulting in an exacerbated urban heat island effect.



#### CHANGES IN INTERANNUAL RAINFALL VARIABILITY

The change in total annual precipitation projected under both RCP4.5 and RCP8.5 is minimal: **a decrease of up to 5%** by 2050. However, Johannesburg is likely to experience **large** increases in interannual variability, with years of exceptionally high rainfall followed by exceptionally dry years.

Projections suggest that rainfall will follow similar seasonal patterns as it has historically, though variation between months is likely to increase. Late summers are projected to get wetter, while the first month of spring is likely to get drier. This may delay rainfall onset.

#### CLIMATE HAZARD: DROUGHT/ WATER SECURITY RISK

Changes could contribute to an increasing drought and water security risk.



Flooding



Heatwave



Drought



Extreme hot days



#### CHANGES IN RAINFALL INTENSITY

Projections of potential changes in the frequency of extreme rainfall events showed an increase in rainfall intensity in the summer months of +6.4% by 2030 and +7.5% by 2050. The summer months are also projected to see **increased peak rainfall volumes**.

For some months, a decrease in rainfall volume is projected alongside an increase in rainfall intensity, meaning that these months will see fewer but more intense rainfall events. In months with projected increased rainfall volume and intensity, the number of rainfall events may stay the same, but each event is likely to be more intense. These **increases in** peak precipitation may result in flooding. These events are often very localised in nature and are particularly likely to occur in areas projected to receive increased rainfall volumes in the summer months.

#### CLIMATE HAZARD: FLOODING RISK

The City of Johannesburg is already susceptible to urban flooding today. Increased frequency and severity of flooding events is one of the most severe climate change risks facing the City, particularly informal settlements.



Flooding



Heatwave



Drought



Extreme hot days



#### TEMPERATURE CHANGES AND URBAN HEAT ISLAND EFFECT

Average monthly temperatures in the City of Johannesburg are projected to increase under all climate change scenarios. Under the RCP8.5 scenario, single day extreme temperatures are projected to increase by 6°C by the end of the century. Under the RCP4.5 scenario, the rise in single day extreme temperatures plateaus at -3°C around 2050.

Due to the urban heat island effect, temperatures within the City of Johannesburg are on average 0.15°C higher than in the surrounding areas, but the magnitude of the effect varies according to the level of development across the city. Combined with the projected increase in average and maximum daily temperatures, the result is a projected temperature increase of between 2.2 – 2.7°C by 2050.

#### CLIMATE HAZARD: HEAT RISK TO HUMAN HEALTH AND DISCOMFORT

Increasing temperatures are a major concern, particularly in inland areas of South Africa. Extreme and prolonged heat exposure can constitute a direct human health risk and also increases the need for additional cooling, leading to increased energy demand.



Flooding



Heatwave



Drought



Extreme hot days

The projections show that future climate change vulnerability will follow similar patterns to current vulnerability: despite expected improvements, areas that are currently vulnerable to climate change risks will remain so in the future. Areas of particular concern for all three prioritised climate change risks under both RCPs include vulnerable groups in settlements such as Soweto, Alexandra, Ebony Park, Diepsloot, Stretford, Roodepoort, Rabie Ridge, Poortjie, Orange Farm, Mayibuye, Lenasia, Lakeside, Kanana Park, Kaalfontein, and Ivory Park (particularly vulnerable sub-divisions of these areas are listed in Table 4). Evaluating vulnerability in a complex city such as Johannesburg is exceedingly difficult. Further analysis and investigation will be required to build on the initial assessments presented here.

The climate change vulnerability index for the City of Johannesburg under RCP4.5 and RCP8.5 projected changes in sensitivity to climate risks and adaptive capacity at the ward level.

The results show that most areas of Johannesburg are not projected to be particularly vulnerable to changes in precipitation variability. Some areas are projected to show slight increases in vulnerability to changes in precipitation intensity. It must be noted, however, that vulnerability was calculated as an average at ward level. It is likely that within wards, significant populations will be highly vulnerable to climate change, particularly to increased precipitation intensity and the associated risk of flooding. Vulnerability maps with a higher resolution would show this intra-ward variability. The population of Johannesburg appears to be most vulnerable to increasing temperatures and heat island effects. These are most dangerous in the poorer parts of the city that are home to highly vulnerable communities with limited adaptive capacity.

	Diepsloot SP2, Fairview, Goldev, Johannesburg SP, Lakeside Ext 1, Thembalihle, Orange Farm Ext 7, Rabie Ridge Ext 4, Cosmo City, Zandspruit SP, Dhlamini, Dobsonville, Doornkop 2, Jabavu, Klipspruit, Moroka North, Orlando West, Phiri, Zola, Stretford Ext 6
	Alexandra Ext 30, Alexandra Ext 32, Goldev, Kanana Park SP, Thembalihle, Zandspruit SP, Dhlamini, Dobsonville, Dobsonville Ext 2, Doornkop 2, Dube, Jabavu, Jabulani, Klipspruit, Meadowlands East Zone 4 and 5, Meadowlands West Zone 7, Moletsane, Moroka, Phiri, Thulani, Tshepisong, Zola
	Alexandra Ext 10, 30, 32, 59 and 61, Diepsloot SP1 and SP2, Diepsloot West 5, Ebony Park Ext 3, Ivory Park Ext 2, 5 and 12, Eldorado Park, Goldev, Johannesburg SP, Lombardy East, Longdale, Lakeside Ext 1, Poortjie SP, Rabie Ridge Ext 4, Newclare, Cosmo City, Discovery, Florida, Witpoortjie, Zandspruit SP, Far East Bank Ext 3, Bram Fischerville, Chiawelo Ext 2 and 3, Dhlamini, Diepkloof Zone 1 and 5, Dobsonville, Dobsonville Ext 2, Doornkop 2, Dube, Emdeni, Jabavu, Jabulani, Klipspruit, Meadowlands East Zone 4 and 5, Meadowlands West Zone 7 and 9, Moletsane, Moroka North, Naledi Ext 1, Orlando East, Orlando West, Phiri, Pimville Zone 4, Protea North, Thulani, Tshepisong, Stretford Ext 6

**Table 4: List of areas vulnerable to drought, flooding and heatwaves in the City of Johannesburg**



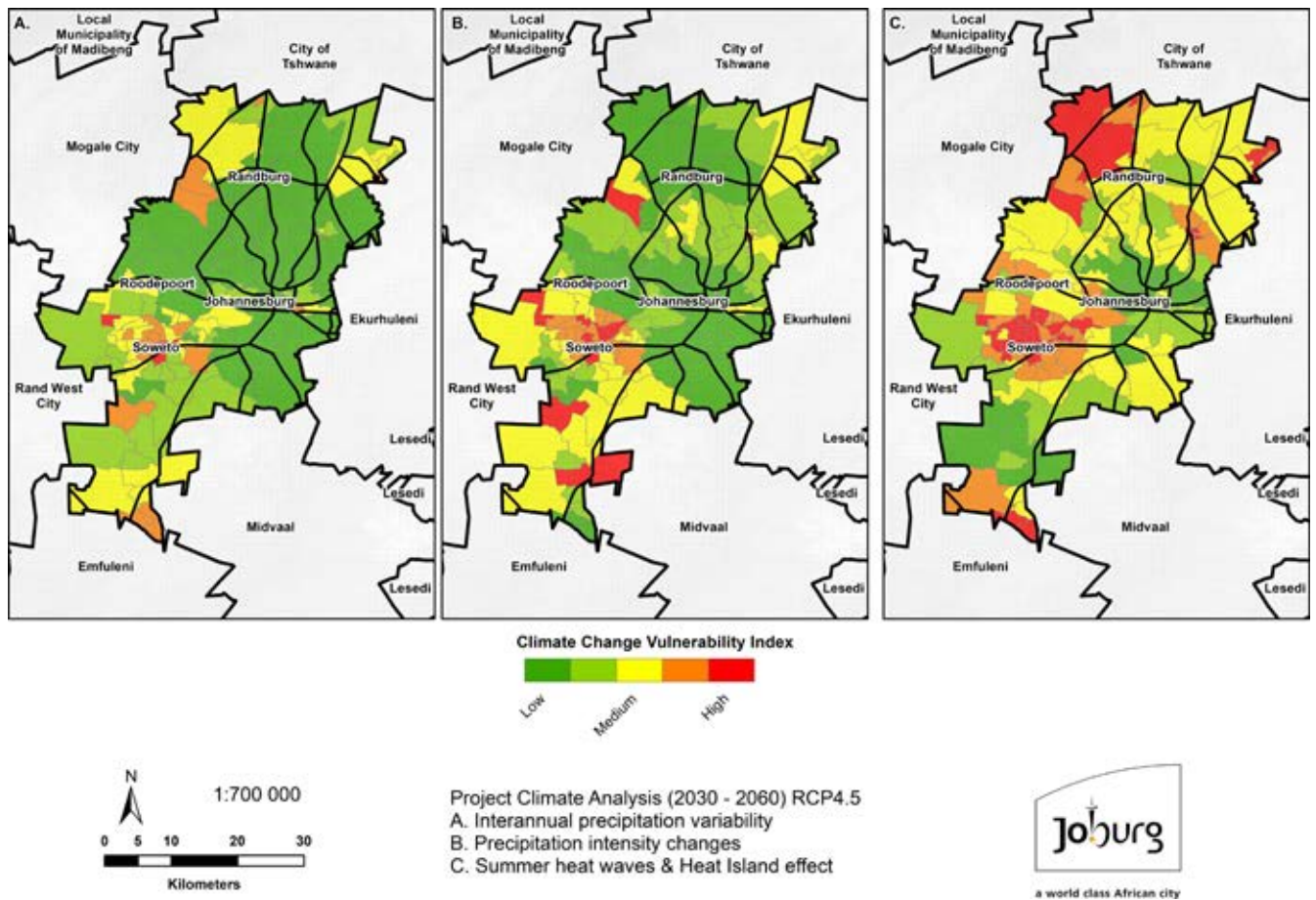


Figure 19: RCP4.5: Maps showing the City of Johannesburg's climate change vulnerability index scores per climate hazard (2030 – 2060).

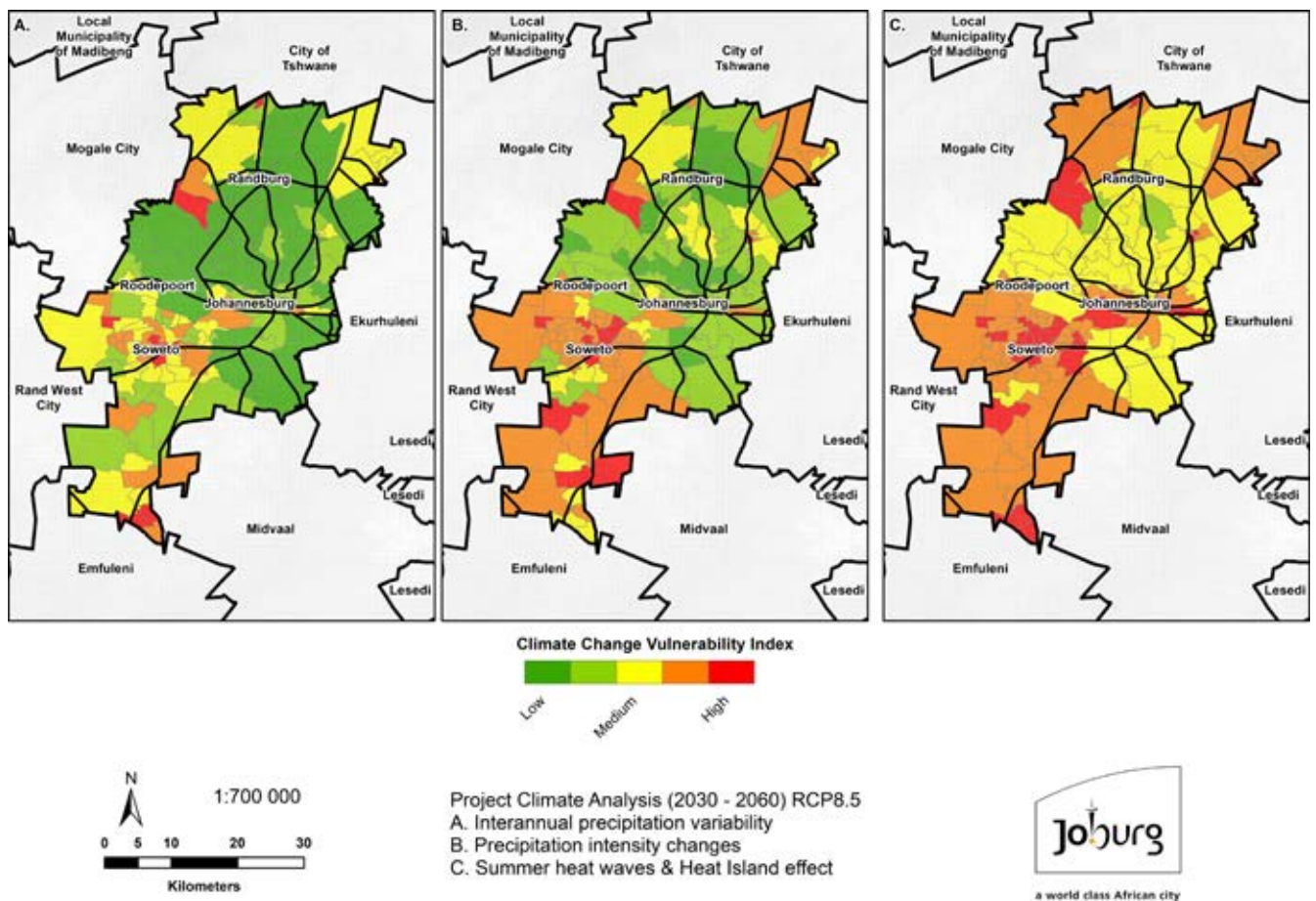


Figure 20: RCP8.5: Maps showing the City of Johannesburg's climate change vulnerability index scores per climate hazard



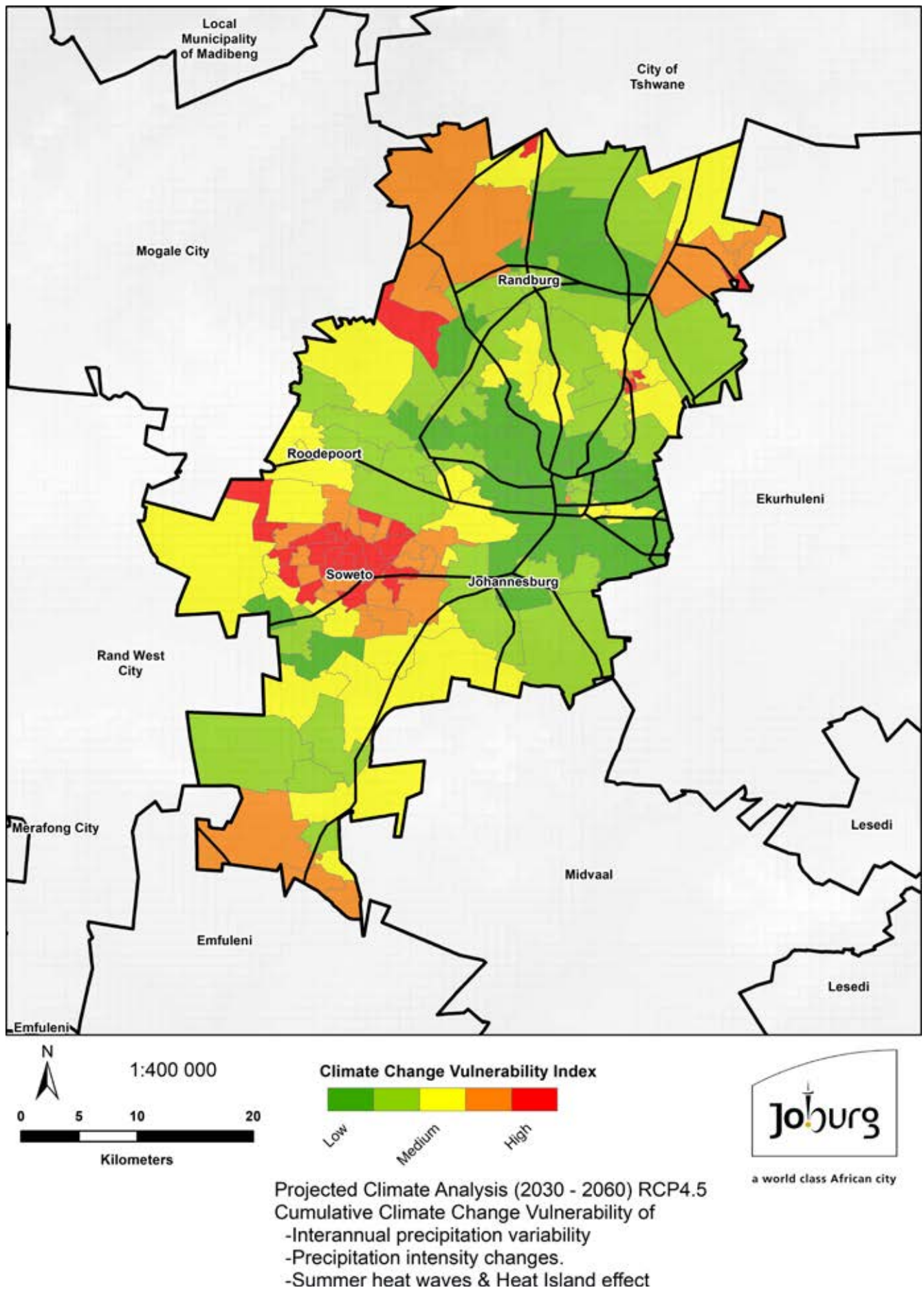
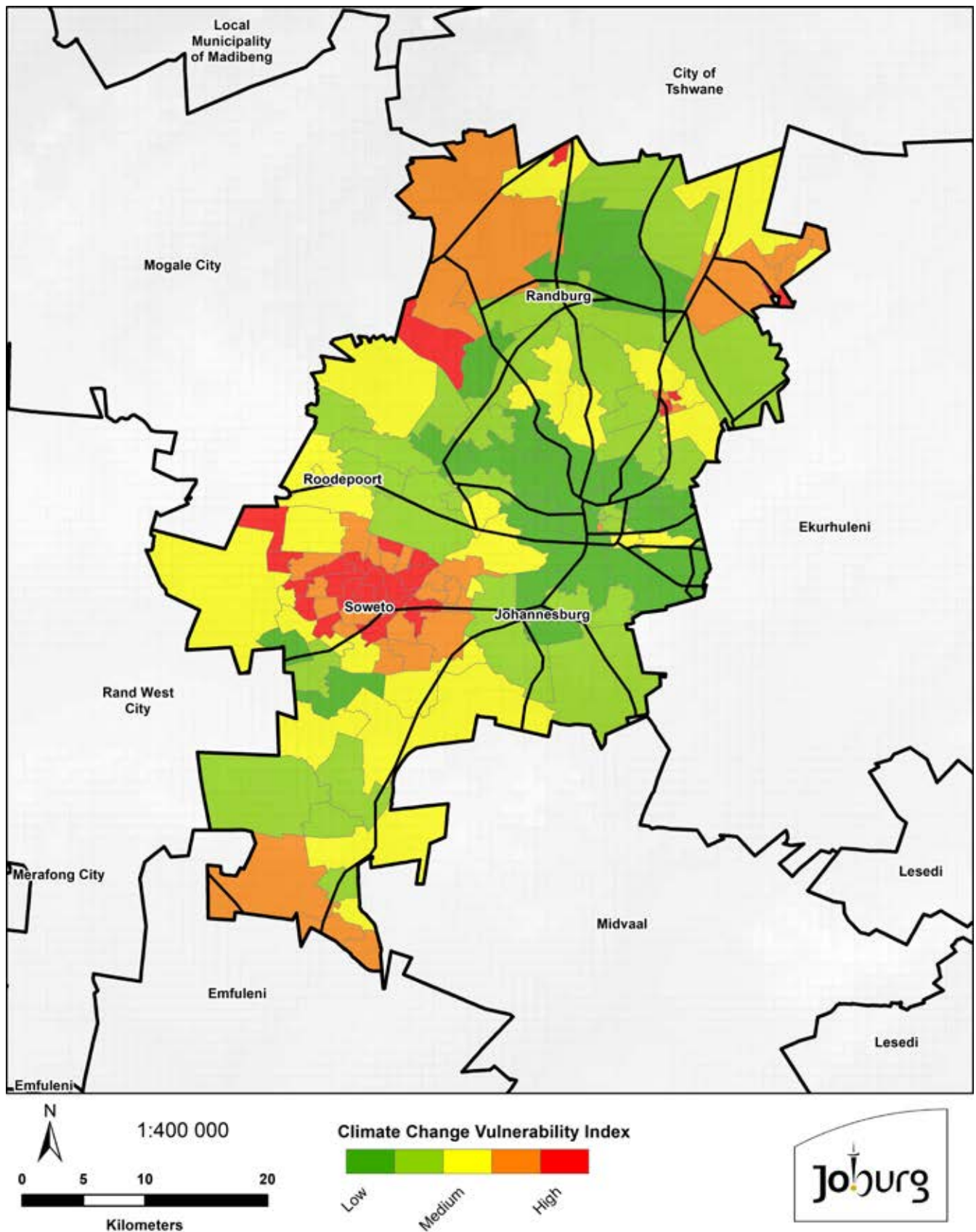


Figure 21: Combined climate change vulnerability index scores for the City of Johannesburg under RCP4.5, based on the average scores for the three priority hazards.



Projected Climate Analysis (2030 - 2060) RCP4.5  
 Cumulative Climate Change Vulnerability of  
 -Interannual precipitation variability  
 -Precipitation intensity changes.  
 -Summer heat waves & Heat Island effect

Figure 22: Combined climate change vulnerability index scores for the City of Johannesburg under RCP8.5, based on the average scores for the three priority hazards.

### **3.5 Measuring the impact of the City's Climate Actions**

The methodology used to compare high-level costs and benefits of the Climate Actions builds on the evidence established the Vulnerability Assessment and the GHG Emissions. The costs of the Climate Actions were estimated using conventional financial approaches, sourcing data from departmental budgeting sources, as well as data from existing studies where it exists. The assessment of benefits of Climate Actions sought to balance understanding the direct and primary impact of actions as well as their broader, holistic influence on the development of the City.

#### **3.5.1 Adaptation Actions Impact**

The process for estimating the high-level benefits of the City's adaptation actions combined two mutually beneficial approaches to determine climate action 'Benefit-Cost Profiles.' Firstly, evidence was collated through desktop research to support the high-level estimation of the economic value of benefits according to key co-benefit categories within the CAP action prioritisation framework (Health and Wellbeing, Economic Prosperity, Environment, and Public Service Delivery).

The evidence supporting the valuation of the various benefit categories was then used to support the estimation of a Human Benefit Indicator (Cartwright et al., 2013), to quantify the primary benefits of adaptation actions. The HBI is a people centred approach to impact assessment that uses the product of the number of people benefiting from a particular intervention, and the extent of the benefit that is imparted on different sub-sets of those people benefiting. The extent of benefit was classified as "had their lives been saved", or "significant", "moderate" or "small" improvements in their well-being, and weighted 0.7, 0.2, 0.07 and 0.03, respectively.

The target population for each adaptation programme was informed by the Vulnerability Assessment which characterised the City's wards based on their vulnerability to the three main climate hazards (Drought, Flash Flooding, and Heatwave). The adaptation actions targeting the various hazards as their primary focus would be implemented in the wards where there is greatest vulnerability to the hazards. As such the number of people benefiting from each adaptation action is estimated by the number of people living in the wards which were characterised as Medium-High and High vulnerability to the primary hazard the adaptation action seeks to address. The degree to which those people would benefit was estimated based on the qualitative and quantitative evidence collected to value the benefit categories.

#### **3.5.2 Mitigation Actions Impact**

For mitigation actions, the primary benefit was quantified as the potential GHG emissions abatement associated with energy savings, energy efficiency, alternative fuels, and emissions reduction measures.

The analysis focused on the components of actions that will be implemented in the short term (i.e. up to 2025) and assessed the impact of short-term implementation over a 30-year period until 2050. The performance of the short-term mitigation actions is based on reasonable assumptions regarding available technology, scale of application, phasing of capital expenditure and analytical parameters such as the discount rate. Where possible, these assumptions have been derived from existing studies where detailed modelling was completed.

Secondary evidence from existing studies was collated through desktop research to demonstrate how mitigation actions also contribute broader co-benefits in the Health and Wellbeing, Economic Prosperity, Environment, and Public Service Delivery categories.







# 4



# Joburg Climate Action Plan

# 4. Joburg Climate Action Plan

“Johannesburg – a World Class African City of the Future – a vibrant, equitable African city, strengthened through its diversity; a city that provides real quality of life; a city that provides sustainability for all its citizens; a resilient and adaptive society.”

(Joburg 2040, 2011)

This chapter presents the City of Johannesburg's Climate Action Plan (CAP). It covers key goals that the City has committed to and the actions required to achieve them. The CAP seeks to accomplish the following two overarching goals:

1. **Net-zero emissions** by 2050
2. **A Climate-resilient City** by 2050

## GOAL 1 NET-ZERO EMISSIONS TARGETS

### Affordable Clean Energy

- By 2030, 35% of electricity consumed is generated from renewable energy sources.
- By 2050, all residents have access to safe, affordable and net-zero emissions energy.

### Optimised Energy Efficiency in Buildings

- By 2030, new buildings operate at net-zero emissions. In addition, the City commits to only developing, owning and occupying assets with net-zero emissions operations.
- By 2050, all buildings operate at net-zero emissions.

### Green Transport

- By 2030, 70% of commuters use public transport, walk or cycle.
- By 2050, 90% of commuters use public transport, walk or cycle and all residents have access to safe, affordable and net-zero-emissions transport.

### Alternative Waste Management

- By 2030, per capita municipal solid waste generation has been reduced by at least 15%. The volume of municipal solid waste sent to landfill or incinerated has been reduced by at least by 50%, and at least 70% of waste is diverted away from landfill and incineration, compared to 2016.
- By 2050, 100% of solid waste is diverted from landfill and remaining methane emissions from waste are captured.

### Improved Water Supply & Wastewater Treatment

- By 2030, a comprehensive review has been undertaken of the energy use by, potential energy savings and energy generation opportunities in the water and wastewater systems, and a Net-Zero-Energy programme has been developed.
- By 2050, net-zero emissions has been achieved in all water and wastewater systems, including water treatment, conveyance, supply, and wastewater treatment and disposal.

Table 5: Climate change mitigation targets

For each goal, five core themes have been defined, with specific targets. Each theme in turn contains several action areas with corresponding actions and sub-actions.

The goals, themes and targets for this CAP are presented in the tables on these pages.

This chapter includes an evidence-based list of actions, informed by the city's strategic documents, international best practices, expert review and extensive stakeholder input. The list includes actions to be implemented city-wide, by various stakeholders including municipal entities. These actions will be ranked in order of priority and defined in further detail during the implementation planning phase of the CAP. The following criteria were employed to assess the suitability of actions for inclusion in the CAP:

- GHG mitigation potential;
- Climate resilience building potential;
- Whether the City has the authority to implement the action;
- Alignment with the city's political vision;
- Alignment with provincial, national and international plans and commitments;
- Cost of implementation;
- Expected co-benefits.

## GOAL 2 A CLIMATE RESILIENT CITY TARGETS

### Water Security

- By 2030, 100% of residents have access to a reliable water supply and 96% have access to sanitation services. The city is fully water secure.
- By 2050, 25% of water supplied comes from alternative sources, average per capita water demand is reduced to 175 litres per day, water losses are reduced to below 20% and Blue Drop status is maintained above 95%.

### Resilient Human Settlements

- By 2030, all households have access to safe, resilient, and affordable basic services.
- By 2050, 100% of the population is accommodated in affordable, resilient and low-carbon housing. All citizens have access to safe and sustainable open space, with tree cover of over 30%.

### Flood & Drought Management

- By 2030, flood management is mainstreamed and improved across all sectors to minimise social, economic and environmental impacts of flooding.
- By 2030, fully functional early warning systems are in place for floods, droughts, fires and storms, and the response plans for floods and droughts have been updated.
- By 2050, no houses, offices, industries or critical infrastructure are located in high-flood risk areas and water supply and food systems are drought proof.

### Resilient Infrastructure

- By 2030, all current backlogs of upgrades to urban stormwater infrastructure have been addressed and updated stormwater guidelines have been developed.
- By 2050, the City of Johannesburg has been transformed into a Water Sensitive City which incorporates Water Sensitive Urban Design (WSUD) into all aspects of urban planning.
- By 2050, the city has 30% green cover(including green roofs) for city and passive building cooling.

### Healthy Communities

- By 2030, the City is compliant with the National Ambient Air Quality Standards (NAAQS) and aspires towards compliance with WHO standards.
- By 2030, the negative impacts of higher temperatures and heat waves on food security, human and environmental health have been reduced.
- By 2050, all communities enjoy clean air, are resilient to the health impacts of climate change and are food secure.

**Table 6: Climate change adaptation targets**

# Goal 1

## A Net-Zero

## Emissions City

To achieve net-zero emissions, a city must reduce its GHG emissions to as close to zero as possible and mitigate any residual emissions. However, beyond just eliminating emissions, attaining net-zero emissions offers the opportunity to create a city that is sustainable, resilient, efficient and inclusive, a place where people enjoy living, working and doing business. Achieving these goals and driving the societal transformations and technological shifts that are needed for success will require sustained, ambitious efforts from all stakeholders, from government to civil society and the private sector. The City of Johannesburg views the path to net-zero emissions as an opportunity to not only deliver important environmental objectives and honour the City's commitment to the goals of the Paris Agreement, but also to create a better City for the future.

Chapter 3 presented three possible trajectories for the City's emissions under business as usual (no further climate action), given existing and planned actions, and given more ambitious but achievable climate action.

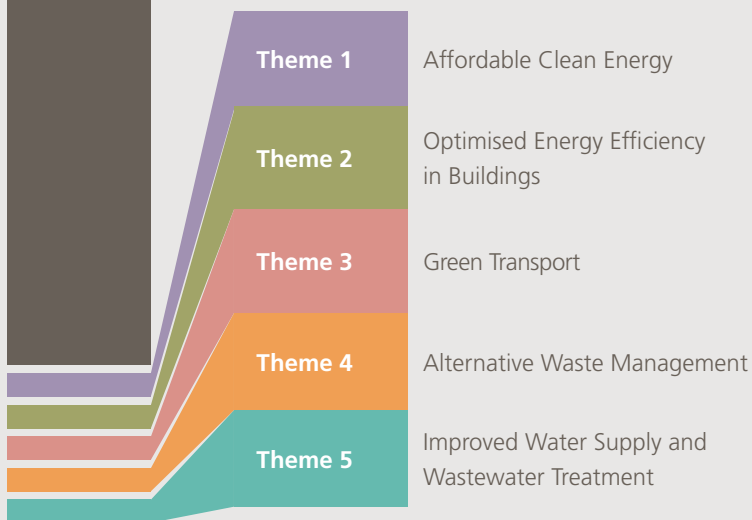
The ambitious scenario demonstrated the scale of change necessary to set the City of Johannesburg onto a pathway towards net-zero emissions, including zero emission buildings and energy supply, large increases in the use of public transport and replacing private vehicles with electric vehicles (EVs) fuelled by renewable energy. In addition, significant reductions in the volume of waste are required, as well as improved treatment processes to reduce direct and indirect emissions. Spatial planning will play a key role by ensuring universal easy access to green transport and to support sustainable living.

For each of the five mitigation themes, the City has defined a set of priority actions to deliver the required emission reductions. Many of these actions have been designed for implementation in the short term, to ensure that climate action starts immediately.





# Goal 1



**Affordable Clean Energy** focusses on the need to shift the local and national energy grid from fossil fuels to renewable generation, to reduce emissions, enhance security of supply and tackle energy poverty.

**Optimised Energy Efficiency in Buildings** includes actions to improve the efficiency of residential and commercial/institutional buildings. These include conducting retrofits for existing buildings and improving standards and regulations for new buildings.

**Green Transport** includes actions to boost the use of public and non-motorised transport. In addition, a transition to cleaner vehicles will be initiated by promoting the use of electric vehicles and vehicles with improved fuel efficiency. Finally, the targets for this theme will be mainstreamed into spatial planning to ensure new developments are transit-oriented.

**Alternative Waste Management** includes actions to promote waste reduction and increased recycling. In addition, the City will upgrade and improve waste treatment processes.

**Improved Water Supply and Wastewater Treatment** focusses on technological solutions to improve the efficiency of water conveyance and to upgrade wastewater treatment systems.



# Goal 1

**The section below presents the following details for each action:**

- The lead and supporting implementers.
- The scale, whether national, regional, city-wide, in a specific neighbourhood or in a specific street.
- The anticipated timescale for implementation.
- The projected GHG reductions.
- The projected cost, including upfront or capital costs (CAPEX) and operational or running costs (OPEX), for the City and for non-city stakeholders (such as private businesses or financiers).
- The potential for job creation.
- The projected benefits for communities, including benefits to economic prosperity, health and wellbeing, environment, service delivery, and inclusivity and civil society.
- Critical non-City implementation partners, including businesses, NGOs, national government and civil society.

Each action also contains a number of 'sub-actions', key steps that are required for success.

There are two types of sub-actions, "enabling" refers to policies, plans, campaigns and other supporting activities whereas "implementing" refers to tangible projects on the ground which directly reduce emissions or climate risk.

Some sub-actions may contribute to multiple goals and are therefore be repeated across sections.



## Key:

This key will help guide you through the following pages, giving you an illustrative breakdown of what predictive levels of success and the impact it will have on that specific sector. Refer to the table below to get an understanding of how each measure has been gauged.

Action type		Emission reductions		Job creation		Costs		GHG impact	
Enabling		Nil		Low		Nil		Indirect	
Implementing		Low		Medium		Low		Direct	
		Medium		High		Medium			
		High				High			

Benefits									
Health and wellbeing		Environmental		Economic prosperity		Public service delivery		Inclusivity and civil society	





# Theme 1

## Affordable Clean Energy

### 2030

**35% of electricity consumed is generated from renewable energy sources.**

The City of Johannesburg meets 94% of its energy needs with coal-based electricity supplied by Eskom through the national grid.<sup>xv</sup> Limits to Eskom's capacity have led to rolling blackouts across the country, which have had severe social and economic impacts. As a result, many households and businesses in Johannesburg have opted to invest in decentralised renewable energy generation and more than 33,000 solar photovoltaic (PV) systems have been installed across the city.<sup>xvi</sup> In addition, electricity prices have risen at a rate faster than inflation in the last decade<sup>xvii</sup> and are predicted to continue to rise.<sup>xviii</sup> Despite Johannesburg's relatively high rate of access to electricity (90.8%), energy poverty remains a critical issue as many households are unable to afford enough electricity to meet their energy needs. The City has already implemented large-scale programmes to combat energy poverty through renewables: over 70,000 solar water heaters have been distributed to communities. In total, nearly 130,000 solar water heaters have been installed in the city.

### 2050

**All residents have access to safe, affordable and net-zero emissions energy.**

The energy sector is responsible for 54% of emissions in Johannesburg, so an ambitious overhaul of the sector is required to achieve net-zero emissions. A more favourable policy and regulatory environment is predicted to precipitate a massive shift towards localized, renewable energy generation. This presents a significant opportunity for the City of Johannesburg to position itself as a frontrunner and realize its target to provide safe, clean, reliable and affordable energy for all.

The following action areas have been identified to deliver the City's targets:

1. Electricity generation;
2. Grid decarbonisation and optimisation;
3. Eradicate energy poverty;
4. Energy efficiency and coal phase-out.





### Action: Promote small and large-scale embedded and distributed generation

This action will promote the installation of new renewable energy generation capacity in the city using a range of technologies, including solar PV and thermal (rooftop or ground-mounted), biogas, methane gas and wind. It will also promote the installation of battery storage capacity.

#### Lead Authorities

- EISD
- City Power

#### Supporting Authorities

- Group Finance
- Smart City Office
- Economic Development

#### Partners

- National Department of Environment, Forestry and Fisheries
- National Department of Energy and Mineral Resources
- Private Sector
- Research institutions
- National Energy Regulator of South Africa
- Unions
- Youth

#### Benefits



**Health**  
Direct



**Environmental**  
Indirect



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Direct

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
<ul style="list-style-type: none"> <li>• Site</li> <li>• Street</li> <li>• Neighbourhood</li> <li>• City</li> </ul>	<b>5</b> Years	 Indirect		 Capex Opex	 Capex Opex

Sub-action	Potential technology	Action type	GHG impact
Investigate the potential for the development of City-owned clean energy installations.	Solar PV/thermal (rooftop or ground-mounted), biogas, methane gas, wind		
Develop a City-owned RE programme with budget, timeframes and hiring of specialists for site assessments, geotechnical/environmental assessments and preliminary designs.	Solar PV/thermal (rooftop or ground-mounted), biogas, methane gas, wind		
Develop and advertise an RFP via a Section 33 process for independent power producer (IPP) generation installations of less than 10MW to be located within the city boundaries.	Biogas, gas, solar, wind and storage under 10 MW		
Revise the electricity metering and billing system (to allow for bi-directional flows of electricity).	Solar, storage (other)		
Conduct an assessment of the financial implications of small-scale embedded generation for municipal revenue and develop a strategy to mitigate negative impacts.			
Design and seek NERSA's approval for embedded generation tariffs.	Solar, storage (other)		
Set up a system for monitoring and reporting on small-scale embedded generation installations, as required by NERSA.			
Partner with institutes of higher education to deliver a renewable energy skills training programme to City Power staff & building managers.	Solar PV/thermal (rooftop or ground-mounted), biogas, methane gas, wind		
Support community-owned renewable energy installations.	Solar PV/thermal (rooftop or ground-mounted), biogas, methane gas, wind		

Action type: Enabling Action type: Implementing GHG impact: Direct GHG impact: Indirect



## Action: Increase the share of renewable energy

This action aims to decarbonise and optimise the electricity grid by increasing the share of renewable generation in the energy mix, investing in smart grids and battery storage and developing a diverse energy supply portfolio to achieve the target of net-zero emissions by 2050.

### Lead Authorities

- EISD
- City Power

### Supporting Authorities

- Group Finance
- Smart City Office
- Economic Development

### Partners

- National Department of Environment, Forestry and Fisheries
- National Department of Energy and Mineral Resources
- National Energy Regulator of South Africa
- Eskom
- Unions



**Health**  
Direct



**Environmental**  
Indirect



**Economic prosperity**  
Direct

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
<ul style="list-style-type: none"> <li>• Regional</li> <li>• National</li> </ul>	<b>5-10</b> Years	 Indirect	 Direct	Capex            Opex	Capex            Opex

Sub-action	Potential technology	Action type	GHG impact
Lobby national government to increase the share of renewables in the Integrated Resource Plan and seek to participate in grid impact and national optimisation planning.			
Conduct detailed feasibility studies for large-scale IPP procurement from installations outside the city boundaries and apply for a section 34 determination for such an IPP procurement.			
Establish a procurement process/framework with a view to developing a trading platform.			
Establish power purchase agreements with renewable energy suppliers (once GG 43277 of 5 May 2020 comes into effect).			
Transform City Power's business model and ensure foundations are in place to ensure the financial and technical feasibility of the transition to renewable energy (cost-reflective tariff plan, wheeling tariffs, grid impact studies, etc).			
Invest in smart grids and battery storage to enable bidirectional electricity flows, improved energy efficiency and arbitrage.	Battery storage, ICT		
Develop a local energy supply plan to define the optimal diversified energy supply portfolio to achieve the goal of net zero emissions by 2050.			

Action type: Enabling Action type: Implementing GHG impact: Direct GHG impact: Indirect



## Action: Ensure the supply of clean, reliable and affordable energy

This action aims to ensure access to clean, reliable and affordable energy for poor communities through the deployment of technology solutions such as mini-grids, solar water heaters and solar lighting and the implementation of information programmes on energy efficiency.

### Lead Authorities

- EISD
- City Power

### Supporting Authorities

- Housing
- Economic Development
- Development Planning
- Group Finance
- Public Safety
- Social Development
- Smart City Office

### Partners

- National Department of Energy and Mineral Resources
- National Department of Environment, Forestry and Fisheries
- NGOs
- Unions
- Youth

### Benefits



**Health**  
Direct



**Environmental**  
Indirect



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Direct

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
<ul style="list-style-type: none"> <li>• Neighbourhood</li> <li>• City</li> </ul>	<b>5</b> Years	 Direct	 Direct	 Capex Opex	 Capex Opex

Sub-action	Potential technology	Action type	GHG impact
Roll out of solar-PV mini-grids with battery storage to ensure a reliable supply of clean, affordable energy to informal settlements and unproclaimed areas.	All: RE mini-grids, solar home systems, gas cookstoves and heaters, battery storage, LED and solar lights, solar water heating, insulation.		
Expand the social programme for solar water heaters (carry out new installations and repair and replacement of older units) whilst encouraging community involvement and entrepreneurship.			
Design and implement a social programme for clean cooking that also supports local entrepreneurship.			
Design and implement a social programme for solar lighting for unelectrified households.			
Develop and run an energy efficiency awareness programme/campaign to ensure that poor communities are able to maximize the benefits from their Free Basic Electricity allocations.			
Establish thermal insulation and energy efficiency requirements for new social housing developments (potentially by making an existing social housing certification compulsory where financially viable).			
Pilot small-scale embedded generation in high-density public housing.			

Action type: Enabling Action type: Implementing GHG impact: Direct GHG impact: Indirect



### Action: Improve industrial energy efficiency and reduce the share of coal-fuelled industrial production

This action aims to incentivize the deployment of energy-efficiency and low-carbon interventions in industry, using technology such as high-efficiency pumps and boilers.

#### Lead Authorities

- EISD
- Economic Development

#### Supporting Authorities

- City Power
- Development Planning
- Smart City Office

#### Partners

- National Department of Trade and Industry
- National Department of Energy and Mineral Resources
- National Department of Environment, Forestry and Fisheries
- Private sector
- Research institutions



**Health**  
Indirect



**Environmental**  
Indirect



**Inclusivity and civil society**  
Indirect

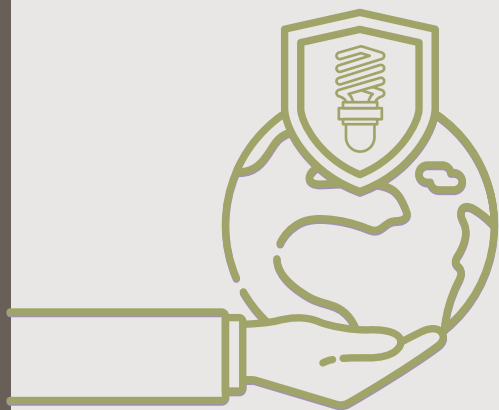
Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
<ul style="list-style-type: none"> <li>• Site</li> <li>• City</li> </ul>	<b>5</b> Years	 Indirect		Capex                      Opex	Capex                      Opex

Sub-action	Potential technology	Action type	GHG impact
Lobby national government to develop regulations and incentives to encourage energy efficiency measures in industry.	All: efficient industrial technology (pumps, boilers, etc.)		
Lobby national government to develop regulations and incentives to encourage fuel switch to lower-carbon alternatives.			
Set voluntary GHG emission reduction targets for industries, linked to Atmospheric Emission Licenses.			
Partner with private sector associations to implement an advocacy programme on industrial energy efficiency, promoting energy audits and providing a forum for open dialogue, guidance on clean energy alternatives and information on incentive schemes (e.g. tax breaks).			

Action type: Enabling Action type: Implementing GHG impact: Direct GHG impact: Indirect







## Theme 2

# Optimised Energy Efficiency in Buildings

## 2030

**New buildings are carbon neutral. The City commits to owning, occupying and developing only assets that are net zero carbon in operation.**

Buildings are among the largest consumers of energy in the City of Johannesburg. Energy efficiency in buildings presents a key opportunity to reduce GHG emissions by avoiding carbon lock-in, since buildings designed and constructed today will impact the city's emissions profile for decades to come. The City of Johannesburg has already implemented several large-scale energy efficiency interventions and benefited from the associated cost savings. Interventions implemented to date include the retrofitting of street lighting and municipal buildings. In 2018, the City signed a commitment to ensure new buildings and existing buildings operate at net-zero emissions

## 2050

**All buildings operate at net-zero emissions.**

by 2030 and 2050 respectively. Since making this commitment, the City has been working towards these targets together with South Africa's C40 Buildings Programme, by developing and implementing a new Green Building Policy.

The City will undertake the following actions areas to deliver its targets:

1. Energy efficiency of existing buildings;
2. Energy efficiency of new buildings;
3. Net-zero emissions municipal buildings and operations



## Action: Improve the energy efficiency of existing buildings with the goal of achieving net zero emissions by 2050

This action aims to improve the energy efficiency of existing buildings using technologies such as efficient lighting, heating, ventilation and cooling, solar water heaters, heat pumps and rooftop PV.

### Lead Authorities

- Development Planning
- EISD
- City Power

### Supporting Authorities

- Johannesburg Property Company
- Housing
- Johannesburg Social Housing Company
- Economic development
- Group Finance
- Smart City Office

### Partners

- National Department of Trade and Industry
- National Department of Energy and Mineral Resources
- National Department of Environment, Forestry and Fisheries
- National Department of Public Works and Infrastructure
- Private sector (real estate, banking, developers, ESCOs, lighting and other industry associations)
- Department of Trade and Industry
- Council for Scientific and Industrial Research
- Academia

### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Inclusivity and civil society**  
Direct

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
<ul style="list-style-type: none"> <li>• Site</li> <li>• Neighbourhood</li> <li>• City</li> </ul>	<b>10+</b> Years	 Indirect	 Direct	 Capex Opex	 Capex Opex

Sub-action	Potential technology	Action type	GHG impact
Implement and enforce the Green Building Policy (from 2021 onwards) and by-law to ensure that all buildings operate at net-zero emissions by 2050. All lines of responsibility must be institutionalised through city systems (KPIs, etc.).	All: efficient lighting, heating, ventilation and cooling, solar water heating, heat pumps, rooftop PV, efficient water devices, insulation, various other technologies in the built environment space		
Partner with the private sector to support mass roll-out of solar water heaters and heat pumps with an emphasis on boosting local entrepreneurship.			
Partner with the private sector to develop a list of technology options and local pricing incentives to promote energy efficiency.			
Implement an awareness raising campaign on energy efficiency, building codes and technology options and pricing incentives, targeting property associations and facility managers.			
Develop a list of 'quality-assured' ESCOs to perform retrofits and support efforts to develop local MSMEs in the sector.			
Partner with the real estate sector to develop 'point of sale' energy use intensity or sustainability reporting.			
Support the rollout of national Energy Performance Certifications by providing information and developing a supporting registry of large building energy use intensity (EUI) scores.			

Action type: Enabling Action type: Implementing GHG impact: Direct GHG impact: Indirect



## Action: Improve the energy efficiency of new private and public buildings with the goal of achieving net-zero emissions by 2030

This action aims to improve the energy efficiency of new buildings using technologies such as efficient lighting, heating, ventilation and cooling, solar water heating, heat pumps and rooftop PV.

### Lead Authorities

- Development Planning
- EISD
- City Power

### Supporting Authorities

- Johannesburg Property Company
- Johannesburg Development Agency
- Housing
- Johannesburg Social Housing Company
- Economic development
- Group Finance
- Smart City Office

### Partners

- National Department of Trade and Industry
- National Department of Energy and Mineral Resources
- National Department of Environment, Forestry and Fisheries
- National Department of Public Works and Infrastructure
- Private sector (financiers, developers, real estate sector)

### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Inclusivity and civil society**  
Direct

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
<ul style="list-style-type: none"> <li>• Site</li> <li>• Neighbourhood</li> <li>• City</li> </ul>	<b>5</b> Years	 Indirect	 Direct	 Capex Opex	 Capex Opex

Sub-action	Potential technology	Action type	GHG impact
Implement and enforce the Green Building Policy (from 2021 onwards) and by-law to ensure that new buildings operate at net-zero emissions by 2030. All lines of responsibility must be institutionalised via city systems (KPIs, etc.)	All: efficient lighting, heating, ventilation and cooling, solar water heating, heat pumps, rooftop PV, efficient water devices, insulation, various other technologies in the built environment space		
Develop and implement an awareness-raising campaign on energy efficiency and building codes, targeting property developers and building users.			
Require EUI reporting in all permit applications for new buildings and substantial renovations, and record data for monitoring and sharing with market stakeholders.			
Collaborate with national government and the private sector to develop a national building initiative, including integration of EUI/NZC into National Standards and the development of financial mechanisms to enable a large-scale transformation of the sector.			
Mandate that building design and layout should be optimised for passive heating and cooling by considering the north-south axis.			
Mandate the design of buildings and systems that can be serviced and maintained with local materials, parts and labour.			
Partner with institutes of higher education and non-profit organisations to deliver training programmes on SANS XA (amended), achieving net-zero emissions in buildings and energy modelling to Development Planning, City Power staff and building managers.			

Action type: Enabling Action type: Implementing GHG impact: Direct GHG impact: Indirect





### Action: Ensure that all municipal operations and buildings developed, owned and occupied by the City operate at net-zero emissions by 2030 (through on-site installations and IPP procurement)

This action aims to achieve net-zero emissions in all City operations and buildings by 2030 through the installation of technologies such as solar rooftop PV, heat pumps and efficient lighting, heating, ventilation and cooling.

#### Lead Authorities

- EISD
- City Power

#### Supporting Authorities

- Housing
- Development Planning
- Corporate and Shared Services
- Group Legal and Contracts
- Community Development
- All relevant municipal entities

#### Partners

- National Department of Energy and Mineral Resources
- National Department of Environment, Forestry and Fisheries
- National Department of Public Works and Infrastructure
- Private sector

#### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Inclusivity and civil society**  
Direct

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
<ul style="list-style-type: none"> <li>• Site</li> <li>• City</li> </ul>	<b>5</b> Years	 Direct	 Direct	Capex            Opex	Capex            Opex

Sub-action	Potential technology	Action type	GHG impact
Install rooftop solar PV on City-owned buildings wherever possible.	All: efficient lighting, heating, ventilation and cooling, solar water heating, heat pumps, rooftop PV, efficient water devices, insulation, various other technologies in the built environment space		
Ensure all new public housing developments within the City's jurisdiction achieve net-zero emissions by 2030, based on life cycle budgeting approaches. (Consider use of EDGE certification requirement; refer to Action 1.3.6).			
Install onsite generation capacity and perform deep energy retrofits of city-owned buildings (through participation in the Energy Efficiency in Public Building and Infrastructure Programme).			
Amend the City's procurement policy to include a minimum energy performance level for rental buildings, appliances and equipment.			
Develop a Municipal Building Energy Management and Monitoring System & conduct annual energy audits of all city owned and occupied buildings.			
Equip all streetlights with energy efficient solar-powered LED-lighting by 2030.			
Ensure all new municipal facilities (clinics, offices, community facilities) within the City's jurisdiction achieve net-zero emissions by 2030, based on life cycle budgeting approaches.			

Action type: Enabling Action type: Implementing GHG impact: Direct GHG impact: Indirect



# Theme 3

## Green Transport

### 2030

**70% of commuters use public transport, walk or cycle.**

Over the past decade, the City of Johannesburg has pursued an ambitious agenda to address spatial inequality through urban planning and the provision of public transport. Transportation accounts for 35% of the city's emissions and is a key source of air pollution. Most inhabitants of Johannesburg travel by means of private minibus taxis, subsidized buses and commuter trains, while wealthier households use private cars. Due to the growth of the middle class and continued urban sprawl, car ownership is on the rise, resulting in high levels of congestion. In peak traffic, travel times increase by 68%. Freight vehicles are also a key source of GHG emissions and air pollution, and contribute to congestion and increased wear-and-tear on the roads. The City's Growth and Development Plan promotes eco-mobility, striving for a pedestrian- and public transport-oriented city by 2040. Great progress has been made with the completion of phases 1A and 1B of the Rea Vaya Bus Rapid Transit (BRT)

### 2050

**90% of commuters use public transport, walk or cycle and all residents have access to safe, affordable, net-zero-emissions transport.**

system in 2009 and 2013 respectively. Phase 1C, planned to be completed in 2021 will see the system expanded to northern suburbs, including Alexandra, Sandton and Midrand.

EVs are becoming more popular in South Africa, in line with the global shift away from fossil fuel-powered vehicles. Anticipating this trend, the city aims to play a proactive role in facilitating the technological transition by ensuring that it is ready to meet the additional energy demand through renewable sources. The following action areas have been identified to deliver the City's targets:

1. Public transport;
2. Non-motorised transport;
3. Fuel switch;
4. Fuel efficiency;
5. Transit-oriented development.



# Case study:

## **City of Johannesburg Rea Vaya Bus Rapid Transit (BRT) system**

The City of Johannesburg's Rea Vaya Bus Rapid Transport (BRT) systems improves the lives of students, commuters and all other residents by providing public transport that is safe, affordable and reliable. The City's flagship public transport project consists of dedicated bus lanes on major roads and a fleet of modern buses running on low-sulfur diesel and equipped with advanced pollution reduction technology.

Rea Vaya's Phase 1A route was launched in 2009 and features a trunk route that runs from Thokoza Park in Soweto to Ellis Park in Doornfontein, and several feeder routes linking to local stations. In 2013, Phase 1B was completed, extending the original route from Thokoza Park to Noordgesig Extension and from Auckland Park to the Library Gardens. A new route, Phase 1C, is currently under construction. Phase 1C will connect Phases 1A and 1B to Alexandra and Sandton via the Johannesburg CBD. It is planned for completion in 2021 and includes 13 new stations with four interchanges to facilitate the integration of various modes of public transport, including Gautrain, minibus taxis and connections with City of Tshwane and City of Ekurhuleni's BRT systems.

[www.reavaya.org.za](http://www.reavaya.org.za)



### Action: Enable a shift towards public transport

This action aims to encourage Johannesburg residents to shift from private transport towards public transport, by improving public transport infrastructure and fleets and providing economic and behavioural incentives for private transport users.

#### Lead Authorities

- Transport
- Rea Vaya
- Metrobus

#### Supporting Authorities

- Development Planning
- Public Safety
- EISD
- Johannesburg Roads Agency
- Community Development
- Smart City Office

#### Partners

- National Department of Environment, Forestry and Fisheries
- National Department of Transport
- Passenger Rail Agency of South Africa
- Gautrain
- Taxi associations
- Automobile Association
- Research institutions
- Citizens

#### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Direct

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
<ul style="list-style-type: none"> <li>• Neighbourhood</li> <li>• City</li> </ul>	<b>5-10</b> Years	 Indirect	 Direct	 Capex Opex	 Capex Opex

Sub-action	Potential technology	Action type	GHG impact
Ensure the expansion and integration of public transport and of non-motorized transport routes and infrastructure, as captured in the Integrated Transport Plan.	All: low-emission buses, electric vehicles, infrastructure development (BRT expansion, charging stations, rail networks)		
Establish partnerships to extend the rail network and switch to renewable energy-powered trains, to provide sustainable, reliable, safe and affordable high-speed transport.			
Eliminate minimum parking standards and/or introduce maximum parking development standards, as mandated in the City's parking management strategy.			
Develop and pilot congestion charges.			
Implement high-occupancy vehicle lanes.			
Pilot no-car zones within the CBD and other suitable areas.			
Facilitate the transition towards a single ticketing system for public transit.			
Investigate the potential of alternatives to rail, such as mono-rail.			
Destigmatize public transportation through public awareness campaigns, improvements in safety and visible security.			
Ensure safe and accessible mobility options for vulnerable groups including the poor, women, children, the elderly and people with disabilities.			



### Action: Promote non-motorised transport

This action aims to encourage residents to shift from using private transport and public transport towards walking and cycling, by making changes to infrastructure and providing economic and behavioural incentives, including information campaigns.

#### Lead Authorities

- Transport
- Development Planning

#### Supporting Authorities

- Public Safety
- Johannesburg Roads Agency
- Johannesburg Development Agency
- EISD
- Smart City Office

#### Partners

- National Department of Environment, Forestry and Fisheries
- National Department of Transport
- Private sector
- Citizens

#### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Direct

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
<ul style="list-style-type: none"> <li>• Neighbourhood</li> <li>• City</li> </ul>	<b>5</b> Years	 Indirect			

Sub-action	Potential technology	Action type	GHG impact
Pilot a public bicycle share scheme.	All: bicycles, infrastructure development, solar lighting.		
Develop and implement a cycling and road safety public awareness campaign.			
Amend development applications to require the inclusion of considerations for non-motorized transport (see Action 3.5).			
Partner with the private sector to promote walk- and cycle-to-work days and to implement cycle-to-work programmes (employer covers the upfront cost of bike purchase and deducts costs from employee's salary each month).			
Partner with the private sector to pilot a cargo cycle programme as a last-mile solution.			
Pilot secure bike parking infrastructure in public spaces.			
Construct segregated and wider bike lanes to encourage cycling and ensure safety.			
Pedestrianize streets and widen sidewalks to encourage walking and ensure safety.			
Redesign intersections in the CBD to prioritise pedestrians and their safety over traffic speed.			
Partner with the private sector to develop visible, on-the-ground policing in identified nodes (e.g. City Improvement Districts).			

Action type: Enabling Action type: Implementing GHG impact: Direct GHG impact: Indirect





### Action: Facilitate a switch to alternative fuels and electric vehicles

This action aims to encourage a switch to alternative fuels and EVs by investing in infrastructure for publicly owned operations and facilities including public transport, and by partnering with the private sector to provide behavioural and financial incentives for private vehicle owners.

#### Lead Authorities

- Transport
- Rea Vaya
- Metrobus
- City Fleet
- EISD
- City Power

#### Supporting Authorities

- Johannesburg Development Agency
- Development Planning
- Economic development

#### Partners

- National Department of Environment, Forestry and Fisheries
- National Department of Trade and Industry
- National Department of Transport
- Business and industry associations (Taxi associations, fuel industry)
- Eskom
- Unions

#### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
<ul style="list-style-type: none"> <li>• Site</li> <li>• City</li> </ul>	<b>5</b> Years	 Indirect	 Direct		

Sub-action	Potential technology	Action type	GHG impact
Undertake stakeholder engagement and develop an information and awareness-raising campaign to increase EV uptake (immediate).	All: electric, CNG, LPG, hydrogen fuels and related infrastructure		
Convert the municipal fleet to electric vehicles by 2040, and from 2030 ensure 100% of new vehicles procured by the City are EV.			
Partner with the private sector to enable large-scale investment in public charging infrastructure (including charging stations at the Civic Theatre and two other locations by 2021).			
Develop an EV tariff for city-owned charging stations (2024) and design incentive schemes to boost uptake.			
Install charging stations at all City-owned properties (2024).			
Undertake a smart-charging pilot and explore the business case for vehicle-to-grid charging and electricity sale (2025).			
Lobby national government to develop a strategy to enable the private sector to transition to 100% electric vehicles by 2050 (minibus taxis, buses, freight).			
Launch a zero-emission bus pilot programme and test small fleets of electric buses.			
Conduct a feasibility study on buses running on solar-power-generated hydrogen.			
Partner with the private sector to investigate options to electrify freight vehicles with a focus on last mile delivery.			
Partner with the private sector to promote the use of electric scooters and establish electric scooter share schemes.			

Action type: Enabling Action type: Implementing GHG impact: Direct GHG impact: Indirect



### Action: Improve vehicle fuel efficiency

This action aims to improve vehicle fuel efficiency by procuring more efficient vehicles, retiring older vehicles, establishing standards for fuel contracts and banning coal-based feedstocks for fuel production. The City also plans to partner with the private sector to incentivise the purchase of more efficient vehicles.

#### Lead Authorities

- Transport
- Rea Vaya
- Metrobus
- City Fleet
- EISD
- City Power

#### Supporting Authorities

- Group legal
- Contracts

#### Partners

- National Department of Environment, Forestry and Fisheries
- National Department of Transport
- National Department of Energy Minerals and Resources
- Business
- Industry associations
- National Cleaner Production Centre
- Trade and Industrial Policy Strategies



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Indirect

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
• City	<b>5</b> Years	 Indirect	 Indirect	 Capex Opex	 Capex Opex

Sub-action	Potential technology	Action type	GHG impact
Procure Euro VI diesel buses immediately and transition to 100% zero emission bus purchases by 2029.	All: clean fuel technology, CNG busses, EVs		
Retire city fleet vehicles older than 15 years (from 2024).			
Enforce an allowable sulfur content of maximum 10 ppm in new diesel fuel supply contracts.			
Ban the use of coal as a diesel feedstock in existing and future fuel supply contracts.			
Partner with the private sector to incentivise the purchase of fuel-efficient company and private vehicles through reimbursement schemes.			

Action type: Enabling Action type: Implementing GHG impact: Direct GHG impact: Indirect



## Action: Ensure transit-oriented development

This action aims to ensure transit-oriented development by preventing urban sprawl and promoting densification through incentivising mixed-use development.

### Lead Authorities

- Development Planning
- Johannesburg Development Agency
- Transport
- EISD

### Supporting Authorities

- Economic development
- Housing
- Community Development
- Citizen Relationships Urban Management

### Partners

- Business (developers)



**Health**  
Indirect



**Environmental**  
Indirect



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
<ul style="list-style-type: none"> <li>• Neighbourhood</li> <li>• City</li> </ul>	<b>5</b> Years	 Indirect	 Direct	 Capex Opex	 Capex Opex

Sub-action	Action type	GHG impact
Limit urban sprawl by enforcing the urban edge.		
Promote densification by enforcing the City's nodal policy, incentivising mixed-use development across the city and land use intensification in areas well-served by public transport and within close proximity to schools, workplaces and social facilities.		
Invest in multi-modal transport facilities, non-motorized transport and service infrastructure within the city's designated transit-oriented development precincts and corridors, to create functional transit-oriented development.		
Assess geographic vulnerability of transit access and equity by conducting a vulnerability assessment that combines storm surge and extreme rainfall projections with transit availability.		Adaptation
Ensure safe and accessible mobility options for vulnerable groups including the poor, women, children, the elderly and people with disabilities.		
Develop a phased plan to strengthen inner city precincts, address movement challenges, and improve the quality of the built environment across the inner city.		
Design transit nodes with heat stress in mind by providing shading, shelter and public drinking water fountains.		Adaptation
Design transit nodes with flood control in mind by integrating stormwater management and developing emergency evacuation plans in case of a flood.		Adaptation
Provide multiple mobility options to improve transport connectivity.		

Action type: Enabling Action type: Implementing GHG impact: Direct GHG impact: Indirect





# Theme 4

## Alternative Waste Management

### 2030

**Per capita solid waste generation has been reduced by at least 15%, municipal solid waste destined for landfill & incineration has been reduced by at least 50%, and at least 70% of waste is diverted from landfill and incineration, compared to 2016.**

The City of Johannesburg's approach to waste management is informed by the waste hierarchy. From most to least favoured option, waste should be reduced, reused and recycled. Waste that is unsuitable for the '3 Rs' should be treated. Recovery of energy from waste is a last-resort option. To support the vision of zero waste to landfill as articulated in the Growth and Development Strategy, the City has passed a municipal by-law which requires residents to separate their waste at home in order to divert recyclables such as paper, glass, and certain grades of plastic from landfill. Diverting waste from landfill not only increases the lifespan of the City's landfills, but also eases the strain on the country's national resources, improves economic efficiency and creates jobs in both the formal and informal waste reclamation sectors.

### 2050

**100% of solid waste is diverted from land fill and remaining methane emissions from waste are captured.**

Whilst not yet a formal signatory, the City of Johannesburg aspires to meet the ambition articulated in C40's Advancing Towards Zero Waste Declaration by 2030.

The following action areas have been identified to deliver the City's targets:

1. Diversion of solid waste from landfill;
2. Diversion of recyclables from landfill and incineration;
3. Optimise organic waste management;
4. Optimise waste collection and treatment.





## Case study:

### **City of Johannesburg Sustainable Waste Management Project**

In 2007, the City of Johannesburg initiated a project as part of the city's sustainable waste management programme, to address greenhouse gas emissions from landfills. The city generated approximately 19MW of electricity by harvesting methane from three selected landfill sites. This electricity produced is fed into the city's grid, providing more households with power.

To implement this project, the first of its kind in the country, the city entered into an agreement with a private project developer to construct, operate and maintain the landfill gas to energy installation at no cost to the city. The city receives royalties, while the service provider enjoys exclusive rights for harvesting gas and generating electricity.

In June 2018 the city, recorded a reduction in GHG emissions of 13% (1,813 tCO<sub>2</sub>e). In 2019, emissions were reduced by 19%. The initiative generates over 25,000 Carbon Credits annually and is registered as a Clean Development Mechanism project.



### Action: Waste reduction

This action aims to reduce the volume of waste generated by households and businesses, to limit the need for waste processing and reduce volumes of waste sent to landfill. Waste reduction is a key action in support of other waste management actions and is the most favourable option in the waste hierarchy 'reduce, reuse, recycle'.

#### Lead Authorities

- EISD
- Pikitup

#### Supporting Authorities

- Economic development

#### Partners

- National Department of Environment, Forestry and Fisheries
- Business
- NGOs

#### Benefits



**Health**  
Indirect



**Environmental**  
Direct



**Economic prosperity**  
Indirect



**Public service delivery**  
Indirect



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
<ul style="list-style-type: none"> <li>• Neighbourhood</li> <li>• City</li> </ul>	<b>5</b> Years	 Insignificant	 Insignificant	Capex            Opex	Capex            Opex

Sub-action	Action type	GHG impact
Partner with the private sector to develop a waste minimisation initiative (precinct-level and city-wide).		
Develop regulations to phase out non-recyclable materials and single-use items.		
Amend by-laws and develop a food waste reduction programme to enable retailers to donate surplus quality food to charity.		
Ensure all city meetings are paperless.		
Lobby national government to extend producer responsibility for waste.		

Action type: Enabling Action type: Implementing GHG impact: Direct GHG impact: Indirect



### Action: Divert recyclables from landfill and incineration

This action aims to divert recyclables from landfill and incineration through improved and enforced waste separation, the establishment of additional facilities and services to support segregated waste collection, the establishment of additional recycling facilities and the adoption of enabling policies and financial mechanisms to ensure that all recyclables are indeed recycled. Whilst emission reduction benefits to the city are negligible, significant indirect GHG mitigation benefits will result from the utilization of recycled materials and reduced demand for raw material extraction and processing.

#### Lead Authorities

- EISD
- Pikitup

#### Supporting Authorities

- Economic Development

#### Partners

- National Department of Environment, Forestry and Fisheries
- Private sector (waste producers and recyclers)
- Cooperatives
- Citizens
- NGOs

#### Benefits



**Health**  
Indirect



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Indirect



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
<ul style="list-style-type: none"> <li>• Neighbourhood</li> <li>• City</li> </ul>	<b>5</b> Years	 Insignificant	 Low	Capex            Opex	Capex            Opex

Sub-action	Action type	GHG impact
Legally enforce waste separation at the source.		
Equip all public spaces (including provincial government facilities, schools, parks and hospitals) with recycling bins.		
Partner with the private sector to ensure that all shopping malls, stadiums, private schools, residential and commercial blocks and other quasi-public spaces that generate large volumes of waste are equipped with recycling bins.		
Deploy neighbourhood containers and establish transfer stations to improve local collection in hard-to-reach informal areas.		
Lobby national government to provide waste infrastructure grants.		
Launch a public education and awareness campaign on reducing, reusing and recycling waste, and promote innovations that incentivise recycling.		
Provide mechanisms for informal waste pickers to formalise their roles and implement measures to improve their working environments.		
Partner with the private sector to promote e-waste recycling.		
Partner with the private sector to establish a platform for advertising recyclables.		
Increase the capacity of existing recycling facilities (including buy-back centres, material-recovery facilities, sorting and processing plants).		
Develop recycling facilities for building rubble and create partnerships to re-use building materials.		



### Action: Optimise organic waste management

This action aims to optimise organic waste processing in the city. The decomposition of organic waste is the largest source of emissions in the waste sector. Improving the way it is managed, in particular by establishing alternatives to landfill, will have a significant impact on GHG emissions from the sector (although these only constitute a small part of the city's total emissions).

#### Lead Authorities

- EISD
- Pikitup

#### Supporting Authorities

- Community Development
- Social Development
- Citizen Relationships
- Urban Management

#### Partners

- National Department of Environment, Forestry and Fisheries
- Business (producers of organic waste, composters and compost off-takers)
- Citizens
- NGOs

#### Benefits



**Health**  
Indirect



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Indirect



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
<ul style="list-style-type: none"> <li>• Site</li> <li>• Neighbourhood</li> </ul>	<b>5</b> Years	 Insignificant		 Capex Opex	 Capex Opex

Sub-action	Potential technology	Action type	GHG impact
Partner with the private sector to expand the composting of organic waste.	All: composting		
Pilot segregated collection of food waste and organics.			
Partner with the province to develop and implement a composting, biogas and produce gardening programme for schools.			
Install a biodigester at the Joburg Market.			
Pilot onsite composting programmes at Johannesburg parks and the Zoo.			

Action type: Enabling Action type: Implementing GHG impact: Direct GHG impact: Indirect



## Action: Optimise waste collection and treatment

This action aims to optimise the ways in which waste is collected and treated in the City, by improving management and upgrading technology at the City's landfill sites, and by improving waste collection systems.

### Lead Authorities

- EISD
- Pikitup

### Supporting Authorities

- Group Finance

### Partners

- National Department of Environment, Forestry and Fisheries
- Business (producers of organic waste, composters and compost off-takers)
- Citizens
- NGOs
- Research institutions

### Benefits



**Health**  
Indirect



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Indirect

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
<ul style="list-style-type: none"> <li>• Site</li> <li>• Neighbourhood</li> </ul>	<b>5</b> Years	 Insignificant	 Significant	Capex            Opex	Capex            Opex

Sub-action	Potential technology	Action type	GHG impact
Optimise landfill gas capture systems.	All: landfill management and landfill gas capture		
Undertake periodic data gathering on the volume of waste generated in the city, its sources, composition, calorific value and other characteristics.			
Develop a strategy to reduce emissions from waste collection and improve the efficiency of waste collection logistics.			
Investigate solutions for waste compaction at source to reduce the number of waste collection trips required (especially in commercial and shopping districts).			

Action type: Enabling Action type: Implementing GHG impact: Direct GHG impact: Indirect





# Theme 5

## Improved Water Supply and Wastewater Treatment

### 2030

**A comprehensive review has been undertaken of the energy use by, potential energy savings and energy generation opportunities in the water and wastewater systems, and a net-zero-energy programme has been developed.**

Water supply and wastewater treatment systems generate a small share of the City's emissions, but still offer substantial opportunities for mitigation. In addition, in water-scarce countries like South Africa, reducing water use provides significant environmental and socio-economic benefits. Finally, water savings translate to energy and cost savings.

Aging infrastructure poses a major challenge to water saving efforts: in 2019, Johannesburg lost 38% of its bulk water supply due to burst pipes. The City has already implemented several infrastructure upgrade initiatives to reduce water losses and will continue these activities.

### 2050

**Net-zero emissions has been achieved in all water and wastewater systems, including water treatment, conveyance, supply, and wastewater treatment and disposal.**

The City has also installed biogas-to-electricity systems at two of its six wastewater treatment works (WWTW), Johannesburg Water's Northern WWTW and Driefontein WWTW. Electricity generated on site helps to offset the energy costs of wastewater treatment. Savings made are passed on to residents.

The following action areas have been identified to deliver the City's targets:

1. Enhance the sustainability of wastewater treatment;
2. Improve water conveyance efficiency.



## Case study:

### **Wastewater Treatment Works - Biogas to Electricity Project**

In 2004, the City of Johannesburg initiated a research project to explore the technical and economic feasibility of electricity generation from biogas at wastewater treatment works (WWTW).

The project was launched to mitigate the rising cost of electricity and to reduce the WWTWs' R100-million annual electricity bill. The first combined-heat-and-power project at the Northern WWTW was approved for construction in 2010 and the plant began operations in 2012.

The electricity produced at the WWTW is used on site, in parallel with electricity supplied by the grid. The plant can meet approximately 10% of the WWTW's power demand. Currently, biogas is collected from four digesters. Additional digesters are under refurbishment to allow for biogas collection. Once all existing digesters at NWWTW have been upgraded and all sludge is treated anaerobically, the plant will have a capacity of up to 4.5MWe, meeting approximately 56% of the WWTW's demand. Provisions have already been made to accommodate the required additional gas engines.



## G1 5.1

## Enhance the sustainability of wastewater treatment

### Action: Enhance the sustainability of wastewater treatment

This action aims to reduce GHG emissions resulting from the treatment of wastewater in the city whilst improving service delivery to and affordability for a growing number of consumers.

#### Lead Authorities

- EISD
- Johannesburg Water

#### Supporting Authorities

- Group Finance
- Economic Development

#### Partners

- National Department of Water and Sanitation
- Research institutions
- Private sector
- Other Metropolitan Municipalities

#### Benefits



**Health**  
Indirect









**Environmental**  
Direct







**Economic prosperity**  
Indirect



**Public service delivery**  
Indirect

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
• City	<b>5-10</b> Years	 Insignificant		  Capex Opex	  Capex Opex

Sub-action	Action type	GHG impact
Optimise biogas production and efficiency at anaerobic digestion facilities.		
Improve sludge treatment with the aim of generating waste products for the market (fertilizer, etc.).		

Action type: Enabling  Action type: Implementing  GHG impact: Direct  GHG impact: Indirect 



## G1 5.2

## Improve water conveyance efficiency

### Action: Improve water conveyance efficiency

This action aims to improve the efficiency of water conveyance by installing more efficient pumps to reduce energy use, improve service delivery and reduce charges for consumers.

#### Lead Authorities

- EISD
- Johannesburg Water

#### Supporting Authorities

- Group Finance
- Development Planning
- Smart City Office

#### Partners

- National Department of Water and Sanitation
- National Department of Science and Technology
- National Cleaner Production Centre

#### Benefits



**Health**  
Indirect



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Direct

Scale	Timeframe	Emission reductions	Job creation	City costs	Non-city costs
• City	<b>5</b> Years	 Insignificant	 Significant	 Capex Opex	 Capex Opex

Sub-action	Potential technology	Action type	GHG impact
Improve management of network pressure and install more energy-efficient pumps.	VSD or similar efficient pumps, appropriate pump sizing, pressure management devices		

Action type: Enabling Action type: Implementing GHG impact: Direct GHG impact: Indirect

# Goal 2

## A Climate

## Resilient City

A climate-resilient city is able to manage disaster risk and mitigate the negative impacts of climate change on its population and economy. Achieving the goal of climate resilience requires a dual focus on people and the environment, and buy-in from all citizens. Accordingly, themes and action areas under this goal concentrate on the following:

- Density, diversity and mixed use of infrastructure and public spaces;
- Transit-supportive development;
- Soft and green infrastructure (i.e. governance and nature);
- Development of building types and urban forms that reduce maintenance costs and environmental impact;
- Provision of daily needs within walking distance;
- Conservation and enhancement of natural systems;
- Planning and design for durability of safety systems and critical infrastructure systems;
- Enhancement of the effectiveness, efficiency, and safety of technical and industrial systems and processes.

To enhance stakeholder buy-in and sustainability of results, the following principles were followed in the design of actions:

- Actions must be replicable and help solve multiple challenges;
- Actions must deliver social, environmental and economic returns;
- Actions must deliver risk reduction with measurable outcomes and indicators for success;
- The City must ensure stakeholder involvement and buy-in to enhance effectiveness of actions.

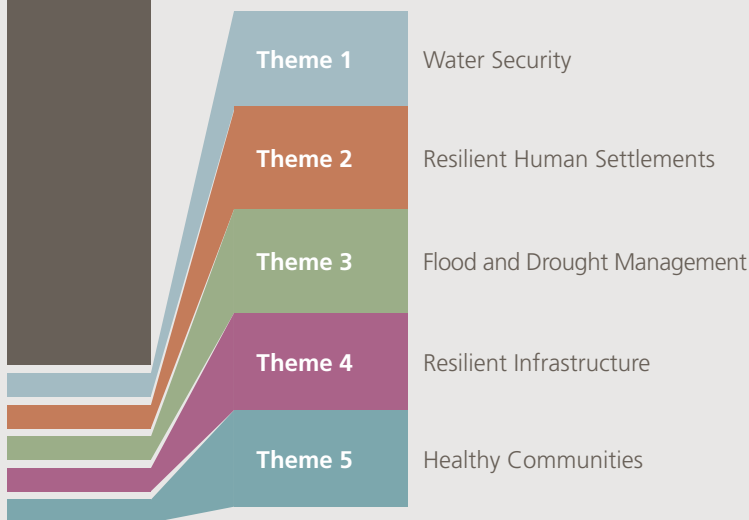
The City's adaptive capacity is determined by the resources available for adaptation and the City's ability to use those resources effectively. Key determinants of adaptive capacity are quality of and equitable access to technology, infrastructure, institutions, knowledge (i.e. information and skills) and economic resources.

Each of the action areas under the themes below has been evaluated in terms of the above-mentioned key determinants for building adaptive capacity. This section does not consider hazard-specific adaptive capacity, but rather outlines how the determinants are relevant for building adaptive capacity to a variety of hazards.





## Goal 2



**Water security** includes actions to ensure that Johannesburg has a reliable availability of water to meet the city's needs both in terms of quantity and quality.

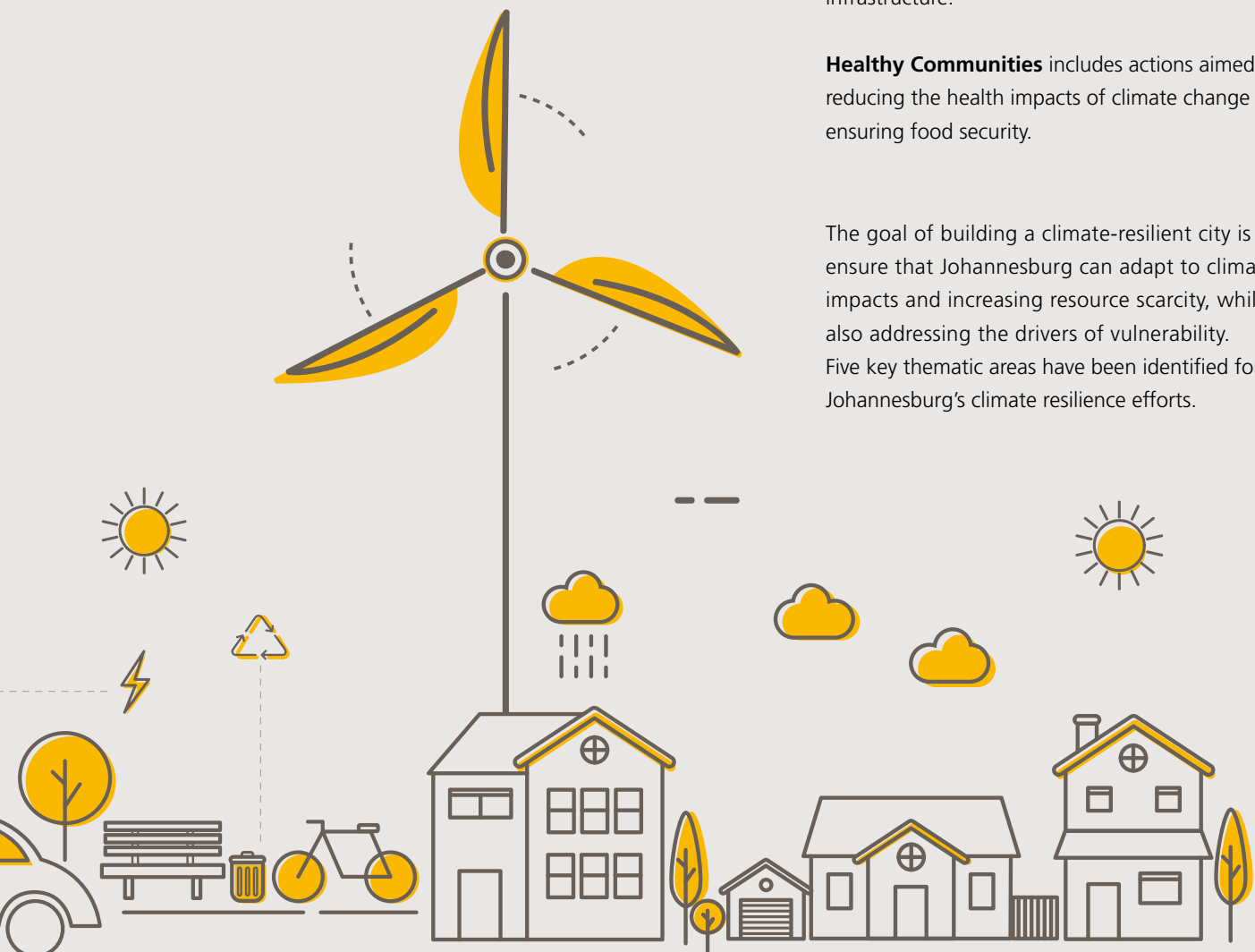
**Resilient Human Settlements** promotes climate-sensitive urban planning and management in order to safeguard communities.

**Flood and Drought Management** focuses on actions to minimize and manage the risk of climate impacts.

**Resilient Infrastructure** includes actions to safeguard hard infrastructure as well as ecological infrastructure.

**Healthy Communities** includes actions aimed at reducing the health impacts of climate change and ensuring food security.

The goal of building a climate-resilient city is to ensure that Johannesburg can adapt to climate impacts and increasing resource scarcity, while also addressing the drivers of vulnerability. Five key thematic areas have been identified for Johannesburg's climate resilience efforts.



## Goal 2

The themes were designed to enhance cooperation among city stakeholders. The solutions proposed are in line with the City's urban agenda to achieve the SDGs.

The following information is presented for each action:

- The lead and supporting implementers.
- The scale, whether national, regional, city-wide, in a specific neighbourhood or in a specific street.
- The anticipated timescale for implementation.
- The potential for job creation.
- The anticipated reduction in exposure to the relevant hazard.
- The projected cost, including upfront or capital costs (CAPEX) and operational or running costs (OPEX), for the City and for non-city stakeholders (such as private businesses or financiers).

- The projected benefits for communities, including benefits to economic prosperity, health and wellbeing, environment, service delivery, and inclusivity and civil society.
- Critical non-City implementation partners, including businesses, NGOs, national government and civil society.

Each action also contains a number of 'sub-actions', key steps that are required for success.















There are two types of sub-actions, "enabling" refers to policies, plans, campaigns and other supporting activities whereas "implementing" refers to tangible projects on the ground which directly reduce emissions or climate risk.

Some sub-actions may contribute to multiple goals and are therefore be repeated across sections.

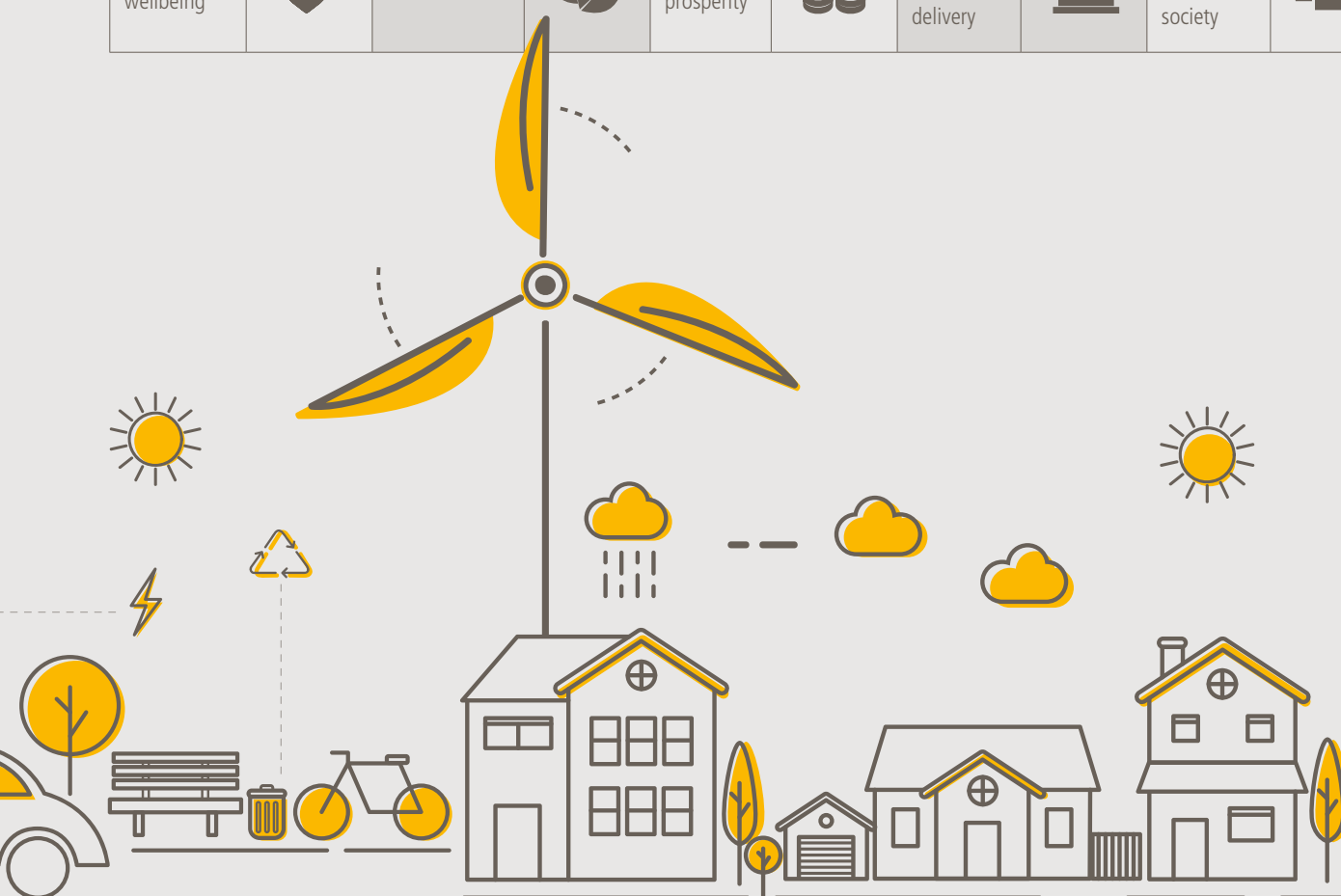


## Key:

This key will help guide you through the following pages, giving you an illustrative breakdown of what predictive levels of success and the impact it will have on that specific sector. Refer to the table below to get an understanding of how each measure has been gauged.

Action type		Risk reduction		Job creation		Costs		Maladaptation	
Enabling		Low		Low		Nil		Yes	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Implementing		Low medium		Medium		Low		No	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
		Medium		High		Medium			
		Medium high				High			
		High							

Benefits									
Health and wellbeing		Environmental		Economic prosperity		Public service delivery		Inclusivity and civil society	





# Theme 1

## Water Security

### 2030

**By 2030, 100% of residents have access to a reliable water supply, 96% of residents have access to sanitation services, and the city is fully water secure.**

The City of Johannesburg strives to achieve a sustainable water supply. Due to its continuing growth, the City will need to assess water and sanitation needs in developing areas and invest in infrastructure to meet these needs. Sufficient water resources are crucial for the continued sustainable economic development of the City.

Climate change is projected to increase the risk and frequency of both droughts and floods, the impacts of which will be exacerbated by ageing infrastructure. Failure to address climate change impacts on water security would exacerbate existing

### 2050

**By 2050, 25% of water supplied comes from alternative sources, average per capita water demand is reduced to 175 litres per day, water losses are reduced to below 20% and Blue Drop status is maintained above 95%.**

vulnerabilities of the City's inhabitants, affect the sustainability of communities and drive up costs to the extent that water may become unaffordable.

Climate adaptation action areas for water security include:

1. Water Demand
2. Water Supply
3. Water Innovation
4. Water Quality



## Case study:

### **Sustainable Urban Drainage System (SUDS) in Diepsloot**

The informal settlement of Diepsloot lacks appropriate drainage infrastructure, as a result stormwater runoff is mixed with pollution and wastewater. A research team funded by the Gauteng City-Region Observatory assessed the feasibility of developing a low-cost, flexible sustainable urban drainage system (SUDS) to manage drainage and improve water quality. Diepsloot is highly susceptible to flooding due to its location in the Jukskei River floodplain. The area is also densely populated, fully covered with impervious surfaces and has very little green space, all characteristics that exacerbate flood risk.

The project constructed SUDS solutions including pervious channels, semi-vegetated channels, soakaways and a miniature bio-retention area to allow stormwater to seep into the soil thereby preventing flooding and improving water quality. Diepsloot's SUDS requires ongoing maintenance. Local residents are responsible for monitoring litter accumulation and structural damage, which is critical for the effective functioning of the system. The routine clearing of litter by local residents resulted in the emergence of a 'SUDS champion' who now manages this activity (Fitchett, 2017).

The reduction of surface water positively impacted upon the social amenity in the area and the improved water quality improved the quality of life of the residents. The adaptive co-management process encouraged social learning and the development of technical skills through interactions with the researchers.<sup>xix</sup>





### Action: Water conservation and demand management

This action aims to minimize water losses, ensure equitable access and improve water use efficiency by implementing education and awareness-raising campaigns, improving demand management structures, investing in infrastructure and amending regulations.

#### Lead Authorities

- EISD
- Johannesburg Water

#### Supporting Authorities

- Development Planning

#### Partners

- Gauteng Department of Agriculture and Rural Development
- Department of Water and Sanitation
- Private Sector

#### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Job creation	City costs	Non-city costs
City	5 Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Drought				<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

Sub-action	Action type
Implement education and awareness-raising campaign to encourage water saving.	
Implement Water Conservation and Demand Management Strategy.	
Introduce efficiency-induced pricing structures.	
Implement demand management solutions (metering, step tariffs, restrictions, incentives & technology).	
Repair and upgrade existing water infrastructure (pipe replacement, pressure management, bulk meter repairs).	
Promote water-conserving technologies and practices for urban agriculture.	
Revise water level regulation licences to encourage water demand reduction.	
Clear invasive vegetation from infested catchments.	
Review existing WWTWs and evaluate the potential for direct and indirect re-use of water for drinking.	

Action type: Enabling Action type: Implementing



### Action: Establish recycled water schemes

This action aims to scale up the water supply by adopting water recycling approaches. Engaging with relevant stakeholders throughout, the City will undertake integrated development planning, assess water sources for recycling, and evaluate the option to extract groundwater to augment existing supply.

#### Lead Authorities

- EISD
- Johannesburg Water

#### Supporting Authorities

- Development Planning
- Citizen Relations
- Urban Management

#### Partners

- Gauteng Department of Agriculture and Rural Development
- Department of Water and Sanitation
- Private Sector

#### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Job creation	City costs	Non-city costs
City	<b>5-10</b> Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Drought				<b>Yes</b> <input type="checkbox"/> <b>No</b> <input type="checkbox"/>

Sub-action	Action type
Undertake integrated development planning to determine how water recycling will fit into short- and long-term water use and supply.	
Identify and characterise potential water sources for recycling to match them with users and to provide a baseline for determining the types of additional treatment or facilities that may be required.	
Develop clear and practical guidelines defining water treatment requirements and quality standards for reuse.	
Implement the rainwater harvesting guideline.	
Assess water supply quantities and demand fluctuations to determine storage and treatment capacity requirements.	
Extract groundwater to augment water supply at city facilities.	
Assess the water reuse market/demand and determine infrastructure requirements.	
Develop and implement a stakeholder engagement programme.	
Identify and obtain the required environmental, health, and other approvals for implementation.	
Implement Supplier Development Programmes.	
Procure services for construction/upgrading and maintenance of technologies and infrastructure for water recycling.	



## Action: Decentralised water supply systems

This action aims to increase the share of water supplied from alternative sources to 25%, to enhance the resilience of the water system.

### Lead Authorities

- EISD
- Johannesburg Water

### Supporting Authorities

- Smart City Office

### Partners

- Gauteng Department of Agriculture and Rural Development
- Department of Water and Sanitation
- Private Sector

### Benefits



**Health**  
Direct



**Environmental**  
Direct









**Economic prosperity**  
Direct










**Public service delivery**  
Direct



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Job creation	City costs	Non-city costs
City	<b>5-10</b> Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Drought				<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Sub-action	Action type
Identify potential alternative water sources.	
Mainstream the use of the identified alternative water sources into the Integrated Water Management Plan and Spatial Development Framework.	
Review and update municipal guidelines for water recycling, greywater use and stormwater harvesting.	
Develop and deploy a small-scale water treatment and purification system.	
Develop a water use strategy that identifies additional interventions.	
Investigate the potential for stormwater harvesting.	
Initiate a pilot project for decentralised water use including water recycling and stormwater harvesting.	

Action type: Enabling  Action type: Implementing 



### Action: Water-sensitive urban design

This action aims to integrate the urban water cycle into urban design principles, to minimise environmental degradation and improve aesthetic and recreational appeal using methodologies such as runoff management in open spaces and improvements to the drainage of surface water.

#### Lead Authorities

- EISD
- Development Planning

#### Supporting Authorities

- Johannesburg Roads Agency

#### Partners

- Gauteng Department of Agriculture and Rural Development
- Department of Water and Sanitation
- Private Sector
- Surrounding municipalities

#### Benefits



**Health**  
Direct



**Environmental**  
Direct









**Economic prosperity**  
Direct








**Public service delivery**  
Direct



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Job creation	City costs	Non-city costs
City	<b>10+</b> Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Flash/surface flood				<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Sub-action	Action type
Develop guidelines for sustainable urban drainage systems.	
Implement a pilot project to demonstrate the benefits of ecological infrastructure.	
Identify, design/redevelop, connect and protect multifunctional open spaces that can be used for runoff management at strategic points.	
Mandate the use of cool, permeable paving to reduce the urban heat island effect and reduce flood risk.	
Implement sustainable urban drainage systems to drain surface water in a more sustainable manner than conventional techniques.	

Action type: Enabling  Action type: Implementing 



## Action: Water pollution monitoring and management programme

This action aims to minimise pollution of water resources through more stringent water quality monitoring and the enforcement of standards as well as through the restriction of polluting behaviours.

### Lead Authorities

- EISD
- Johannesburg Water

### Supporting Authorities

- Johannesburg Metro Police Department

### Partners

- National Department of Water and Sanitation
- Gauteng Department of Agriculture and Rural Development
- Surrounding municipalities

### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Job creation	City costs	Non-city costs
Site	5 Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Drought				<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

Sub-action	Action type
Monitor and enforce standards limiting pollution of water sources by industries, mines, construction sites etc.	
Monitor water pollution in rivers and other water sources and implement river restoration measures.	
Prepare regular 'state of rivers' reports containing river health assessments.	
Promote environmental health for the city's catchment areas.	
Reduce water pollution by encouraging responsible use of fertilisers.	
Minimise acid mine drainage through industrial water assessment and mitigation programmes.	
Improve management of solid waste to reduce pollution risks to urban water sources.	
Reduce the risk of urban nonpoint source pollution by expanding access to sanitation and improving management of wastewater treatment works.	
Support the development of a Water Quality Management Plan for the Vaal Dam and Vaal River.	
Implement catchment management practices to reduce water quality risks to urban dams and attenuation ponds.	

Action type: Enabling Action type: Implementing







# Theme 2

## Resilient Human Settlements

### 2030

**By 2030, all households have access to safe, resilient, and affordable basic services. Social, environmental and resilience criteria are incorporated into all urban planning and development processes.**

Rapid population growth in Johannesburg has led to spatial inequality, which was historically exacerbated by South Africa's spatial planning laws. The sustainable development of settlements can help to address issues not directly related to climate change such as unsustainable resource exploitation and pollution.

Creating resilient human settlements will require a shift towards clean, efficient and affordable transport and climate-sensitive urban planning and management. The City should adopt a holistic approach to urban planning that links environmental and social systems, integrating climate change, resilience and sustainability as well as social, environmental and economic aspects.

### 2050

**By 2050, 100% of the population is accommodated in affordable, resilient and low-carbon housing. All citizens have access to safe and sustainable open space, with tree cover of over 30%.**

The City needs to effectively support its vulnerable citizens, especially those in informal settlements, in the face of climate-related risks. One strategy will be to limit encroachment of urban sprawl on natural areas that provide protection from extreme events.

Affordable transport is key to allow people living in vulnerable areas to access economic opportunities outside of their immediate neighbourhoods, and thereby enhance their resilience to climate change impacts and other shocks. New public transport should be based on renewable energy to reduce its impact on natural resources, biodiversity and air quality.



Action areas to create resilient human settlements include:

1. Supporting vulnerable communities;
2. Transport and spatial planning;
3. Human settlements and urban management.



### Action: Sustainable livelihoods programme

This action aims to develop the skills and assets of disadvantaged people and those living in poverty, enhancing their climate resilience by providing them with a clear understanding of risks. The City will also undertake studies to determine where investment should be directed for maximum impact.

#### Lead Authorities

- EISD
- Social Development

#### Supporting Authorities

- Citizen Relation and Urban Management (CRUM)
- Economic Development

#### Partners

- Private sector
- NGOs
- Youth
- Academia

#### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Direct

Scale	Timeframe	Job creation	City costs	Non-city costs
City	<b>10+</b> Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Flooding				<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

Sub-action	Action type
Identify communities' physical, social, human, financial and natural assets and identify their vulnerabilities and strengths through community surveys.	
Identify climate-related and non-climate-related shocks, vulnerabilities and critical trends in hazards facing vulnerable communities.	
Develop and raise awareness of strategies to improve livelihoods based on strengths identified in the community surveys.	
Develop and invest in pilot phases of sustainable livelihoods programmes.	
Identify infrastructure that should be prioritised for protection from climate change to preserve livelihoods and public investment.	

Action type: Enabling Action type: Implementing



### Action: Settlement upgrading programme

This action aims to identify critically vulnerable communities and determine whether these need to be relocated. Engaging with relevant stakeholders throughout, the City will analyse informal settlements, focus investment in development in areas not threatened by climate hazards and develop an integrated human development plan.

#### Lead Authorities

- Housing and Development Planning

#### Supporting Authorities

- Municipal-Owned Entities
- Johannesburg Property Company
- Johannesburg Road Agency (JRA)
- Citizen Relation and Urban Management (CRUM)

#### Partners

- Private sector
- NGOs
- Youth
- Academia
- National Department of Housing
- Gauteng Department of Agriculture and Rural Development

#### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Direct

Scale	Timeframe	Job creation	City costs	Non-city costs
Neighbourhood	<b>5-10</b> Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Floods				<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

Sub-action	Action type
Identify all informal settlements and collect data on their demographics and growth patterns.	
Identify critically vulnerable communities at risk of climate change-related disasters and determine whether these communities need to be relocated.	
Analyse whether the land informal settlements are located on is suitable for development.	
Identify and prioritise in-situ upgrades to public infrastructure and services where land is not vulnerable to climate change hazards.	
Identify areas suitable for equitable resettlement of informal settlements that are highly vulnerable to climate hazards.	
Develop an integrated human development plan that is inclusive and climate change compatible.	
Protect the urban edge and ensure that development is limited to areas with access to key infrastructure.	
Consult with community stakeholders to collect feedback on and gain buy-in for protection and relocation measures.	
Implement an informal and formal settlement upgrading policy based on the results of the above.	





## Action: Spatial planning and land use

This action aims to promote the sustainable and efficient use of land to mitigate the negative impacts of climate change by placing restrictions on development and land use, creating buffers, developing a spatial risk assessment for key infrastructure and designing and planning settlements with their natural corridors in mind.

### Lead Authorities

- Development Planning
- Transport

### Supporting Authorities

- Group Strategy
- Policy Co-ordination and Relations
- EISD

### Partners

- National Department of Rural Development and Land Reform
- Gauteng Department of Agriculture and Rural Development
- Academia

### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Job creation	City costs	Non-city costs
City	<b>5-10</b> Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Flash/surface flood				<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

Sub-action	Action type
Establish restrictions to protect open spaces and the areas surrounding them from undesirable and potentially damaging development and land-use change.	
Place development and land-use restrictions on current and future landfill sites and buffer zones around these.	
Place strict restrictions on new upstream developments to limit any negative impacts downstream.	
Identify vulnerable infrastructure and infrastructure key to an effective disaster response.	
Prohibit new development and infrastructure construction on land highly vulnerable to climate hazards.	
Develop a spatial risk assessment for key infrastructure.	
Create buffers between zones with incompatible land uses and between communities and high-risk areas.	
Observe, where possible, the natural contours of settlements in the development of their layout and plans for their growth.	
Identify and protect areas for the establishment of regional attenuation facilities.	

Action type: Enabling Action type: Implementing



### Action: Urban growth management strategies

This action aims to foster innovative local solutions to urban climate change vulnerability, while identifying the optimal scales for each action and restricting development in high-risk areas.

#### Lead Authorities

- Housing and Development Planning

#### Supporting Authorities

- Citizen Relation and Urban Management (CRUM)
- Transport

#### Partners

- National Department of Housing
- Gauteng Department of Agriculture and Rural Development
- NGOs
- Academia

#### Benefits



**Health**  
Direct



**Environmental**  
Direct











**Economic prosperity**  
Direct





**Public service delivery**  
Direct



**Inclusivity and civil society**  
Direct

Scale	Timeframe	Job creation	City costs	Non-city costs
Neighbourhood	<b>5-10</b> Years		 	 
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Flash/surface flood				<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Sub-action	Action type
Conduct a technical review of the Human Settlement Plan for the whole City and ensure that it is inclusive and climate change compatible.	
Lobby the national government to develop national adaptation strategies to encourage and support urban development that avoids the areas most at risk from climate change impacts.	
Conduct a study to establish current and future needs, development trends and growth projections for human settlements.	
Identify suitable sites for the construction of key infrastructure based on population growth projections.	
Ensure the availability of land for the development of bulk infrastructure.	
Determine and define the outer limit of urban expansion (urban edge) as part of an urban growth management strategy.	
Implement buffer zones between incompatible use zones and high-risk areas.	
Establish measures to protect valuable peri-urban land and environmental features.	
Protect the urban edge through land-use restrictions.	
Redesign streets to increase liveability (e.g. through green energy blocks).	

Action type: Enabling  Action type: Implementing 



# Theme 3

## Flood and Drought Management

### 2030

**By 2030 flood management is mainstreamed and improved across all sectors to minimise social, economic and environmental impacts of flooding.**

**By 2030, fully functional early warning systems for floods, droughts, fires and storms are in place, and response plans for floods and droughts are updated.**

Extreme weather events such as floods and droughts can serve as catalysts for change as they expose systemic vulnerabilities and raise awareness of climate risks. Settlements in low-lying areas in particular often face flooding when ageing, poorly maintained and/or inappropriate stormwater drainage infrastructure cannot support the high volumes of runoff associated with increasingly heavy rainfall. Barriers to adaptation to flooding and improved stormwater management include a lack of available land, human resources and technical capacity, and difficulties securing a budget.

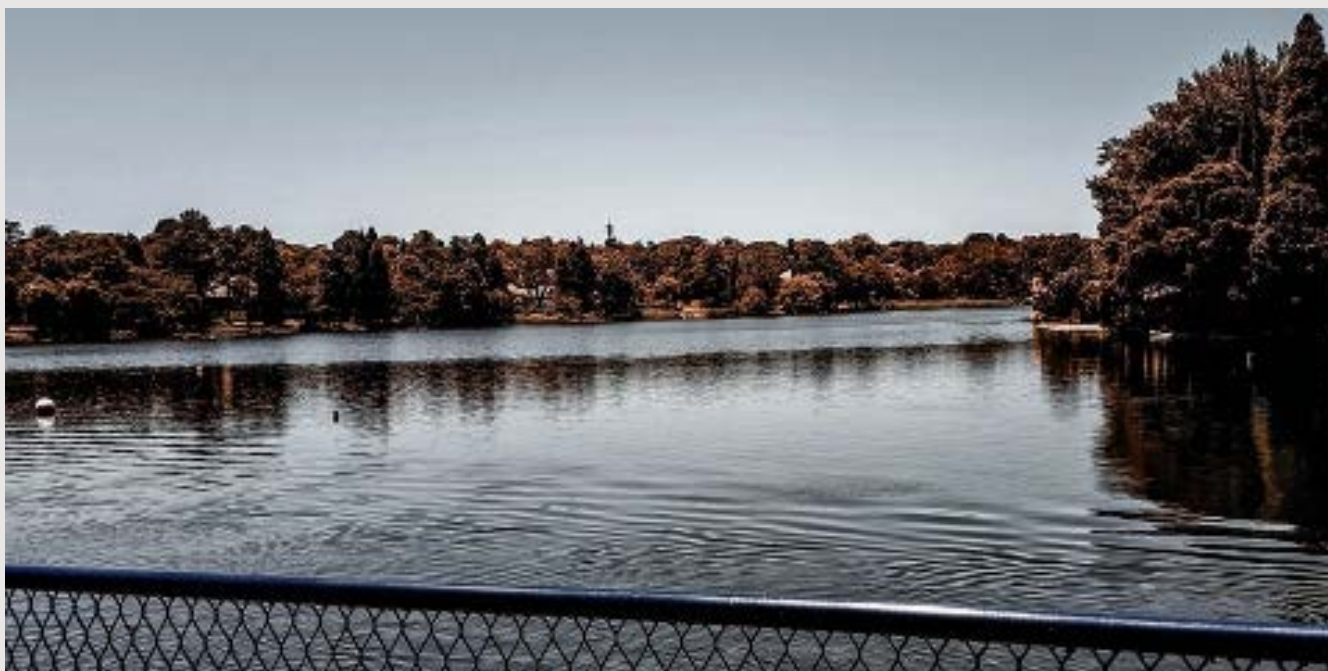
Effective flood management can minimise the risks and impacts of flooding. Vulnerability to flooding can also be significantly reduced by relocating highly vulnerable communities to areas that are less exposed and adopting and enforcing stricter building codes.

### 2050

**By 2050, no houses, offices, industries or critical infrastructure are located in high-flood risk areas and water supply and food systems are drought-proof.**

On the other hand, droughts are expected to periodically cause a decrease in water availability for many essential services and have a negative impact on water quality. Therefore, the City and its residents need be aware of the fact that water is a scarce resource and make efforts to conserve it. Changes in average annual rainfall and inter-annual variability can contribute to increasing risks of drought and water insecurity. It is important to note, however, that the majority of water used in the City of Johannesburg is supplied through the Integrated Vaal System.

A large share of Johannesburg's water originates in the Lesotho Highlands Water Project. Hence, any changes in precipitation levels in the City of Johannesburg itself will have a relatively small impact on water security.



## Case study:

### **Re-imagining Stormwater Management for the City of Johannesburg**

The Environment and Infrastructure Services Department (EISD) and Johannesburg Roads Agency (JRA) are actively re-imagining the City of Johannesburg's approach to stormwater management by implementing the principles of water-sensitive urban design (WSUD). WSUD can not only enhance resilience to increasing flood risks resulting from expanding urban development and climate change, but also help to create a cooler and more liveable city. Thus far EISD and JRA have, among other activities, updated the City's Stormwater Guidelines, rehabilitated existing stormwater dams and investigated the potential for increased regional attenuation. The intention is to improve stormwater management in existing areas as well as to introduce WSUD principles early on in the planning of new developments.

Climate adaptation action areas for flood and drought management include:

1. Flooding response and resilience;
2. Drought response and resilience.



### Action: Flood response and improved resilience programme

This action aims to protect communities and infrastructure from the impacts of flooding by reducing risk and recovery time and costs through measures including integrated planning, enforcement of land-use and development restrictions and infrastructure development.

#### Lead Authorities

- Johannesburg Road Agency (JRA)
- Public Safety
- EISD

#### Supporting Authorities

- Smart City Office
- All relevant municipal entities
- Health
- Housing

#### Partners

- Surrounding municipalities
- Provincial Disaster Management Centre
- DEFF,
- COGTA
- Private sector (insurance companies)

#### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Job creation	City costs	Non-city costs
City	5 Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Flash/surface flood				<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

Sub-action	Action type
Integrate climate change into the City's Stormwater Master Plan.	
Conduct flood risk assessments to facilitate flood risk reduction and awareness-raising in high risk communities.	
Map the 100-, 50- and 20-year flood lines for rivers and streams within the urban edge and review these maps every five years.	
Visibly demarcate flood lines in order to prevent development in zones with high flood risk and to allow for better management and public safety.	
Enforce strict land-use and development restrictions to prevent development in at-risk areas and in areas within the 100-year flood lines.	
Use pervious materials in settlements, to allow for effective runoff management.	
Develop a flood risk education and awareness programme for high-risk communities.	
Identify new or planned facilities above the 100-year flood line and introduce disaster management measures.	
Ensure easy access and room to manoeuvre for emergency vehicles.	
Identify and protect critical disaster response infrastructure including ICT, health facilities, electrical infrastructure, social facilities, fire stations and escape routes.	
Design new developments with emergency access in mind.	
Increase the capacity of the city's infrastructure for stormwater drainage and flood control.	
Develop a detailed Master Drainage Plan for all river catchments.	





### Action: Drought response and improved resilience programme

This action aims to protect residents, land and infrastructure from droughts by reducing the risk and the cost of recovery through measures including the review and enforcement of land use and development restrictions and the identification of critical interventions.

#### Lead Authorities

- Public Safety
- EISD

#### Supporting Authorities

- Social Development
- Smart City Office

#### Partners

- Department of Environment, Forestry and Fisheries
- National Department of Water and Sanitation
- Gauteng Department of Agriculture and Rural Development
- Private sector
- National Department of Cooperative Governance and Traditional Affairs.

#### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Job creation	City costs	Non-city costs
City	<b>5</b> Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Drought				<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Sub-action	Action type
Formalise institutional roles and partnerships for drought mitigation.	
Develop an early warning system for droughts.	
Review current restrictions on water use and demand and develop an updated drought response plan.	
Identify critical interventions to be implemented during a drought to minimise social and economic impacts.	

Action type: Enabling Action type: Implementing



# Theme 4

## Resilient Infrastructure

### 2030

**By 2030, all current backlogs of upgrades to urban stormwater infrastructure have been addressed, and updated stormwater guidelines have been developed.**

Resilient physical infrastructure and improved ecological infrastructure are key to creating a resilient Johannesburg. The city's quickly growing population and energy demand have resulted in the destruction of natural areas and the rapid development of non-resilient infrastructure to meet demand.

Examples of adaptation actions for Resilient Infrastructure include:

- Development of green precincts and agricultural corridors;
- Relocation of certain species of flora and fauna to areas more favourable to their survival under changing climatic conditions.

Infrastructure challenges are worsened by inadequate maintenance, and a lack of human resources and budget often causes delays in implementation.

### 2050

**By 2050, the City of Johannesburg has been transformed into a Water-Sensitive City, which incorporates Water Sensitive Urban Design (WSUD) into all aspects of urban planning.**

**By 2050, the city has 30% green cover (including green roofs) for city and passive building cooling.**

To build resilience to the adverse effects of climate change, the City must use the available space efficiently. Green spaces must be regarded as productive places that can mitigate some of the effects of climate change and, through involving residents in their maintenance, enhance adaptation. Along with expanding green spaces, the City will protect species that are vulnerable to climate change and ensure biodiversity is maintained.

Biodiversity is key to the functioning of the ecosystems that provide services such as water retention and microclimate regulation. A climate change-induced loss of biodiversity would result in a reduced quality of life for the residents of the City of Johannesburg.



## Case study:

### **Cedar Lofts Development – Conservation of an Urban Wetland**

Cedar Lofts is an estate with 425 residential units, situated on four hectares of natural wetland. Known as the Witkoppen Wetland, it is one of the few urban wetlands remaining in such a heavily built-up area and it is already suffering degradation. The site is located within a rapidly developing node which formed around the intersection of several major transport routes. The wetland threatens the feasibility of further development by causing challenges including the management of excess stormwater, flooding and habitat protection. The developer of Cedar Lofts obtained a waiver of the physical wetland buffer requirement, provided they ensured the sustainability of the core wetland by mimicking the natural hydrology of the site. A collaborative problem solving approach involving members of the professional team, the site contractor and the landscaper, supported by a developer who allocated sufficient resources to the project, resulted in a design that improved considerably on the initial proposal, and ultimately managed to conserve a large portion of the original wetland without any major disturbance or excavation, with associated cost savings. The design sought to mimic the subsurface lateral flows of water to the wetland through careful design of drainage under and between buildings, as well as through landscaped berms and soakaways, which provide bioretention to remove pollutants. Surface flow is dispersed over the site using reno mattresses and other devices, so that water is fed into the wetland in a way that sustains the vegetation and does not concentrate flows. The development retained indigenous vegetation and trees, protected habitats and encouraged birdlife. The Cedar Lofts development demonstrated that it is possible to achieve the residential densities required for a 'compact city' while also conserving natural assets and the ecosystem services they provide.

Climate adaptation action areas to create resilient physical and ecological infrastructure include:

1. Municipal infrastructure;
2. Green spaces, biodiversity and buildings.



## Action: Infrastructure protection

This action aims to minimise the exposure of key infrastructure (such as roads, stormwater drains, public facilities, and the energy grid) to climate-related hazards by ensuring appropriate development and asset management planning, performing infrastructure retrofits, updating inspection procedures and increasing maintenance.

### Lead Authorities

- EISD
- Office of the COO

### Supporting Authorities

- Johannesburg City Parks and Zoos
- Johannesburg Water
- Development Planning
- Smart City Office

### Partners

- National Treasury
- National Department of Environment
- Forestry and Fisheries
- National Department of Cooperative Governance and Traditional Affairs
- Gauteng Department of Agriculture and Rural Development.

### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Job creation	City costs	Non-city costs
Site	5 Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Flash/surface flood				<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Sub-action	Action type
Perform a detailed analysis of the latest climate data and modelling of the climate system to determine impacts on municipal infrastructure.	
Ensure new public developments incorporate water-sensitive and passive-cooling urban design principles.	
Ensure asset management plans and risk registers consider revised climate data.	
Invest in municipal infrastructure to reduce the volume and slow down the flow of stormwater runoff from developed areas.	
Identify sites that can be used/redeveloped for infiltration of rainwater runoff..	
Identify critical city assets at risk of flooding and develop appropriate mitigation measures.	
Retrofit existing infrastructure to meet revised design criteria that incorporate climate change-related risk.	
Enhance the inspection and maintenance of all critical city infrastructure to minimise the impacts of climate risks.	
Relocate and separate stormwater and wastewater sewers.	
Develop a coordinated procedure for inspection, clearance and maintenance of stormwater channels.	
Integration of the stormwater management system with the overall development plan.	
Install rainwater harvesting systems.	
Construct regional flood attenuation facilities in high risk areas.	



### Action: Expansion of green spaces and habitat restoration

This action aims to conserve and protect the ecological infrastructure that provides ecological support, recreation and stormwater management by developing and implementing training and education programmes, planting trees and resilient plant species, investing in the conservation of natural habitats, rehabilitating urban wetlands and expansion of green public spaces.

#### Lead Authorities

- Johannesburg City Parks
- Zoos
- EISD

#### Supporting Authorities

- Johannesburg Road Agency
- Development Planning

#### Partners

- National Department of Environment
- Forestry and Fisheries
- National Department of Cooperative Governance and Traditional Affairs
- Gauteng Department of Agriculture and Rural Development

#### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Job creation	City costs	Non-city costs
Neighbourhood	<b>5-10</b> Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Drought and heat				<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Sub-action	Action type
Develop training materials for ecological infrastructure maintenance.	
Develop an environmental education programme for environmental literacy and conservation.	
Develop policies to protect vegetation and natural greenery.	
Develop networks of open spaces to enable migration of flora and fauna.	
Plant water-wise, non-invasive, wind-resistant species to serve as windbreaks.	
Identify existing and potential open spaces where vegetation cover can be increased.	
Set a target percentage of urban tree canopy increase and expand tree planting programme to meet this target.	
Invest in an ecological infrastructure protection and rehabilitation programme.	
Develop community gardens and other multi-functional green spaces.	
Rehabilitate urban wetlands, prioritising those with the highest flood abatement potential.	
Plant trees in mobility corridors to provide shading and fruit for commuters.	
Identify species of flora and fauna which may need to be relocated to areas more favourable to their survival under changing climatic conditions.	
Protect and restore riparian vegetation.	



# Theme 5

## Healthy Communities

### 2030

**By 2030, the City is compliant with the National Ambient Air Quality Standards (NAAQS) and aspires towards compliance with WHO guidelines.**

**By 2030, the negative impacts of higher temperatures and heat waves on food security, human and environmental health have been reduced.**

Climate change is predicted to cause periods of extreme heat, drought and flooding, which will negatively affect the health of Johannesburg's communities and impact all parts of the health system.

The City will need to provide residents with cooling during periods of excessive heat. This can be achieved by creating networks of cool shelters to protect community health and care for vulnerable groups. Moreover, rising temperatures can increase the risk of transmission of vector-borne and other diseases, for which supervision and control protocols will need to be established. In addition, food security will be a

### 2050

**By 2050, all communities enjoy clean air, are resilient to the health impacts of climate change and are food secure.**

critical issue for those that live below the food poverty line, as droughts can affect the availability and affordability of food. Adaptive practices and smart food production and distribution systems will be required to build resilience to this risk.

Adaptation action areas the City will address include:

1. Health and air quality;
2. Disease prevention;
3. Agriculture and food;
4. Disaster risk reduction and recovery.





# Case study:

## **Food Resilience Programme in the City of Johannesburg**

In 2013, the City of Johannesburg established its food resilience unit to enable food-insecure urban communities across the city to grow their own food. The initiative quickly became a success as the unit established some 37,000 homesteads, over 50 co-operatives, four farms and an urban agri-zone that provides an enabling environment for farmers to grow and sell their own food. The programme managed to build the self-reliance in many communities that had previously relied on food parcel donations. Additional benefits these communities enjoy include access to improved nutrition and related health benefits, increased individual self-reliance and economic opportunities for a new generation of urban farmers.<sup>xx</sup>

## **Food gardens in low income communities**

In Orange Farm, the southernmost part of the City of Johannesburg, community members have embarked on a small-scale farming project. The project aims to promote farming education, food security and economic development.

Founded and managed by Mr. Abba from his backyard, the farming project includes a nursery where seedlings and flowers are grown, a beehive, chickens, ducks and pigeons. It is not part of the City of Johannesburg's food resilience programme but was initiated by the community because of Orange Farm's distance from and lack of transport options to the City.

Mr. Abba's initiative has developed into a co-operative involving additional three members of the same community. It has fostered relationships with other food security initiatives, including with the University of Johannesburg's Izindaba Zokudla project, and has facilitated knowledge sharing of agricultural practices by conducting workshops for local youth, schools and NGOs.



### Action: Protection from heat-related health effects

This action aims to improve human health and increase resilience to high temperatures by implementing awareness-raising campaigns, conducting research to improve understanding of the impacts of heat, developing mechanisms to cool health facilities and developing green infrastructure.

#### Lead Authorities

- EISD
- Health

#### Supporting Authorities

- Johannesburg Metropolitan Police Department
- Johannesburg City Parks and Zoos
- Community Development and Development Planning

#### Partners

- National Department of Environment
- Forestry and Fisheries
- National Department of Health
- Gauteng Department of Health
- Gauteng Department of Agriculture and Rural Development.

#### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Job creation	City costs	Non-city costs
City	<b>5-10</b> Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Heat wave				<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Sub-action	Action type
Conduct an awareness-raising campaign to educate citizens on how to remain cool during a heat wave.	
Draw up a response plan linked to a data management system.	
Evaluate the feasibility of developing more green spaces to reduce heat.	
Conduct research to improve understanding of heat-related mortality and morbidity.	
Equip health facilities with renewable energy to meet energy demands for cooling.	
Design new development/settlements and redesign existing developments to allow for air circulation by facilitating the flow of prevailing winds.	
Integrate spray parks into the design of public spaces if water availability allows.	
Develop green infrastructure to build communities' resilience to temperature increases.	
Create networks of cool shelters to protect community health and care for vulnerable groups.	

Action type: Enabling Action type: Implementing



### Action: Optimal air quality under a changing climate

This action aims to improve liveability and community health by developing air quality standards, enhancing air quality monitoring and increasing enforcement of emissions regulations.

#### Lead Authorities

- EISD

#### Supporting Authorities

- Health Department

#### Partners

- National Department of Environment
- Forestry and Fisheries
- National Department of Health
- Gauteng Department of Health
- Gauteng Department of Agriculture and Rural Development
- private sector

#### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Direct

Scale	Timeframe	Job creation	City costs	Non-city costs
City	<b>5-10</b> Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Extreme hot days				<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Sub-action	Action type
Adopt WHO guidelines as the City's air quality target.	
Assess the effects of climate change and its impacts, such as increased incidence of fires, on air quality.	
Enhance the City's human resource capacity to enable better enforcement of the air pollution control by-law.	
Increase air quality monitoring capacity within the city.	
Identify key sources of PM <sub>10</sub> and SO <sub>2</sub> emissions.	
Enforce PM <sub>10</sub> and SO <sub>2</sub> emission regulations.	
Work with adjacent municipalities to address sources of emissions that contribute to both air pollution and climate change.	

Action type: Enabling Action type: Implementing

### Did you know?

**Approximately half of Johannesburg's  $\text{PM}_{2.5}$  air pollution originates outside the city boundaries.**

Working at the airshed level will therefore create new opportunities for coordinated climate change mitigation and air quality management. By facilitating joint data collection and peer learning, a multi-city approach to air quality management can also strengthen the capacity of adjacent cities to identify air pollution sources and improve current mitigation actions.

If all cities in the airshed act together, they can improve air quality for the entire region.



### Action: Increasing resilience against disease

This action aims to reduce the number of people affected by diseases resulting from floods, by implementing education and training programmes, improving stormwater management and carrying out a vaccination programme.

#### Lead Authorities

- Health and Public Safety

#### Supporting Authorities

- EISD
- Community Development
- Social Development

#### Partners

- National Department of Environment
- Forestry and Fisheries
- National Department of Health
- National Department of Cooperative Governance and Traditional Affairs
- Gauteng Department of Health
- Gauteng Department of Agriculture and Rural Development

#### Benefits



**Health**  
Direct



**Environmental**  
Indirect









**Economic prosperity**  
Direct












**Public service delivery**  
Direct



**Inclusivity and civil society**  
Direct

Scale	Timeframe	Job creation	City costs	Non-city costs
City	<b>5-10</b> Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Flash/surface flood				<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

Sub-action	Action type
Assess the risk of new water-borne diseases appearing in the city.	
Conduct education and training programmes on sanitation and safe water.	
Facilitate the development and launch of an E-health system.	
Provide more hospitals and clinics with a reliable supply of renewable energy to mitigate against load shedding further straining the health system.	
Improve stormwater management to minimise volumes of standing water following flooding events.	
Conduct a Risk Assessment to identify possible changes in transmission behaviours for new vectors.	
Launch a campaign to raise awareness of the most prevalent and/or dangerous diseases.	
Enhance the analysis of data resulting from the 'notifiable medical conditions' surveillance system.	
Carry out vaccination programmes.	



### Action: Sustainable agriculture programme

This action aims to support local food production and reduce vulnerable communities' exposure to food price fluctuations and food shortages by identifying suitable land for urban agriculture, promoting sustainable organic farming, implementing urban agriculture measures and diverting groundwater from low-lying land to urban farms.

#### Lead Authorities

- Social Development

#### Supporting Authorities

- Johannesburg City Parks and Zoos
- EISD
- Health
- Development Planning

#### Partners

- National Treasury
- National Department of Environment
- Forestry and Fisheries
- NGOs
- Gauteng Department of Agriculture and Rural Development
- Private sector
- Youth

#### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Direct

Scale	Timeframe	Job creation	City costs	Non-city costs
Site	<b>5-10</b> Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Drought				<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

Sub-action	Action type
Identify suitable land for urban agriculture.	
Conduct research on the impact of climate change on Johannesburg's food supply.	
Promote sustainable organic farming.	
Protect land suitable for agriculture by implementing spatial plans such as the Spatial Development Framework.	
Adapt crop development programmes based on climate change projections.	
Encourage food industries to develop contingency plans to reduce the impacts of heatwaves on food supply chains.	
Implement urban agriculture measures (e.g. zoning).	
Divert groundwater from low-lying areas to urban farms.	
Manage infestations of the polyphagous shot hole borer.	
Encourage the planting of rooftop gardens/urban agriculture through building standards such as the Green Star Rating.	
Launch initiatives that provide free edible plants to customers who spend a certain amount of money in stores (e.g. the Checkers initiative).	
Make the planting and maintenance of food gardens more attractive to the youth (e.g. develop food garden mobile apps to sell produce).	

Action type: Enabling Action type: Implementing





### Action: Early warning systems (floods, droughts, storms, heatwaves, disease)

This action aims to protect Johannesburg's residents and businesses from climate change-induced hazards such as floods, droughts, storms, heatwaves and disease by establishing early warning systems that can effectively and quickly distribute reliable, useful information to all Johannesburgers. The City will also develop preparedness and response plans to reduce damage, recovery time and cost for each of the identified hazards.

#### Lead Authorities

- Public Safety

#### Supporting Authorities

- Group Information Communication Technology
- EISD
- Smart City Office
- Citizen Relationship and Urban Management

#### Partners

- National Treasury
- National Department of Environment
- Forestry and Fisheries
- Gauteng Department of Agriculture and Rural Development
- NGOs
- Private sector
- Youth
- Academia

#### Benefits



**Health**  
Direct



**Environmental**  
Direct



**Economic prosperity**  
Direct



**Public service delivery**  
Direct



**Inclusivity and civil society**  
Indirect

Scale	Timeframe	Job creation	City costs	Non-city costs
City	<b>5-10</b> Years		 Capex Opex	 Capex Opex
Risk reduction				
Primary hazard	Reduction of exposure	Reduction of sensitivity	Enhancement of adaptive capacity	Risk of maladaptation
Flash/surface flood				<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

Sub-action	Action type
Develop and implement flood preparedness, mitigation and management plans.	
Develop a drought response protocol to enhance preparedness, including provisions for drought monitoring early warnings, drought severity assessments, mitigation interventions (including water use restrictions) and recovery interventions.	
Establish early warning systems and information dissemination mechanisms to alert people to potential heatwaves.	
Develop a drought early warning system.	
Design and implement an early warning system and response protocol for floods.	

Action type: Enabling Action type: Implementing



## Understanding synergies and trade-offs

Although mitigation and adaptation actions have been presented separately in this report, it is important to note that in practice, these two aspects of climate action are complementary and closely connected. Jointly addressing mitigation and adaptation can maximise the effectiveness of actions taken, allow full benefits to be derived from any synergies and ensure that any action taken in pursuit of one goal does not undermine progress towards the other.

On a global scale, successful early mitigation efforts may reduce future impacts of climate change and related adaptation costs. However, in some parts of the world climate change impacts are already being felt and will worsen even if ambitious mitigation action is taken. Therefore, adaptation as well as mitigation is necessary.<sup>xxi</sup> Potential interactions between actions in the CAP are identified in Figure 23 next page. These should be investigated in further detail during planning for implementation.



## Key mitigation – mitigation synergies/trade-offs

- Enhanced building energy efficiency reduces energy demand and can make renewable energy more affordable;
- A reliable renewable energy supply is required to enable a transition towards electric vehicles;
- Biogas from waste treatment could potentially be used to fuel vehicles (in the short term, pending the transition to electric vehicles).



## Key mitigation – adaptation synergies/trade-offs

- Reducing water losses and demand will reduce energy required for water treatment and supply;
- Improvements in waste management will reduce flooding;
- Urban densification can result in increased flood risk and should be implemented in a manner which conserves the city's natural capital;
- Any new energy, transport, waste and wastewater infrastructure should be located in areas not prone to flooding.



## Key adaptation – adaptation synergies/trade-offs

- Water security is essential to healthy communities: not only is water a basic human need, it is also needed to promote urban agriculture and prevent disease;
- Planting trees has many benefits including cooling the city but it also increases the demand for water

Figure 23: Synergies and trade-offs between CAP actions







# Implementing Climate Actions

# 5. Implementing Climate Actions

**Tomorrow belongs  
to the people who  
prepare for it today**

- African proverb

Implementation planning is the technical process of progressing from an idea to a funded project or programme. This process has begun for the CAP and will be advanced during the first quarter of 2021. This phase of the project will be coordinated by EISD and led by the relevant implementing departments and entities with support from external stakeholders including other spheres of government, the private sector, youth, NGOs and academia. It will involve the following activities:

- Cost-benefit analyses;
- Financing of climate actions;
- Implementation of actions
- Monitoring, evaluation, reporting and revision of the CAP;
- Continued stakeholder engagement (described in Chapter 6).

## 5.1. Cost-benefit analysis

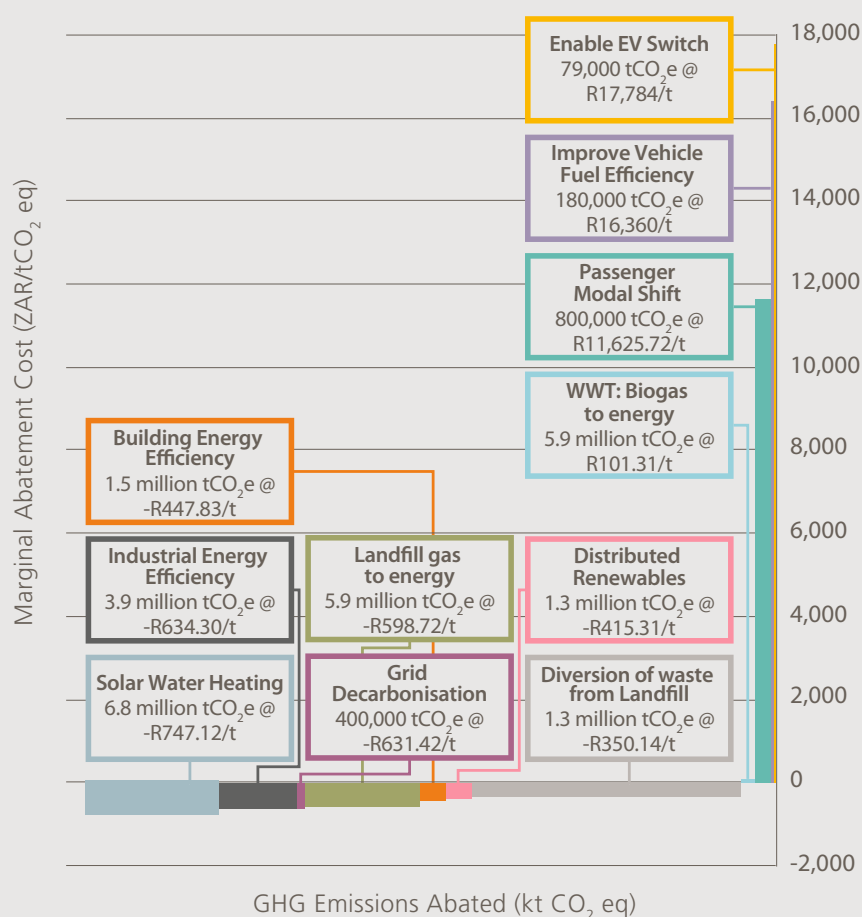
An indicative, high-level cost-benefit analysis has been conducted for key adaptation and mitigation actions to support the business case for CAP implementation. This cost-benefit analysis covers only those actions planned for implementation within the next Integrated Development Plan cycle (2021/22-2025/26) and projects costs and benefits until 2050. The findings are summarized below.

More detailed feasibility studies may need to be undertaken to inform the implementation of certain actions and to determine cost implications for different planning horizons.

### 5.1.1 Mitigation cost-benefit analysis

It is often easier to assess the costs and benefits of mitigation actions than to do the same for adaptation actions. Cost savings as a result of energy efficiency interventions, for example, are well documented and easily calculated. However, mitigation actions also provide a variety of other benefits that are more difficult to quantify, which may include benefits to inclusivity, health benefits, improved air quality, reduced congestion and of course, in the long term, the avoidance of the worst impacts of climate change. Cost-benefit analyses for mitigation actions usually employ marginal abatement cost curves, which reveal the relative cost of a measure per tonne of abated CO<sub>2</sub>e emissions. The marginal abatement cost curves for the City of Johannesburg's planned mitigation actions are shown in Figure 24. As the figure shows, in the short term, the most cost-effective mitigation actions are investing in solar water heating and in building and industrial efficiency measures, which reduce emissions and energy costs while improving the resilience of the City's energy system. Transport-related actions are currently the least cost-effective in terms of GHG emissions abatement, given the high capital and operational costs associated with the introduction of improved buses and public transport infrastructure. It should be noted, however, that this analysis does not consider the broader financial viability or benefits of these actions. The CAP forecasts a need for R10 billion in capital investment for prioritised mitigation actions until 2050, as well as an annual operations budget of approximately R25 billion for the same time period.





### 5.1.2 Air quality benefits

Implementing the CAP will improve the city's air quality and contribute to global climate change mitigation. All strategies included in the CAP are expected to improve air quality in the city. Figure 25 shows which climate change actions yield the greatest air quality benefits, under the ambitious scenario. Whilst grid decarbonisation does not yield significant air quality benefits within the City of Johannesburg, it will result in air quality benefits in areas where coal mines and power plants are located.

The CAP actions related to road transport have the greatest potential to improve local air quality as well as mitigate climate change. Switching to cleaner transport fuels and to low-emission modes of transport can contribute 50% of the total expected reduction in air pollution.

Figure 24: Indicative marginal abatement cost curve for Johannesburg mitigation actions 2020 - 2050

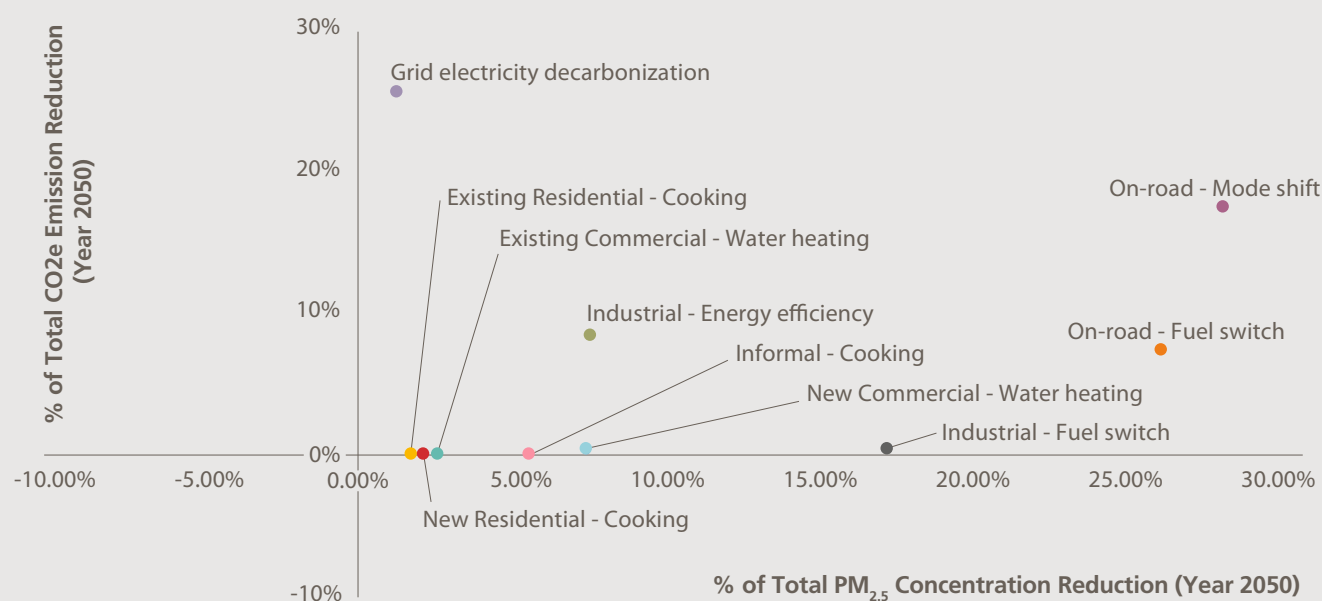


Figure 25: PM<sub>2.5</sub> and CO<sub>2</sub>e reductions for priority CAP actions (ambitious scenario)

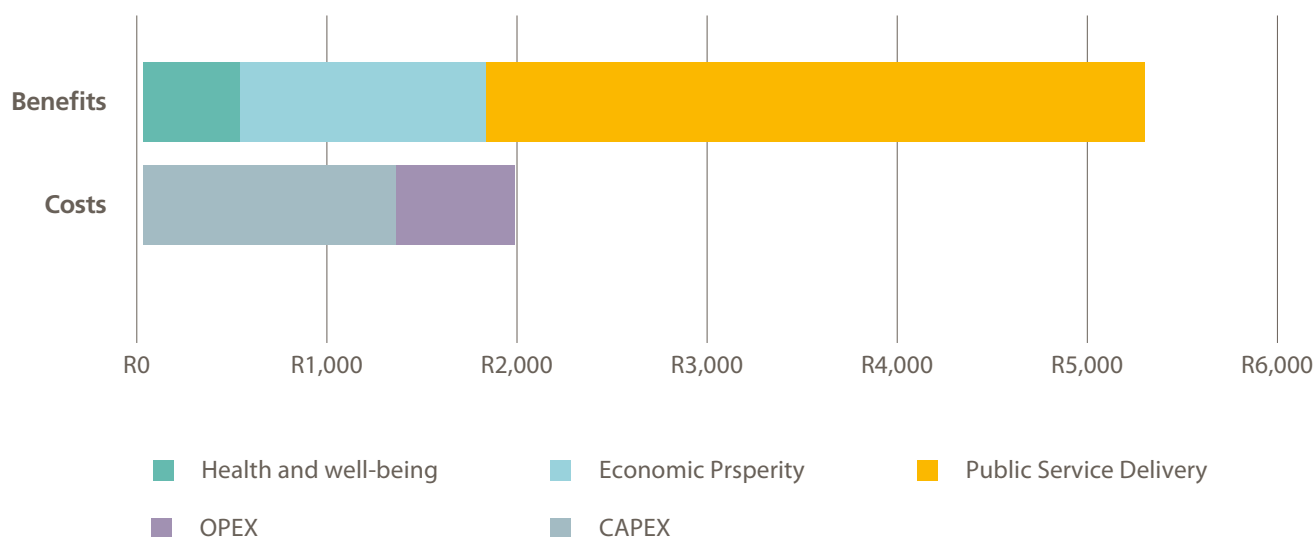


Figure 26: Indicative benefit-cost profile of Johannesburg's planned climate adaptation actions

### 5.1.3 Adaptation cost-benefit analysis

The benefits that can be unlocked through the implementation of the adaptation actions identified in the CAP far outweigh the costs of implementation, as depicted in Figure 26 above. Adaptation actions have been assessed based on the extent to which they mitigate the primary hazard and based on their human benefit index score. The Human Benefit Index is calculated by multiplying the number of people benefiting from a particular intervention with a numerical value indicating the extent of the benefit that is imparted. Investments that address the impacts of heat (which affects a large number of people), as well as those that mitigate the effects of flash flooding (which affects a smaller number of people, but is highly destructive), generate the greatest human benefit impact. Investment in adaptation should not necessitate a complete diversion of funds from already planned projects. Rather, the shift must apply an adaptation lens to regular service delivery and infrastructure development.

Financing adaptation actions involves sourcing the funding and investment required to protect people and assets, build resilience, and reduce exposure. The CAP forecasts a need for R1.3 billion in capital investment for prioritised adaptation actions until 2050, as well as an annual operations budget amounting to approximately R650 million for the same time period.<sup>4</sup> Some 60% of the required financing can be sourced from the City's existing budget, and can be committed by applying a climate lens to critical service provision and resilience building.

## 5.2 Financing of climate actions

A lack of financing is often quoted as a key barrier to implementation of climate actions. However, significant sources of climate finance are available both locally and internationally and many innovative approaches to accessing finance can be explored. To finance the CAP, the City of Johannesburg will draw upon a combination of sources listed below:

### Internal finance

This includes finance raised through taxes, user fees, transfers and bonds within the municipality and through other spheres of government. A key approach related to this source of finance is budgetary mainstreaming (see Section 2.4.8, page 30 and below for further details).

### External finance

This includes international and local sources such as bilateral and multilateral donors, concessional finance and funds as well as co-financing through public-private partnerships, market-based approaches and private sector investment.

Lastly, while not a financing option for the implementation of climate action, insuring city assets can serve as a critical financial buffer by helping provide the City with the necessary resources to recover from climate-related disasters.

<sup>4</sup> See CBA Technical Report for Adaptation.

### 5.2.1 Internal finance and budgetary mainstreaming

The City's budget is allocated to four clusters, namely: Sustainable Services, Human and Social Development, Economic Growth and Good Governance. Sustainable Services is the priority cluster for climate change action and receives the largest overall capital and operational budget allocation. For instance, the City currently has a total annual budget of R68.1 billion, and of this amount, R7.5 billion<sup>xxiii</sup> has been earmarked for capital expenditure in the Sustainable Services cluster. City Power and Joburg Water are part of the Sustainable Services Cluster and receive the majority of this capital expenditure allocation, just over R5 billion. Where possible, the City will seek to fund CAP actions using its existing budget, primarily through budgetary mainstreaming. Budgetary mainstreaming refers to the process of aligning the City's budget prioritization process with the goals and targets of the CAP. It is of critical importance, as it will ensure that CAP actions are funded and that investments which may lead to carbon lock-in and maladaptation are avoided. EISD has initiated this process by conducting a climate risk and vulnerability assessment to deter investments in high risk areas and by developing criteria which can be embedded within the City's budget prioritisation tool.

The Integrated Development Plan (IDP), a five-year plan required in terms of the Municipal Systems Act, Act 32 of 2000, has been touted as the critical tool through which to address climate change at the municipal scale. However, experience suggests that merely mentioning climate change in the IDP at a high level does not guarantee mainstreaming nor implementation of climate actions. In addition, given that it is uncommon for cities to ring-fence specific climate change funds, it is important to mainstream climate change adaptation and mitigation into project development. The City is in the process of integrating climate risk assessment tools like the vulnerability assessment into its budget planning and prioritization toolkit. Vulnerability assessments will form a key requirement during the process of capital project development. In this way, in addition to including wording about climate change in the IDP, climate change concerns are brought in at the project inception stage. Furthermore, using the Johannesburg Strategic Infrastructure Platform, the City can track funding assigned to climate change actions per project and as a share of all capital projects.

The following actions will be implemented by EISD to expedite budget mainstreaming:

- Ensure that climate change risks and responses are embedded within the City's spatial planning and budget prioritization systems to avoid maladaptive investment;
- Ensure that weighted criteria related to climate change mitigation and adaptation are included in the City's budget prioritisation tool;
- Request written commitment from implementing sectors and entities to commence the implementation of priority CAP actions within the financial year following the adoption of the CAP;
- Request quarterly reports from Executive Management Team members to the Group Chief Financial Officer and the City Manager on the amount of funding allocated to the implementation of the CAP;
- Work with the Department of Economic Development to develop a Green Procurement Policy to stimulate climate change project implementation.

### 5.2.3 External financing

When external funding is required, it is critical that actions are designed and structured to meet the requirements of donors and financiers. Annex 1 presents a summary of national and international funders that may finance the implementation of the CAP. In order to access these funds, the City will:

- Build capacity across teams and departments for the development of bankable project proposals;
- Create a live database of funding options and regularly share updates with City departments and entities;
- Hire a dedicated funds manager to support City teams in the development of project proposals and the identification of suitable funding opportunities.

## 5.3 Monitoring, evaluation, reporting and revision of the CAP

Monitoring the effectiveness of implementation is critical to ensure accountability and guarantee that expected results are achieved. In addition, demonstrating robust procedures for monitoring, evaluation and reporting will help to attract finance.

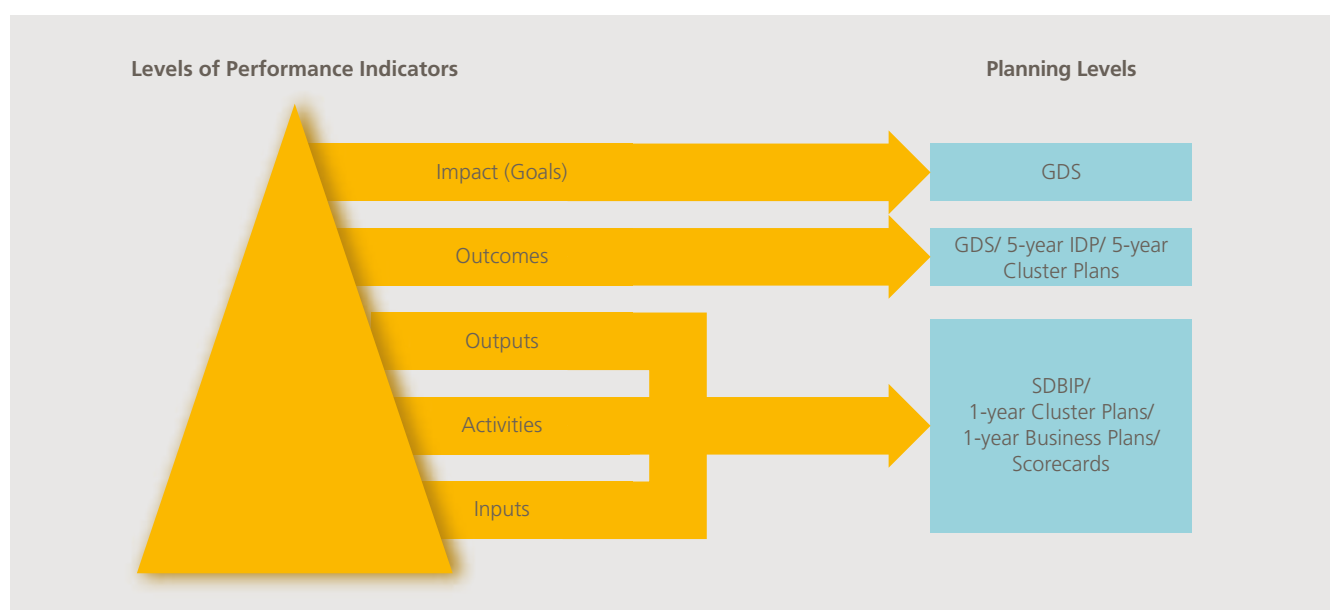
As stated in Chapter 2, the climate change function within the EISD is responsible for monitoring, evaluation and reporting on climate adaptation and mitigation both internally and internationally. The EISD will therefore play a key role in coordinating with implementers to:

- Identify quarterly targets and key performance indicators (KPIs);
- Ensure that CAP targets and KPIs are reflected in the business plans of departments and entities and on staff scorecards;
- Regularly monitor and report at least annually on implementation progress.

Group Strategy, Policy Coordination and Relations will also play a key role in supporting the mainstreaming of CAP indicators and targets into the City's overarching Monitoring and Evaluation Framework.

### 5.3.1 The City of Johannesburg's Monitoring and Evaluation Framework

Monitoring and evaluation (M&E) processes form a critical part of the City of Johannesburg's performance management system. This system is designed to facilitate increased accountability and learning and improvement, and also serves as an early warning system that notifies leaders and managers of potential risks that may threaten achievement of the Integrated Development Plan.<sup>xxiii</sup> Meanwhile, the Republic of South Africa has adopted the outcomes approach to M&E, defining twelve Key Outcomes as measures of success. These Outcomes have been passed down from national government to provincial and local governments through Intergovernmental Protocols. At the local government level, the primary relevant Outcome is number 9: "A responsive, accountable, effective and efficient local government system."<sup>xxiv</sup> Local governments have committed themselves to achieving this outcome through a delivery agreement with the national government. Using the same approach as the national government, the City of Johannesburg has defined its own Key Outcomes in its 2040 Growth and Development Strategy (GDS). Climate action is addressed under Outcome 2, which calls for the provision of "a resilient, liveable and sustainable urban environment – underpinned by infrastructure supportive of a low-carbon economy."<sup>xxv</sup> This Key Outcome has been integrated into the IDP, the Service Delivery and Budget Implementation Plan (SDBIP), and into business plans and individual staff scorecards. The alignment between the national outcomes approach and the city planning processes as per the City's 2012 M&E Framework is shown in Figure 27 below:



**Figure 27: The national outcomes approach to measuring success (left) and its alignment with the City of Johannesburg's planning levels (right).**

<sup>4</sup> See CBA Technical Report for Adaptation.

As shown in Figure 28 below, the processes mandated through the City's broader M&E framework follow an annual and five-year planning schedule. These timeframes are aligned with the timeframes for CAP review (every five years). The figure presents the various forms of planning, monitoring,

evaluation and reporting undertaken by the City, alongside their associated timeframes. CAP targets and indicators will be mainstreamed into the next IDP (2021/22) and SDBIP, as well as into business plans and individual scorecards.

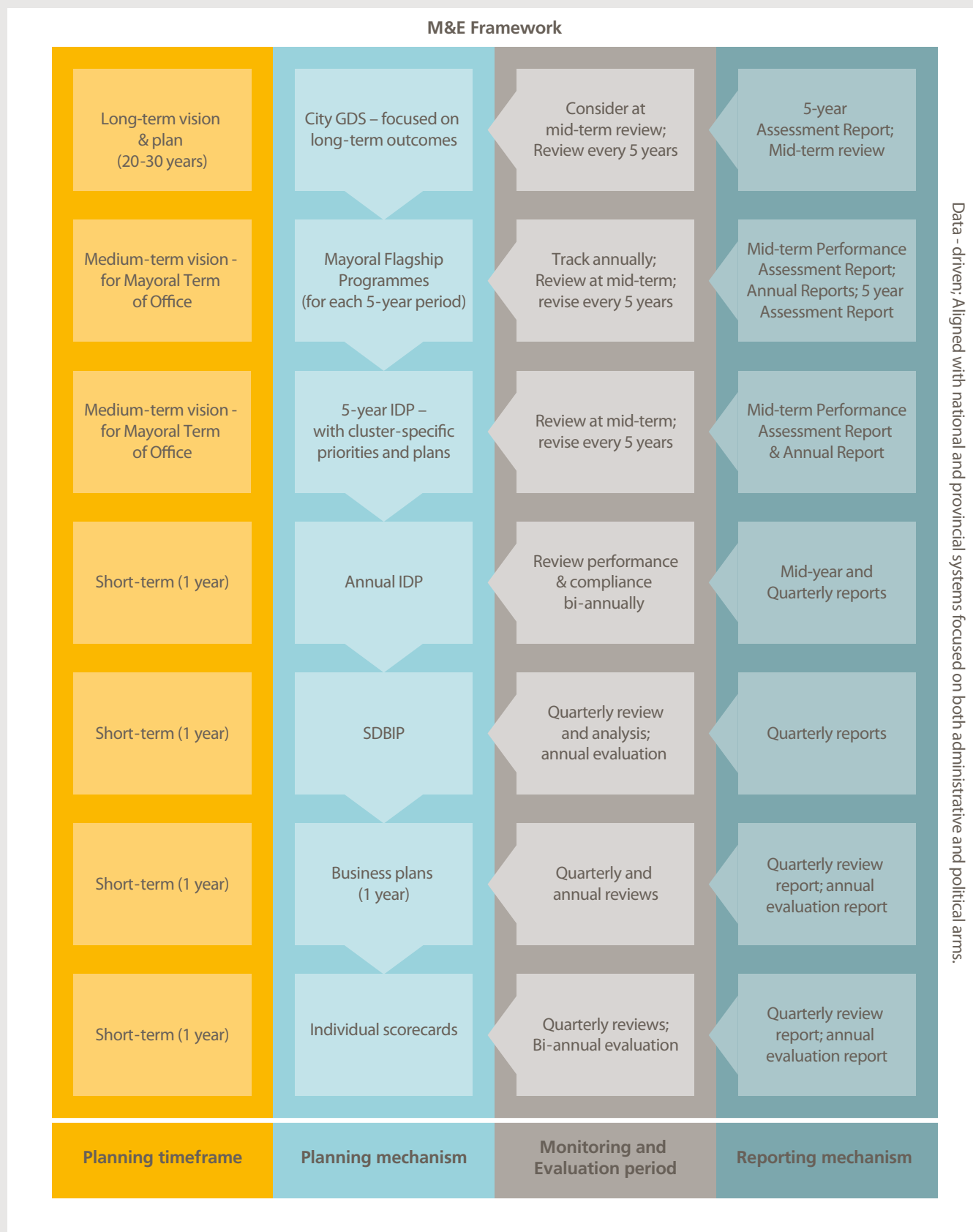



Figure 28: An overview of planning, monitoring, evaluating and reporting structures in the City (Based on the City of Johannesburg's M&E Framework).<sup>xxvi</sup>

### 5.3.2 The CAP's monitoring and evaluation framework



A high-level CAP Monitoring and Evaluation Framework is presented below, including anticipated outcomes and proposed KPIs for each action. This framework will be further developed


through engagement with the lead implementers in the first year following the CAP's adoption. The indicators proposed are therefore indicative and require further details in order to be quantifiable and more robust. The template to be detailed by lead implementers has also been included, see page 142.


### Goal 1: A Net-Zero Emissions City – actions & indicators

Theme	Action Area	Actions	Anticipated Outcome	Proposed KPI*	Implementation		
					2025	2035	2050
 <b>Providing Affordable and Clean Energy</b>	<b>Electricity generation</b>	Promote small- and large-scale embedded and distributed generation	By 2030, 35% of electricity consumed to be from renewable energy sources. By 2050 all residents to have access to safe, affordable and net-zero emissions energy.	MW renewable energy capacity installed within city boundaries.			
	<b>Grid decarbonisation and optimisation</b>	Increase the share of renewable energy	By 2050 all residents to have access to safe, affordable and net-zero emissions energy.	Percentage of renewable energy in the city's energy mix			
	<b>Eradicate energy poverty</b>	Ensure supply of clean, reliable and affordable energy	By 2030, 35% of electricity consumed to be from renewable energy sources . By 2030, entire viable roof space in the city centre to be covered with grid-tied PV (about 50% of city centre roof space). By 2050 all residents to have access to safe, affordable and net-zero emissions energy.	Percentage of households with access to efficient electrical or solar lighting			
	<b>Energy efficiency and coal phase-out</b>	Improve industrial energy efficiency and reduce the share of coal-fuelled industrial production	By 2050 all residents to have access to safe, affordable and net-zero emissions energy.	KWh/year fossil fuels consumed			





Theme	Action Area	Actions	Anticipated Outcome	Proposed KPI*	Implementation		
					2025	2035	2050
 <b>Maximising Energy Efficiency</b>	<b>Energy efficiency of existing buildings</b>	Improve the energy efficiency of existing buildings with the goal of achieving net-zero emissions by 2050.	By 2050, all buildings operate at net-zero emissions.	Electricity demand across different sectors.			
	<b>Energy efficiency of new buildings</b>	Improve the energy efficiency of new private and public buildings with the goal of achieving net-zero emissions by 2030.	By 2030, new buildings operate at net-zero emissions. The City commits to developing, owning and occupying only assets with net-zero emissions operations.	KWh/year improvement in energy efficiency and/or energy use intensity (EUI)- avg Kwh/m2 per building type; installed small-scale embedded generation or trusted renewable energy certificates registered.			
	<b>Net-zero emissions municipal buildings and operations</b>	Ensure that all municipal operations and buildings developed, owned and occupied by the City operate at net-zero emissions by 2030	By 2030, new buildings operate at net-zero emissions. The City commits to developing, owning and occupying only assets with net-zero emissions operations.  By 2050, all buildings operate at net-zero emissions.	KWh/year energy consumed - improvement in energy efficiency.			
 <b>Green Transport</b>	<b>Public transport</b>	Enable a shift towards public transport	By 2030, 70% of commuters use public transport, walk or cycle. By 2050, 90% of commuters use public transport, walk or cycle, and all residents to have access to safe, affordable, net-zero emissions transport.	Rail network expansion in kms; reduction in petrol and diesel consumption.			
	<b>Non-motorised transport</b>	Promote non-motorised transport	By 2050, 90% of commuters use public transport, walk or cycle, and all residents to have access to safe, affordable, net-zero emissions transport.	Kms of walking and cycling lanes constructed.			
	<b>Fuel-switch</b>	Enable a fuel switch to alternate fuels and electric vehicles	By 2050, 90% of commuters use public transport, walk or cycle, and all residents to have access to safe, affordable, net-zero emissions transport.	Total petrol and diesel fuel consumption; number of electric vehicles (EV 'parc')			
	<b>Fuel efficiency</b>	Improve vehicle fuel efficiency	By 2050, 90% of commuters use public transport, walk or cycle, and all residents to have access to safe, affordable, net-zero emissions transport.	Average vehicle fuel efficiency.			
	<b>Transit-oriented development</b>	Ensure transit-oriented development	By 2050, 90% of commuters use public transport, walk or cycle, and all residents to have access to safe, affordable, net-zero emissions transport.	Inhabitants/km2 (citywide) and percentage of development plans approved within transit-oriented development nodes.			

Theme	Action Area	Actions	Anticipated Outcome	Proposed KPI*	Implementation		
					2025	2035	2050
 <b>Alternative Waste Management</b>	<b>Diversion of solid waste from landfill</b>	Waste reduction.	By 2030, municipal solid waste generation per capita has been reduced by at least 15%, municipal solid waste destined for landfill or incineration has been reduced by at least by 50%, and at least 70% of waste is diverted away from landfill and incineration, compared to 2016. By 2050, 100% of solid waste is diverted from landfills and remaining methane emissions from waste are captured.	Volume of waste (total and per capita)			
	<b>Diversion of recyclables from landfill and incineration</b>	Divert recyclables from landfill and incineration	By 2030, municipal solid waste generation per capita has been reduced by at least 15%, municipal solid waste destined for landfill or incineration has been reduced by at least by 50%, and at least 70% of waste is diverted away from landfill and incineration, compared to 2016. By 2050, 100% of solid waste is diverted from landfills and remaining methane emissions from waste are captured.	Waste diversion volume or percentage (paper, plastic) recycled			
	<b>Optimise organic waste management</b>	Optimise organic waste management	By 2030, municipal solid waste generation per capita has been reduced by at least 15%, municipal solid waste destined for landfill or incineration has been reduced by at least by 50%, and at least 70% of waste is diverted away from landfill and incineration, compared to 2016. By 2050, 100% of solid waste is diverted from landfills and remaining methane emissions from waste are captured.	Percentage organics or 'green waste' diverted; percentage waste diversion to composting			
	<b>Optimise waste collection and treatment</b>	Optimise waste collection and treatment	By 2030, municipal solid waste generation per capita has been reduced by at least 15%, municipal solid waste destined for landfill or incineration has been reduced by at least by 50%, and at least 70% of waste is diverted away from landfill and incineration, compared to 2016. By 2050, 100% of solid waste is diverted from landfills and remaining methane emissions from waste are captured.	Landfill gas capture rate			

Theme	Action Area	Actions	Anticipated Outcome	Proposed KPI*	Implementation		
					2025	2035	2050
 <b>Improving Water Supply and Wastewater Treatment</b>	<b>Wastewater treatment</b>	Enhance the sustainability of wastewater treatment	By 2030, a comprehensive review has been undertaken of the energy use by, potential energy savings and energy generation opportunities in the water and wastewater systems system, and a Net-Zero-Energy programme has been developed. By 2050, net-zero emissions has been achieved in all water and wastewater systems, including water treatment, conveyance, supply, and wastewater treatment and disposal.	Percentage of facilities using efficient technology (OR KWh/facility)			
	<b>Water conveyance</b>	Improve water conveyance efficiency	By 2030, a comprehensive review has been undertaken of the energy use by, potential energy savings and energy generation opportunities in the water and wastewater systems system, and a Net-Zero-Energy programme has been developed. By 2050, net-zero emissions has been achieved in all water and wastewater systems, including water treatment, conveyance, supply, and wastewater treatment and disposal.	Operational efficiency (OR KWh/facility)			

## Goal 2: A Climate-Resilient City – actions & indicators

Theme	Action Area	Actions	Anticipated Outcome	Proposed Indicator*	Implementation		
					2025	2035	2050
 <b>Water Security</b>	<b>Water Demand</b>	Water Conservation and Demand Management	Minimise water losses and improve social equity, water access, and water use efficiency.	Non-revenue water consistently below XX%			
	<b>Water supply</b>	Recycled water systems	Upscale the augmented water supply through recycling for potable and non-potable use	% of recycled water available to the city			
	<b>Water innovation</b>	Decentralised water supply systems	Increased proportion of water used from alternative sources by 25%, which increases resilience of the water supply system.	% of daily water supply from alternative sources			
	<b>Water innovation</b>	Water-sensitive urban design	Integration of the urban water cycle into urban design to minimise environmental degradation and improve aesthetic and recreational appeal.	All public open spaces that could play a strategic role in flood attenuation and cooling services identified and managed			
	<b>Water quality</b>	Water pollution monitoring and management programme	Minimisation of major sources of pollution that impact water resources	Water auditing system score above a certain %			
 <b>Resilient Human Settlements</b>	<b>Resilient human settlements</b>	Sustainable livelihoods programme	Positively impacting people experiencing poverty and people who are disadvantaged to develop their abilities and assets to help improve their lives	% of people below the poverty line			
		Settlement upgrading programme	Identification of critically vulnerable communities and their relocation	% of vulnerable households protected or relocated			
		Urban growth management strategies	Increased innovative local adaptation to urban vulnerability with an understanding of scales for action and restricted development in high-risk areas.	% of new developments and non-essential infrastructure located in areas projected to be high-risk			
	<b>Transport and Spatial Planning</b>	Spatial planning and land use	Promoting the sustainable and efficient use of land to limit climate change impacts	% transportation infrastructure which have been climate-proofed. % land area considered to be of low risk to climate hazards			




Theme	Action Area	Actions	Anticipated Outcome	Proposed Indicator*	Implementation		
					2025	2035	2050
 <b>Flood and Drought Management</b>	<b>Flood response and resilience</b>	Flood response and improved resilience programme	Protection of communities and infrastructure from inland and urban flooding with reduced risk, cost and speed of recovery.	Flood lines incorporated into the Spatial Development Framework as well as other spatial and strategic planning processes % of population who are flood resilient			
	<b>Drought response and resilience</b>	Drought response and improved resilience programme	Protection of life, land and infrastructure from droughts with reduced risk and cost of recovery.	Number of litres of water sourced from alternative water sources % reduction in water demand per capita % of population who are drought resilient			
 <b>Resilient infrastructure</b>	<b>Municipal infrastructure</b>	Infrastructure protection	Positively impacting people experiencing poverty and people who are disadvantaged to develop their abilities and assets to help improve their lives	% of people below the poverty line % of vulnerable households protected or relocated % of new			
	<b>Green spaces and biodiversity</b>	Expansion of green spaces and habitat restoration	Conservation and protection of ecological infrastructure for ecological support, recreation and stormwater management.	m2 of green spaces developed/restored			
 <b>Healthy communities</b>	<b>Health and air quality</b>	Protection from heat-related health effects	Improved human health and resilience to high temperatures and the impact of heat waves.	% reduction in loss of life from climate hazards			
		Optimal air quality under a changing climate	Improved liveability and health	Air quality index			
	<b>Disease prevention</b>	Increasing resilience against disease	Reduced number of people affected by disease resulting from floods.	% reduction in loss of life from diseases.			
	<b>Agriculture and food</b>	Sustainable agriculture programme	Support of local food production and reduced exposure to food price increases and food shortages.	m2 of urban farms created % of food secure population			
	<b>Disaster risk reduction and recovery</b>	Early warning systems (floods, droughts, storms, heatwaves, disease)	Protection of life, land and infrastructure from droughts with reduced risk and cost of recovery.	% reduction in loss of life from climate hazards % reduction in financial costs relating to loss and damage caused by climate impacts			

Table 7 below provides a template that the City can use for monitoring and evaluating CAP progress. The EISD is in the process of establishing a climate change data management system to support monitoring and evaluation processes for the CAP.

The objectives of the data management system are as follows:

- Provide centralised collection of and access to climate change adaptation and risk mitigation inventory data;
- Ensure information security;
- Standardize information and improve operational efficiency;
- Guarantee business continuity;
- Monitor and evaluate the implementation of climate actions.

Action & target			Monitoring indicators	Evaluation of impact	Tracking annual progress on prioritized actions
Action	Target	Baseline	Electricity generation	Promote small- and large-scale embedded and distributed generation	MW renewable energy capacity installed within city boundaries.

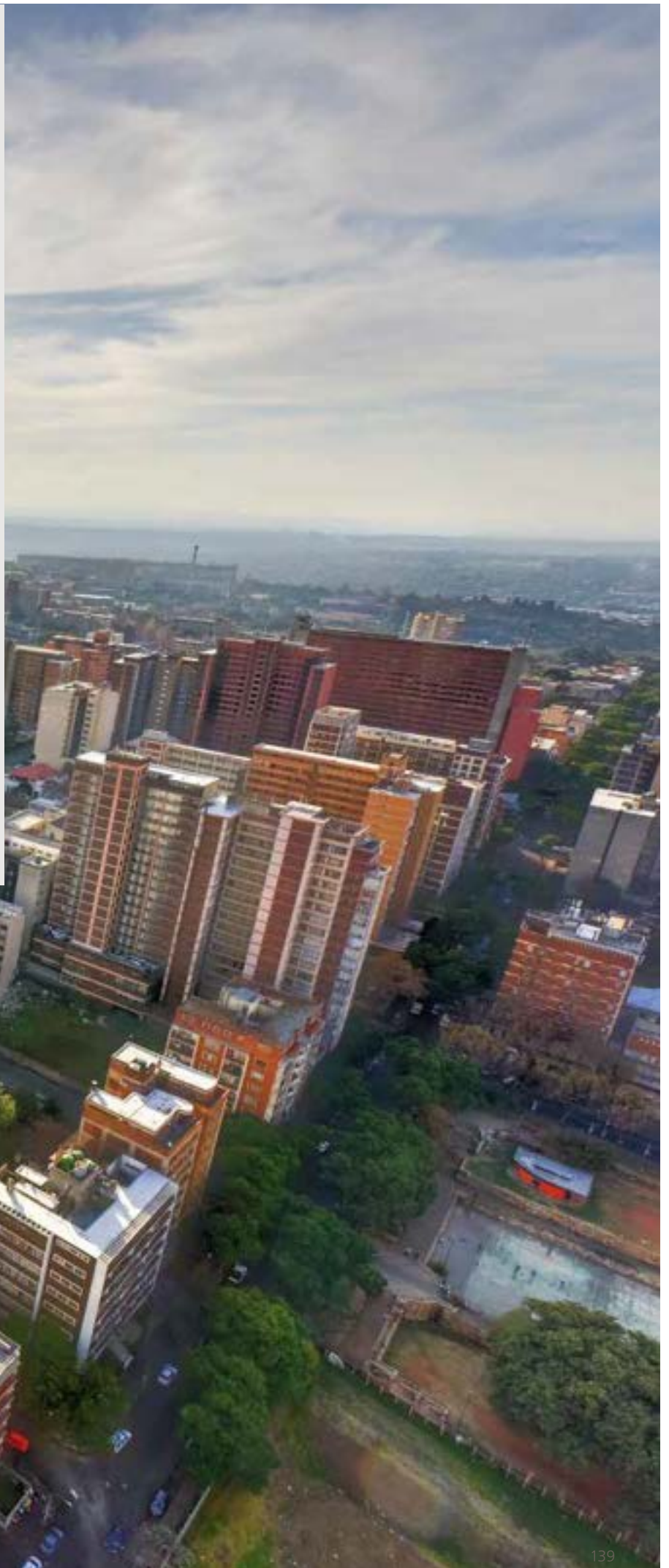
Table 7: Proposed detailed CAP Monitoring and Evaluation Framework





### 5.3.3 Revision of the CAP

The Air Quality and Climate Change Directorate within EISD is responsible for revising the CAP every five years as per the City's budget planning cycle. Revisions will be guided by the principles highlighted in Section 1.5 and informed by extensive stakeholder engagement. Targets may be adjusted to increase ambition over time as more favourable conditions emerge.









# Mobilising Stakeholders

# 6. Mobilising Stakeholders

## 6.1 Mobilising Stakeholders

A city-wide cross-sectoral approach will be required to facilitate engagement with citizens, local businesses and other key stakeholders both to raise awareness of climate change and to mobilise support for climate change mainstreaming and CAP implementation.

Stakeholder buy-in is critical for incorporating climate change concerns and actions into City structures. The City must develop a programme to encourage businesses and citizens to participate in tackling climate change and inspire them to change any climate-unfriendly behaviours. Furthermore, new, innovative, local solutions can only be developed if the City of Johannesburg partners closely with experts from the business community, the research sphere and those that live in, travel through and use the City of Johannesburg on a daily basis.

A central coordination and support unit is crucial for effective planning, implementation and verification of climate change action. However, the responsibility for evaluating the CAP's impacts should not be the EISD's alone. To make CAP successful, it is key to ensure that it is owned and supported by the City, external stakeholders and local communities alike and embedded into strategic plans and service delivery.

To inform the CAP, the EISD has undertaken an extensive engagement process with stakeholders in the City's departments and entities as well as in national and provincial government. However, many stakeholders beyond the three spheres of government will need to be involved in the implementation and will enjoy the benefits of the CAP. Therefore, engagement with and input and buy-in from external stakeholders is crucial. Many of the stakeholder groups identified in Table 8 have been involved in the development of the CAP to varying extents. Unfortunately, many engagements had to be cancelled due to COVID-19, however a concerted effort will be made to ensure that all stakeholders are adequately consulted in the CAP implementation phase and in future revisions.

The following section includes a special input from one of the city's most important and interested stakeholder groups, the youth. This section serves as the Youth Climate Action Plan (YCAP) and is to be read in conjunction with the CAP itself.

## 6.2 Contribution from the Young People of the City of Johannesburg:

Representatives of the young people of the City of Johannesburg have worked with City representatives to produce input for the CAP process and document. Below, we discuss key areas of concern and aims that we, the youth, will seek to assist the City in realising in support of effective climate action and social justice.

### Intersectionality

As the youth, we envision an inclusive society that prioritizes the collective success of communities and that adopts an integrated and sustainable approach to tackling prevailing socio-economic inequalities. We therefore call for the following actions and initiatives:

- ***Inclusivity and representation of the marginalized***
  - Foster research into the unique vulnerabilities and the differential impacts of climate change on the youth, the elderly, different races, sexes, genders and people with disabilities, and utilize this research in policy formulation in order to enhance the adaptive capacity of vulnerable groups;
  - Uplift and support marginalised people and indigenous peoples in the climate action and climate justice space.
- ***Community focus***
  - In the implementation of this CAP, ensure that strategies are informed by and are tailored for the challenges and contexts of individual communities;
  - Recognizing that a one-size-fits-all approach will not work, tailor the mechanisms for policy and strategy development and implementation to individual communities.

- **Climate change education** (see CAP G2 4.2 – Sub-action 2 on developing an education programme for environmental literacy and conservation). We, the youth, believe this can be achieved through both informal and formal education.
  - A pragmatic and comprehensive climate education and awareness-raising curriculum needs to be developed and disseminated through formal and informal education. The City could collaborate with youth and provide resources and funding for classroom and after-school programmes that enable young people to engage with climate change, but also spread awareness to other young people and community members so that they can take climate action. The youth can help to inform the content of these sessions;
  - Establish dedicated systems to disseminate information on climate change and sustainable development through every clinic, school, counsellor's office, City building, library, and community radio/newspaper, using eco-friendly but accessible media such as digital information packs. In addition, invite the private sector to train staff appropriately and make available the aforementioned resources.

Stakeholder sectors	
	<b>Academic and scientific institutions</b> Providers of information on scientific and technological developments, vulnerability and potential responses.
	<b>Community-based organisations and small businesses</b> Helpful intermediaries that may already be implementing responses to climate change.
	<b>NGOs</b> Can support advocacy and stakeholder dialogues and can offer strategic advice and technical assistance.
	<b>Financial institutions</b> Can finance specific projects and provide support during and after emergencies.
	<b>Industry/Business</b> Key source of employment, goods and services for the city's population and can contribute to the City's financial capacity to implement mitigation and adaptation actions.
	<b>Youth and labour</b> Can help to build broad popular support for the implementation of climate mitigation and adaptation actions.
	<b>Citizens</b> An informed and active citizenry is key to inclusive, effective climate action. Citizens will be engaged via regional consultations and the City's IDP process.

**Table 8: Key stakeholders to be consulted throughout the climate action planning and implementation process.**

- **Green skills**
  - Equip young people to create an ecosystem of young individuals with different skills, knowledge, experience and hobbies to work together to support climate action. Environmentalists cannot do this on their own – we need people with all types of skills, be they engineering or marketing, organising or co-ordinating, reading or writing, fact-finding, waste-picking or creating, photography or psychology.

### Systemic change

In our pursuit of holistically-oriented societies, we note that there is a dire need to change current consumption patterns, which lead to excessive waste and unsustainable levels of plastic use. We lobby for climate-action oriented approaches that acknowledge our position in the global community as a distinctly African City. Furthermore, we support Pan-African solutions to the issues we face today.

- **Decentralization** (see CAP G1 1.1 – Sub-action 3). We, the youth, want to underscore the need for greater community engagement with and incentives to support this aim, informed by a striving for social justice.
  - Empower communities through the decentralization of energy production - allow communities to produce their own renewable energy and increase access to clean and sustainable energy.
- **Decolonization**
  - In recognition of the contribution of colonialism to present day socio-economic inequalities, we advocate for support for platforms that amplify the voices of marginalised people and climate-vulnerable communities in the climate change discourse;
  - Facilitate the destigmatisation of public transport by improving safety and visible security.
- **Waste management**
  - Recognize the City's existing partnerships with and the contributions made by informal industries such as waste pickers and informal traders, and strengthen these by decentralizing and scaling up projects such as the 'recycle at source' project (see CAP G1 4.2 Sub-action 7 - these efforts need to be scaled up);
- **Good governance** (CAP Chapter 2). We, the youth, emphasize the need for not just architectures for governance but a strong focus on good governance.
  - Acknowledge the importance of good governance for preventing disenfranchisement and discontent among communities that can give rise to populist ideologies and climate change denial coupled with lack of action;
  - Good governance will increase cooperation from the public in public participation processes and foster trust in municipal leadership. This will further ensure the sustainability and continuity of these engagements;
  - Ensure proper management of and accountability for municipal funds to ensure that basic services are delivered to all communities.
- Strive for a systematic transition that actively incorporates gender and youth perspectives into policy planning and implementation.

### Just transition

We recognize that a just paradigm shift from a carbon-intensive economy to one that is both carbon-neutral and independent will require the revisiting and upholding of principles of climate justice. This will ensure that the people in our societies who are most vulnerable and have the lowest adaptive capacities do not end up paying the highest price for the transition to a more sustainable society.

- Encourage business to reduce carbon emissions through an 'award' system that promotes and recognizes their emission-reducing practices;
- Provide technical and financial support for youth and green businesses within the following areas: water conservation, sustainable forestry, biofuels, geothermal energy, environmental remediation, sustainability, energy audits and recycling; to ensure a just transition that is responsive to the needs of all people in the city.

### Leadership and advocacy

As the youth of the City of Johannesburg and custodians of the Youth Climate Action Plan (YCAP), we acknowledge the importance of good governance and effective youth leadership and advocacy to accelerate climate action. We stress that unlocking the collective potential of all individuals in the city cannot be achieved without support for existing youth-led climate organisations and call for greater investment in capacity building programmes to mentor young individuals. Furthermore, we recognize cooperation and collaboration between youth-led climate organisations and city officials as a key necessity for youth voices to be heard in policymaking and implementation.

- The City of Johannesburg should elect youth climate ambassadors that will actively participate in City council meetings and provide input on community-related climate issues, and will also be responsible for networking and cooperating with other youth advocacy structures such as the Johannesburg Junior Council;
- Foster public-private partnerships that will develop the capacity of youth through apprenticeships and internships.

### Innovation

In order to put the principles of this YCAP into practice, we require technological and systems innovations that address social and environmental needs.

- Emphasize the need for establishment of a roadmap that will enhance the ease of implementation of manufacturing practices that extend the lifespan of products and further the transition to a circular economy.



## Accessibility and sustainability

We remain undeterred in our striving to ensure that all residents of the City of Johannesburg benefit from its resources. We note that the prevalent socio-economic challenges faced by individuals in underprivileged areas often prevent their effective participation in the climate change discourse. We call for intensified approaches to the dispensation of resources to raise awareness around climate issues and to foster an environment that promises enrichment of individual talents regardless of race, class, creed, gender, age etc.

- Reiterate the need to channel opportunities such as employment back into local communities to empower them in the climate change discourse;
  - Give due consideration to circumstances that prevent the active public participation and stakeholder engagement of vulnerable or underprivileged communities;
  - **Food Security** (see CAP G2 5.3 – Sub-action 12). We urge that along with making food gardens more attractive to young people, youth and communities also need to be enabled to participate more fully in these programmes.
    - Enhance food security through monetary and in-kind support for community food gardens, and establish more food gardens across the city to make food more affordable, accessible and readily available for local distribution;
    - Promote small-scale local production and consumption of food and goods to stimulate local economies and support MSMEs.
- We endorse in particular the aims of the CAP to:
- Assist individuals and schools to adopt sustainable practices such as recycling, rooftop and urban farming (see CAP G1 4.2 – Sub-actions 2 and 10);
  - Provide green technical and vocational training such as disaster risk reduction training so that young people are equipped to handle the challenges their communities face.
  - Foster the circular and green economy by implementing better waste management strategies, including but not limited to:
    - Management of single use packaging items (plastics);
    - City-wide recycling initiatives for households and public spaces;
    - Limit biological waste (food) that can be composted.
  - Promote the creation of safe, green transport systems in inner city areas to reduce emissions and congestion from private vehicles on nodal routes, either by upgrading existing systems or by developing new ones. In addition, adopt effective and innovative transport solutions from other parts of the world and adapt them to the local context (see CAP G1 3.1-3.5);
  - Facilitate a just transition from fossil fuels and insist on greater investments in renewable energy (see the definition of decarbonisation in the glossary and G1 1.2 – Sub-action 5);
  - Encourage food wholesalers to distribute food that is past its sell by-date to shelters (see CAP G1 4.1 – Sub-action 3);
  - Invest in solar-powered street lighting as an environmentally-friendly solution to safety concerns in unlit areas at night (See Introduction, 1.4).

## Existing Youth Activities/Projects

- 1 Youth Policy Committee – Policy participation and youth advocacy
- 2 The Collective Movement – Intersectional climate justice movement
- 3 The Conscious Campaign – Discourse- and art-based social justice society
- 4 The Activist Hour – Social media activism
- 5 African Climate Alliance – Climate, ecological and social justice group

## Acknowledgements:

The youth CAP inputs were developed by young people from across the City of Johannesburg. The process was initiated through a workshop that was led by the Youth Programmes at the South African Institute of International Affairs (Youth@SAIIA), the Global Change Institute at the University of the Witwatersrand and the City of Johannesburg. Youth from various schools, universities and organisations provided their inputs and a youth drafting committee compiled the final submission. The lead youth authors are Celiwe Shivambu, Ditebogo Lebea, Khahliso Myataza, Rachel Guise-Brown, Sibusiso Mongezi, Sibuso Mohlwayo and Tyler Booth. For more information contact [youth@saiaa.org.za](mailto:youth@saiaa.org.za).



# Conclusion and way forward

# 7. Conclusion and way forward



**We are the first generation that can end poverty, and the last generation that can take steps to avoid the worst impacts of climate change. Future generations will judge us harshly if we fail in upholding our moral and historical responsibilities.**

**- Ban Ki-Moon<sup>xxvii</sup>**

The City of Johannesburg is beginning to chart a path towards a post COVID-19 future. The CAP reaffirms the City's commitment to supporting the well-being and livelihoods of all its citizens by pursuing a sustainable and just recovery. The COVID crisis has helped to highlight the potential severity of another global crisis, the climate breakdown: those hardest hit by the pandemic are largely the same people also facing the greatest threat from climate change. The CAP will ensure that the Johannesburg of the future will be carbon neutral and resilient to the devastating impacts of climate change, for the benefit of all its residents. The City will work towards these overarching goals step by step, through targets set with different deadlines (2025, 2030, 2040 and 2050).

By developing the CAP, the City has cemented its position as a leading African City, a champion of ambitious climate action planning which will soon result in accelerated implementation. As stated above, the City has chosen the year 2025 as its first implementation milestone for delivering tangible results, including a 10% reduction in emissions as compared to the 2016 baseline. Such a near term target is representative of the City's bold commitment to a transformative development agenda and indicative of the groundwork that is already in place. The City has been a trailblazer of innovative climate finance solutions, as demonstrated by its first green bond, and will continue to explore innovative financing mechanisms.



The City aims to achieve its Deadline 2020 commitment (25% emission reduction as compared to the 2016 baseline) by 2030. This target is consistent with the South Africa's National Climate Change Response White Paper and the National Development Plan. The City of Johannesburg's GHG emissions should peak no later than 2030 and then decline rapidly to reach zero by 2050. This trajectory is also consistent with South Africa's Nationally Determined Contribution (NDC) under the Paris Agreement, in which the country has committed to achieving peak GHG emissions between 2020 and 2025, after which emissions will plateau for ten years before declining rapidly.

The CAP will also be instrumental in leading the City towards a climate-resilient future. The City's long-term Growth and Development Strategy (GDS 2040) makes provisions for a liveable, sustainable urban environment with climate change resilience and environmental protection as leading principles. The City's resilience goals and targets will ensure water security, the creation of resilient human settlements, enhanced implementation of flood and drought management strategies, resilient infrastructure and healthy communities. By 2050, the City aims to have achieved its overarching goals of net-zero emissions and resilience in line with the Paris-Agreement. CAP targets for both mitigation and adaptation will be achieved by attracting national and international support, establishing strong partnerships, and pursuing vertical integration, technological support and investment.

In addition, the City has already begun establishing a strong foundation for good climate governance that will be critical for the implementation of the CAP. Internally, the Climate Action Forum (CAF), together with its working groups, is already instrumental in coordinating climate actions and making recommendations to the CAP Steering Committee (CAP SC). The recommendations of the CAP SC to the Executive Management Team will continue to be key as this body plays a central role in endorsing climate action decisions and deciding on trade-offs. As a technical forum endorsed by the Executive Management Team, the CAF will undertake the crucial task of reporting on the implementation of the CAP on an annual basis and updating the CAP every five years. This will enable a rapid acceleration of climate action and ensure that climate change mainstreaming in the City becomes a reality. To advance climate governance the City will build on and monitor the implementation of the actions outlined in chapter two.

The City is fully aware that the scale of urban transformation required to achieve the goals of climate resilience and net-zero emissions can only be realised through strengthening climate governance to facilitate a city-wide response. We would like to reiterate our commitment to ensuring that the CAP is implemented in an inclusive and equitable manner. This will be achieved through extensive public participation and open dialogues with all stakeholders including the youth, civil society, academia and research institutions, labour, business and all residents of the City of Johannesburg. We look forward to working together to achieve a sustainable, resilient future for all.







# Glossary

# 8. Glossary

As the terminologies used in this document align with IPCC's definitions, most of the glossary below is an extract from the IPCC's Special Report.<sup>xxviii</sup>

**1.5°C pathway** See Pathways.

**2030 Agenda for Sustainable Development** A UN resolution in September 2015 adopting a plan of action for people, planet and prosperity in a new global development framework anchored in 17 Sustainable Development Goals.<sup>xxix</sup> See also **Sustainable Development Goals (SDGs)**.

**Accessibility** A concept that focuses on providing all citizens with access to resources, basic needs that sustain livelihood and wellbeing. It also fosters a culture of transparency and accountability in both public and private bodies. The use of assistive technology capacitates effective participation of all individuals.

**Adaptability** See **Adaptive capacity**.

**Adaptation** In human systems, the process of adjustment to actual or expected climate change and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate change and its effects; human intervention may facilitate adjustment to expected climate change and its effects.

See also **Adaptive capacity** and **Maladaptive actions (Maladaptation)**.

**Adaptive capacity** The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. This glossary entry builds on definitions used in previous IPCC reports and the Millennium Ecosystem Assessment.<sup>xxx</sup> See also **Adaptation** and **Maladaptive actions (Maladaptation)**.

**Air pollution** Degradation of air quality with negative effects on human health or the natural or built environment due to the introduction, by natural processes or human activity, into the atmosphere of substances (gases, aerosols) which have a direct (primary pollutants) or indirect (secondary pollutants) harmful effect.

**Business as usual (BAU)** A scenario for future patterns of activity which assumes that there will be no significant change in people's attitudes and priorities, or no major changes in technology, economics, or policies, so that normal circumstances can be expected to continue unchanged.

**Carbon dioxide (CO<sub>2</sub>)** A naturally occurring gas, CO<sub>2</sub> is also a by-product of burning fossil fuels (such as oil, gas and coal), of burning biomass, of land-use changes (LUC) and of industrial processes (e.g., cement production). It is the principal anthropogenic greenhouse gas (GHG) that affects the Earth's radiative balance. It is the reference gas against which other GHGs are measured and therefore has a global warming potential (GWP) of 1. See also **Greenhouse gas (GHG)**.

**Carbon neutrality** is achieved when anthropogenic CO<sub>2</sub> emissions are balanced globally by anthropogenic CO<sub>2</sub> removals over a specified period See **Net zero emissions**.

**Climate** Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

**Climate change** Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: ‘a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.’ The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes. See also **Climate variability** and **Global warming**.

**Climate extreme** (extreme weather or climate event) The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. For simplicity, both extreme weather events and extreme climate events are referred to collectively as ‘climate extremes.’ See also **Extreme weather event**.

**Climate governance** See **Governance**

**Climate justice** See **Justice**.

**Climate model** A numerical representation of the climate system based on the physical, chemical and biological properties of its components, their interactions and feedback processes, and accounting for some of its known properties. The climate system can be represented by models of varying complexity; that is, for any one component or combination of components a spectrum or hierarchy of models can be identified, differing in such aspects as the number of spatial dimensions, the extent to which physical, chemical or biological processes are explicitly represented, or the level at which empirical parametrizations are involved. There is an evolution towards more complex models with interactive chemistry and biology. Climate models are applied as a research tool to study and simulate the climate and for operational purposes, including monthly, seasonal and interannual climate predictions.

**Climate projection** A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases (GHGs) and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence

on the emission/concentration/radiative forcing scenario used, which is in turn based on assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized.

**Climate sensitivity** Climate sensitivity refers to the change in the annual global mean surface temperature in response to a change in the atmospheric CO<sub>2</sub> concentration or other radiative forcing.

**Climate system** The climate system is the highly complex system consisting of five major components: the atmosphere, the hydrosphere, the cryosphere, the lithosphere and the biosphere and the interactions between them. The climate system evolves in time under the influence of its own internal dynamics and because of external forcings such as volcanic eruptions, solar variations and anthropogenic forcings such as the changing composition of the atmosphere and land-use change.

**Climate target** Climate target refers to a temperature limit, concentration level, or emissions reduction goal used towards the aim of avoiding dangerous anthropogenic interference with the climate system. For example, national climate targets may aim to reduce greenhouse gas emissions by a certain amount over a given time horizon, for example those under the Kyoto Protocol.

**Climate variability** Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability). See also **Climate change**.

**CO<sub>2</sub> equivalent (CO<sub>2</sub>e) emission** The amount of carbon dioxide (CO<sub>2</sub>) emission that would cause the same integrated radiative forcing or temperature change, over a given time horizon, as an emitted amount of a greenhouse gas (GHG) or a mixture of GHGs. There are a number of ways to compute such equivalent emissions and choose appropriate time horizons. Most typically, the CO<sub>2</sub>-equivalent emission is obtained by multiplying the emission of a GHG by its global warming potential (GWP) for a 100-year time horizon. For a mix of GHGs it is obtained by summing the CO<sub>2</sub>-equivalent emissions of each gas. CO<sub>2</sub>-equivalent emission is a common scale for comparing emissions of different GHGs but does not imply equivalence of the corresponding climate change responses. There is generally no connection between CO<sub>2</sub>-equivalent emissions and resulting CO<sub>2</sub>-equivalent concentrations.

**Community** can be defined as a group of people who live, work or belong in a similar local area. These areas are found at different levels; schools, businesses, neighbourhoods, a city or country. Individuals may form groups to work in harmony, choose responsibilities that allow them to contribute to the community and build systems that allow them to co-exist.

The **Compact of Mayors** is a global coalition of mayors and city officials pledging to reduce local greenhouse gas emissions, enhance resilience to climate change, and to track their progress transparently.

**Cost–benefit analysis** Monetary assessment of all negative and positive impacts associated with a given action. Cost–benefit analysis enables comparison of different interventions, investments or strategies and reveals how a given investment or policy effort pays off for a particular person, company or country. Cost–benefit analyses representing society's point of view are important for climate change decision-making, but there are difficulties in aggregating costs and benefits across different actors and across timescales. See also Discounting. **Cost-effectiveness** A measure of the cost at which policy goal or outcome is achieved. The lower the cost the greater the cost-effectiveness.

**Decarbonisation** The process by which countries, individuals or other entities aim to achieve zero fossil carbon existence. Typically refers to a reduction of the carbon emissions associated with electricity, industry and transport.

**Disaster risk management (DRM)** Processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response, and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, and sustainable development.

**Drought** A period of abnormally dry weather long enough to cause a serious hydrological imbalance. Drought is a relative term, therefore any discussion in terms of precipitation deficit must refer to the particular precipitation-related activity that is under discussion. For example, shortage of precipitation during the growing season impinges on crop production or ecosystem function in general (due to soil moisture drought, also termed agricultural drought), and during the runoff and percolation season primarily affects water supplies (hydrological drought). Storage changes in soil moisture and groundwater are also affected by increases in actual evapotranspiration in addition to reductions in precipitation. A period with an abnormal precipitation deficit is defined as a meteorological drought.

**Early warning systems (EWS)** The set of technical, financial and institutional capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare to act promptly and appropriately to reduce the possibility of harm or loss. Dependent upon context, EWS may draw upon scientific and/or Indigenous knowledge. EWS are also considered for ecological applications e.g., conservation, where the organization itself is not threatened by hazard but the ecosystem under conservation is (an example is coral bleaching alerts), in agriculture (for example, warnings of ground frost, hailstorms) and in fisheries (storm and tsunami warnings).

**Ecosystem** An ecosystem is a functional unit consisting of living organisms, their non-living environment and the interactions within and between them. The components included in a given ecosystem and its spatial boundaries depend on the purpose for which the ecosystem is defined: in some cases they are relatively sharp, while in others they are diffuse. Ecosystem boundaries can change over time. Ecosystems are nested within other ecosystems and their scale can range from very small to the entire biosphere. In the current era, most ecosystems either contain people as key organisms, or are influenced by the effects of human activities in their environment.

**Emission pathways** See **Pathways**.

**Emission scenario** A plausible representation of the future development of emissions of substances that are radiatively active (e.g., greenhouse gases (GHGs), aerosols) based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socio-economic development, technological change, energy and land use) and their key relationships. Concentration scenarios, derived from emission scenarios, are often used as input to a climate model to compute climate projections. See also **Mitigation scenario**, **Socio-economic scenario**, **Scenario**, **Representative Concentration Pathways (RCPs)** (under Pathways) and **Shared Socio-economic Pathways (SSPs)** (under Pathways).

**Enabling conditions** Conditions that affect the feasibility of adaptation and mitigation options, and can accelerate and scale-up systemic transitions that would limit temperature increase to 1.5°C and enhance capacities of systems and societies to adapt to the associated climate change, while achieving sustainable development, eradicating poverty and reducing inequalities. Enabling conditions include finance, technological innovation, strengthening policy instruments, institutional capacity, multilevel governance, and changes in human behaviour and lifestyles. They also include inclusive processes, attention to power asymmetries and unequal opportunities for development and reconsideration of values.

**Energy efficiency** The ratio of output or useful energy or energy services or other useful physical outputs obtained from a system, conversion process, transmission or storage activity to the input of energy (measured as kWh kWh<sup>-1</sup>, tonnes kWh<sup>-1</sup> or any other physical measure of useful output like tonne-km transported). Energy efficiency is often described by energy intensity. In economics, energy intensity describes the ratio of economic output to energy input. Most commonly energy efficiency is measured as input energy over a physical or economic unit, i.e., kWh USD<sup>-1</sup> (energy intensity), kWh tonne<sup>-1</sup>. For buildings, it is often measured as kWh m<sup>-2</sup>, and for vehicles as km liter<sup>-1</sup> or liter km<sup>-1</sup>. Very often in policy 'energy efficiency' is intended as the measures to reduce energy demand through technological options such as insulating buildings, more efficient appliances, efficient lighting, efficient vehicles, etc.

**Energy security** The goal of a given country, or the global community as a whole, to maintain an adequate, stable and predictable energy supply. Measures encompass safeguarding the sufficiency of energy resources to meet national energy demand at competitive and stable prices and the resilience of the energy supply; enabling development and deployment of technologies; building sufficient infrastructure to generate, store and transmit energy supplies; and ensuring enforceable contracts of delivery.

**Equality** A principle that ascribes equal worth to all human beings, including equal opportunities, rights, and obligations, irrespective of origins.

- **Inequality** - Uneven opportunities and social positions, and processes of discrimination within a group or society, based on gender, class, ethnicity, age, and (dis)ability, often produced by uneven development. Income inequality refers to gaps between highest and lowest income earners within a country and between countries. See also Equity, Ethics and Fairness. Equilibrium climate sensitivity See **Climate sensitivity**.

**Equity** Equity is the principle of fairness in burden sharing and is a basis for understanding how the impacts and responses to climate change, including costs and benefits, are distributed in and by society in more or less equal ways. It is often aligned with ideas of equality, fairness and justice and applied with respect to equity in the responsibility for, and distribution of, climate impacts and policies across society, generations, and gender, and in the sense of who participates and controls the processes of decision-making.

**Eskom** is a South African electricity public utility.

**Exposure** The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected. See also **Hazard** and **Risk**.

**Extreme weather event** An extreme weather event is an event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10<sup>th</sup> or 90<sup>th</sup> percentile of a probability density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., drought or heavy rainfall over a season). See also **Heatwave** and **Climate extreme (extreme weather or climate event)**.

**Flood** The overflowing of the normal confines of a stream or other body of water, or the accumulation of water over areas that are not normally submerged. Floods include river (fluvial) floods, flash floods, urban floods, pluvial floods, sewer floods, coastal floods, and glacial lake outburst floods.

**Food security** A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.<sup>xxxi</sup>

**Fossil fuels** Carbon-based fuels from fossil hydrocarbon deposits, including coal, oil, and natural gas.

**Global warming** The estimated increase in global mean surface temperature (GMST) averaged over a 30-year period, or the 30-year period centered on a particular year or decade, expressed relative to pre-industrial levels unless otherwise specified. For 30-year periods that span past and future years, the current multi-decadal warming trend is assumed to continue. See also **Climate change** and **Climate variability**.

**Governance** A comprehensive and inclusive concept of the full range of means for deciding, managing, implementing and monitoring policies and measures. Whereas government is defined strictly in terms of the nation-state, the more inclusive concept of governance recognizes the contributions of various levels of government (global, international, regional, sub-national and local) and the contributing roles of the private sector, of nongovernmental actors, and of civil society to addressing the many types of issues facing the global community.

**Green infrastructure** The interconnected set of natural and constructed ecological systems, green spaces and other landscape features. It includes planted and indigenous trees, wetlands, parks, green open spaces and original grassland and woodlands, as well as possible building and street-level design interventions that incorporate vegetation. Green infrastructure provides services and functions in the same way as conventional infrastructure.

**Greenhouse gas (GHG)** Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself and by clouds. This property causes the greenhouse effect. Water vapour (H<sub>2</sub>O), carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>) and ozone (O<sub>3</sub>) are the primary GHGs in the Earth's atmosphere. Moreover, there are a number of entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO<sub>2</sub>, N<sub>2</sub>O and CH<sub>4</sub>, the Kyoto Protocol deals with the GHGs sulphur hexafluoride (SF<sub>6</sub>), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). See also Carbon dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), Nitrous oxide (N<sub>2</sub>O) and Ozone (O<sub>3</sub>).

**Green skills** refer to the technical skills, knowledge, values and attitudes needed in the workforce to develop and support sustainable social, economic and environmental development.

**Green jobs** refer to employment opportunities in agriculture, manufacturing, R&D, administrative, and service activities aimed at substantially preserving or restoring environmental quality.

**Hazard** The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources. See also **Disaster**, **Exposure** and **Risk**.

**Heatwave** A period of abnormally hot weather. Heatwaves and warm spells have various and in some cases overlapping definitions. See also **Extreme weather event**.

**Impacts** (consequences, outcomes) The consequences of realized risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather and climate events), exposure, and vulnerability. Impacts generally refer to effects on lives; livelihoods; health and well-being; ecosystems and species; economic, social and cultural assets; services (including ecosystem services); and infrastructure. Impacts may be referred to as consequences or outcomes, and can be adverse

or beneficial. See also **Adaptation**, **Exposure**, **Hazard**, **Loss and Damage**, and **losses and damages**, and **Vulnerability**.

**Institution** Institutions are rules and norms held in common by social actors that guide, constrain and shape human interaction. Institutions can be formal, such as laws and policies, or informal, such as norms and conventions. Organizations – such as parliaments, regulatory agencies, private firms and community bodies – develop and act in response to institutional frameworks and the incentives they frame. Institutions can guide, constrain and shape human interaction through direct control, through incentives, and through processes of socialization. See also **Institutional capacity**.

**Institutional capacity** Institutional capacity comprises building and strengthening individual organizations and providing technical and management training to support integrated planning and decision-making processes between organizations and people, as well as empowerment, social capital, and an enabling environment, including the culture, values and power relations.<sup>xxxii</sup>

**Integrated water resources management (IWRM)** A process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

**Justice** Justice is concerned with ensuring that people get what is due to them, setting out the moral or legal principles of fairness and equity in the way people are treated, often based on the ethics and values of society.

- **Climate justice** - Justice that links development and human rights to achieve a humancentred approach to addressing climate change, safeguarding the rights of the most vulnerable people and sharing the burdens and benefits of climate change and its impacts equitably and fairly. This definition builds upon the one used by the Mary Robinson Foundation – Climate Justice.<sup>xxxiii</sup>
- **Social justice** - Just or fair relations within society that seek to address the distribution of wealth, access to resources, opportunity, and support according to principles of justice and fairness.

See also **Equity**.

**Just Transition** secures the future and livelihoods of workers and their communities in the transition to a low-carbon economy. It is based on social dialogue between workers and their unions, employers, government and communities.



**Life cycle assessment (LCA)** Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product or service throughout its life cycle.<sup>xxxiv</sup>

**Likelihood** The chance of a specific outcome occurring, where this might be estimated probabilistically. Likelihood is expressed in this report using a standard terminology.<sup>xxxv</sup>

**Livelihood** The resources used and the activities undertaken in order to live. Livelihoods are usually determined by the entitlements and assets to which people have access. Such assets can be categorised as human, social, natural, physical or financial.

**Maladaptive actions (Maladaptation)** Actions that may lead to increased risk of adverse climate-related outcomes, including via increased GHG emissions, increased vulnerability to climate change, or diminished welfare, now or in the future. Maladaptation is usually an unintended consequence.

**Mitigation (of climate change)** A human intervention to reduce emissions or enhance the sinks of greenhouse gases.

**Mitigation measures** In climate policy, mitigation measures are technologies, processes or practices that contribute to mitigation, for example, renewable energy (RE) technologies, waste minimization processes and public transport commuting practices. See also **Mitigation option** and **Policies (for climate change mitigation and adaptation)**.

**Mitigation option** A technology or practice that reduces GHG emissions or enhances sinks.

**Mitigation scenario** A plausible description of the future that describes how the (studied) system responds to the implementation of mitigation policies and measures. See also **Emission scenario**, **Pathways** and **Socio-economic scenario**.

**Monitoring and evaluation (M&E)** Monitoring and evaluation refers to mechanisms put in place at national to local scales to respectively monitor and evaluate efforts to reduce greenhouse gas emissions and/ or adapt to the impacts of climate change with the aim of systematically identifying, characterizing and assessing progress over time.

**Net zero emissions** Net zero emissions are achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period. Where multiple greenhouse gases are involved, the quantification of net zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon).

**Paris Agreement** The Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) was adopted on December 2015 in Paris, France, at the 21<sup>st</sup> session of the Conference of the Parties (COP) to the UNFCCC. The agreement, adopted by 196 Parties to the UNFCCC, entered into force on 4 November 2016 and as of May 2018 had 195 Signatories and was ratified by 177 Parties. One of the goals of the Paris Agreement is 'Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels', recognising that this would significantly reduce the risks and impacts of climate change. Additionally, the Agreement aims to strengthen the ability of countries to deal with the impacts of climate change. The Paris Agreement is intended to become fully effective in 2020. See also **United Nations Framework Convention on Climate Change (UNFCCC)**.

**Pathways** The temporal evolution of natural and/or human systems towards a future state. Pathway concepts range from sets of quantitative and qualitative scenarios or narratives of potential futures to solution-oriented decision-making processes to achieve desirable societal goals. Pathway approaches typically focus on biophysical, techno-economic, and/or socio-behavioural trajectories and involve various dynamics, goals and actors across different scales.

- **1.5°C pathway.** A pathway of emissions of greenhouse gases and other climate forcers that provides an approximately one-in-two to two-in-three chance, given current knowledge of the climate response, of global warming either remaining below 1.5°C or returning to 1.5°C by around 2100 following an overshoot.
- **Adaptation pathways** A series of adaptation choices involving trade-offs between short-term and long-term goals and values. These are processes of deliberation to identify solutions that are meaningful to people in the context of their daily lives and to avoid potential maladaptation.
- **Development pathways** Development pathways are trajectories based on an array of social, economic, cultural, technological, institutional and biophysical features that characterise the interactions between human and natural systems and outline visions for the future, at a particular scale. Emission pathways Modelled trajectories of global anthropogenic emissions over the 21<sup>st</sup> century are termed emission pathways.
- **Mitigation pathways** A mitigation pathway is a temporal evolution of a set of mitigation scenario features, such as greenhouse gas emissions and socio-economic development.

- **Representative Concentration Pathways (RCPs)** Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/ land cover.<sup>xxxvi</sup> The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasizes the fact that not only the long- term concentration levels but also the trajectory taken over time to reach that outcome are of interest. RCPs were used to develop climate projections in CMIP5.
- **RCP2.6:** One pathway where radiative forcing peaks at approximately 3 W m<sup>-2</sup> and then declines to be limited at 2.6 W m<sup>-2</sup> in 2100 (the corresponding Extended Concentration Pathway, or ECP, has constant emissions after 2100).
- **RCP4.5 and RCP6.0:** Two intermediate stabilization pathways in which radiative forcing is limited at approximately 4.5 W m<sup>-2</sup> and 6.0 W m<sup>-2</sup> in 2100 (the corresponding ECPs have constant concentrations after 2150).
- **RCP8.5:** One high pathway which leads to >8.5 W m<sup>-2</sup> in 2100 (the corresponding ECP has constant emissions after 2100 until 2150 and constant concentrations after 2250). See also Coupled Model Intercomparison Project (CMIP) and Shared Socio-economic Pathways (SSPs).

**Policies** (for climate change mitigation and adaptation) Policies are taken and/or mandated by a government – often in conjunction with business and industry within a single country, or collectively with other countries – to accelerate mitigation and adaptation measures. Examples of policies are support mechanisms for renewable energy supplies, carbon or energy taxes, fuel efficiency standards for automobiles, etc.

**Projection** A projection is a potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Unlike predictions, projections are conditional on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realized. See also Climate projection, Scenario and Pathways. Representative Concentration Pathways (RCPs) See **Pathways**.

**Resilience** The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation, learning and transformation.<sup>xxxvii</sup> See also **Hazard** and **Risk**.

**Risk** The potential for adverse consequences where something of value is at stake and where the occurrence and degree of an outcome is uncertain. In the context of the assessment of climate impacts, the term risk is often used to refer to the

potential for adverse consequences of a climate- related hazard, or of adaptation or mitigation responses to such a hazard, on lives, livelihoods, health and well-being, ecosystems and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure. Risk results from the interaction of vulnerability (of the affected system), its exposure over time (to the hazard), as well as the (climate-related) hazard and the likelihood of its occurrence.

**Risk assessment** The qualitative and/or quantitative scientific estimation of risks. See also Risk, Risk management and Risk perception.

**Risk management** Plans, actions, strategies or policies to reduce the likelihood and/or consequences of risks or to respond to consequences. See also **Risk** and **Risk assessment**.

**Scenario** A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technological change, prices) and relationships. Note that scenarios are neither predictions nor forecasts, but are used to provide a view of the implications of developments and actions. See also **Baseline scenario**, **Emission scenario**, **Mitigation scenario** and **Pathways**.

**Social inclusion** A process of improving the terms of participation in society, particularly for people who are disadvantaged, through enhancing opportunities, access to resources, and respect for rights.<sup>xxxviii</sup>

**Socio-economic scenario** A scenario that describes a possible future in terms of population, gross domestic product (GDP), and other socio-economic factors relevant to understanding the implications of climate change. See also **Baseline scenario**, **Emission scenario**, **Mitigation scenario** and **Pathways**.

**Sustainability** A dynamic process that guarantees the persistence of natural and human systems in an equitable manner.

**Sustainable development (SD)** Development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987) and balances social, economic and environmental concerns. See also **Sustainable Development Goals (SDGs)** and **Development pathways** (under **Pathways**).

**Sustainable Development Goals (SDGs)** The 17 global goals for development for all countries established by the United Nations through a participatory process and elaborated in the 2030 Agenda for Sustainable Development, including

ending poverty and hunger; ensuring health and well-being, education, gender equality, clean water and energy, and decent work; building and ensuring resilient and sustainable infrastructure, cities and consumption; reducing inequalities; protecting land and water ecosystems; promoting peace, justice and partnerships; and taking urgent action on climate change. See also **Sustainable development** (SD).

**Transformation** A change in the fundamental attributes of natural and human systems.

- **Societal (social) transformation** A profound and often deliberate shift initiated by communities toward sustainability, facilitated by changes in individual and collective values and behaviours, and a fairer balance of political, cultural, and institutional power in society.

**Uncertainty** A state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from imprecision in the data to ambiguously defined concepts or terminology, incomplete understanding of critical processes, or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures (e.g., a probability density function) or by qualitative statements (e.g., reflecting the judgment of a team of experts).<sup>xxxix</sup> See also **Likelihood**.

**United Nations Framework Convention on Climate Change (UNFCCC)** The UNFCCC was adopted in May 1992 and opened for signature at the 1992 Earth Summit in Rio de Janeiro. It entered into force in March 1994 and as of May 2018 had 197 Parties (196 States and the European Union). The Convention's ultimate objective is the 'stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.' The provisions of the Convention are pursued and implemented by two treaties: the Kyoto Protocol and the Paris Agreement. See also **Paris Agreement**.

**Well-being** A state of existence that fulfils various human needs, including material living conditions and quality of life, as well as the ability to pursue one's goals, to thrive, and feel satisfied with one's life. Ecosystem well-being refers to the ability of ecosystems to maintain their diversity and quality.

**Youth** are category of people falling within the age group of 14 to 35 years.

## ACRONYMS

BAU	Business as usual
BRT	Bus rapid transport
CAF	Climate Action Forum (City of Johannesburg)
CAP	Climate Action Plan
CAP SC	Climate Action Plan Steering Committee (City of Johannesburg)
CBD	Central business district
COGTA	Department of Cooperative Governance and Traditional Affairs (Republic of South Africa)
COP	Conference of Parties (of the UNFCCC)
CRUM	Citizen Relation and Urban Management (City of Johannesburg)
CSIR	Council for Scientific & Industrial Research (Republic of South Africa)
DEFF	Department of Environment, Forestry & Fisheries (Republic of South Africa)
EISD	Environment and Infrastructure Services Department (City of Johannesburg)
ESCO	Energy service company
EUI	Energy-use intensity
EV	Electric vehicle
GDARD	Gauteng Department of Agriculture and Rural Development
GDP	Gross Domestic Product
GDS	Growth and Development Strategy 2040 (City of Johannesburg)
GHG	Greenhouse gas
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
GVA	Gross Value Added
ICLEI	International Council for Local Environmental Initiatives
IDP	Integrated Development Plan (City of Johannesburg)
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent power producer
JCPZ	Johannesburg City Parks and Zoos
JRA	Johannesburg Road Agency
KPIs	Key performance indicators
LED	Light-emitting diode
M&E	Monitoring & evaluation
NERSA	National Energy Regulator of South Africa
NGO	Non-governmental organisation
PRASA	Passenger Rail Agency of South Africa
PV	(Solar) Photovoltaic
RCP	Relative Concentration Pathway
RD&D	Research, development and deployment
RE	Renewable energy
RFP	Request for proposals
RSA	Republic of South Africa
SDBIP	Service Delivery and Budget Implementation Plan
SDGs	Sustainable Development Goals
SUDS	Sustainable urban drainage system
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
WSUD	Water-sensitive urban design
WWTW	Wastewater Treatment Works







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### List of supporting documents

- Pathways CAP Technical Report
- Pathways AQ Technical Report
- Climate Change Risk and Vulnerability Assessment
- Mitigation Cost Benefit Report
- Adaptation Cost Benefit Report
- Draft Climate Change Data Management System Specification

## Annex 1: Possible funding mechanisms for the CAP

Financing Mechanism		Eligible Applicants	Finance Mechanism	Technology	Project Type	Comments
International Multilateral Finance Mechanisms						
1	Green Climate Fund (GCF)	Accredited entities	Grants, loans, equity, guarantees	Mitigation, Adaptation, Cross-cutting	Micro, Small, Medium and large scale projects	Co-funding an advantage
2	Global Environmental Fund (GEF)	Government agencies, Civil society organisations, Private sector companies, Research institutions	Grants and leveraging Co-financing	Biodiversity, Chemicals and waste, Climate Change, Forests, International water, Land degradation	Full-sized projects, Medium sized projects, Enabling Activity, Program	Co-financing an advantage
	GEF-Small Grants Programme (SGP)	Community based, Non-Governmental Organisations	Grant	Mitigation, Energy, Energy efficiency, Low carbon, Renewable energy, Transport	Small Projects (Max 50 000 USD)	For Projects up to USD 50,000 ONLY
3	NAMA Facility	National Government	Loans, Grants, Equity, Guarantee		Demonstration, Projects ready for commercialisation	
4	Energy and Environment Partnership (EEF) Fund	Companies + start-ups, Non-profit + social enterprises, Research institutes	Early Stage grants, repayable grants, co-financing	Renewable Energy, Energy Efficiency	Feasibility study, Demonstration, Pilot, Replication, scale-up	
5	Facility for the Investment in Renewable Small Transactions (FIRST)	Small and Medium size projects	Loans	Renewable Energy		
Domestic Finance Mechanisms						
6	Green Fund	Small to Medium sized companies, large corporates. Municipalities, state owned enterprises and higher education institutions	Recoverable and non-recoverable grants, Loans and equity	Green Cities Towns, Low Carbon Economy, Environmental and Natural Resource Management	Projects from early research and development stage to project expansion	Owned by DEA & Managed by DBSA
7	Municipal EEDSM	Municipalities	Grants	Energy efficient technologies ranging from traffic and street lighting to energy efficiency in buildings and water service infrastructure	Energy Efficiency: Traffic lights, street lighting, building lights, HVAC, energy efficiency water infrastructure and wastewater treatment	Managed by DoE



Financing Mechanism		Eligible Applicants	Finance Mechanism	Technology	Project Type	Comments
International Multilateral Finance Mechanisms						
8	ESCO Financing model	Entire public sector	Project Design and Implementation Funding	Energy Efficiency and small Renewable Energy Projects	Energy Efficiency	Shared savings model does not require upfront investment by the public entity
9	Urban Settlements Development Grant (USDG)	Metropolitan Municipalities	Grant	Built environment	Built environment	
10	DBSA funding	Entire public sector	<ul style="list-style-type: none"><li>• Project preparation funds</li><li>• Debt, mezzanine finance</li><li>• Limited and non-resource lending</li></ul>	Various technologies, including low-carbon technologies	From project preparation to implementation	DBSA lending rates are often higher than those of other financial institutions
11	IDC funding	Entire public sector	<ul style="list-style-type: none"><li>• Debt</li><li>• Equity</li><li>• Quasi-equity</li><li>• Guarantees</li><li>• Trade finance</li><li>• Bridging finance</li><li>• Venture capital</li></ul>	Various technologies, including	All stages	





