First, climate change is a global problem that affects both current and future generations, and responses must be sensitive to both spatial and temporal consequences. Climate Change adaptation taken to benefit one sector or group may undermine the security and well-being of others, such as by influencing resource access and the integrity of ecosystems that many people depend upon for their livelihoods. Second, widespread poverty makes many individuals, households, communities and cities vulnerable to even small shocks and stressors. The tendency of poor people to be highly vulnerable to climate change is often used as a justification for implementing adaptation; however, whether or not the proposed adaptation measures will actually assist poor groups is seldom assessed. An underlying premise for the concept of sustainable adaptation is that many responses to climate change will create social and environmental externalities, including trade-offs and negative consequences. Sustainable adaptation thus considers the wider effects of adaptive responses on other groups, places and socio-ecological systems, both in the present and in the future.

Third, the need to drastically reduce greenhouse gas emissions and facilitate a rapid transition to low-emission economies suggests that adaptation measures should emphasize low-emission solutions. Responses to climate change can thus be seen as a means for promoting alternative development pathways, such as transitions to low-carbon economies, urban organic agriculture and horticulture, ecological sanitation, water harvesting, water purification by the use of solar energy, alternative modes of transport, decentralized renewable energy supply, recycling or participatory plant breeding.

Africa is one of the most vulnerable continents to climate change and climate variability, a situation aggravated by the interaction of ‘multiple stresses’, occurring at various levels, and low adaptive capacity (high confidence). Africa’s major economic sectors are vulnerable to current climate sensitivity, with huge economic impacts, and this
vulnerability is exacerbated by existing developmental challenges such as endemic poverty, complex governance and institutional dimensions; limited access to capital, including markets, infrastructure and technology; ecosystem degradation; and complex disasters and conflicts. These in turn have contributed to Africa’s weak adaptive capacity, increasing the continent’s vulnerability to projected climate change.

It is important to understand the impacts of climate change in South Africa as a country since a city like Johannesburg imports the bulk of its resources from the neighboring provinces and municipalities. At a local scale of the City of Johannesburg, future model projections indicate significant increases in temperatures over the next four to five decades, with this trend continuing into the subsequent century. The warming trend will have a significant impact on average seasonal temperatures. The average of the seven climate model projections indicates an annualised temperature increase in the order of 2.4°C by the “near future” and 4.5°C further into the future. Largest increases are expected to occur in spring: an increase of 5°C and 5.2°C in average maximum day-time minimum night-time temperatures respectively by 2081-2100.

Figure 1a: Mean seasonal cycle of downscaled daily maximum temperature (°C)
Control period i.e. 1961-2000 (in orange),
Near-future i.e. 2046-2065 (in green) and
Far-future i.e. 2081-2100 (in blue) periods.
The lines are the median values, while the shaded area represents the range or envelope of the seven CGM projections.
(Source: CSAG, 2009)

Figure 1b: Mean seasonal cycle of downscaled minimum temperature (°C)

Future Rainfall Projections

Rainfall is a far more complex variable to model than temperature. Projections for rainfall generally have a greater degree of uncertainty associated with them when compared to the projections for temperature. Despite the higher uncertainty associated with the rainfall predictions, the general indication among the climate models analysed is that rainfall may be expected to increase moderately, but significantly, into the future. This would potentially be accompanied by a lengthening of the rainy season, particularly into early autumn and potentially starting earlier in spring as well, and an increase in both the frequency and intensity of rainfall (see Fig 2 below).
Alternatively, the change in the average of the seven downscaled model projections may be represented as percentages as in Table 1. The averaged precipitation projections for the seven climate models shows an 18% increase in annual rainfall by mid-century, with a slightly larger increase of 27% projected for the period 2081-2100. These percentages are not intended to be presented as firm predictions of future rainfall. Despite this limitation, they nevertheless provide for a useful indication of the possible scale of the impacts of climate change on rainfall in the CoJ as well as indicating the probable trend i.e. for increased rainfall.

There is also a general agreement among the models for an increase in the number of rain days going forward i.e. increased average rainfall may come not only in the form of more intense rainfall events, but also due to an increase in the frequency of rainfall events.

![City of Johannesburg: annual mean daily precipitation](image)

**Figure 2:** Time series of downscaled mean annual daily precipitation (mm). Control Period: 1961-2000, near future: 2046-2065 and far future: 2081-2100 for Johannesburg. The horizontal line represents the long-term median value for the 7 model simulations of the control period (1961-2000). The dark line represents the median value for the 7 projections.
of the future climate. The shaded area denotes the envelope of these projections (CSAG 2009).

**Extreme Precipitation**

Heavy rainfall days (over 10mm/day) are projected to increase moderately into the future. Further increases are projected to occur by the turn of the century, but these increases appear to occur predominantly in the autumn and spring. However, the model projections indicate only a marginal increase in the relative frequency of the heaviest of rainfall events (days with precipitation over the 90th percentile). It is noted that there is a significant degree of uncertainty with respect to the projections for extreme precipitation events.
Potential Impacts of Climate Change in the City of Johannesburg

As at both the global and country scale, climate change will negatively affect the food production, health, biodiversity, human settlements and industry in the City of Johannesburg. Table below gives an indication of the impacts of climate change on these sectors.

Table 1: Sectoral impacts of climate change in Johannesburg

<table>
<thead>
<tr>
<th>Phenomenon and direction of trend</th>
<th>Food production &amp; Biodiversity</th>
<th>Water resources</th>
<th>Human Health</th>
<th>Human Settlements, Society &amp; Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot days and nights</td>
<td>Decrease in food production, increase insect outbreaks</td>
<td>Decrease in water availability due to evapo-transpiration</td>
<td>Decreased activity and economic output</td>
<td>Increase in energy demand for cooling, deterioration of air quality</td>
</tr>
<tr>
<td>Warm spells/Heat Waves</td>
<td>Decreased food yields due to heat stress, decrease in food security and increased danger of wild fires</td>
<td>Increased water demand and decrease in water quality e.g. algal blooms</td>
<td>Increased risk of heat related mortality, especially for the elderly, chronically sick and socially isolated</td>
<td>Decrease of quality of life especially for those without appropriate housing</td>
</tr>
<tr>
<td>Heavy Rainfall</td>
<td>Destruction of biodiversity</td>
<td>Potential impacts on the quality of surface and groundwater</td>
<td>Increased risk of deaths, injuries and infectious respiratory and skin diseases</td>
<td>Disruption of settlements, commerce, logistics and societies due to flooding. Damage to infrastructure and loss of property</td>
</tr>
<tr>
<td>Dry spells/drought</td>
<td>Loss of biodiversity &amp; decreased food productivity</td>
<td>Decrease in water availability for many essential services</td>
<td>Increased risk of malnutrition, increase in food and water</td>
<td>Water shortages for human settlements, industry and society, potential for loss of investment and competitiveness</td>
</tr>
<tr>
<td>Thunderstorms and strong winds</td>
<td>Wind throw/uprooting of trees</td>
<td>Power outages disrupting water supply</td>
<td>Increased risk of death and injuries, Post</td>
<td>Disruption of economic activity, loss or property,</td>
</tr>
</tbody>
</table>
Building Resilience to Climate Change

It is important to note that even if we were to cut the greenhouse gas emissions at this moment, we will still be committed to a certain level of human induced climate change and adaptation will be necessary. Climate change adaptation is especially important in developing cities since those cities are predicted to bear the brunt of the effects of climate change. That is, the capacity and potential for humans to adapt (adaptive capacity) is unevenly distributed across different regions and populations, and developing cities generally have less capacity to adapt. The adaptation challenge grows with the magnitude and the rate of climate change. Therefore, accounting for and adapting to potential effects of climate change in the water sector among others are imperative—indeed, non-consideration of potential effects of climate change and adaptation on the city’s sectors, should be viewed as an act of omission. Consequently, many sectors in the CoJ will have to put adaptation measures to climate change since much of the change that will occur in the latter half of the century will be due to the past and current greenhouse gas emissions. Investment in adaptation can be unnecessarily confused and result in a delay in planning and implementation of urgent actions. Differentiating two forms of adaptation namely “acclimation type” and “resilience type” adaptation can assist with making the right investment decisions. Acclimation type adaptation addresses strategies to cope with the gradual changes in the background e.g. gradual warming. On the other hand, resilience type adaptation addresses the potentially damaging effects of changing climate extremes e.g. sudden major floods exacerbated by poor drainage systems (Midgley et al 2007).
Climate Change Adaptation Action Plan

As part of the formulation of the Adaptation Plan, climate model projections were carried out for the City of Johannesburg by the Climate Systems Analysis Group (CSAG) at the University of Cape Town. Seven internationally accepted General Circulation Models (GCMs) were statistically downscaled, using historic data from eight weather stations based in and around the City. The projections have been developed under the A2 ‘business as usual’ scenario similar to the Intergovernmental Panel on Climate Change in 2007. This study was commissioned to understand the anticipated climate change and the estimate of the extent and magnitude thereof at City level.

Climate Change Risk Assessment was undertaken subsequent to the above mentioned study to understand the risks and vulnerabilities. This resulted in the formulation of the Adaptation Action Plan for the City of Johannesburg. This study identified the following risks categorised according to a four tiered scale (or ‘Action Level’). Based upon the potential magnitude of the risk’s impact as well as the likelihood of the risk eventuating, the tiered action levels are:

a. Action Level A: Prioritise for Adaptation
b. Action Level B: Review Opportunities / Adapt within Constraints
c. Action Level C: Surveillance Monitoring
d. Action Level D: No Concern

The risks identified as Action Level A – Prioritise for Adaptation are:

- Risk T1: Increase in Heat-Related Deaths
- Risk T2: Increased Energy Demand
- Risk T3: Increased Water Demand (within the CoJ)
- Risk TP5: Biodiversity Impacts on Disease Vectors (Health Risks)
- Risk P1: Urban Flood Risk – Damage to Water Supply and Sanitation Infrastructure
- Risk P2: Urban Flood Risk – Damage to Property, Personal Injury and Impacts on Livelihood
- Risk P3: Urban Flood Risk – Increased Road Accidents and Traffic Congestion
• Risk P4: Urban Flood Risk to Electrical and Telecom Infrastructure
• Risk X1: Disruption to Water Security (arising from outside the CoJ)
• Risk X2: Climate-Change-driven Refugees and Migrants

An additional twelve Action Level B-rated risks were also identified which will warrant further attention in future, including the risk of increased shack and veld fires and the risk of disruption to food security. The climate change adaptation plan report has focused on the highest priority (in terms of climate change) Action- Level A-rated risks.

A key issue highlighted in this study is that much of the CoJ’s climate change-related vulnerability stems from the fact that several of the systems considered most likely to be impacted upon by climate change are already severely stressed under existing climatic conditions. This is particularly true for the CoJ’s stormwater infrastructure – of the ten Action Level A rated risks; four are related directly to the threat of an increase in urban flooding. It is the existing strain on the stormwater infrastructure that potentially gives rise to the greatest cause for concern. A wide range of adaptations have been developed for each of the Action Level A-rated risks and with consideration to the specific needs, constraints and requirements of the CoJ. Of critical importance in the short-term is the development of an Early-Warning System that will be used to prevent loss of life and property during extreme flooding events. Whereas there is no empirical evidence to determine a direct relationship between heat waves and loss of life in the COJ, this area however is of critical importance given the projected increase in maximum temperatures. It is important for the COJ to develop a heat wave response plan. In addition to these risk specific adaptations, a number of strategic-level adaptations have also been identified which have the potential to address a broad number of risks across multiple sectors.

These strategic adaptations are regarded as being fundamental for the CoJ’s effort to effectively adapt to the evolving threat of climate change. The strategic adaptations focus on the following areas:

• Integrating climate change adaptation into the CoJ’s strategic planning mechanisms, including a review of the management and organisational structures for implementing climate change adaptation (and mitigation) projects
• Developing alternative financing options for the funding of adaptations
• Developing a Climate Change Information Management System to support effective decision making within the CoJ
• Improving stakeholder engagement

Effective implementation of these and other risk specific adaptations will require commitment at both the planning and resource level from a broad range of CoJ departments, municipal entities and other stakeholders. More importantly, it will rely on effective communication and coordination among the different role-players. Hence it is advised that the Environmental Management Department take an active role in facilitating this coordination and communication wherever the need arises.

**Energy efficiency measures & green energy**

Energy Efficiency is regarded as a quick win area of intervention to improve electricity usage by all sectors. It requires measures that mainly include behavioral change especially in the context of South Africa where electricity has been cheap and in abundance for many years. Key initiatives to fast track Energy Efficiency include intensive campaigns to induce behavioral change and encouraging the public to invest in energy efficient appliances. Another quick win area is retrofitting of buildings with energy efficient lighting, geysers, energy saving IT gadgets and central warming systems where possible.

The City has been implementing a number of interventions to enhance energy efficiency and reduce demand across the city such as retrofitting Council owned buildings to improve consumption (lighting), retrofitting of solar water heaters in low cost housing, public/street lighting as part of the climate proofing and sustainable human settlements programmes for the city.
Resource Efficiency

Economic development at a national and city level will be impacted by the shifts in climatic systems. Commercial enterprises rely on resource availability, sustained energy supply, high business risk and associated social impacts. Almost all of the sectors listed in this report are directly or indirectly related to the economy. Resource availability will be hindered by climate change at a commercial and subsistence level. Commercial enterprises will experience hikes in water prices and other raw materials, as water availability decreases (as a result of decrease in rain in some parts of the country and increases in water demand) and climate change impacts on the current production of goods and services. Increased prices will impact smaller businesses, which rely on cheap commodities, possibly resulting in the closure of these enterprises. Food productivity and availability will also be impacted by the decrease in productivity and increase in raw material prices.

Climate change will therefore increase the vulnerability of the poor who rely on subsistence urban agriculture, and those businesses that rely on cheaper, readily available raw materials. Joburg is a key economic hub within Gauteng and South Africa, and strives to be a world class African city through its development goals. It is the single largest contributor to South Africa’s gross domestic product (GDP), and a high user of cheap energy supplies. Of foremost concern in the economic sector is the global
increase in the price of raw materials. This would hike the price of basic commodities and thus the price of living. Communities and society will be impacted not only by the impact of climate change (such as extreme events), but also by the increase in the cost of living. The ability to cope with these changes will determine the vulnerability of the society.

Joburg experienced an economic growth averaging 2% per annum over the last ten years (SoER, 2003). In 2002, GDP growth peaked at 6.5% (Joburg, 2006(a)). The City’s Integrated Development Plan (IDP) for 2007/08 has listed accelerating economic growth to 9% as a key objective for the City. As stated in the IDP (2007, 9): “in the future, Johannesburg will continue to lead as South Africa’s primary business city, a dynamic centre of production, innovation, trade, finance and services.” Joburg is an energy-intensive economy, and accelerating growth and development without consideration of the City’s vulnerability to climate change will result in several market-related impacts, described above. In addition, non-market impacts would include a reduction in living standards as more capital is spent on coping with the impacts of climate change. The output of an economy in a given year is dependant on the labour force, environmental quality and capital available. All three will be affected by climate change – either from the damaging effects on the health and productivity of the workforce, or loss and damage to infrastructure, or lower quality investment and capital. A preliminary assessment of impacts to the economy was conducted in 2002.
Other climate change vulnerabilities within Joburg include:

Mining and manufacturing – Although many of the gold mines that Johannesburg is legendary known for have closed down, mines and industries are still a major source of air pollution thereby contributing to deteriorating air quality for the citizens. Rainfall variability and/or extended periods of heavy or no rainfall will greatly impact these two economic sectors. These sectors currently account for one quarter of South Africa’s gross domestic product (Jury, 2002). The mines and/or industries are vulnerable to landslides and decreased productivity due to extreme weather events and the impact of decline in health of workers, damage to infrastructure, etc.; Mines and industries will need to review facilities such as storm water control systems, etc, in order to protect against extreme weather conditions, such as intense rain in short periods of time, flash flooding, hotter temperatures affecting working conditions and adequate ventilation, etc. The City will need to drive this to facilitate strategies which are not in conflict with the City’s growth and development plans;

Forestry and agriculture – Grasslands, woodlands, forests and cultivated land together account for about 13% of total land use in Joburg (SoER, 2003). Agriculture is not considered to be a vital contributor to the economic growth of the City (Joburg, 2006(b)) and contributes a mere 0.2% (Joburg, 2007). Should this sector decrease productivity, Joburg will not be affected economically directly, but rather through the indirect supply of products;

Food security – Joburg relies heavily on food brought in from other parts of the province and country, as well as other countries. Imported food will be affected as farmers and other producers adjust to the changes in land-use and biological systems that will result from changes in the climate, on a regional, national and global scale. In order to address food security, it will be necessary to assess the quantity of food brought into the city and the origin of the food. Alternative suppliers should be considered if the vulnerability of the supplier under climate change is too great. Measures should also be taken to raise the living standards to ensure that the population is able to afford inevitable rising food prices.
Insurance (Higher business risk) – The increase in business risk is a global trend – in Britain, changes in weather was identified as a driver of a 2% – 4% annual increase in property losses, and insurance models have estimated a 45% increase in previously expected insured losses due to the changes in the physical characteristics of extreme weather events (Thacker, 2006). Although more applicable to areas on the coastline where the possibility of sea levels rising exists, insurance claims could also increase in inland areas. Increases in extreme weather conditions and/or events would result in more claims. This could be as a result of severe episodes of rainfall, mudslides and other claimants affected by extreme weather events. Without effective mitigation measures in place, higher business risks could dissuade investors from investing in the City;

Tourism – Joburg is the most important destination in the province. Tourism to Joburg contributes significantly as a source of employment and revenue to Gauteng’s GDP; Soweto contributed R143 million to Gauteng’s GDP (Abraham, 2005). Tourists are from one of three categories – domestic, visiting friends and relatives and international tourists. Uncomfortable and/or unhealthy climatic conditions could result in a decrease in tourism to South Africa. People from countries with cold climatic conditions who would normally choose to visit South Africa could now also no longer find the need to do so as their climate warms up. Extreme weather conditions would also serve as a deterrent to tourists;

Migration – In the period between 1996 and 2001, Gauteng experienced a growth of 27%. While more than 400 000 individuals relocated to the province from KwaZulu Natal, Limpopo, Mpumalanga, North West and Free State (see Figure 14; Prinsloo, 2001), a significant number also come from the SADC region and Europe (Gauteng, 2004). In particular, Johannesburg experienced an average growth rate of 3.5% as of May 2007 (Masondo, 2007). As natural resources and food become scarce in other parts of the country and continent, increased movement of rural persons to the city will occur. This will place added strain on services and service delivery, and changes in climate will increase the vulnerability of these services functioning effectively. Migration into the city will be slightly more difficult to restrict. The City should attempt to prepare itself for the increase in population. Job creation, additional housing, service delivery and security will
be essential areas to consider. On the other hand, incentives will need to be put in place to retain the existing workforce within the city;

**Health** – Safe drinking water, sufficient food, secure shelter, and good social conditions are among the factors responsible for public health. Climate variability and climate change has the potential to affect some, if not all, of these factors, subsequently increasing health concerns among the poorest communities (Campbell-Lendrum and Corvalán, 2007). Population growth and unplanned urbanisation, which contributes to overcrowding, poverty and poor sanitation, will further exacerbate the following health impacts:

- Variable precipitation (resulting in flooding or droughts) will affect the availability of freshwater, thereby increasing the risk of water- and food-borne diseases;
- Changes in temperature, moisture, carbon dioxide levels and the spread of pests and diseases such as the East Coast Fever can result in a higher incidence of malnutrition due to unstable food production;
- Temperature-related illness and death;

Joburg forms the largest urban complex in South Africa, with an urbanization rate of 97%. Approximately 33% of the population is housed in less than adequate accommodation, with poor basic service delivery (SoER, 2003). Communities living in poverty-stricken areas of the City will be most vulnerable to health risks such as malaria that are associated with climate change impacts, as their ability to cope with new challenges are somewhat limited (see Figure 21). In addition, the lack of clean and hygienic surrounds increases the likelihood of the disease or parasite flourishing. For instance, in areas with more ‘rural’ surrounds (e.g. Alexandra, Orange Farm, Ivory Park), vector control e.g. the removal of larval breeding sites is often difficult. On the other hand, dengue fever is a largely urban disease and will be important in highly urbanized communities with poorly managed water and solid waste systems (Githeko *et al*., 2000).

Food insecurity as a result of poor crop production places communities at great risk of malnutrition and disease. This will be exacerbated during extreme weather conditions, and particularly for communities living in informal settlements, who will experience high
levels of water pollution, water shortages and the associated heat stress. The population of the City is projected to increase to approximately 3.1 million by 2010, a projected decrease in the growth rate by approximately 0.9% per annum (SoER, 2003). This places the already high density living places communities in risk of health impacts.

**Sustainable Human Settlements**

The city realises the multiple benefits of adopting the new approach of sustainable human settlements from a precinct based perspective. The latter approach allows for holistic planning that includes sustainable infrastructure, environmentally friendly transport systems, resource (energy, water & space) use efficiency, and a healthy society. The Cosmo City Climate Proofing project set a benchmark in the city for future sustainable settlements. The settlements comprised of houses with ceilings to improve the regulation of temperature during winter and summer season, fruit trees to green the environment, provide food and create shade and finally solar water heaters to enhance energy efficiency. The CoJ has identified several projects that incorporate some or all of these components. However the major shift in this area is the proposed densification along the transport routes that include Rea Vaya Bus Rapid Transit System, Gautrain, Metrobus and the Metrorail systems (Figure 3). The plan is for commuters to access the integrated public transport system within a maximum distance of 1 kilometer.
Strategic / spatial priority

1km distance from

- Existing / Upgraded Rail +
- Developing Gautrain +
- Developing Phase1 BRT =

- Densification priority
- Infrastructure priority
- Capex priority
- Development priority

- Solar water heaters installed in Cosmos city
- Ceiling insulation, energy efficient lighting, planting of trees, rainwater harvesting and food gardens
Figure 3: Cosmo City Climate Proofing Project serves as the benchmark for transforming informal settlements into sustainable human settlements.
Measurement and Planning

The City is amongst the largest greenhouse gas emitters in South Africa and the main sources are sectors such as Industry and Commerce, Transport, Local Authority, Households etc.

The City is currently embarking on a course to calculate its carbon footprint to understand the state of Greenhouse gas emissions in the City. The World Resources Institute (WRI), C40 Cities Climate Leadership Group (C40), and ICLEI – Local Governments for Sustainability (ICLEI) are jointly developing an international greenhouse gas (GHG) accounting standard for cities, called the Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC). The standard provides cutting-edge advice and support to local governments for a transparent, consistent and common approach to emissions measurement. This can enhance access of local governments to global climate funds. The GHG Protocol also offers the City of Joburg an internationally
accepted management tool to help to compete globally and to make informed decisions about climate change.

The City of Joburg is one of the first cities to implement this protocol as it is looking to measure and manage its emissions to improve quality of life and attract funding. In the long term the GHG monitoring system will assist in allocating carbon budgets to the different sectors as articulated in the National White Paper on Climate Change. It is therefore crucial that the City establishes a GHG monitoring system to create a baseline for the city’s carbon footprint as well as future trajectories under business as usual and required by science scenarios.

An initial greenhouse gas emissions inventory which was based on National targets resulted in the following sectoral targets for short, medium and long terms. The targets on table 2 below were derived from the national Energy Efficiency Strategy and the Long Term Mitigation Scenarios (LTMS) which assumes that all interventions outlined in the action plan are undertaken with minimal costs. The targets indicate that on the short term basis till 2015, the target for the municipality as a whole would be 28,863MWh per annum energy savings, resulting in a CO₂ reduction of 27,760t of CO₂ emissions by 2015. However, the targets mentioned below must be revised to include data from other sectors and give an accurate baseline and realistic future targets. This target will be one of the CoJ achievements that will be announced at the C40 Mayor’s Summit to be hosted by the City in February 2014.

**Table 2 : Implied 50-years sectoral target for CoJ**

Incorporating the principles of the Energy efficiency strategy and the LTMS, emission reduction targets from the table below for CoJ have been categorised into the following:

<table>
<thead>
<tr>
<th>Duration</th>
<th>Short Term</th>
<th>Medium Term</th>
<th>Long Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual % Reduction for this period</td>
<td>10%</td>
<td>20%</td>
<td>13%</td>
</tr>
</tbody>
</table>
The emissions reduction showing in the table below is cumulative for the three reduction phases as described above:

<table>
<thead>
<tr>
<th>Sector</th>
<th>Target (%)</th>
<th>Target (GJ)</th>
<th>Target (MWh)</th>
<th>Target (Tonnes CO₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industrial and Commerce</strong></td>
<td>2015 (10 %)</td>
<td>2,908,022</td>
<td>807,842</td>
<td>704,786</td>
</tr>
<tr>
<td></td>
<td>2025 (30%)</td>
<td>8,724,066</td>
<td>2,423,527</td>
<td>2,114,359</td>
</tr>
<tr>
<td></td>
<td>2050 (43%)</td>
<td>15,412,517</td>
<td>3,473,722</td>
<td>3,030,581</td>
</tr>
<tr>
<td><strong>Local Authority</strong></td>
<td>2015 (10 %)</td>
<td>103,933</td>
<td>28,863</td>
<td>27,660</td>
</tr>
<tr>
<td></td>
<td>2025 (30%)</td>
<td>311,799</td>
<td>83,589</td>
<td>82,980</td>
</tr>
<tr>
<td></td>
<td>2050 (43%)</td>
<td>5,508,45</td>
<td>149,974</td>
<td>146,598</td>
</tr>
<tr>
<td><strong>Transport</strong></td>
<td>2015 (10 %)</td>
<td>8,999,061</td>
<td>2,499,948</td>
<td>608,767</td>
</tr>
<tr>
<td></td>
<td>2025 (30%)</td>
<td>26,997,183</td>
<td>7,499,844</td>
<td>1,826,301</td>
</tr>
<tr>
<td></td>
<td>2050 (43%)</td>
<td>47,695,023</td>
<td>13,249,725</td>
<td>3,226,466</td>
</tr>
<tr>
<td><strong>Domestic</strong></td>
<td>2015 (10%)</td>
<td>2,516,750</td>
<td>699,167</td>
<td>597,396</td>
</tr>
<tr>
<td></td>
<td>2025 (30%)</td>
<td>7,550,250</td>
<td>2,097,501</td>
<td>1,792,188</td>
</tr>
<tr>
<td></td>
<td>2050 (43%)</td>
<td>19,127,300</td>
<td>3,705,585</td>
<td>3,166,199</td>
</tr>
<tr>
<td><strong>Total by year 2050</strong></td>
<td></td>
<td>82,234,840</td>
<td>20,579,006</td>
<td>9,569,844</td>
</tr>
</tbody>
</table>

**NB**: Total reductions per sector by 2050 is 43%

### Energy efficient buildings

Power supply shortages are expected to put the squeeze on new property development in Johannesburg. Starting immediately, a set of basic requirements for energy efficient development will be considered in the adjudication of all development applications sent in to the City. The approval of new building plans will specifically consider two criteria: the natural heating provided in winter through north-facing buildings; and buildings allowing eave overhangs of at least 700mm on north, east and west facades, facilitating shade in summer and sun penetration in winter. Other measures that will be strongly
encouraged include solar water heating systems, roof insulation, energy efficient light fittings, and motion or timer sensors on lights, air conditioners and geysers.

The new requirements will force property developers and home builders to ensure greater energy efficiency and will cut demand for electricity. They will apply to City-initiated projects as well as private sector developments. Initially the new requirements will rely on voluntary compliance; however they will soon be regulated.

The City will also strongly encourage the retrofitting of existing buildings with energy saving devices. Incentives for this are being considered. Over the next five years, the City hopes to reduce electricity consumption in Johannesburg by 25 Megawatt hours. It is working towards becoming energy efficient and is busy retrofitting selected council buildings with energy efficient lighting. This project will eventually be extended to all council-owned buildings and street lighting. Other plans include introducing energy efficient pump systems at its water treatment works; installing solar heaters in low cost housing; and solar street lighting in informal settlements.

The Council for Scientific and Industrial Research has helped the City to draw up guidelines for energy efficient buildings and in promoting the project among developers. These guidelines have been developed to support the development of energy efficient buildings within the City of Johannesburg. It provides practical guidance on ways of designing buildings that minimize the requirement for energy and has been developed by the City as part of a strategy to reduce energy consumption and address climate change within the municipality. It focuses on the design of buildings and have been developed for use in the early design stages of a new building. While the guidelines mainly address energy use in building operation they also include aspects where buildings can contribute to energy efficiency in the wider context, through for instance, reducing vehicular use etc.

City of Johannesburg as a C40 Steering Committee Member

The City of Johannesburg's participation at the C40 cities network has proven that the mayor has powers necessary to mitigate and adapt to the impacts of climate change can
never be underestimated. While many national governments have consistently struggled at home and on the international stage to take actions necessary to prevent catastrophic climate change, C40 cities have forged ahead as innovators and leaders in this arena.

The C40 is making a significant difference in improving the scale and speed with which the cities take climate change action. There is considerable opportunity to accelerate carbon reduction and climate adaptation measures across C40 cities such as Johannesburg. The city of Johannesburg is already undertaking significant and innovative climate action and plays a leading role in the African Continent. As the first African city to host the C40 Mayors Summit in 2014, the City of Johannesburg is already aligning its strategies and plans within specific sectors that respond directly to the impacts of climate change. There is a considerable opportunity for the city to accelerate emission reduction in sectors such as transportation, buildings, waste management, water, energy supply, Planning and urban land use, Food and urban agriculture, Information and communication technology, finance and economy, sustainable communities and climate adaptation etc. The City of Johannesburg is looking forward to working collaboratively with other C40 cities through the networks to deliver on our shared and transformative aspirations.