Local Renewables: South-south cooperation between cities in India, Indonesia and South Africa

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Ekurhuleni Metropolitan Municipality

Urban Energy Profile

1 Preface

ICLEI – Local Governments for Sustainability, with the support of Renewable Energy and Energy Efficiency Partnership (REEEP), under a project entitled: 'Local Renewables: South-south cooperation between cities in India, Indonesia and South Africa' initiated a project on carbon emission reduction through city level local action plans by integrating renewable energy (RE) and energy efficiency (EE) measures into city activities. This project is led by the ICLEI South Asia Secretariat which through its city network is providing knowledge and experience on best practices and lessons learnt from the established ICLEI Local Renewables initiatives successfully implemented in Asia. Through the partnerships with ICLEI South East Asia and ICLEI Africa, the Indian city, Coimbatore, acted as the Local Renewables *Resource City*, providing guidance and experience to the two implementing project cities or Local Renewables *Model Cities*, which are Ekurhuleni Metropolitan Municipality in South Africa and Yogyakarta City in Indonesia.

This project commenced in October 2011 with all activities and processes planned and implemented up to the project end date, March 2013. The main activities under this initiative was to strengthen stakeholder engagement, enhance and strengthen capacity of RE and EE, update the existing GHG into an urban energy profile, provide cost effective low emissions solutions and recommendations that could assist future plans to support local emission targets. This document aims to provide information that would assist future activities within the urban area to achieve carbon emission reduction across all city sectors and promote green urban growth by encouraging the use of RE and EE technologies at the city and community levels.

In the process of developing this document Ekurhuleni Metropolitan Municipality (EMM) State's Energy report was considered as a baseline for energy information. The EMM State of Energy Report was prepared in 2003/2004 to assist and inform the development of the EMM Energy and Climate Change Strategy (2007). The State of Energy Report (2004) provides a baseline for urban energy policy and planning, defines the energy and emission balance consisting of energy use by energy carrier, by users (demand sectors) and supply sources.

ICLEI – Local Governments for Sustainability – Africa (ICLEI Africa) and EMM engaged with a stakeholder group throughout the project duration consisting of EMM sectoral departments, Department of Energy from the local, provincial and national governments, private entities, NGOs, academic institutions, development agency, RE/EE equipment manufacturers and suppliers, energy consultancies, associations and architects. This group provided input to the project deliverables and supported the project team towards the development of the project outputs.

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2 Disclosures

ICLEI – Local Governments for Sustainability

ICLEI - Local Governments for Sustainability is the world's leading association of cities and local governments dedicated to sustainable development. ICLEI is a powerful movement of 12 mega-cities, 100 super-cities and urban regions, 450 large cities as well as 450 small and medium-sized cities and towns in 84 countries. ICLEI provides technical consulting, training, and information services to build capacity, share knowledge, and support local government in the implementation of sustainable development at the local level. Our basic premise is that locally designed initiatives can provide an effective and cost-efficient way to achieve local, national, and global sustainability objectives.

The ICLEI Africa Secretariat (www.iclei.org/africa) collaborates closely with the global ICLEI network and other regional offices around the world, in sharing tools, materials, strategies and good practices specifically designed and implemented at the local level. ICLEI Africa's key environmental work streams within the Secretariat include Energy and Climate Change, Disaster Risk Reduction, Water and Sanitation, Urban Biodiversity and Integrated Urban Planning.

Renewable Energy and Energy Efficiency Partnership (REEEP)

Renewable Energy and Energy Efficiency Partnership (REEEP) is an active global partnership that structures policy initiatives for clean energy markets and facilitates financing for sustainable energy projects. The Partnership was established alongside the 2002 World Summit on Sustainable Development in Johannesburg. Over its ten-year lifespan, REEEP has established itself as a vocal champion for clean energy – energy efficiency and renewable energy – punching above its weight in three ways: by funding innovative projects, by providing internet-based information resources, and by supporting clean energy stakeholders. The organisation is now comprised of 400 partners including 45 governments as well as a range of private companies and international organisations. Some 5200 individuals are also registered as Friends of REEEP.

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Acknowledgements

Without the support and commitment from the Energy Services Department of Ekurhuleni Metropolitan Municipality, this project would not have been a success; therefore we would like to acknowledge their support towards delivering the project and for ensuring their commitment towards future low emission development. Special thanks to all the departments/agencies that provided the energy consumption data, which enabled the research team to undertake the necessary urban carbon analysis.

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ICLEI – Africa

Contributions by:

Ekurhuleni Metropolitan Municipality

in partnership with

ICLEI – South Asia

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3 Introduction: Role of Cities in the Climate Change Challenge

Climate change, arising due to increasing concentration of Greenhouse Gases (GHGs) in the atmosphere since pre-industrial times, has emerged as a serious global environmental issue and poses a threat and challenge to mankind. The scientific consensus holds that this is largely a consequence of human-generated emissions of GHGs. The situation is likely to worsen if the human population continues to emit large quantities of carbon dioxide and methane and other GHGs into the atmosphere. Urban areas are the major sources of emission of GHG which result in short term and long term climatic change related problems. Cities represent half of the world's population and consume 80% of the total energy and emit a significant amount of emissions into the atmosphere (World Bank 2010). GHGs are released through consumption of electricity in residential areas, commercial setups, industrial zones, and from a range of local authority activities. It is estimated that more than half of the world's population will soon reside in urban centres increasing the pressure on satiating energy needs manifold while GHG emissions rise in parallel. Therefore, the essential requirement is to enable cities to understand the energy consumption patterns and provide guidance for local authorities to reconstruct a change in energy use and resources through the identification of local energy efficiency measures and renewable energy alternative sources. This ensures creation of sustainable means to satisfy current and future energy demands from available options thus ensuring returns from affordable investments in the initiatives undertaken thereof.

Local governments (LGs) can comprehensively address climate change challenges by facilitating conciliation of public and private partnerships and interests; integrating sustainable energy use into local development goals and by implementing low carbon actions.

4 Urban Energy Profile Objectives

EMM Urban Energy Profile aims to assist and provide focus and direction in the achievement of the specific goals within the EMM Energy and Climate Strategy (2007) and informs the development of the EMM Climate Change Action Plan. The EMM Urban Energy Profile used raw verified energy consumption data that was available and accessible at that time by transparent data sources to establish the current energy status of the urban activities.

This document will assist to ensure systematic processes in implementing energy performance measures. Tangible steps for short, medium and long term actions should be regularly evaluated, monitored and updated on an annual basis, to reflect recent achievements, changes in performance, and shifting priorities. Section 8 emphasizes the need for the cyclic monitoring and evaluation process to continue beyond the lifespan of such a project. It provides a step-by-step approach for a city to customize, monitor, evaluate and report the GHG emissions. Which include the targets and reduction measures required by national, international standards and the principles embedded within the International Local Government Greenhouse Gas Emissions Analysis Protocol (IEAP).

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5 Ekurhuleni Background

EMM was established as one of eight metropolitan municipalities subsequent to the restructuring of local governments in South Africa in 2000. EMM is the fourth largest municipality in South Africa with nine local authorities and 101 wards.

EMM is also known as East Rand, the eastern region of Gauteng Province in South Africa. It consists of 192, 355 hectares of land which is occupied by about 3.2 million people (Statistics South Africa, 2011), occupying approximately 900,000 households (EMM Full Term Report 2006-2011, 2011).

EMM united eleven former councils into one local government authority to meet the needs of the communities in a holistic approach. The councils are Alberton, Benoni, Boksburg, Brakpan, Edenvale, Germsiton, Kempton Park/Tembisa, Nigel, Springs, Khayalami Metropolitan Council and Eastern Gauteng Service Council (see Figure 1).

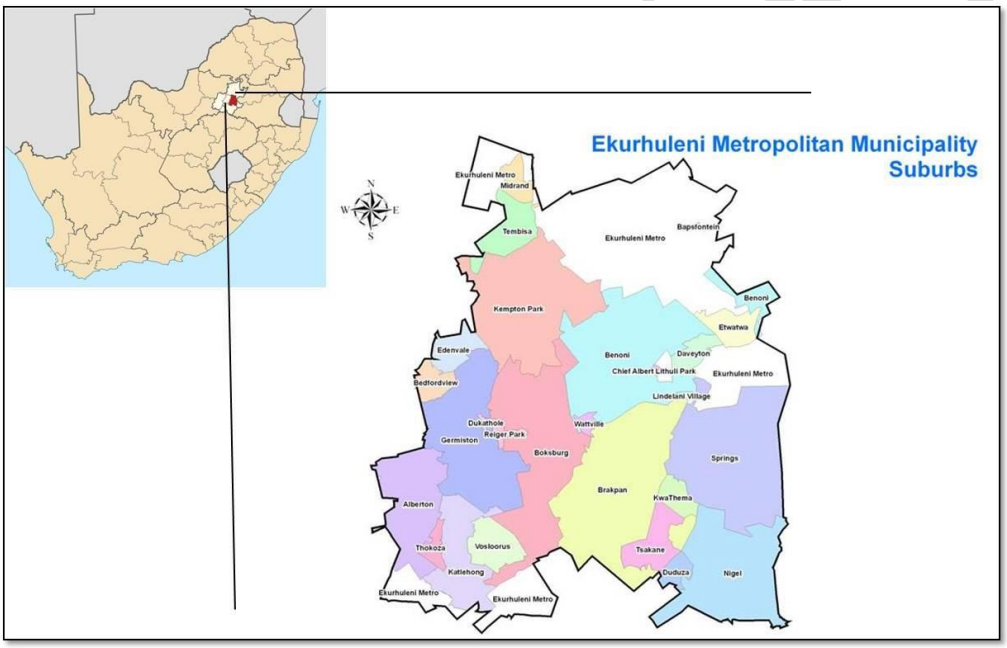

Figure 1: Ekurhuleni Metropolitan Municipality (EMM) situated within Gauteng Province, Republic of South Africa

EMM is responsible for about 23% of the Gross Geographic Product of Gauteng with the inputs of approximately 33,000 business entities, including 8,000 industries, over 5,000 supporting enterprises and an active commercial sector (EMM Full Term Report 2006-2011, 2011). EMM is an entity of globally competitive business and industry. It is regarded as the transportation hub of the country with a network of roads, airports, rail lines, telephones, electricity grids and telecommunication networks. The municipality is home to the O.R. Tambo International Airport, the busiest airport in Africa with nearly 19 million passengers in 2011 (ACSA, 2012).

Table 1: Ekurhuleni Facts and Figures. (Sourced from EMM Full Term Report 2006-2011, 2011)

Surface Area	1,924 km^2
Population	3.2 million (StatsSA,2011)
Population Density	1,400 people per km^2
Proportion of Gauteng Population	28%
Population Growth (2004-07)	1.6%
Main Income Areas	Manufacturing, Trade, Social Services
Electricity Use per Annum	15,513,201,926 kWh
Emissions per Capita	7.7 tCO_2e
Annual Budget	R21 Billion
Budget for IDP Projects	R2 Billion

Ekurhuleni Metropolitan Municipality
Vision: The Smart, Creative and Developmental City.
Mission: Ekurhuleni provides sustainable and people centred development services that are affordable, appropriate and of high quality. EMM are focused on social, environmental and economic regeneration of the city and communities, as guided by the principles of Batho Pele (means '*People First*') and through the commitment of a motivated and dedicated team.

5.1 Local Government Organogram

Ekurhuleni's Political, Administrative and Departmental structures at the local level

5.1.1 Political setup:

Figure 2: Political Structure of EMM

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5.1.2 Administrative setup:

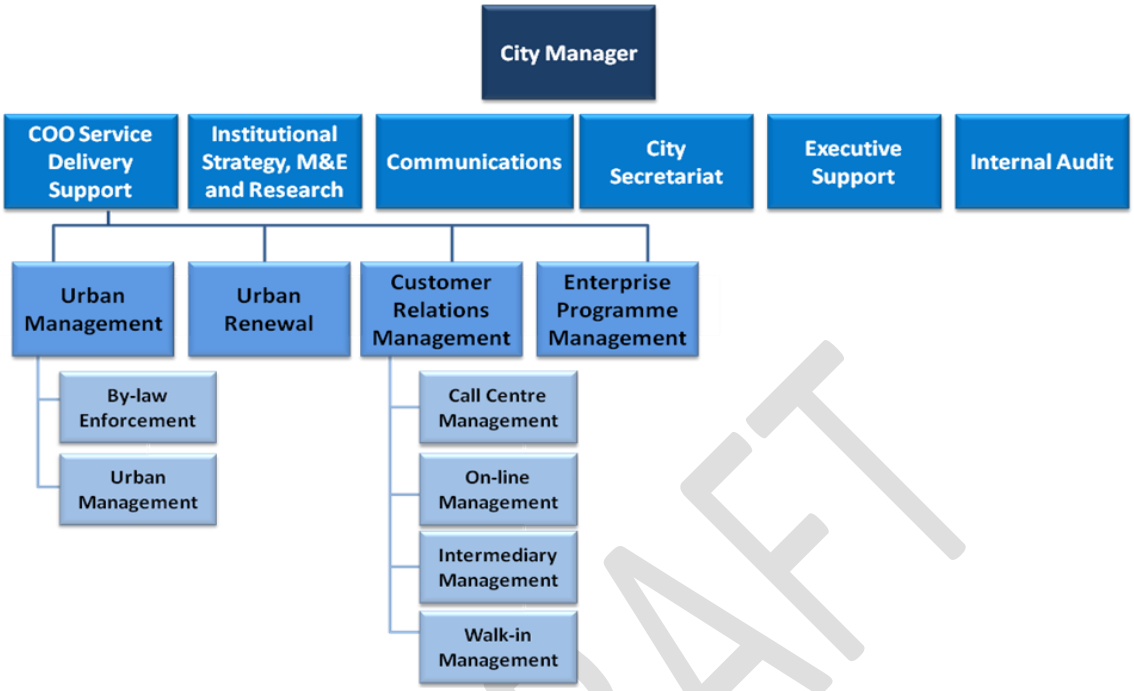

Figure 3: Administrative Structure of EMM – 6 departments providing institutional management

5.1.3 Departmental setup:

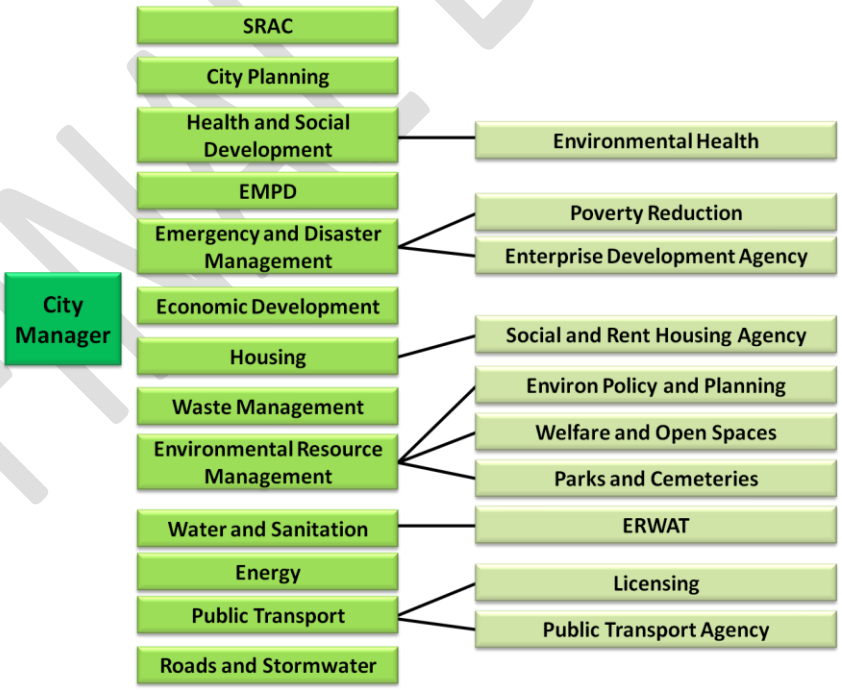

Figure 4: EMM Service Delivery Structure

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5.1.4 Ekurhuleni's Legislation and Regulation

2002: **Electricity By-law** – This document provides for the supply and usage of electricity within the municipal area of the municipality and to provide for matters incidental thereto.

2004: **State of the Environmental Report** – The Report provides information to decision-makers within EMM to enable them to make informed decisions about the environment in Ekurhuleni. This document presents a summary of the *First Year State of the Environment Report for 2003/2004*. Both documents aim to provide information on the condition of the existing environment in Ekurhuleni to the public, and to raise awareness of environmental issues which will contribute to the progress toward the achievement of sustainable development.

2004: **Ekurhuleni State of Energy Report** – The document provides a status report on the use of energy in EMM, which includes an assessment of the type of data available relating to energy supply and demand by energy carrier and by energy user. Through this report it was documented that energy consumption data was not easily accessible at the local level by city sectors, commercial and industrial sectors. Sources of data used for the report to determine the local energy status was obtained by private entities, such as Eskom and national government departments such as Department of Mineral and Energy and Department of Transport. Results from this report concluded the following energy consumption totals and statistic per sector:

Transport:	48,448,484 GJ (41%)
Industry and construction:	42,665,448 GJ (36%)
Residential:	16,974,631 GJ (14%)
Mining:	4,510,144 GJ (4%)
Commercial:	3,554,479 GJ (3%)
Local Government:	1,271,119 GJ (1%)
Agriculture:	1,227,983 GJ (1%)
TOTAL:	**118,652,288 GJ (100%)**

2007: **Climate Change and Energy Strategy** – This strategy is a plan that aims to integrate and entrench sustainable energy approaches and practices at the local level. It prioritises and co-ordinates energy and climate change activities. It promotes the improvement of service delivery and quality of life, saving of money and reduction of greenhouse gas emissions. In the short term, it assists the city with its overall development objectives. The strategy indirectly makes reference to a emissions reduction target by referring to the national energy reduction targets stated within the DME Draft Energy Efficiency Strategy (April 2004) and the National Energy Regulator's Regulatory Policy on Energy Efficiency and Demand Side Management (EEDSM) for South African Electricity Industry (May 2004), however there is emission reduction target stated within local policy to demonstrate municipal targets for emissions reduction. The DME draft policy provides specific targets for reducing energy demand by 2014 within given demand sectors, with an overall target of 12% reduction in consumption.

Devoid of a specific energy reduction target the, the Climate Change Energy Strategy aims to support the city's social, economic and environmental wellbeing, through (SEA, 2007):

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• Providing adequate energy for economic growth.
• Supporting poverty alleviation by promoting clean, safe and modern energy to households.
• Saving money by improving the efficiency of energy use.
• Reducing harmful effects of energy use such as pollution and global warming, by promoting cleaner, renewable energy sources.
• Promoting the use of more efficient transport, with a focus on public transport.

5.1.5 Ekurhuleni's past energy status:

Eskom supplies the city with electricity, from which EMM sells and redistributes electricity to over 400 000 customers, totalling budget sales for year 2011/2012 of approximately R10 billion (EMM, 2011). To understand the energy emissions for EMM as a whole, EMM undertook an energy audit and released the results in the Ekurhuleni State of Energy Report in 2004. From this report the Ekurhuleni Energy and Climate Change Strategy (2007) was developed with the aim to integrate and entrench sustainable energy approaches and practices at the local level.

Ekurhuleni's sectoral emission contribution is illustrated within the three pie charts below for 2004[1], 2007[2] and 2011[3] (Figure 5). These GHG inventories are from three different studies providing different GHG results. Between the first two studies it can be noted that carbon emissions have decreased by almost half in the transport sector and the industry sector increased its carbon emissions from 36% (2004) to 42% (2007). The 2011 study provides a different picture and illustrates a change in the cities carbon emissions pattern. In 2011 the Residential/Housing carbon emissions are the largest emitters with the Commercial sector contributing to a larger extent in comparison to the previous studies.

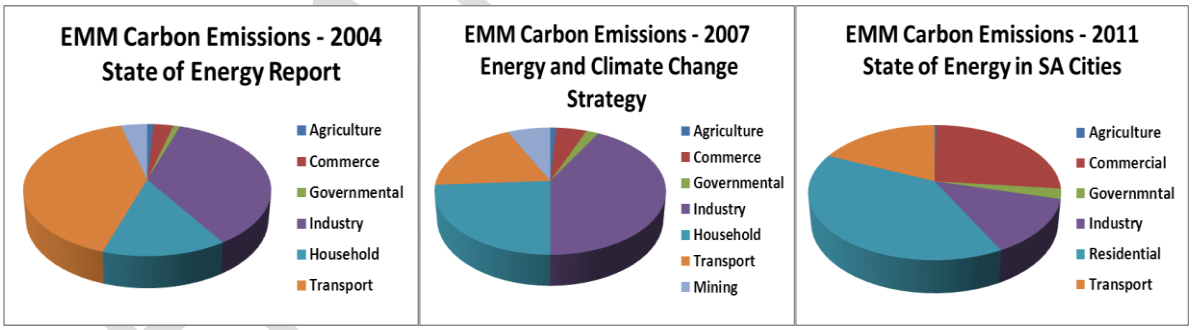

Figure 5: Three GHG Inventory study results that were undertaken for Ekurhuleni in 2004, 2007 and 2011

A recent study compiled by Sustainable Energy Africa (SEA) in 2009, revealed the state of energy in the 'Gauteng Integrated Energy Strategy: Status Quo Report' (Figure 6). The report revealed that the largest energy consumption in the province comes from transport sector accounting for 66% of the total energy use, with households and commercial sectors using 16% and 10% of the total demand' respectively (SEA, 2009). The following energy data analysis was revealed from baseline 2007 data for Ekurhuleni Metropolitan Municipality:

[1] EMM State of Energy Report, 2004. Baseline year: 2002/2003,
[2] EMM Energy and Climate Change Strategy, 2007. Baseline year: 2003/2004
[3] State of Energy in South African Cities 2011. Baseline year: 2007.

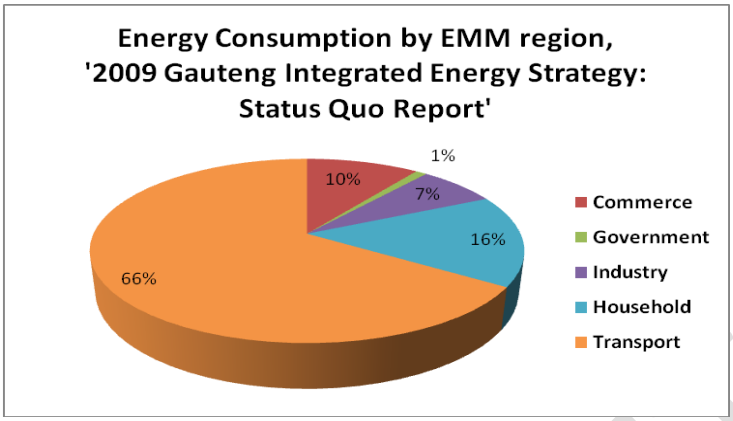

Figure 6: Ekurhuleni energy consumption sectoral totals that were revealed within the 2009 Gauteng Integrated Energy Strategy: Status Quo Report (SEA, 2009)

5.1.6 Energy initiatives undertaken by Ekurhuleni from 2006 - 2011[4]

- Free Basic Electricity (FBE) set at 100 units (twice of what is required by National Policy) is provided to Tariff A-lifeline and Tariff A customers since June 2005;
- Since 2006 368 High Mast Lights were installed to promote safety and security within the communities;
- A total of 3445 street lights were installed;
- The Electricity 20 year Master Plan informs expansion and strengthening of networks;
- January 2010 an Energy Director was appointed to focus on energy efficiency initiatives;
- 2000 high pressure solar water heater systems were installed in various council owned buildings;
- 1350 low pressure solar water heater systems were installed in hostel complexes;
- 10 000 solar water heaters were installed to low cost housing during 2010/11 with a ten year free maintenance period;
- 43 000 energy efficiency lights of various sizes were installed at various council buildings;
- 400 traffic light intersections were converted to low power LED signal heads;
- 8 659 street lights were converted to energy efficiency units;
- A number of key interventions were made to ensure that electricity revenue processes are managed effectively such as Revenue demand meter, credit meters and Prepayment meters.

Did you know?
Ekurhuleni received Gauteng Clean and Green Bontle ke Botho award in 2005/06 and was a finalist in the National Cleanest Towns Competition.

[4] Ekurhuleni Metropolitan Municipality Full Term Report, March 2006 to April 2011

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6 Ekurhuleni Energy Profile

6.1 Methodology

This section focuses on the Urban Energy Profile for EMM for the year 2011. The Urban Energy Profile was conducted in accordance to the approved principles and standards of the International Local Government Greenhouse Gas Emissions Analysis Protocol (IEAP) version 1.0 (October 2009) developed by ICLEI – Local Governments for Sustainability. The IEAP provides a set of guidelines to assist local governments in quantifying the greenhouse gas emissions from both their internal operations and from the whole communities within the geographical boundaries. The Protocol aims to improve the consistency with which the standard is applied and which the resulting information is publically reported.

This report aims to adhere to the IEAP principles through local government emission ***relevancy, completeness*** by accounting of all GHG activities within the boundary, promoting ***consistency*** of GHG accounting methodology, through ***transparency*** in a factual and coherent manner and enhancement of the ***accuracy*** of the information to enable decision making with reasonable assurance.

In an effort to develop a comprehensive carbon inventory and to understand the city activities impacts, emissions and what mitigation measures best suit the local government's development plans, an ICLEI emissions accounting software package was used to provide the analysis. HEAT+ incorporates the latest technical findings (IPCC, 2006) and is based on the International Local Government GHG Emissions Analysis Protocol (IEAP). Under the ^{Local}Renewables initiative, HEAT+ was proposed to be the anchoring tool for GHG emissions accounting providing an opportunity for it to be used and tested in the South African context. Complimentary to HEAT + a number of other GHG emissions calculators were used during the carbon inventory analysis.

The emissions inventory comprises of two parallel analyses, one for the local government operations and one for all the emissions within the community determined by the geographical boundaries of the jurisdiction. It must however be acknowledged that analysing community-scale emissions presents its own challenges as the natural flow of energy and materials is typically most accurate at the national level. Reducing the spatial area of an analysis, from national to sub-national level results in a lower level of accuracy in reflecting the energy flows. Therefore, analysing GHG emissions at a local community level means that a combination of national and local area information is required in order to model the emissions.

The section that follows will outline Ekurhuleni's main activities that are contributing to the urban carbon dioxide emissions, identifying the main energy carrier and the intense carbon emitting sectors that are situated within the urban boundaries of EMM.

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6.2 Data Sources

ICLEI Africa engaged through meetings and letters with a number of EMM, local, sub-national and national stakeholders to source the energy consumption data focusing on the large carbon emitters within the urban area. Energy consumption data was not easily accessible at the local level by city sectors, commercial and industrial sectors. Sources of data used for the report to determine the local energy status was obtained by private entities (such as Eskom), parastatals (such as RandWater, ERWAT), national governmental and provincial governmental departments as well as local government sectoral departments.

The baseline data year for this study was set for 2011 and each data set received included 2011 energy consumption data along with the previous years. The data used in this report was received by the sources listed below. To contact these data sources, requests should be directed to Director: Energy Services, Energy Department, EMM.

- Bulk Electricity sold to EMM: Eskom Ekurhuleni Regional Office
- EMM Electricity consumption by user: Revenue Services, Energy Department, EMM
- Residential Pre-Paid Electricity Consumption data: Customer Care Centre, Benoni, EMM
- Waste data: Landfill Management, Department of Environmental Development, EMM
- EMM vehicle fleet data: Brakpan Bus Services and Finance Department, EMM
- Traffic data: Licensing Department, EMM
- Metrorail electricity consumption: Passenger Rail Agency of South Africa (PRASA)
- OR Tambo Jet fuel and air travel passenger data: Airport Company South Africa (ACSA)
- Water CO2 Footprint: Scientific Services, Process Technology, Rand Water and Water and Sanitation Department, EMM
- Electricity consumption for Sewage Treatment: East Rand Water Care Company (ERWAT)
- Magisterial Fuel Sales Volume: Department of Energy, South Africa

6.3 Carbon Inventory

For this analysis, all the emission calculations performed in this report used emission factors that have been published by research organizations like Energy Research Centre of the University of Cape Town, Energy Information Administration (EIA) and Intergovernmental Panel on Climate Change (IPCC) reports. Emission factors used are region specific, where available.

For this analysis, the greenhouse gases that are quantified and included within this GHG Inventory report are the emissions of carbon dioxide (CO_2), methane (CH_4) and nitrogen oxide (N_2O) from fossil fuel combustion. Electricity generation (the indirect emissions associated with electricity use), waste disposal and wastewater are also considered the most significant source of greenhouse gas emissions.

These individual gases were converted to a carbon dioxide equivalent (CO_2e), which is the standard unit that accounts for the different strengths of each respective gas and its effect on climate change. It is called the g*lobal warming potential*. The global warming potential conversion factors are outlined by the UNFCCC for national reporting and in the IPCC's Second Assessment Report. i.e. 1 unit CO_2 is equivalent to 1 CO_2e; 1 unit CH_4 is equivalent to 21 CO_2e and 1 unit N_2O is equivalent to

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310 CO_2e. Therefore it must be noted that the results of a CO_2e study will have significantly higher figures than a CO_2 analysis.

Emission scopes were considered in this analysis; they are used to categorize emission sources as follows:

***Scope 1** emission* – All direct emission sources located within the geographical boundary of the local government.

***Scope 2** emission* – Indirect emissions that result from as a consequence of activity within the jurisdictions.

***Scope 3** emission* – All other indirect and embodied emissions that occur as a result of an activity within the geographical boundary.

The EMM analysis is outlined in the following sections below. Data summaries are provided in tables with a selection of graphs representing CO_2e emissions results for **Energy Types** (Electricity, Waste and Fuel), **Sectoral Emission Summary** and **Community vs. Government** comparison.

6.3.1 Energy Types

I. Electricity consumption

The annual bulk electricity sold by Eskom to EMM was received from Eskom's data base. It enabled a comparative analysis of the total electricity that is redistributed by EMM to the respective users. The 2011 bulk electricity sold to EMM was 10,926.58 MU (million kilowatt hour units); EMM redistributed 10,385.83 MU which could be accounted for. The unaccounted 540.75 MU was classified as 'distribution losses' and assigned, according to energy protocols, to the local government emissions separately and not directly allocated to local government operations. Electricity losses can be as a result of 'technical' losses (when electricity is transformed from higher voltages to lower voltages) and 'non-technical' losses (from theft or if electricity consumption is not metered in the system). These losses are difficult to manage and assign accountability as it could be consumed by several urban sectors and therefore is allocated separate from the sectoral energy consumption results.

Electricity is redistributed by EMM to end users and these are classified according to the EMM Electricity Supply Tariffs codes, which are determined by the required voltage and capacity. Some of the Tariff codes were accompanied by tariff descriptions providing further information on end user specifications which enabled some of the data to be categorized within a particular sector (i.e. Residential, Commercial, and Industrial). However some of the data could only be classified as per Tariff code and thereafter assumptions were made accordingly. For example such an assumption was made for: Tariff A consumers are classified as *low voltage and small customers*, therefore categorized under residential sector; Tariff D consumers are classified as *high voltage and large consumers*, therefore categorized as industrial sector. Approximately 500 million kWh was distributed to end users; however the end users could not be classified according to an EMM Electricity Supply Tariffs code and therefore grouped as 'Unknown End User', which is also assigned to the local government separately and not allocated to local government operations.

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Additional electricity consumption data was incorporated into these calculations such as electricity consumed by pre-paid customers and water supply and sewage treatment sectors that are within the municipal boundary jurisdiction.

Figure 7 represents the electricity consumption per sector, keeping in mind the assumptions mentioned above. The EMM electricity consumption by sector chart indicates that the Industrial sector consumes the greatest proportion of electricity (47%), followed by Residential (31%), Commercial (11%) and the Local Government operations only 1%. An Unknown electricity group and electrical losses constitute 10% of the EMM electricity consumption with Agriculture and Local Government operational activities constituting minimal amounts in the urban area. Total indirect emission as a result of the electricity consumption within the EMM region accounts for 22 million tonnes carbon dioxide equivalent for 2011.

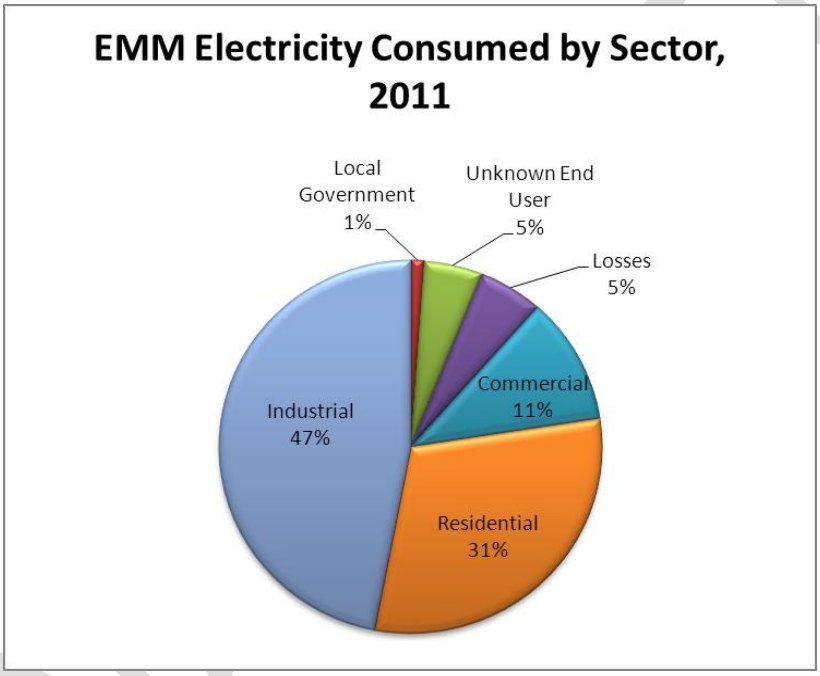

Figure 7: Sectoral distribution of EMM electricity consumption for 2011

II. Waste generation

Comprehensive waste data sets were provided by EMM Landfill Management unit for year 2006 – 2011 which were used for the EMM GHG Urban Energy Profile. The 2011 data set was used for the baseline year. The waste totals by end users for each of the years are provided in Table 2. The Municipality had already categorized the waste generated by end users as Private, Account Holders and Municipalities and therefore end users could be classified into sectors as Residential, Commercial and Local Government respectively. The waste composition types with the associated quantities for year 2011 are presented in Table 3 indicating that Mixed Municipal Solid Waste (Mixed MSW) is the largest quantity (77%) of generated waste within the metropolitan area (Figure 8).

The total amount of waste generated within the Ekurhuleni region for 2011 was just over 1.7 million kilograms which over the preceding years will emit an estimated total of 769.66 tCO2e.

Table 2: Waste disposal within the Ekurhuleni region by three different groups for 2006-2011.

	2007	2008	2009	2010	2011	TOTAL (kg)
Residential	329,395.33	307,034.08	264,884,603.00	186,181.75	294,493.34	**266,001,707.50**
Commercial	419,379.62	452,620.72	452,485,277.00	379,728.12	326,982.92	**454,063,988.38**
Local Government	865,548.03	806,329.72	930,398,683.00	874,662.11	1,084,649.30	**934,029,872.16**
TOTAL (kg)	**1,614,322.98**	**1,565,984.52**	**1,647,768,563.00**	**1,440,571.98**	**1,706,125.56**	**1,654,095,568.04**

Table 3: Total waste generated (classified by composition) within Ekurhuleni by user, 2011.

Composition	Local Government	Residential	Commercial
Mixed MSW	997,315.03	53,407.77	252,128.31
Yard Waste	82,590.07	229,533.22	67,025.70
Food Waste	2,225.52	488.28	2,225.52
Compost: Plant debris	2,516.02	10,681.59	2,117.31
Mixed Recyclables	-	0.16	-
Total (kg)	**1,084,646.64**	**294,111.02**	**323,496.84**

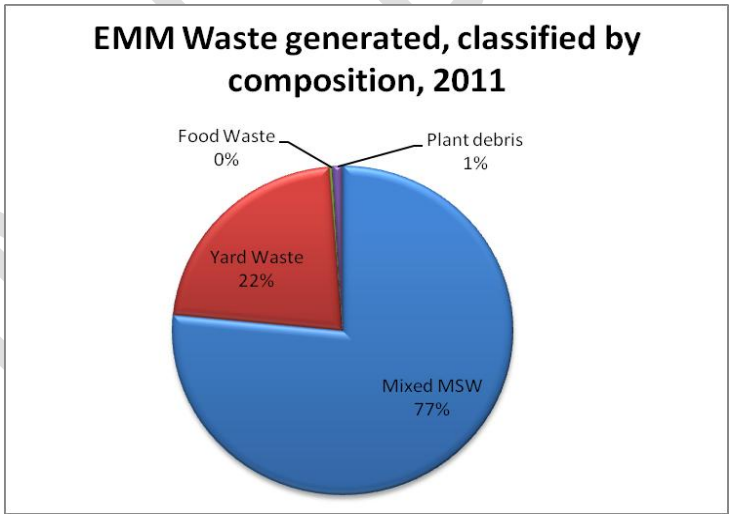

Figure 8: Graphical representation of the total waste that is weighed and classified at each of the landfill sites within Ekurhuleni for 2011

III. Fuel consumption

Ekurhuleni has 8 439 km of road network, of which 6639 km is tarred and 1 800 km is gravel, which includes 360 km of freeways. By and large the EMM does not suffer from traffic congestion. Only 7.2 per cent of roads experience a level of service E and another 3.5 per cent level of service F (indicating a high level of congestion). The congestion index for all roads in Ekurhuleni is

considerably lower than either Johannesburg or Tshwane. EMM has the greatest length of freeway, 0.43 lane-kilometres per 1000 population compared to 0.29 in Johannesburg and 0.42 in Tshwane (EMM State of Energy Report 2004). The total number of vehicles registered in the Ekurhuleni region was 1,071,830 vehicles in March 2012 (Table 4).

Table 4: Live vehicle population in Ekurhuleni region. Source: EMM Traffic Department.

Live Vehicle Population as at 31 March 2012	
Type of vehicle	**Total**
Heavy load veh(GVM>3500Kg, not to draw)	31169
Heavy load veh(GVM>3500Kg, equip to draw)	48769
Light load veh(GVM 3500Kg or less)	269826
Heavy passenger mv (12 or more persons)	3052
Light passenger mv (less than 12 persons)	626139
Minibus	27902
Motorcycle/Motor tricycle/Quadrucycle	37109
Special Vehicle	27117
Unknown	747
TOTAL	**1,071,830**

Table 4 indicates that over a million vehicles (privately owned) are licensed by the metropolitan's traffic department. Data providing information of private owned vehicles fuel consumption or total kilometres travelled for privately owned vehicles was not accessible and therefore for the purposes of the GHG Inventory some assumptions were made pertaining to these calculations.

The fuel used by the EMM region, obtained and verified by the Department of Energy of South Africa, for the year of 2011 was 3.623 million kilolitres consisting of 7 fuel types: Jet Fuel, Gasoline, Diesel, Furnace Oil, Liquid Petroleum Gas (LPG), Paraffin and Petrol. The fuel types were desegregated according to the National Department of Energy's desegregation by trade category methodology into respective sectoral percentages. The total amount of fuel used for EMM vehicle fleet and EMM Brakpan Bus Service was obtained by respective data sources which corresponds to the National Department of Energy's percentage split of allocation of fuels to the local government. EMM vehicle fleet (in 2011 was 5231 vehicles) and Brakpan Bus Service fleet (in 2011 was 40 vehicles) fuel consumption data was obtained and allocated to the local government operational emissions.

Vehicles are not stationery, but mobile and it cannot be assumed that where fuel is purchased it is consumed and emissions emitted within the proximity within the boundaries of the local government. Therefore quantities of emissions from the combustion of transportation were calculated based on the quantity of fuel purchased by suppliers within the region.

The percentage of RandWater's fuel consumption by transportation was also incorporated within this GHG Inventory to provide an estimate of the associated emissions for the delivery and supply of potable water for the Ekurhuleni region.

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EMM Water Department were unable to provide the fuel or electricity consumption quantities for each water pump station and therefore reverted to a Carbon Footprint study undertaken by RandWater which supplies the larger and extended region of Gauteng with potable water. For the year of 2011 RandWater supplied the region with an annual quantity of 1.47 trillion litres (daily average supply of 4 million litres) of which Ekurhuleni received and consumed a total of 0.33 trillion litres, therefore EMM constitutes about 22% of RandWater's consumption. It is then assumed that indirectly EMM is responsible for the emissions associated with water treatment, transportation and delivery accounted for in the RandWater Carbon Footprint. The figure allocated to water operations reflects 22% of the total emissions quantity provided by the RandWater study.

Fuel consumed by the EMM region for 2011 is presented by percentage in Figure 9. The EMM fuel volume sale figures were segregated into respective sectors according to the 2011 Trade Categories disclosed by the National Department of Energy.

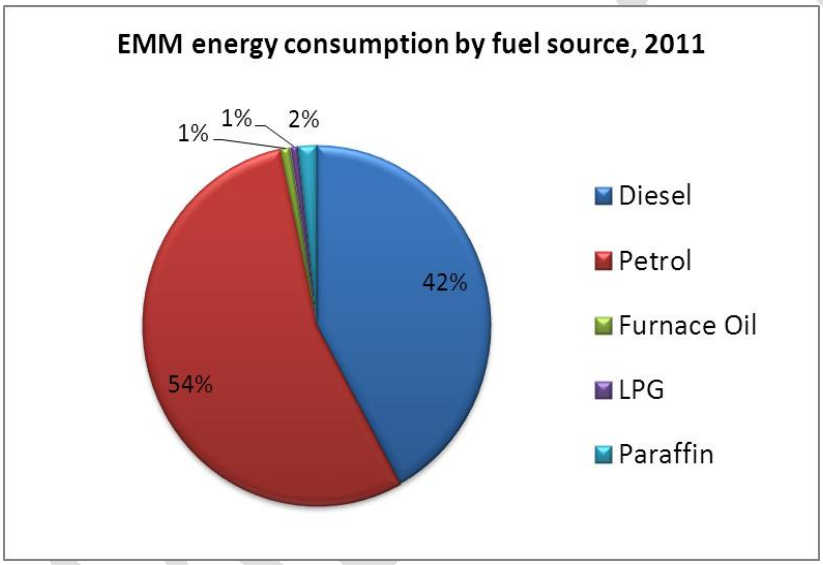

Figure 9: Emissions by Fuel Type in Ekurhuleni region, 2011

The total amount of emissions (tCO_2e) emitted from the consumption of fuel within the Ekurhuleni region for the inventory year of 2011 was 4.815 million tCO_2e.

Figure 10 presents the summary of carbon equivalent emitted by energy sources within the EMM region for 2011. Emissions from electricity consumed accounts for the highest percentage, 81%, while Fuel only 19% and Waste minimal in the larger picture.

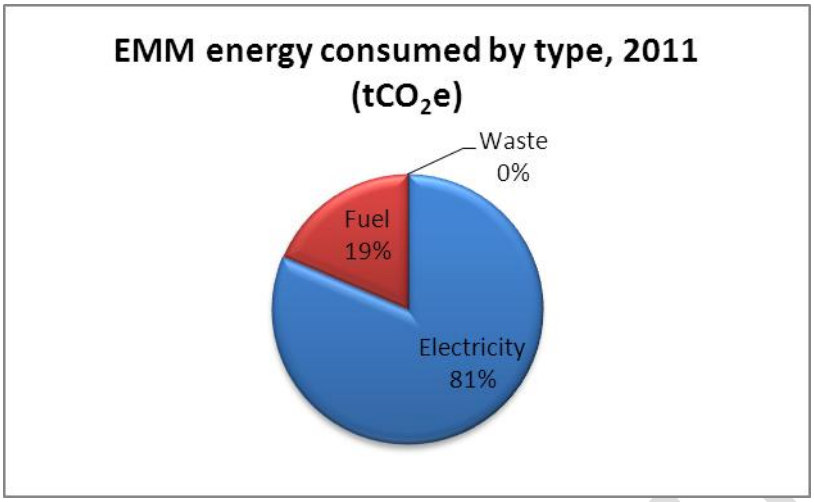

Figure 10: Pie chart summarising the carbon emitted by energy type for Ekurhuleni in 2011

6.3.2 Sectoral Emission Summary

According to the GHG analysis undertaken with the energy consumption data available, the sectoral total was 27.054 million tons of carbon dioxide equivalent (tCO_2e) emitted for the year 2011 (Table 7 in Section 6.3.4). The sector that contributed largest proportion of CO_2e emissions for 2011 was the industrial sector with a total of 10.941 million tCO_2e, 41% of the total, followed by Residential (26%), Transport (17%), Commercial (11%), Local Government (1%) and the remainder from the unknown electricity end users and Agriculture (Figure 11).

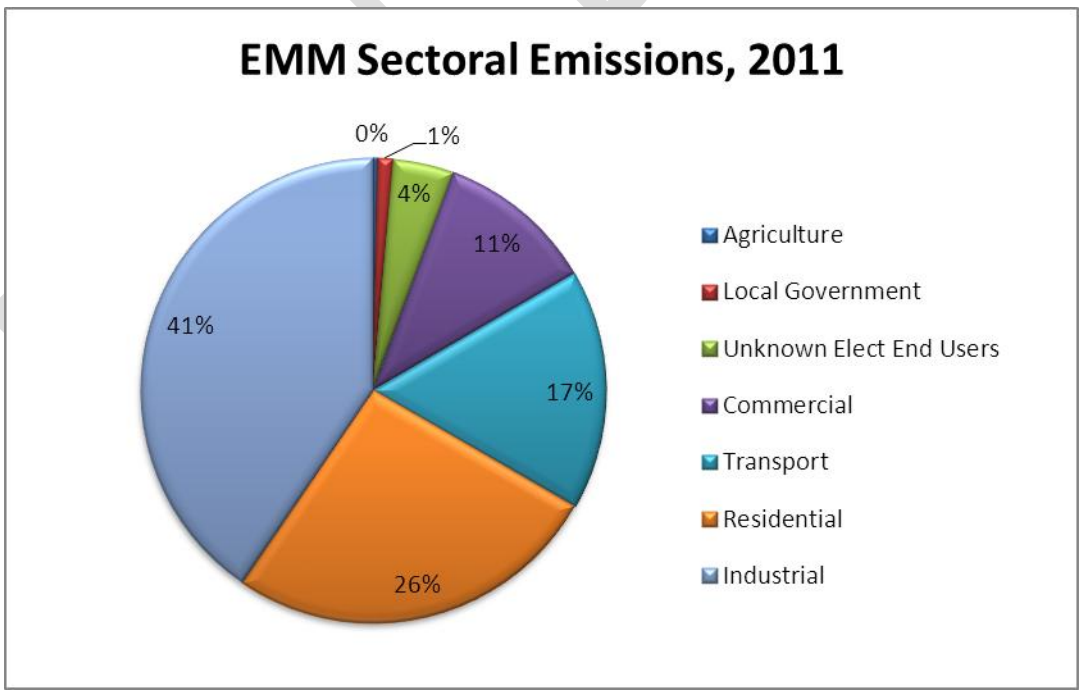

Figure 11: A graphical representative showing the intense carbon emitting sectors within the Ekurhuleni region for 2011

6.3.3 Community vs. Government emissions

A comparative study was undertaken to determine the amount of carbon emitted by the local government versus the community (residential, community and industrial) modules to determine where possible measures could be implemented to achieve emission reduction targets. Table 5 summarises that government operational activities contribute to 291,487.64 tonnes CO_2e (1.13%), while community activities contribute to 25.617 million tonnes CO_2e (98.87%) for the year 2011. As mentioned in Section 6.3.1.i there were elements of uncertainty regarding two additional electricity consumption groups that are allocated to the local government: 'Unknown Electricity End User' and 'Electricity Losses'. Once included within the government module, EMM is accountable for 9.52% of the total emissions for 2011.

Table 5: Carbon footprint comparative analysis for government and community activities within the Ekurhuleni region for 2011.

	tCO_2e	
	Community	**Local Government**
Waste	249.76	519.90
Electricity	20,831,931.27	260,522.93
Fuel	4,784,883.96	30,444.80
Module Sub-total	**25,617,064.99**	**291,487.64**
Sectoral total	**25,908,552.63**	
Percentage	**98.87**	**1.13**
Unknown Elect End User		1,145,837.53
Electricity Losses		1,259,345.54
Module Total	**25,617,064.99**	**2,696,670.70**
Total	**28,313,735.69**	
Percentage	**90.47**	**9.52**

For this GHG inventory, scope 1 and 2 emissions were incorporated in the analysis where data was available for both the government and community activities. Table 6 represents the Ekurhuleni total emissions including the total annual aviation fuel consumption, scope 3 emission, by OR Tambo International Airport. Aviation fuel and air travel is an indirect carbon intensive emitter, which has a 'greater climate impact than the same emissions made at ground level' (Ross, 2009). It is debatable where exactly the fossil fuel based emissions are emitted during take-off, in-flight and landing. However these emissions should still be accounted for where possible. Stringent improvements in the energy efficiency of the aviation system should be put in place in order to keep pace with the increasing demand of air travel with the growing economy.

The aviation fuel consumed by O.R Tambo International Airport, located within the EMM borders, is an indirect emission and is questionable whether the aviation fuel consumed by the airport can be directly associated and included to the Ekurhuleni's regional emissions.

As seen in the Table 6, aviation fuel translates into the largest emitting activity and increases the total EMM carbon dioxide equivalent emission to approximately 32.896 million tCO_2e, translating to 10.35 tCO_2e carbon footprint per capita.

Table 6: Carbon footprint analysis including Scope 3 emissions for the Ekurhuleni region, 2011.

Year: 2011	Community	Local Government
Module Total	25,617,064.99	2,696,670.70
Total		**28,313,735.69**
Percentage	90.48	9.52
Carbon Footprint per capita	8.91	
Aviation Fuel	4,582,937.03	
Module Total	30,200,002.02	2,696,670.70
EMM TOTAL EMISSIONS		**32,896,672.73**
Carbon Footprint per capita	10.35	

6.3.4 Concluding Remarks

In conclusion a total of 32.896 million tonnes carbon dioxide equivalent are emitted (directly and indirectly) into the atmosphere within the region of Ekurhuleni, 90.47% by community activities and 9.53% allocated to local government module. Of the total emissions, electricity (scope 2 emitter) was the dominant energy type used and the largest contributing emitter for the region. The sector that is contributing to the largest proportion of the CO_2e is Industry (41%), followed by Residential (26%) and Transport (17%) sectors, which are seen to be the largest carbon emitters in the region. The carbon footprint per person for the Ekurhuleni region is calculated as 8.91 tonnes CO_2e per capita for 2011. However when including indirect aviation fuel emissions within the mix of energy types used by the region, the total carbon emissions increases significantly translating to 20.35 tCO_2e per capita for 2011 (Table 7).

Table 7: Summery of the total emissions emitted in the Ekurhuleni jurisdiction for 2011.

EMM 2011 Energy, carbon figures (conversion factors as per IPCC)	
Energy Source	**CO2e tonnes**
Electricity	22,238,291.73
Solid Waste	769.66
Diesel	2,025,405.22
Petrol	2,629,760.80
Furnace Oil	42,613.08
LPG	32,177.01
Paraffin	85,291.18
Sub-total	27,054,308.68
Population 2011	3,178,470.00
Carbon emission per capita	8.51
Electricity Losses	1,259,345.54
Aviation Fuels	4,582,937.03
Total tCO2e	32,896,591.25
Carbon emission per capita	10.35

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The data reflected within this report represents only that which was available and accessible at the time, the raw data is in full ownership of the Ekurhuleni Metropolitan Municipality and any queries should be directed to the Energy Services Department.

7 Energy Reduction Solutions

The Carbon inventory for EMM presented that electricity was the dominant, carbon intensive energy type used within the Ekurhuleni region for the 2011 inventory year. This section presents some low cost energy efficient solutions that, if implemented in the short, medium and long term and monitored and evaluated through the given time periods, would potentially reduce electricity consumption and reduce emissions significantly in the region.

The renewable energy and energy efficient options provided below are non-exclusive and are merely providing options accompanied by the energy savings to further inform the development of the EMM Climate Change Action Plan. The Action Plan will incorporate detailed sectoral actions towards low emissions activities by the Ekurhuleni Metropolitan Municipality.

7.1 Suggested EE and RE actions and solutions

The EE and RE actions and solutions listed below will have a large impact to energy efficiency and savings of electricity if implemented, monitored and reported. In section 5.2 further information on the devices and savings is given on a selection of the below suggested items.

7.1.1 Energy Efficiency (EE)

EE and DSM measures would help in reducing the energy demand. Energy Efficiency (EE) initiatives are the most financially feasible energy saving options. In this report, the EE measures have been analysed for the four sectors, i.e. residential, commercial, industrial and municipal. A sector-wise techno-economic analysis of potential energy efficiency and DSM measures needs to be carried out for a complete analysis. The list of EE and DSM measures suggested for different sectors is given below:

Residential Sector

- Replace Incandescent Lamps with Fluorescent
- T5 tube light + Electronic Ballast to replace T12/T8 tube light+ Magnetic Ballast
- Efficient ceiling fans to replace conventional ceiling fans
- Replacement of conventional air-conditioners with EE star rated ACs
- Replacement of conventional refrigerators with EE star rated refrigerators
- Replacement of conventional water pumps with EE water pumps
- Reduce energy consumption in existing private buildings
- Reduce energy consumption in all new construction

Commercial and institutional building Sector

- Replace Incandescent Lamps with Fluorescent
- T5 tube light + Electronic Ballast to replace T12/T8 tube light+ Magnetic Ballast
- Efficient ceiling fans to replace conventional ceiling fans

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- Replacement of conventional air-conditioners with EE star rated ACs
- Replacement of conventional refrigerators with EE star rated refrigerators
- Replacement of conventional water pumps with EE water pumps

Industrial Sector

- Replace Incandescent Lamps with Fluorescent
- T5 tube light + Electronic Ballast to replace T12/T8 tube light+ Magnetic Ballast
- Efficient ceiling fans to replace conventional ceiling fans
- Replacement of conventional air-conditioners with EE star rated ACs
- Energy efficiency in motors, furnaces, boilers, etc.

Municipal Sector

- Replace Incandescent Lamps with Fluorescent
- Replacement of 250 watt High Pressure Sodium Vapour Lamps (HPSV) with LEDs
- Replacement of 150 watt High Pressure Sodium Vapour Lamps (HPSV) with LEDs
- Replacement of 40 watt T8/T12 tube lights with T5 tube lights
- Sensors for automatic on/off of street lights
- Proper pump-system design (efficient Pump, pumps heads with system heads
- Installation of variable speed drivers
- Power saver installation in pump house
- Plugging of leakages in the water supply system and use of efficient pumps and motors

7.1.2 Renewable Energy (RE)

A list of potential RE technologies are listed below and if implemented by sectors would result in considerable amount of energy and emissions savings.

Residential Sector

- Installation of Solar Water Heating System
- Use of Solar cookers (Box and dish type)
- Solar lanterns to replace kerosene lamps/ candles
- Use Solar Home Systems (SHS)

Commercial and institutional building Sector

- Solar PV system hotels, restaurants and hostels
- Solar Water Heating System for hostels and restaurants
- Steam Cooking for hostel and restaurants
- Biogas from Kitchen waste of hostels and restaurants
- Use of Solar cookers for cooking mid-day meals in primary schools

Industrial Sector

- Solar Steam generating system
- Solar Water Heaters
- Solar PV Power Plant

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- Biogas

Municipal Sector

- Building sector
  - Solar Steam generating system
  - Solar Water Heaters
  - Solar PV Power Plant
  - Biogas

- Outdoor Lighting
  - Solar Street Lights
  - Solar PV Traffic Lights

7.2 Energy reduction and saving devices

Energy saving products demonstrates low cost energy efficient solutions that have potential to reduce electricity consumption significantly. Section 5.2.1–5.2.5 provides in brief, energy efficient and renewable energy solutions which have significant potential to reduce per capita carbon emissions.

The most cost effective and energy efficient technology in Table 8 is the consideration of retrofitting light bulbs from Candescent Lighting to Light Emitting Diodes (LEDs) which represents an annual savings of R45.68 per light bulb changed, which translates to a total annual emission reduction of 230,683 tCO_2e if 2.8 million lights are retrofitting (1 light bulb per person in the Ekurhuleni region).

Table 8: Energy efficiency solutions and yearly energy savings

Electrical Device	Product Power (W)	Power Consumption (kWh)	Cost (R) [Tariff 0.61per kWh]	Daily quantity used per day (hr.)	Monthly quantity used monthly (kWh)	Monthly expenditure (R)	Monthly Savings	Yearly costs	Yearly Savings
Normal Appliance	1000	1	0.61	24	720	439.2		5270.4	
Star Energy Appliance	750	0.75	0.4575	24	720	329.4	109.8	3952.8	**1317.60**
Candescent Lighting	60	0.06	0.0366	4	120	4.392		52.704	
CFL	15	0.015	0.00915	4	120	1.098	3.294	13.176	**39.52**
Candescent Lighting	60	0.06	0.0366	4	120	4.392		52.704	
LED	8	0.008	0.00488	4	120	0.5856	3.8064	7.0272	**45.68**
CFL	15	0.015	0.00915	4	120	1.098		13.176	
LED	8	0.008	0.00488	4	120	0.5856	0.5124	7.0272	**6.15**
Oven	1000	1	0.61	3	90	54.9		658.8	

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50% oven use + Wonderbag	1000	1	0.61	0.5	15	9.15	45.75	109.8	**549**

*annual saving per light bulb subject to tariff rates.

Energy saving through low cost changes and retrofitting of household shower and hot water devices: An average household with a 150L geyser can achieve a monthly energy saving of 122 kWh and R67 on cost of energy if a thermostat temperature is reduced from 70 to 60C and the geyser is switched off between 6am and 9pm (Eskom, 2011). See calculations below in Table 9, for further household savings.

Table 9: Household energy and water saving calculations

Normal Shower head uses on average 20L per minute. *Efficient Shower Head* uses on average 10L per minute, which is half that of a normal shower head.	
Geyser Specifications for an average household: 2kW, 100L, thermostat 70C **Savings with an Efficient Showerhead:**	Geyser Specifications: 2kW, 100L, thermostat 60C **Savings with a thermostat:**
Water has a heat capacity of 4.1813 joules to heat one gram by one degree C. 1 litre is 1000 grams. For the purposes of this example, the geyser tank has a capacity of 100L. As a hundred litres is 100 000 grams of water, it takes 4.183J * 100 000 = 418130 joules to heat this amount by one degree Celsius. A joule is equivalent to 1 watt-second, therefore 418130 joules is 418130/3600 = 116.15Wh. If the thermostat of the household geyser is **70C**, the energy needed to heat 100L of water is 116.15*70 = 8130.5Wh If the voltage of the device is 2000W (2kW), then it would take 8130.5Wh/2000 = 4.065 hours to heat the 100L geyser tank to 70C. The electricity tariff rate of South Africa in 2012 is on average R0.61 per kWh, therefore the cost to heat 100L tank to 70C is (8130.5/1000)kWh*R0.61 per kWh = R4.96 By using an energy and water saving shower head a household can save **R905.20** (R4.96/ 2*365) per year on electricity. <u>Water saving:</u> If a household has four people, each	Water has a heat capacity of 4.1813 joules to heat one gram by one degree C. 1 litre is 1000 grams. For the purposes of this example, the geyser tank has a capacity of 100L. 4.1813 joules*100 000=418130 joules A joule is equivalent to 1 watt-second, therefore 418130/3600 = 116.15Wh. If the thermostat of the household geyser is **60C**, the energy needed to heat 100L of water is 116.15*60 = 6969Wh The electricity tariff/rate of South Africa in 2012 was on average R0.61 per kWh, therefore (6969/1000)kWh*R0.61/kWh = R4.25 By changing the thermostat of the water geyser by 10C, a household can save **R0.71** (R4.96-R4.25) per 100L heating to 60C rather 70C. The annual saving is, assuming a household consumes only 100L for showering per day, is R259.15 (0.71*365). If an efficient shower head is used, water consumed is: 4people*10minutes*10L/minute*2 a day*30 days a month = 24000L = 24kL

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take a shower twice a day for 10 minutes, by using a normal shower head, the consumption of water per month would be as follows: 4people*10minutes*20L/minute*2 a day*30 days a month = 48000L = 48kL Water Tariff in South Africa 2012 is approximately R5.83 per kL. An efficient shower head uses half the amount of water than a normal showerhead, therefore saving R139.92 (24kL*R5.83) per month, which is an annual saving of **R1679.04**.	Savings on heating a tank of 100L is R0.71; therefore monthly savings on the electricity consumption on heating 24000L is R170.4 (24000/100*0.71). The total amount of water and electricity saving per month using energy efficient devices amounts to an estimate of **R310.32** (R139.92+R170.4), which is an annual saving of **R3723.84** per year.

7.2.1 Photovoltaic

Photovoltaic (**PV**) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. The photovoltaic effect is the creation of voltage or electric current in a material upon exposure to light. Photovoltaic power generation employs solar panels composed of a number of solar cells containing a photovoltaic material. Materials used for creating photovoltaic's include monocrystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium gallium selenite/sulphide. Due to the growing demand for renewable energy sources, the manufacturing of solar cells and photovoltaic arrays has advanced considerably in recent years (Jacobson, 2009).

7.2.2 Lighting

Solar Bottle Bulb

Solar Bottle Bulbs are an easy and effective lighting solution for low cost housing in pro-poor areas. The name originates from the concept from which it is made. It is made up of an empty 1.5 litre plastic bottle with water, liquid bleach and purified water. The Solar Bottle Bulb can be used as an alternative electric powered light bulb placed on a rooftop that is exposed to sunlight. Although this invention is useful during daytime, its luminance can produce as much light as a 50W incandescent bulb.

Cost: minimal

Materials needed: plastic bottle, roof sheet material, purified water, chlorine and a rubber sealant.

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Portable Solar Light and Charger

There are many solar kits available in the market that offers a small portable solar panel and a battery for storing solar energy. The solar energy is sufficient energy to supply approximate range of 4 to 50 hours of light to a LED lamp on high and low settings respectively. The kit also provides cellphone chargers and adaptors that are suitable for most cellphones.

Cost: R500 – R2000

Solar Street Light

Solar streetlights work on the principle of the photovoltaic cell or solar cell which absorbs energy from the sun during day. The solar cell converts solar energy to electrical energy which is stored in a battery. The solar lamp draws the current from this battery and requires no other wiring or energy from any other alternative source. Solar street lights are currently manufactured in South Africa, the supplier list can be seen below.

Solar lighting can make use of three types of bulbs; sodium vapour, LED and induction technology lighting. Depending on the lights chosen there are many additional benefits of using solar street lighting. LED solar lighting is long lasting and can be used for approximately 20 years without replacement. It uses a lower voltage to produce a brighter light and the thin-film solar panel is highly durable even during high temperatures and hail storms.

Cost: varying on prices, dependent on quantity and type.

7.2.3 Cooking

Parabolic Cookers

Parabolic cookers are energy efficient devices that require no other energy resources except solar energy. A parabolic cooker is designed with a large dish with a spherical curvature that focuses sunrays inwards which heats the focus point such as a pot of water or food. The parabolic cooker cooks food at the same rate as that of a conventional oven and boils a litre of water in 15 minutes. These cookers are considered to be a better alternative for outdoor cooking and camping as they require no firewood, gas or electricity.

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Cost: R200 (small) – R2500 (large).

Energy Saving: (Power output: 500 watts (small) – 2000watts (large)).

Solar Box Cooker and Oven

A solar box cooker (similar to the parabolic cooker principles) is a box with reflective lining material that absorbs and reflects the sun's rays and directs it within the box to convert it into heat energy. The heat generated can purify and boil water, cook and bake food and sterilize various instruments.

Box Cookers cook meals at half the speed of a conventional oven.

Cost: R3500

7.2.4 Water Heating

Solar Water System

Solar water heating systems absorb solar radiation, which then transfers heat directly to an interior space or storage device and thus distributes the heat. Solar water heating systems are the most commonly used household water heating alternative. Solar water systems save households 40 - 60% of their energy bill paying themselves back within 3 years. South Africa is fortunate with abundant direct sunlight which makes it feasible to make use.

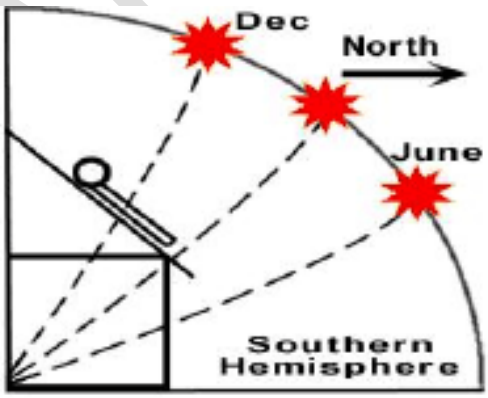

Figure 12: Southern hemisphere buildings should install solar panels on roof tops facing the northern direction to receive optimal solar radiation

Solar Water Systems are available in many designs and makes and are manufactured locally in South Africa. There are three main solar water systems available on the market, which are:

1. Thermosyphon SWH systems

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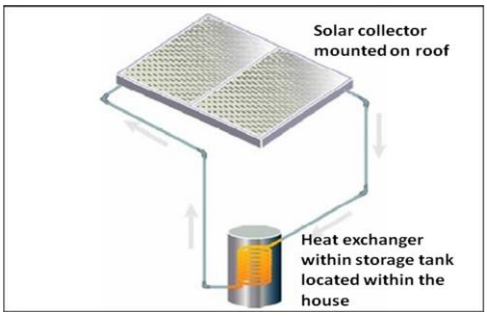
The **thermosyphon** is a simple, efficient, reliable and low maintenance system in hot and moderate climates, often referred to as a passive heat exchange. The installation costs are minimal and require no pumps or special control devices, however a controller can be used to monitor the water temperature and switch the element on at a pre-programmed time. A collector mounting system and an insulated storage tank are mounted on a roof (facing north in the southern hemisphere). The open pipe system allows hot water to rise through the top of the collector into the storage tank through the natural convection principal.

2. Split Pressurized SWH systems

The split pressurized SWH system is simiar in design and principle to that of the thermosyphon system, the difference is that the collector and tank are seperated. The storage tank can be located anywhere in the house and the existing geysors can be retrofitted to allow for solar water heating using a conversion kit.The roof mounted collector is located on a north facing roof allowing optimal radiation and absorbtion.

3. Indirect SWH systems

Indirect or closed systems do not heat the water directly rather they use fluid with a low-freezing point to absorb radiant energy from the sun. This system uses heat exchanger that separates the potable water from the fluid, known as the 'heat-transfer fluid' (HTF), that circulates through the collector. The two most common HTFs are water and an antifreeze/water mix that typically uses non-toxic propylene glycol. After being heated in the panels, the HTF travels to the heat exchanger, where the heat is transferred to the potable water. This system is slightly more expensive the the other two, however indirect systems offer freeze and overheating protection.



Cost: Cost of each system is dependent on size, type and make of the solar heating system, therefore it is recommended that one should apply for a series of quotes with various suppliers, rebates from Eskom are available and should be considered as a saving option.

Energy Saving: Solar Water Systems save households 40 - 60% of their energy bill paying themselves back within a 3 year period.

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8 Monitoring and Evaluation

For any action plan to be undertaken successfully in a complex institutional structure it is vital to have the four main pillars established to ensure consistency, continuity and sustainability of an initiative independent of scope. The four pillars are: 1. Management Support; 2. Strategy Plan; 3. Technical Ability and 4. Monitoring and Evaluating System.

Management support: High level management should make a commitment to allocate manpower and funds to achieve continuous improvements within the energy sector. To establish the energy management programme, leading organizations should appoint and support an energy manager, form a dedicated energy team, institute an energy policy and continuously monitor and evaluate progress and achievements.

Strategy Plan: Energy Policy should provide the foundation for successful energy management and implementation. It formalizes management's support and articulates the organization's commitment to energy efficiency for employees, shareholders, the community and other end users.

Technical Ability: *A*n important requirement is adequate technical ability for analysing and implementing energy saving options and monitoring and evaluating the effectiveness of the policy implementation.

Monitoring and Evaluating System is also an important part of the pillar within the system which enables strengthening of the system through a cyclic process of feeding positive and successful attributes as well as recording areas of concern and areas that have potential for adjustment and improvement.

In order to promote sustainability of the EMM Action Plan (2012), it is recommended that a structured monitoring and evaluating system be established to: 1. Assess Energy Performance; 2. Set Goals and review annually; 3. Report progress; and 4. Communicate Audits.

1. **Assess Energy Performance**

Understanding current and past energy use and demand will assist a local government to identify opportunities to improve energy performance and gain financial benefits. Assessing energy performance is the periodic process of evaluating energy use for all major facilities, functions and services that a local government provides and comparing it to a baseline for measuring future results of energy efficiency efforts. Key aspects include data collection and management, establishing baseline, benchmarking, analysis and evaluation and conducting technical assessment and audit.

In order to evaluate the performance of the energy services provided and monitor whether targets and goals are being met, it is essential to set up a data collection and storing system (recommended on a quarterly basis).

Periodic analysis of energy consumption data provides the benefit of determining high energy users, trends which can assist the local authority to better understand factors that affect energy

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performances in order to amend and/or re-prioritize strategies and actions steps for reducing energy consumption.

Evaluating energy performance requires good information on how, when, and where energy is being used through the local authority. Collecting and tracking this information is necessary for establishing and building upon baselines and managing energy use sustainably in the future. Establishing baselines, benchmarks and goals enables comparison between energy users and enables prioritisation over time to focus on improvements to accomplish end targets.

2. Set Goals

It is essential to set goals for energy supply and demand and monitor and evaluate the progress towards the attainment of these goals. Create and express clear, measurable goals, with target dates, for the entire local government, inclusive of all sectors, facilities, and units.

Performance goals drive energy management activities and promote continuous improvement. Setting clear and measurable goals is critical for understanding intended results, developing effective strategies, and reaping financial gains.

Well-stated goals guide daily decision-making and are the basis for tracking and measuring progress. Communicating and posting goals can motivate staff, sectoral departments and private sectors (commercial and industrial sectors). The Energy Department should undertake analysis of the progress towards the short, medium and long term goals respective of the timeframes to allow continuous strategy planning to reach beyond the goals that are set.

3. Report Progress

Based on the data analysis and audit results, produce a detailed summary of individual facility, unit and departmental energy usage over a fixed period and present yearly audits (if available) to establish energy trends. From the energy audit actual steps that can be taken to reduce energy use can be established through a consultation process with key players concerned. The report should recommend actions ranging from simple adjustments in operation to equipment replacement. Estimates of resource requirements for completing actions should also be included.

Reports help in evaluating past projects and best practices of higher-performing facilities/sectors to determine the feasibility of transferring these practices to other parts of the local authority.

4. Communicate Audits, Progress and Achievements

It is important to communicate energy goals, energy implementation initiatives, energy audits and achievements to city officials, businesses and the general public. Awareness raising, communication material and information should be tailored to the needs and objectives of the intended audience.

It is also necessary to undertake an evaluation of the impact and effectiveness of awareness campaigns, business audit reports and energy saving initiatives in order to improve upon approaches and manner of which the material is being communicated.

Training is essential for monitoring and evaluation of energy use and implementation of energy saving methods. It is essential that city officials understand the importance of energy performances

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and are provided with adequate information necessary to make informed decisions. Training also provides an excellent opportunity for gathering employee feedback and evaluations. The type and nature of training will vary with local authority and for specific action plans.

Lastly, it is important to provide incentives and communicate about them to encourage energy saving and to monitor and evaluate the effectiveness. Public and private sectors should be provided with energy consumption trends of comparative and competitive sectors and should be recognised with energy consumption reductions.

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9 Commitments

Ekurhuleni Metropolitan Municipality (EMM) is committed to achieve sustainable development through enhanced services to its citizens. EMM believes in energy conservation (energy efficiency and renewable energy) as one of the pillars to achieve sustainable development. Therefore, EMM is committed to:

Reduce overall city conventional energy consumption by at least 10% from 2011 level by 2020

EMM will strive to accomplish the above by:

Incorporating energy efficiency in all its present and future planning ***(to achieve overall 10% reduction in conventional energy consumption in municipal services and facilities from 2011 level by 2020)***

- Promoting renewable energy sources such as solar water heating systems in all commercial and domestic activities.
- Adopting new and renewable energy sources for all its applications such as its parks/campus and street lighting, traffic signals, etc.
- Establishing solid waste management project like waste to energy, recycling and composting projects.
- Partnering with relevant Government agencies, institutions and business to support new technologies.
- Creating energy efficient guidelines for all its municipal services and citizens.
- Promoting Building codes for the new buildings by providing incentives, schemes or mandatory means.
- Compliance, monitoring, enforcement and evaluation of energy efficiency measures.
- Provide assistance in developing energy management capability in industrial associations, residential and commercial sectors and promote energy efficiency measures.
- Improve public transport system to increase public transits.
- Enhancing and increasing education and awareness programs on energy conservation to schools, citizens and municipal staff.
- Commit to the Mexico City Pact and monitor, report and verify local actions through the ICLEI carbon*n* Climate Change Registry (cCCR) for emission target setting and monitoring.

EMM believes in continuous improvement in energy conservation and be a model city in renewable energy and energy efficiency for others cities in the province, South Africa and at an international level.

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