KwaDukuza Municipality:

Greenhouse Gas Inventory 2012 Report

By ICLEI – Local Governments for Sustainability – Africa

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1. Executive Summary

The KwaDukuza Greenhouse Gas (GHG) Inventory was conducted using energy data from the 2012 calendar year as the baseline for this study. The GHG inventory is compliant with the international accounting protocols, techniques and methodologies of both International Local Government Greenhouse Gas Emissions Analysis Protocol (IEAP) version 1.0 and the Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC). Data sources, assumptions and gaps are outlined within the detailed report in Section 2.

KwaDukuza Municipality (KDM) is located in the ILembe District in KwaZulu-Natal Province of South Africa. The municipality includes two main towns, Ballito, which is located on the eastern side on the N2 national highway along the east coast, and Stanger, which is situated inland from the coast on the western side of the N2. Ballito is a residential and commerce center as well as a tourist and holiday destination. Stanger is the district node of ILembe, but also contains predominantly residential and commercial entities, surrounded by agriculture and industrial activities (Paper and Sugar Mills) in the outskirts.

The characteristics of the local context are mirrored by the GHG results with the residential, commercial and industrial sector sharing the larger proportion of the emissions for the area. With a relatively small population, 231 189 (2011), the energy and emissions per capita is 23 GJ/capita and 7.3 tCO_2e/capita respectively. It is difficult to compare these results to other municipalities in South Africa as the local context, including the size, population and economic drivers differ significantly to the some of the municipalities that have undertaken a GHG Inventory using 2012 energy data. The detailed analysis can be viewed in Section 3 of the report.

Electricity is the dominant energy type used in KwaDukuza as illustrated by the supply-side energy consumption pie charts in Figure 1, with the liquid fuels of diesel and petrol being the second and third dominant energy types used respectively. It should be noted, which is also explained in detail in the report, that although electricity generates 41% of the energy, it emits 78% of the indirect emissions per unit (scope 2) die to the fact that electricity is generated by 'dirty' coal burning power stations from low calorific value coal.

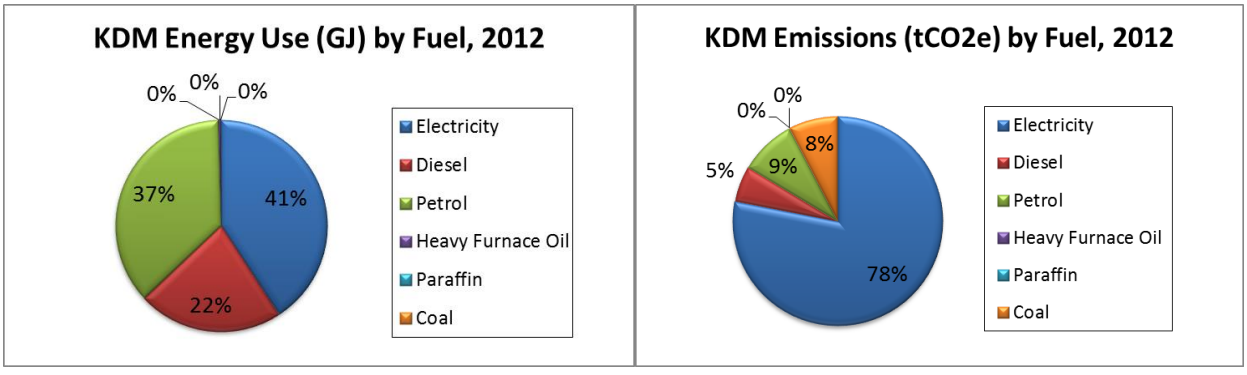


Figure 1: KwaDukuza energy consumption and energy-related emissions by fuel type, 2012

The sector consuming the greater proportion of energy in the area is the transport sector. The demand-side energy consumption pie charts are seen in Figure 2 illustrating the high energy use and high carbon emitting sectors.

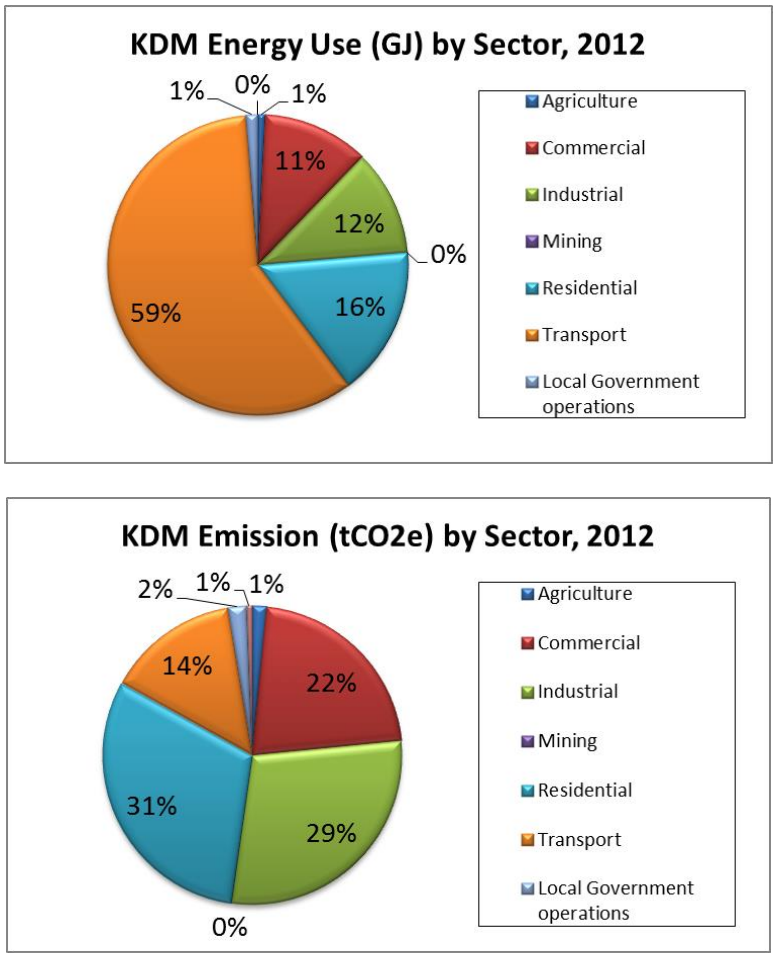


Figure 2: Energy consumption and energy related emissions by sector in KwaDukuza, 2012.

1.5 million tonnes of carbon equivalent (tCO_2e) emissions (5.316 million GJs), (which could be accounted for in this study), was emitted in year 2012 in KwaDukuza.

98% was emitted by the community (i.e. Residential, Industrial, Transportation etc. activities).

2% was emitted directly by the local authority's own operational activities (with the exclusion of electrical losses).

See Table 1 for the final summary of carbon emissions emitted by both community and government in KwaDukuza.

Table 1: KwaDukuza Greenhouse Gas emission results, 2012

KwaDukuza 2012 Energy, Carbon Figures (conversion factors as per IPCC)		
Energy Source	**Carbon (tCO_2e)**	**Energy (GJ)**
Electricity	1 189 289.42	2 038 781.86
Solid Waste	9 674.81	-
Diesel	85 558.67	1 130 520.20
Petrol	136 022.95	1 864 415.09
Heavy Furnace Oil	1 359.22	19 690.92
Paraffin	91.87	1 363.46
Coal	118 174.04	1 686.21
Sub-total	1 540 170.98	5 056 457.75
Population 2011	231 189	231 198
Carbon emission per capita	6.66	21.87
Losses (electrical)	151 807.14	260 240.81
Total tCO_2e	**1 691 978.12**	**5 316 698.57**
Carbon emission per capita	7.32	23.00

The following statistics in Table 2 represent a selection of the key transport, energy and greenhouse gas indicators resulting from the analysis which can then be compared to other urban areas from similar studies undertaken.

Table 2: KwaDukuza energy and greenhouse gas indicators, 2012

Key energy and greenhouse gas Indicator	Unit of Measure	Local Level (2012)
Number of total vehicles per capita	No. of veh/capita	0.19
Number of total vehicles per household	No. of veh/household	0.61
Private vehicles per capita	No. of veh/capita	0.11
Private vehicles per household	No. of veh/household	0.36
Energy consumption per capita	GJ/capita	23.00
GHG per capita	tCO2e/capita	7.3
Energy per *Gross Value Added (GVA) (R' mill)	GJ /GVA	218.2
GHG per Gross Value Added (GVA) (R' mill)	tCO_2e/GVA	685.7

*Gross Value Added (GVA) is an estimation of Gross Domestic Product (GDP), which is a key indicator of the state of the economy.

The Energy per Gross Value Added (GVA) and GHG emissions per GVA provides the amount of energy consumed per unit of economic production, therefore the carbon intensity per product or goods produced in a local economy.

The last representation of the data is showcased in Table 3, which presents the emissions by sector per scope, as per the international standards for local governments, entitled Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC), which is described in detail in Section 3 of the report.

Table 3: Greenhouse Gas emissions by sector per scope in KwaDukuza, 2012

2012 Community GHG Profile Reporting Standard						
Sector	**Sector Total (tCO2e)**	**Subsector**	**Subsector Total (tCO2e)**	**Subtotal (tCO2e)**	**GHG Emissions Sources**	**GPC No.**
STATIONARY UNITS	**1 461 634.45**	Agriculture	**23 827.72**	23 827.72	Stationary Units Agriculture Energy Indirect Emissions (Scope2)	I.1.ii
		Residential Buildings	**474 022.69**	91.87	Stationary Units Residential Direct Emissions (Scope1)	I.1.i
				473 930.83	Stationary Units Residential Energy Indirect Emissions (Scope2)	I.1.ii
		Commercial/Institutional Facilities	**519 742.85**	337 809.74	Stationary Units Commercial/Institutional Facilities Direct Emissions (Scope1)	I.2.i
				181 933.11	Stationary Units Commercial/Institutional Facilities Energy Indirect Emissions (Scope2)	I.2.ii
		Industrial Energy Use	**444 041.19**	119 533.27	Stationary Units Industrial Energy Use Direct Emissions (Scope1)	I.4.i
				324 507.92	Stationary Units Industrial Energy Use Energy Indirect Emissions (Scope2)	I.4.ii
MOBILE UNITS	**220 652.24**	On-Road Transportation (Cars, LDV, HDV/Buses, others)	**220 652.24**	220 652.24	Mobile Units On-Road Transportation (Cars, LDV, HDV/Buses, others) Direct Emissions (Scope1)	II.1.i
		Aviation		-	Mobile Units Aviation Indirect Emissions from Inter-City Domestic Flights (LTO and Cruise) (Scope3)	II.4.iii
WASTE	**9 674.81**	Solid Waste Disposal	**9 674.81**	9 674.81	Waste Solid Waste Future Indirect Emissions from Community Generated Waste Landfilled in the Community in the Analysis-Year (Scope1)	III.1.i
IPPU	**16.62**	Industrial Processes (Mining)	**16.62**		IPPU Direct Emissions from Industrial Processes (Scope1)	IV.1.i
				16.62	IPPU Indirect Emissions from Industrial Processes (Scope2)	IV.1.ii
	1 691 978.12	**TOTAL Community Emissions (tCO2e) by *2012 Accounting Standard* (for benchmarking)**				

Aggregate tCO2e by Scope		
	tCO2e Scope-1	687 762
	tCO2e Scope-2	1 004 216
	tCO2e Scope-3	-
Total		**1 691 978**

2. Methodology

Protocols

The GHG Inventory was conducted in accordance to the approved principles and standards of both local government Protocols, the ***International Local Government Greenhouse Gas Emissions Analysis Protocol*** (IEAP) version 1.0 and the ***Global Protocol for Community-Scale Greenhouse Gas Emissions*** (GPC). Both these protocols provide internationally based methodologies and guidelines to assist local governments in quantifying the greenhouse gas emissions from both their internal operations and from the whole community (residential, commercial and industrial sectors) within the geographical boundaries.

The IEAP was developed by ICLEI - Local Governments for Sustainability, informed by the Intergovernmental Panel on Climate Change (IPCC) 2006 international methodological standards in 2009. Based on the IEAP and other recognised protocols, and in collaboration with partners an international protocol is being formalised for international standard reporting for sub-national governments across the world. The GPC has been developed in collaboration with C40 Cities Climate Leadership Group, ICLEI – Local Governments for Sustainability and World Resources Institute (WRI) and is currently being tested by local governments across the world. By the end of 2013 the pilot test results will be incorporated into a more comprehensive GHG accounting standard for community-scale emissions, including consideration of a full range of direct and indirect GHG emissions from urban activities. This will enable local governments to account for how the demand for goods and services as well as local innovative technologies can impact on an urban GHG footprint.

The Protocol aims to improve the consistency with which the international standard is applied and how the resulting information is publically reported.

This GHG report aims to adhere to the protocol principles through local government emission ***relevancy, completeness*** by accounting of most 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 energy and carbon inventory, to understand the city activities, to measure the emissions and to provide options of mitigation measures best suited for the local government's development plans, an ICLEI emissions accounting software package was used to assist with the analysis. Harmonized Emission Analysis Tool Plus (HEAT+) incorporates the latest technical findings (IPCC, 2006) and is based on the International Local Government GHG Emissions Analysis Protocol (IEAP). It also incorporates the new international reporting requirements and standards outlined in the Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC). HEAT+ is the tool used for GHG emissions accounting in the Urban-LEDS project; 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 to verify and strengthen results further.

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 Municipality's 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 GHG report identifies the main energy carriers and the intensive carbon emitting sectors that are situated within the municipal boundary of KwaDukuza Municipality and are therefore contributing to the Municipality's carbon footprint, as well as to the local air pollution.

Data Sources and Collation

The baseline year for this study was the calendar year of 2012 as most of the data sources were able to provide full data sets for this baseline year. A GHG inventory had not been conducted before for the local government and therefore it was necessary to undertake a detailed analysis of the main energy uses and sources of energy consumption within the jurisdiction.

A full GHG inventory includes emissions from energy, waste, agriculture, forestry and land-use change, however due to limited resources and data constraints, the direct emissions from agriculture, land-use change and forestry sectors were not concluded due to limited data.

ICLEI Africa and KwaDukuza Municipal staff members engaged through meetings and letters with a number of municipal, local, sub-national and national stakeholders to source the relevant energy consumption data focusing on the large carbon emitters within the municipal area. Supply and demand-side data was therefore collected and analysed for this study.

Supply-side refers to the classification of both primary and secondary energy types that are distributed to the demand-side for use; these include liquid and solid fuels, electricity and renewables. Demand-side energy refers to the energy end user, i.e. the sectors like residential, commercial, industrial users of energy within and urban jurisdiction. The supply-side and demand side data sources are elaborated in the tables below.

Table 4: Supply-side energy data sources

Fuel Type	Data Sources
Electricity	Eskom and KwaDukuza Municipality
Liquid Fuel	South African Petroleum Industry Association (SAPIA) via the Department of Energy
Coal	Tongaat Sugar Co. Limited and Gledhow Sugar Company (Pty) Ltd

Table 5: Demand-side energy data sources

Sector	Data Sources
Agriculture	Eskom electricity distribution
Commercial	Eskom electricity distribution, Municipal electricity distribution
Industry	Eskom electricity distribution, Municipal electricity distribution
Mining	Eskom electricity distribution
Residential	Eskom electricity distribution, Municipal electricity distribution, StatsSA household census statistical data
Local Government operations	Municipal electricity distribution
Transport	SAPIA, eNaTiS, StatsSA, Municipal vehicle management, municipal traffic department
Waste	Waste Management Department, KwaDukuza Municipality
Other	Quantec, StatsSA, Municipal Integrated Development Plan (IDP) and related policies.

Data assumptions and gaps

Eskom Electricity Data

Electricity data was provided by Eskom, the South African electricity public utility, for the municipal area for three consecutive years, 2010-2012. Data was classified in terms of electricity used, i.e. by large power users, small power users and pre-paid users which were already desegregated into demand-side sectors (such as Agriculture, Commercial, Industrial Mining, Residential, etc.). This data contributed enormously to the study in terms of identifying sectors that are heavily dependent on electricity within the KwaDukuza municipal boundary. The percentage that Eskom distributes within the municipal boundary in proportion to the bulk electricity the municipality receives from Eskom and redistributes to its customers, is stated within this report. A non-disclosure agreement was signed with Eskom to obtain the required data and permission was granted to display the data as it is presented within this report.

SAPIA liquid fuel data

The liquid fuel data, Fuel Sale Volumes (FVS) by magisterial district is accessible through the Department of Energy website which is provided by South African Petroleum Industry Association (SAPIA). This information is unfortunately not desegregated according to end user or sector for a local government jurisdiction and therefore certain assumptions and sector allocations were made based on consultation with the local

government and in accordance to similar GHG inventory studies undertaken in the recent past[1] of a similar context:

a. Heavy Fuel Oil (HFO) was allocated to the industrial sector.
b. Petrol and diesel were mainly allocated to the transport sector. Aside from a few processes using diesel generators, the main use for these fuels is from transportation; regardless of the sector.
c. According to a National Treasury Report (2003) over 70% of paraffin is consumed by households. Due to the age of this data and uncertainty as to the apportioning of the remaining paraffin, it was decided to assign paraffin use entirely to the residential sector.
d. Liquid Petroleum Gas (LPG) was not included within the FSV bulk liquid fuel for the KwaDukuza magisterial district. It is therefore assumed that there are no large points of sale in this region and sales of LPG in this area are not measured and reported. For the purposes of this study LPG was not included as data would need to be sourced by smaller LPG outlets or suppliers and data may not be accessible or reliable. The exclusion of LPG in the study would not impact the total energy and carbon results significantly as a whole.

Coal

Bulk coal consumption at a municipal level is not readily available, unless coal quantities are measured and reported by smaller outlets, especially for the residential users. To understand the industrial use of coal, the large industries that fall within the municipal boundaries were identified, contacted and requested for coal consumption quantities. From the exercise, two large industries which consume coal within the boundaries of KwaDukuza provided their annual consumption quantities of coal which was then incorporated into the study. The two industries are Tongaat Sugar Co. Limited and Gledhow Sugar Company (Pty) Ltd. Tongaat publish their energy use and carbon footprint in their annual Sustainability Report, which is available on their website.

Municipal Data

Electricity

At the local level, detailed electricity data (which is redistributed from the municipality to the community) was easily accessible from the Finance Department of the municipality. Enough information was provided to support the desegregation of data from the designated Municipal Tariff Codes into customer categories i.e Demand-side sectors. The table below provides the municipal tariff codes and the allocated sectoral categories.

[1] Methodological statements for liquid fuel desegregation was taken by the recent Western Cape GHG Report, 2012, undertaken by Sustainable Energy Africa (SEA), titled in full: Database of energy consumption and energy-related co2e emissions inventory for the Western Cape Province

Table 6: Municipal distributed electricity by Tariff Code and the allocated end user category/sector

Description	Tariff Code	Allocated Sector
Industrial	543, 550, 1543, 1550	Industry
Commercial Large	502, 517, 522, 538, 539, 540, 541, 1502, 1517, 1522, 1538	Commercial
Commercial Small	504, 511, 512, 514, 525, 530, 544	Commercial
Domestic credit metered	505, 506, 520, 526, 535	Residential
Domestic bulk customers	515, 557	Residential
Pre-Paid: Indigent	20 listed named customers	Residential
Pre-Paid: Indigent FBE	572	Residential
Indigent	534	Residential
Departmental	501, 509, 1509	LG operations
Street Lighting: Departmental	507, 510, 527	LG operations
Street Lighting: Private	545, 546	Commercial
(Unknown)	542	LG operations

Waste

The total quantities of solid waste generated within the municipal area were available from the Waste Management Section of the Municipal Services Department from September 2012 – June 2013. Waste collection and dumping is undertaken by a private company, data for which is then recorded and reported to the department on a monthly basis for payment of services. Since September 2012, the municipality started monitoring and evaluating the waste collection and disposition within the local landfill. All waste from all users is collected together, weighed per load and recorded. There is no segregation of the waste generated by sector, nor is the waste segregated by composition. The waste is measured as per load of mixed waste, therefore the unit used is cubic meters. Calculations for a variety of waste densities that are assumed to be incorporated within the mixed waste (cardboard, food, garden grass, glass, polystyrene, rubble, mixed garbage) were used to calculate a mixed solid waste density per cubic meter to calculate the monthly waste quantities in kilogram units. These quantitative measures were then used to calculate estimated methane emissions emitted by the managed landfill.

NaTiS (Electronic National Traffic Information System)

Live vehicle numbers as per July 2013 were sourced from the eNaTiS data base which includes all vehicles that are registered within a registering authority. Within KwaDukuza there is only one vehicle registering authority, Stanger, which was accounted for within the study. However it should be noted that there may be vehicles that are registered within a particular municipal authority but live and commute in different areas of the country.

It is useful to track over time the number of vehicles per population and the number of public versus private vehicles. The transport section below provides further details of the assumed transport modal split for KwaDukuza.

Table 7: Live vehicle categories and assumed classification

eNaTiS category	Assumed vehicle type
Heavy load vehicle (GVM>3500 Kg, not to draw)	Freight
Heavy load vehicle (GVM>350 0Kg,equip to draw)	
Light load vehicle (GVM 3500Kg or less)	
Special Vehicle	Other
Unknown	
Light passenger mv(less than 12 persons)	Private
Motorcycle / Motortricycle / Quadrucycle	
Heavy passenger mv (12 or more persons)	Public
Minibus	

StatsSA 2011 Census data

Municipal statistical data was obtained by the Statistics South Africa (StatsSA) from the recent South African National 2011 Census including demographic, household and household services information. All household and per capita figures reflect the data from the year 2011.

Gross Value Added Value (GVA) from Quantec

Gross Value Added (GVA) figures were obtained by Quantec for KwaDukuza Municipality, KwaZulu-Natal and South Africa. The GVA measures the contribution to the economy of each individual producer, industry or sector. The GVA is equal to Gross Domestic Product (GDP) minus the taxes and subsidies. GVA also allows for regional analysis and productivity comparisons to be made. These figures were readily available and therefore were used for the per capita estimations within the study.

Carbon Inventory

Emission Factors

All the emission calculations performed in this report use emission factors (EFs) that have been published by authoritative research organizations such as 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; these are listed in the table below.

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 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. For example:

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 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.

Table 8: Greenhouse Gas emission factors for South Africa

Fuel Type	Unit	tCO_2e per unit			tCO_2e	Reference
		CO2	CH4	N20		
Diesel	litres	0.0026870	0.00000362600	0.000021760000	0.00 702	www.emissionfactors.com (Using 4th Assessment Report GWP)
Petrol	litres	0.0022640	0.000 00 032670	0.00 00 00019600	0.002 277	www.emissionfactors.com (Using 4th Assessment Report GWP)
Aviation Gasoline	litres	0.0021920	0.000 00 031310	0.00 00 00018780	0.002205	www.emissionfactors.com (Using 4th Assessment Report GWP)
Jet Kerosene (Jet fuel)	litres	0.0025010	0.000 00 034980	0.00 00 00020990	0.002516	www.emissionfactors.com (Using 4th Assessment Report GWP)
Illuminating Paraffin	litres	0.0025620	0.000 00 035640	0.00 00 00021380	0.002577	www.emissionfactors.com (Using 4th Assessment Report GWP)
Heavy Furnace Oil	litres	0.0029530	0.000 00 038150	0.00 00 00022890	0.002968	
Electricity	kWh				0.001030	Eskom Annual Reports, 2011 (excluding T&D losses)
Natural Gas	litres	0.0020090	0.000 00 017900	0.00 00 00003580	0.000 002	www.emissionfactors.com (Using 4th Assessment Report GWP)
Liquid Petroleum Gas	litres	0.0016180	0.00012820 000	0.00 00 025650 00	0.001622	www.emissionfactors.com (Using 4th Assessment Report GWP)
Coal (Bituminous)	kg	0.0026250	0.000 00 002610	0. 00 00 000 40050	0.002810	www.emissionfactors.com (Using 4th Assessment Report GWP)
Anthracite	kg	0.0000001	0.000 00 000 001	0.00 00 000 000 02	0.002643	www.emissionfactors.com (Using 4th Assessment Report GWP)
Marine Fuels (Diesel)	litres	0.0027667	0.000 00 300 000	0.00 02 898 000 00	0.003060	www.emissionfactors.com (Using 4th Assessment Report GWP)

Energy conversion factors

All conversion factors relating to the study are available in the electronic database. Below are the Energy Conversion factors used to convert original units into gigajoules (GJ) and the associated source of that factor.

Table 9: Energy conversion factors

Energy Source	Conversion	Units	Source
Electricity	0.0036	GJ/kWh	Energy Information Administration, USA, 2001
Coal (bituminous)	0.031	GJ/kg	Energy Information Administration, USA, 2001
Heavy Furnace Oil	0.04	GJ/litre	Energy Information Administration, USA, 2001
Diesel	0.037	GJ/litre	Energy Information Administration, USA, 2001
Paraffin	0.036	GJ/litre	Energy Information Administration, USA, 2001
Petrol	0.034	GJ/litre	Energy Information Administration, USA, 2001
LPG	0.0268	GJ/litre	The South African Pipeline Gas Association
Jet Fuel	0.04315	GJ/litre	BP Products handbook.
Aviation Gas	0.04465	GJ/litre	BP Products handbook.
Gas (Natural)	0.0268	GJ/litre	Set to same as LPG

Emission Scopes

Emission scopes were considered in this analysis, based on the guidelines of the GPC Protocol; 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

Concluding remarks

In general, data required to undertake the GHG inventory was accessible by the relevant stakeholders and data sources were able to assist to provide further clarification and classification to data where needed. The municipal electricity distribution data was provided in monthly quantities for municipal financial years (June - June) and therefore two consecutive financial years were required to process a complete calendar year for the purpose of the study. National Energy Regulator of South Africa (NERSA) is undertaking a process whereby all local data will be collected and stored in a central data base and therefore will avoid municipal data collection of this nature. It will therefore aim to standardise the municipal electricity tariff codes, which is hoped to standardise reporting across the country.

It must be noted that KwaDukuza Municipality has limited information on energy efficiency initiatives and have limited renewable energy initiatives to date. However once such initiatives are developed through funding programmes such as the Energy Efficiency Demand Side Management (EEDSM) and Solar Water Heaters (SWH) programs, these emission reduction measures can feed into the HEAT + tool and the impact and affects it has on the total urban emissions can be expressed.

3. Greenhouse Gas (GHG) Inventory

3.1. The Energy Picture

KwaDukuza Municipality (KDM) is located in the ILembe District in KwaZulu-Natal Province of South Africa. The municipality includes two main towns, Ballito, which is located on the east side on the N2 national highway along the east coast, and Stanger, which is situated in the valleys inland from the coast on the western side of the N2. Ballito is characterized by residential and commerce center and largely a tourist and holiday destination. Stanger is the district node of ILembe, but is also predominantly residential and commercial entities, surrounded by agriculture and industry (Paper and Sugar Mills) in the outskirts.

In summary, Table 10 provides key highlights of some sustainable energy indicators which have been derived for other municipalities in South Africa, particularly Steve Tshwete Local Municipality and all local and District Municipalities in the Western Cape[2]. Therefore this table can be compared to other municipalities in South Africa. It must however be noted that the context in relation to the local economy differ from region to region and so will the results. Refer also to the accompanying Baseline report for KwaDukuza Municipality conducted complimentarily to the GHG Report which provides further details of the local context in terms of socio-economic drivers and services.

Table 10: Key sustainable energy indicators in KwaDukuza Municipality

Key sustainable energy indicator	Unit of Measure	Local Level (2012)	National Level (2000)*
Energy consumption per capita	GJ/capita	23	53.0
GHG per capita	tCO2e/capita	7.3	7.7
Energy per Gross Value Added (GVA) (R' mill)	GJ /GVA	685.7	1095.0
GHG per Gross Value Added (GVA) (R' mill)	tCO2e/GVA	218.2	159.0

*Source: Department of Energy: South African Energy Synopsis 2010: data for 2006 only/SA's 2nd National Communication, 2011, data for 2000 only

The KDM GHG analysis is outlined in the following sections below. Data summaries are provided in tables with a selection of graphs representing energy and emission results for **Supply-side** (Electricity, Waste and Fuel), and **Demand-side** energy and emissions, followed by concluding summaries.

[2] Western Cape GHG Report, 2012, undertaken by Sustainable Energy Africa (SEA), titled in full: Database of energy consumption and energy-related co2e emissions inventory for the Western Cape Province

3.2. Supply side energy and emissions

Supply-side refers to the classification of both primary and secondary energy types that are distributed to the demand-side sectors for use; these include liquid and solid fuels, electricity and renewables.

Table 11 and Figure 3 below provide an overview of the energy types used and consumed in the KDM area for 2012. It is clear that electricity is the dominant energy type consumed typically used for the large industries in the area as well as the growing commerce and residential sectors. Diesel and petrol liquid fuels are the second and third largest fuel type consumed, which would typically be associated with transportation for the main economic sectors in this area.

It should be noted that although electricity accounts for 41% of the energy consumed, its GHG emissions accounts for 78% of the total emissions, which is as a result of the high emission factors allocated to electricity in the South African context as a result of its source in low grade, 'dirty' coal. The use of coal is also worth noting, a total of 54 394 tonnes of coal was used for industrial purposes by two coal using industries in the area, this accounts for 0.03% of the energy consumed (Gigajoules) but accounts for 8% of the GHG emissions for the area.

The Supply-side energy data results are expressed in the table and graphs below.

Table 11: KwaDukuza energy consumption and energy-related emissions by fuel type, 2012

KDM 2012 Energy, Carbon Figures (conversion factors as per IPCC)		
Energy Source	**Energy (GJ)**	**Carbon Emissions (tCO_2e)**
Electricity	2 038 781.86	1 189 289.42
Diesel	1 130 520.20	85 558.67
Petrol	1 864 415.09	136 022.95
Heavy Furnace Oil	19 690.92	1 359.22
Paraffin	1 363.46	91.87
Solid Fuel (Coal)	1 686.21	118 174.04
Total	**5 056 457.75**	**1 530 496.17**

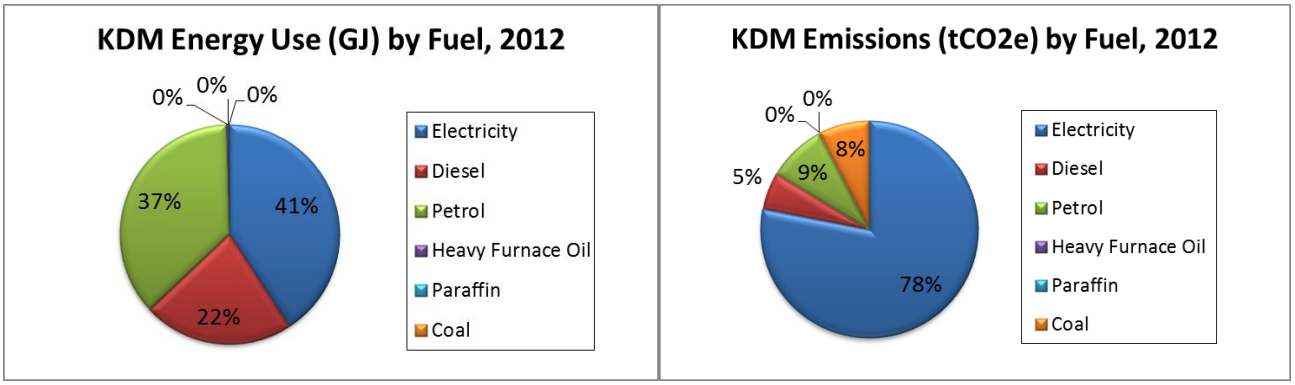


Figure 3: KwaDukuza energy consumption and energy-related emissions by fuel type, 2012

It is important for the sustainability of the environment that the communities and businesses located in the area contribute towards a low carbon future in collaborative efforts with the municipality. This is needed in order to address the challenges posed by high energy demand, to enable diversification of energy, increased energy efficiency and decreasing GHG emissions by increasing the use of clean energy and renewables.

As seen within the supply-side energy results, coal plays a significant role in the contribution of over 85% of the emissions directly from the consumption and burning of coal for energy. Business and industries particularly can play a role and invest in alternative energy sources to reduce their reliance on coal as the primary energy source.

3.3. Demand-Side Energy

Demand-side energy refers to the energy end user, i.e. the sectors like residential, commercial, industrial users of energy within and urban jurisdiction. For reference to the section below the concluding graphs of the demand-side sectors are represented below for an overview of the detail section to follow. From Section 3.3.1, a breakdown of the different fuel types (electricity, liquid fuel and waste generation) will illustrate the contribution per sector.

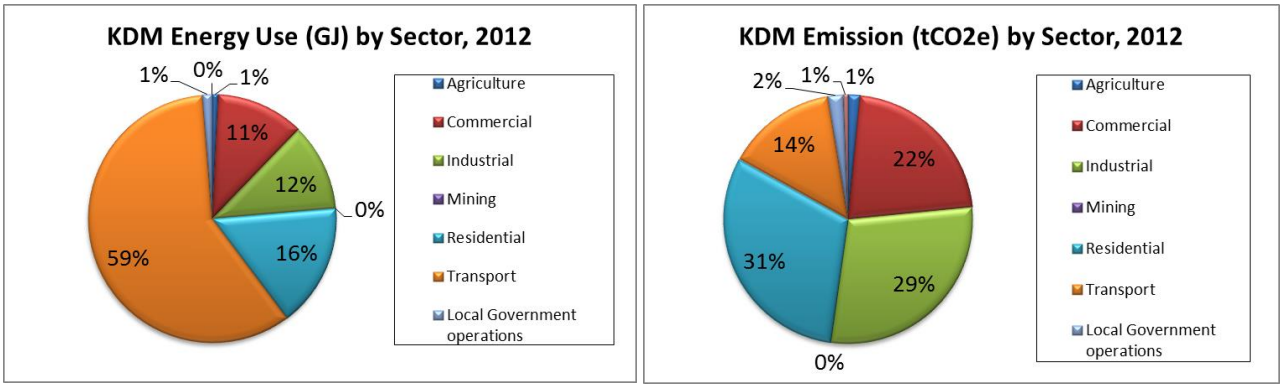


Figure 4: Energy consumption and energy related emissions by sector in KwaDukuza, 2012.

3.3.1. Electricity

Electricity is supplied by South African electricity public utility, called Eskom. Eskom supplies electricity directly to end users within the municipal boundary, and also supplies bulk quantities to municipalities across South Africa for municipalities to supply electricity through the municipal electricity grid to end users within the boundary.

Electricity data was obtained from Eskom, which provides electricity to individual customers and provides bulk monthly quantities to the local authority for redistribution to the rest of the community. The local authority provided the detailed data recorded based on the local authority redistribution tariffs. Given the great importance of electricity in GHG emissions, especially taking cognizance that South African's energy is

coal-fired generated, it was very valuable to have received such comprehensive electricity data from the respective sources.

Eskom Distribution and Sectoral Analysis

During 2012, Eskom distributed a total of 638 GWh to the KwaDukuza area. The bulk electricity supply to the local government for redistribution was the biggest customer to Eskom contributing 91% of the electricity supplied by the national utility entity for the area.

The Residential (4%), Agricultural (2%), Commerce (2%) and Industry (1%) sectors being the other sectors contributing to the Eskom electricity sales in the area. Table 12 and Figure 5 below provide further details of the Eskom electricity sales in the area.

Electricity sales data was obtained from 2010-2012 from Eskom and annual averages were calculated. They can be seen in Table 12 below. These calculations provide a number of indications; sectoral growth from the uptake of increased electricity consumption, expansion/contraction of sectors, energy efficiency in certain sectors.

It is seen that Mining and Industrial activities have the greatest average annual increase of electricity consumption in the area with the Commerce and Agricultural sectors also showing positive percentage increases. Although the total consumption of electricity by the Mining and Industrial sectors is small compared to the other sectors, it is clearly noted that these are the growing sectors in the area. It is recommended that the local authority acknowledge the growth in these two sectors particularly and engage with the fast growing industries to ensure low carbon initiatives are incorporated within future growth and development strategies and plans going forward.

The two sectors that have showed negative annual growth in terms of electricity use over the past three consecutive years is street lighting with a significant average reduction of electricity consumption of 19%, which may be attributed to energy efficiency measures taken by both Eskom and the local authority. The bulk supply to the municipality has also reduced by 3%, which may have an impact on the local authority's revenue by electricity redistribution.

As a whole, electricity sales in the area have reduced by 2%, see the Table and Figures below. There is an increase in electricity supplied by Eskom between 2010 and 2011, however decrease in electricity supplied between 2011 and 2012. From consultation with Eskom, the exact reason for this could not be determined at the time of the study. It would be important for investigation to continue and for the 2013 electricity data to be collected to determine if an electricity consumption pattern exits over time.

Table 12: Eskom's electricity customers, sectoral totals (kWh), KwaDukuza (Source: Eskom)

Sectors	2010 (kWh)	2011 (kWh)	2012 (kWh)	Average annual % increase
Agriculture	11 197 069.15	10 154 947.00	11 346 532.33	0.12
Commercial	10 388 117.96	10 729 983.97	11 303 360.11	4.13
Industrial	6 243 023.00	6 668 697.00	8 741 142.00	15.05
Mining	5 538.00	8 589.00	7 915.00	13.50
Residential	17 378 862.97	18 058 601.62	19 542 222.92	5.68
Public Lighting	122 006.00	88 413.00	87 835.00	-19.33
Pre-Paid	5 183 374.10	5 449 970.10	5 580 656.70	3.62
KDM Bulk	612 308 247.00	659 291 895.00	582 007 746.00	-3.08
Total	**662 826 238.18**	**710 451 096.69**	**638 617 410.06**	**-2.27**

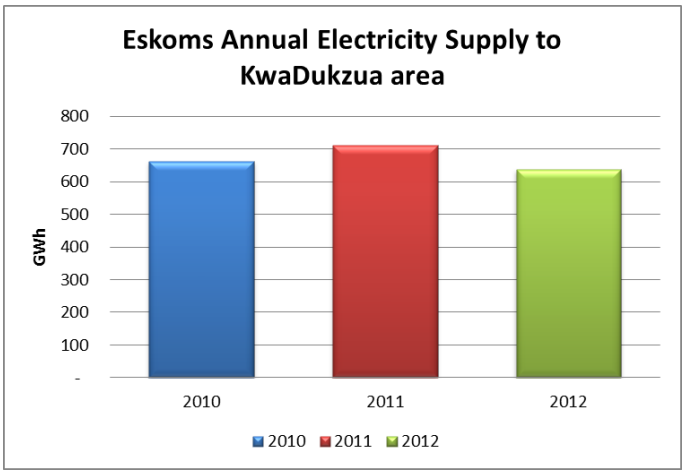


Figure 5: Annual electricity supplied by Eskom from 2010-2013 in the KwaDukuza Municipal area. (Source: Eskom)

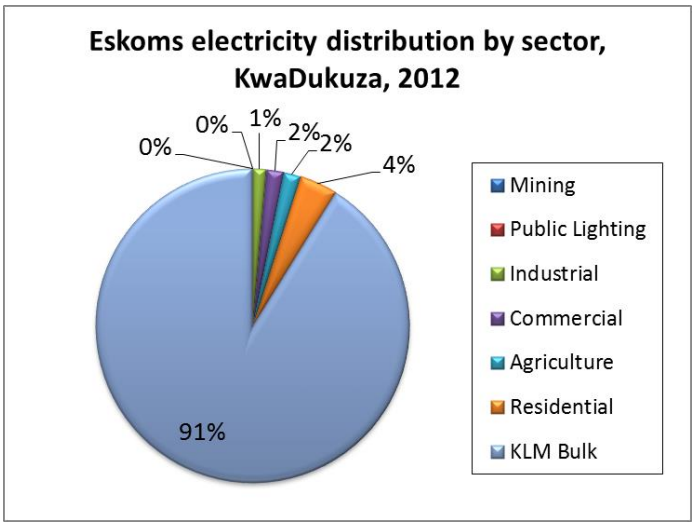


Figure 6: Eskom's electricity supply to sectoral customers in KwaDukuza, 2012. (Source: Eskom)

KwaDukuza Municipal Electricity Distribution

KwaDukuza Municipality receives bulk electricity by Eskom, which the local authority then re-distributes to end users within the area. For the year 2012 KDM received a total of 582 GWh from Eskom, of which it captured a recording of a total of 509 GWh which was redistributed to the community. An annual total of 72 GWh could not be accounted for and was classified as electrical losses, constituting 13% of the bulk electricity total received by Eskom. These electricity losses can be concluded as technical (transmission and distribution through the electrical infrastructure) and non-technical (non-metered electricity use and theft) losses.

Industrial (25%), Large Commercial entities (21%) and Domestic credit metred customers (18%) are the main consumers of the municipal electricity supply as seen in Table 13 and Figure 7 below.

It is interesting to note that there are only two customers on the municipal customer list for the industrial sector which contributes to 25% of their electricity sales.

Table 13: Summary table of KwaDukuza distribution of electricity to end-users (2012)

Sector	Tariff Codes	No. of Customers	Electricity sales (kWh)	%
Industrial	543, 550, 1543, 1550	2	145 786 439	25.05
Commercial Large	502, 517, 522, 538, 539, 540, 541, 1502, 1517, 1522, 1538	346	124 134 279	21.33
Domestic credit metered	505, 506, 520, 526, 535	9 968	106 771 506	18.35
Pre-Paid: Indigent	20 listed named customers	16 058	71 713 437	12.32
Commercial Small	504, 511, 512, 514, 525, 530, 544	1 100	24 490 927	4.21
Street Lighting: Departmental	507, 510, 527	37	12 716 842	2.18
Domestic bulk customers	515, 557	44	11 808 629	2.03
Pre-Paid: Indigent FBE	572	3 808	9 471 825	1.63
Departmental	501, 509, 1509	39	1 501 715	0.26
Indigent	534	80	793 070	0.14
Street Lighting: Private	545, 546	8	490 654	0.08
Unknown	542	1	39 308	0.01
Sub-total			**509 718 631**	
Losses	Eskom supplied [-] KDM redistributed		72 289 115	12.42
TOTAL		**31 491**	**582 0007 746**	**100.00**

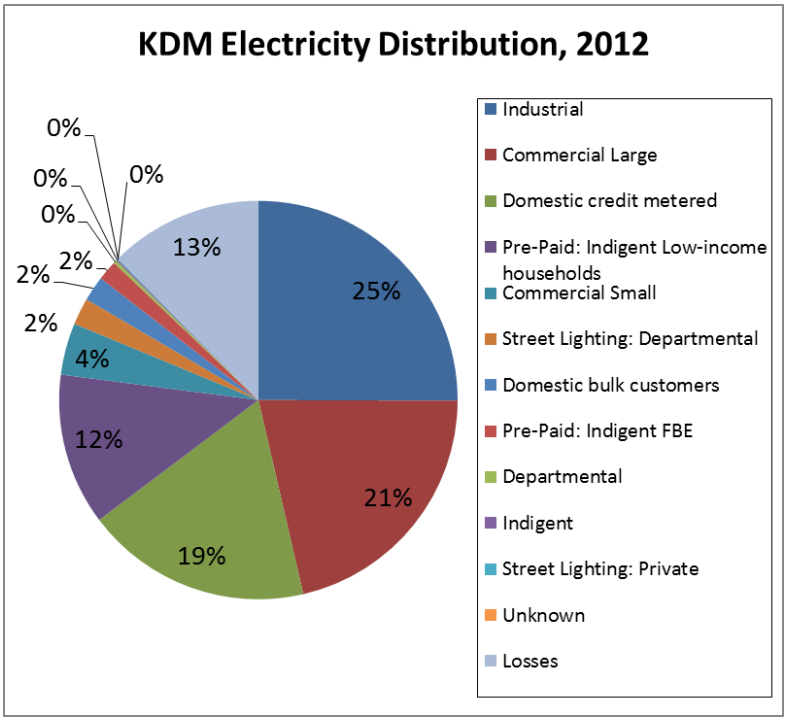


Figure 7: Sectoral representation of KwaDukuza distribution of electricity, 2012

Sectoral analysis of total electricity consumption in KwaDukuza

The summary provided in Table 14 and Figure 8 provides the total electricity consumption in the KwaDukuza area distributed by both Eskom and the local authority, represented by the Demand-side sectors.

The demand for electricity is split between three sectors; Residential (35%), Commercial (25%) and the Industrial (24%) sector. It is by these sectors where electricity saving measures can be implemented to curb and reduce the electricity and associated emissions. As seen in Table 12 above, the Mining and Industry sectors are the growing sectors in relation to annual average growths in electricity consumption and therefore energy saving strategies should be aimed at insuring that these sectors develop in a low carbon manner in the future.

Although 'electricity losses' is not a demand side sector it is under its own sector to be incorporated within the analysis as it is a cost to the Municipal authority and impacts significantly on the potential revenue from electricity sales. For KwaDukuza, the electrical losses accounts for 11% of the total electricity supplied to the region which is significant in comparison to the actual demand side sectoral percentages of the total electricity consumed in the area.

The percentage losses are in line with other municipalities in South Africa in reference to the publication: State of Energy in South African Cities 2011 by Sustainable Energy Africa. These electricity losses can be concluded as technical (transmission and distribution through the electrical infrastructure) and non-technical (non-metered electricity use and theft) losses. It is recommended that the municipality put

measures in place to understand the main causes for the electrical losses in order to reduce both technical and non-technical electrical losses in future.

Table 14: Total Electricity consumed in KwaDukuza - sectoral representation

Sector	Electricity sales (kWh)	%
Mining	7 915	0.00
Agriculture	11 346 532.33	1.78
Local Government operations	14 345 700.16	2.25
Losses	72 289 114.93	11.32
Industrial	154 527 581.00	24.20
Commercial	160 419 220.00	25.12
Residential	225 681 346.60	35.34
Total	**638617410.10**	**100**

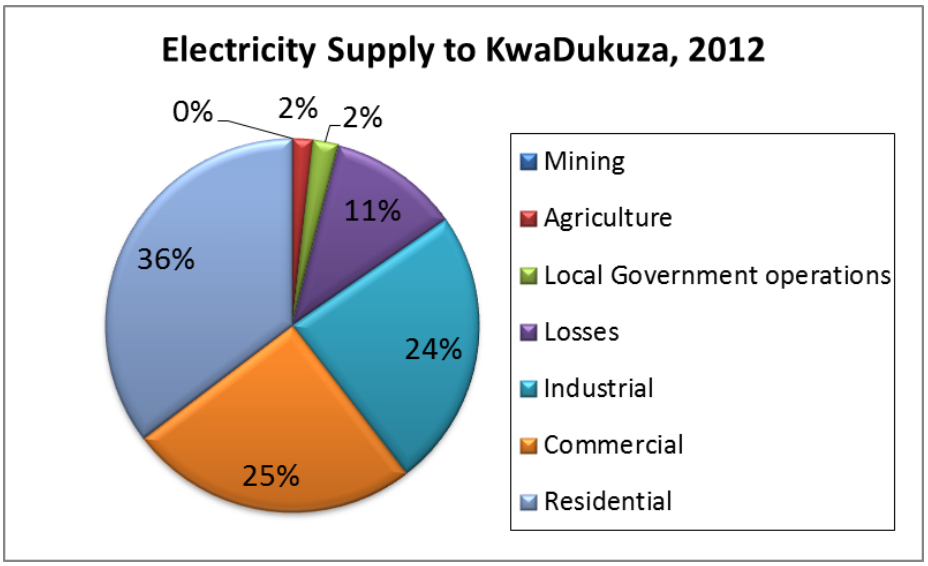


Figure 8: Graphic representation of total electricity consumed by sectors in KwaDukuza, 2012

Municipal Consumption

It is important to note that KDM measures and captures municipal electricity consumption under the 'Departmental' Tariff Codes (501, 509 and 1509) and under 'Street lighting: Departmental' Tariff Codes (507, 510, 527), which is then incorporated under the Demand-side sector namely Local Government operations. Local government operations constitutes 2.25% of the total electricity consumed in KwaDukuza and 2.79% of the electricity that is redistributed by the local authority, see Table 14.

Due to either a lack of metering or information captured by the local government for the municipal operations, it is uncertain whether the Tariff Codes as indicated above provides a true reflection of the internal municipal consumption of electricity, as water and waste water treatment is either captured under

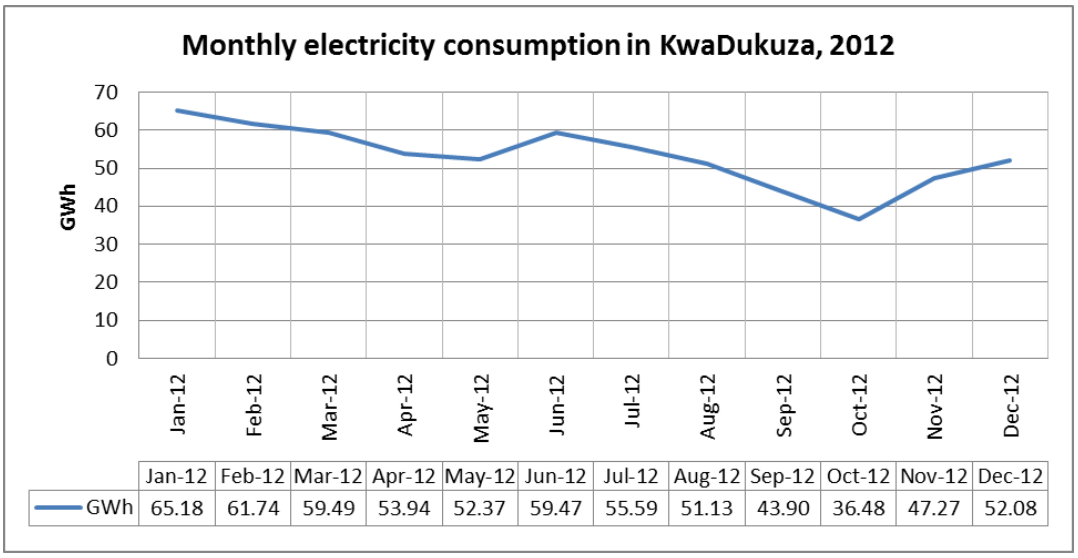
the Departmental Tariff Codes or is omitted and therefore not captured within this study. From the study it concludes that street lighting is the major electricity cost under the municipal operations and therefore a street lighting retrofitting project would be the recommended energy saving measure to reduce electricity consumption and savings for the municipality if not yet already done so.

It is highly recommended that the municipality meters and reports individually on as many of its local government buildings, facilities and operations as is feasible, in order to better manage consumption and savings from energy reduction measures over time and to help develop a business case for doing so.

A detailed graph of the local government operations energy generation and emissions can be seen in the Figure 15 in the below section.

Monthly analysis of electricity consumption

The monthly electricity consumption in the KwaDukuza Municipal region is represented in Figure 9, and is on average 53.22 GWh per month with consumption peak demand during the winter period of June and summer months of December-January. Lower consumption demand levels can be seen during April-May and the month of October. It can be assumed that an attributing factor for the electricity peaks during the months mentioned are due to heating and cooling by residential, commercial and industrial sectors. To curb electricity consumption during these peak months, electricity efficient campaigns can be conducted to target the residential sectors to take up technologies such as ceiling insulations, solar geyser installations, and gas heaters in order to reduce the demand of electricity during these peak months.



	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
GWh	65.18	61.74	59.49	53.94	52.37	59.47	55.59	51.13	43.90	36.48	47.27	52.08

Figure 9: Monthly electricity consumption for KwaDukuza area for 2012.

Residential Sector: Energy use

The graphs below represents data from the 2011 Household Survey which illustrates the household fuel mix in meeting the main household energy needs, notably lighting, cooking and space heating.

The 2011 Census data revealed that there are 70 291 households in KDM. In terms of access to housing, 75% of households reside in formal dwellings, while 5% live within traditional dwellings, 8% within informal settlements and 12% in other informal dwellings. Lighting can be used as a proxy for electrification, as electrified households use electricity for lighting first and foremost. It be concluded that the majority of households in the municipality are electrified at 90.21% which compares strongly to the national estimation of 82% households electrified in South Africa.

For comparative purposes the list of Provinces are listed below in Figure 11 demonstrating the percentage of households that use electricity for lighting. This graph illustrates that KwaDukuza Municipality is a above KwaZulu-Natal's figures of 78% which is significantly lower when compared to other provinces in South Africa.

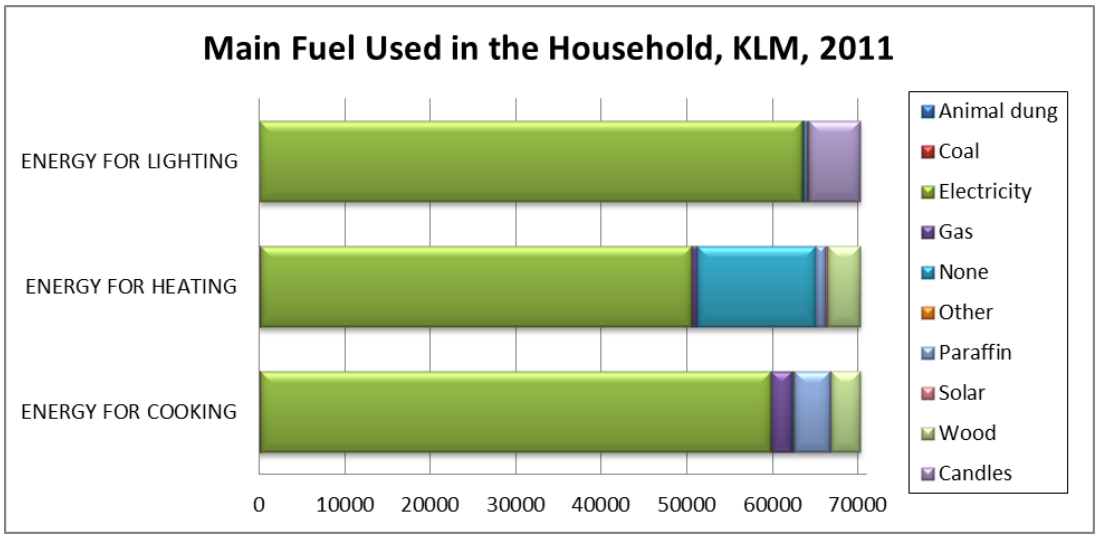


Figure 10: Fuels used for lighting, heating and cooking in KDM, 2011 (Source: StatsSA)

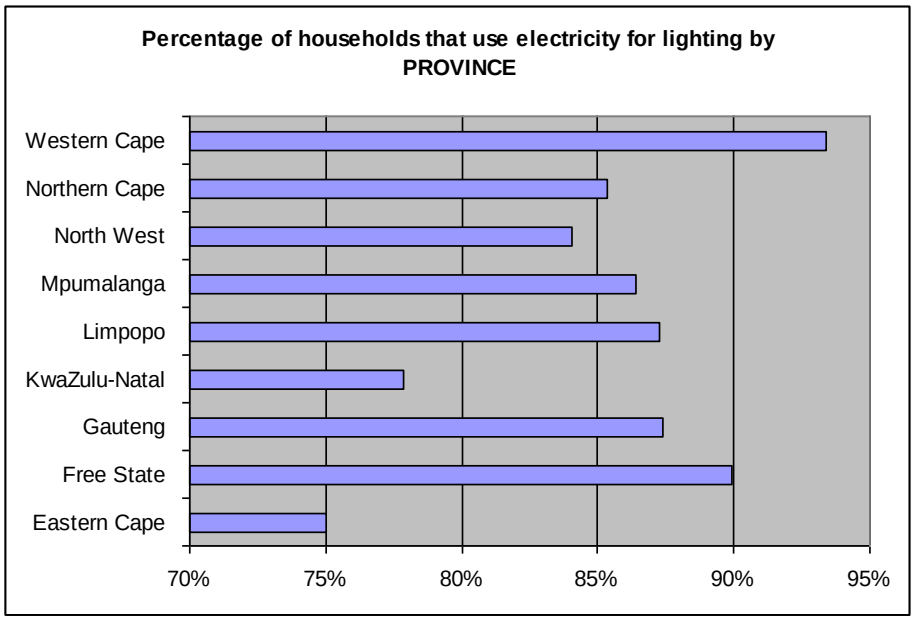


Figure 11: Comparative study by province of the households that have access to electricity for lighting purposes. (Source: StatsSA)

Energy poverty on the other hand is indicated by the proportion of non-electricity fuels used for cooking and space heating, due to the high cost of electricity, rather than the proportion of non-electrified households. From the graph below it can be seen that gas (3%), paraffin (6%) and wood (5%) are the alternative cooking fuels in households while the alternative source of lighting is candles (9%). KwaDukuza is located in KwaZulu-Natal which experiences a warm tropical climate and therefore temperatures remain moderate even in winter months so heating household spaces is not a necessity. Where it is used, electricity is still the dominant energy source for space heating, though 20% of households don't use energy at all for heating their households.

Residential Sector: Electricity use

The monthly electricity data obtained by KDM provided sufficient information to undertake a detailed analysis determining the proportion of households in the residential sector that can be categorized in terms of household income. This can then further support conclusions in relation to estimated consumption patterns and revenue received by these domestic customers respectively.

For the purpose of this analysis, Eskom's residential customers and consumption figures were excluded as Eskom was unable to provide revenue values for each sector category. Without this data, accurate analysis could not be completed. Although the Eskom residential customers are excluded it is assumed that Eskom provides electricity to informal and low-income houses and establishments. The total number of customers under each sector category was also not released by Eskom to ensure customer confidentiality.

Figure 12 A, B and C below are illustrations of the proportion of electrified domestic households which are further categorized by household income levels. This is directly related to the assigned municipal customer

tariff codes. Therefore the tariff code, outlined in Table 15, provides an estimation of the level of income of households. These assumptions were made in consultation with the municipal authority.

Table 15: Domestic types determined by municipal tariff codes, KDM

Sector	Tariff Codes	No. of Customers
Domestic credit metered	505, 506, 520, 526, 535	9 968
Pre-Paid: Indigent	20 listed named customers/areas	16 058
Domestic bulk customers	515, 557	44
Pre-Paid: Indigent FBE	572	3 808
Indigent	534	80

Graph 12A represents the number of customers according to the municipal residential tariff codes. The 'Domestic credit metered' customers are assumed to be the mid-high income households, which represents one third of the residential dwellers (33%) in the urban area, while 54% are Pre-paid indigent customers and 13% Pre-paid indigent FBE (Free Basic Electricity), the latter two groups are assumed to be low income household groups.

Graph 12B illustrates that the mid-high income households are consuming 53% of the residential sector electricity and contributing to 54% of the electricity revenue from the sales thereof. In contrast pre-paid households (54%) of the residential customers only contribute 37% of the revenue generated by electricity sales while Indigent customer group only contributing 4% of the revenue.

If in the future mid-high income households who can afford and see the monetary benefits of transitioning and investing in alternative sources of energy for electrification, such as solar energy, the municipal authority will feel the impact in terms of revenue generated from these customers. Sustainable Energy Africa are currently researching and modelling alternative revenue models in collaboration with various municipal electricity departments.

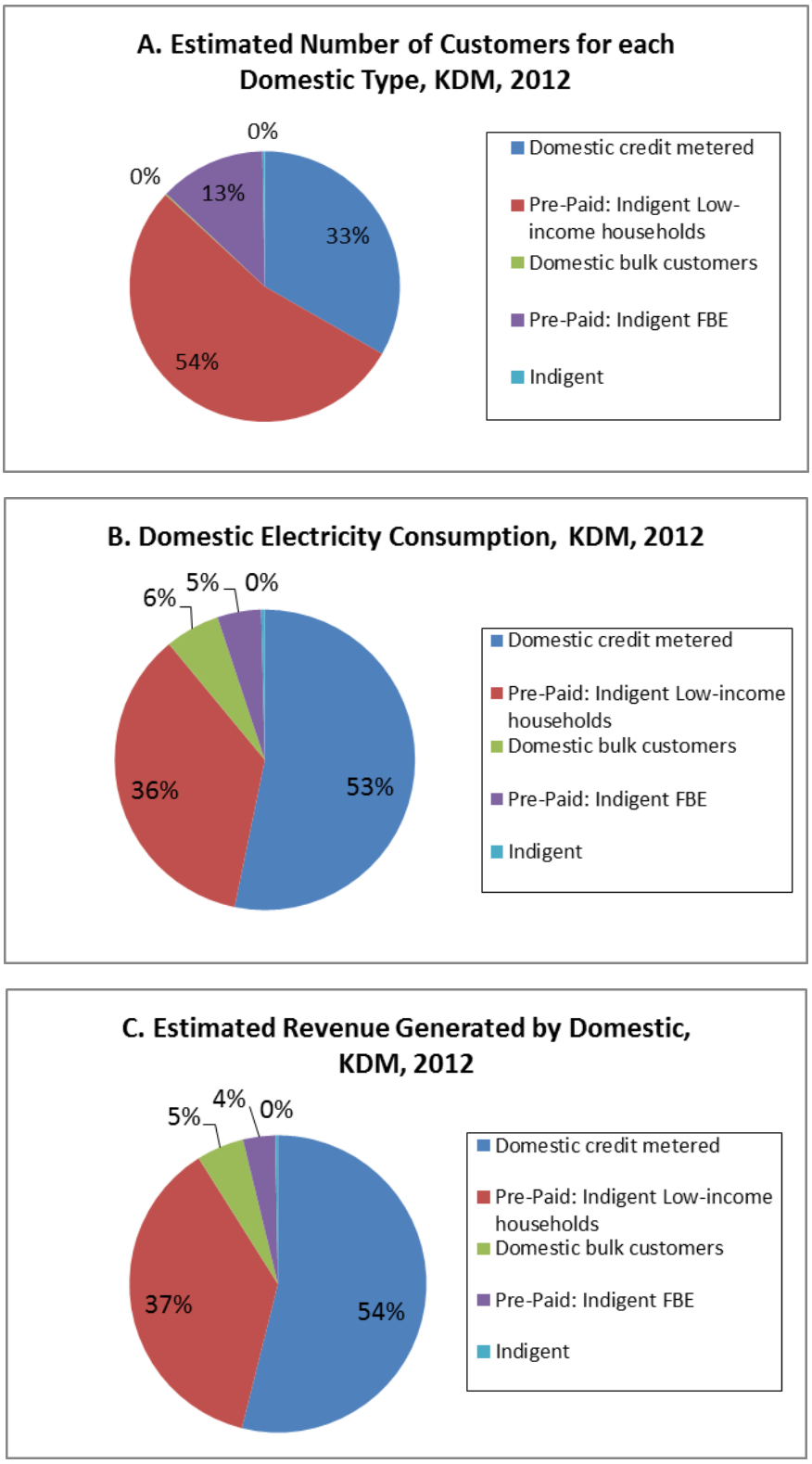


Figure 12: Illustration of electricity revenues from KDM domestic income groups in relation to high, mid and low income households.

3.3.2. Liquid Fuel Consumption

Liquid Fuel consumed within the Lower Tugela magisterial district (the district in which KDM falls within), was obtained by SAPIA and is represented in the below table accompanied by the assumed sectoral categories outlined in the Methodological section of the report. Diesel and petrol are the two liquid fuels that are largely used in the area. The consumption thereof is assumed to be by the transportation sector.

Table 16: Fuel Volume Sales for Lower Tugela magisterial district by SAPIA, DoE, assumed sector consumers, 2011

Liquid Fuel Type	Quantity (litres)	Assumed Sector
Diesel	30 554 600	Transport
Petrol	54 835 738	Transport
Heavy Furnace Oil	492 273	Industry
Paraffin	37 874	Residential
Total	**85 920 485**	

From the Diesel and Petrol totals above the municipality consumes the below quantities for the municipal vehicle fleet which can therefore be subtracted from the bulk magisterial totals of these liquid fuels. The remainder of the fuel is therefore assumed to be used by the rest of the community within the Transportation sector.

Table 17: KwaDukuza Municipal liquid fuel consumption for 2011

Liquid Fuel types	2011 (litres)
LG Diesel	86 689
LG Petrol	253 426
Total	**340 115**

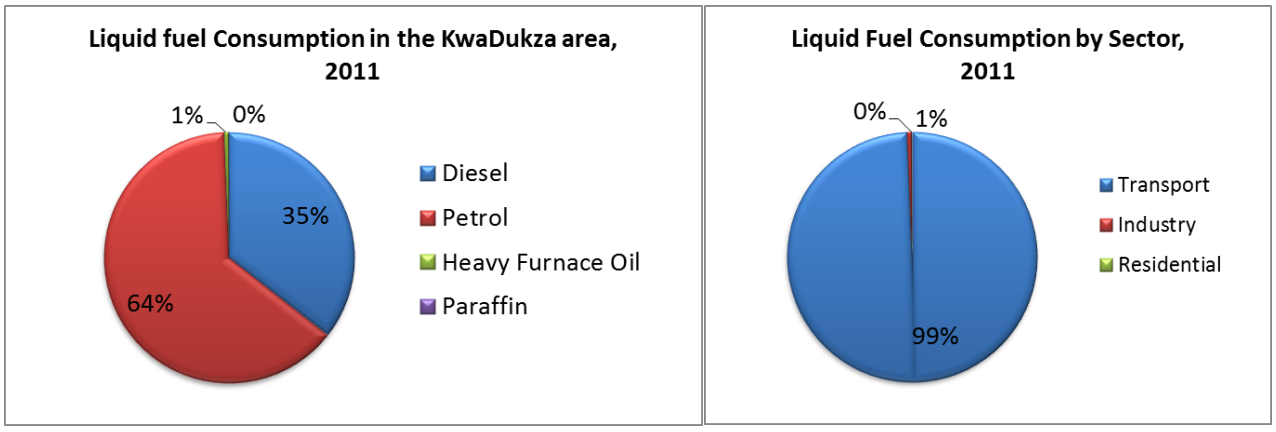


Figure 13: KwaDukuza fuel consumption per liquid fuel type and liquid fuel used per sector, 2011

Transportation Sector

Transportation is seen as the main liquid fuel consumer in this municipal area and is consistent with other municipal areas as well as at the national level. It is recommended that KwaDukuza build strong partnerships with all the existing local authorities within the east coast growth corridor, between Durban and Richards Bay, to prioritize sustainable transportation in the fast growing economy area. It is also encouraged that the municipal areas incorporate vehicle population management and integrated public transportation systems into all future planning policies to ensure fuel emissions can be monitored, measured and managed in a verifiable manner to ensure increased reduction in emissions in this sector.

The total number of vehicles within the KwaDukuza area are presented within the below table.

Table 18: Total live vehicles in KwaDukuza as of June 2013

eNaTiS category	Sub-totals	Assumed vehicle type	Totals
Heavy load veh(GVM>3500 Kg, not to draw)	1453	Freight	14 417
Heavy load veh(GVM>350 0Kg,equip to draw)	1278		
Light load vehicle (GVM 3500Kg or less)	11686		
Special Vehicle	1783	Other	1 845
Unknown	62		
Light passenger mv(less than 12 persons)	24487	Private	25 599
Motorcycle / Motortricycle / Quadrucycle	1112		
Heavy passenger mv(12 or more persons)	169	Public	1 109
Minibus	940		
Total	**42970**		**42 970**

The total number of vehicles registered under the municipal fleet register for 2013 is 211. The detailed breakdown of classified vehicles are shown in the below table, accompanied by the approximate average age of the vehicle categories. The grey highlighted categories (Trucks, Light duty vehicles and Motor vehicles) are the categories with the larger number of vehicles which is assumed to contribute to a greater proportion of carbon emissions for this particular sector for the municipal operations.

Table 19: Live Vehicles registered for the municipal vehicle fleet for 2013.

Type of Vehicle	Total	Average Age
Trucks	54	6-24 years
Fire Engines	4	3-4 years
Light duty vehicles	61	6-12 years
Motor Vehicles	62	2-12 years
Motor Cycles	2	12-16 years
Grader	4	0-26 years
Front-End loader	3	6-17 years
Roller	3	3-7 years
Tractors	1	6-19 years
Compressor	1	3 years

Back-Actor	1	6 years
Trailers	15	2-21 years
Total	211	

Summary remarks

From the 2011 population figures the following transportation indicators are derived regarding the transportation sector in KwaDukuza:

Table 20: KwaDukuza transportation indicators

Key transport statistics	
Number of total vehicles per capita	42970/231 189 = 0.19
Number of total vehicles per household	42970/ 70 291 = 0.61
Private vehicles per capita	25 599/231 189 = 0.11
Private vehicles per household	25 599/ 70 291 = 0.36

For comparative purposes, the Steve Tshwete (Middelburg), Mpumalanga transport indicator figures are shown in Table 21.

Table 21: Transport indicators for Steve Tshwete

Key transport statistics	
Number of total vehicles per capita	82 971/229 831 = 0.36
Number of total vehicles per household	82 971/ 64 970 = 1.28
Private vehicles per capita	42 379/229 831 = 0.18
Private vehicles per household	42 379/ 64 970 = 0.62

3.3.3. Waste Generation

Waste generation

Waste services in KwaDukuza are undertaken by a private company, Dolphin Coast Waste Management, serving the municipal area of KwaDukuza. The municipality has monthly waste quantity records available from September 2012. The waste quantities are measured as per load of waste delivered at the waste landfill site, measured in cubic meters. The waste composition of the loads is not separated at source or at the landfill and therefore it can be assumed that the waste comprises of mixed solid waste.

Estimations of the waste weighted was calculated using amalgamation of varies mixed solid waste composition densities (kilogram per cubic meter), such as densities of paper, cardboard, glass, plastic, food waste, plant debris, rubble and so forth to provide an estimation of tonnage of waste generated on a monthly basis by the municipal area. From these theories, an estimation of one meter cubed of medium compacted waste calculated to 192.71 kilograms.

Table 22 reflects the quantity of waste recorded per load and the estimated tonnage generated on a monthly basis. The cost of the service to the municipality is also included to inform future decisions made for Waste Management. The cost of every kilogram of waste generated is costing the municipality approximately R2 (or R350 per cubic meter). This cost can be reduced drastically with the implementation of waste minimization at source programs and initiating recycling depots for glass, plastic and paper in residential areas, business centers and industrial parks.

Table 22: Total waste measured and reported by KwaDukuza Municipality for the municipal area

Month	Year	Total Loads (m^3)	Est. Weight (Kg)	Cost (R)
September	2012	7589	1 462 508.71	2 660 268.38
October	2012	8292	1 597 986.86	2 693 863.91
November	2012	8127	1 566 189.00	2 668 334.92
December	2012	12879	2 481 967.29	2 817 415.07
January	2013	10358	1 996 134.57	2 692 481.71
February	2013	11326	2 182 682.00	2 707 179.75
March	2013	10813	2 083 819.57	2 686 182.55
April	2013	12450	2 399 292.86	2 750 224.02
May	2013	10773	2 076 111.00	2 710 329.33
June	2013	9276	1 787 617.71	2 609 542.75
10 Month TOTAL		**101 883.00**	**19 634 309.57**	**26 995 822.39**

The quantity of waste is relatively stable through the 10 month period compared to the associated cost for Waste services, as seen in Figure 14. It is important that waste quantities are monitored and evaluated on a monthly and annual basis in future in order to manage waste minimization by the respective sectors and areas of the communities in order to reduce costs for the municipality, Money saved can then be spent on more productive uses to address socio-economic and environmental issues in the area.

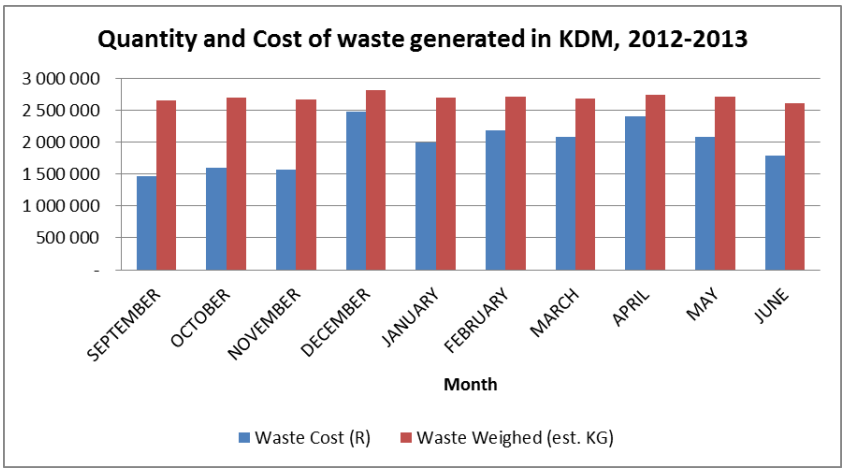


Figure 14: Waste measured and reported in KwaDukuza, 2012-2013.

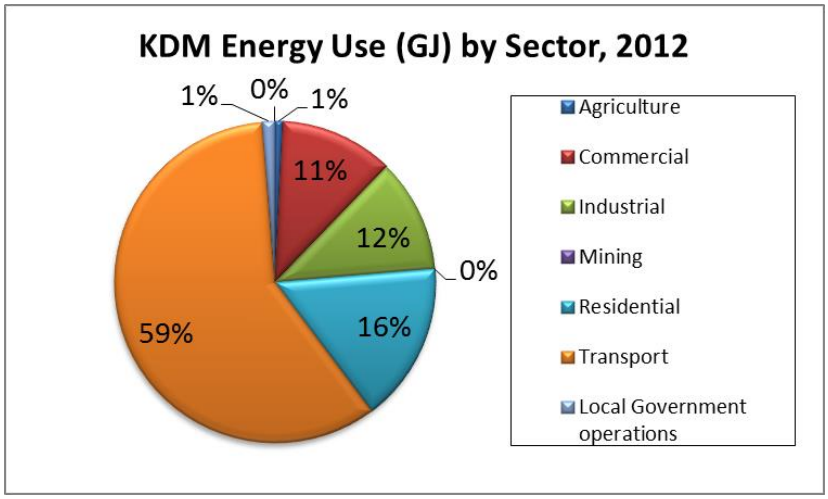
3.4. Demand side energy and emissions conclusions

Demand-side energy refers to the energy consumed by the energy end user, i.e. sectors such as residential, commercial, industrial use of energy within an urban jurisdiction. The table and pie charts below illustrate the distribution of energy use and carbon emissions across sectors within this municipal boundary.

It is evident that the transportation sector is a high energy sector, constituting nearly 60% of the total energy consumed in the KwaDukuza area for 2012. The residential (16%), industrial (12%) and commercial (11%) sector are responsible for the remaining 39% of the total energy consumed. Although the transport sector dominates the energy consumed in the area, this sector only emits 14% of the carbon equivalent emissions, while the three latter sectors are higher carbon emitters due to the heavy reliant on electricity (mainly coal) as the primary source of energy.

Table 23: Sectoral Analysis of Energy and Emissions in KwaDukuza, 2012

Sector	Energy (GJ)	Carbon (tCO_2e)
Agriculture	40 847.52	23 827.72
Commercial	577 509.19	336 880.36
Industrial	577 676.43	444 041.19
Mining	28.49	16.62
Residential	813 816.31	474 022.69
Transport	2 982 547.52	220 652.24
Local Government operations	64 032.29	31 055.35
Waste	-	9 674.81
Sub-total	**5 056 457.75**	**1 540 170.98**
Losses	260 240.81	151 807.14
TOTAL	**5 316 698.57**	**1 691 978.12**



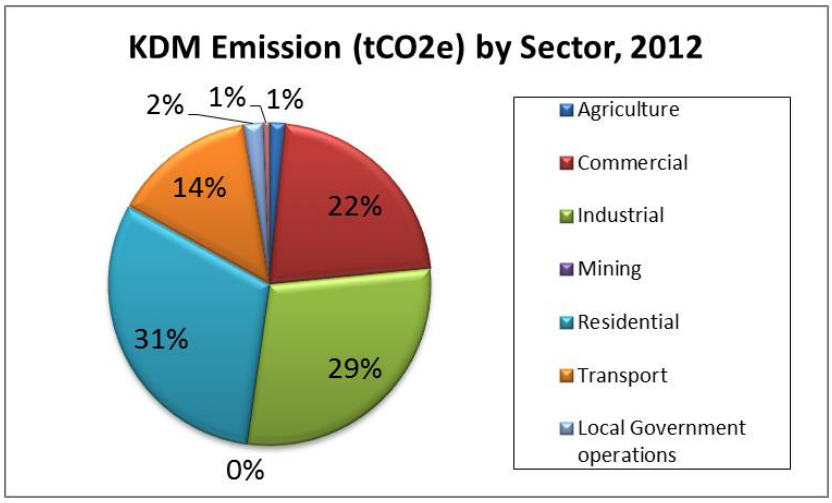


Figure 15: Energy consumption and energy related emissions by sector in KwaDukuza, 2012.

Local Government operations accounts for a very small proportion of the overall energy used and carbon emitted within the municipal area. It is evident (Figure 16) that the greater proportion of energy consumed is by the municipal vehicle fleet and by the municipal departments (under the respective Tariff Code in Table 13). Local governments have a large role to play in terms of leading by example to implement energy efficient and renewable energy measures and to advocate to the demand-side sectors to undertake similar measures to promote emission reduction.

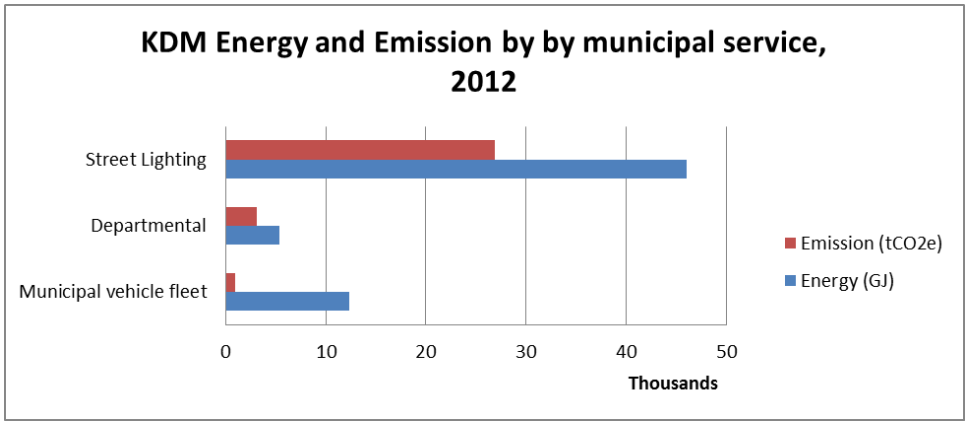


Figure 16: Energy used and carbon emitted by the KwaDukuza Municipal operations, 2012

3.5. KwaDukuza Greenhouse Gas Inventory summary

The total (estimated) energy consumed and carbon equivalent emissions generated in the area for 2012 is 5.316 million GJ and 1.691 million tCO_2e respectively. Electricity is the dominant energy type used in KwaDukuza, which is consistent with other municipalities in South Africa. The sectors emitting the greater proportion of carbon equivalent emissions are shared by the Residential, Industrial and Commercial sectors.

With 1.691 million tCO_2e emitted, 98% is emitted by the community and 2% emitted directly by the local authority operations (with the exclusion of electrical losses). Inclusion of the emissions generated from the unaccounted electrical losses increases the overall emissions emitted by 11% and increases the local government operations proportion to 10%. Per capita, the total emissions accounts for a high 7.3 tCO_2e per capita for the KwaDukuza area based on 2011 population figures.

Table 24: KwaDukuza Energy and Emissions, Government vs. Community

2012	**Carbon emissions (tCO_2e)**	
	Community	**Local Government**
Waste	9 674.81	
Electricity	1 159 430.45	29 858.97
Liquid Fuel	220 652.24	929.38
Solid Fuel	118 174.04	
Supply Sub-total	**1 507 931.54**	**30 788.35**
Supply total	**1 538 719.88**	
Percentage	**98.00**	**2.00**
Electricity Losses		151807.14
Sub-total	1507931.54	182595.49
Total		**1 690 527.03**
Percentage	89.20	10.80

Table 25: Energy and Emissions by Sector, KwaDukuza, 2012

KDM 2012 Energy, Carbon Figures (conversion factors as per IPCC)		
Energy Source	**Carbon (tCO_2e)**	**Energy (GJ)**
Electricity	1 189 289.42	2 038 781.86
Solid Waste	9 674.81	-
Diesel	85 558.67	1 130 520.20
Petrol	136 022.95	1 864 415.09
Heavy Furnace Oil	1 359.22	19 690.92
Paraffin	91.87	1 363.46
Coal	118 174.04	1 686.21
Sub-total	1 540 170.98	5 056 457.75
Population 2011	231 189	231 198
Carbon emission per capita	6.66	21.87
Electricity Losses	151 807.14	260 240.81
Total tCO_2e	1 691 978.12	5 316 698.57
Carbon emission per capita	7.32	23.00

Table 26 shows the emissions by sector per emission scope, as per the international standards for local governments, entitled Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC).

Emission scopes, based on the guidelines of the GPC Protocol; 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

Table 26: Greenhouse Gas emissions by sector per scope in KwaDukuza, 2012

2012 Community GHG Profile Reporting Standard						
Sector	**Sector Total (tCO2e)**	**Subsector**	**Subsector Total (tCO2e)**	**Subtotal (tCO2e)**	**GHG Emissions Sources**	**GPC No.**
STATIONARY UNITS	**1 461 634.45**	Agriculture	**23 827.72**	23 827.72	Stationary Units Agriculture Energy Indirect Emissions (Scope2)	I.1.ii
		Residential Buildings	**474 022.69**	91.87	Stationary Units Residential Direct Emissions (Scope1)	I.1.i
				473 930.83	Stationary Units Residential Energy Indirect Emissions (Scope2)	I.1.ii
		Commercial/Institutional Facilities	**519 742.85**	337 809.74	Stationary Units Commercial/Institutional Facilities Direct Emissions (Scope1)	I.2.i
				181 933.11	Stationary Units Commercial/Institutional Facilities Energy Indirect Emissions (Scope2)	I.2.ii
		Industrial Energy Use	**444 041.19**	119 533.27	Stationary Units Industrial Energy Use Direct Emissions (Scope1)	I.4.i
				324 507.92	Stationary Units Industrial Energy Use Energy Indirect Emissions (Scope2)	I.4.ii
MOBILE UNITS	**220 652.24**	On-Road Transportation (Cars, LDV, HDV/Buses, others)	**220 652.24**	220 652.24	Mobile Units On-Road Transportation (Cars, LDV, HDV/Buses, others) Direct Emissions (Scope1)	II.1.i
		Aviation		-	Mobile Units Aviation Indirect Emissions from Inter-City Domestic Flights (LTO and Cruise) (Scope3)	II.4.iii
WASTE	**9 674.81**	Solid Waste Disposal	**9 674.81**	9 674.81	Waste Solid Waste Future Indirect Emissions from Community Generated Waste Landfilled in the Community in the Analysis-Year (Scope1)	III.1.i
IPPU	**16.62**	Industrial Processes (Mining)	**16.62**		IPPU Direct Emissions from Industrial Processes (Scope1)	IV.1.i
				16.62	IPPU Indirect Emissions from Industrial Processes (Scope2)	IV.1.ii
	1 691 978.12	**TOTAL Community Emissions (tCO2e) by *2012 Accounting Standard* (for benchmarking)**				

Aggregate tCO2e by Scope		
	tCO2e Scope-1	687 762
	tCO2e Scope-2	1 004 216
	tCO2e Scope-3	-
Total		**1 691 978**

4. Recommendations

The following recommendations are listed below in response to the GHG analysis within this report under the respective headings. These should be considered when developing and outlining objectives and actions as part of the development of an Urban Low Emission Development action plan, during the Urban-LEDS project and beyond.

Energy data collection and analysis:

- Assign responsibility within the municipality to undertake this specific data management under an appropriate staff members key performance area (KPA)
- Repeat data collection and analysis on an annual basis
- Store data readily available on a central data base system, also by installing an internal energy management system
- Disseminate and publically display GHG findings within the municipality to respective sectors and to external stakeholders (newspaper, website, posters).
- Annually report energy data and climate action to the HEAT + and carbon*n* Cities Climate Registry (cCCR)

Continuation of measuring, monitoring and reporting:

- Put systems in place to measure electricity consumed by individual local government operations (buildings, water and sanitation facilities, street and traffic lighting)
- Continuously report on individual consumption patterns and report to respective municipal platforms
- Report and record to a central data base any projects relating to energy savings that will have an impact on electricity consumption from local government operations – publically disseminate information to the public.

Measures and solutions:

- Local Government operations
  - Measure and report all municipal electricity consumption by local government operations (services and facilities)
  - Monitor fuel consumption by the municipal vehicle fleet; put measures in place to reduce fuel consumption.
  - Measure and report on recycling initiatives by community school and individual members, include these records within waste management data base and report to respective platforms on performance.
  - Introduce non-transportation mechanisms for municipal staff

- Reduce car-based travelling allowance for staff members to encourage less fuel consumption.
- Subsidise public transportation for respective staff members.

Waste Management

- Initiate residential waste separation and recycling initiatives and provider incentives to the residential, commercial and residential sector.
- Develop bi-annually reports of waste generation quantities and report to respective internal and external platforms.

Electricity use

- Undertake energy savings campaigns among municipal staff, public and schools
- Promote Earth Hour (normally annually in March) to 'switch off' lights and electrical appliances to raise awareness for electricity saving.
- Annually report on electricity consumption per sector and encourage energy savings by large electricity consumers in the area (create a competitive spirit between organisations of similar nature.
- Acknowledge and reward private sectors for energy savings

Transportation

- Revise transportation policy to encourage non-motorised transportation
- Encourage non-motorised transportation amongst citizens
  - Promote public transport where available,
  - Promote bicycle use
  - Encourage car pooling
- Undertake public awareness campaigns for energy efficient transportation mechanisms

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