2014

Modelling Energy Efficiency Potential in Municipal Operations of the SACN Member Cities

South African CitiesNetwork

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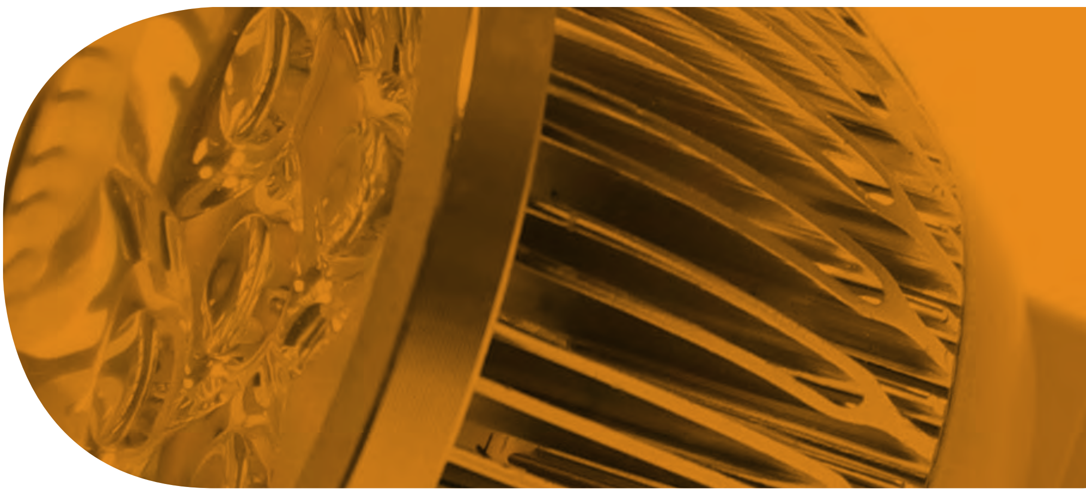


EXECUTIVE SUMMARY

This is a summary report of the study commissioned by the South African Cities Network (SACN) to establish the energy savings potential that can be realised from energy efficiency (EE) interventions in municipal facilities and operations in its nine member cities. South African municipalities can promote EE in their jurisdictions by developing and implementing projects to improve the energy efficiency of municipal facilities and operations. They will thereby lead by example, motivate the private sector and other stakeholders to follow suit, and achieve cost savings by improving the energy efficiency of their facilities and day-to-day operations.

Estimating energy savings potential is a complex exercise as it has to be based on energy end use applications. In this study, the modelling of EE potential is based on energy consumption baseline data across selected sectors within the SACN members. The modelled sectors include the following: electricity consumption by street & traffic lighting; municipal buildings; bulk water and wastewater treatment plants; as well as fuel consumption by municipal vehicle fleets.

EE potential was modelled using the Municipal Energy Efficiency Planning Tool, developed for this analysis. The tool makes use of baseline energy consumption data and the estimated penetration rates of energy efficiency measured in the respective sectors across all the study cities. The modelling relied on the interventions listed below for the different sectors. The proposed interventions were deemed commercially viable during the research period, 2014. Also included are the expected payback periods of the interventions based on a MegaFlex electricity tariff of R0.55c/kWh as shown in Table 1.

Table 1: Potential energy savings from street lighting retrofits

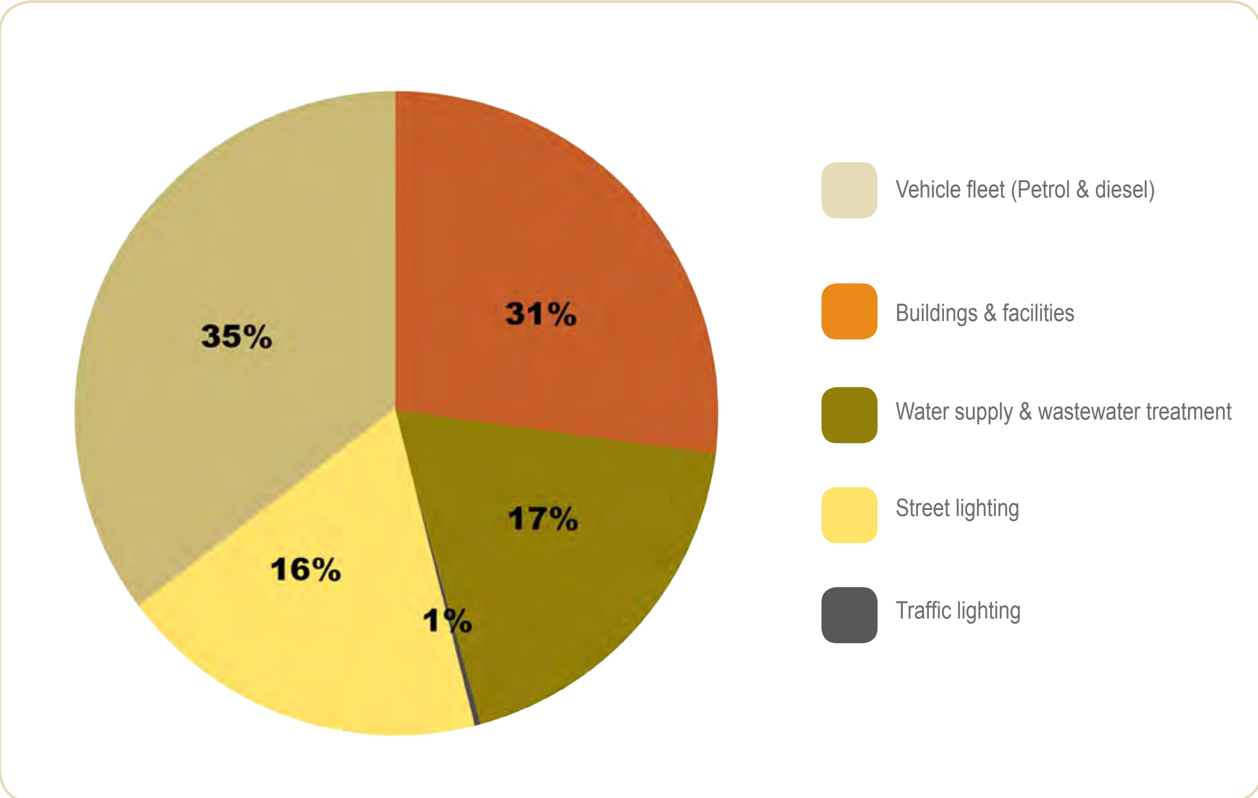
Sector	Old Technology	Proposed New	Potential Savings	Payback Time
Street lighting	400W MV	250W HPS	619kWh	4 years
	250W MV	150W HPS	412kWh	7 years
	150/125W MV	70W HPS	226kWh	8.1 years
	80W MV	50W HPS	124kWh	10 years
Traffic lighting	75W incandescent	10W LED	1569.4kWh	2 years
Building lighting	T8	T5	29.2kWh	2 years
	T8	LED	58.4kWh	6 years
Building HVAC system	Conventional VRV using refrigerants such as water; R22; R407c, etc	Efficient VRV using efficient refrigerant like R410A; latest inverter technology, and latest	325kWh	6 years
Water supply & wastewater treatment	IE1 motors	IE2/ IE3 motors with VSDs	20%	2.7 years
Vehicle Fleet	Diesel and petrol vehicles	Improved practice/	32%	0

Overarching data findings

Baseline Consumption

From the available, but notably limited data, the dominant energy consuming sector is the municipal vehicle fleet accounting for 35% of the total energy consumed. Electricity consumption in buildings and facilities accounts for 31% of the total energy use; while it is 17% and 16% in water supply and wastewater treatment and street lighting respectively. Traffic lighting only accounts for 1% of the total electricity consumption. One of the reasons for such low energy consumption might be attributed to the success of traffic lighting energy efficiency programmes that have been completed in most of the municipalities under study.

Figure 1: Average baseline energy consumption per sector (GJ/a)

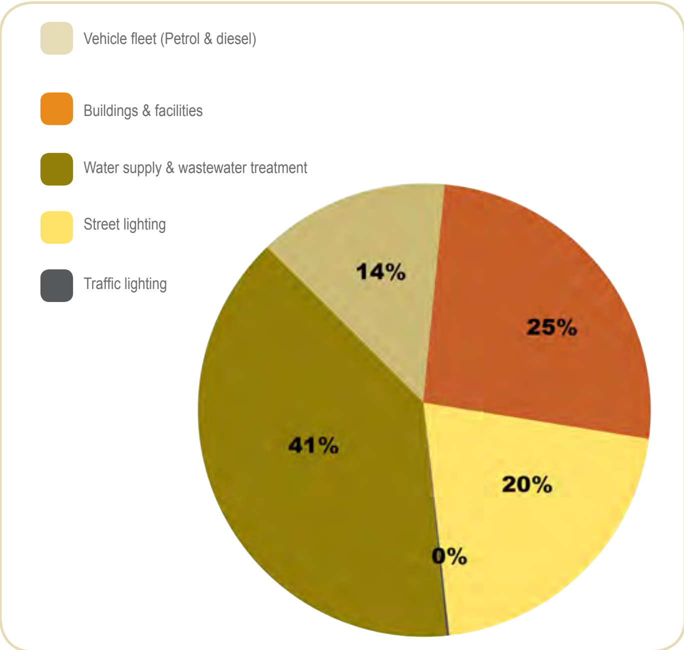


Energy efficiency potential across the sectors

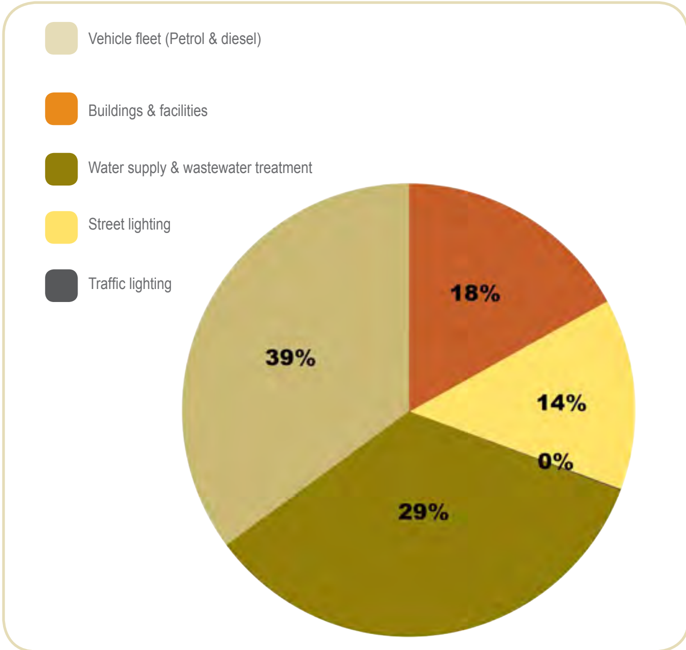
Although the data gathered remains incomplete, the report clearly illustrates that there are significant energy efficiency opportunities in municipal operations in most sectors covered. The municipal vehicle fleet sector accounts for 39% of the end-use savings potential, the water supply and wastewater sector 29%, buildings and facilities 18% and street lighting 14%. Capturing the full potential of energy savings also represents a significant reduction in carbon emissions across the sectors, as depicted in Figure 2. While the municipal vehicle fleet sector presents a high energy saving potential, it however accounts for a low carbon emission reduction figure due to the high carbon content associated with our grid supplied electricity relative to that of liquid fuels.

Figure 2: Potential energy savings and carbon emissions reductions per sector yearly

Potential energy savings per sector (GJ/a)

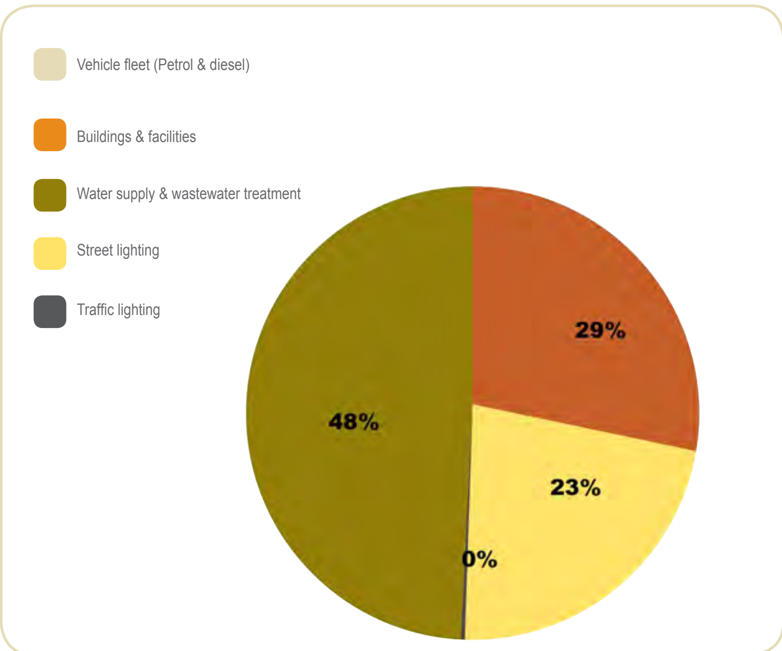


Potential carbon reductions (tCO2e/a)



The water supply and wastewater treatment sectors have the highest electricity efficiency savings potential among the electricity consuming sectors. In this sector, the greatest potential is in retrofitting the standard motors in water pumps with energy efficient motors coupled with Variable Speed Drives (VSDs). In the municipal vehicle fleet sector, the greatest potential is in improved (behavioural) practices. EE lighting, followed by retrofitting of HVACs, in municipal buildings is the end use that continues to have the largest and cost-effective energy saving potential. Figure 3 summarises the modelled results of electricity efficiency potential across all the selected sectors in the SACN cities.

Figure 3: Potential electricity savings per sector (MWh/a)



Four of the assessed municipalities indicated a 100% penetration of energy efficient LED luminaires in their traffic lighting systems. Within the four sectors surveyed (excluding traffic lighting due to existing high efficiency penetration), the savings that can be realised amount to over R10 million per municipality per year, representing a significant benefit to municipal revenues. The payback times for interventions are also often reasonable. Some cities have been involved in the Department of Energy's (DoE) Division of Revenue Act (DORA)-funded Municipal Energy Efficiency and Demand Side Management (EEDSM) programme, which has enabled these cities to launch EE retrofit programmes within their operations. The contribution to carbon reduction in the municipalities, as well as nationwide, is also significant, and supporting municipalities with energy efficiency programmes should continue to receive support from national government.

While municipalities may delay implementing EE improvements owing to the high upfront costs associated with EE interventions, this can also be costly as it results to high operating costs associated with inefficient energy end uses. A number of financial instruments exist for municipalities to fund their energy efficiency projects and these include: use of internal funds, loans, bonds, energy performance contracting, lease purchase agreements as well as grants. The institutionalisation of EE in a strategy, and also preferably in the Integrated Development Plan (IDP), is an important first step in raising awareness within the municipality and enabling more resources to flow to implementation. Proactivity of staff is also essential to make progress in the implementation of energy efficiency programmes and the development of green procurement policies in some municipalities.

Table 2 summarises the modelled energy efficiency potential of different interventions across sectors in the member municipalities. Energy consumption and the savings potential are highly variable across the municipalities. Note that data used here is for a number of different years across the study municipalities owing to the absence of current data or data for a uniform year.

The study aims to provide key information on energy usage baseline, energy saving potential and opportunities and successes achieved.

Table 2: Overview of energy consumption and energy efficiency potential in SACN member cities

Municipality	Sector	Baseline Energy Consumption (GJ/a)	EE measure penetration (%)	Potential Electricity Savings (MWh/a)	Potential Energy Savings (GJ/a)	Carbon emissions reduction (tCO2e/a)	Financial Saving (ZAR)
Buffalo City	Buildings & Facilities	No data	No data	No data	No data	No data	No data
	Street lighting	19,307	19%	2,084	7,501	2,146	R 1,145,976
	Traffic lighting	1,686	100%	-	-	-	R -
	Wastewater treatment	21,711	7%	2,078	7,482	2,141	R 1,143,062
	Petrol (l)	No data	0%	No data	-	No data	No data
	Diesel (l)	No data	No data	No data	-	No data	No data
Cape Town	Buildings & Facilities	968,682	11%	42,484	152,942	43,758	R 23,366,033
	Street lighting	355,134	59%	24,106	86,783	24,830	R 13,258,490
	Traffic lighting	42,767	100%	-	-	-	R -
	Bulk water supply & wastewater treatment	390,223	0%	51,039	183,742	52,570	R 28,071,624
	Petrol (l)	206,256	0%	1,929,881	66,002	13,583	R 61,484,548
	Diesel (l)	404,934	0%	3,401,017	129,579		
Ekurhuleni	Buildings & Facilities	235,057	10	10,429	37,544	10,738	R 5,733,625
	Street lighting	No data	No data	No data	-	No data	No data
	Traffic lighting	No data	No data	No data	-	No data	No data
	Bulk water supply & wastewater treatment	213,096	0%	12,634	45,484	13,014	R 6,948,957
	Petrol (l)	366,250	0%	3,426,901	117,200	19,862	R 90,996,825
	Diesel (l)	531,293	0%	4,462,306	170,014		
eThekwini	Buildings & Facilities	692,076	10	30,694	110,498	31,614	R 16,881,467
	Street lighting	535,120	23%	47,116	169,618	48,529	R 25,913,788
	Traffic lighting	22,430	100%	-	-	-	R -
	Bulk water supply	175,555		15,445	55,603		
	Wastewater treatment	83,066	0%			15,909	R 8,494,964
	Petrol (l)	152,707	0%	1,428,837	48,866	11,203	R 50,419,556
	Diesel (l)	350,380	0%	2,942,825	112,122		
Johannesburg	Buildings & Facilities	103,334	10%	4,835	17,406	4,980	R 2,659,029
	Street lighting	22,866	No data	No data	-	No data	No data
	Traffic lighting	No data	No data	No data	-	No data	No data
	Bulk water supply & wastewater treatment	1,308	0%	38,700	139,320	39,861	R 21,285,000
	Petrol (l)	14,268	0%	133,505	4,566	1,174	R 5,252,817
	Diesel (l)	38,333	0%	321,957	12,267		
Mangaung	Buildings & Facilities	92,710	10%	4,112	14,803	4,325	R 2,261,429
	Street lighting	142,165	20%	No data	-	No data	No data
	Traffic lighting	No data	No data	No data	-	No data	No data
	Bulk water supply & wastewater treatment	36,473	0%	26,139	94,100	26,923	R 14,376,440
	Petrol (l)	30,780	0%	288,000	9,850	1,693	R 7,751,040
	Diesel (l)	45,720	0%	384,000	14,630		
Msunduzi	Buildings & Facilities	22,723	10%	1,008	3,629	1,038	R 554,266
	Street lighting	4,269	No data	No data	-	No data	No data
	Traffic lighting	No data	No data	No data	-	No data	No data
	Water & wastewater treatment	Umgeni Water	N/A	N/A	N/A	N/A	N/A
	Petrol (l)	4	0%	348	12	26	R 111,415
	Diesel (l)	1,109	0%	9,315	355		
Nelson Mandela Bay	Buildings & Facilities	18,458	10%	819	2,948	843	R 450,238
	Street lighting	42,268	20%	4,068	14,646	4,190	R 2,237,601
	Traffic lighting	No data	100%	-	-	-	R -
	Bulk water supply	95,144	0%	10,846	39,046	11,172	R 5,965,368
	Wastewater treatment	86,465			-		
	Petrol (l)	No data					
	Diesel (l)	No data					
Tshwane	Buildings & Facilities	173,754	40%	5,137	18,493	5,291	R 2,825,530
	Street lighting	32,572	25%	2,860	10,298	2,946	R 1,573,267
	Traffic lighting	4,666	37%	1,090	3,924	1,122	R 599,229
	Bulk water supply & wastewater treatment	171,662	0%	10,252	36,907	10,560	R 5,638,633
	Petrol (l)	75,001	0%	701,762	24,000	8,675	R 38,311,331
	Diesel (l)	311,989	0%	2,620,382	99,837		
TOTAL ENERGY		**7,335,772**			**2,062,017**	**414,715**	

1. ENERGY EFFICIENCY POTENTIAL - SECTORAL ANALYSIS

1.1 Baseline energy consumption in municipal facilities and operations

Municipalities are significant energy end users in their buildings and facilities, accounting for between 1% and 2% of total energy consumption within the municipal area, depending on the size of the municipality. The major energy loads in a municipality are typically water pumping systems, wastewater treatment and handling, street and traffic lighting. Municipal buildings also contribute to the high municipal energy use.

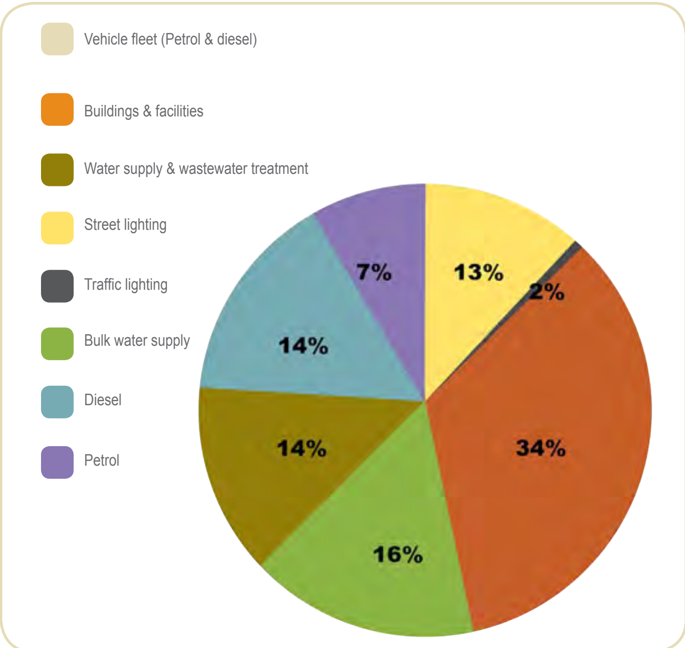
In municipalities with full data sets, the indication is that electricity consumption is split as shown in the Figure 4, presenting data for the CoCT and eThekwini Metropolitan Municipality for 2013 and 2010, respectively.

payback periods of the interventions based on a MegaFlex electricity tariff of R0.55c/kWh as shown in Table 1.

Figure 4: Internal energy proportional sector consumption comparisons between CoCT and eThekwini

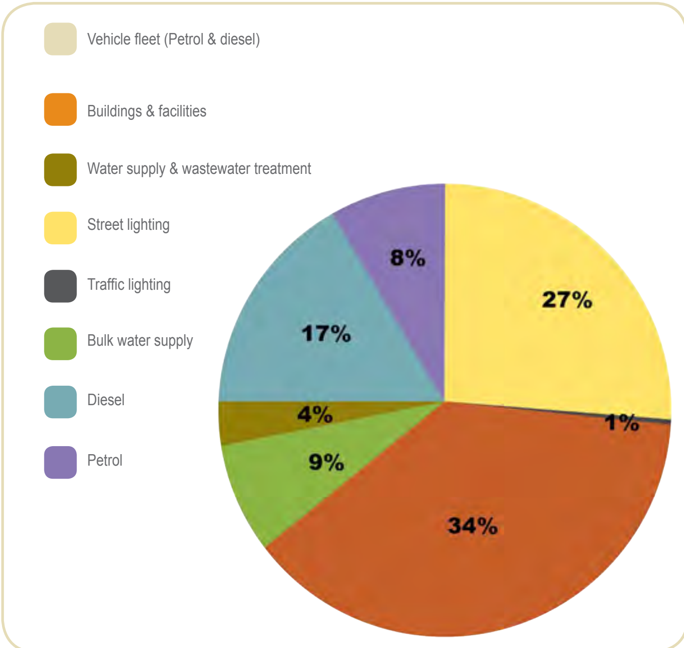
City of Cape Town

Total energy consumption by sector (GJ/a)



eThekwini Metropolitan Municipality

Total energy consumption by sector (GJ/a)



However, there tend to be a variation in the proportion of energy consumption across sectors and across municipalities due to a number of factors. Some municipalities subcontract a portion of their service delivery, for example, in the CoJ, bulk water supply is managed by Joburg Water. Often it is more difficult to obtain data from private entities; thus, the CoJ may appear to have lower electricity consumption figures than another city where consumption data is not recorded internally. In some municipalities, bulk water or wastewater has to be pumped over long distances from the water source, or to the sewage treatment plants, and over varying gradients. Street lighting is also to varying degrees divided between the municipality and Eskom. These factors all lead to differences in total electricity consumption and render city comparisons meaningless, and generalised proportions cannot be developed.
Table 3 presents annual energy consumption data across different sectors in the member cities.

Table 3: Energy consumption in all sectors per year

Municipality	Electricity Consumption (kWh)					Vehicle Fleet (Petrol) Litres	Vehicle Fleet (Diesel) Litres	Data Year
	Buildings & Facilities	Bulk Water Supply	Wastewater Treatment	Street Lighting	Traffic lighting			
Buffalo City	No data	No data	6,030,878	5,362,924	468,315	No data	No data	2008
Cape Town	269 078 304	128 996 808	108,395,360	98,648,244	11,879,700	6,030,878	10,628,177	2013
Ekurhuleni	65 293 581	428 418	58,764,958	No data	No data	10,709,064	13,944,707	2011
eThekwini	192 243 372	48 765 261	23,073,750	148,644,505	6,230,607	4,465,116	9,196,329	2010
Johannesburg	28 704 000	No data	363,444	6,351,730	No data	417,204	1,006,116	2008
Mangaung	25 752 778	10 131 388		39,490,278		1,200,000	900,000	2004
Msunduzi	6 311 888	Umgeni Water	Umgeni Water	1,185,851	No data	1,088	29,108	2013
Nelson Mandela Bay	5 127 233	26,428,909	24,018,182	11,741,169	No data	No data	No data	2013
Tshwane	48 265 000	No data	No data	9,047,661	No data	2,193,005	8,188,693	2013

Although, challenges were experienced in obtaining current data, experience working with municipal energy consumption data has however shown that significant variations over years in reported figures relates mainly to the quality of available data rather than to substantial changes in actual energy consumption. Therefore, the relatively 'older' and varying years of the data drawn on in this study is still deemed to provide a reasonable picture of energy efficiency savings potential and in the absence of more current values such data has been used.

1.2 Energy efficiency potential in street and traffic lighting

Street and traffic lighting usually account for between 15% and 30% of the total energy consumption within a municipality's operations and it is one of the easiest energy efficiency intervention areas. Most of the common technical measures applied to address energy efficiency in street lighting can generate between 38% and 54% energy savings per measure and these have very short payback periods. Traffic lighting interventions can generate 70% to 80% energy savings per measure and have a 1 to 2 year payback. Additional benefits of energy efficient street and traffic lighting include a reduction in maintenance costs and phasing out environmentally harmful lighting technologies. Good street lighting is essential for keeping pedestrians, drivers, and other roadway users safe, while promoting night time mobility.

However, many street lighting facilities in municipalities are outdated and therefore highly inefficient. Old lighting technology also has higher maintenance requirements. In municipalities with outdated lighting systems, street lighting can count for a large proportion of a municipality's electricity consumption. Significant potential exists to improve lighting quality, reduce energy use and costs, and contribute to the reduction of climate change causing greenhouse gas emissions through energy efficient retrofits of both street and traffic lighting.

Financial savings realisable from efficient street lighting are based on the technology reduction in energy use and maintenance costs relative to the old lighting fittings. From a lifecycle perspective, the majority of costs related to conventional street lighting stems not from the capital cost (15% of total cost) itself, but from post-installation costs i.e. energy and maintenance costs (85%).

Municipalities have a legal obligation regarding road safety and must ensure that their lighting systems comply with various technical norms and standards (e.g. SANS 10098-1).

1.2.1 Street lighting

There are various street lighting technologies or luminaires used across municipalities. These technologies include mercury vapour (MV), metal halide (MH), high-pressure sodium (HPS), compact fluorescent lamps (CFLs) and the new technologies such as light emitting diodes (LED) and induction lighting.

Street lighting technologies

MV lamps are said to have been introduced in 1948 and were deemed a major improvement over the incandescent light bulbs. These lamps are coated with a special material made of phosphors inside the bulb to correct the lack of orange/red light. The ultraviolet (UV) light excites the phosphor, producing a more white light. Metal halides are a newer and more efficient than MV lighting technology; however these are less efficient than high-pressure sodium (HPS) lamps. MH luminaires operate at high temperatures and pressures, emit UV light and need special fixtures to minimise risk of injury or accidental fire when the lamp bursts at the end of its useful life. HPS lamps have a high efficiency when compared to MV and MH lamps on a lumen/watt scale. Their main drawback is that they produce a narrow spectrum of yellow lighting technologies include MV, MH, HPS,CFLs and the new technologies such as LED and induction lighting.

CFL luminaires have improved over time although their use in street lighting is rare in South African municipalities. CFL lamps have limited lumen output, high heat build-up in the self-contained ballast. New lighting technologies, such as LED or induction lights emit a white light that provides high levels of scotopic lumens allowing street lights with lower wattages and lower photopic lumens to replace existing street lights. Induction lighting is relatively new in the market and these luminaires make use of radio frequency or microwaves to create induced electrical fields, which in turn excite gases to produce light. Induction lights work at peak efficiency with minimal warm-up time, much like LED technology. LEDs are rapidly developing in light output, colour rendering efficiency and reliability (Grah Lighting, 2014). The table below provides a summary of comparisons of the different lighting technologies.

Table 4 provides a summary of comparisons of the different lighting technologies.

Old Technology: 125W MV light

New Technology: 50W HPS

Table 4: Comparisons of the different lighting technologies

Light Technology	Colour of light	Lifetime (hours)	Lumens per Watt	CRI	Overview, pros and cons
Mercury Vapour	Bluish-white	12 000 – 24 000	13 – 48	15 – 55	Very inefficient, contains mercury, ultraviolet radiation, inexpensive, medium length life
Metal Halide	White	10 000 – 20 000	60 – 100	70 – 105	Good colour rendering and lumen maintenance, high cost, low life hours, high maintenance, UV radiation, contains mercury and lead, risk of bursting at the end of life.
High Pressure Sodium	Golden yellow	12 000 – 24 000	45 – 130	25	Medium length life, good lumen maintenance, more energy efficient than MV & MH counterparts, low CRI with yellow light, contains mercury and lead
Compact fluorescent lamps	Soft white	12 000 – 20 000	50 – 80	85	High efficiency, colour rendering excellent, limited lumen output, high heat build-up in self-contained ballast, low life/burnout due to frequent cycling (on/off) of lamp
Induction	White	60 000 – 70 000	70 – 90	80	Rapid start-up, long life, good colour rendering, energy efficient, higher initial cost, contains mercury
Light emitting diodes	White	50 000 – 70 000	70 – 150	85 – 100	Relatively higher initial cost, high energy efficiency and low maintenance/long life, free of harmful substances, low rates of lumen depreciation

Baseline and retrofitted street lights to date

Table 5 summarises the reported distribution of different lighting technology types across the nine cities.

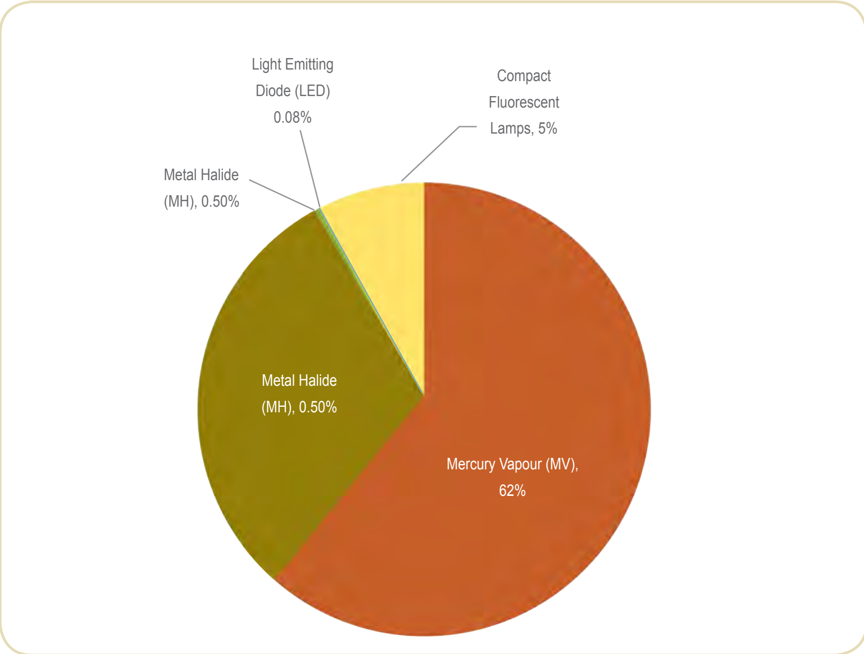
Table 5: Current luminaire types in use per city

Current Luminaire Types in use in the Municipalities																										
	Mercury Vapour							High Pressure Sodium Vapour								Metal Halide				Compact Fluorescent Lamp						LED
Municipality	400W	250W	150W	125W	113W	80W	TOTAL No	400W	250W	150W	125W	100W	70W	50W	Total No	250W	150W	70W	Total No	250W	150W	120W	100W	57W	Total No	117W
Buffalo City	1 625			103 500			105 125		3 250		1 625			20 000	24 875											
Cape Town	3 547	21 552		3 843		57 663	86 605		400	19 145		4 377	99 858	30	123810											
Ekurhuleni							0																			
eThekwini	8 147	27 167	19 525			126 010	180 849	8 147	25 767	19 060					52 974	1 400	465		1 865							
Johannesburg							0						22 000		22000											
Mangaung	1 410			13 892			15 302		2 801				1 048		3849	1 568		404	1 972							
Msunduzi							0						1 943		1943											592
Nelson Mandela Bay	2 000	7 000					9 000													2 000	50	7 100	350	25 477	34 977	
Tshwane	300	25 000	7 000		60 000		92300						30 338		30338											

Data Source: SEA, 2014 based on municipal responses and online searches.

Table 5 shows that the CoCT use energy efficient luminaires, the high pressure sodium's (HPS), now outnumber the old inefficient MV luminaires. Nelson Mandela Bay municipality is the only municipality that reported replacing MV luminaires with compact fluorescent luminaires (CFL).

Figure 5: Breakdown of existing street lighting luminaires



Inefficient MV luminaires make up 62% of the total number of installed luminaires across the nine cities. The potential impact for energy savings in street lighting in South African municipalities is substantial. However, energy efficiency retrofits taking place in some of the municipalities have resulted in a rapid increase in the number of efficient luminaires installed such as the HPS luminaires. This can be attributed to the success of the National Treasury's DORA Municipal EEDSM programme being managed by the Department of Energy. Msunduzi is the only municipality that indicated current retrofits of its 150W HPS luminaires with 117W LED luminaires. Nelson Mandela Municipality is reported to have retrofitted 25,000 125W MV with 57W CFLs in its minor roads. However, the municipality is yet to retrofit the mercury vapour luminaires on its major roads.

Some retrofitting of street lighting has occurred within the nine municipalities, although only a limited number of these retrofitted lights have comprehensive M&V data linked to them. The table below presents an outline of available information on street lighting retrofits underway mainly funded through the Municipal DORA EEDSM programme.

Table 6: Summary of street lighting retrofits in the SACN municipalities funded through the DORA EEDSM programme

Municipality	Project scale
Buffalo City	Replacement of over 20 000 125W MV street light luminaires with 50W HPS luminaires and 3 250 400W MV with 250W HPS luminaires between 2009 and 2012.
CoCT	Retrofitting of over 99 000 125W MV luminaires with 70W HPS luminaires, 19 145 250W MV to 150W HPS and over 4 000 250W MV to 100W HPS since 2009/10 to present.
CoJ	22 000 70W HPS have been installed and no data was availed on the total number of induction lighting luminaires currently installed
City of Tshwane	Retrofitting of 30 338 125W MV luminaires with 70W HPS luminaires between 2010 and 2012.
Ekurhuleni	No data on the number of luminaires retrofitted.
eThekwini	Retrofitting of 25 767 400W MV luminaires with 125W HPS luminaires, 19 060 250W MV with 150W HPS luminaires.
Mangaung	Street lighting retrofit of 2 801 400W MV luminaires with 250W HPS luminaires and the replacement of 1048 125W MV with 70W HPS. Also the replacement of 1 568 400W MV luminaires with 250W MH luminaires between 2010 and 2011.
Msunduzi	Installation of a total of 1 943 70W HPS luminaires in the place of 80W and 90W MV luminaires between 2011 and 2012. Replacement of 404 150W HPS and 188 250W HPS with 592 117W LED luminaires. Planned retrofit of 1 028 150W HPS with 117W LED
Nelson Mandela Bay	25 000 street lights in minor roads retrofitted from 125W MV to 57W CFL. MV luminaires on major roads have not been retrofitted to date.

Energy efficiency opportunities and assessment methodology

To calculate the energy savings potential in street lighting in the nine municipalities, the following assumptions were made:

- It was assumed that all lighting types had the same hours of operation - 4,125 hours per year or 11.3 hours per day, and the power drawn is assumed to be constant
- Lighting levels for the different road types i.e. both major and minor roads are in accordance with national 2012).

This modelling exercise did not analyse other variables, which might impact energy savings such as road configurations, pole configurations, fixture type, light levels and luminaire light uniformity ratio.

Results of the modelled energy efficiency potential in street lighting

In estimating the potential energy savings that can be realised from street lighting retrofits, the team made use of the common retrofit choices made by municipalities participating in the DOE's EEDSM programme. Average efficiencies resulting from the preferred retrofits are indicated in Table 7:

Table 7: Average savings for preferred retrofits

Luminaire Retrofits	Old Luminaire (W)	New Luminaire (W)	Average Savings (%)
MV – to - HPS	400	250	38%
MV – to - CFL	125	57	54%
MV - to – LED	400	117	71%
HPS – to- LED	150	117	22%

Retrofitting MV luminaires with LEDs results in the highest energy savings (71%). However, most of the municipalities have been retrofitting with HPS luminaires because LEDs are still regarded with some caution due to lighting characteristic, untested lifespan and costs. Nelson Mandela Bay is the only one that has been retrofitting with CFL luminaires, which offer a considerable energy saving than HPS luminaires. However, the CoCT had tested use of CFLs in its street lights and found these had problems with the moist air conditions prevailing in the city. It would be interesting to look at the reasons given for the decision by Msunduzi Municipality to retrofit its more energy efficient HPS luminaires, i.e. more efficient than MVs, with LED lamps which only offer an average saving of 22%. It was not possible to obtain the total number of the different luminaires currently installed in the municipality.

Table 8: Potential energy savings from street lighting retrofits

	Baseline Energy Consumption by Existing Luminaires & Proposed Retrofits							Potential Energy Savings		
Street lights	**Total current electricity consumption p.a.**	**Old lighting technology wattage per fitting (typical)**	**Efficient light consumption per fitting (typical)**	**Replacement type**	**Existing retrofit penetration**	**Proportion of energy from new lights**	**Proportion of energy from old lights**	**Total remaining saving potential for full retrofit**	**Potential carbon savings from new luminaires**	**Financial saving**
Units:	MWh/yr	Watts	Watts		%			MWh/yr	tCO2e/yr	R/yr
eThekwini	148 644,50	400	250	MV-HPS	23%	15%	85%	47 115,98	48 529	R 25 913 788
Cape Town	98 648,24	125	70	MV-HPS	59%	44%	56%	24 106,35	24 830	R13 258 490
Buffalo City	5 362,92	125	70	MV-HPS	19%	12%	88%	2 083,59	2 146	R1 145 976
Johannesburg	6 351,73	125	70	MV-HPS	No data	No data	No data	No data	No data	No data
Ekurhuleni	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
Mangaung	39 490,28	No data	No data	No data	No data	No data	No data	No data	No data	No data
Msunduzi	No data	150	117	HPS-LED	No data	No data	No data	No data	No data	No data
Nelson Mandela Bay	11 741,17	250	120	MV-CFL	20%	11%	89%	5 434,23	5 597	R2 988 826
Tshwane	9 047,66	113	70	MV-HPS	25%	17%	83%	2 860,49	2 946	R1 573 267

The CoCT has the highest penetration of energy efficient street lighting luminaires among the nine municipalities. However, energy and financial saving opportunities still exist. The above cost savings are only for savings realisable from changing of lighting technologies and do not include substantial savings related to maintenance costs. Also, not included in the above calculations are possible savings that may result from retrofitting high mast lighting e.g. 1 000W and 2 000W MV luminaires.

It should be noted that a further 10% of electricity savings can be realised from using voltage reduction devices. Voltage reduction devices are important in that they provide a safe and constant reduced voltage to the lamps with no interfering harmonics in the power system. With a reduction in voltage, there is a corresponding reduction in power consumption. According to Energy Controls Ltd (2011), voltage reduction devices ensure that the lamps are not damaged by the system and can operate to their full potential. However, according to BEKA (2008) voltage reduction devices have an impact of reducing lighting levels to as much as 35%. Therefore, it is further advised that these devices be applied in Class B road lighting installations, which would have been initially overdesigned by 50%. These will still operate within the parameters of the SANS Standard (SANS 10098).

1.2.2 Traffic lighting

LED lighting has become the standard efficient retrofit technology for traffic lights. Where incandescent and halogen light bulbs require replacement every four months, LED traffic light fittings last 5 to 8 years, substantially reducing mainte¬nance costs. Operating costs are also massively reduced due to the same level of lumination available with LED lighting, at a much lower wattage. The LED technology is easy to retrofit as it fits the existing aspects (SEA 2012:4). A summary of traffic lighting retrofits to date across the nine municipalities are presented in the table below:

Table 9: Status of traffic light retrofits

Municipality	Old Technology	New Technology	Penetration rate (%)
Buffalo City	75W Incandescent bulbs	8W LED lamps	100%
Cape Town	75W Incandescent bulbs	8W LED lamps	100 %
City of Joburg	No data	No data	No data
City of Tshwane	75W Incandescent bulbs	LED lamps	37%
Ekurhuleni	No data	No data	No data
eThekwini	75W Incandescent bulbs	10 W LED lamps	100%
Mangaung	No data	No data	No data
Msunduzi	75W Incandescent bulbs	8W LED lamps	54%
Nelson Mandela Bay	75W Incandescent bulbs	10W LED lamps	100%

A few cities, including the Buffalo City, CoCT, eThekwini and Nelson Mandela Bay have achieved 100% penetration of energy efficient traffic lighting.

Results of the modelled energy efficiency potential in traffic lighting

Table 10: Potential energy, carbon and financial savings from LED traffic lighting retrofits

Traffic lights	Total current consumption p.a.	Old consumption per fitting	LED consumption per fitting	Existing retrofit penetration	Proportion of energy from LED lights	Proportion of energy from old lights	Total remaining saving potential for full retrofit	Carbon savings from LED lights	Financial saving
Units:	MWh/yr	Watts	Watts	%			MWh/yr	tCO2e/yr	R/yr
Buffalo City	468	75	8	100%	100%	0%	-	-	R -
Cape Town	11 880	75	8	100%	100%	0%	-	-	R -
Ekurhuleni	No data	75	8	100%	100%	0%	No data	No data	No data
eThekwini	6 231	75	10	100%	100%	0%	-	-	R -
Johannesburg	No data	75	8	100%	100%	0%	No data	No data	No data
Mangaung	No data	75	8	100%	100%	0%	No data	No data	No data
Msunduzi	No data	75	8	54%	11%	89%	No data	No data	No data
Nelson Mandela Bay	No data	75	8	100%	100%	0%	No data	No data	No data
Tshwane	1 296	75	8	37%	6%	94%	1 090	1 122	R599 229

Municipalities that have not achieved a 100% retrofit, of their existing inefficient traffic lights, with LED luminaires stand to benefit from expanding their current programmes to replace all inefficient lamps on their traffic lights. CoT stands to save 1,090 MWh/year from increasing the penetration rate of LED traffic lighting and in the process reduce the city's carbon footprint by 1,122 tCO2e per year. At the same time the city will reduce its electricity bill by R599,229. It was not possible to determine the savings that could be realised from other municipality's traffic lighting retrofits, as the electricity consumption figure by traffic lighting in the municipality had not been provided.

1.3. EE potential in municipal buildings

Baseline energy consumption and retrofitted buildings to date

Municipalities have an extensive portfolio of buildings and these buildings typically consume more than 30% of a municipality's total energy consumption. Through the implementation of energy efficiency measures targeting the heating, ventilation and air conditioning (HVAC) component and lighting, savings of over 30% of building energy consumption can be realised.

Municipal building stock consists of municipal offices, amenities (parks, camp sites, ablution blocks, swimming pools, etc.) community facilities (community halls, schools, crèches, post offices, libraries, colleges, etc.) and services (fire stations, electricity sub-stations, water towers, water pump stations, surf-life saving club houses, etc.). The larger cities and towns also have substantial social housing stock, although numbers can be variable.

While resource consumption in building efficiency rating systems is usually measured per m2 floor area, this level of detail would be far beyond the existing data system capacity. Information on the building stock in the nine cities is presented in Table 3. Some municipalities were not able to report on the number of buildings they have or provide a clear indication of what the buildings are used for.

Table 11: Number of recorded municipal buildings, floor area and electricity consumption

Municipality	No. of Buildings	Electricity Use in Public Buildings (kWh/a)
Buffalo City	276	No data
Cape Town	96 offices & 91 clinics	269,078,304
Ekurhuleni	No data	65,293,581
eThekwini	105 offices, 71 libraries, 75 clinics,	192,243,372
Johannesburg	12 large administrative buildings (91,022m2) & 450 Community Development Buildings	28,704,000
Mangaung	No data	25,752,778
Msunduzi	90 offices	6,311,888
Nelson Mandela Bay	No data	5,127,233
Tshwane	318	48,265,000

As cities begin to meter and record building energy consumption within their operations, the recorded electricity consumption increases.

Energy efficiency opportunities and assessment methodology

Municipal buildings are disaggregated by their building sizes. Large buildings are considered to be multi-storey office blocks with a floor area exceeding 10,000m2. The remaining municipal buildings with a floor area less than 10,000m2 are then classified as small.

Table 12: Assumption and modelling information

Assumptions and modeling information	
LARGE BUILDINGS	
Large building proportion of total building elec use	70%
Lighting	
Typical % of building electricity use for lighting	35%
%improvements through replacing T8 with T5 tubes	*22%*
%improvements through replacing T8 with LED	*44%*
Overall resulting efficiency assumed:	**30%**
HVAC	
Typical % of building electricity use	40%
% saving possible through efficient technologies	*30%*
Overall resulting (practical) eff assumed:	**16%**
Note: behaviour change saving potential (not modeled)	*12%*
SINGLE STOREY BUILDINGS	
Small building proportion of total building elec use	30%
Lighting	
Typical % of building electricity use for lighting	55%
%improvements through replacing T8 with T5 tubes	*22%*
%improvements through replacing T8 with LED	*44%*
Overall resulting efficiency assumed:	**30%**
HVAC	
Typical % of building electricity use	20%
% saving possible through efficient technologies	*30%*
Overall resulting (practical) eff assumed:	**16%**
Note: behaviour change saving potential (not modeled)	*12%*

Table 12 summaries the assumptions used in the modelling exercise. In estimating the energy savings potential in municipal buildings it was assumed that the distribution of electricity consumption between large and small buildings was 70% for large buildings and 30% for smaller buildings. This split is based on the available electricity consumption comparisons from some of the municipalities. Also based on existing information, the distribution of electricity by end-use is assumed as follows:

- In large buildings it is assumed that 35% of electricity use is for lighting and 40% for HVAC systems, and
- In small buildings it is assumed 51% of electricity consumption is for lighting and 20% for HVAC systems.

The remaining electricity usage is attributed to water heating by conventional geysers and boiling of water using kettles, as well as consumption by other office equipment, which comprises of desktop computers, laptops, fans, fridges, televisions, water coolers, shared printers/copiers and dedicated printers. The overall lighting efficiency improvement was taken as 30%, assuming a mix of T5 fluorescent retrofits over T8 tubes (22% saving) and LED retrofits over T8 tubes (44% energy saving). Savings of 16% are taken as reasonable from retrofitting or improvements to HVAC systems using a range of technological interventions, although theoretical efficiency gains are higher – 30%. The efficiency measures related to HVAC generally covered replacing packaged (roof-top) equipment or chiller with more efficient units, or installing economisers (Carbon Energy Africa & SEA, 2013). Behaviour change, although not modelled in this exercise, holds a further potential energy saving of 12% for HVAC systems.

The most significant energy saving measures in office equipment involves power management of computer networks (including night time shutdown of desktop computers). However, network management systems in some municipalities may require night-time file backup and automated software upgrades would appear incompatible with such power management activities (Belzer, 2009). IT equipment savings have been omitted in this exercise as some of the interventions form part of an energy efficiency awareness campaign or training programme. This also relates to the remaining energy consumption by other electrical appliances such as kettles, fans, oil heaters etc. Therefore, it is important that any energy efficiency programme within a municipality is accompanied by an energy awareness campaign so as to maximise the energy savings. Without behaviour change, the mentioned potential savings might be difficult to achieve as well.

A 10% penetration rate of energy efficiency retrofits was assumed for all municipalities. This appears reasonable based on discussions with municipal staff in some cities, however it remains indicative because of data unavailability, with the exception of Tshwane and Cape Town who indicated an estimate of 40% and 11% completed retrofits, respectively.

Results of the modelled energy efficiency potential in municipal buildings

Table 13 below summarises results of the modelling exercise in the building sector for each municipality, where data was available.

Table 13: Summary of estimated energy, carbon and financial savings potential in the municipal building sector

BUILDINGS		LARGE BUILDINGS					SINGLE STOREY BUILDINGS					TOTALS		
	Total building elec use	% buildings where EE retrofits done	Lighting savings potential	HVAC savings potential	Total potential savings	Total potential financial savings	% buildings where EE retrofits done	Lighting savings potential	HVAC savings potential	Total potential savings	Total potential financial savings	Total potential savings	Total potential savings	Total potential financial savings
			30%	16%				30%	16%					
Municipality	MWh/yr	h/yr	MWh/yr	MWh/yr	MWh/yr	Rands		MWh/yr	MWh/yr	MWh/yr	Rands	MWh/yr	tCO2e	Rands
Buffalo City	No data	10%	No data	No data	No data	No data	10%	No data	No data	-	R -	No data	No data	No data
Cape Town	269,078	11%	17,602	10,729	28,330	R 15,581,746	11%	11,854	2,299	14,153	R 7,784,287	42,484	43,758	R 23,366,033
Ekurhuleni	65,294	10%	4,319	2,633	6,952	R 3,823,494	10%	2,909	564	3,473	R 1,910,131	10,425	10,738	R 5,733,625
Ethekwini	192,243	10%	12,717	7,751	20,468	R 11,257,483	10%	8,564	1,661	10,225	R 5,623,984	30,694	31,614	R 16,881,467
Johannesburg	28,704	10%	955	582	1,537	R 845,250	10%	2,762	536	3,298	R 1,813,779	4,835	4,980	R 2,659,029
Mangaung	25,753	10%	1,704	1,038	2,742	R 1,508,044	10%	1,147	223	1,370	R 753,385	4,112	4,235	R 2,261,429
Msunduzi	6,311.9	10%	418	254	672	R 369,615	10%	281	55	336	R 184,651	1,008	1,038	R 554,266
Nelson Mande	5127.233	10%	339	207	546	R 300,243	10%	228	44	273	R 149,995	819	843	R 450,238
Tshwane	48,265	40%	2,128	1,297	3,426	R 1,884,217	40%	1,433	278	1,711	R 941,312	5,137	5,291	R 2,825,530

1.4. Energy efficiency potential in water and wastewater treatment works

According to ESMAP, electricity costs are usually between 5% to 30% of the total operating costs in water and wastewater treatment plants. Such energy costs are said to contribute to high and unsustainable operating costs that directly affects the financial health of a municipality or utility in charge of wastewater treatment works (WWTW). The energy costs represent the largest controllable operational expenditure of most water treatment plants, and many energy efficiency measures have a payback period of less than five years, therefore investing in EE can support quicker and greater expansion of clean water access for the poor by making the system cheaper to operate.

As urban populations increase, there is also an increase in demand for water and wastewater services within the urban areas. Experience from the developed countries shows that as new stricter health and pollution regulations are introduced, water and wastewater treatment becomes more energy intensive. To meet the new regulations water and wastewater facilities will require additional and more sophisticated equipment that uses more energy. Therefore, improving EE in municipal water and wastewater systems will have a number of benefits, such as: better service provision, lower costs to consumers, help to ensure the long-term financial stability of municipal operations and contribute to greenhouse gas mitigation.

According to ESMAP, review of existing literature, most of the common technical measures applied to address energy efficiency in wastewater treatment plants generate 10% to 30% energy savings per measure and have 1 to 5 year payback periods. The financial viability of energy efficiency in wastewater works is dependent on a couple of factors including: conditions of the facility, technologies used at the water works, energy prices and other factors affecting the technical and financial operations of the individual plants.

There are two areas with most energy saving potential in water and wastewater treatment plants:

- Pumps and Pumping (Common potential ranges between 5% to 30%)
- Aerobic sewage treatment (Up to 50%)

Energy efficiency opportunities and assessment methodology in water services infrastructure

Energy usage in wastewater treatment plants also varies substantially, depending on treatment technologies, which often are dictated by pollution control requirements and land availability. ESMAP notes that advanced wastewater treatment with nitrification can use more than twice as much energy as the simple trickling filter system. Pond-based treatment is low energy but requires large land area. Administrative and production buildings of wastewater treatment plants use a small percentage of the total electricity consumed within these facilities. In wastewater treatment plants, the aerators and mixers consume most of the electricity.

Pumping for the distribution of treated water dominates the energy use of surface water-based supply systems, with the exception of gravity-fed systems. Water distribution usually accounts for between 70% and 80% or more of the overall electricity consumption in bulk water supply operations. The remaining electricity usage is split between raw water pumping and the treatment processes. It was not possible to determine the fraction of ground-water based supply systems in the study municipalities. Ground-water supply systems are more energy intensive than surface water-based systems. However, groundwater usually requires much less treatment than surface water, often only the chlorination of raw water, which requires very little electricity.

Energy efficiency opportunities in water works

Municipalities should start by focusing on the main booster and bulk water pumping stations as these consume the most energy (Energy Cybernetics, 2008:12). Through the installation of energy efficient motors a municipality can save about 5% of electricity consumption compared to standard motors. If VSDs are installed together with energy efficient motors, typical electricity savings could be as much as 20% combined. Expected savings from the above interventions were confirmed from the retrofit work done in Polokwane.

Additional energy savings in wastewater treatment plants can be realised from changing fan belt driven systems to direct drive systems where the former still exists. By replacing mechanical aerators, in plants that still use these, with air diffusers electricity consumption could be reduced by almost 30% compared to the mechanical aerators. It was not possible to obtain information on the different aeration techniques used in all municipal wastewater plants during this project.

Table 14: Potential energy, carbon and financial savings from energy efficiency retrofits in water supply and wastewater treatment plants

Water supply and wastewater treatment plants	Total current consumption p.a.	Existing retrofit penetration	Proportion of energy consumption by retrofitted plant	Proportion of energy from unretrofitted plants	Total remaining saving potential for full retrofit	Potential carbon savings from retrofits	Financial saving
Units:	MWh/yr	%			MWh/yr	tCO2e/yr	R/yr
Buffalo City	10 208,50	7%	5%	95%	2 078,29	2 140,64	R 1 143 062
Cape Town	237 392,17	0%	0%	100%	51 039,32	52 570,50	R 28 071 624
Ekurhuleni	58 764,96	0%	0%	100%	12 634,47	13 013,50	R 6 948 957
eThekwini	71 839,02	0%	0%	100%	15 445,39	15 908,75	R 8 494 964
Johannesburg	180 000,00	0%	0%	100%	38 700,00	39 861,00	R 21 285 000
Mangaung	121 576,66	0%	0%	100%	26 138,98	26 923,15	R 14 376 440
Msunduzi	N/A	0%	0%	100%	N/A	N/A	N/A
Nelson Mandela Bay	50 447,09	0%	0%	100%	10 846,12	11 171,51	R 5 965 368
Tshwane	47 684,00	0%	0%	100%	10 252,06	10 559,62	R 5 638 633
- % saving via improved pump efficiency (6.5%) and use of VSDs (15%)							

Further energy savings can be realised from reducing pressure on the water feeds and also through power factor correction.

Load shifting opportunities in water works

While municipalities can realise energy and financial savings from EE interventions in the water treatment system, load shifting holds an additional significant financial saving. Financial savings of up to 40% can be realised by running the water pumps and reservoirs during off-peak hours. Municipalities pay more for electricity consumed during peak hours compared to during off-peak hours, which is a drain to the municipal fiscus. The pumping stations can be run at their highest possible capacity during off-peak periods in order to build reservoir capacity. According to Energy Cybernetics, during peak electricity demand periods, the reservoir would be full enough in order to switch off some of the load. Customers will continue being supplied by the stored capacity provided by the destination reservoirs.

Energy Cybernetics suggested that, for load shifting to work municipalities or wastewater utilities would have to do the following:

- Install meters to monitor the exact operation of the aerators.
- Do detailed designs of load shifting opportunities.
- Gather dissolved oxygen data from the wastewater plants to determine how the aerators typically aerate the plant i.e. whether they over, under or just aerate to the required level.

However, if load shifting is considered in wastewater treatment plants, microbial loads may be an issue and they would need to be monitored.

1.5. Energy efficiency potential in municipal vehicle fleet

South African municipalities own and operate thousands of vehicles. These vehicle fleets are significant consumers of energy within municipalities accounting for more than 20% of total energy consumption. By improving the fuel efficiency of individual vehicles, operating them more efficiently and improving overall fleet management, municipalities can save significant amounts of energy and money while contributing to the reduction of carbon emissions. Factors that affect energy or fuel consumption in vehicle fleets include vehicle kilometres travelled, fuel economy, vehicle technology, maintenance practices and driving style. Some municipalities have developed or have indicated an interest to develop or adopt policies to purchase and/or lease the most fuel efficient vehicles for different tasks. Through such programmes, municipalities can serve as a model for private fleet operators in their communities.

The National Energy Efficiency Strategy has set an EE target of reducing fuel consumption by 9% by 2015. EE interventions within municipalities would contribute towards this target.

Table 15: Liquid fuel consumption by municipal vehicle fleet

Liquid fuel consumption by municipal vehicle fleet per year			
Municipality	Petrol (litres)	Diesel (litres)	Data Year
Buffalo City	No data	No data	2013/14
Cape Town	6 030 878	10 628 177	2007
Johannesburg	417 204	1,006,116	2011
Ekurhuleni	10,709,064	13,944,707	2010
eThekwini	4,465,116	9,196,329	2004
Mangaung	1,200,000	900,000	2007
Msunduzi	1,088	29,108	No data
Nelson Mandela Bay	No data	No data	2013/14
Tshwane	2,193,005	8,188,693	100%

The CoJ's Metrobus, the second largest municipal bus operator in South Africa, was reported to be buying 150 new buses using dual fuel and an additional 30 would be converted to run on a mixture of compressed natural gas and diesel (CoJ, 2014b).

Recommendations on improving energy efficiency in the vehicle fleet

For municipalities to address energy consumption within their vehicle fleet, they have to adopt a multi-pronged approach. Listed in Table 16 are possible interventions that cities will have to consider in their efforts to 'green their fleets'.

Table 16: Interventions to improve energy efficiency in vehicle fleet and expected savings[3]

Intervention	Description	% energy saving
Fleet renewal	Older vehicles in the municipal vehicle fleet can be replaced with newer fuel-efficient vehicle technology - preferably fuel efficient diesel engine technologies and/or alternative technologies.	
Downsizing	The fuel consumption of any vehicle is affected by the mass of the vehicle as it takes more energy to accelerate a heavier vehicle. Municipalities must select vehicles for their fleets that are appropriate in terms of size and ensure that additional weight is not permanently carried around in vehicles.	
Maintenance	Fixing a vehicle that is noticeably out of tune or has failed an emissions test can improve its efficiency by a significant proportion. Fixing a serious maintenance problem, such as a faulty oxygen sensor, can improve mileage by as much as 40%.	12 – 18%
Dieselisation of Fleet	Converting the municipal petrol vehicle fleet to diesel has a significant impact on efficiency and carbon emissions. The carbon footprint of diesel is approximately 16% lower than petrol on an in-use basis.	15 – 18%
Fuel efficient tyres	A tyre management programme be implemented to ensure that fuel-efficient tyres are used on the entire fleet and that they are inflated at the correct pressures and checked on a regular basis. According to the Society of Automotive Engineering (SAE) fuel-efficient tyres can reduce fuel consumption by 8% compared to standard tyres (Onco, 2009).	2 -3% fuel efficiency
Tyre management programme	Keeping tyres inflated to the proper pressure can improve fuel efficiency.	1% to 2% fuel efficiency
Reduced mileage	Combining errands into one trip saves time and money. Several short trips taken from a cold start can use twice as much fuel as a longer multipurpose trip covering the same distance when the engine is warm.	5% to 15% fuel efficiency
Education campaign on driving style	The driving habits or “style” of the operator of a vehicle can have a very large influence on the amount of fuel consumed. High-speed driving and harsh acceleration can have a profound impact on vehicle fuel consumption. Education is vital, hence a simple communication campaign along with training is recommended.	1 – 2% fuel saving
Assign vehicles appropriate to the task	Often larger, more powerful vehicles are used when smaller, more efficient ones would perform the task as effectively. Fleet managers should have the authority to analyse how vehicles are used and assign those that are the most appropriate for the task. Using a powerful pickup truck for a trip that does not require hauling large or heavy items is not energy efficient.	
Fleet management information system	Create an inventory for all municipal vehicles. Include the types of vehicles, the quantity of each vehicle type, the kind and amount of fuel they use. Closely track maintenance schedules, fuel consumption, mileage and other information. This way, the fleet manager can identify problems and develop solutions to reduce costs and fuel consumption.	

The CoCT piloted a smart driver-training programme aimed at training the city’s fleet drivers to develop responsible driving behaviour that will result in drivers operating their fleet vehicles significantly more efficient. The city is currently monitoring and evaluating the success of the programme, however preliminary results suggest that the training was a success.

Results of modelled EE savings from municipal vehicle fleets

To estimate the savings that may result from EE interventions in the vehicle fleet the study made use of two measures or interventions. The first intervention was dieselisation of the petrol vehicle fleet, and the remaining interventions where combined into one measure, improved vehicle practices i.e. improved maintenance, fuel efficient tyres, tyre management programme, reduced mileage and education campaign. The vehicle efficiency gain potentials of these interventions is as indicated in the table below. The improved efficiency practices measure results to a combined efficiency gain of 32% and dieselisation has an efficiency gain of 17%.

Table 17: Vehicle fleet efficiency gain potential

Measure	% Efficiency Gain
Fuel efficient tyres	3%
Improved maintenance	15%
Tyre management programme	2%
Reduced mileage	10%
Education campaign	2%
Improved efficiency subtotal	32%
Dieselisation	17%

Table 18 summarises the modelled EE potential savings that could be realised through either improved practices or dieselisation of the petrol vehicle fleets.

Table 18: Potential energy, carbon & financial savings from EE interventions in the municipal vehicle fleet

Vehicle fleet	Petrol consumption per year	Diesel consumption per year	Improved practice savings	Improved practice petrol savings	Improved practice diesel savings	Improved practice financial savings (petrol + diesel)	Improved practice carbon savings (petrol + diesel)	Dieselisation fuel consumption (diesel only)	Dieselisation carbon savings	Dieselisatio financial savings**
Units:	litres	litres	%	litres	litres	ZAR	tCO2e/yr		tCO2e	R/yr
Buffalo City	No data	No data	32%	No data	No data	No data	No data	No data	No data	No data
Cape Town	6 030 878	10 628 177	32%	1 929 881	3 401 017	R 61 484 548	13 583	15 633 806	(2 533)	R 11 881 433
Ekurhuleni	293	7 090 873	32%	94	2 269 079	R 26 163 567	6 127	7 091 116	(0)	R 577
eThekwini	4 465 116	9 196 329	32%	1 428 837	2 942 825	R 50 419 556	11 203	12 902 375	(1 875)	R 8 796 725
Johannesburg	417 204	1 006 116	32%	133 505	321 957	R 5 252 817	1 174	1 352 395	(175)	R 821 934
Mangaung	900 000	1 200 000	32%	288 000	384 000	R 7 751 040	1 693	1 947 000	(378)	R 1 773 090
Msunduzi	1 088	29 108	32%	348	9 315	R 111 415	26	30 011	(0)	R 2 143
Nelson Mandela Bay	No data	No data	32%	No data	No data	No data	No data	No data	No data	No data
Tshwane	2 193 005	8 188 693	32%	701 762	2 620 382	R 38 311 331	8 675	10 008 887	(921)	R 4 320 439

*- dieselisation savings assume entire petrol fleet is converted to diesel (may not be feasible in practice)

** - assumes no improved practice interventions implemented

Given that dieselisation might be an expensive intervention, it is recommended that it be implemented through procurement of replacements of old stock. According to Onco Consulting, the cost of diesel passenger vehicles is currently considerably more than their petrol equivalents and their payback period is relatively long - in the region of 60 months, based on 20 000 kilometres per year, therefore worth not implementing.

2. IMPLEMENTATION ENABLERS

This section provides a summary of the tools that can be explored to optimise energy efficiency in municipalities. Several financing opportunities that help municipalities manage the costs associated with energy efficiency improvements are also explored.

2.1. Financing

Municipalities usually cite the high upfront costs associated with energy efficiency projects as a barrier to implementing such projects in their facilities and operations. However, delaying cost-effective energy efficiency improvements can also be costly; since it results in increased operating costs. A range of financial instruments exists for municipalities to fund their energy efficiency projects and these include: use of internal funds, loans, bonds, energy performance contracting, lease-purchase agreements as well as grants.

2.2. Institutional development

Several municipalities now have experience with EE implementation, and have successfully negotiated some of the barriers that are typically listed in this regard. The following points are useful to consider for municipalities intending to implement energy efficiency measures.

- Municipalities should allocate budgets from their internal funds for efficiency interventions.
- Sharing information from those that have demonstrated success with implementation gives confidence to decision makers that this approach is legally, financially and technically feasible.
- Proactivity of key staff is still essential to make progress.
- Exploring multiple funding sources is an effective strategy.

2.3. Jobs potential for EE implementation

The potential to create jobs would enhance political support for energy efficiency projects. However, employment creation is unlikely to be significant. One general report on the topic considers that EE employment creation is at around 0.47 jobs per GWh for South Africa (Greenpeace, 2010), and another estimates about 8 000 jobs country-wide from adopting green building efficiency measures similar to those covered in this study (IDC et. al, 2011). Neither of these are particularly convincing, however, both are based on multiple assumptions and generalisations. From more direct experience of EE implementation within municipalities, employment creation can vary from zero (if implementation is done in-house) through to between 15 and 20 workers per contractor when the implementation is sub-contracted.

2.4. Procurement and energy efficiency

Procurement procedures in municipalities often struggle to digest new approaches, although for sound legal reasons. This has been the case with the use of Energy Service Company (ESCOs) in municipalities. Performance contracting does not fit easily with standard procurement procedures, raising issues around asset ownership (of installed equipment) and requiring financial arrangements very different from the 'pay on delivery of a specified service' model. Several municipalities now have Green Procurement policies and/or procedures in place.

3. CONCLUSION

The modelling of energy efficiency potential done for this study brings the following key points to note in designing an approach to maximising energy efficiency gains within municipalities:

- Although the data gathered remains incomplete, the report illustrates clearly that there are significant energy efficiency opportunities in municipal operations in most sectors covered, with the exception of traffic lighting where many municipalities have already retrofitted most or all of their installations with LEDs.
- Across sectors, the savings that can be realised amount to over R10 million per year, representing a significant benefit to municipal revenues. The payback times for interventions are also often reasonable.
- The government funded DORA EEDSM programme has enabled several municipalities to launch energy efficiency programmes. After some teething problems, participating municipalities have institutionalised these programmes. It is important that this support is sustained if energy efficiency opportunities are to be further exploited. This may be the most effective single measure that has accelerated energy efficiency in municipalities in general.
- The contribution to carbon reduction in the municipalities, as well as nationwide, is also significant, and supporting municipalities with energy efficiency programmes should therefore be taken seriously by national government, and should be guided by the SALGA strategy in this regard (SALGA, 2014).
- Gathering the necessary data from municipalities has been difficult and is largely due to under capacitated departments or poor data collection systems. The resulting database upon which the report is based on is therefore a mix of newly provided data and old data from State of Energy or other reports. However, significant data gaps remain.
- Procurement systems are by nature conservative and often still struggle to accommodate expenditures with higher capital costs even if they have significantly lower life cycle costs. The development of green procurement policies in many cities is a positive step in this regard and is to be encouraged.

The SACN member cities can set achievable energy savings targets and design programmes to achieve the long-term potential based on findings of this report. Funding levels required for delivering an energy efficiency programme can be determined using this report's findings.

Some of the images used in this report are courtesy of the nine SACN member cities.

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