



Sustainable energy towards productive cities



Introduction

South Africa is not only in the throes of a major political and social transition. The South African economy is also undergoing fundamental re-structuring. This is partly the result of internal transformation but it is also a response to global economic developments. Global trends which are relevant to issues affecting economic production related to energy in cities include the supply and use of fossil fuels, energy efficiency, renewable energy, climate change and greenhouse gas (GHG) emissions, and world trade and globalization.

Until the late 1980s, economic development in South Africa was predicated on, and for some time was built and thrived on, primary resource extraction, cheap and dirty energy production, use and protection of local manufacturing industries and lack of social responsibility towards large parts of the population. This was the economically productive base on which cities were built. All of these conditions have now reversed: the contribution of primary resource extraction as a mainstay of economic production in South Africa is unsustainable and has already declined significantly in terms of its contribution to the economy. Cheap energy no longer provides the economic competitiveness or contribution to the economy it once did; environmental conditions increasingly govern use of energy; industry in South Africa faces global competition, and social responsibility is a key component of policy.

However, the economies of many South African cities are still largely dependant on the legacy of energy-intensive industries. The legacy of these industries and transport systems threatens the competitiveness of city economies and industries as they face the challenge of open international competition within an environment which increasingly



values sustainability, environmental protection and social responsibility.

Energy in relation to Productive cities explores what energy is required by city economies; how this energy is used in the city economies to supply local needs, and how it is used to retain and improve economic competitiveness in local, regional, national and global markets;

and how the energy sector can contribute directly to local resource utilization, including employment creation.

Energy management for productive cities needs to include a thorough assessment of how various options address a comprehensive range of issues. Cities need to boost household spending power, create a supportive environment for micro-enterprise development, establish a stable environment and institutional efficiency to attract investment, develop job-creating enterprises and improve skills and capacity. Energy has a key role to play within all areas of productive city development. With economic concentration and the majority of people resident in cities, cities also have a key role to play in meeting national social economic and environmental objectives. In order to begin to address these issues, cities need to make strategic choices and to follow through with implementation plans which often stretch over decades.

The data points to the study cities contributing nearly 40% to energy consumption in South Africa¹. If the four additional cities not included within the study, which contribute to the ‘backbone’ of the South African economy (Mogale City, Rustenburg, Nelspruit, Polokwane) and substantial energy consuming Drakenstein municipality, are included, this is likely to reach 50%. Given this substantial contribution to national energy consumption, cities become a

critical area within any national energy strategy. National strategy does exist within the Department of Minerals and Energy to tackle industrial energy efficiency issues, however, city transport, which comprises some half of city energy consumption, remains outside of national energy policy work.

Although energy per unit of economic production must be interpreted with caution at the city level due to forward and backward economic linkages, South African cities reflect the national picture of high energy intensity – high levels of energy are consumed for economic value generated. Just about all city energy is derived from fossil fuels. Little data exists on how well cities are responding to and supplying energy to support the development needs of the ‘second’ or more marginalised township economy.

The review cities in the South African economy

The 15 review cities include 13 of the 17 cities considered to be the “backbone” of the South African economy². The review cities contribute some 60% of national GDP and account for nearly 40% of national energy consumption.

The review doesn’t include the secondary cities that are important locations as government service centres, or which service rural areas, namely: Drakenstein, Mafikeng, Vryburg, Newcastle, Upington, Musina, Greater Giyani, Ulundi and George. Important industrial areas also not falling within the study are the Sasol Synfuel Complexes at Sasolburg and Secunda; Mossel Bay near which the PetroSA gas-to-liquid fuels plant is situated, the gold mining area of Welkom, the coal mining area of Witbank and secondary industrial towns

1. The study area notably excludes electricity consumption by Eskom in its generation of electricity, which accounts for some 10% of national electricity consumption and 6% of national energy consumption; the Sasol Synthetic Complex, which in electricity consumption alone comprises 1% of national energy consumption; the mining sector; the majority of the country’s mining sector and the remaining 269 municipalities.

2 Luus & Grugell, 2005, p10. Of the top 17 cities considered to form the “backbone” those not included in this study include: Mogale City (West Rand), Rustenburg, Nelspruit and Polokwane (each contributing approximately 2–3% national GDP). Additional cities included are Saldanha Bay and King Sabata.



of Newcastle, Ladysmith, Estcourt and Brits. With the exception of the last three, these industrial centres are very important to the national energy system, because they are large energy producers and consumers but they have small populations.

There are 170 small towns across SA that are characterized by low populations, with average population densities of less than 50 persons/sq.km, with very small contributions to GDP, which function mainly as rural service centers and do not form part of this study.

It is significant that the review cities' economic growth is not keeping pace with urbanization and population growth. Between 1996 and 2001, already high unemployment rates increased even more in all 15 review cities, save Tshwane, with unemployment rates in Buffalo City, Nelson Mandela and uMshunduzi exceeding the national average of 44.7³. Unemployment in 2001 within the 9 SACN cities averaged 38.3% (close

on the national average of 44.7%).

The picture has been one of jobless economic growth, particularly in manufacturing, with increasing reliance on capital-intensive, high-tech, rather than labour, inputs. Accompanying this has been an increase in the income of the top earners, and decrease in that of the poor majority; company turnover has increased while remuneration has declined⁴. Poverty in cities is rising.

Since 1994 the development of the small, micro, medium enterprise (SMME) economy has been stated as a core national policy objective⁵. The reason given is that SMMEs are seen as key in job creation and poverty alleviation. However, studies point to this sector continuing to be mainly constituted of survivalist enterprises, with growth in this sector largely being involution, i.e. spread of survivalist enterprises such as side of road hawking, rather than evolution of the sector with increasing scale of enterprises and job creation⁶.

3 SACN, 2004, p48.

4 SACN, 2004, p54.

5 RSA, 2005 as quoted in SACN, 2004, p58.

6 SACN, 2004, p59.

INDUSTRIAL ENERGY EFFICIENCY: De Beers, Kimberly

Obad Shachman, Nomi Mblanga, Ed Mason

The city of Kimberley is synonymous worldwide with diamonds. In turn, diamonds are equated with De Beers. Since the discovery of diamonds in Kimberley in 1871, De Beers has grown into a formidable giant, producing more than 40% of global gem diamonds, generated from mines throughout Africa.

Today, two De Beers-owned mines, two treatment plants, and a few other smaller De Beers holdings still operate in Kimberley. The mining and treatment operations require a large amount of energy, predominantly in the form of electricity. De Beers accounts for 10% of all energy use in Sol Plaatje Municipality and is the single biggest user of energy in the municipality. To meet these needs, De Beers purchases electricity directly from Eskom.

The table below provides data on the annual electricity consumption and related cost for each of the De Beers operations. It also shows the cost of electricity per tonne of ore mined.

De Beers Case Study

2004 versus 2003 electricity use and cost for De Beers, Kimberly operations

Operation	Tonnes ore	Tonnes ore	MWh	MWh	Cost	Cost	kWh/tonne ore	kWh/tonne ore	Rand/tonne ore	Rand/tonne ore	Savings (Rands)	Savings MWh
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004		
Wesselton	673570	831464	23471	22216	R3,578,064	R3,731,889	35.77	29.19	5.31	4.49	R684,922	7525
Jointshaft	854168	785435	24388	22602	R3,657,909	R 3,601,494	29.42	30.35	4.28	4.59	R -237,929	505
NTP	1533153	2539500	18723	19725	R2,806,027	R 4,186,485	12.75	11.19	1.83	1.65	R 461,391	12653
CTP	2779060	4786017	71305	88484	R10,155,910	R 11,361,729	25.65	16.52	3.65	2.37	R 6,128,486	34277
											R 7,036,871	54961

With substantial electricity costs per month, De Beers looked very carefully at energy efficiency in all of its operations in order to reduce costs. The following measures were introduced:

- replacement of inefficient machinery and equipment with new, energy-efficient technology;
- training staff to help reduce energy use;
- managing operations to take advantage of reduced electricity tariffs during off-peak times; and
- careful monitoring and evaluation of energy use and identifying further energy efficiency measures.

As the table shows, De Beers managed to save 54 961MWh of electricity through the introduction of energy efficiency measures (calculated by looking at what energy would have been consumed in 2004 if De Beers had been using the same levels of energy per tonne of coal produced as in 2003). This translated into a saving of R7 million for the company.

WIND TO WATTAGE: EXPLORING WIND POWER IN NELSON MANDELA METROPOLITAN MUNICIPALITY

Wayne Kitching, Nelson Mandela Electricity and Business Unit

Port Elizabeth – the windy city! Today, Port Elizabeth has reason to be proud of its name.

The South African Weather Service has confirmed that Port Elizabeth is indeed the windiest city in South Africa, making it an excellent place for creating local, wind-powered electricity. Executive Mayor Mr Nceba Faku has taken the bull by the horns and tasked the Electricity and Energy Business Unit of the Nelson Mandela Metropolitan Municipality with investigating the possibility of using wind to generate power.

The Electricity and Energy Business Unit is always open to new possibilities and keeps track of the latest technology and trends concerning cutting-edge electricity distribution. Assisted by an independent consulting group, the unit has conducted a preliminary investigation into the viability of local wind-generated power. Different locations for a wind farm have been considered and environmental impact assessments have been conducted at these sites.

Research shows that wind-power producing countries often upgrade to bigger turbines and the smaller second-hand turbines can be bought at a reasonable price. The investigative team from Port Elizabeth have been considering a set of turbines standing on the harbour wall of Rotterdam in Europe. These turbines include sixteen Nedwind NW41 turbines and ten Nedwind NW35 turbines, totalling a wind turbine plant capacity of 13 MW. Viability studies for Port Elizabeth were based on the use of these specific turbines.

As turbines only generate power when the wind has reached a minimum speed, it has been important to use real, site-specific wind data in the viability study. This data was unfortunately not available for each of the proposed sites, and extrapolations and estimates had to be used. However data from the EIA, existing power use figures and the extrapolated wind data have allowed fairly reasonable viability studies to be completed. This research pointed to the area opposite the industrial area of Deal Party as the best potential site.



The study showed that the possible return on investment for this project could be seven to eight years.

The sensitive relationship between wind speed and power generation can have a significant impact on cost implications for a wind farm project. The research team thus recommended that more detailed wind data be collected at the potential sites to ensure a more realistic and accurate viability study. Fourteen new weather stations are now being installed. The data will be used to create an accurate three-dimensional wind model of the Metro. This will allow a more detailed viability study to be conducted and a specific site can then be selected.

It hasn't yet been decided who will be responsible for generating and buying the wind power. However, a few large industrial consumers within the region have been approached about the possibility of buying green energy and have indicated that they are open to this possibility.

The opportunity for local power generation at municipal level seems to be much more realistic than many of us would have believed. So next time you're in Port Elizabeth, don't complain about the wind: it may be the only reason the traffic lights are working!

Darling Wind Farm and Power Purchasing Agreement with City of Cape Town

Darling, 70km north of Cape Town, is to be the site of South Africa's first commercial wind farm. The farm is to be developed in two phases, the end result being a farm of 13 MW from ten 1.3 MW wind turbines. The project became economically feasible when a favourable Power Purchase Agreement was reached between the developer and the City of Cape Town. The City will pay a premium for the purchase of the renewable electricity as part of its commitment to sustainable development: the City wants 20% of its electricity to come from renewable sources by 2020. During its lifetime this project will prevent:

- 298,125 tonnes of carbon dioxide emissions,
- burning of 100,000 tonnes of coal,
- use of 60 million litres of water.

ISSUE: Understanding city energy consumption

The types and quality of energy available enable various kinds of economic activities⁷. In addition to economic production by other players, city governments are important suppliers of goods and services in their own right and as the manager of other entities supplying outsourced services. This requires energy inputs and involves energy usage and city governments are large energy users. City management is in a position to play a leading role in demonstrating the implementation of energy policies such as improving energy efficiency, decreasing negative environmental impacts involved with energy production, and use of (and increasing the use of) renewable energy sources. City procurement policies can play a role in encouraging shifts in energy production, supply and usage. To this end cities have a key role to play in supporting and implementing national energy strategies.

Measure: Energy consumption in cities as a proportion of national energy consumption

The review cities account for 41% of population, 38% of energy consumption, and 41% of electricity consumption, and contribute 61% to GDP in South Africa (Table 2.1). The metros account for a third of the country's population and account for about a quarter of energy and electricity consumption, while producing over half of South Africa's GDP. The indication is that cities have a substantial role to play in implementing and supporting national energy strategies.

In terms of population and GDP the industrial towns and other towns are relatively unimportant compared with the metros (Table 2.2):

Table 2.2 Population, GGP, energy consumption and electricity consumption of industrial and other towns, 2004

	Population % SA	GGP		Energy consumption		Electricity consumption	
		Per capita [2004 ZAR]	% SA	Per capita [GJ]	% SA	Per capita [KWh]	% SA
Metros	33	45,688	54	44	25	3,821	26
Industrial towns	4	24,583	4	153	11	16,150	13
Non- industrial towns	5	22,786	4	25	2	1,888	2

Source: Derived from data gathered in City Energy Review, 2006

The metros account for most of the economic production by the review cities. However, despite the small percentage contribution of the industrial towns to GDP, there are strong economic linkages between the energy-intensive industries in the industrial towns and the rest of the South African economy, and so the importance of these towns in terms of economic production should not be gauged solely in terms of their measure of 4% contribution to GDP.

⁷ Energy requirements for social uses is covered in *Energy Towards Inclusive Cities*.

Table 2.1 Population, Gross Geographic Product (GGP), energy consumption and electricity consumption of metros, 2004

	Population		Energy consumption		GGP			Electricity consumption	
	People	% SA	(GJ)	% SA	2004 ZAR	% SA	Per capita	KWh	% SA
SOUTH AFRICA	46,586,607		2,717,859,800		1,297,399,192,192		27,849	226,732,963,000	
City of Cape Town	3,069,404	6.6	135,791,249	5.0	143,996,431,879	11.1	46,913	11,874,000,000	5.2
City of Johannesburg	3,585,545	7.7	130,941,453	4.8	207,120,583,381	15.9	57,765	12,471,048,000	5.5
City of Tshwane	1,678,806	3.6	92,323,596	3.4	106,844,764,401	8.2	63,643	7,934,512,000	3.5
Ekurhuleni	2,761,253	5.9	167,319,123	6.2	91,866,383,496	7.1	33,270	12,740,392,000	5.6
eThekweni	3,269,641	7.0	127,271,937	4.7	118,262,059,564	9.1	36,170	10,674,977,595	4.7
Nelson Mandela	1,013,883	2.2	30,092,498	1.1	34,522,064,611	2.7	34,049	3,067,998,000	1.4
Metro total/ave	15,378,532	33	683,739,856	25.2	702,612,287,331	54.2	45,688	58,762,927,595	25.9
uMsunduzi	562,373	1.2	29,100,933	1.1	11,719,063,108	0.9	20,839	1,482,218,000	0.7
Saldanha Bay	79,315	0.2	29,638,927	1.1	2,936,230,069	0.2	37,020	1,567,521,000	0.7
Sedibeng	883,772	1.9	170,097,688	6.3	18,030,400,397	1.4	20,402	12,562,486,667	5.5
uMhlathuze	360,002	0.8	60,263,447	2.2	13,664,088,639	1.1	37,956	14,838,464,000	6.5
Industrial total/ave	1,885,462	4.1	289,100,995	10.6	46,349,782,214	3.6	24,583	30,450,689,667	13.4
Buffalo City	702,671	1.5	18,226,570	0.7	14,690,264,880	1.1	20,906	1,305,568,323	0.6
King Sabata	421,233	0.9	5,473,868	0.2	4,644,692,544	0.4	11,026	155,200,000	0.1
Mangaung	662,063	1.4	18,181,414	0.7	1,795,519,2730	1.4	27,120	1,396,694,000	0.6
Potchefstroom	129,075	0.3	4,332,903	0.2	4,044,910,000	0.3	31,338	387,327,000	0.2
Sol Plaatje	196,846	0.4	6,274,145	0.2	6,786,093,857	0.5	34,474	514,158,929	0.2
Non-industrial total/ave	2,111,888	4.5	52,488,900	1.9	48,121,154,010	3.7	22,786	3,758,948,252	1.7
Total	19,375,882	41.6	1,025,329,751	37.7	797,083,223,555	61.4	41,138	92,972,565,514	41

Source: Derived from data gathered in City Energy Review, 2006

Measure: Per capita energy and electricity consumption

The energy economy of each city is very different and the value of conclusions that can validly be drawn solely on the basis of these

average figures is limited. Our concern here is whether and how energy enables economically productive activity.

The phenomenon of South Africa's Dual Economy is a well-documented: a prosperous developed economy exists alongside a poverty-ridden, under-developed economy, historically organized spatially along racial lines. Interpreting the per-capita figures in this context, the following can be said about the measure of per capita energy and electricity consumption:

- * The historically developed areas of the metros have adequate access to energy and electricity and consumption levels enabling economic activity. However, given the Dual Economy the average per-capita electricity consumption, at levels within about 20% above and below the 4,000KWh implies that in under-developed areas the per capita consumption is well below the 4,000KWh level required to enable a minimum level according to Human Development Index) (HDI) measures⁸. Thus, the per capita consumption figures suggest that in under-developed areas, per capita electricity consumption indicates a severe constraint on economic production.
- * In non-industrial towns, the per-capita electricity consumption of less than half the 4,000KWh level required to enable a minimum level according to HDI measures indicates a severe constraint on economic production in under-developed areas in these towns.
- * Electricity consumption by energy-intensive industries in the industrial towns prevents any valid conclusions being drawn from the average per-capita electricity consumption measure, except in uMsunduzi where the figure of 2,636KWh, which is well below

Table 2.3 Energy and electricity consumption per capita in South African cities, 2004

	Energy consumption per capita [GJ p.a.]	Electricity consumption per capita [KWh p.a.]
SOUTH AFRICA	58	4,867
City of Cape Town	44	3,869
City of Johannesburg	37	3,478
City of Tshwane	55	4,726
Ekurhuleni	61	4,614
eThekweni	39	3,265
Nelson Mandela	30	3,026
Metro total/ave	44	3,821
uMsunduzi	52	2,636
Saldanha Bay	374	19,763
Sedibeng	192	14,215
uMhlatuze	167	41,218
Industrial total/ave	153	16,150
Buffalo City	26	1,858
King Sabata	13	912
Mangaung	27	2,110
Potchefstroom	34	3,001
Sol Plaatje	32	2,612
Non- industrial total/ave	25	1,888
City average	53	4,810

Source: Derived from data gathered in City Energy Review, 2006

⁸ Pasternak, 2000, finds a strong correlation between HDI indexes and electricity consumption up to 4,000KWh/capita per annum.

the 4,000KWh level, indicates a severe constraint. However, conditions in the underdeveloped areas of these towns, the “African Locations” of the apartheid era, are generally even worse than in the metros and so one can conclude that the per-capita electricity consumption measure indicates at least as severe constraint in these areas as it does in the metros.

ISSUE: Energy intensity

Measure: Energy consumption per unit of GGP⁹

The overall productivity of energy usage is important because it indicates the economic effects on production that upwards trends in the costs of energy might have: both source costs of fuels and consequent costs of emissions related to energy usage. These are of special relevance at the beginning of an era when this upward pressure is likely to intensify, possibly even exponentially, especially for an energy-intensive economy. Cities with strong economic linkages to energy-intensive activities face mounting challenges.

The South African economy has one of the highest values for energy intensity, i.e. the amount of energy used per unit of economic production, in the world. Also, just about all South African energy is derived from fossil fuels and much of this is produced in very inefficient (from an energy-in versus energy-out ratio) coal-powered electricity generation and coal-fed liquid fuels plants.

Because of concerns with global warming

and the depletion of non-renewable fossil fuel reserves, the world is entering an era when the economic competitiveness of inefficient and/or fossil fuel-based economic activities will come under increasing pressure. This should be of concern to cities where these types of economic activities contribute significantly to GDP. Another cause for concern is if other inputs to local economic production, such as city transport systems, are energy-inefficient and based on non-renewable fossil fuels. Even cities without energy-intensive industries rely on electricity from fossil-fuel generated electricity with high CO₂ emission levels.

Table 2.4 Energy consumption per unit of GGP, 2004

	KJ/2004 ZAR
SOUTH AFRICA	1,856
City of Cape Town	900
City of Johannesburg	618
City of Tshwane	841
Ekurhuleni	1,736
eThekweni	1,030
Nelson Mandela	830
Average for metros	938
uMsunduzi	2,373
Saldanha Bay	9,602
Sedibeng	4,093
uMhlatuze	4,087
Average for industrial towns	4,009
Buffalo City	1,191
King Sabata	1,462
Mangaung	992
Potchefstroom	1,071
Sol Plaatje	895
Average for non-industrial towns	1,084
Average	2,010

9 There was also desire by stakeholders to explore energy consumption per GGP per capita, but this has not been included at this stage.

Source: Derived from data gathered in City Energy Review, 2006

All South African cities need to do thorough assessments of the likely impacts of global economic conditions that will affect local economic activities with relatively high energy intensities with related high CO₂ emissions levels and/or are based on fossil fuels.

There may be a sense that city governments have a limited role in influencing major input factors such as the use of local natural resources (such as coal) or the ultimate source of electricity used in their area of jurisdiction when it seems that the only option at present is supply from large energy-inefficient coal-fired generating stations. However, if developments in global conditions affect local economies to the extent that there are large negative impacts on local production, possibly even closure of large industrial facilities, then city governments will have to address many of the challenges of these impacts, whether national government is responsible or not. In fact, city government is often better placed to understand the challenges faced by industries in their jurisdictions and to engage with players to design solutions.

Measure: Sectoral energy consumption

Sectoral energy consumption gives further information on which economic sectors in cities will be affected by development costs related to energy supply and energy use. The figures below provide a comparison of sectoral energy consumption in South Africa as a whole, and across the different city ‘types’.

Comparative sector energy consumption, 2004

Figure 2.1 Metro sector energy consumption, 2004

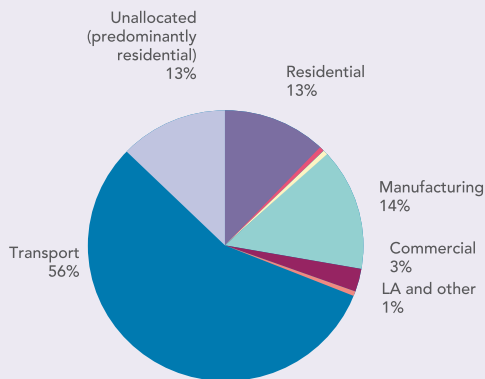


Figure 2.2 Non-industrial towns sector consumption, 2004

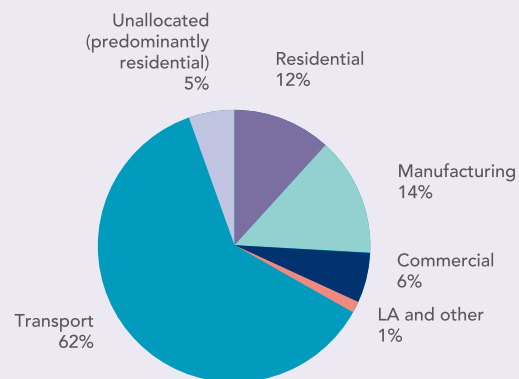


Figure 2.3 Industrial towns sector consumption, 2004

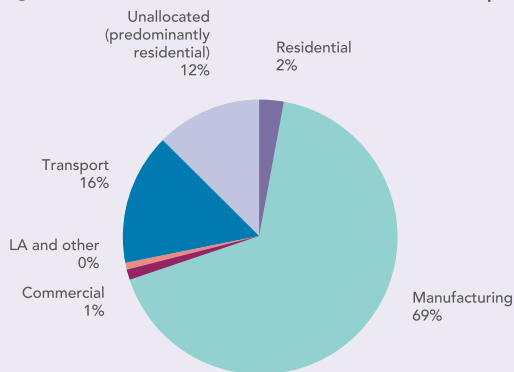
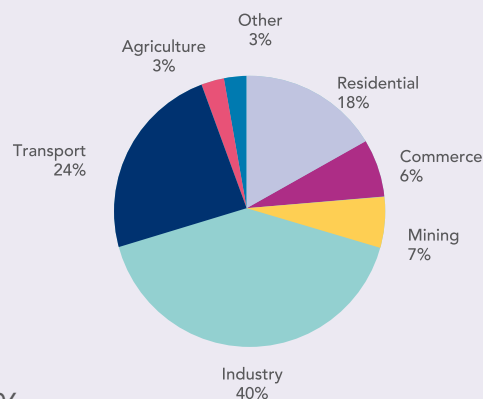


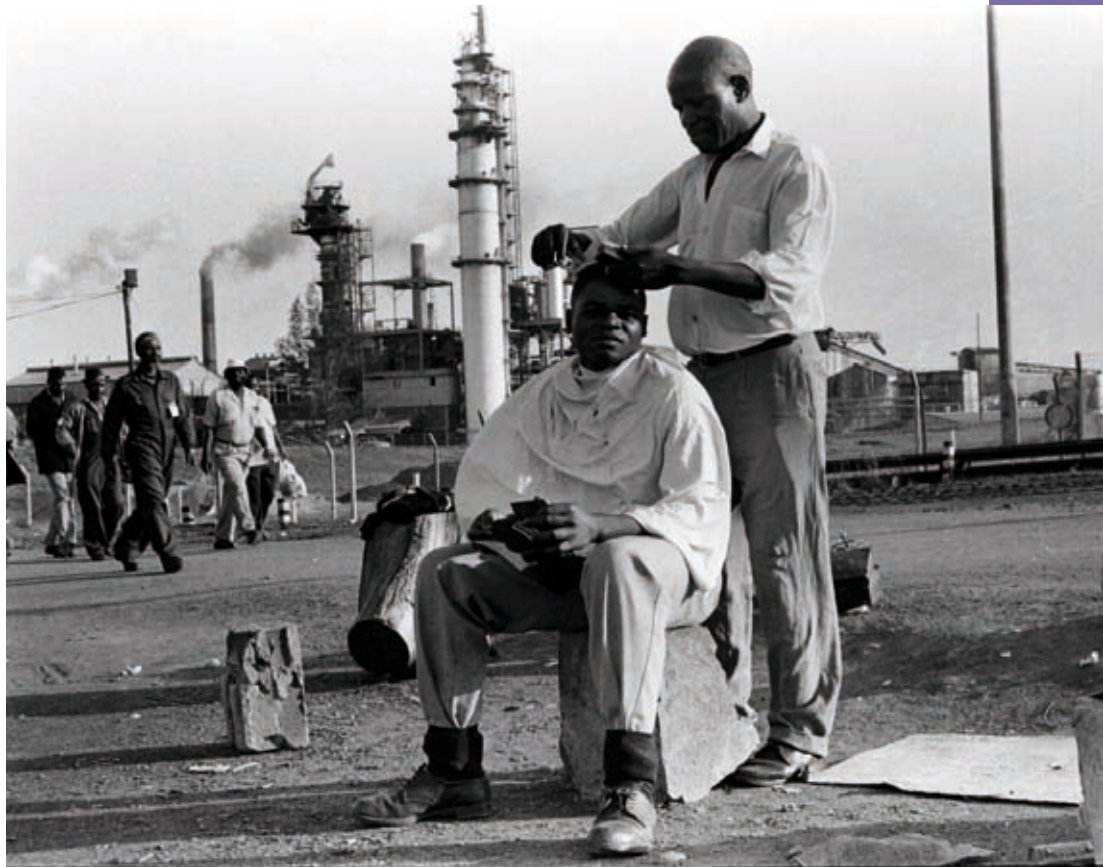
Figure 2.4 South African energy use by sector, 2002



Source: Derived from data gathered in City Energy Review, 2006

Identifying sector consumption of energy enables targeted policy development. What stands out within city energy consumption, relative to national consumption, is the huge proportion of energy consumed within the transport sector. As the majority of unallocated energy is paraffin and LPGas, it is likely that this represents a substantial portion of residential energy consumption – bringing residential consumption of energy in cities in line with national figures. At some 18–19% the residential sector represents a large proportion of city energy consumption. Where heavy industry exists it dominates the energy picture making this a key area of concern in future economic production in these towns. Within the metros and non-industrial towns industry represents only 14% of total consumption.

Commerce and industry accounts for a third of total consumption across the study cities and so is important to future developments in the productive bases of these cities. The National Department of Mineral and Energy Affairs (DME) is currently establishing capacity to measure energy efficiency in industry. This will enable city governments to assess the potential impacts of future developments on energy-inefficient industries. Industrial energy policies could include measures to encourage or assist these industries to improve energy efficiency or measures to diversify the economic base.



ISSUE: Fuel diversification

An important aspect of sustainability is fuel diversification – ensuring security of supply through a variety of sources. Although there is an apparent diversity of fuel use in the review cities, the level of diversification is extremely low if the additional factors of fuel substitutability and primary energy supply are taken into account.

The transport sector relies on fossil-based liquid fuels and without major structural changes, which would take a decade at least, these cannot be substituted. The same holds true for the reliance on coal and very-low-cost electricity in the minerals processing and manufacturing industries. As far as primary

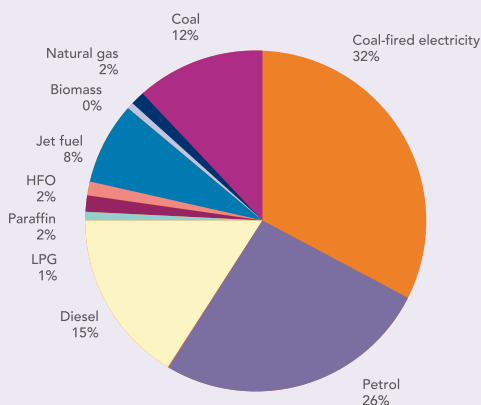


energy is concerned, South Africa depends on local coal to manufacture just about all of its electricity, and about 30% of liquid fuels. The remainder of liquid fuels¹⁰ are manufactured from imported crude oil or imported direct.

In terms of economic production and transport, which is a critical input for economic production, cities are therefore essentially dependant on locally produced coal and imported crude oil. The energy transformation systems, transport systems and energy-intensive industries are highly inflexible as far as fuel substitutability is concerned. While it is unlikely that the mechanics of coal production faces any plausible threat, the economics of energy-intensive industries, carbon-based fuels and transport systems that depend wholly on fossil fuels or that are energy-inefficient are under serious threat. Thus the very low level of fuel diversification on which the economic production of South African cities depends presents a potential serious threat to their future economic production and well-being.

While South African cities are not alone in having to address this situation, this does not take away the threat. A large and growing number of cities have already established programmes to address the challenges

Figure 2.5 City energy use by fuel type, 2004



Source: Derived from data gathered in City Energy Review, 2006

¹⁰ Except for a small amount of manufactured natural gas from the almost depleted southern coast gas-fields.

posed by the need for energy diversity, and energy efficiency, decreasing GHG emissions and increasing use of renewables. Cities that are unsuccessful in implementing such programmes face an increasing likelihood of stagnation or decline in levels of economic production.

Measure: City energy consumption fuel mix

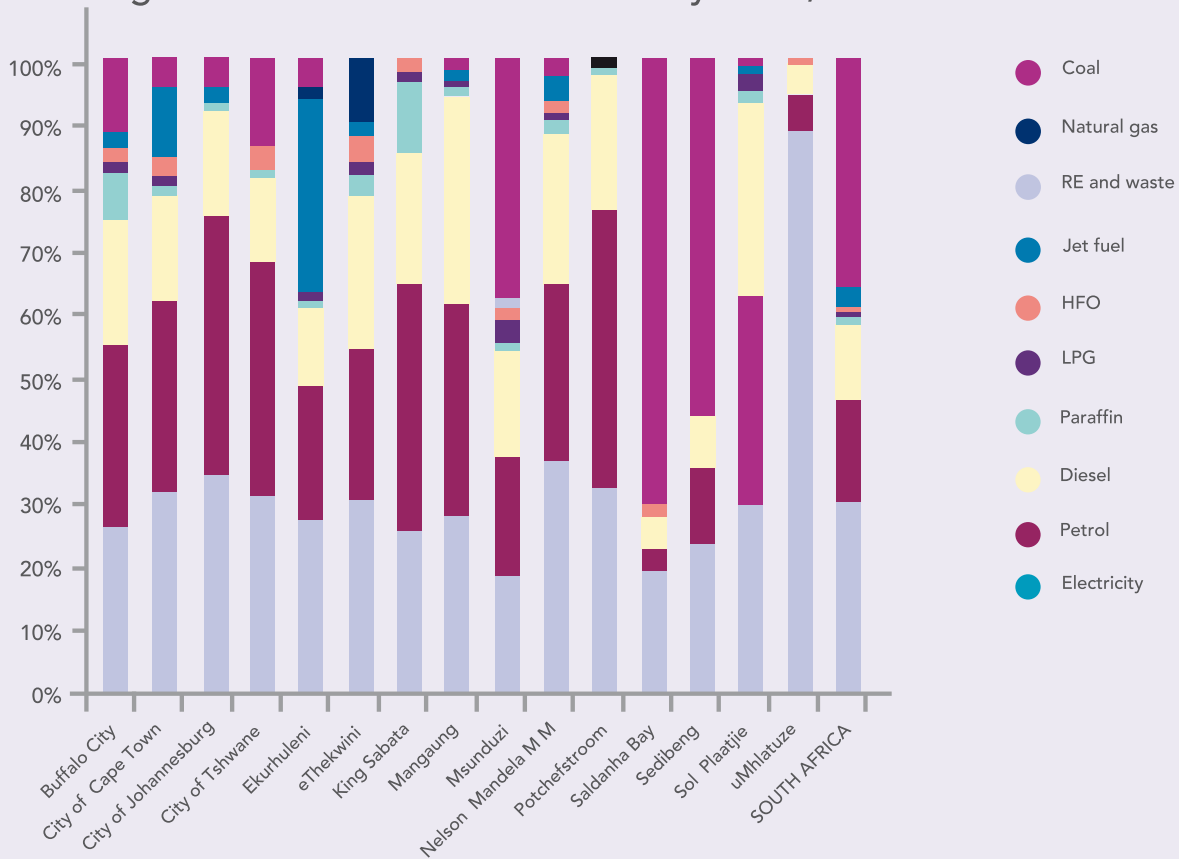
South African cities remain heavily dependent on fossil fuels. Electricity and petrol and diesel dominate the fuel mix within the study cities (Figure 2.5), though there is a fair degree of variation

Data comment

Coal may be underreported due to difficulties in accessing data.

Biomass is likely to form an important fuel source, particularly within Buffalo City and King Sabata, but data on this fuel is notoriously difficult to obtain.

Figure 2.6 Fuel mix across the study cities, 2004



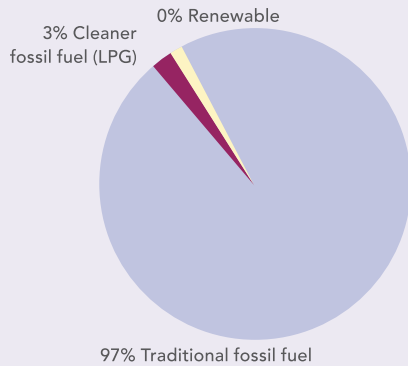
Source: Derived from data gathered in City Energy Review, 2006

between cities’ fuel mix. Coal dominates in the three industrial towns of Sedibeng, Saldanha and uMsunduzi, with some use of coal within industrial processes in some of the metros. Residential coal consumption takes place in the towns on the highveld – which have both cold winters and ready access to the coal fields. The presence of Johannesburg International Airport within Ekurhuleni results in a domination of jet fuel with their fuel mix. Paraffin consumption stands out in Buffalo City and King Sabata – both with poor, rural components.

Measure: Share of renewable energy within the city energy consumption fuel mix

Apart from biomass – predominantly firewood which is notoriously difficult to quantify – cities rely at the moment almost exclusively on the use of fossil fuels. ‘Cleaner’ fuels refer to those, such as LP gas, that are fossil-fuel based, but have a lower carbon content (and related emissions level) per unit of energy.

Figure 2.7 Fossil fuel, cleaner and renewable city mix, 2004



Source: Derived from data gathered in City Energy Review, 2006

ISSUE: Local energy generation and energy

The review cities are not involved in energy production¹¹, although two of the cities host petrochemical refineries that make a significant contribution to their local economies. However, there is growing acknowledgement of the need to diversify energy sources to assure the sustainability of economic production within cities and there is also an acknowledgement that energy production within cities offers economic benefits in terms of local economic development. Potential diversification opportunities include energy efficiency programmes, electricity from renewable sources, biofuels, and energy for water heating from solar water heaters.

Data comment

Measures to capture the level of energy efficiency measures implemented, or services produced have not been developed here. This is an important area to address in future monitoring.

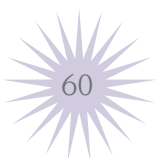
Measure: Quantity of local energy produced

The review cities have little control over the generation of electricity and ensuring its supply. Currently the only cities in which electricity is produced at the local level, defined here as within a 100km radius, are City of Johannesburg, City of Tshwane, City of Cape Town and (to a small extent) eThekweni (Table 2.5).

Measure: Renewable source electricity generated within a city region (100km radius), or generated elsewhere and bought into the region

The contribution of renewable-source electricity in the review cities is negligible (Table 2.6). The low cost of Eskom power implies that special measures will be required for this nascent industry to be established.

In the absence of a feed-in tariff, renewable electricity generation is reliant on Power Purchasing Agreements (PPAs) where customers, such as a local authority, pay upfront, generally at a higher rate than coal-fired electricity, for “green” electricity.



Tongaat-Hulett produce 67 397MWh of electricity in eThekweni. The City of Cape Town has a PPA with the DarLIPP wind farm and it is anticipated that the first “green” source electricity will be purchased once the wind farm is operational. Nelson Mandela Municipal Metro is busy developing local wind-powered electricity generation.

Measure: Local production of biofuel¹²

Biofuel has recently become a priority area within DME’s renewable energy implementation and fuel safety strategy. Information on biofuels being produced within our cities was not sourced within this study. While it is believed that levels of production are still very small, this needs follow up. Biogel is also being rolled out within municipalities within Kwa-Zulu Natal in lieu of electricity within the Basic Electricity Support Service Tariff.

While biofuels may be more renewable than fossil fuels, with lower pollution effects, it should also be noted that there are concerns around potential habitat destruction, genetically modified

Table 2.5 Local energy production and related fuel source, 2006.

City	Capacity (MW)	Source of electricity
TSHWANE Rooiwal/ Pretoria West	300MW (Rooiwal) 180 MW (Pretoria West)	Coal
JOHANNESBURG Kelvin	600MW (City Power)	Coal
CAPE TOWN Koeberg Roggebaai gas turbine Athlone gas turbine Darling Wind Farm (in development)	1,800MW (Eskom) 40MW (CCT) 40MW (CCT) 5.5MW (anticipated first phase, DARLIPP)	Nuclear Gas Wind
ETHEKWINI Hulett Sugar Maidstone Sugar Mill	29MW	Biomass (Bagasse)

Source: Derived from data gathered in City Energy Review, 2006

crops, and displacement of land for basic food production. A more detailed process to monitor all aspects of biofuels should be considered.

Data comment

IPP registration and reporting and any renewable generation should include where the electricity is consumed. TREC (Tradeable Renewable Energy Certificate) registration processes may also provide a record of the location of renewable electricity consumption.

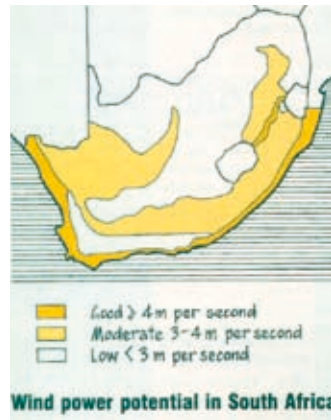
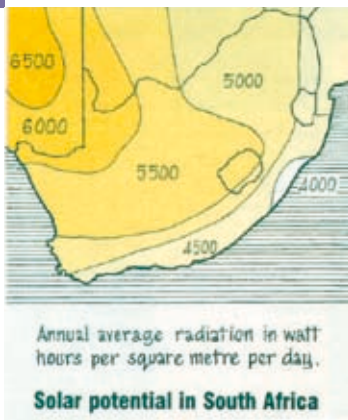
A detailed system to monitor all aspects of biofuels needs to be implemented.

Table 2.6 Quantity of locally produced renewable source electricity 2004 (January to December)/year

Name	Municipality	Licensed capacity (MW)	Energy generated (MWh)
Tongaat-Hulett Sugar			
Maidstone Sugar Mill	eThekweni	29MW	67,397
DarLIPP: Not operational	City of Cape Town	5.2MW	–

Source: NERSA, 2005.

¹² This is included by default in “Fuel types used” but is explicitly listed here to indicate special priority accorded by stakeholders in the review process.



Measure: Renewable energy sources utilized as a percentage of total, economic renewable capacity

All cities have renewable energy resources for energy services – in the form of sunlight and roof catchment capacity, wind and other such resources. The size of these resources (potential and economic) remains unknown. It is therefore not currently possible to determine the

utilization of renewable resource capacity as a share of assessed renewable capacity. Biomass (wood) is used within cities, but is also difficult to quantify.

Measure: domestic solar water heater (swh) installed capacity

Although this is in effect a sub-category of renewable capacity examined above, SWHs are receiving increasing attention as one of the most cost effective and easily achievable measures towards renewable energy and energy efficiency targets of government (local and national)¹³.

No data is currently in place, save for a small amount of localized Cape Town data indicating that there were approximately 380 new SWH installations in 2004¹⁴ or 30–40 per month, with a total installed capacity of some 16–20,000 units.

In a 2005 study Holm synthesised information on

Table 2.7 City projects in low income households, 2005

City and Project	Date	Systems	Comments
CCT: Lwandle	1999–2000	295 units, 884m ² , 59,250 litres	Largest low-income SWH project in SA established through a Development Bank of South Africa loan. Project has not been fully implemented yet: Backup electricity is not installed, prepayment electricity not in place and maintenance systems not established.
CCT: Kuyasa, Khayelitsha	2001–	10 retrofit SWH to 30m ² RDP houses	A Clean Development Mechanism (CDM) Gold Standard project in which the municipality's involvement has been central. Savings worked on the basis of an assumed "suppressed energy demand".
CCT: Ubushushu Bendalo Trust	2006–	Aim: 80,000 units - mixed	Looking to establish support to meet CCT target to install 80,000 SWH over six years. These will be a mix of systems suitable to low and high income homes.
eThewini	2002–	100 units, 50% subsidized, saving 5–10% monthly income	Has come up against affordability limits on adoption, even with 50% subsidy on very low cost unit. Local authority buy-in essential for project success, awareness crucial and finance and standards prerequisite.
eThekwini	2005–	Aim: 3–4,000 low cost SWH in Durban Metro	Project a pilot to inform eThekwini municipality on general institutionalization of SWHs in subsidized low cost housing in eThekwini.

Source: Holm, D, 2005



¹³ The Renewable Energy (RE) Market Transformation (REMT) study, commissioned by the World Bank to support South Africa in achieving its RE targets identified SWHs as one of the "low-hanging fruits" for early implementation (Conningarth Economists, 2004, quoted in Holm, 2005).

¹⁴ OneWorld Sustainable Investments, for INWENT, Solar Water Heating Market Study for the Western Cape Report Summary, 2005.

SWHs in low income housing projects (Table 2.7).¹⁵ It is important to note that SWHs planned within projects such as the Hull Street housing project in Galeshewe, Sol Plaatje and Shayamonya, in Cato Manor, Durban have often fallen away at the final hour due prohibitively high upfront capital costs – affordability frequently limiting uptake.

Measure: Jobs and related skills generated from local renewable energy and energy efficiency implementation

Renewable energy development and energy efficiency implementation offer economic development opportunities.¹⁶ As these energy sectors develop it will be important to gather data on their contribution to local economic development.

Data comment

Greater knowledge needs to be developed around economic renewable capacity at the local level. The potential contribution of these sectors to local economic development needs to be collated.



Key policy issues

Representing a large proportion of national energy consumption, energy management in cities becomes a key issue. It is key for both national energy goals and strategies, and in ensuring that city economies are well prepared to meet the challenges ahead – notably global pressures in the face of climate change to switch away from fossil-fuel based, energy-intensive economies and the depletion of non-renewable fossil fuel reserves. The evidence is that efforts by South African cities to ensure their economically productive bases through diversifying energy usage and energy sources are in their infancy. In light of existing lack of energy-source diversity, dependence on high energy intensity industry and global trends, cities need to address this issue.

Key to addressing these issues from a productive city point of view is the development of a local economic development approach and strategy that addresses energy issues, particularly as they relate to the development of the Second Economy within cities. The key challenge here is how to access energy sector related resources so that the economically productive bases of the Second Economy in cities can be developed to achieve an effective integration with the First Economy.

¹⁵ From Holm, 2005

¹⁶ A study by Agama Energy indicates that a 100% domestic deployment of SWHs in South Africa would yield 118 000 new jobs. Austin, G, 2003

SELLING SOLAR POPCORN

Dorah Lebelo, GreenHouse Project

“Using a solar cooker is very easy,” says Tumi Ramolefi (27) of Braamfisherville, West Johannesburg. You may have seen Tumi before: all around Soweto, outside the Oriental Plaza in Fordsburg, in Newtown, or outside the GreenHouse People’s Environmental Centre in Joubert Park. You may have been stuck behind him in the traffic – an unusual figure, slowly pedalling a huge tricycle with a large, silver solar cooker on the back.



Tumi sells ‘solar’ popcorn. He does this in order to raise awareness about renewable energy technologies, while also making a living. After failing matric in 1998, Tumi, who lives with his girlfriend and their baby daughter and is also responsible for his mother and the rest of his family, decided it was time to earn a living.

Tumi started riding the solar tricycle around Soweto in early 2005. The initiative came about through an innovative partnership between Rapid Dawn Solar Company, the GreenHouse Project and the Soweto Information Centre, where Tumi had worked. A 14KW parabolic solar cooker was installed on a tricycle. Armed with a 10kg bag of popcorn and the tricycle, Tumi set out. He keeps any income generated from the popcorn, and also earns commission on each renewable product he sells.

Waking at 6 am every day, Tumi catches a minibus taxi to the GreenHouse where he stores the tricycle. He starts the day by collecting the appliances from the storeroom and putting these on the tricycle. Stoves, popcorn, apron, oven gloves and, most importantly, sunglasses, must all be ready. He also checks the tricycle to make sure brakes and tyres are all in working condition. Then he rides to his chosen spot of the day. Initially, Tumi worked all over from Newtown to Joubert Park. Currently he is based on the pavement next to the GreenHouse entrance where he is assured of a warm welcome and his demonstration attracts hundreds of pedestrians.

On a sunny day, Tumi opens the Solar Cooker into the direction of the sun, places a black pot with a glass lid in the centre of the cooker, heats up oil in the pot and adds the popcorn. After two minutes the corn starts popping and in another five minutes he has a whole pot of fresh popcorn. “A black pot will absorb the heat best,” says Tumi, who also recommends that the best time for cooking in such a stove is between two hours after sunrise and two hours before sunset, “when the sun is high and shines bright.”

By 9 am Tumi will have made the first five packets of popcorn and he will have spoken to more than 20 people about the renewable energy appliances on show. During bright sunny days, Tumi uses the parabolic Solar Cooker to cook popcorn, while also warming ready-made popcorn in the Sun stove. During cloudy days he uses the Vesto stove or Ethanol-gel fuel stove to pop the corn.

Tumi continues his cooking through the day, while people watch and ask questions about different appliances on show. “The brightness and the shape of the parabolic cooker create an interest for people to come and check it out,” says Tumi. “Some people thought that it was a satellite dish. The glare of the cooker irritated some people and as a result they lost interest in looking at it!”

A challenge is balancing the provision of information with the business requirements of making and selling the food. “At times I would forget about making money and instead concentrate on explaining this new gadget. Most people have indicated the willingness to spend their money on it, while some thought it was too expensive. The most frequently asked questions are: What happens when it rains? What happens when there is no sunshine? Where am I going to store it?”

By 2 pm on a good business day Tumi will have sold up to 20 packets of popcorn and will also have talked to more than 100 people about renewable energy and energy efficient appliances and technologies. At 4 pm he packs everything back onto the tricycle and heads back to Joubert Park.

Is it worth it? Tumi makes on average R600 a month from selling popcorn and a small additional amount from renewable appliance sales commission. The income is currently too small for him to pay his bills and look after his family, but Tumi has ideas to grow the project. His ambition is to learn more about energy efficiency and to visit factories that manufacture these products in order to set himself up as a community energy facilitator, supporting unemployed youth to do this work.

The *GreenHouse Project* is an NGO empowering Johannesburg’s residents to create and recreate the city in ecologically, socially and economically sustainable ways. The project provides onsite demonstrations on renewable energy, energy efficiency, ecological water and sanitation, zero waste, organic food gardening and medicinal plant cultivation. The project has supported Tumi and Rapid Dawn’s solar tricycle project from the beginning. Their role will now be to help him and Rapid Dawn scale up the project, using the remaining nine tricycles available from Soweto Information Centre. These will be fitted with renewable appliances and handed over to other unemployed youth to make popcorn, hot-dogs, *vetkoek* and the like. The GreenHouse Project will help find funders to support the project – providing training to participants and funds for tricycle modification and renewable appliances. The idea of formalising the operators of the tricycles into a cooperative is also being explored.



