South African Solar City Guidebook

Sustainable urban planning and design for Local Governments

Prepared under the project:

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

April 2013

Prepared by:

ICLEI – Africa

in partnership with

ICLEI – South Asia

Funded by REEEP

Disclosure Page

ICLEI – Local Governments for Sustainability

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

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

Renewable Energy and Energy Efficiency Partnership (REEEP)

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

Acknowledgements:

Publisher: ICLEI Africa, ICLEI South Asia

Copyright:
All rights reserved © ICLEI e.V. 2013
The material of this publication is copyrighted. Requests to reproduce the material, in part or in full, should be in writing to the Africa Secretariat of ICLEI – Local Governments for Sustainability. ICLEI encourages the active dissemination and use of this report, and permission to reproduce will usually be granted promptly without charge if the reproduction is for non-commercial purposes

Further Information:

ICLEI Africa Secretariat
Cape Town, South Africa
Iclei-africa@iclei.org
www.iclei.org/africa

Contents

Disclosure Page 2

ICLEI – Local Governments for Sustainability 2

Renewable Energy and Energy Efficiency Partnership (REEEP) 2

Terms, Abbreviations and Acronyms: 7

Preface 9

The Local Renewables Initiative and Network 9

About the project 'Local Renewables: South-south cooperation between cities in India, Indonesia and South Africa' 9

About the Solar City Guidebook for South Africa 10

Executive Summary 11

Chapter 1: Introduction 12

International perspective of climate change and energy 13

African perspective of energy and climate change 14

South African perspective on energy and climate change 16

South African Commitment 17

South Africans Carbon Story 17

Chapter 2: National and Sub-national Obligations 22

National Legislation 22

Provincial 24

Western Cape (Department of Environmental Affairs and Development Planning) 24

Eastern Cape (EC Economic Development and Environment Affairs) 25

Northern Cape (Department of Environmental Affairs and Nature Conservation) 25

North West (The Department of Economic Development, Environment, Conservation and Tourism) 25

Free State (Economic Development Tourism and Environmental Affairs) 26

KwaZulu-Natal (Agriculture and Environment: Sustainable resource Management) 26

Mpumalanga (Economic Development, Environment and Tourism) 26

Gauteng 26

Limpopo (Economic Development Environment and Tourism) 27

Chapter 3: Evolution of the Solar City Concept 29

Features of international solar city programs 30

ICLEI Local Renewables Network 40

Chapter 4: Development and Implementation of a Solar City in South Africa 42

Motivation for 'Solar City' Program in South Africa 42

Activities towards the development of a Solar City 42

1. Institutional: 42
2. Baseline Study and City Energy Profile 44
3. Policy and Strategy Development 46
4. Activities to implement at the local level 49

Indicative measures to be taken by Cities towards the develop of a 'Solar City' 53

Chapter 5: Indicative RE and EE solutions 54

Energy Efficient devices 54

Home Appliances 54

Lighting 54

Cooking 55

Water Saving 59

Water Heating 59

Renewable Energy devices 62

Photovoltaic 62

Lighting 62

Cooking 64

Water Heating 64

Potential Photovoltaic Plants in South Africa 67

Chapter 6: International financing mechanisms 70

International financing options and related mechanisms 70

1. Green or Clean Energy Bonds and Investment Services 70

2. Carbon Finance 70

3. Public Finance Mechanisms 71

4. Energy Certificates 71

References 73

List of Tables

Table 1: Average saving that could be used with various energy efficient devices. The table below makes several comparisons between non-efficient devices versus energy efficient devices and provides potential annual savings. 57

Table 2: Energy and Water Saving Calculations 60

List of Figures

Figure 1: World map in proportion to the global distribution of GHG emissions and responsible geographical areas. 13

Figure 2: Global distribution of carbon dioxide emitted into the atmosphere. 15

Figure 3: Urban population (% of total) in South Africa. 16

Figure 4: South Africa is first on the country list for Africa's emitters. 18

Figure 5: Electricity consumed by sector, 2006. Source NERSA Supply Sector, 2006 18

Figure 6: South Africa's top carbon emitters according to the latest study, Carbon Disclosure Report 2011 19

Figure 7: City comparative study and the 2004 carbon emissions per capita 20

Figure 8a and 8b geographically illustrates Ekurhuleni location within Gauteng Province, South Africa and the local subdivisions of 101 wards at the local government level. 21

Figure 9: Three GHG Inventory study results that were undertaken for Ekurhuleni, 2004, 2007 and 2011. 21

Figure 10: This map represents the policies and legislation at the Provincial level in South Africa; all policies are pertaining to energy and climate change and sustainable development. 24

Figure 11: Solar city initiatives by Nikola Knezevic 30

Figure 12: ICLEI's Local Renewables Network consisting of three types of communities: Model, Resource and Network Communities 41

Figure 13: Southern hemisphere buildings should install solar panels on roof tops facing the northern direction to receive optimal solar radiation. 65

Figure 14: PV Plants Map South Africa 2012 67

Figure 15: Wind Turbines located on the Darling Farm in the Western Cape of South Africa. 68

Terms, Abbreviations and Acronyms:

ANC	African National Congress
CH_4	Methane
CDM	Clean Development Mechanisms
CDP	Carbon Disclosure Report
CO_2	Carbon Dioxide
COP17	17th Conference of the Parties
CFL	Compact Florescent Light
DEA	South African Department of Environmental Affairs
DFIs	Development Finance Institutions
ECC	Energy Efficiency Certificates
EE	Energy efficiency
EIB	European Investment Bank
EMM	Ekurhuleni Metropolitan Municipality
EEDSM	Energy Efficiency and Demand Side Management
ESCo	Energy Service Company
eCO_2	Equivalent Carbon Dioxide
GDP	Gross Domestic Product
GEEREF	Global Energy Efficiency and Renewable Energy Fund
GHG	Greenhouse Gases
GIES	Gauteng Integrated Energy Strategy
$GtCO_2$	Giga-tons of carbon dioxide
$GtCO_2eq$	Giga-tons carbon dioxide equivalent
HEAT +	Harmonised Energy Analysis Tool Plus
HTF	Heat-Transfer Fluid
ICLEI	ICLEI – Local Governments for Sustainability
ICLEI AS	ICLEI – Local Governments for Sustainability – Africa Secretariat
ICLEI SA	ICLEI – Local Governments for Sustainability – South Asia
ICLEI SEA	ICLEI – Local Governments for Sustainability – South East Asia
IDPs	Integrated Development Plans
IEA	International Energy Agency
IFC	International Finance Corporation
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
ISCI	First International Solar Cities Initiative
Kg	Kilogram
kL	Kilo Litre
kHz	Kilo Hertz
km	kilometre
km^2	kilometre squared
kT/yr	Kilo Tonnes per Year
kW	Kilo Watts
kWe	Kilo Watts Equivalent
kWh	Kilo watt-hour

kWp	Kilo Watt Peak
KZN	KwaZulu-Natal Province
L	Litre
LGs	Local Governments
LED	Light Emitting Diode
LR	Local Renewables
LRI	Local Renewables Initiative
LPG	Liquefied Petroleum
LTMS	Long Term Mitigation Scenarios
MEGDP	Mpumalanga Economic Growth & Development Path
Mt	Metric tonnes
Mtoe	Million tonnes of oil equivalent
MU	million units
MW	Mega Watt
MWe	Mega Watt Equivalent
MWh	Mega Watt-hour
MWP	Mega Watt Peak
NCCC	National Climate Change Committee
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental Organisation
NO_2	Nitrogen Dioxide
PNG	Piped Natural Gas
PPP	Public Private Partnership
PV	Photovoltaic
R&D	Research and Development
RE	Renewable Energy
REEEP	Renewable Energy and Energy Efficiency Partnership
SA	South Africa
SWH	Solar Water Heater
T/yr	Tonnes per year
TAR	Third Assessment Report
Te Co_2	Tonnes of Equivalent Carbon Dioxide
ULBs	Urban Local Bodies
UNFCCC	United Nations Framework on Climate Change
W	Watt
Wh	Watt-hour

Preface

The Local Renewables Initiative and Network

With the Local Renewables (LR) Initiative, ICLEI – Local Governments for Sustainability supports and strengthens local governments in their generation and supply of renewable energy (RE) and implementation of energy efficiency (EE) in the urban activities/services. The focus is on the roles and responsibilities of local governments as a driving force for innovation and investment in their communities. The LR initiative consists of a worldwide network of cities.

The aims of the initiative are to:

- increase the sharing of knowledge of locally sustainable energy
- initiate and empower model communities worldwide
- transfer knowledge from cities with recognized expertise
- facilitate networking among local governments internationally

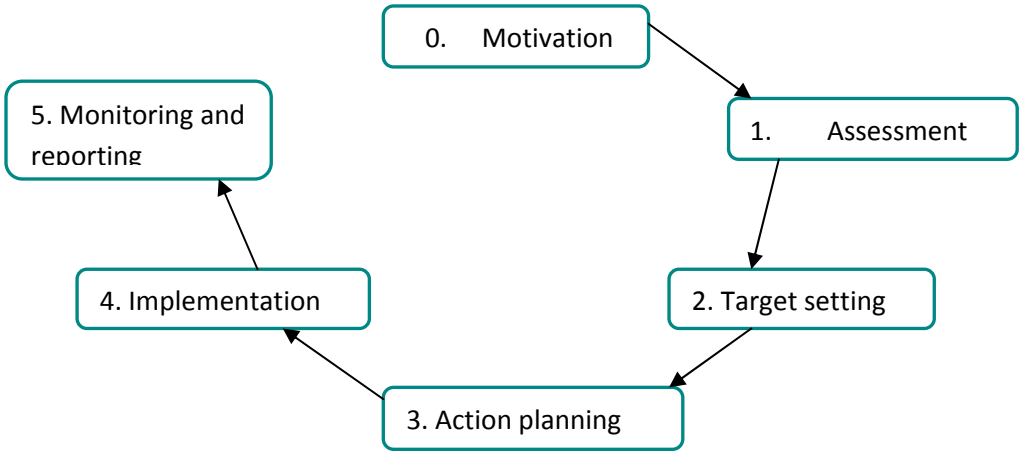
The term 'Local Renewables' attempts to bring into focus the symbiotic relationship between energy efficiency and renewable energy with an emphasis on local level action.

The LR initiative has received support from cities and organizations around the world to enable the issue of renewable energy and energy efficiency at the local level to be advanced and to allow cities to learn from one another.

About the project 'Local Renewables: South-south cooperation between cities in India, Indonesia and South Africa'

The current project 'Local Renewables: South-south cooperation between cities in India, Indonesia and South Africa' is funded by the Renewable Energy and Energy Efficiency Partnership (REEEP). The project aims to develop two model LR communities, one in Ekurhuleni Metropolitan Municipality in South Africa, and the other in Yogyakarta City in Indonesia while providing both with guidance from Coimbatore City in India, an advanced LR city through its participation in an LR project from 2008 to 2010, and to facilitate the adoption of similar initiatives in other South African and Indonesian local governments.

The project, which ran from October 2011 to June 2013, enabled the cities of Ekurhuleni and Yogyakarta to undergo and implement the LR milestone process (depicted below).



About the Solar City Guidebook for South Africa

A landmark achievement of the LR initiative was the input and influence towards the development of the national level Solar Cities programme in India. This large scale national level programme in India, helmed by the Indian Ministry of New and Renewable Energy, aims to help develop a targeted 60 'solar cities' in the country. The Solar Cities programme has many components in line with the Local Renewables programme. Thus, a project that began with 3 cities in India spread its influence to a total of 60 to date.

Through this present project, ICLEI aims to create such an impetus in the two countries of Indonesia and South Africa through the preparation of a Solar City Guidebook. Based on a similar guide developed by ICLEI South Asia for the Indian Solar Cities programme, these country-specific solar city guidebooks aim to make the case for increasing the number of cities adopting local renewables in South Africa and Indonesia. In India, the local level programme encouraged the national government to undertake a countrywide rollout. It is hoped that the South African guidebook may serve as the first impetus for a similar up-scaling in South Africa.

Executive Summary

The South African Solar City Guidebook is intended to serve as an informing document for readers to learn about the various aspects involved in a Solar City, including relevant international developments, technical terms and processes. It is intended to serve as a useful resource for South African local governments when embarking upon a programme to increase the uptake of renewable energy and energy efficiency at the local level.

Beginning with an overview of the global energy scenario, the introductory section provides the basic context to the guidebook and illustrates the renewable energy scenarios and energy efficiency initiatives from a global, African and South African perspective. Chapter two outlines the obligations pertinent in South Africa for local climate action, from national goals to provincial commitments and targets.

Chapter three unfolds and describes the evolution of the solar city concept, international solar city initiatives and ICLEI's Local Renewable initiative and network. A section herein, focus on the solar city programme in India, Indonesia and South Africa related to its objectives, targets and guidelines, making the case for the motivations of developing a solar city programme in South Africa. The fourth chapter outlines the key steps of such a programme at the city level. This section provides solar cities case studies and best practices from around the world, examples of similar programmes, and typical activities conducted through them.

The fifth chapter provides an overview of the various technology, systems and device options which would aid the uptake of renewable energy and energy efficiency at the local level. The final chapter concludes by providing information on the local level implementation strategy that would be required to put in place for a solar city programme and possible international financing options and mechanisms that could be used to implement physical projects on the ground.

This guide aims to serve as an introduction to the specific energy reduction strategies in local government climate change, energy and sustainability strategies for:

- City governments and decision makers
- Professional and institutional groups involved in renewable energy and energy efficiency
- Private organizations and companies interested in investing in renewable energy and energy efficiency projects at the local level

Chapter 1: Introduction

The global climate is controlled by complex interactions between marine and terrestrial systems. These interactions generate a variety of climatic variables across different regions and exert significant influence on day-to-day variations at the global, regional and local levels. Climate change is defined by the International Panel for Climate Change (IPCC) as a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (IPCC, 2007). Climate change may be a result of natural internal processes, external forces or from anthropogenic changes such as increased carbon dioxide (CO_2) emissions. However the United Nations Framework Convention on Climate Change (UNFCCC) makes a clear division between anthropogenic causes that alter the composition of the atmosphere and the natural causes attributing to climate variability. Climate change, as defined by the UNFCCC, is any 'change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and is in addition to natural climate variability over comparable time periods' (IPCC, 2001) and the IPCC (2007) concur that anthropogenic forcing is a major driver.

Repercussions of climate change are expected to be global and across physical, social, ecological and economic dimensions. While several direct and indirect effects of changing climate are anticipated globally, their intensities are expected to be greater in the developing world mainly because of the low level of resilience and preparedness in these parts of the world, especially Africa. While the basic science of climate change is well-founded and scientifically substantiated, the science related to predicting the eventual impacts remains uncertain because of the complexity of earth's natural systems. Strong evidence exists to prove that anthropogenic causes have resulted in increased level of greenhouse gasses in turn resulting in global temperature rise, consequences of which will be highly pervasive (IPCC 2007).

As an issue that is interrelated with several other global challenges like urbanization, rising population and global economic and energy crisis; climate change will have significant influence on political and social developments challenges in different parts of the world. Climate change effects go beyond temperature rise to include changes in global precipitation and mean sea levels, the spread of infectious diseases such as malaria, increased alien vegetation invasions and loss of biodiversity and thereby impacting social and economic activities across the world.

Climate change impacts are region specific, but it is widely acknowledged that Africa as a continent will experience among the greatest impacts, largely because of the vulnerability of its population, which consists of some of the poorest nations in the world. Likewise in cities, the poor communities, with fewer adaptive options, are expected to be most affected (ASSAF, 2011).

Growing energy use has a direct impact on global and local environments. Vehicular and industrial emissions are the main sources responsible for deterioration of air quality in cities. Apart from environmental impacts of increased energy use, energy security concerns are becoming central issues in several developed and developing countries. Rapid depletion of fossil fuels has forced the world to seriously begin to consider exploring possibilities and alternatives for harnessing the renewable energy resources and implementing energy efficient techniques.

Government policies and regulations play a key role in transforming energy markets towards greater adoption of renewable energy and energy efficiency. A vast array of proven renewable technologies is readily available at a marketable and affordable price. Despite the relative abundance of natural resources such as sunshine, wind, water and underground thermal heat, these non-diminishing resources are yet to be fully explored.

International perspective of climate change and energy

As urban population, economic activity and wealth increase, urban energy use is projected to grow rapidly. Currently the world is host to approximately seven billion (2013) people (U.S. Census Bureau, 2013), more than half of who live in urban centres. It is projected that by 2030, cities will house 60% of the world's population – equivalent to the total global population in 1987 (Nigel Jollands, IEA). At the same time, the geographic distribution of urban population is changing, while global urbanization in the first half of the 20th century was dominated by European cities, currently most urban population resides in the Asian continent, and some of the fastest-growing cities are found in the African continent. As cities grow, so too does their demand for energy and resources.

Annual total greenhouse gas (GHG) emissions arising from the global energy sector continue to increase. Combustion of fossil fuels continues to dominate a global energy market that is striving to meet the ever-increasing demand for heat, electricity and transport fuels. GHG emissions from fossil fuels have increased each year since the IPCC 2001 Third Assessment Report (TAR) (IPCC, 2001), despite greater deployment of low- and zero-carbon technologies, (particularly those utilizing renewable energy); the implementation of various policy support mechanisms by many states and countries; the advent of carbon trading in some regions, and a substantial increase in world energy commodity prices. Without the near-term introduction of supportive and effective policy actions by governments, energy-related GHG emissions, mainly from fossil fuel combustion, are projected to rise by over 50% from 26.1 $GtCO_2eq$ (7.1 GtC) in 2004 to 37–40 $GtCO_2$ (10.1–10.9 GtC) by 2030. Mitigation has therefore become even more challenging (IPCC, 2007) for emerging economies.

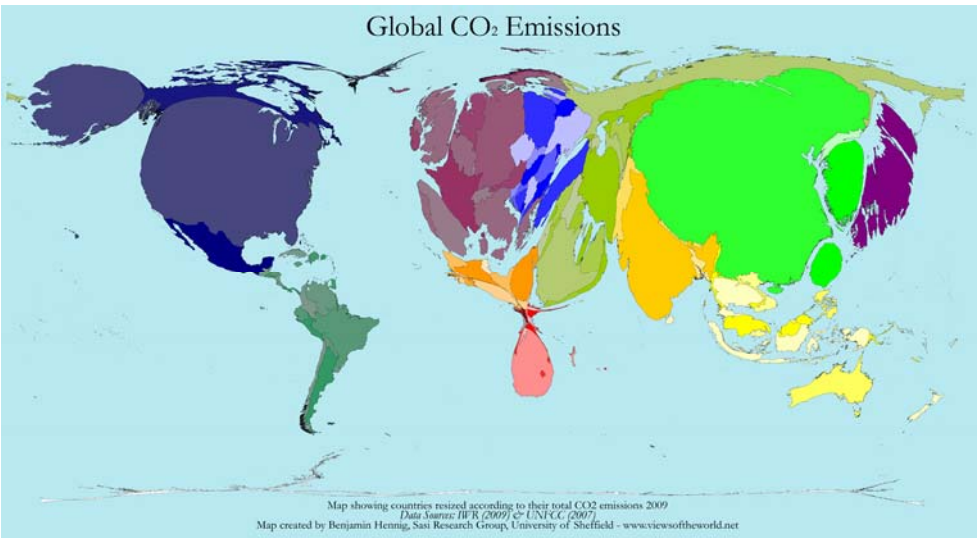


Figure 1: World map in proportion to the global distribution of GHG emissions and responsible geographical areas.

Climate change threatens to undermine many of the development objectives of the countries in Africa and the rest of the developing world, in particularly in the areas of water, energy, health and agriculture. In order to allow low carbon, resource efficient and sustainable economic development in the developing world, a climate change agreement requires nations from both the developing and developed countries to take ownership and comply with international obligations. Globally the IPCC states that emission reductions by 2100 between 60% to 80% from 1990 levels must be achieved. The burden sharing between nations of this target is the subject of international negotiations.

A significant proportion of world's energy is consumed by the ever growing engines of social, economic and technological advancement called cities. As vital centres of global development and innovation, cities themselves hold the key to resolution of some of their own problems. Fuelled by fossils, urban development has attracted unbridled population growth and resource use, resulting in ever increasing resource constraints for further development and the cumulative population suffers tremendously.

African perspective of energy and climate change

Africa is the world's second-largest and second most populous continent after Asia, covering approximately 20% of the total land area. With just over 1 billion (2011) (WorldStat, 2011) people on the continent, it accounts for about 15% of the world's human population (UN Habitat, 2010).

The economic output of Africa is only 3% of the world's status with a Gross Domestic Product (GDP) totalled at US Dollars 2212 billion with the southern African region accounting for the largest proportion of 37% (WEC, 2006). African countries are some of the fastest growing economies in the world with a country consisting of rich resources; however the majority of the people live in poverty with limited access to basic needs and services.

With well-endowed natural energy resources on the African continent, the resources are unevenly distributed and are only concentrated in a few countries. Africa's per capita energy consumption is the lowest of the world's region, representing 3% of the world's average, however Africa's energy intensity (energy consumption per unit of GDP) is approximately 200% of the world's average, which showcases low level of energy consumption, with low energy efficiency (WEC, 2006).

In reference to the growing economies of African countries, the continent is projected to have a cumulative influence on the global CO_2 balance. Currently the African region (Figure 2) constitutes the lowest percentage (4%) of carbon dioxide compared to other regions in the world (Asia and Oceania (43%); North America (21%); Europe (14%); Eurasia (8%); Middle East (5%); Central and South America (4%) (IES, 2010), however with the African economic growth rate increasing approximately 5.5% per annum (IMF, 2010), these figures are likely to rise.

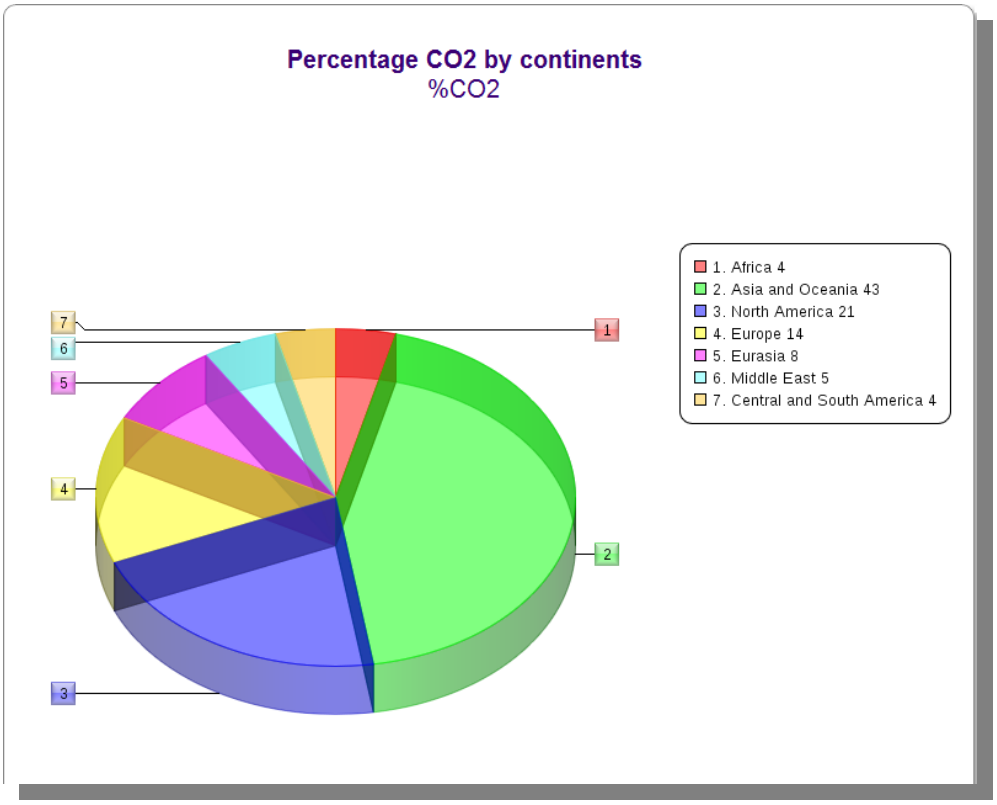


Figure 2: Global distribution of carbon dioxide emitted into the atmosphere.

As mentioned above, the total energy demand in Africa is very high, however compared to the rest of the world; consumption of modern energy, on average, in Africa is very low. The energy demand for the region is approximately 267 Mtoe comprised of 54% traditional energy (80% if South Africa is excluded), 27% oil, 14% solid fuel, 3% hydropower and 2% gas.

In Africa, electricity is inaccessible, unaffordable, and unreliable for most people, which immerse people within the cycle of poverty. In most cases the low average consumption of modern energy is directly related to inaccessibility and affordability of energy (electricity or renewable energy) to the poor. Some of the challenges and obstacles that Africa faces within the energy sector are (Fall, 2007):

- High growing population with majority suffering from poverty
- Lack of access to electricity due to distance from urban service providers
- Lack of modern energy infrastructure in rural settings
- Limited political will and high political risks linked to high cost energy projects
- Unfavourable investment climate and non-transparent business practices
- Limited knowledge of opportunities for financing and investment of energy projects

Lack of electricity access resulting mainly from the lack of energy infrastructure and poor financing of local energy projects are some of the main challenges that cities in developing countries face.

Clouded by socio-economic issues like cross-border resource conflicts and political problems like unstable governments and civil unrest. Cities in the emerging countries priorities on other significant issues and therefore have limited capacity and capital to address challenges of alternative energy resources.

Africa's current cumulative renewable energy boasts 1.1 Gigawatts of hydropower capacity, 9000 Megawatt of geothermal potential and abundant biomass, solar and significant wind potential, however the renewable energy resource potential in Africa has not been fully explored, mainly due to the limited policy initiative and investment levels. The African continent is well endowed with energy resources but most remain untapped. Solutions to this problem include: boosting cross-border power trade, improving existing utility companies, improving access to electricity on a large scale, while helping countries chart low-carbon growth paths (World Bank, 2012).

South African perspective on energy and climate change

South Africa occupies the southernmost part of the African continent with a surface area of 1,219,090 km^2. The coastline stretches for about 3,000 km from Namibia in the west to Mozambique in the east. The South African population was estimated at 50.5 million (2011) with a 2.1% annual growth rate that the government aims to stabilise to 80 million or 1.9% growth rate by 2100 (Statistics SA 2011; DEAT 2003). South Africa's population comprises of a diverse range of cultures and eleven official languages are spoken. In 2011, approximately 60.7% (Trading Economics, 2012) of the population resided in urban areas (Figure 3).

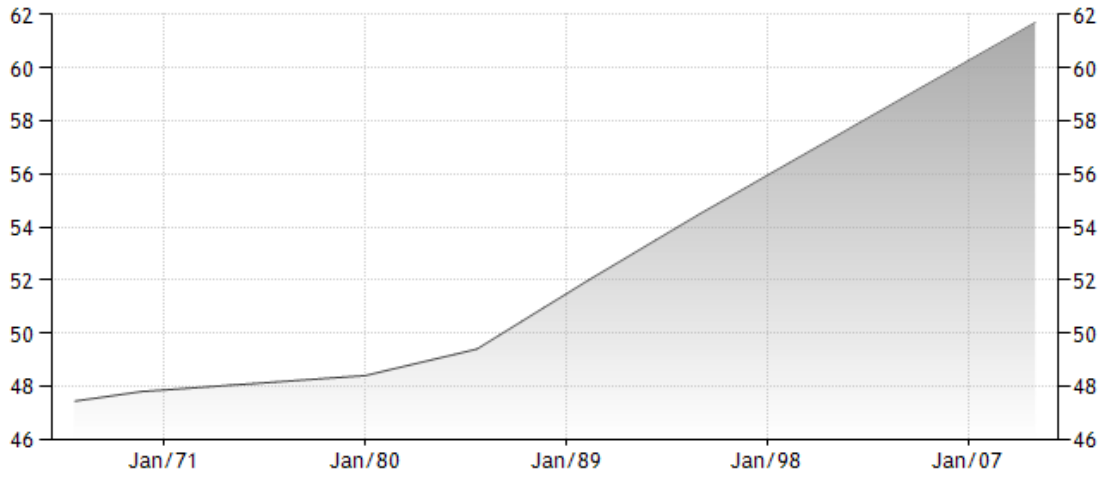


Figure 3: Urban population (% of total) in South Africa. Source: Trading Economics
http://www.tradingeconomics.com/south-africa/urban-population-percent-of-total-wb-data.html

South African Commitment

Post 1994, in response to the 1st Intergovernmental Panel on Climate Change (IPCC) Assessment Report (1991) and the growing international concerns about climate change, the South African Department of Environmental Affairs (DEA) established the National Climate Change Committee (NCCC), with the main purpose to advice and consult on matters relating to national responsibilities with respect to climate change, particularly in relation to the United Nations Framework Convention on Climate Change (UNFCCC).

Subsequent to the 2nd IPCC Assessment Report (1995) there was controversy pertaining to the actions outlined by the UNFCCC, this then motivated for the development of the Kyoto Protocol which was finalised in 1997. The main aim of the Kyoto Protocol was to contain emissions of the main anthropogenic (human-emitted) GHGs in ways that reflect underlying national differences in GHG emissions, wealth, and capacity to achieve the reductions. In August 1997, South Africa supported and ratified UNFCCC and its Kyoto Protocol.

The ruling African National Congress (ANC) committed to setting a target for GHG reduction during the 52nd National Conference, held in Polokwane in 2007. In 2008 government published the Long Term Mitigation Scenarios (LTMS) report, which employs several scenario models to explore the consequences of various policy interventions aimed at reducing GHG emissions. Since South Africa is a large emitter in comparison to the rest of Africa, the South African National Government recognised the need to plan for a low carbon future and commit to post-Kyoto negotiations that took place in Copenhagen in 2009 during the UNFCC fifteenth Conference of the Parties (COP15).

South Africa released the national Climate Change Response White Paper in October 2011, whereby the government committed to fixed targets and GHG emissions reductions to keep well below a maximum of 2˚C above pre-industrial levels (DEA 2011, 25).

Unfortunately, there was no formal agreement established during the deliberations at UNFCCC COP17, 2011 negotiations and deliberations in Durban, South Africa, however there strides were taken towards the development of an action plan, a plan to reduce all GHG emissions by all major countries in the world. COP17 was a success in that it demonstrated that the nations are able to work together to move forward on addressing climate change challenges, which is hoped to encourage and stimulate more action and optimism at the country and community scales.

South Africa's Carbon Story

South Africa's greenhouse gas emissions are high, ranking the country within the top 15 greenhouse gas emitting countries globally (Boden, T.A., G. Marland, and R.J. Andres. 2010). This means that the country emits well above the developing country average – and more than many developed countries. This is mainly (79%) as a result of reliance on coal for electricity (DEAT, 2010). Figure 3 geographically illustrates the main CO_2 emitters on the African continent.

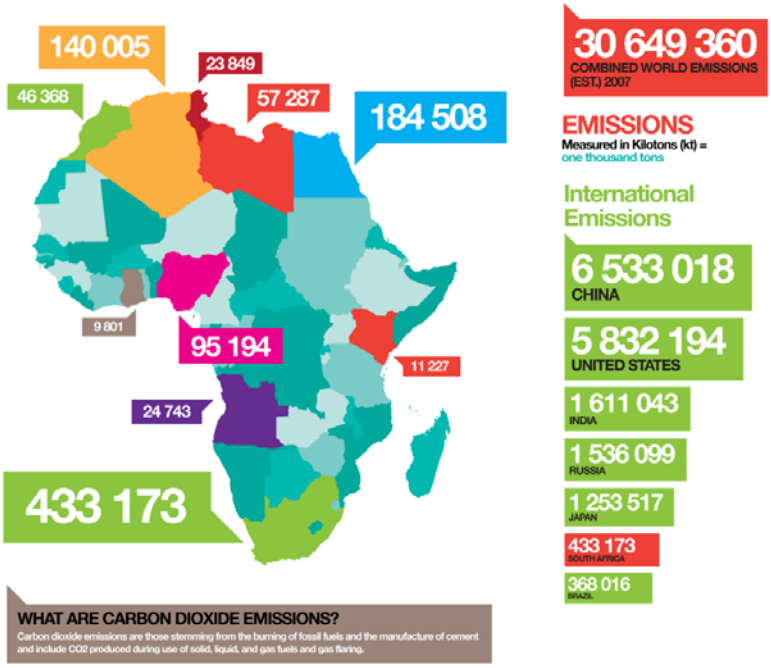


Figure 4: South Africa is first on the country list for Africa's emitters.
Source: World Bank Data, 2007, data.worldbank.com.

South Africa's GHG emissions in the atmosphere consist of 80% carbon dioxide (CO_2), 15% methane (CH_4) and 5% nitrogen dioxide (NO_2). These GHGs are mainly sourced from energy related emissions (80%); industrial processes and product use (15%); agriculture, forestry and land use (6%) and emissions from waste and other sources (2%) (ASSAF, 2011). The electricity supply statistics for South Africa's sectors for 2006 are illustrated in the graph of Figure 5.

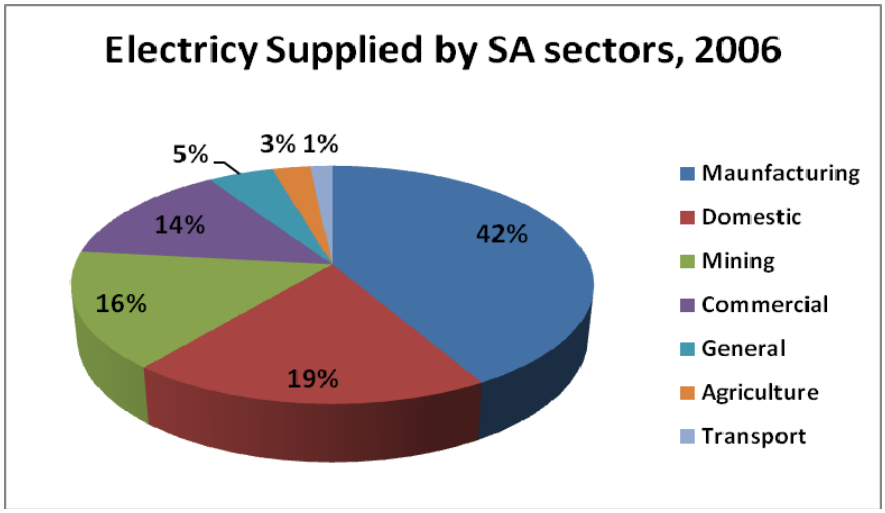


Figure 5: Electricity consumed by sector, 2006. Source NERSA Supply Sector, 2006

The 2011 Carbon Disclosure Report (CDP) demonstrates the top emitters in the country (Figure 6), with Eskom reaching high amounts with over 250 million CO_2e emissions of tons generated per

annum. South Africa's emissions are projected to soar as the South African National Government commitments to produce more coal fired power stations to generate electricity, unless electricity demands are curbed significantly maintaining and reducing demand.

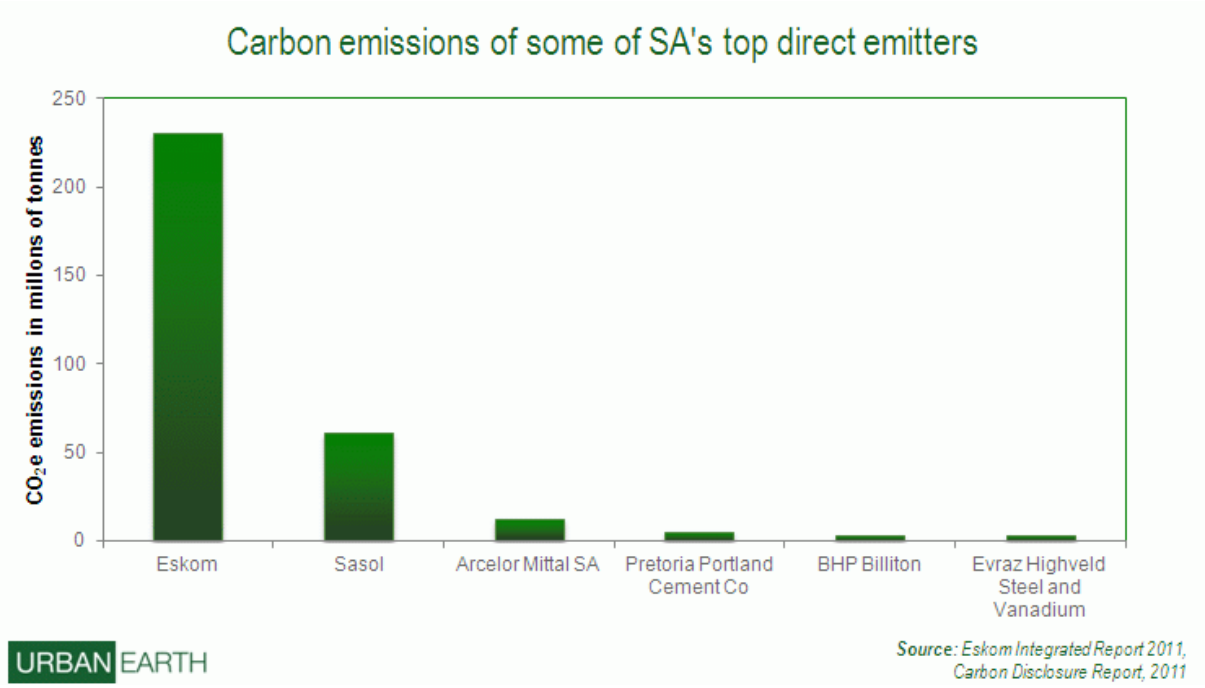


Figure 6: South Africa's top carbon emitters according to the latest study, Carbon Disclosure Report 2011

Statistics show that South Africa has one of the world's largest shares of electricity production from coal: in 2009, 92% of electricity was generated from coal, nuclear accounted for 6% and hydroelectricity for around 2% - therefore the CO_2-free electricity generation accounted for only 8% of the total power generation (ABB, 2011).

If one looks at the South Africa's average energy consumption it is much higher than that of the world's average: 2.7 toe versus 1.8 toe. This is in line with South Africa's electricity consumption per capita (4,150 kWh), which is about 60% higher than the worlds average (2,550 kWh) of 2009 (South ABB, 2011). According to the SA's national country report (2011) and the underlying national GHG targets, the country level aim is to reduce energy intensity by 12% by 2015 and 15% reduction in energy demand for industries by 2015.

In response to the imperatives of climate change and sustainability, and the historically coal- and oil-based energy profile of South Africa, there is widespread recognition globally that renewable energy has to play a larger part of the future energy supply mix. The scale of renewable energy and energy efficiency has been implemented at the local level but the generation remains small in comparison to the greater energy demands of the country. The National Renewable Energy White Paper (2003), calls for 10 000 GWh of renewable energy contribution by 2013. The 2011 Renewable Energy Bid tender issued by the Department of Energy for 3725 MW of renewable electricity represents the largest order of renewables in the world.

Concerted effort from national government, particularly around the shift towards renewable energy sources and public transport modes is required and many cities are now paving the way and have started developing Energy and Climate Change Strategies to guide the implementation of renewable energy and energy efficiency at the local level. At a national scale, major renewable electricity generation tenders are expected to deliver close to 4000MW of wind, solar and other renewable electricity by 2016. This is significant and represents a step-change in the energy profile of the country.

While renewable and efficient energy interventions are starting to find traction in local governments, they are not yet mainstreamed, however there are now local policies, strategies and planning processes been made in the direction of reducing energy and carbon emissions at the city level.

However, as a result of South Africa's strong reliance on fossil fuels for electricity generation it mirrors a similar profile for South African cities, implying that city mitigation efforts will have to consider, at least, the various mitigation interventions stated within the LTMS report.

Figure 7 provides an overview of the urban areas that contribute to the atmospheric GHG emissions. Urban areas like Saldanha Bay, UMhlathuze (Richards Bay) and Sedibeng are amongst the three top CO_2 emitters per capita in South Africa (SEA, 2006).

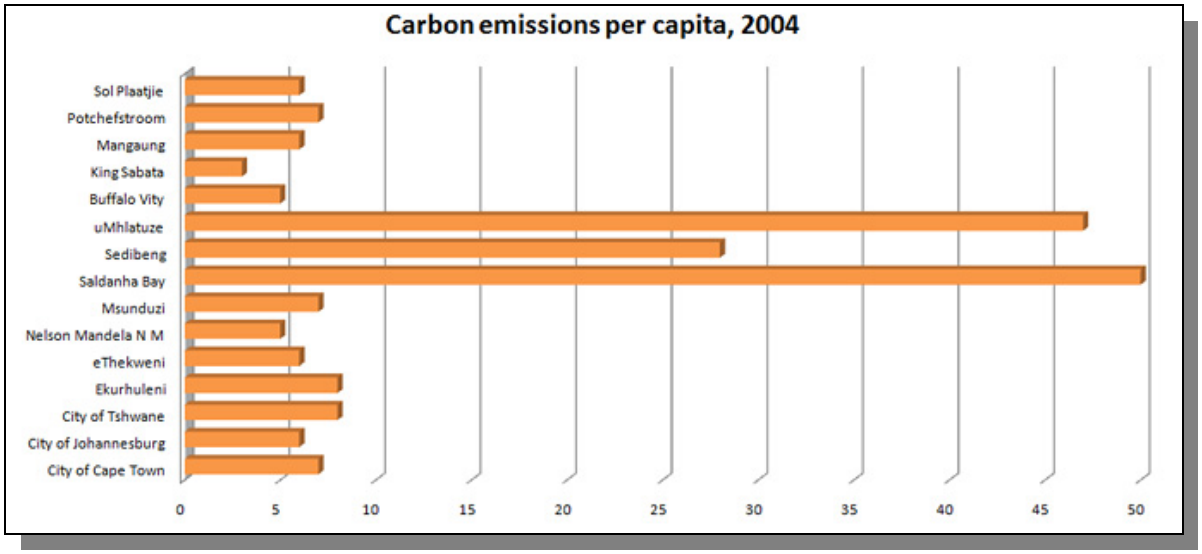


Figure 7: City comparative study and the 2004 carbon emissions per capita. Source: State of Energy in South African Cities, 2006, Sustainable Energy Africa.

Ekurhuleni Metropolitan Municipality (EMM) is amongst the top five urban emitters in South Africa. Regarded as the transportation hub of the country, EMM has a complex network of roads, airports, rail lines, telephones, electricity grids and telecommunications networks. The municipality is home to the OR Tambo International Airport, the busiest airport in Africa with some 14 million passengers passing through this airport each year.

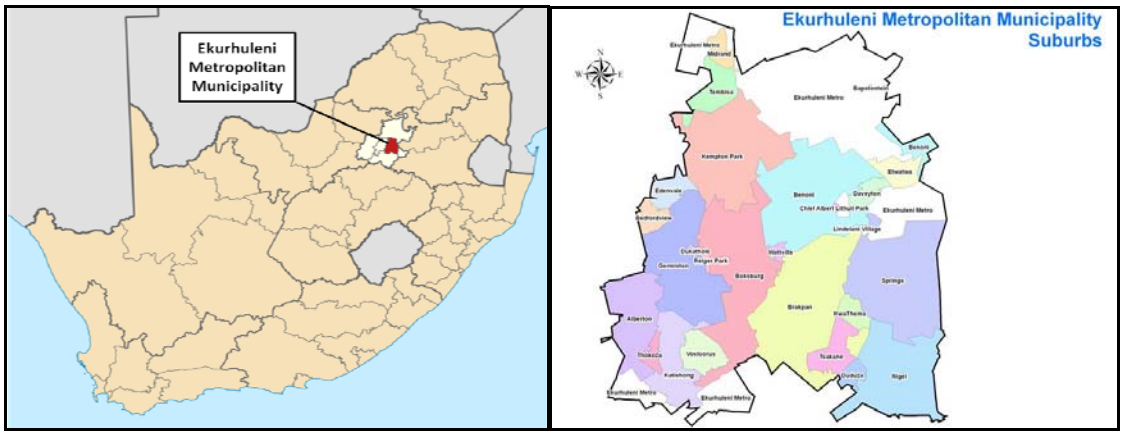


Figure 8a and 8b geographically illustrates Ekurhuleni location within Gauteng Province, South Africa and the local subdivisions of 101 wards at the local government level.

EMM was established as one of eight metropolitan municipalities subsequent to the restructuring of local government frameworks in South Africa in 2000. EMM is rated as the fourth largest municipality in South Africa consisting of nine separate municipalities and 101 wards. EMM, also known as East Rand, the eastern region of Gauteng Province in South Africa, consists of about 192 355 hectares of land which is occupied by about 2.8 million people, occupying approximately 900 000 households (EMM, 2011).

Eskom supplies the city with electricity, from which EMM provides electricity to over 400 000 customers, totaling average sales of R10 billion per annum. To understand the energy emissions for EMM as a whole, EMM undertook an energy audit and released the results within the Ekurhuleni State of Energy Report in 2004. From this report the Ekurhuleni Energy and Climate Change Strategy (2007) was developed which aims to integrate and entrench sustainable energy approaches and practices at the local level.

Ekurhuleni's sectoral GHG contribution is illustrated within the three pie charts below for 2004, 2007 and 2011 respectively (Figure 8). These GHG inventories are from three different studies providing evolving GHG scenarios. Between the first two studies it is seen that carbon emissions have decreased considerably in the transport sector by almost half, with the industry sector is seen as increasing carbon emissions from 36% (2004) to 42% (2007). The 2011 study provides a multi-dimensional picture and illustrates a change in the cities carbon emissions pattern. Here residential/housing is the largest emitter with the commercial sector contributing to a larger proportion in comparison to the previous studies.

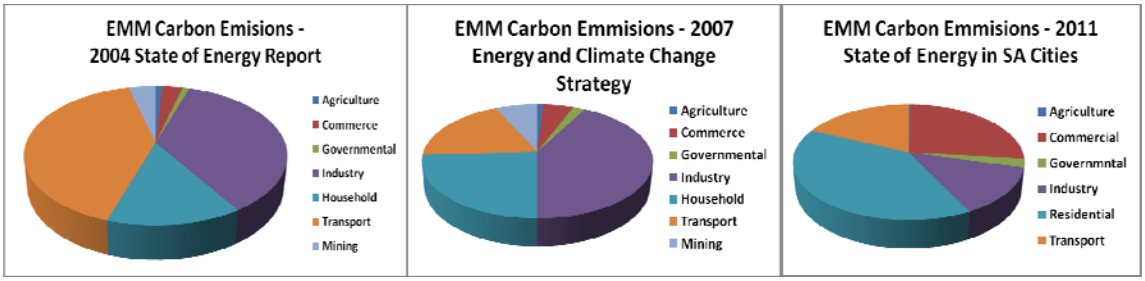


Figure 9: Three GHG Inventory study results that were undertaken for Ekurhuleni, 2004, 2007 and 2011.

Chapter 2: National and Sub-national Obligations

Government plays a major role in climate change mitigation in cities. The policies and strategies emerging from the South Africa national government recognise that cities are major GHG emitters and are vulnerable to the impacts of climate change. For South Africa to achieve reduction targets of around 34% by 2020 and 42% by 2025 (CDP, 2010), there is a need for cities to play a pivotal role in the attainment of these goals as they the hubs of carbon intensive activities and focusing on cities provides the highest emissions reduction impacts. By focusing on providing their own electricity supply, aligning their climate change mitigation targets with the Long Term Mitigation Scenario and ensure that climate mitigation and adaptation are integrated within the local government Integrated Development Plans (IDPs), cities will be well aligned with the national policy. Local governments are encouraged to take advantage of the energy related opportunities and should need to capitalise on the priorities of national government, the green economy, to promote economic growth within the cities, while taking full advantage of climate change co-benefits that exist (Gunn, 2007).

The following section identifies legislation at the National and Provincial levels, from which cities should align local efforts with higher level obligations, while the Southern African nation as a whole can collaborate on joint efforts to build and work towards a healthier and sustainable future.

National Legislation

1998: **National Environmental Management Act (NEMA) – Act No. 107:** This provides for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by organs of state; and to provide for matters connected therewith.

1998: **White Paper on Energy Policy of the Republic of South Africa** - The White Paper is intended for a wide group of stakeholders such as parliamentarians, public and private stakeholders, energy suppliers and consumers, researcher's institutions, environmentalists and policy makers. The White Paper provides specific policy statements for the promotion and achievement renewable energy and improvement of energy efficiency in South Africa.

2003: **White Paper on Renewable Energy** - This White Paper on Renewable Energy supplements the White Paper on Energy Policy, which recognises that the medium and long-term potential of renewable energy is significant. The document provides the Government's vision, policy principles, strategic goals and objectives for promoting and implementing renewable energy in South Africa. It informs the public and the international community of the Government's vision, and how the Government intends to achieve these objectives. Government committed to greater levels of competition in electricity markets and set a target for the generation of 10 000 GWh renewable energy for 2013.

2004: **A National Climate Change Response Strategy for South Africa** – This strategy sets certain strategic objectives, principles and proposals for addressing national priorities related to global climate change.

2005: **Energy Efficiency Strategy of the Republic of South Africa** – This strategy sets a national target (not mandatory, only policy objective) for energy efficiency improvement of 12% by 2015 and provides for a number of "enabling instruments" to achieve these targets.

2007: **The Long Term Mitigation Scenarios: Strategic Options for South Africa (LTMS)** - The LTMS sets the pathway for South Africa long-term climate policy development and informs legislative, regulatory and fiscal packages that will give effect to the policy package at a mandatory level. The overall goal is to develop a plan of action which is economically risk-averse and internationally aligned to the world effort on climate change.

2008: **National Energy Act, Act 34** – This Act ensures that diverse resources are available in sustainable quantities and at affordable prices to the South Africa. These efforts would support the economy and economic growth. The document promotes energy planning, increased generation and consumption of renewable energies, contingency energy supply, appropriate upkeep and access to energy infrastructure. The document encourages to transparency towards data and information sharing and exchange and states that energy research is required to enhance capacity amongst various stakeholders at diverse levels. The Act stipulates that the Integrated Energy Plan must take account of plans relating to transport, electricity, petroleum, water, trade, macro-economy energy infrastructure development, housing, air quality management, greenhouse gas mitigation within the energy sector and integrated development plans of local and provincial authorities.

2010: **Energy Efficiency and Demand Side Management (EEDSM) Policy -** This policy intends to stimulate energy efficiency through enabling regulations and institutional governance structures, and introducing targeted financial incentives. The objectives of this policy is to provide a framework for EEDSM interventions such as energy efficiency standards, tariff-based incentives and setting targets relating to EEDSM within the domestic, commercial and industrial sectors.

2011: **National Climate Change Response White Paper** – The White Paper sets out South Africa's principles and approach to achieve the strategic priorities: risk reduction and management; mitigation actions with significant outcomes; sectoral responses; policy and regulatory alignment; informed decision making and planning; integrated planning; technology research, development and innovation; facilitated behaviour change; behaviour change through choice; and resource mobilisation. In Section 6 of the policy, South Africa affirms its responsibilities to balance the contribution to the international effort to curb global emissions

Provincial

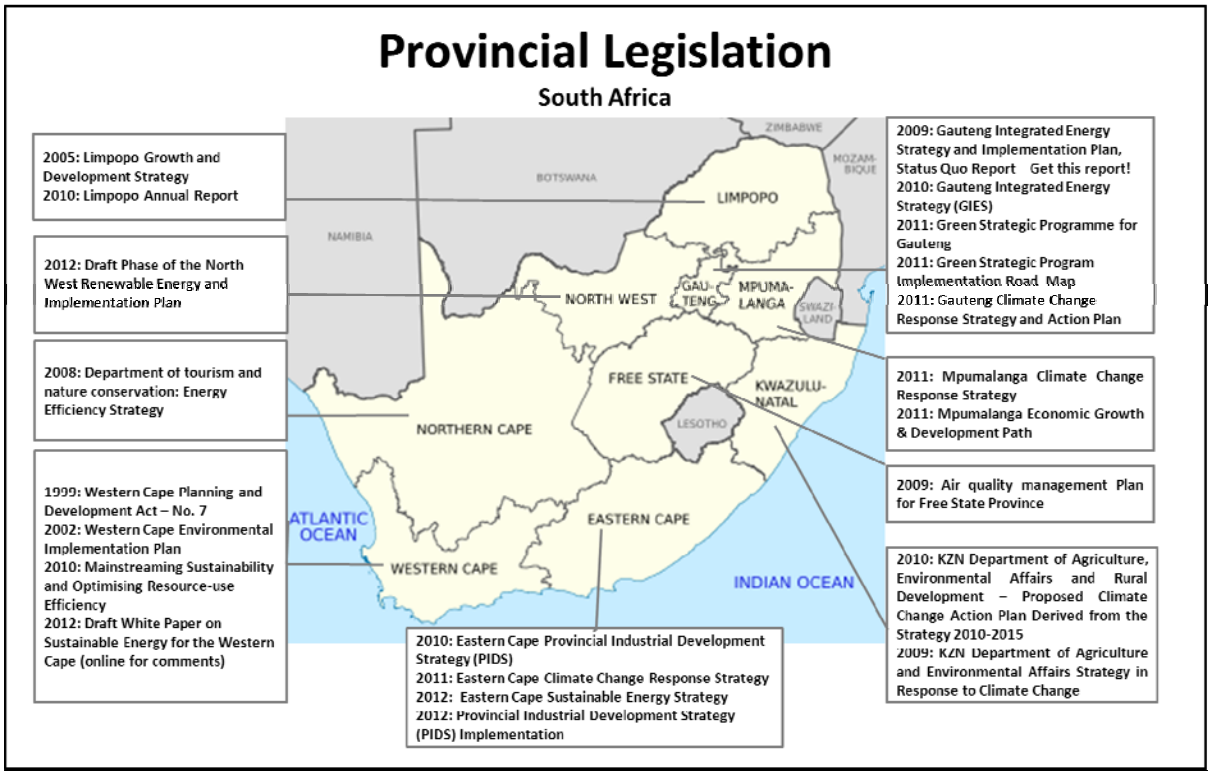


Figure 10: This map represents the policies and legislation at the Provincial level in South Africa; all policies are pertaining to energy and climate change and sustainable development.

Western Cape (Department of Environmental Affairs and Development Planning)

1999: **Western Cape Planning and Development Act – No. 7** – An Act that intends to co-ordinate and harmonise environmental policies, plans, programmes and decisions made by government bodies that are responsible for the promotion and protection of a sustainable environment.

2002: **Western Cape Environmental Implementation Plan** – A strategy or sectoral plan that deals with environmental concerns in a particular area and includes an environmental strategy or environmental management plan as contemplated in other provincial and national legislation.

2010: **Mainstreaming Sustainability and Optimising Resource-use Efficiency -** The objective is to ensure that the Provincial Government of the Western Cape (PGWC) integrates sustainability and resource-use efficiency within all activities and spheres for influence of all Departments. Six key policy priorities inform the actions to be taken by the Western Cape Government to ensure the efficient use of provincial resources and the sustainability of the province, these are: Climate Change Mitigation, Water Management, Pollution and Waste Management, Biodiversity Management, Land-Use Management and Agriculture and Built Environment.

2012: **Draft White Paper on Sustainable Energy for the Western Cape** (online for comments) –This White Paper sets out the vision, policy, principles, goals and objectives to develop a sustainable

energy system which is built around the sustainable development goals aimed at social, environmental and economic development. The PGWC intends to increase its efforts to maximize energy efficiency in the four sector scenarios, namely residential, commercial and public buildings, transport and industry.

Eastern Cape (EC Economic Development and Environment Affairs)

2010: **Eastern Cape Provincial Industrial Development Strategy (PIDS)** – Within this strategy one of the key priorities is the establishment of the green economy through the promotion and implementation of renewable energy, low carbon transport initiatives, carbon extraction, environmental management, carbon trading and setting of thresholds through policy and legislation.

2011: **Eastern Cape Climate Change Response Strategy –** This strategy aims at developing and enabling an environment for renewable energy and promoting rural livelihoods around rural renewable energy hubs.

2012: **Eastern Cape Sustainable Energy Strategy** – This Strategy aims to facilitate the support and development of local energy supply capacity for the Eastern Cape Province, which will result in local economic development and job creation, while, at the same time lowering the contribution in emissions of greenhouse gasses by the Province. The proposed Strategy encourages industrial development by strengthening local production of renewable and other energy related components.

2012: **Provincial Industrial Development Strategy (PIDS) Implementation Plan** – Within this Plan, the Eastern Cape Provincial Government have outlined the key priority areas within the industrial sector: Establishment of a governance and leadership framework for energy services; Establishment and communication of an energy vision for the Eastern Cape; Identification and marketing of carbon project opportunities; Establishment of a green industry business unit and publicising of results on an annual basis; Publication of the Eastern Cape energy demands and projections over short, medium and long term periods. Each of these priority areas are strategically designed with an action goal, objectives, criteria, role players, funding model and timeframes for effective implementation.

Northern Cape (Department of Environmental Affairs and Nature Conservation)

2008: **Department of tourism and nature conservation: Energy Efficiency Strategy** – The Strategy sets a departmental target for energy savings, of at least 10%, to be achieved annually. The department strategy aims to increase awareness of the importance of energy efficiency; outline roles responsibilities for different sectors; establish an Energy Compliance Committee and lastly to set and monitor departmental targets for energy efficiency improvements which will be compared to the National 2014 targets of 12%.

North West (The Department of Economic Development, Environment, Conservation and Tourism)

2012: **Draft Phase of the North West Renewable Energy and Implementation Plan** – This document is still at the beginning phases of development. The plan aims to undertake an analysis of the provinces current energy situation and aims to look into different option to generate alternative

energy within the province. The plan will provide options and different projects at the local level that are feasible for implementation in order to take the process forward.

Free State (Economic Development Tourism and Environmental Affairs)

2009: **Air quality management Plan for Free State Province** – This plan seeks to identify the current air pollution situation, identify the problem areas and establish the necessary tools and actions needed to meet objectives and goals. The plan also provides a management framework to maintain and improve air quality in the province through setting goals and objectives driven by national, provincial and local policies and priorities.

KwaZulu-Natal (Agriculture and Environment: Sustainable resource Management)

2010: **KZN Department of Agriculture, Environmental Affairs and Rural Development – Proposed Climate Change Action Plan Derived from the Strategy 2010-2015 –** The goal of this action plan is to minimize or eliminate the risks to the impacts of climate change by embarking on a concerted and cohesive plan that will address the impacts of climate change through scientific and technological means based on mitigation; adaptation and increased awareness to vulnerable communities.

2009: **KZN Department of Agriculture and Environmental Affairs Strategy in Response to Climate Change** – The Action Plan builds upon the Status Quo Vulnerability Study for KwaZulu-Natal Province and sets out our direction now the long term actions. The Strategy commits to partnering with the relevant stakeholders, taking a holistic approach to minimising climate change adverse impacts and enhancing capacity within the public and private sectors within the province.

Mpumalanga (Economic Development, Environment and Tourism)

2011: **Mpumalanga Climate Change Response Strategy –** This strategy provides a framework for the coordination of provincial responses to establish, monitor, mitigate and adapt to the impacts of climate change in Mpumalanga.

2011: **Mpumalanga Economic Growth & Development Path –** The primary objective of the MEGDP is to foster economic growth that creates jobs, reduce poverty and inequality in the Province. The growth path is anchored on a number of parameters including sector development, Inclusive & shared growth, spatial distribution, regional integration, sustainable human development and environmental sustainability with clearly defined strategic targets over the medium to long term.

Gauteng

2009: **Gauteng Integrated Energy Strategy and Implementation Plan, Status Quo Report** – This report identified the sustainable energy and climate change initiatives being undertaken internationally, nationally and within the Gauteng and at the municipal level. The report illustrated that there is variation between individual municipalities within the province in terms of the strategies in place and their level of implementation.

2010: **Gauteng Integrated Energy Strategy (GIES)** – The GIES is an implementation plan which aims to direct the use and supply of energy is supplied within the Gauteng province during the next 4

years (2014); 15 years (2025); 45 years (2055) and beyond, in an integrated and comprehensive manner. The strategy aims to improve Gauteng's environment, reduce Gauteng's contribution to climate change, and tackle energy poverty, whilst at the same time promoting economic development in the province.

2011: **Green Strategic Programme for Gauteng** – This program prioritises the shift towards green growth and the creation of green jobs, as articulated in the Medium Term Strategic Framework and the Gauteng Employment Growth and Development Strategy, respectively. The program encourages each provincial department and municipality, and ideally also national government departments and agencies working in Gauteng to align to and work co-operatively towards the vision and programme commitments in this Green Strategy Programme.

2011: **Green Strategic Program Implementation Road Map** – This road map provides decisive steps for Gauteng Provincial Government to move towards the attainment of a green economy and low carbon economy for the future prosperity of the province. The road map consolidates all the actions that are required to be undertaken across the spectrum of stakeholders within the province.

2011: **Gauteng Climate Change Response Strategy and Action Plan** – Gauteng has adopted two main priorities for this strategy, 1) Proposal of mitigation interventions designed to ameliorate the concentration of GHG emissions into the atmosphere and 2) Implementation of mitigation measures coupled to adaptation actions that integrate climate change responses with socio-economic development. The Action Plan provides practical actions that address sustainable energy supply mix, urban development and infrastructure, transportation, industrial and agricultural activities that will continue to build on the economic gains and development trajectory in the Gauteng province.

Limpopo (Economic Development Environment and Tourism)

2010: **Limpopo Annual Report** – The vision of Limpopo is to enhance its contribution towards the innovations and solution for sustainable development. The aim of Department of Economic Development, Environment & Tourism of Limpopo is the creation of decent work and sustainable livelihoods through the following: 1) To enhance the ability of the Department to deliver public services by providing Leadership and administrative support in accordance with legislation and relevant policies and 2) Sustainable resource management and use.

2005: **Limpopo Growth and Development Strategy** – Government of Limpopo emphasizes the need to put in place a development framework that should guide growth and sustainable development during 10 years (2004-2014) focusing on improving the quality of life through a further elaboration of the adopted policy framework at international, national and provincial levels.

Other documents of interest to the city level:

2003: **Energising SA Cities and Towns Booklet** - This booklet was designed as a guide to sustainable energy planning for local governments, by SEA.

2009: **Sustainable Cities Report** – This programme highlighted the need for cities to develop strategies that consider the sustainable use of finite resources in the creation and delivery of infrastructure. The programme looked beyond the green issues and examined the impact on the quality of life and cost of living in urban centres. The priority themes for this report included renewable energy and waste-to-energy strategies, biodiversity, green building standards, sustainable public transport and climate change. Report published by SACN

2009: **How to implement Renewable Energy and Energy Efficiency Options, support for South African local governments** – This guide was developed by SEA, funded by REEEP which aims to be a practical guide for Local Government on how to implement energy efficiency and renewable energy options, by SEA.

2009: **Sustainable Urban Energy Handbook** – The mitigation tool, was developed in cooperation with UN-HABITAT and UNEP and gives a comprehensive overview of Sustainable Urban Energy planning and implementation in developing countries at the local government level, by ICLEI African Secretariat.

2009: **LED Street lighting** – This publication provides case studies of what international cities are doing in terms of LED street lighting and how SA cities can move forward in a similar way, by SEA.

2010: **Ceilings in low income households (eSEED)** – Why and how to undertake a ceilings retrofit programme in government-delivered municipal housing stock, by SEA.

2011: **State of Energy Report in South African Cities** – This report assesses progress made in all metros and secondary cities in South Africa in improving service delivery, advancing development and promoting good governance, by SEA.

2011: **State of Cities Report (SoCR)** – This report assesses the progress made by South African municipalities in achieving the key development objective of improving the socio-economic and environmental conditions of their citizens, both in absolute terms and relative to the rest of the country by SACN.

2011: **Towards a Low Carbon City, focus on Durban** – This report aims to address both mitigation and adaptation opportunities, with a focus on profiling city of Durban in relation to a low carbon economy, developing environmental citizenship, governance and the low carbon city. The report provides key strategic recommendations which Durban needs to address in order to transition to a low carbon city. While focusing on Durban, the recommendations are also applicable to cities in developing countries and can be used as a guideline for local governments in other cities, by ASSAF.

The Municipal Electricity Efficiency Response Tool – This tool is designed to assist municipalities develop a 3-year electricity efficiency response plan. The tool will enable municipalities to prioritise, plan and budget electricity interventions in a systematic and strategic programme, rather than on an ad hoc projects basis. The tool examines the potential efficiency impact of 100% penetration of a variety of tested electricity efficiency interventions within a municipality – based on the baseline municipal electricity consumption data, by SEA.

Greening Rental Unit Upgrades – Cities continually upgrade, renovate and repair their stock of rental units and this guide provides some information on how to 'green' this process, by SEA.

Chapter 3: Evolution of the Solar City Concept

With rapid urbanization and concentration of economic activities in urban areas, cities have emerged as large consumers of energy and resources. With the coming of age position taken towards better and greener cities led to the development of many concepts for sustainable city development, and one of which was the concept of a Solar Cities.

Initiatives began in the form of networks made up of cities, sometimes coordinated by national or regional governments that worked on creation of policy and enabling market mechanisms along with strong awareness generation for the local adoption of renewable energy. Some of the initial groups that joined this movement included the Brundtland City Energy Network formed in 1999, the European Green Cities Network in 1996, Energie Cites Association [Energie C].

The First International Solar Cities Initiative (ISCI) World Congress was held in Daegu, South Korea, November 14-18 2004. At this Congress, 19 cities from around the world presented their policies and programs for incorporating renewable energy and other clean energy forms into urban development.

City solutions range from solar photovoltaic panels to offshore wind farms, to a concentrating of solar power towers. Environmental auditing, smart metering and certification are other strategic solutions that are employed in several cities around the world. All of these initiatives are supported in all such cities by strong awareness raising and promotional activities.

"The term 'solar (and sustainable) cities' is a broad term that can encapsulate many different initiatives, activities, and technologies. Generally, it implies renewable energy, energy efficiency, sustainable transport options, new urban planning methods or goals, architectural innovation, and environmental health.

Definitions of "solar cities" by the International Solar Cities Initiative and the European Solar Cities Initiative also include a "climate-stabilization" aspect, whereby cities responsibly set per-capita targets for future *greenhouse-gas emissions at levels consistent with stabilizing future levels of atmospheric carbon dioxide and other greenhouse gases."*

Eric Martinot (www.martinot.info)

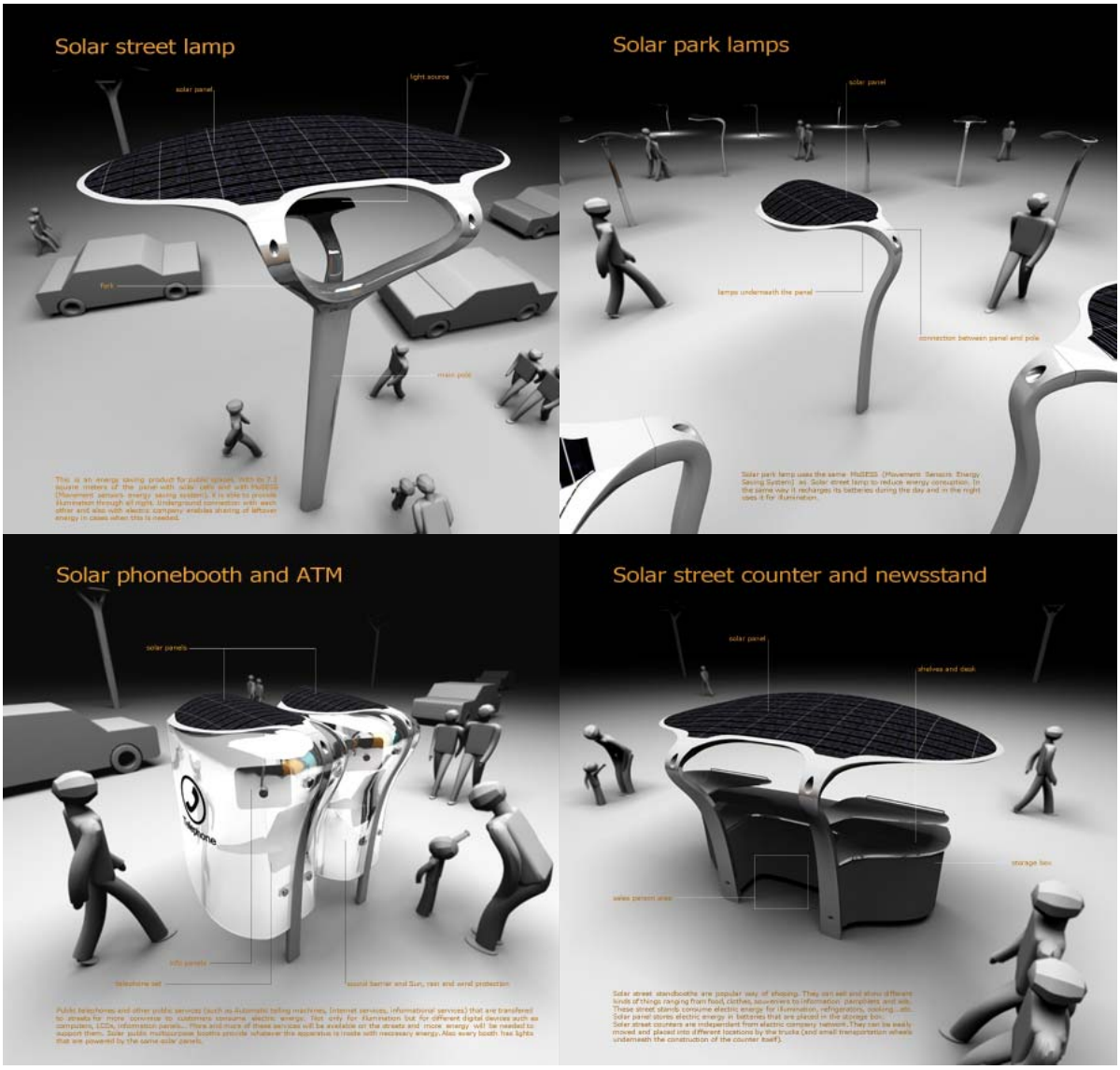


Figure 11: Solar city initiatives by Nikola Knezevic

Features of international solar city programs

The tables below provide nine case studies of international solar city programs, in summary the Program names are listed below:

1. 100,000 Rooftops Solar Power Program (Germany)
2. Solar Cities (Australia)
3. Development of Solar Cities (India)
4. Solar America Communities (America)
5. European Solar Cities
6. Freiburg Solar City (Germany)
7. SolarCity Linz (Austria)
8. Solar City Daegu (SCD) 2050 (South Korea)
9. Solar Cities in China (China)

S. no.	Particulars	Description
1	Name of Program	100,000 Rooftops Solar Power Program (Germany)
2	Instating agency	German Federal Government
3	Timeline	1999 to 2004
4	Scope	Country-wide initiative to install solar panels on 100,000 rooftops with cumulative increase over the program duration. Anyone with a south facing and adequate roof area was eligible for the program
5	Motivation	Increasing the renewable energy share in the country's energy mix and to decrease dependence on fossil fuels. Emission reduction commitment under Kyoto protocol was also a factor. Other aims/objectives were to: • Address energy issues independent of nuclear energy • Gain experience with solar installations • Make new housing compatible with renewable electricity generation needs
6	Approach	Interested home owners and institutions applied for the loan from the total funding earmarked by the Federal Government at $500 million. 10-year low interest loans were sanctioned to the applicants who were to contract solar PV companies and installers for installation based on their individual home requirements. The loan precluded any down payments or interest for the first two years and the installation was subsidized to roughly about 20% of its total value.
7	Impact	• Successful installation of solar panels on 100,000 rooftops in the country • The program significantly increased the share of solar energy use in Germany with 130 MW installed until 2000 and significant capacity increments expected thereafter. • Increase in the mass manufacture capability of German solar panel manufacturers • Increased public interest, awareness in solar energy eventually stimulating consumer usage of solar energy • Continued and reliable dependence on solar energy in domestic and industrial sectors continues making 20% of German energy needs renewable energy dependant
8	Sources	http://www.a1solar.co.uk/german_rooftop_program.html http://thebreakthrough.org/blog/2009/04/soaking_up_the_sun_solar_power.shtml

S. no.	Particulars	Description
1	Name of Program	'Solar Cities' (Australia)
2	Instating agency	German Federal Government
3	Timeline	2004 and on going
4	Scope	Australian Government in partnership with the community and industry is set to trail a range of products and services under real-world conditions in seven cities across the country.
5	Motivation	The government intends to reduce household energy bills and limiting and deferring upgrade to electricity infrastructure by leveraging solar energy towards urban self-sufficiency.
6	Approach	Seven cities Adelaide, Alice Springs, Blacktown, Central Victoria, Moreland, Perth and Townsville were developed as Solar Cities with financial and technical assistance from the Government. The program is aimed at monitoring and rewarding the households that use energy wisely, implement solar technologies and engage in actively reducing their emissions. The review would entail benefits like tax cuts, higher family benefits, higher pension and allowances.
7	Impact	• The program ties in with other climate change mitigation and low carbon initiatives of the Australian government • The success of the 'Solar Cities' program has helped instigating the National Solar Schools Program which is a country-wide initiative and has recently added 784 more schools to about 3000 existing ones. The schools are being given grants of up to $50,000. The program began on 13th Feb 2012 and will last for a year. • Among other achievements some were: ✓ Two 300 kW PV parks in Bendigo and Ballarat ✓ Australia's largest roof-mounted solar system (at the time of installation)—a 305 kW PV system at Crowne Plaza in Alice Springs
8	Sources	http://www.cleanenergyfuture.gov.au/solar-cities-a-catalyst-for-change/ http://www.cleanenergyfuture.gov.au/more-schools-to-go-solar/

S. no.	Particulars	Description
1	Name of Program	'Development of Solar Cities' (India)
2	Instating agency	Central Government of India, through the Ministry of New and Renewable Energy (MNRE)
3	Timeline	2008 and on going
4	Scope	MNRE is targeting 60 cities to be developed as Solar Cities out of which 31 have been given in-principle approval for development into solar cities. The program is administered by Central government designated State-level nodal agencies and will include a set of activities to be mandatorily undertaken in efforts to plan for a10% reduction in conventional energy demand over the next 5 years.
5	Motivation	Burgeoning cityscapes and rapid urbanization are increasing the energy demand on already energy-strained Indian cities. As a means of developing Indian cities as self-sustaining energy hubs, the program aims at introducing renewable energy and energy efficiency initiatives through comprehensive planning, implementable activities and increasing local capacity building
6	Approach	MNRE undertook a novel approach in implementation of the program: • The cities are invited to sign-up for the program based on the guidelines issued by MNRE • The cities then prepare a Master Plan through MNRE authorized consultants outlining the activities and plan of action • Upon approval of the Master Plan, the city Corporations implement the pilot projects and set the solar city development in motion • Funding for the program is subsidized by the MNRE and the cities are developed as pilot cities and model cities for demonstration of success • Each solar city is directed to establish a dedicated solar city cell which will serve as the nodal point for all activities taking place under the program
7	Impact	• Solar Cities program has imparted State and local level autonomy to undertake renewable energy and energy efficiency initiatives which are best suited to local conditions • In principle approval has been issued to 48 cities out of which 37 cities have had their Master Plan sanctioned • Seven cities have already started executing the Master Plans and out of Rs. 17.23 crore earmarked for 37 cities, Rs. 2.75 has been released for utilization to nodal agencies/municipal corporations • The project will be expanded over the next few years with learning taking place from its initial phases.
8	Sources	*mnre.gov.in/file-manager/UserFiles/solar_city_guidelines.pdf* http://www.mnre.gov.in/schemes/decentralized-systems/solar-cities/

S. no.	Particulars	Description
1	Name of Program	'Solar America Communities' (America)
2	Instating agency	Department of Energy, Government of USA
3	Timeline	2007 to 2008; Scaled up in 2010
4	Scope	The program was aimed at increasing the federal-local partnerships and development of feasible solutions in 25 cities in the country. The program also involved capacity building and training local government staff to facilitate development of Solar America communities. The program guidance and capacity building initiatives were also scaled-up in 2010 with an aim to be expanded to reach up to 5,000 local governments supported by a funding of $10 million over 5 years.
5	Motivation	The program was aimed at increasing widespread, large-scale adoption of solar across America by making solar energy systems cost-competitive with other forms of energy by the end of the decade.
6	Approach	Within each of the 25 cities, the following activities facilitated the project execution: • Instatement of a Solar Advisory committee and local solar coordinator. • Preparation of targets based on survey of city inhabitants and identification of local barriers • Guidance and training of local governments in solar policy and regulations, financial initiatives and workforce training
7	Impact	Besides successfully creating jobs and awareness of the program in American cities, the program has increased the public-private partnerships. Funding from DOE's Solar America Initiative of approximately $150 million for 13 solar technology development projects has been earmarked to advance the commercial competitiveness of solar electricity and to bring down the costs of Solar PV.
8	Sources	http://solaramericacommunities.energy.gov/ http://www.good.is/post/for-more-solar-energy-occupy-rooftops/ http://www.icleiusa.org/news/press-room/press-releases/department-of-energy-selects-iclei-to-accelerate-solar-adoption

S. no.	Particulars	Description
1	Name of Program	European Solar Cities
2	Instating agency	European Union
3	Timeline	Non-specific timeframes
4	Scope	The European Solar Cities initiative is a diversified mandate committed by the EU to render financial and organizational support such initiatives across Europe.
5	Motivation	Within a larger aim towards emissions reduction and climate change mitigation, the European Solar Cities initiative is motivated towards: ✓ Mobilizing stakeholders ✓ Increasing communication between cities ✓ Integrating cities especially from the Eastern Europe in Solar City development ✓ Maintaining a repository of information for activities under the Solar City development mandate
6	Approach	European Union under its climate change mitigation framework has committed to co-fund, support and partly administer projects that leverage solar power for empowerment of cities to generate renewable energy. Some examples of the programs supported by the EU are: ✓ Multiplying Sustainable Energy Communities (MUSEC) ✓ Concerto Initiative ✓ European Solar Cities Initiative (ESCi) ✓ Desertec
7	Impact	EU has committed to an independent economy-wide emissions reduction target of 20% by 2020, compared with 1990 levels. In line with this commitment, each of the EU member country is increasing the use of solar and other renewable forms of energy through city level initiatives co-funded by the EU. Until Dec 2010, the total installed solar PV capacity was 29.32 GW_p.
8	Sources	http://www.eurobserv-er.org/pdf/baro202.pdf https://www.ises.org/ises.nsf/f3e5b699aa79d0cfc12568b3002334da/eba26afbc357097ac1256d73004be5ea?OpenDocument http://concerto.eu/concerto/about-concerto http://www.musecenergy.eu/web/project.html

S. no.	Particulars	Description
1	Name of Program	Freiburg Solar City (Germany),
2	Instating agency	Freiburg Local Government
3	Timeline	Non-specific timeframes
4	Scope	Working within their jurisdictional boundaries, Freiburg has introduced interventions in domestic, commercial, industrial and municipal sectors through systematic initiatives in the areas of transport, waste
5	Motivation	Driven by the city's energy policy based on energy conservation, the use of new technologies and the use of renewable energy sources, the city has resolved further to reduce emissions through calls for initiatives in the areas of transport, waste and industrial production, as well as energy
6	Approach	In Freiburg, the on-going solar city development is progressive and is not defined by timelines. The approach followed in this case is to introduce sustainable and eco-friendly measures (as explained above) through ordinances and government orders. Similar model of policy direction has been adopted by other European cities like Madrid, Pamplona, Sevilla, and Conil.
7	Impact	Freiburg has successfully reached a total installed solar PV capacity of 3.2 MW earlier than most European cities producing 3 million kWh per year for use in the grid. In addition, the city has introduced SWH systems and Solar Thermal systems for use in community swimming pools. Such ordinances and policies for environmentally conscious development have proved to be an asset for the city of Freiburg. Furthermore. The city aims to reduce its dependence on nuclear energy and increase use of renewable forms of energy.
8	Sources	http://www.solarregion.freiburg.de/solarregion/freiburg_solar_city.php

S. no.	Particulars	Description
1	Name of Program	SolarCity Linz (Austria)
2	Instating agency	EU and Local Government (Linz)
3	Timeline	Non-specific timeframes
4	Scope	Urban housing design and planning in Linz and the housing policy has been aligned for sustainable and environmentally conscious development.
5	Motivation	Besides the requirement of housing for a large section of city inhabitants, the program is motivated towards providing energy efficient living arrangements which stems from avoiding the use of fossil fuels and energy conservation.
6	Approach	Linz city government has developed sustainable urban spaces and housing projects. The project has satiated the rising housing needs of the inhabitants and also proved beneficial for future urban development projects through restructuring of outmoded housing policies.
7	Impact	The project began in early 90's and has succeeded in reducing housing investments through use of district heating systems and SWH etc. In addition, waste water management and its reuse for agricultural purposes have been successfully implemented. About 1300 housing apartments were built in the pilot phase and the urban and infrastructural development policies in Linz have been since restructured for sustainable urban development.
8	Sources	http://www.linz.at/english/life/3199.asp

S. no.	Particulars	Description
1	Name of Program	Solar City Daegu (SCD) 2050 (South Korea)
2	Instating agency	Daegu Local Government
3	Timeline	Near-term project
4	Scope	The project is intended to develop and promote new and renewable energy industries within its borders and thereby increase 5% of its renewable energy use.
5	Motivation	The project is intended to increase, besides the share of renewable energy in the country's energy mix, community participation, real energy transition and spread of renewable energy projects in Asia.
6	Approach	The Solar City Daegu 2050 is a comprehensive city wide program composed of several initiatives including Green Villages, Solar Schools and Solar Villages. The project considers urban and peri-urban development through targeted programs which offer spill over benefits for further project promulgation.
7	Impact	Until 2006, the renewable energy development driven under the project has been successful in installing 4,412 at 35 sites and 170kW solar power generation facilities in 75 general households. The project also covered public places, precincts and community halls in addition to parking spaces and bus stops for solar PV installations.
8	Sources	http://www.world-renewable-energy-forum.org/2004/download/Kim.pdf http://www.ceep.udel.edu/publications/sustainabledevelopment/publications/2006_sd_BSTS_solar_cities_Daegu_2050_project.pdf

S. no.	Particulars	Description
1	Name of Program	Solar Cities in China (China)
2	Instating agency	Beijing Municipal Commission of Development and Reform
3	Timeline	Non-specific
4	Scope	Cities in China are heading towards extensive solar deployment in alignment with National solar development policy.
5	Motivation	Chinese renewable energy investments peaked in 2011 and increasing the share of renewable energy share in the country's energy mix, Chinese government is targeting renewable energy use in cities as a method to abate the impending energy crisis due to rising fossil fuel costs and its huge population.
6	Approach	The government has instated the development of solar energy through establishment of 6 major "Golden Sunlight Projects" which include 20,000 kW rooftop solar photovoltaic (PV) power generation project, a 50,000 kW on-grid solar power station demonstration project. Several similar such demonstration projects have been planned across the country and are intended to have a positive effect on global perception of Chinese clean technologies but also accelerate the country's solar development.
7	Impact	The project has been touted to increase Chinese share in global renewable energy percentage with total solar energy power generation capacity at 70 MW. The projections indicate that increase in capacity will even hit 300 MW by 2020. Beijing is thought to be the first solar city in China, heading to the target of being the largest solar market throughout the world. Beijing's solar development policies have been emulated at other cities like Dezhou, Rizhou, Kunming and others.
8	Sources	http://www.chinasolarcity.cn/Html/dezhou/index.html http://inhabitat.com/rizhao-the-sunshine-city/ http://www.gokunming.com/en/blog/item/295/kunming_named_chinas_solar_city

ICLEI Local Renewables Network

With the Local Renewables Initiative (LRI), ICLEI – Local Governments for Sustainability supports and strengthens the role of local governments that promote the generation and supply of renewable energy and energy efficiency in the urban environment. The focus is on the roles and responsibilities of local governments as a driving force for innovation and investment in their communities.

The focus on local government adoption and promotion of renewable energy and energy efficiency is because local governments play a key role in promoting sustainable energy at a community level. They have a political mandate to govern and guide their communities, provide services and manage municipal assets. They have legislative and purchasing power that they can use to implement change in their own operations and in the wider community. Local governments can further play a role as a model in their region or country, showing how policies and local actions can be shaped to guide communities in the transition to a sustainable energy future.

Leading cities cooperate in the global Local Renewables Network, share their expertise and experience on Renewable Energy and Energy Efficiency. The Network is open to cities and towns around the world that have either already shown exemplary activities to strengthen renewable and sustainable energy at the local level (LR) and/or are developing themselves into model LR communities. The network started with cities in Europe, India and Brazil. The initial funders of this network are GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit) and GOF (UK Global Opportunity Fund) through the British Embassy in Brazil.

The Network aims to link three types of communities:

Model communities: Local governments that are selected and in the process of becoming sustained and sound LR Model Communities, benefiting from support through a project.

Resource Communities: Local governments that already have comprehensive integrated strategies and actions in place addressing sustainable energy, in particular focusing on RE and EE, providing advice to model communities and benefiting from the exchange.

Network Communities: Local governments that are linked to a current LR project and are committed to promoting the initiative and learning from the Model Communities in each country or region but do not have the full financial benefits of a current project.

Figure 12: ICLEI's Local Renewables Network consisting of three types of communities: Model, Resource and Network Communities

Chapter 4: Development and Implementation of a Solar City in South Africa

Motivation for 'Solar City' Program in South Africa

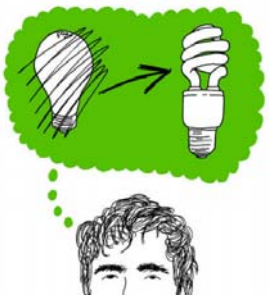
South African local governments are currently at different stages of solar city development. It is necessary that local governments formalize their strategies and policies in-line with National and Provincial legislation in the aim to reduce energy demand and supply and increase and promote the use of renewable and energy efficient technologies. The goal of the Solar City program is to promote the use of renewable energy in urban areas by providing support to municipalities for preparation and implementation of a road map to develop their cities as Solar Cities. The objectives of this initiative are:

- To enable/empower urban Local Governments (LGs) to address energy challenges at the city - level;
- To provide a framework and support to prepare a master plan including assessment of current energy situation, future demand and action plans;
- To build capacity in the Urban Local Bodies (ULBs) and to create awareness amongst all sections of civil society;
- To involve various stakeholders in the planning process;
- To oversee the implementation of sustainable energy options through public - private partnerships.

Activities towards the development of a Solar City

1. Institutional:

a. Technical Assistance, Service Delivery and Information Dissemination



A technical officer, energy champion, within the city plays a critical role in obtaining interest, political buy-in and technical support at the city level. The champion will be required to lead the community into a behavioural change and new approach, from business-as-usual to an innovative way of thinking towards low carbon development from the house hold level to large industrial development. The champion mandate will be to facilitate the Solar City process and should be able to deliver quick and efficient technical assistance for the better understanding of RE and EE technologies, scientific concepts and equipment handling and usage. The technical assistance could be in the form of technical documents, vocal discourse, brochures and pamphlets.

Roles and Responsibilities:

- Contact point within local authority for all stakeholders on matters concerning energy and climate change;
- Keep informed of related international, national and local current affairs;
- Co-ordinate related projects and campaigns;

- Facilitate and mainstream energy and climate change policies and strategies across all local government department.

b. Establish a Stakeholder Committee

The Solar City Stakeholder Committee is a very integral component for the development of the Solar City process. The purpose of establishing an internal stakeholder committee is to ensure the parallel set up of a local site for exchange and collection of relevant data for sustenance, promotion and awareness generation of renewable energy and energy efficiency at the local level. The stakeholder committee will be the focal point and a critical player for implementation of the solar city development.

A "Solar City Stakeholders Committee" will be set up for advisory support involving representation from elected representatives in the municipal bodies, local research and academic institutions, resident welfare associations, industries and corporate organizations, NGOs, State Nodal Agencies and other relevant stakeholder

The stakeholder committee will be established within the municipality and will function under the full administration of the local government. The City Manager which will be the highest level authorizing personnel with a senior technical officer at the level of executive engineer or project manager whom will facilitate the process, activities and implementation. The officer in-charge will prepare all strategy and functioning modalities of the stakeholder committee, facilitate and support day-to-day activities, documentation, communication and every other activity under stakeholder committee. The stakeholder committee will provide technical guidance, expertise and financial analyses of projects for potential investors, individuals and companies.

Roles and responsibilities:

- Provide input and agree upon stakeholder committee terms of reference;
- Commit to terms of reference obligation;
- Be in attendance to all stakeholder committee meetings;
- Actively participate and provide best knowledgeable experience and expertise to agenda items and assignments;
- Be diligent and punctual on assigned portfolios or duties;
- Support and advocate the stakeholder committee within other networks.

2. Baseline Study and City Energy Profile

a. Baseline Study

A baseline study is required to link and incorporate all international, regional and national conventions, strategies, laws and climate related targets and action plans to the local government's core service delivery and plans. The city's planning and decision makers needs to ensure that these components are well aligned with the city's short-, medium- and long term plans and strategies to incorporate all the sectors and strive towards achieving an holistic approach towards city management.

b. City Energy Profile (GHG Inventory)

An important component towards the development of a Solar City is the understanding of the cities energy patterns and profile. Before the drafting of a city's master plan or/and action plan it is vital to undertake an energy audit, also known as a GHG inventory. For this activity it is important to consult the Stakeholder Committee established to provide an overview of the energy consumption consumed by the urban area. The respective Stakeholder Committee members will be able to identify all relevant energy consumption sources within the urban jurisdiction. It is recommended that data is collected and assigned to one of two modules: the governmental energy consumption and the community energy consumption.

Based on the collected secondary and primary data, an energy baseline would be prepared for each municipal sector. The secondary data should be collected for the past 5 years, which provides a baseline and illustrates trends to inform more accurate projections of total and sectoral energy/emissions on current and future growth rates.

Accurate data is essential for energy planning and because the pool of data sources is large and often sources are scattered, it is not easy for the technical officer to collect all the data in a limited time period. In order to facilitate data collection, it is advisable that the technical officer within the local governments to schedule and facilitate meetings (or inception workshop) of all concerned departments/institutions at the beginning of the project. In such a meeting the technical officer can present on the data requirements and the local government can identify the correct agencies that would be the appropriate source for respective data. Local government departments and the Solar City Stakeholder Committee should assist with disseminating appropriate data request letters to all concerned agencies introducing the project, with a request for providing the respective data.

Data on energy consumption (electricity, petroleum products, coal and biomass) should be collected from community, commercial, industrial and local governmental sectors (Waste, Transport, Waste Water, Water, Electricity). Community module includes residential households and residential housing complex, while commercial sector includes all offices, shops, shopping centres, multiplexes, hotels, restaurants, advertisement bill boards and institutional/government buildings include hospitals, schools, colleges, churches, hostels, jails, government offices, etc.

The major sources of energy for both residential and commercial sector are electricity and Liquid Petroleum Gas (LPG). In addition, a variety of fossil fuels may be used for power back-up e.g. diesel generators. In some cases, biomass fuels are also used for cooking and water heating.

The industrial sector includes all industries that fall within the municipal jurisdiction. Other than the electricity as an energy source, other fuels that are used within the South African context include petroleum products (diesel, natural gas, naphtha and furnace oil), wood, coal and biomass

Municipal sector includes municipal services (water pumping, street lighting, sewage treatment). The main source of energy here would also be electricity.

A few steps to undertake to assist with the data collection:

- Asses the city boundary or jurisdiction;
- Identify types of energy used within the city;
- Identify key energy users within the city (i.e. Industry, Commercial, Transport, Residential);
- Separate the list of energy users into the two modules: Government and Community;
- Develop a data sheet form of the data required for each module;
- Schedule individual meetings with key stakeholders whom may assist with the data collection. Provide the data sheet for energy users to complete.
- Gather electronic data systematically and store data within a suitable GHG energy tool;
- Once all the required data is collected undertake the necessary calculations, accounting and reporting.

HEAT (Harmonised Energy Analysis Tool) Plus

HEAT+ is ICLEI's newest software tool designed to help local governments reap the benefits of reducing greenhouse gas emissions and common air pollutants—such as CO2, NOx, SOx, CH4, CO, and VOC—and the benefits are significant. Save money. Improve air quality. Mitigate global warming. Protect public health.

For the first time ever, cities using HEAT+ can compare "apples to apples" and benchmark emissions levels against local, state, national, provincial, and international standards. Anyone interested in translating energy use, transportation demand, and waste activities into emissions data can use HEAT+ to

- Inventory and forecast emissions
- Prepare Action Plans
- Track commitments
- Measure progress against targets
- Inform policy decisions
- Determine Priorities
- Quantify progress, and
- Report results

HEAT+ is the only web-based product of its kind, offering secure data storage, a global data bank, comprehensive technical support, and accessibility 24 hours a day, 7 days a week. A variety of software packages are available.

Website: http://heat.iclei.org/heatplusv4/index.aspx

3. Policy and Strategy Development

Once the energy audit and the necessary inventory and city energy profile reports are complete, use the results and outputs to assist with the understanding and prioritizing of the critical energy issues for each of the modules and sectors.

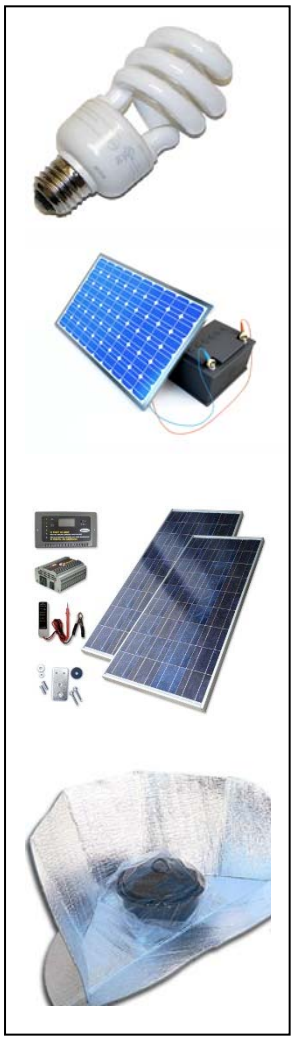
A draft Action Plan should be the first step towards the development of the city level Energy Master Plan. The Master Plan should provide a complete sector-wise base-line energy utilization and GHG emissions in the city. It should further provide total and sector-wise projections for energy demand and supply for a required period. Year-wise targets for energy conservation, renewable energy addition and GHG abatement along with the action plan for implementation will be clearly highlighted within the Master Plan.

Potential sources of funding from respective organizations (both public and private) for providing financial support should be identified. The Master Plan should set clear and realistic targets and goals for energy reduction; local reduction targets should be in-line with national targets; annual targets should be realistic however ambitious in order to achieve beyond long term reduction goals; recording of energy saving interventions from energy efficiency measures and generation from renewable energy installations should be reported and accounted for annually.

Activities to undertake towards the development of a 5-10 year Master Plan

a. Energy Demand Forecasting for next 10 years

This step involves predicting the energy demand for the period of 5-10 years. To estimate the energy demand, the growth in energy use of different sectors needs to be established. These growth rates are established based on immediate past trends and future growth plans. Based on the past time-series data and information on growth plans, growth rate in energy demand for different sectors can be estimated. These growth rates are used for making future projection of energy demand in each sector for the next 5-10 years.



b. Sector wise Renewable Energy Strategies

A renewable energy resource assessment should be undertaken in order to identify the potential renewable energy sources and opportunities within the city. This would include assessment of solar radiation, wind power density and availability, biomass resources and municipal/industrial wastes. The next step would be listing of all potential renewable energy technology options. An indicative list of renewable energy technologies/systems is discussed in the chapter 5.

c. Sector wise Energy Efficiency Strategy

While renewable energy technologies would provide clean energy, EE and DSM measures would help in reducing the energy demand. An indicative list of EE and DSM measures that can be introduced in different sectors – residential, commercial, and industrial and municipal is discussed in chapter 5. A sector-wise techno-economic analysis of potential energy efficiency and DSM measures should be carried out.

d. Stakeholders Consultations

Stakeholders' consultation is a very important step in the preparations and development of the master plan. Several external stakeholders' consultations are suggested such 1) as an initial inception meeting to introduce the project and present the data requirements, 2) one immediately after the analysis of sector-wise energy audit outputs; and 3) one towards the end to discuss the draft master plan. The participants can include elected representatives including external experts from, local research and academic institutions, resident welfare associations, industries and corporate organizations, ESCOs, RE manufacturing industries, NGOs, SNA, etc. Stakeholders committee formed as part of the Solar City process should be consulted on all developments and processes.

Recommended outlines of a Master Plan

1. Projection for energy demand and supply for 10 years
   - Sector wise
   - Total
2. Base line of energy utilization & GHG emissions
   - Residential
   - Commercial/ Industrial
   - Institutional
   - Municipal Services
   - GHG emission
3. Renewable Energy Strategy
   - Resources
   - RE Strategy for Residential Sector
   - RE Strategy for Commercial and Institutional Sector
   - RE Strategy for Industrial Sector
   - RE Strategy for Municipal Sector
4. Energy Efficiency Strategy
   - EE Strategy for Residential Sector
   - EE Strategy for Commercial and Institutional Sector
   - EE Strategy for Industrial Sector
   - EE Strategy for Municipal Sector

5. Year-wise goals of savings in conservation energy through demand side management & supply side measures based on Renewables.

6. Action Plan for achieving the set goals & expected GHG abatements. This will include capacity building and awareness generation.

7. Budget estimates and potential sources of funding from respective sources (both public and private)

4. Activities to implement at the local level

a. Solar City Resource Centre

One of the on-ground projects that can be easily implemented is a Solar City Resource Centre. Development of a local Resource Center is a space within the city's governmental buildings, which is easily accessible to the general public and end users to showcase local initiatives and products informing the community about RE and EE innovations. The location is of vital importance as it will be a means to easier and quicker dissemination of knowledge and information to a wider scale of audience. Examples of locations are within education and awareness centres, city libraries or accessible municipal buildings.

All technological options available under RE and EE should be displayed within a space to showcase and promote such technologies; this space is given the proposed name, Solar City Resource Centre within the Solar City Program.

It is a resource base of information and physical exhibition of models related to RE and EE techniques.
The information promoted within this space should include:

- Available RE/EE techniques in the region
- Feasibility analysis of each technique
- Technology suitable for a particular client considering his/her requirements and budget
- Required capital
- Sources of funding
- List of manufacturers of RE/EE equipment in that region
- List of consultants in that region
- City implementation projects and description of each
- City Energy Plan and related policies and strategies

Connecting People with Energy through the Resource Centre
The target audience for the Solar City Resource Centre is:

- Municipal Corporations/departments
- Local Utilities, Local Business
- Developers of Large Scale Construction projects
- Architects, city planners
- International and local organisations
- City residents and resident welfare associations
- School children and students

Indian Case Study: Capacity Building within the Solar City Program
Under the Local Renewables Model Communities Network project funded by GTZ, ICLEI-SA has conceptualized and assisted in establishment of the Renewable Energy & Energy Efficiency Resource Centres within **Bhubaneswar**, **Nagpur** and **Coimbatore**. Other well established Resource Centres are Freiburg, Bonn and Vaxjo (under the International Network of European Programme); Betim (Brazilian Solar City Program) cities, which form part of ICLEI International Training Centre, ICLEI European Secretariat and ICLEI US offices respectively.

The Resource Centres are strategically located in all four of these cities whereby the general public is able to view the material as any given time. In Bhubaneswar, at the entrance lobby of the Corporation building; in Nagpur, at the Citizens Facility Centre in the Corporation premises; and in Coimbatore, the Resource Centres is located adjacent to the Citizen's Service Centre in the Corporation premises.

RE and EE equipment manufacturers have shown positive interest and support towards these Resource Centres in the respective cities. At present, Gayatri Solar and Tata BP Solar have exhibited their equipment and information materials at the Bhubaneswar Resource Centre whereas in Nagpur Tata BP Solar is now associated with the Resource Centre. Resource Centres in the cities are receiving encouraging response (in terms of number of people visiting) from the citizens as well as Corporation officials. These Resource Centres continuously undergo efforts to update and include new technologies within the centres.

Programmes and Activities for the Resource Centre

- Display and demonstration of RE and EE equipment
- Conceptualize various campaigns, workshops, seminars, panel discussions, meetings, and exhibitions targeting RE and EE promotion awareness generation and voluntary adoption of technology measures by individuals, communities, associations, and institutions. These programmes should ensure the active participation of local residents, private players, ESCos, local/state RE and EE manufacturing companies, etc
- Provide and produce all resources for promotional and awareness generation activities like reports, booklets, equipment brochures, pamphlets, posters, banners and related matter
- Maintain all records of activities charted in monthly activity target list. Usage of proper detailed documentation methodology should be a priority. Monthly and yearly data should be recorded both in soft and hard copies
- A target list of potential stakeholders, private partners, ESCos or RE and EE manufacturing companies should be made updated every two month to involve them as partners/members/funding sources for the sustainability and promotional activities of the Solar City Resource Centre

Coimbatore Resource Centre

Established under the Local Renewables Model Community Project, Coimbatore Resource Centre has served as a one-stop outreach, awareness and information provider for renewable energy and energy efficiency projects, products and related financing options available.

As a model community, Coimbatore city Corporation has been instrumental in execution of a number of activities in the city with the logistical and organisational support rendered through the Resource Centre.

As an indicator of success under the project, Coimbatore Resource Centre has and continues to assume the following roles:

- Comprehensive resource base for information on renewable energy and energy efficiency projects/products
- Platform for outreach to target audience which include local entrepreneurs, schools, Corporations of other cities, Architects and urban planners, local utilities and generally anyone interested in green initiatives
- Administrates the action plans and annual activity plans which fall under the purview of RE and EE initiatives taking place in the city
- Ensures provision of logistical and organisational support in implementation and subsequent monitoring of the projects

b. Communication, Education and Public Awareness (CEPA)

Awareness, Publicity and Capacity Building

Awareness and Publicity Programmes are encouraged to provide awareness among target audiences within the city pertaining to the financial benefits and incentive of renewable energy technologies and devices. Under these programmes, information on technological developments, financial benefits and cost savings from RE system and EE measures, government initiatives and incentives for such devices/measures, availability, price should be disseminated through various media platforms. The following activities are proposed for creation of awareness and publicity.

Publicity through electronic media

- Production and telecast of documentary films, short duration films, TV spots/advertisements through local TV networks;
- Production and broadcast of radio sponsored programmes, radio spots/jingles and Radio Talks etc. through local FM channels

i. Print Media/Publication

- Advertisements in colour and black & white in newspapers/magazines/journals etc.
- Printing of booklets, folders, brochures, posters, calendars and newsletters.
- Develop educational programs and workshops on energy efficiency, distributed generation, and renewable energy systems in buildings for homeowners, businesses, government staff, and those in the building industries.

ii. Exhibitions, Outdoor Publicity, Campaign

- Use of Exhibitions and Outdoor Publicity activities like hoardings, kiosks, bus panels, bus-stop shelters, wall paintings, computerized animation display systems, etc. in the city.
- Display and demonstration of RE and EE equipment in the Solar City Resource Centre.
- Organizing runs, debates, seminars, quiz, drawing, model making, poster, essay and slogan writing competitions among others for school children and others;
- Promotion and publicity of RE and EE by displaying models and posters and related printed media in different public places, institutions/organizations, hospitals and bus stands.
- Encourage maximum participation by residents and business owners in the local authority's energy efficiency programs through marketing and education exercises.
- Educate government purchasing agents in each city departments regarding the benefits of Energy Star rated equipment, including the cost savings to the city.
- Encourage community input on strategies for improving energy efficiency in building.

iii. Workshops and Seminars

It is proposed to organize workshops and seminars on specific technologies for targeted audiences from residential, commercial, institutional, industrial and municipal sectors.

iv. Training and Education Programs

The key areas of training should be prioritized such as technical, management or general. Crucial aspects which should be addressed primarily at this stage for the development of the Solar City Resource Centre to be well suited for a range of activities (training, exhibition, workshops) should be addressed or undertaken:

- User-needs and resource assessments and feasibility studies.
- Renewable energy project design including the economical and financial aspects;
- Renewable energy project management;
- Operation, maintenance and monitoring of RE and EE systems

v. Creating a Web Portal

Portals could be created by the City within the Energy Department website page to provide citizens access to RE and EE technologies, and activities occurring in and around the area. Instant access to technological options available to end-users, their capital cost, returns on investment and other useful information through this mode of knowledge exchange which is a quick and easy communication mode for generating awareness and sensitizing the general public. Creating an interactive website exclusively for "Solar City" for awareness campaigns, information sharing and support to the users will be a useful tool.

vi. Demonstration projects

The technical feasibility and economic viability of solar technology can be addressed by implementing a number of demonstration projects, such as solar hot water heating system for hospitals, hotels and catering services could be implemented. Others include solar industrial process heat in the drying, food and textile industries. Dissemination activities can be carried out using information materials such as leaflets, posters, videos and media advertisements. These projects will further provide a wider level of acceptance and better understanding of the technology and the benefits of such devices. The demonstration projects will also in paving the way forward and providing first hand experiences for improvements in the training and skills of the stakeholders as well as increased efforts in research and development activities.

Indicative measures to be taken by Cities towards the develop of a 'Solar City'

Some of the measures that can be adopted by city governments while developing their city/ town as a solar city are:

- South African National Government's involvement and support for the oversight of implementation of the strategies in the local authorities' Master plan during 5-10 years (financial value if any). The concerned local government is encouraged to send proposals with the budget to respective provincial, national department as well as to private sectors to support the project planning and implementation process.
- Annual Budget from National Government for RE and EE programmes and projects at the local level.
- Development of "Solar City Stakeholder Committee" for the sustainability of the Solar City Programme initiatives is encouraged. Solar City Cell consisting of the stakeholder committee and resource centre (further details can be found in Chapter 4) The solar city cell is an essential tool for planning, implementation of strategies, raising awareness, capacity building, involving private partners, and major stakeholders (architects, engineers, builders & developers, financial institutions, NGOs, technical institutions, manufactures/suppliers).
- Awareness generation: each South African local authority is encouraged to promote RE and EE through the Solar City Resource Centre, awareness campaigns, publications and through relevant media channels to capacitate the public on RE and EE innovations that can be implemented at the local level (such as workshops/ seminars/ training / publications/ awareness campaigns etc.).
- A timely audit of government and public sector should be scheduled and measures taken for ensuring conservation of energy.
- Local authorities are encouraged to promote energy efficiency within each sector drafting and developing bye-laws for municipal sectors.
- Government orders can be issued for construction of energy efficient buildings at the most within government/public sectors, in accordance with any feasible green building codes like GBCSA)
- Solar water heating could be made a mandatory bye-law for buildings (old/new) within the municipality jurisdiction, especially in buildings of special category like hotels, hospitals, hostels etc.
- Compliance with Municipal Solid Waste regulations and efforts to recycle, re-use and reduce solid waste. Maximum efforts should be taken up to implement waste to energy projects.
- The municipalities should ensure energy conservation in street lights/garden lights, traffic lights, hoardings and roadside blinkers by replacing old inefficient lights and light fittings with more energy efficient, EE labelled appliances.
- There is a very urgent need for municipal resource mobilization in terms of manpower, infrastructure for monitoring, documentation and information sharing towards achieving the success of implementing the master plan.
- Initiatives and motivation is required to amass funds from private partners, national governments, international organisations and other funding organizations for implementation of solar city strategies and action plans.
- The City manager should successfully ensure the implementation progress and achievement of Solar City targets.

Chapter 5: Indicative RE and EE solutions

This chapter describes different renewable energy devices/systems that can help to bring about reduction in consumption of conventional energy. These following devices described in this section are commercially available and are useful for urban area application.

Energy Efficient devices

Home Appliances

Energy Star Appliances

Energy Star is an international standard for energy efficient consumer products originated in the United States of America. Devices carrying the Energy Star service mark, such as computer products, kitchen appliances, buildings and other products, generally use 20%–30% less energy than required by federal standards. Devices range from home, business and industrial products which can be purchased in South African shops such as: DionWired, Game and HiFi Corporation.

Switch off and unplug appliances when not in use.

An easy and cost effective way to save money in the household and at work is switching off and unplugging electrical equipment when not in use. While devices are still plugged in at the wall they are still drawing power and costing the consumer. Switch off high intensive energy consuming products and unplug electrical equipment when not in use to save on electricity. Eskom has stated that if all households made minor changes such as these, collectively South Africa can save up to 10% (Grange, 2012) of energy consumed, reducing monthly energy bills and reducing the demand on the national grid.

Lighting

LED lights

Light-emitting diodes (LEDs) in comparison to incandescent bulbs are 8 times more efficient and twice as efficient to the florescent bulbs. LEDs are widely used in many appliances and are recommended as the household lighting due to the energy efficiency capacity. The initial cost of the bulbs is higher compared

to the incandescent and florescent light bulbs; however LEDs have a longer life span, generate very little heat, have low sensitivity levels to shocks and varying temperatures and generally produce a brighter light.

Cost: Variation in cost subject to make, type and wattage.

Suppliers: Most of South African grocery and appliance stalls will stock and sell LEDs. Please read product packaging for further information to suit your needs.

Compact Florescent Lights

Compact Florescent Light (CFL) bulbs are electrode tubes containing argon and mercury vapour which by excitement by the atoms within the tubes creates light within the ultraviolet range. The CFL bulbs produce less heat to generate light and therefore are more energy efficient than incandescent bulbs. A 15-watt florescent light bulb produces the same amount of light as a 60-watt incandescent, therefore saving energy and money. CFL bulbs are safer to operate and can also reduce energy costs associated with cooling homes and offices.

Precautionary measures must be taken during breakage and disposal of a CFL bulb. See the Eskom website for precautionary measures: http://www.eskomidm.co.za/residential/residential-behaviours

Cost: Variation in cost subject to make, type and wattage.

Suppliers: Most of South African grocery and appliance stalls will stock and sell LEDs. Please read product packaging for further information to suit your needs.

Cooking

Wonderbag™

Since September 2011 645 jobs have been created by producing a very cost effective cooking device called the Wonderbag™. The Wonderbag is a device made from material and recycled polystyrene designed to use the principle of thermal insulation. Instead of cooking a meal for the full duration on a stove or oven, the Wonderbag reduces the amount of energy used once your pot has come to the boil and placed within the Wonderbag for the remainder of the cooking period. The Wonderbag is estimated to save up to 30% of the total fuel costs associated with cooking with paraffin alone and is currently widely used on the continent with over 150 000 already in use in African homes.

Cost: R150 – R300 (subject to size)

Energy Savings: if the Wonderbag is used 2-3 times per week within one household it can (http://nb-wonderbag.com):

- Reduce cooking fuel consumption by 30-50%
- Save around 50% of energy used for cooking
- Reduce CO2 emissions by approximately 500kg per year
- Savings of R50-75 monthly.

Suppliers:

WonderBag, Contact Paula Harvey Tel: +27 31 536 8220; email: sasales@nb-wonderbag.com; website: http://nb-wonderbag.com

Table 1: Average saving that could be used with various energy efficient devices. The table below makes several comparisons between non-efficient devices versus energy efficient devices and provides potential annual savings.

Electrical Device	Product Power (W)	Power Consumption (kWh)	Cost [SA Tariff = 0.35per kWh] (R)	Amount used per day [xhr](hr)	Amount used per month [xhr each day for xdays]	Monthly Use	Monthly Savings	Amount used per year [20*12=240]	Yearly Savings
Normal Appliance	1000	1	0.35	24	720	252		3024	
Star Energy Appliance	750	0.75	0.2625	24	720	189	63	2268	756
Candescent bulb	60	0.06	0.021	4	120	2.52		30.24	
CFL bulb	15	0.015	0.00525	4	120	0.63	1.89	7.56	22.68*
Candescent bulb	60	0.06	0.021	4	120	2.52		30.24	
LED bulb	8	0.008	0.0028	4	120	0.336	2.184	4.032	26.208*
CFL bulb	15	0.015	0.00525	4	120	0.63		7.56	
LED bulb	8	0.008	0.0028	4	120	0.336	0.294	4.032	3.528*
Oven	1000	1	0.35	2	60	21		252	
50% oven use + Wonderbag	1000	1	0.35	1	30	10.5	10.5	126	126

*annual saving per light bulb subject to tariff rates.

Water Saving

Heating household water contributes to about 40% of all household electricity consumed. Showering with a high efficiency showerhead can save more than half of this energy (and much water) to the advantage of the householder, the environment and under energy and water shortage circumstances, of the supplying utility. An energy and water-saving showerhead typically has a flow rate of less than 10 litres per minute, compared with a conventional showerhead which has a flow rate of between 15-25 litres per minute. There are two types of showerheads that are water and energy efficient, Aerators and laminar flow. Aerator showerheads mix air with water, forming a misty spray while laminar-flow showerheads form individual streams of water.

Cost: R200 – R800

Energy Savings: See the text box for calculations on savings per month and per year.

Water Heating

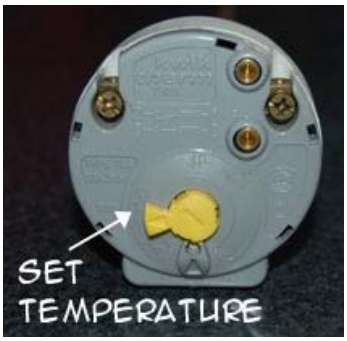
Geyser blanket

A geyser blanket is an additional layer of insulation designed to be wrapped around the geyser, the thicker the insulation the better (100-150mm is not much more expensive but it is twice or three times as effective). A geyser blanket considerably reduces the rate at which the water cools down inside the geyser, furthermore, geyser blankets are relatively inexpensive and easy to install. For further reduction of heat loss from the geyser it is recommended to insulate the outgoing geyser pipes for increased effect.

Cost: R120 – R550

Suppliers: Visit Eskom's site for South African suppliers located within your province: http://eskomidm.co.za/geyserblankets/find/

Geyser thermostat



A Geyser thermostat is a heating element within the geyser that maintains the water temperature to a pre-set temperature. Most home geysers are set to a temperature of 70 degrees Celsius, once this temperature is met, the element switches off. An effective method to reduce electricity usage and save household energy is by reducing the thermostat to a minimum of 60 degrees Celsius this action can reduce electricity consumption by 14% (PowerSavings, 2012).

Cost: no cost, only saving.

Energy Saving: An average household with a 150L geyser can achieve a monthly energy saving of 122 kWh and R67 on cost of energy if a thermostat temperature is reduced from 70 to 60C and the geyser is switched off between 6am and 9pm (Eskom, 2011). See calculations below in Table 2, for further household savings.

Note: Hands on technical tips can be sourced from the internet or your local plumber to assist with the setting of the geyser thermostat.

Table 2: Energy and Water Saving Calculations

Normal Shower head uses on average 20L per minute. *Efficient Shower Head* uses on average 10L per minute, which is half that of a normal shower head.	
Geyser Specifications for an average household: 2kW, 100L, thermostat 70C **Savings with an Efficient Showerhead:**	Geyser Specifications: 2kW, 100L, thermostat 60C **Savings with a thermostat:**
Water has a heat capacity of 4.1813 joules to heat one gram by one degree C. 1 litre is 1000 grams. For the purposes of this example, the geyser tank has a capacity of 100L. As a hundred litres is 100 000 grams of water, it takes 4.1813J * 100 000 = 418130 joules to heat this amount by one degree Celsius. A joule is equivalent to 1 watt-second, therefore 418130 joules is 418130/3600 = 116.15Wh. If the thermostat of the household geyser is **70C**, the energy needed to heat 100L of water is 116.15*70 = 8130.5Wh If the voltage of the device is 2000W (2kW), then it would take 8130.5Wh/2000 = R4.065 hours to heat the 100L geyser tank to 70C.	Water has a heat capacity of 4.1813 joules to heat one gram by one degree C. 1 litre is 1000 grams. For the purposes of this example, the geyser tank has a capacity of 100L. 4.1813 joules*100 000=418130 joules A joule is equivalent to 1 watt-second, therefore 418130/3600 = 116.15Wh. If the thermostat of the household geyser is **60C**, the energy needed to heat 100L of water is 116.15*60 = 6969Wh The electricity tariff/rate of South Africa in 2011 was on average R0.35 per kWh, therefore (6969/1000)kWh*R0.35/kWh = R2.43 By changing the thermostat of the water geyser by 10C, a household can save R0.41 (R2.84-R2.43) per

The electricity tariff/rate of South Africa in 2011 was on average R0.35 per kWh, therefore the cost to heat 100L tank to 70C is (8130.5/1000)kWh*R0.35 per kWh = R2.84

By using an energy and water saving shower head a household can save **R741.86** (R4.065/ 2*365) per year on electricity.

Water saving: If a household has four people, each take a shower twice a day for 10 minutes, by using a normal shower head, the consumption of water per month would be as follows:

4people*10minutes*20L/minute*2 a day*30 days a month = 48000L = 48kL

Water Tariff in South Africa is R4.32 per kL.

An efficient shower head uses half the amount of water than a normal showerhead, therefore saving R103.68 (24kL*R4.32) per month, which is an annual saving of **R1244.16**.

100L heating to 60C rather 70C. The annual saving is, assuming a household consumes only 100L for showering per day, is R149.65 (0.41*365).

If an efficient shower head is used, water con

summed is:

4people*10minutes*10L/minute*2 a day*30 days a month = 24000L = 24kL

Savings on heating a tank of 100L is R0.41; therefore monthly savings on the electricity consumption on heating 24000L is R98.4 (24000/100*0.41).

The total amount of water and electricity saving per month using energy efficient devices amounts to an estimate of **R202.08** (R103.68+R98.4), which is an annual saving of **R2424.96** per year.

Reduce your individual CO2 emissions – use public transport

Making use of public transports helps the environment considerably. Approximately 20% of the total carbon dioxide emitted globally is as a direct result of transport (land, air and sea) of which land transport accounts for 80% (ScienceDaily, 2009). Sustainable transportation solutions can achieve 30-50% (Litman, 2011) emission reductions while helping to address problems such as traffic congestion, accidents and inadequate mobility for non-drivers, and supporting economic development. By taking advantage of public transport options (train, bus, car sharing) a reduction in emissions can be as much as 10-30% of an individual's annual carbon footprint (Litman, 2011).

For driving tips that will reduce your carbon footprint visit: Green Fleet at http://www.greenfleet.com.au/Global/Individuals/index.aspx

Renewable Energy devices

Photovoltaic

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

Lighting

Solar Bottle Bulb

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

Cost: minimal

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

Portable Solar Light and Charger

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

Cost: R500 – R2000

Supplier: **Sunfire Solutions**, Tele: +27 (0) 11 624 2432; email: crosby@sunfire.co.za , website: www.sunfire.co.za

Solar Street Light

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

Solar lighting can make use of three types of bulbs; sodium vapour, LED and induction technology lighting. Additional benefits of using solar street lighting, other than being low cost and making use of renewable energy sources, LED solar lighting is long lasting and can be used for approximately 20 years without replacement, uses a lower voltage to produce a brighter light and the thin-film solar panel is highly durable to high temperatures and hail stones.

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

Suggested Suppliers:

Solar Getaway Africa, Tele: +27(0) 11 740 – 7776 and email: sales@solargateway.co.za, website

Genus Power SA, Tele: +27 (0) 51 447 5965; email: info@genus.co.za; website: http://www.genus.co.za/

Sunfor Technologies, Tele: +27 (0) 11 791 5008; email: sunfor-tech@vodamail.co.za; website: http://www.sunfor.co.za

V-Sun Tech, Tele: +27 (0) 13 741 8038; email: rian@vsuntech.co.za; website: http://www.vsuntech.co.za

Solarport, Tele: +27 (0)21 461 2683; website: http://www.solarport.co.za/

SunFire Solutions, Tele: +27 (0) 11 624 2432; email: crosby@sunfire.co.za , website: www.sunfire.co.za

Cooking

Parabolic Cookers

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

Cost: R200 (small) – R2500 (large).

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

Solar Box Cooker and Oven

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

Box Cookers cook meals with performance varying between half as fast as conventional ovens to almost the same speed.

Cost: R3500

Supplier: **SunFire Solutions**, Tele: +27 (0) 11 624 2432; email: crosby@sunfire.co.za , website: www.sunfire.co.za

Water Heating

Solar Water System

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

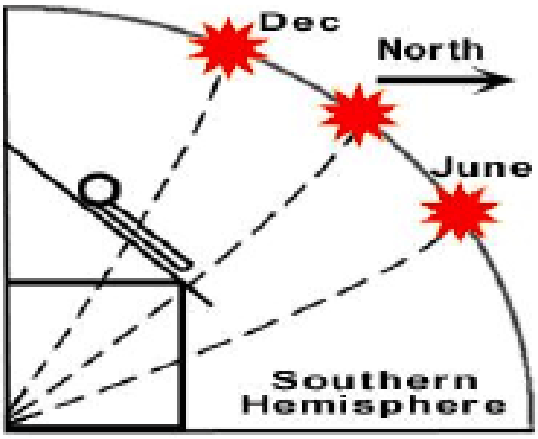


Figure 13: Southern hemisphere buildings should install solar panels on roof tops facing the northern direction to receive optimal solar radiation.

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

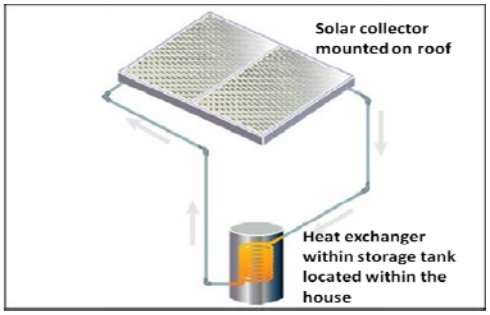
1. Thermosyphon SWH systems

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

2. Split Pressurized SWH systems

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

3. Indirect SWH systems



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

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

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

Supplier:

Provincial suppliers provided by Eskom: http://www.eskomidm.co.za/form/find/confirm.php

SunFire Solutions, Tele: +27 (0) 11 624 2432; email: crosby@sunfire.co.za , website: www.sunfire.co.za

Potential Photovoltaic Plants in South Africa

The "PV Plants Map South Africa 2012" – details the size and location of 18 PV projects that successfully won bids in the first round of the South African renewable energy program.

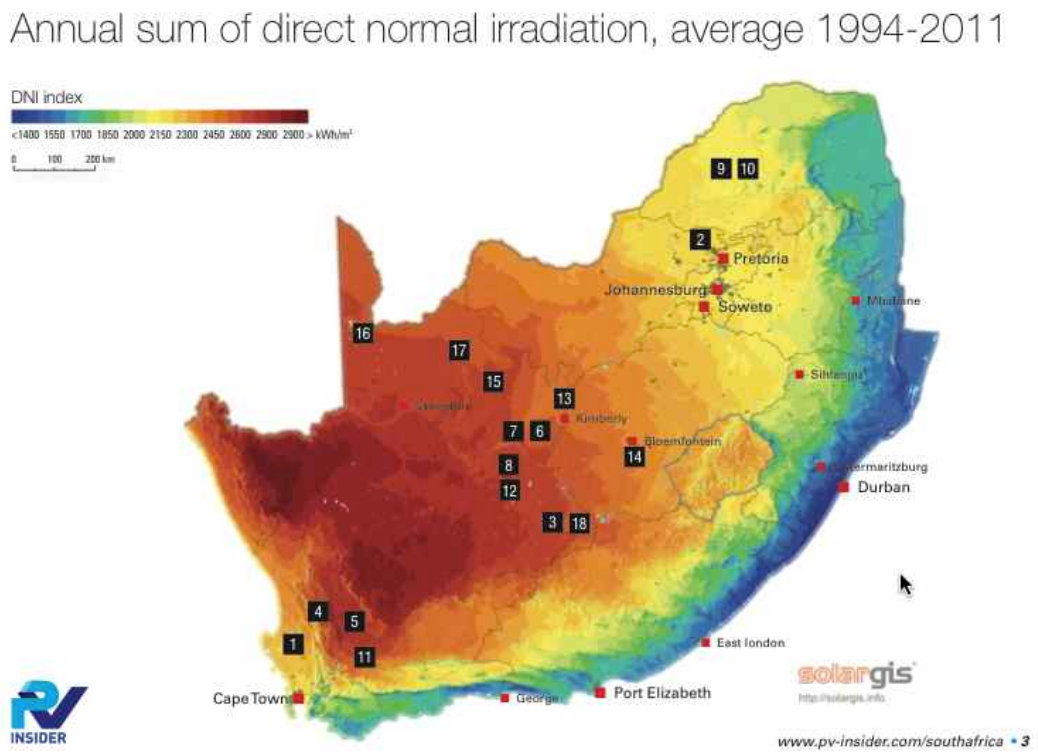


Figure 14: PV Plants Map South Africa 2012. Source: http://www.greenbusinessguide.co.za/pv-plants-map-for-south-africa/

1. Swartland, Western Cape (5.6 MW)
2. Rustenburg, North-West Province (6.8 MW)
3. De Aar, Northern Cape (9.7 MW)
4. Pofadder, Northern Cape (9.7 MW)
5. Kenhardt, Northern Cape (9.7 MW)
6. Douglas, Northern Cape (10 MW)
7. Douglas, Northern Cape (19.9 MW)
8. Prieska, Northern Cape (19.9 MW)
9. Waterberg, Limpopo (28 MW)
10. Waterberg, Limpopo (30 MW)
11. Aquila Private Game Reserve, Touwsrivier, Western Cape (36 MW)
12. Pixley Ka seme, Northern Cape (48.3 MW)
13. Kimberley, Northern Cape (48.3 MW)
14. Bloemfontein, Free State (64 MW)
15. Postmasburg, Northern Cape (64 MW)
16. Kaklbult, North-West Province (72.5 MW)
17. Kathu, Northern Cape (75 MW)
18. De Aar, Northern Cape (75 MW)

Wind Energy

Wind power involves converting wind energy into electricity by using wind turbines. A wind turbine is composed of 3 propellers-like blades called a rotor, which is attached to a tall tower. On average wind towers are about 20m high to reach the strongest winds.

In the White Paper on the Renewable Energy Policy of the Republic of South Africa (2003) and supported within the National Climate Change Response White Paper (2011), the government sets out a vision, policy, goals and objectives for promoting and implementing renewable energy in the country. In order to meet the long term goals of renewable energy, government set a 10 year renewable energy target of 10 000GWh renewable energy contribution by 2013, to be produced mainly by biomass, wind, solar and small scale hydro**.** This constitutes approximately 4% (1667 MW) of the estimated demand in South Africa.

In 2008, a private developer identified a number of potential wind farm development sites in the Western Cape and Northern Cape provinces. These sites are currently in the first phase of wind monitoring further to a lengthy process of securing privately owned sites and negotiating with land owners to make their sites available for wind farm development.

The identified potential capacity of these sites is in the order of 1 000MW and would contribute substantially to government's objective of 10 000GWh. The capacity factor in this area compares favourably with Australian and European sites. The major challenge to develop these sites remains connection to the national grid and reaching agreement with the major off-taker with regard to price and general support of the industry.

Figure 15: Wind Turbines located on the Darling Farm in the Western Cape of South Africa. !

Tidal Energy

Tidal energy is the power achieved by capturing the energy contained in moving water in tides and open ocean currents. Tidal power is classified as a renewable energy source, because tides are caused by the orbital mechanics of the solar system and are considered inexhaustible. Tidal power has great potential for future power and electricity generation because of the essentially inexhaustible amount of energy contained in these rotational systems.

South Africa as a country has large potential in generating electricity through this mechanism as it offers a large coastline with many bays and lagoons which can be used to generate tidal energy. There are many large cities that are located on the coast and would benefit greatly from this kind of power generation.

South Africa has only one nuclear power station, and therefore we rely fully on fossil fuels for our electrical power. Therefore this is a considerable solution due to the significant benefits from this renewable energy source.

Chapter 6: International financing mechanisms

International financing options and related mechanisms

Leveraging international finance is one of the crucial and decisive steps in accomplishment of sound and feasible energy conservation and renewable energy generation projects. Based on the activities to be undertaken in the purview of the project, financing varies in tune with factors like scale, technology employed, economic feasibility and the institutional set up in support of the project. Due to the fact that renewable energy projects have long gestation periods and the returns are usually envisioned with long term perspectives, financing these projects require high initial capital with long term investment. In addition to private capital markets, international bi-lateral or multi-lateral support comes into play to sustain local renewable energy and energy efficiency projects.

International donor organizations such as United Nations, World Bank, European Commission, and REEEP have endeavoured to unlock the collaborative funding potential for renewable energy and energy conservation projects. Some of these international financing options for renewable energy (RE) and energy efficiency (EE) projects are enlisted here along with explanation of their funding mechanism.

1. Green or Clean Energy Bonds and Investment Services

Clean Renewable Energy bonds are unique lending mechanisms for public entities investing in renewable energy projects. Local authorities and implementing agencies issue financial bonds to the public and receive interest free capital. Bond holders are either compensated through the payment of interest or tax credits. This mechanism is viable only if the investing agency is large enough to attract the requisite number of investors. Internationally, these bonds are issued by globally operative banks such as European Investment Bank (EIB), governmental bodies or groups of governments. Bonds offer tax holidays and rebates and are funded via international capital markets, in the case of EIB, additionally through its Green Bond instrument. EIB issues 'Climate Awareness Bonds' to finance projects within the fields of renewable energy and energy efficiency. Issuance of bonds precedes the acquisition of a reasonable credit rating for the project through credit agencies like CRISIL, CARE etc. This requires robust project planning including comprehensive analysis of associated risks and forecast of financial resources over the course of the project.

International Finance Corporation (IFC), the financing arm of World Bank also has a number of financing products and investment services under its funding portfolio. IFC mainly aims at promoting sustainable enterprises, encouraging entrepreneurship, and mobilizing resources that would not otherwise be available. These funds can be leveraged by encouraging entrepreneurial organizations to invest in renewable energy and energy efficiency projects.

2. Carbon Finance

As one of the popular options for Carbon finance, Clean Development Mechanism (CDM) offers an international platform for trading Carbon emission reductions through exchange of Certified Emission Reduction certificates (CERs) between countries. Once registered, the

project is monitored for the actual emission reductions annually and CERs generated thereof are exchanged to receive funding.

ICLEI in partnership with UN Habitat have published a tool in 2012 specifically focusing on *'Making Carbon Markets Work for Cities: A Guide for Cities in Developing Countries'*, which seeks to enhance the capacity of local government officials to initiate, develop and manage GHG reduction projects, and to get the carbon financing they need.

3. Public Finance Mechanisms

Some funding bodies like Global Energy Efficiency and Renewable Energy Fund (GEEREF), which are collaborative multi-lateral investment agencies, focus on renewable energy and energy efficiency projects and invest in private equity funds specializing in equity finance for SMEs. Availing these funds entails a track record of RE and EE projects which have not just been financially but also environmentally sustainable. Direct financing isn't possible with this funding option but can be deemed as a sustainable one as it targets financing the local small and medium RE and EE industry.

Alternatively, leveraging the private capital market through commercial loans is a viable option and helps the local governments fund projects. . In considering a project for commercial bank financing, banks assess the local authority's cash flow and financial viability. Where the credit worthiness of the local authority is in question, a credit guarantee may be required, which could be provided either through the state/province or a third party.

A more self-reliant means of funding local projects is through the self-financing model wherein the local authorities fund renewable energy implementation through granted municipal funds or taxes collected by the local authority. Special investment funds for renewable energy projects may also be set up in conjunction with the state/provincial government. Tax and tariff collections could also be used to self-finance these projects. Factoring in investment recovery is critical, as failure to recover costs directly impacts utility earnings and viability of the investment; also sending a discouraging message for further investments.

4. Energy Certificates

Renewable Energy Certificates (REC) and Energy Efficiency Certificates (EEC) are also a secure means of availing funding by presenting the energy generation/savings potential of the projects. Tradable certificates for every basic unit of energy generated (1 MWh) from RE projects or saved under EE projects can be exchanged for funds in national or international markets. Basically meant to be an easy method of reducing emissions for countries lacking RE potential or lacking the infrastructure to do so, the REC and EEC mechanism enables revenue flow fairly easily by trading the benefits obtained from the projects. Once the REC or EEC has been sold, it ceases to be accounted as an emission reduction achieved under the inventory of the entity which has sold the certificate.

Other funding options may by availed through Regional Development Banks (like Asian Development Bank for the Asian and South Asian region), Development Finance Institutions (DFIs) etc.

References

ABB. 2011. South Africa Energy Efficiency Report: Trends in global energy efficiency 2011. Online. Available: http://www05.abb.com/global/scot/scot316.nsf/veritydisplay/9344c8ededc6aa2fc12578640051aed8/$file/south%20africa.pdf [27 July 2012]

ASSAF. 2011. Towards a Low Carbon City, focus on Durban.

Boden, T.A., G. Marland, and R.J. Andres. 2010. Global, Regional, and National Fossil-Fuel CO2 Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001_V2010

Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Online. Available: http://www.eoearth.org/article/IPCC_Fourth_Assessment_Report,_Working_Group_III:_Chapter_4 [25 April 2012].

EMM. 2011. Ekurhuleni Metropolitan Municipality Full Term Report 2006-2011.

Eskom. 2011. Eskom Fact Sheet. Online. Available: www.eskom.co.za/dsm [3 May 2012]

Fall. 2007. "Tackling the obstacles for Energy Sustainability for Africa", Global Forum on Sustainable Energy GFSE-6th, 29 November – 1 December, Vienna, Austria.

Gunn, A. 2007. A critical assessment of South Africa's legal obligations under the international climate change regime and domestic environmental legislation and suggestions for the creation of an enabling regulatory framework.LLM Research Report. University of the Witwatersrand. Online. Available: http://www.environment.co.za/environmental-laws-and-legislation-in- south-africa/ [19 April 2012].

IEA. 2006. Key World Energy Statistics. Online. Available: http://www.iea.org/textbase/nppdf/free/2006/key2006.pdf [25 July 2012].

IEA. 2009. Key World Energy Statistics. Online. Available: http://www.iea.org/textbase/nppdf/free/2009/key_stats_2009.pdf [23 April 2012].

IEA. 2010. Key World Energy Statistics. Online. Available: http://www.iea.org/textbase/nppdf/free/2010/key_stats_2010.pdf [23 April 2012].

IES. 2010. International Energy Statistics. Online. Available: http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=90&pid=44&aid=8 [25 April 2012].

IMF. 2010. International Monetary Fund: Chapter 2: Country and Regional Perspectives. Online. Available: http://www.imf.org/external/pubs/ft/weo/2010/02/pdf/c2.pdf [25 July 2012].

IPCC Glossary Climate Change. 2001. The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Available. [Online]: http://www.grida.no/climate/ipcc_tar/wg1/518.htm. [12 July 2010].

IPCC. 2007a. Climate Change 2007: The Science Basis. Contribution of Working Groups I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In S. Solomon, D. Qin, M Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tognor and H.L. Miller, eds Cambridge University Press.

IPCC. 2007b. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Core Writing team, Pachauri, R.K and Reisinger, A (eds) IPCC, Geneva, Switzerland.

IPCC .2007c. (Boko, M., I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman-Elasha, R. Tabo and P. Yanda) Africa. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge UK, 433-467.

Jacobson, M.Z. 2009. Review of Solutions to Global Warming, Air Pollution, and Energy Security p. 4.

Jollands, N. 2008. Chapter 6: Cities and Energy. World Energy Outlook 2008. International Energy Agency. Online. Available: http://www.oecd.org/dataoecd/54/18/42544964.pdf [25 July 2012].

KPMG, 2010. Carbon Disclosure Project: South Africa's Carbon Chasm. Based on Carbon Disclosure Project 2010 responses from the JSE 100 Companies. Online. Available: https://www.cdproject.net/CDPResults/south-africa-carbon-chasm.pdf [26 March 2013]

Litman, T. A., 2011. Win-Win Transportation Emissions Reduction Strategies. Online. Available: http://www.vtpi.org/wwclimate.pdf [3 May 2012]

NERSA. 2006. Electricity Supply Statistics for South Africa. Online. Available: http://www.nersa.org.za/Admin/Document/Editor/file/News%20and%20Publications/Publications/Current%20Issues/Electricity%20Supply%20Statistics/Electricity%20supply%20statistics%202006.pdf [25 July 2012]

PowerSavings. 2012. Energy Saving Tips. Online. Available: http://www.savingpower.co.za/index.php?q=con,13,%20Power%20Usage [3 May 2012]

ScienceDaily. 2009. Ways To Reduce Carbon Dioxide Emissions From Transport. Online. Available: http://www.sciencedaily.com/releases/2009/07/090727080836.htm [3 May 2012].

SEA. 2006. State of Energy in South African Cities.

South Africa Country Report, 2011

Statistics SA. 2011. South Africa Population Statistics: StatsOnline. Online. Available: http://www.statssa.gov.za/publications/populationstats.asp [23 April 2012].

Trading Economics. 2012. Urban population (% of total) in South Africa Online Available: http://www.tradingeconomics.com/south-africa/urban-population-percent-of-total-wb-data.html [25 April 2012].

WEC. 2006. “Energy Policy Scenario Study to 2050 – All Africa Data”, Draft report for Africa”.

World Bank. 2010. World Bank Population Data Sheet. Online. Available: http://search.worldbank.org/all?qterm=population%20data [23 April 2012].

World Bank. 2012. Energy in Africa. Online. Available: http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/EXTAFRREGTOPENERGY/0,,contentMDK:21460357~pagePK:34004173~piPK:34003707~theSitePK:717306,00.html [25 July 2012].

Worldstat info, 2011. Online. Available: http://en.worldstat.info/ [27 March 2013]

UN. 2010. "World Population Prospects: The 2010 Revision". Department of Economic and Social Affairs, population division. United Nations. Online. Available: http://esa.un.org/unpd/wup/index.htm [23 April 2012].

UN Habitat. 2010. State of the World’s Cities 2010/2011: Bridging the Urban Divide. United Nations Human Settlements Programme. Online. Available: http://www.unhabitat.org/documents/SOWC10/R7.pdf [27 March 2013]