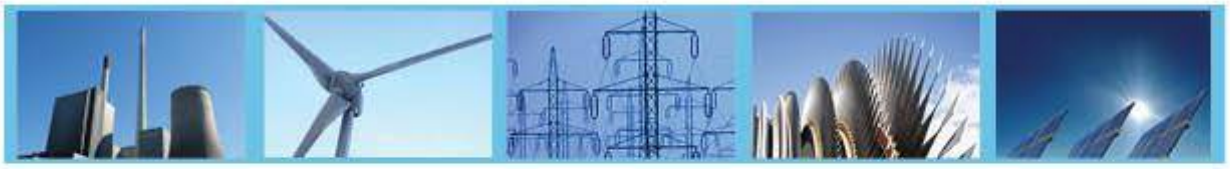


The EnerKey Liliesleaf Action Plan

A cooperative action plan
for a low carbon and sustainable
Global City Region of Gauteng, South Africa

EnerKey

Authors:
Ludger Eltrop, Ulrich Fahl, Harold Annegarn, Sheetal Marathe, Thomas Telsnig, Doruk Özdemir, Jan Tomaschek, Thomas Haasz, Michael Knoll, Johannes Rupp, Audrey Dobbins, Ralf Kober, Yuriy Losinski, Bertine Stelzer, Simon Wössner

Partner institutions:
- University of Stuttgart, Institute of Energy Economics and the Rational use of Energy (IER), Stuttgart, Germany
- University of Johannesburg, Department of Geography, Environmental Management and Energy Studies (GEMES), Johannesburg, South Africa
- Institute for Future Studies and Technology Assessment (IZT), Berlin, Germany
- TÜV Rheinland Group, Cologne, Germany
- Fraunhofer Institute for Building Physics (IBP), Stuttgart, Germany
- INEP Institute Oldenburg GmbH, Oldenburg, Germany

Responsible Author and Editor:
Dr. Ludger Eltrop, IER, University of Stuttgart
Hessbruehlstr. 49a, 70565 Stuttgart, le@ier.uni-stuttgart.de
www.enerkey.info

April 2016

The EnerKey project is funded by the German Ministry of Education and Research (BMBF) and by SANEDI (formerly SANERI), South Africa and the University of Johannesburg.

SPONSORED BY THE
Federal Ministry of Education and Research

UNIVERSITY OF JOHANNESBURG

saneri

The EnerKey Liliesleaf Action Plan

A cooperative action plan for a low carbon and sustainable Global City Region of Gauteng, South Africa

compiled by

The EnerKey team*

For more information please consult

www.enerkey.info

April 2016

*see list of authors and contributors;
responsible Author and Editor: Dr. Ludger Eltrop, IER, University of Stuttgart, Hessbruehlstrasse 49a, 70565 Stuttgart, Germany

Acknowledgements

This work is an output of the EnerKey megacity project, conducted by a research team in Germany and South Africa throughout of five years of research in Gauteng, South Africa. The idea to compile such an action plan for an intensified climate protection and sustainable energy structures grew during project workshop held at Liliesleaf in Rivonia, Johannesburg. It was the idea to take the ideas and results of this workshop to a wider and public audience. Since then, the presented proposal has gone through various additions

The authors would like to thank Prof. Harold Annegarn (University of Johannesburg) for his great support and useful advice throughout the project. The authors would also like to extend their thanks to all South African participants and project partners from various government departments (Gauteng provincial government, GDARD, GDLH, DED, the Energy office of Gauteng, City of Johannesburg, City of Ekurhuleni and City of Tshwane,), research organisations (University of Johannesburg, University of Pretoria, SANEDI, CSIR, HSRC), NGOs (Peer Africa, Sustainable Energy Africa-SEA, SESSA, PSASA) and industry partners (ESKOM, Novo Energy, Prime Africa) for their valuable time and contribution to the successful EnerKey project.

We also thank all donors, who have supported the project partners throughout a long funding period, namely the BMBF in Germany and SANEDI and the NRF in South Africa. The University of Johannesburg has given a tremendous support on various levels, including a substantial amount of money, which was one of the key factors for the successful cooperation between the German and South African teams.

Last but not least we like to thank all students, scientists, co-workers and participants of the various working groups in both countries for their cooperation. Beyond the technical achievements the German-South African cultural understanding is one of the winners of this project.

Contents

I. The EnerKey Liliesleaf Action Plan

The Entry Point

With 12.3 million residents (Stats SA, 2012[1]) and a strong economy, Gauteng is South Africa's most urbanised province and the country's economic hub. Within its limits three metros, Johannesburg, Ekurhuleni and Tshwane and two district municipalities, which are further subdivided into seven local municipalities, form a strong and attractive region. The region itself is densely interconnected and competing on a worldwide level for a competitive 'Global City Region' (GCR). Yet, with an area of just over 18,000 sq. km Gauteng is also South Africa's smallest province. Due to the high population growth and the intense economic activity, energy supply and energy supply security are main issues, strongly questioned in the past through shortage in generation capacity and lack of efficient energy saving measures.

Because energy generation is mainly built on coal, Gauteng also has a high CO_2 emission profile. However, many activities are under way to reduce this burden and improve the sustainability of the energy system as a whole. Within this technical-economic framework, it is evident that the social questions need to be regarded and solved with preference. The income disparity is still vast! Almost two thirds of the households are considered poor or belong to the lower income groups (< 76.800 ZAR/a). Many people live in low-grade houses with poor comfort and lack basic services such as water and sanitation. Thus, solutions for a better energy infrastructure, a stronger implementation of clean renewable energy technologies and socially sensitive government actions are a permanent need and challenge.

The EnerKey Project

In order to address the energy challenges and to get prepared for a more sustainable future, German and South African organizations partnered since 2005 to research and develop specific solutions for Gauteng. The partner network includes research institutions, universities and businesses, all working together to meet key social, economic, and environmental objectives within the energy sector of Gauteng and South Africa. The project, titled EnerKey ("Energy as a key element of a sustainable development of Gauteng") started in May 2008 and ended in August 2013. Within this project, German-South African research teams worked in the areas of building energy, transport, renewable energy technologies, urban development, and energy policy.

A larger part of the work was on energy modelling and developing tools to invest further into sustainable technologies and policy measures. With the modelling results, possible pathways for the energy future of Gauteng, taking into account the priorities of economic development and climate protection, were evaluated.

Also the spatial patterns of energy use and generation in Gauteng were investigated. As a practical validation of the research work a number of pilot studies, such as the 'building energy performance certification' or the 'schools project' were conducted.

The "Liliesleaf" Action Plan

From this work numerous results, conclusions and experiences have evolved (see the EnerKey book, Eltrop et al 2015). Starting at a project conference in Liliesleaf in Gauteng, in 2010, the idea was developed to summarize the results in something that became the "Liliesleaf Action Plan" for Gauteng. Just as Liliesleaf is a place of liberation and a sign of equal treatment of all people, this plan seeks to develop a system of a fair, just and equitable supply of energy for all. However, the authors cannot say that solutions were found for every challenge and every purpose. Being a mainly research driven project, only a selection of important issues were tackled. Main conclusions and results from the research work are presented in this action plan and the booklet at hand. It is not a complete and consistent action plan, but a list of the main findings and conclusions the involved researchers and participants have drawn out from their work. Certainly, many more ideas exist or

[1] Stats SA, 2012: Census Survey carried out in 2011. Statistical release for Statistics South Africa, Pretoria

have been expressed in other literature. The present proposals were developed based on the evidence of research work, not of consultancy or paid services.

The development of the action plan is also an open process. Over time the recommendations may be altered, amended and optimized. The authors are open for any discussion and comments and wish a good recognition and implementation of the recommended actions.

Overall recommendations

From the work a number of overall recommendations and observations were drawn:

1. A **low carbon province is possible**! The "green economy" is the right way for Gauteng! Scenarios show that economic development and poverty alleviation harmonise well with an 'energy transformation' and a 'climate protection' strategy. The strong economic powerhouse of Gauteng will profit from this strategy in the long run through competitive products and services.
2. The **potentials of renewable energies** and energy efficiency inside Gauteng province are high! For an even higher penetration of such energy technologies a cooperation with the 'rest' of South Africa is necessary and useful.
3. **Suitable technologies are available** and are getting economical and competitive more and more. However, they need to be adjusted constantly to serve the social and socio-economic challenges in Gauteng best.
4. A cooperation of partners from the public sector, businesses, the civil society and research/ universities in **"innovation clusters"** is an important driving factor for the green economy! Municipalities and the local administrations have an important function to drive this development.
5. Gauteng Province should take a strong lead in driving the green economy within **a regional network of cities**. The efforts of the cities and municipalities in Gauteng will have an even stronger impact within a strong and harmonized regional approach.
6. Key for this development is to set **ambitious but appropriate targets**! Implement a clear monitoring plan and intermediate milestones to reach your target.
7. Look for a **high level political support and leadership** (mayor, councillor, etc.). Measures are getting a real impact if they are politically backed on a high level.

II. Key Areas and Recommended Actions

Key Areas of the Action Plan

According to the working areas of the EnerKey project the recommended key areas and proposed activities are concentrated in the following topics:

1. Governance – setting the right incentives
2. Government – leading by example
3. Liveable buildings - building an inclusive environment
4. Transport and mobility - integrating the needs
5. Industry – using 'Best Available Technologies' (BAT) and creating a dedicated agency
6. Energy supply systems – taking advantage of regional and renewable resources
7. International cooperation - strengthening the Global City Region
8. Land use and urban development – keeping a balance

For each of these key areas concrete recommendations for activities are given and listed. Out of this list up to three activities (the 'recommended actions') are described in detail. They form the prioritised actions and a subjective selection of important activities.

The key activities are also marked in terms of their potential for:

a. economic development, employment and creating added value, and
b. climate protection, i. e. CO_2 mitigation or adaptation

These potentials are flagged in a three colour coding system:

+ High potential and high priority measures; high impact and effectiveness

× Medium potential measures, to be implemented within a strategy

± Lower potential measures, rather 'nice to have' than 'compulsory'

Key areas and key actions for the EnerKey Liliesleaf Action Plan

Key Areas		Key Actions
	1. Governance - setting the right incentives	**1.1. Leadership** by the Premier's office and other higher level decision makers **1.2. Innovation and knowledge transfer by integrated modelling** and monitoring of demonstration and best practice projects **1.3. Integrated regional planning** and empowering of the "Gauteng Energy Office"
	2. Government – leading by example	**2.1. Energy Detectives Club in Schools:** Education and raising awareness through capacity building **2.2. Efficient and better lighting for all:** Street and traffic lights with LEDs **2.3. Strengthening the facility manager:** Monitoring and Energy Performance Certificates with the help of the facility managers
	3. Liveable buildings – building an inclusive environment	**3.1. EnerKey Performance Certificate:** Introduce and establish the certificate for residential buildings **3.2. Sustainable Low Income Housing:** New buildings to comply with advanced energy efficient building standards **3.3. Appliances for modern living:** Solar Water Heaters - A solution to the increasing hot water demand in Gauteng
	4. Transport and mobility – integrating the needs	**4.1. More stringent emission standards:** Faster implementation and of Euro 5 and Euro 6 emission concepts for new vehicles **4.2. Re-fuelling the transport sector:** Decreasing transport GHG emissions by utilizing alternative fuels and vehicle powertrain concepts **4.3. Integrated public transport:** Maximise benefits from existing systems and make new ones perform better
	5. Industry – using Best Available Technologies and creating a dedicated agency	**5.1. Best available technologies (BAT):** Use of efficient technologies, especially in energy intensive sub-sectors and industrial technology efficiency standards, and improve the cycle pathways **5.2. Establish a Gauteng energy efficiency and climate protection agency (GEECA):** Coordination, information and awareness through an energy efficiency and climate agency
	6. Energy supply systems – taking advantage of regional and renewable resources	**6.1. Install renewable energy capacity and energy efficient technologies** **6.2. Mobilising (bio-) waste as a municipal resource** and creating a mind-shift from "waste" to "resource" **6.3. A regional regulatory framework:** Setting up a "Gauteng Renewable Energy Independent Power Producer Procurement Programme" (GREIPPPP)
	7. International coope-ration – streng-thening the 'Global City Region'	**7.1. Research and innovation:** Strengthen international research projects and innovation based demonstration projects **7.2. CDM and new emission trade instruments**
	8. Land use and urban development – keeping a balance	**8.1. Enforce stricter spatial planning regulations:** Limit urban sprawl through compacter city development **8.2. Integrate urban development:** Support urban development along transport corridors; promote mixed income communities **8.3. Implement sustainable social housing projects:** Include environmental aspects in RDP tendering and install (iEEECO™) showcases

Key Area 1:
Governance – setting the right incentives

Present Situation and Entry Point

In the context of sustainable energy supply and climate protection many strategies were developed within Gauteng Province, among them the regional strategies "Gauteng Integrated Energy Strategy" (GDLGH, 2010) and the "Gauteng Climate Change Response Strategy" (GDARD, 2012). Both being chaired and approved by the respective departments (Gauteng Department of Local Government and Housing - GDLGH and Gauteng Department of Agriculture and Rural Development - GDARD). These strategies are recognized by other departments, but not fully incorporated and implemented in Gauteng yet:

- There is no central information and transfer institution on energy technologies and renewables
- a collaboration of University with Government or Business institutions in an applied research approach is still rare

In order to pursue a coherent and broadly accepted strategy, the EnerKey research team proposes to establish a societal process chaired by the Premier's Office, with participation of all departments and a broad stakeholder and civil society involvement.

Proposed Actions

	Potential for Economic develop.	Potential for climate protection
A) Activities and measures with a high priority and impact: + (for details see following chapter)		
1.1. Leadership by the Premier's office and other higher level decision makers	+	+
1.2. Innovation and knowledge transfer by integrated modelling and monitoring of demonstration and best practice projects	+	+
1.3. Integrated regional planning and empowering of the "Gauteng Energy Office"	+	+
B) Activities and measures with a medium priority and impact: ×		
1. Coordination and bundling decisions and actions between departments	×	+
2. Initiate a stakeholder process with experts coming from the energy and climate-change area and having different professional and/or academic backgrounds to define an energy and climate protection future for Gauteng. Goal of this process is to exploit different perspectives and opportunities of public and private actors and civil society to come up with an accepted vision.	±	×
3. Explore strategic options under a long-term perspective, which are consistent with long-term trends and requirements. During the EnerKey program this task was realized through the EnerKey Long-term Perspective Group (ELPG). This dialogue format of bringing together stakeholders and decision makers was successful to specify research questions (priorities, linkage with other research fields), develop implementation strategies (dissemination into institutions, recommendation for	×	×

pilot actions, broad diffusion) and feed-in regional expertise into research and implementation processes.

4.	Underline the vision with a roadmap, unfolding concrete interventions, measures, actions (funds, legislation, responsibilities, self-commitment, PPP)	×	×
5.	Integrate research in different phases of the process to create system knowledge, e.g. through integrated modelling. Direct knowledge through a future-oriented stakeholder dialogue process (such as the ELPG) and transformation knowledge through research accompanied pilots and roll-outs.	±	×
6.	Define evaluation criteria and monitor the process.	×	×
7.	Establish a modelling group/community on a provincial level applying and developing the TIMES GEECO Model.	×	+
8.	Establish strategic energy modelling (TIMES) courses as part of Bachelor / Master programs at the Universities in Gauteng.	×	×

C) Activities and measures with a lower overall priority: ±

9.	Include the Energy Efficiency Hub at UP as foundation for provincial strategies and capacity building.	×	+
10.	Research local and regional climate change impacts and effects of human behaviour	×	+
11.	Establish and conduct an "Annual Gauteng Energy Day" with participants from all spheres of societal activities.	±	×
12.	Create and publish an annual "State of energy and climate protection report"	×	+

+ High priority and impact; × : medium priority and impact; ± lower priority and impact

Key Actions with high priority in Area 1 "Governance"

Detailed descriptions

Key Action 1.1: Leadership by the Premiers office and other high level decision makers

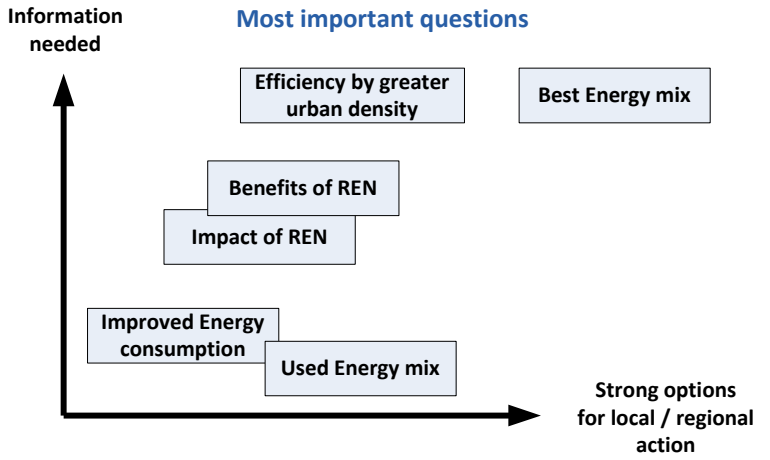
Proposed actions:

- Establish an energy and climate change office as an cross-cutting issue at the Premier's office
- Continue the "Long Term Perspective Group" (LTPG) as a strategic think tank for decision makers
- Create an enabling environment for regional "innovation clusters" of business and research
- Accelerate the entrepreneur and business development support for your entrepreneurs

Energy and climate change are issues that are transverse to sectoral policies and administrative fields. Sectoral policies focus usually on a specific area and do not question, or only insufficiently, which impact decisions have on other policies or if they possibly conflict with medium- and long-term goals. But if energy and climate change are seen as important tasks for improving the living conditions and preservation of livelihoods in Gauteng, these issues must be a top priority. Between departments there must be collaboration and decisions must be coordinated and bundled and beyond the long-term effects have to be analysed. This kind of cooperation needs political leadership and this must come from the top of government - the Premier.

Through the proclamation by the Premier decisions become more meaningful.

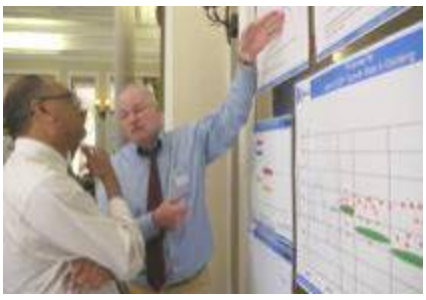
An advisory board can take over the task of preparing for important cross-cutting decisions. A broad participation of stakeholders from provincial departments and cities, business, research and civil society will improve the information base for decisions, their coherence and consistency, and increase their legitimacy.



© IZT

REN = Renewable Energy Technologies

© IZT



© IZT

© IZT

The Long-term Perspective Group (LTPG): A Think-Tank for Decision Makers

The LTPG is supposed to be a body for high level decision makers to discuss innovative ideas in an atmosphere without pressure, to assist in implementing technologies, communication, systems and research tasks and to include a long term sustainable perspective. The LTPG is to serve as a platform for the exchange and the open

discussion of these new and innovative ideas and activities. Thus it forms a strategic think tank, where decision makers may discuss new ideas without the pressure of the everyday working schedule.

The involved decision makers and experts may come from policy, administration, businesses, the civil society and other deciding institutions from the energy and climate-change area and may have different professional and/or academic backgrounds. The aim is to incorporate the views and wishes of key stakeholders into the strategic development in a participatory manner and to communicate across sectoral boundaries (government, academia, private sector and civil society) about the challenges facing a low-carbon development in Gauteng. In the EnerKey project the ELPG (EnerKey Long Term Perspective Group) facilitated and catalysed the implementation of projects and incorporation into the existing frame.

The LTPG would ideally be held about two times a year to secure continuity, but not to be too demanding for decision makers in responsible positions.

Importantly, the LTPG would raise issues concerning the interaction between decisions made today and the consistency and coherence with long-term trends and sustainability requirements. In other words, the LTPG should explore strategic options from a long-term perspective. Eventually, an LTPG is also a catchment area for information sharing and disseminating. Thus, with a broad stakeholder involvement the LTPG stands in the tradition of participatory planning and is aligned with strategic developments and long term planning.

Examples and Best-Practice of Stakeholder Processes in Gauteng

Stakeholder interactions are well incorporated into contemporary South African political culture. For instance, the drafting of strategy papers by the three governmental tiers is often accompanied by a stakeholder consultation phase, either to collect ideas, receive feedback, set priorities or stimulate stronger stakeholder involvement in follow-up or implementation processes.

Due to their political mandates, some of these initiatives were of special interest for EnerKey. So, parallel to the research project, stakeholder consultation took place during the drafting of the Gauteng Integrated Energy Strategy (GIES), the Gauteng Climate Change Response Strategy and the Gauteng 2055 Development Strategy (GDLGH 2010, GDARD 2012, GPG, 2012).

Target group and sector	Government, all departments, diverse stakeholders from business to civil society
Resource and Energy Potential	not quantifiable; high impact likely
Energy issues addressed	- Setting and communicating goals - Coordination between departments regarding activities and priorities - Embedding stakeholders to create ownership
CO_2 reduction potential	not quantifiable; high impact likely
References, sources of information	Knoll, M. and Rupp, J. (2014): EnerKey Long-term Perspective Group (ELPG) – A format to introduce long-term thinking in today's decision-making. In: BERND Mahrin (edit.) (2014): Capacity Development GDLGH – Gauteng Department of Local Government and Housing (2010): Gauteng Integrated Energy Strategy. January 2010. Johannesburg. GDARD – Gauteng Department of Agriculture and Rural Development (2012): Gauteng Climate Change Response Strategy (GCCRS) and Action Plan. Updated draft version 28 September 2012. Johannesburg GPG – Gauteng Provincial Government (2012): Address by Gauteng Premier Nomvula Mokonyane on the occasion of the launch of the Gauteng 2055 discussion document, and the Gauteng 2055 public participation campaign. 24 May 2012. Johannesburg.

Key Action 1.2: Innovation and knowledge transfer by integrated modelling and monitoring of demonstration and best practice projects

Proposed actions:

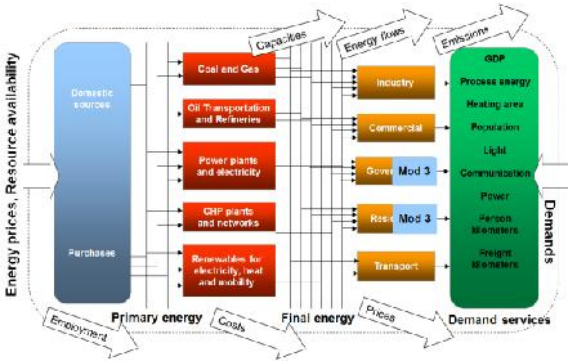
- Support a modelling and monitoring community for energy and environment
- Cooperate with stakeholders and all spheres of government
- Establish a regular discussion "Forum" or "Task Force

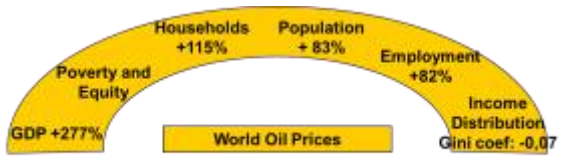
A forum for organising research on energy and environment related topics needs to be established. The forum may function as a hub for researchers and interested parties to share results, discuss challenges and current developments (e.g. in politics). The forum should be open to a broad spectrum of stakeholders, so that interaction and sharing of different perspectives and long-term thinking is possible.

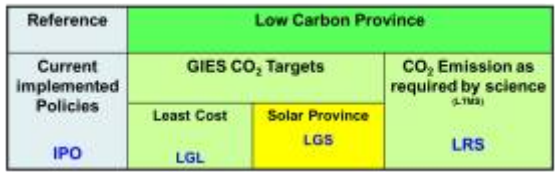
An important stakeholder group of this forum would be the modelling community from Gauteng that works with and further develops an integrated modelling instrument, i.e. the TIMES-GEECO energy system model. Through TIMES courses the EnerKey project built initial capacities but a larger modelling community is needed. Thus, modelling and even TIMES should be an integral part of a Bachelor or Master programme in Gauteng's Universities, supplemented by the energy efficiency hub at the University of Pretoria and a newly established institute for system analysis and renewable energy at the University of Johannesburg.

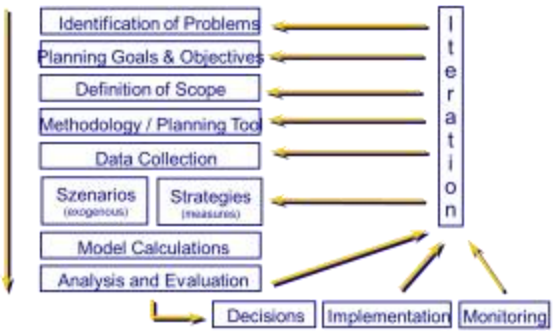
Starting with a yearly monitoring of Gauteng's attributable GHG emissions (e.g. EnerKey GHG inventory) and energy consumption the modelling community should also work on a roadmap that illustrates Gauteng's future energy and GHG emission targets and ways how to achieve these targets. The necessary data (monitoring) for the energy system modelling could be gathered in cooperation with GCRO and SANEDI (e.g. in the CESAR project). An annual "Gauteng Energy and Climate Conference (GECC)" should be held to disseminate the research results.

In this task Universities, research institutions, the public sector and others should work together to find common modelling conditions and frameworks





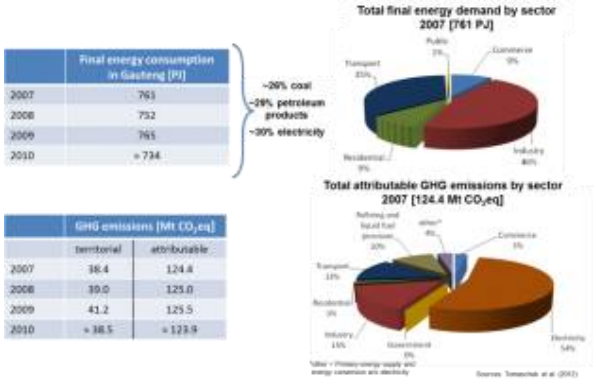
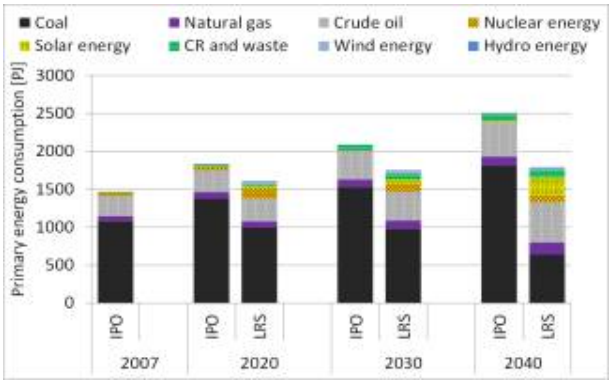




The Gauteng Energy and Emissions Cost Optimization model (TIMES-GEECO)

The Gauteng Energy and Emissions Cost Optimization model (TIMES-GEECO) was one of the central elements and outputs of M1 and has been developed as an energy system optimization model based on TIMES (The Integrated MARKAL-EFOM System). Various training courses have been given showing how to use and apply the model generator.

This model framework is applied to the regional level of Gauteng province. While TIMES-GEECO is a regional model, it also includes national infrastructures like power plants and refineries which supply the province but are not located within Gauteng's boundaries in order to account for greenhouse gas (GHG) emissions that are due to Gauteng's economic activity but are not emitted within the province. Various scenarios have been run through the model and extensive results are available. The model should be used for a continuous updating of the energy and emission balances for Gauteng. Furthermore, TIMES-GEECO can be used for evaluation of the implementation status of the proposed actions of this action plan and beyond.

The Gauteng Energy and Emission Balance 2007	Primary energy consumption by carrier in the IPO and LRS scenario
	

Target group and sector	Universities, researchers, students, politicians / government and interested stakeholders
Resource and Energy Potential	The establishment of a modelling community and a discussion forum would not directly influence greenhouse gas (GHG) emissions and energy consumption but it would raise awareness and contribute to a better informed society.
Energy issues addressed	Energy planning is an integral part of target definition and verification as well as implementation. It covers all sectors and energy carriers and is thus suited to provide an in-depth understanding of inter-linkages and interdependencies in the energy system. Furthermore, capacity building activities offer students perspectives and opportunities for future employment.
CO_2 reduction potential	The proposed measure does not offer a direct GHG mitigation potential but the monitoring of GHG emissions is important for the evaluation of future reduction measures and the formulation of GHG reduction targets.
References, sources of information	Tomaschek, J., Haasz, T., Dobbins, A., Fahl, U., 2012: Energy related Greenhouse Gas Inventory and Energy Balance – Gauteng 2007 – 2009. Institut für Energiewirtschaft und Rationelle Energieanwendung, Universität Stuttgart. 2012. Tomaschek Jan. 2014; Long-term optimizations of the transport sector to address greenhouse gas reduction targets under rapid growth - application of an energy system model for Gauteng province, South Africa. Dissertation IER, Forschungsbericht, Bd. 114

Key Action 1.3: Integrated regional planning and empowering of the "Gauteng Energy Office"

Proposed actions:

- Empowering of the "Gauteng Energy Office"
- Create win-win-situations
- Establish routine information with modern communication pathways

With the establishment of the Gauteng Energy Office the institutional basis is placed for coordinated and concerted action to improve the energy efficiency and the development of renewable energy in the province.

Core objectives of the Energy Office should be (GDLG+H (2010)

- building effective partnerships and networks with all spheres of government and other key stakeholders in the Province and in SA
- support and foster implementation of the Gauteng Integrated Energy Strategy (GIES) and monitor the effectiveness of the strategy and the implementation process
- lobby for energy and climate protection action, to be more prominently featured within the principles of the policy and provided with a reliable budget, promote capacity building and awareness raising
- source and inform on adequate funding and financing of innovation and new technologies

GAUTENG PROVINCIAL GOVERNMENT

Energy Office

Background - The Gauteng Green Strategic Program

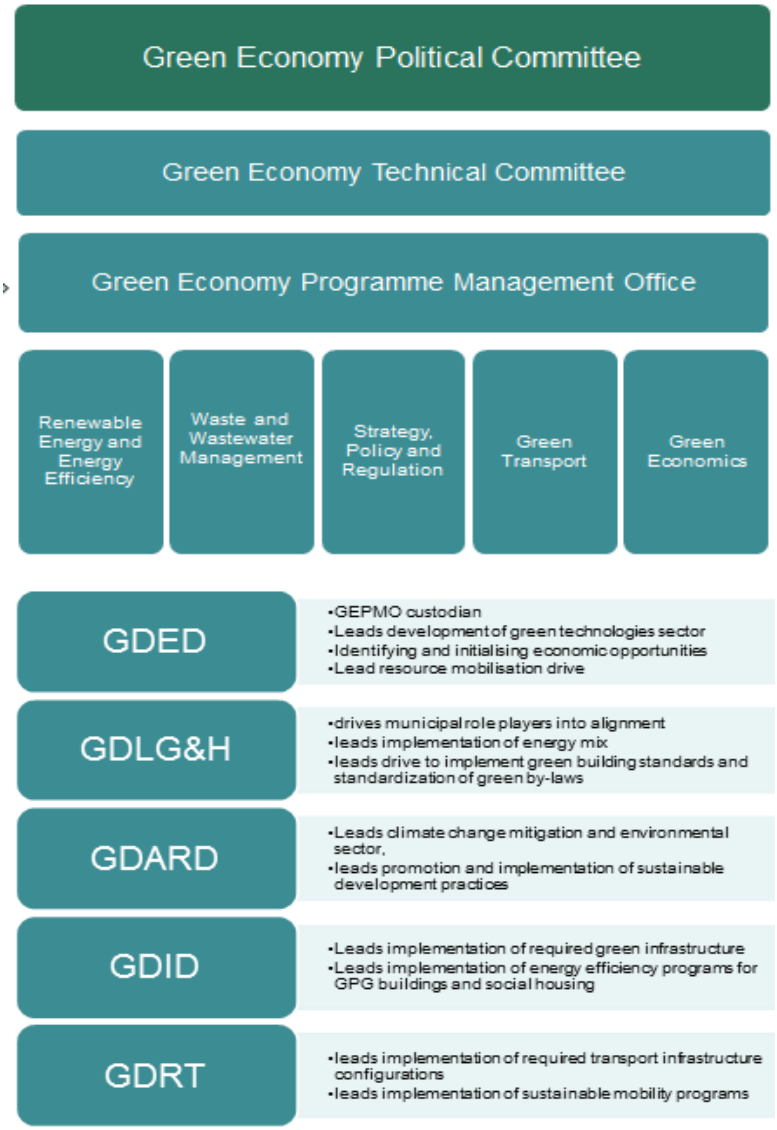
- The green economy is one of the key policy and growth path choices of the Gauteng Employment, Growth and Development Strategy, 2009-2014 (GEGDS).
- The Gauteng Provincial Department of Economic Development is tasked, through the Gauteng Green Inter-Ministerial Committee, to develop the Green Strategic Program for Gauteng.
- The Green Strategic Program for Gauteng comprises a consolidation of all the officially-approved green programs, policies, strategies and attendant targets produced by the GPG, Municipalities and local entities within Gauteng.

The Gauteng Green Strategic Program entails a multi-dimensional approach of growing the Gauteng Economy by transforming it into a low carbon usage, increased resource efficient and socially inclusive economy. This will be achieved by

- policy led interventions that aims to embed green economy principles into the Gauteng Developmt. path
- massive public investment in basic services + industrial production/consumption infrastructure, in order to create demand for green services and green jobs;
- enhancing innovation and developing new skills around green industries, manufacturing and production
- growing the economy by reducing resource consumption rather increasing resource consumption

Source: Ntombi Radebe, Gauteng Province, April 2013

Institutional arrangements (l) and stakeholders responsibilities (r)
in the Gauteng Green Economy Program



Source: Ntombi Radebe, Gauteng Province, April 2013

Target group and sector	Provincial Government, all departments, stakeholders from private sector, civil society and research
Resource and Energy Potential	Institutional Support
Energy issues addressed	All energy-related issues including energy efficiency and energy saving in all sectors, renewable energies and low-carbon technologies, information and education and, awareness rising in all spheres of society.
CO_2 reduction potential	Not quantifiable
References, sources of information	GDLG+H (2010): Gauteng Integrated Energy Strategy (GIES). Compiled by Sustainable Energy Africa. Radebe, Ntombi, 2013: Presentation at the EnerKey project meeting, Gauteng Province, April 2013.

Key Area 2:
Government – leading by example

Present Situation and Entry Point

The government itself represents only a smaller share in the overall economy, energy use and climate change impact. Nevertheless, the government (all over the world) plays a significant role in sustainable development and climate protection. Not because of its significant share in resource or energy share but because of its leading role and exemplary case. The buildings for governments play an important role in that.

Public buildings have a crucial role in the awareness raising for energy efficient buildings. Although they don't have a significant share in the overall energy consumption, their value is more that people need to go there and therefore see what is happening from an energy point of view. Energy Performance Certificates are a brilliant example. Not the fact, that there is a certificate in a building raises awareness, but the frequent spotting of those certificates make people aware and eventually look at them.

Public buildings and public lighting must lead by example. Why shall building owners' care for their energy performance, when government doesn't.

Proposed Actions

	Potential for Economic develop.	Potential for climate protection
A) Activities and measures with a high priority and impact: + (for details see following chapter)		
2.1. <u>Energy Detectives Club in Schools</u>: Education and raising awareness through capacity building	+	+
2.2. <u>Efficient and better lighting for all</u>: Street and traffic lights with LEDs	+	×
2.3. <u>Strengthening the facility manager</u>: Monitoring and Energy Performance Certificates with the help of the facility managers	+	+
B) Activities and measures with a medium priority and impact: ×		
1. Initiate an energy management system for the public buildings	×	±
2. Introduce Energy Performance Certificates in all public buildings. The facility managers shall create them.	×	×
3. Introduce an energy management system and link this information with a building registry. This can be started on a low level approach with the help of the maintenance staff.	×	±
4. Strengthening the role of the facility manager by adding responsibility for meter reading and rational use of energy in the building	×	×
5. Introduce Energy Detective Clubs in every school.	±	×

6. Training and capacity development to understand energy in the build environment using the EnerKey Adviser	±	×
7. Energy audits, Consistent assessment methodology and tools (EnerKey Adviser) Target group: Facility managers & consultants, coordinated by Energy Office	×	×
8. Office building (Gauteng Energy Office): Showcase for technologies and implementation	×	×

±

C) Activities and measures with a lower overall priority:

1. School Exchange Programme (Gauteng - Stuttgart)	±	±
2. Enforcement of Building standards	±	×
3. LED und CFL Lighting for all income groups	±	×
4. Capacity building in public sector	±	±

+ High priority and impact; × : medium priority and impact; ± lower priority and impact

Key Actions with high priority in Area 2 "Government"

Detailed descriptions

Key Action 2.1: Energy Detectives Club in Schools: Education and raising awareness through capacity building

Proposed actions:

- Establish learners and pupils groups in schools as "energy detectives"!
- Let the energy detectives identify energy problems and weaknesses at school and develop ideas and recommendations for solutions
- Support the 'energy detectives' with knowledge about energy and basic services like water etc.

School buildings as an important component of public buildings are eminently suitable for introducing energy efficiency measures. The idea of the Schools Project is to raise awareness on issues of energy efficiency and to encourage learners to understand where and how much energy is used in buildings.

Furthermore, saving energy and unnecessary expenditures on energy supply and the development of an integrated approach of improving energy provision are important objectives. The use of energy can be improved through behavioural changes (measures without investment) which lead to better learning conditions.

The best way to implement this in schools to let the pupils and learners teach themselves and get active about energy (and basic services) and environmental issues. Therefore an "Energy Detectives Schools Club" is a good way to activate the young scholars and to do something to solve a problem in a sustainable way.

Target group and sector	Government (Department of Education), schools, teachers, learners, parents, neighbours
Resource and Energy Potential	High impact potential. Through the change of user behaviour to energy efficient mind-set, the learners will be enabled to be multiplicators for their community.
Energy issues addressed	The Schools Project consists of several different activities, such as the School Exchange Programme through Skype and emails, the Energy Detectives Club, the training of energy officers, the compilation of energy and climate education material and a photovoltaic project.

	The School Exchange Programme started with partner schools from Stuttgart, Germany and Soweto, South Africa. For a more frequent exchange, the programme has to be shifted from international to national or local exchanges. The Energy Detectives Club was founded on a voluntary basis for interested learners. The club undertakes energy walkthroughs with an energy toolkit in the afterhours. The findings have to be shared with all learners, e.g. during a science day. EnerKey project partners organized components for a photovoltaic solar off-grid system that was installed on the roof of the Pace College in Soweto by local technicians.
CO_2 reduction potential	Significant reduction of energy use and CO_2 emissions through the change of user behaviour in the participating schools. The energy walkthroughs revealed a high potential of saving energy and CO_2 without any costs. The installation of the photovoltaic system will reduce electricity consumption and CO_2 emissions at Pace College in Soweto. The CO_2 savings are presented on a solar display in the school foyer.
References, sources of information	www.enerkey.info/images/stories/intern/module2/Documents/enerkey_education_material_2012_02.pdf U.S. Department of Energy Efficiency & Renewable Energy Energy education and workforce development. Project Learning Tree Energy & Society Activity Guide © American Forest Foundation.

Key Action 2.2: Efficient and better lighting for all: Street and traffic lights with LEDs

Proposed actions:

- Replace existing street lamp system with modern LED
- Record exemplary the energy consumption "before" and "after" the replacement
- Disseminate an experience report and explore opportunities for financial support for municipalities

The lamp systems are normally equipped with fluorescent lamps. These systems still have comparatively high energy consumption and due to the mercury used, have to be disposed as hazardous waste. Furthermore, the lamps' heat emission could have bad impacts especially on the working environment during summer times. By using the new lighting technology LED in the sectors of in house and outdoor illumination you can reduce the input electricity by the same luminance intensity. The LED technology can be install as a retrofit system or a new installation system, so it can be install in new buildings and in modernized buildings.

Replacing traditional street lights with LED lighting can reduce your energy usage and maintenance costs considerably. Also the light quality and output at the street level is improved. Key advantages of quality LED street lights include:

- higher color temperature and better white light
- longer life duration
- lower energy consumption
- reduced maintenance costs
- Instant-on, no run-up or re-strike delays
- No mercury, lead or other known disposable hazards, thus also a lower environmental footprint
- controls for bi-level lighting and other

www.theclimategroup.org

Target group and sector	Government, civil society and private sector
Resource and Energy Potential	The demand for electricity in South Africa is increasing steadily in recent years. Due to exhausted capacity, it always comes back to power outages, which result in enormous economic damage. It is estimated that by the year 2030, the electricity industry must double its capacity of 80,000 MW. In order to finance the expansion of power plants, Eskom, South Africa's dominant energy company, has announced massive increases in electricity prices. Eskom estimates that the current electricity prices from the current 0.45 Rand / kWh (0.03 € ct) are at 1.1 Rand / kWh (7.5 € ct) in 2020 to rise. The rising electricity prices lead more and more to the fact that the growing awareness of investments in energy efficiency measures. However, currently there is still reluctance and it remains to be seen whether the present electricity prices are already incentive enough for actual investments in energy efficiency technologies. In the different building types from private flats over public building to warehouses you have different potentials to reduce the energy consumption by illumination the objects. The biggest saving potential of lighting energy was in warehouse about 80% than offices, administration buildings and schools with roundabout 50% of energy saving potential. The LED lamps technology need up to 70% less electrical energy than conventional fluorescent lamps and the life time is up 10 times higher. The disposal of the LED lamp systems can be handled without any problems, so the general environmental aspects are better than other lighting systems.
Energy issues addressed	Calculation example for the energy efficiency of LED systems: General conditions and parameters for the calculation example: • Burning time of lamp systems in South Africa (Johannesburg): 4200 hour/ year • Energy cost : 5 ct/kWh • CO_2-Emission factor/ kWh : 0.550kg Example of a street lamp: • Conventional street lamp system with two lamps 125 W with HME total power of 284 W Result: • CO_2-Emissions: 645 kg/year • Electricity cost: 297 €/year Alternative system LED: LED lighting system with total electricity power 58 W with the same illumination density as the conventional street lamp system: Result: • CO_2-Emission of 125 kg/year • Electricity cost 122 €/year Total Savings: • 75% of CO_2 emission • 60% of energy cost
CO_2 reduction potential	The generation of electricity in South Africa is dominated by coal power plants. This is associated with extremely high emissions of harmful CO_2 emissions. By reducing the power consumption through energy efficiency measures, the national CO_2 emissions can be significantly reduced. So you have a high potential to reduce the CO_2 emissions by the installation of LED lamps in the different building types.
References, sources of information	Demo installation of LED lamp system in South Africa at a winery promoted through DEG Germany.

Key Action 2.3: Strengthening the facility manager: Monitoring and Energy Performance Certificates with the help of the facility managers

Proposed actions:

- Provide a guideline for facility managers with emphasis on energy efficiency and measuring the performance (monitoring) with the energy certificate resp. the EnerKey Advisor tool.
- Implement the EnerKey Performance Certificate on any public building
- Disseminate the methodology and the implementation within the city

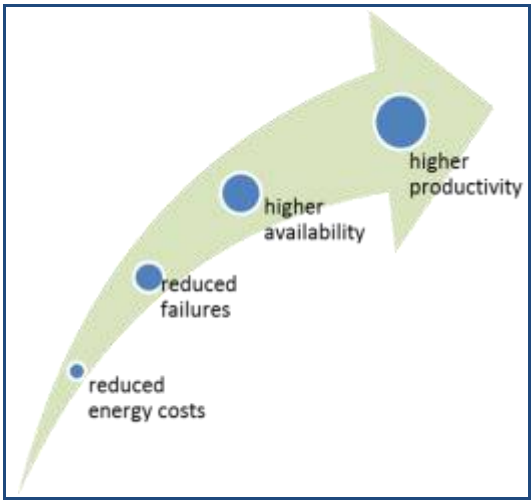
In many municipalities, budgetary constraints have been preventing the performance of effective and necessary energy conservation investments for several years now. In the past, in many cases the individual local authority departments have not been in a position to implement proposed improvements. Departments have rather focused upon user satisfaction, attractiveness or image. Thus often only small measures could be realized within the context of ongoing building maintenance. In many cases, measures of budgetary relevance could only be implemented with several years delay or not at all.

Moreover, in the past the individual department derived no benefit from saving energy. Energy funds not consumed could not be channelled to other purposes. Often the dilemma also arose that the property budget had to provide the investment finance for larger measures, while it was the administrative budget which benefited over the long term from the lower energy costs.

A need was thus perceived to create a financing system which permitted the short-term implementation of cost-effective energy conservation measures.

These financing schemes require a municipal energy management strategy. The facility managers can play a crucial role in a low-level, but for the current state of the public buildings very effective, energy management system.

source: www.embl.de



Facility and energy management includes planning and operation of energy-related production and consumption of energy in objects like houses or house groups. It targets at resource conservation, climate protection and cost savings and is closely connected to environmental management, production management and logistics. It is important to integrate the energy management in the organizational structure, so that it can be implemented effectively. Responsibilities and the interaction of the decision makers should be organized well. The delegation of functions and competencies extend from the top management to the executive worker.

Target group and sector	All public buildings
Resource and Energy Potential	No direct quantifiable potential, but absolutely crucial for any retrofits or energy management systems. Although the Public Building Sector contributes only 8 % of the national energy usage the energy saving potential is known to be significant.
Energy issues addressed	An energy management in the public building stock helps to: • reduce energy costs • reduce CO_2 emission • counteract against the instability of the energy supply • be a role model for energy efficiency • increase the market penetration of innovative and effective retrofit solutions to improve energy efficiency and implement renewables. • improve working conditions for the employees • educate of user in how to keep the temperature in the room comfortable without forgetting to air the room adequately • create jobs in the sustainable sector • counteract against financial barriers, make it easier to implement energy saving measures • raise public awareness
CO_2 reduction potential	No direct quantifiable potential
Recommendations	- Energy Management on provincial or municipal level require a monitoring of the energy consumption - This is also required for instruments like the revolving fund. - If not already existing, a computer based monitoring system is nice to have, but not crucial - The facility managers shall be responsible for a monthly meter reading. This may require an update of their job description. - The values are entered into a database, where all required building information for an energy management system is stored. - The consumption of all buildings of e.g. a department is plotted in a diagram. Unexpected high or low consumptions can be tracked. - As meters are read, the bills based on "estimated meter reading" can be checked. - Once a year an energy performance certificate is printed and put into a public visible place. - The facility manager takes care of campaigns to reduce the energy consumption of "his" building. This can be posters, competitions, etc. - The FM also gets the responsibility to enforce user behaviour measures, like switching off lights and appliances in the end of the day.
References, sources of information	Wössner, S., Schrade, J., Erhorn, H., 2013: EnerKey - Energy management for the public building stock

Key Area 3: Liveable buildings - building an inclusive environment

Present Situation and Entry Point

Using energy in an efficient way in residential buildings is crucial, but for different reasons. While the higher income groups must improve their building performance in order to reduce the greenhouse gas emissions, the lower income groups need to use energy as efficiently as possible to afford a living. Especially since as the lower income groups increase their standard of living so will the need for energy to meet those demands increase.

- Residential sector is responsible for about 10% of Gauteng's Final Energy Consumption
- High income inequality
- High share of electricity in energy consumption, multiple fuel use
- Inefficient buildings, supressed demand (energy poverty)

In 2011, the long awaited building standards were introduced as a mandatory requirement to get a building permit. The standard SANS 10400-XA references the SANS 204 and uses parts of it as a requirement. Innovative technologies are available, so the urgent need is more on enforcing the requirements than on new technologies.

Proposed Actions

	Potential for Economic develop.	Potential for climate protection
A) Activities and measures with a high priority and impact: + (for details see following chapter)		
3.1. <u>EnerKey Performance Certificate</u>: Introduce and establish the certificate for residential buildings	+	+
3.2. <u>Implement Sustainable Housing for Low Income Groups</u>: New buildings to comply with advanced energy efficient building standards	+	+
3.3. <u>Appliances for modern living</u>: Solar Water Heaters - A solution to the increasing hot water demand in Gauteng	+	+
B) Activities and measures with a medium priority and impact: ×		
1. Cooking stove exchange programme	×	±
2. Awareness and communication campaign for efficient energy consumption	×	±
3. Alternative financing options for lower income households	×	±
4. Training and capacity development to understand energy in the build environment using the EnerKey Adviser to develop Energy Performance Certificates	±	×

C) Activities and measures with a lower overall priority: ±

1.	Aspects in RDP tendering → accept additional costs (upfront costs), e.g. iEEECO™	×	±
2.	LED for indoor lighting	×	±
3.	Appliance labelling	±	±
4.	Smart metering	±	±
5.	IC Technologies	±	×

\+ High priority and impact; × medium priority and impact; ± lower priority and impact

Key Actions with high priority in Area 3 "Liveable Buildings"

Detailed descriptions

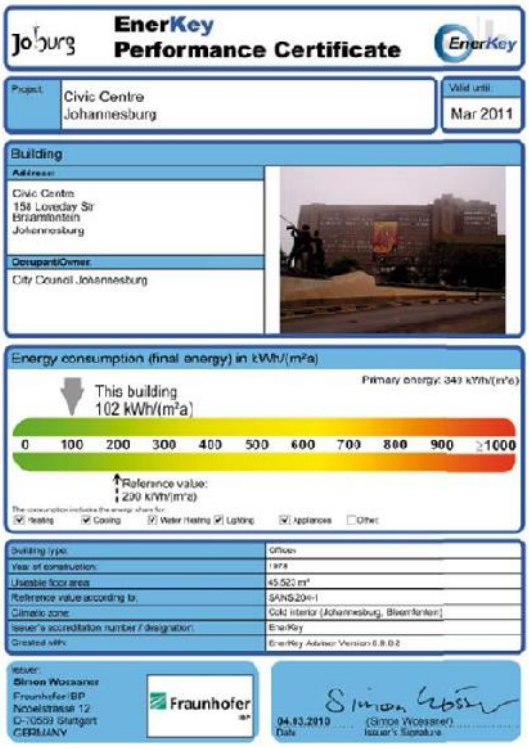
Key Action 3.1: EnerKey Performance Certificate: Introduce and establish the certificate for residential buildings

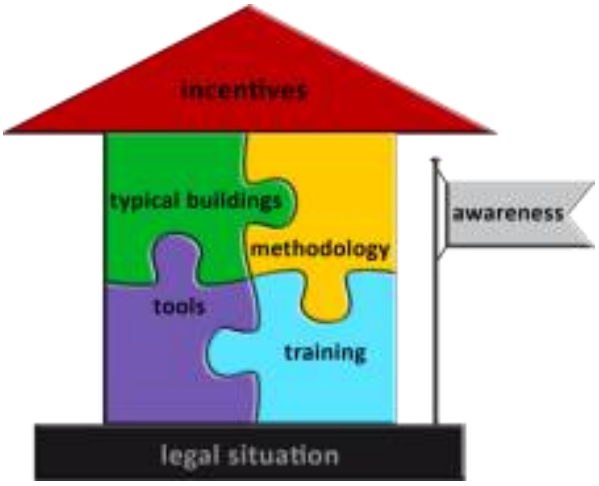
Proposed actions:

- Develop a standard for performance rating of energy efficient (public) buildings
- Train energy auditors to do the energy performance ratings
- Establish a certificate for certified energy auditors
- Perform an energy audit for all public buildings and display the certificate at visible points

It is crucial that awareness is present in the public opinion that energy efficiency and energy consumption is an important issue. The national strategy on energy efficiency (DoE, 2012) cannot be successful unless people see a need for it. This must be supported with awareness campaigns to show why it is so important to reduce the energy demand.

A very interesting instrument to show the significance of energy consumption in the built environment is energy performance certificates (EPC). They show a kind of labelling for the energy performance of a building. This labelling is known from white or brown goods - where every fridge and TV lists information on the energy consumption. The fuel consumption is an important factor when one is buying a car, but hardly anyone knows about the energy consumption of buildings. It is also not common that the consumption of a building can be rated in terms of a rather high or fairly low consumption.





Target group and sector	Builders, Building Control Officers, Cities, Government, Consultants, Students, Energy Auditors, Building owners
Resource and Energy Potential	The labelling of the energy demand of a building is one of the instruments to increase the common awareness on energy efficient buildings. The need for energy performance certificates is also stated in the Gauteng Integrated Energy Strategy (GIES).
Energy issues addressed	The importance to know the consumption of a building is evident. In many other areas, the energy efficiency of any equipment is given in some kind of labelling, usually with energy efficiency classes. As there is currently no energy certification scheme for buildings available in South Africa, the EnerKey Performance Certificate (EPC) was developed. It fully complies with SANS 204-1. The EnerKey Performance Certificate shows the consumption of a building in comparison to national reference values.
CO_2 reduction potential	The European Union expects that energy performance certificates will have a major impact by increasing the awareness of building owners and users of the energy performance of their buildings It will play a key role in activating the improvement of existing buildings, which is a major challenge in reducing building CO_2 emissions. Therefore all member states are required to introduce energy performance certificates for all buildings in Europe. This is applicable similar to South Africa.
References, sources of information	EnerKey Adviser. http://www.EnerKeyAdviser.info

- Energy performance certificates will have to be available when buildings are sold or rented and will be displayed in public buildings.
- It is expected that this will have a major impact by increasing the awareness of building owners and users of the energy performance of their buildings.
- In France over 2 million certificates are issued every year.
- It will play a key role in activating the improvement of the existing building stock, which is a major challenge in reducing building CO_2 emissions.

The EnerKey Adviser contains at the moment the following possibilities:

1. An easy to handle rating tool for the energy consumption of buildings. The user easily gets an impression how a specific building performance in comparison to national benchmark consumptions.
2. The generation of EnerKey Performance Certificates
3. Information on energy efficient measures for buildings
4. A calculation tool for residential buildings. At the moment the only way to calculate energy demands for buildings in South Africa is to run a simulation of a building. As those simulations are quite time consuming and need skilled knowledge, a calculation tool for the energy demand in residential buildings based on the methodology of EN 13790 is included. The calculation method was adjusted to South African conditions and includes the energy demand for heating, cooling, domestic hot water, lighting, appliances and cooking.
5. An inspection protocol to guide the energy assessment of a building.

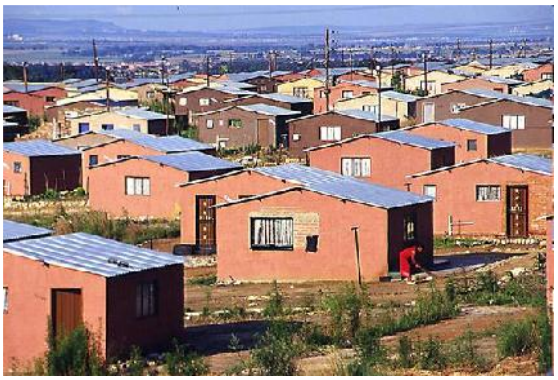
The toolkit is available for free on the EnerKey website http://enerkey-adviser.info

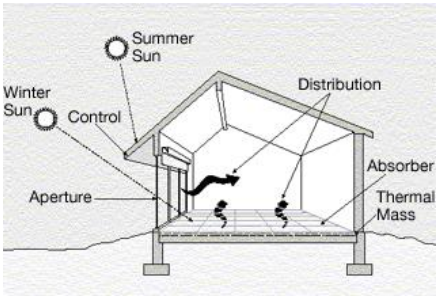
Key Action 3.2: Implement Sustainable Housing for Low Income Groups: New buildings to comply with advanced energy efficient building standards

Proposed actions:

- Monitoring and enforcing building standards and a shift from freestanding to semi-detached homes
- Improve the building envelope of low-income households such that the budget includes an allocation for ceilings, which will improve the comfort of the house in summer and winter.
- For new site layouts, the street directions should run East-West, so houses can be North-facing

The majority of houses in South Africa are freestanding, and this trend is also reflected in the lower income sector. Freestanding houses have been shown to use 60% more energy than semi-detached houses. Lower income households currently do not heat as much as higher income households as this is a comfort many households cannot afford. Therefore, small improvements in the building envelope for lower income households, such as changing from a free-standing house to a semi-detached house or adding a ceiling will increase the comfort of living and reduce household energy expenditure on space heating. However, as this demand is currently suppressed, it is expected that the energy demand in lower income households will increase in order to satisfy a higher standard of living. Furthermore, ensuring that the most used rooms in a house are North-facing will enable homes to harness the benefits of passive solar energy for lighting and warmth.





Source: US DOE

Target group and sector	Department of Human Settlement, Housing Developers, private sector, Civil society
Resource and Energy Potential	High impact potential: Monitoring and enforcing an energy efficient building code for lower income households will ensure that energy for space heating and lighting will be reduced while increasing the comfort of living. A passive solar design, as well as implementing semi-detached construction over freestanding houses has the potential to decrease the energy demand of a building by up to 50% compared to current standard low-income housing developments. Passive solar construction can be realised with no additional costs during the planning phase of housing developments by taking housing orientation and street alignment into consideration. As far as semi-

	detached housing goes, awareness of the benefits should be communicated to overcome the stigma that freestanding houses are the best. The budget for each house needs to include an allocation for a ceiling, which will go a long way to improving the comfort and space heating demand of the house, which in turn will decrease the need for energy and thereby avoid the production of additional emissions.
Energy issues addressed	Currently, lower income houses are constructed without a ceiling and are typically freestanding without complying with any building standards. Complying with building standards will address the low-quality, energy inefficient low-income building construction and energy poverty among the low-income population in South Africa. An improved energy performance of the building with the help of passive solar construction and ceiling insulation will contribute to less demand for heating within the building envelope. Savings from a decrease in heating demand have a potential of 10-20% for a ceiling, while North-facing houses can improve energy consumption by 25%. Furthermore, the impact on respiratory diseases can be decreased by limiting the heating demand that is in part met by the open combustion of fossil fuels, such as paraffin, wood and coal.
CO_2 reduction potential	Moderate CO_2 reduction potential. The proposed building code both directly and indirectly influences CO_2 emission reduction. A reduction in electricity consumption will also decrease the indirect emissions (which make up the majority of emissions in the residential sector), while the reduction of direct emissions is reduced to a lesser extent through the use of less fossil fuels for space heating. CO_2 emissions can further be reduced through the use of renewable energy sources for electricity generation, the integration of grasslands and plantations of trees as CO_2 sinks or the use of building materials that are not CO_2 intensive in their manufacture.
References, sources of information	City of Cape Town. "Smart Living Handbook" Environmental Resource Management Department, Cape Town. May 2011. Stelzer, B., Braun, N., Hofstätter, W., 2013: "Potential of Photovoltaic Systems for Social and Economic Empowerment in Peri-Urban and Rural Aras in South Africa". In: Energy and Sun. Sustainable Energy Solutions for Future Megacities. Jovis Tomaschek et al., 2012: Tomaschek, J., Dobbins, A., Fahl, U.: A Regional TIMES Model for Application in Gauteng, South Africa. International Energy Workshop 2012. University of Cape Town. US. Department of Energy. Passive solar graphic. http://www.eere.energy.gov/de/passive_solar_design.html Wössner, Simon, 2013. Reduction potential on net energy demand for heating. Fraunhofer IBP.

The iEEECo™ housing concept by Peer Africa: The triple E benefit: Energy efficient, Economic and Environmental protective

- A range of interventions are possible to make RDP subsidy houses more energy efficient – within the subsidy allowances
- Recently developed SANS 204 energy efficient building standards - yet to be enforced
- Fundamental step is to orient houses facing north – still great resistance from architects and planners on aesthetics overriding sustainability
- Successful example is the Witsands iEEECO project in Atlantis, Western Cape – 400 homes built and occupied peacefully

Contact: Peer Africa (Pty) Ltd., South Africa, Douglas Mothusi Guy, ieeecodlg@gmail.com

Key Action 3.3: Appliances for modern living: Solar Water Heaters - A solution to the increasing hot water demand in Gauteng

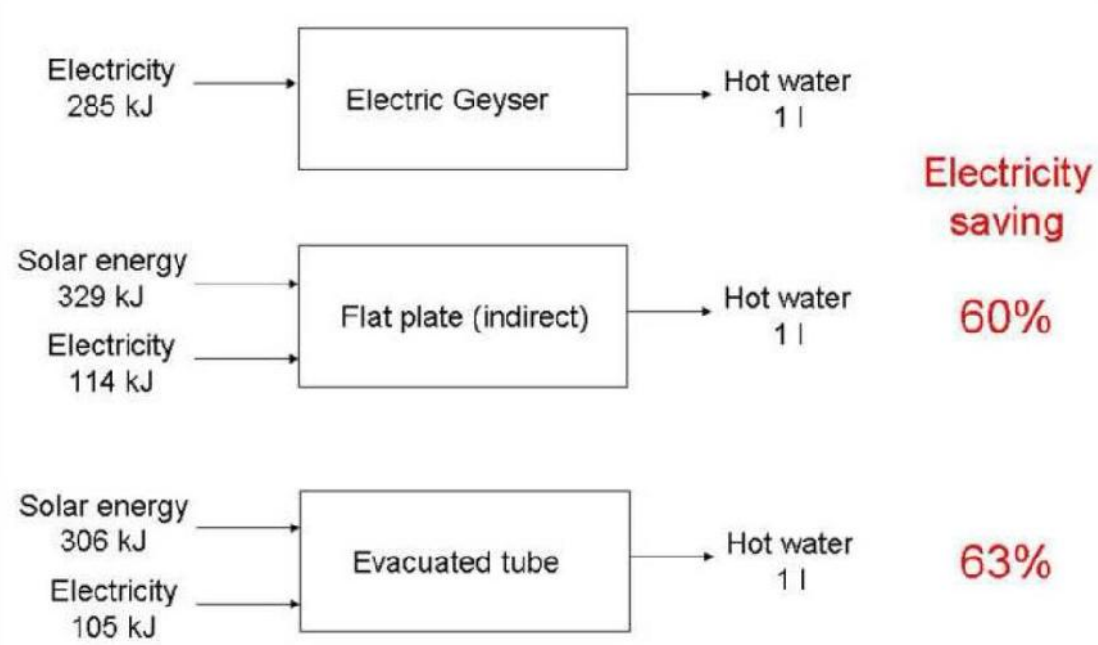
Proposed actions:

- Enforce the installation of SWH on individual homes and houses
- Enforce the standardisation and certification
- Educate and train workers and entrepreneurship for a better maintenance and repair
- Improve the performance through better quality assurance and an image campaign

Due to the insufficient generation capacity and coal based electricity conversion, which causes a high environmental footprint, it is clear that there is a need to reduce electricity consumption. However, the demand for energy services in the residential sector is not distributed evenly because of the high income inequality in South Africa. Therefore, unique solutions are required for each income group. The residential sector in Gauteng consumes 10% of the total final energy out of which more than 40% energy is used for heating water. Hence, SWHs would provide a perfect solution to reduce the peak electricity demand.

The government of South Africa has set a target for renewable energy to generate 10,000 gigawatt hours of final energy by 2013. Solar water heaters may contribute almost a quarter towards this target. The energy utility Eskom has set up a rebate program for efficient SWH (www.eskom.co.za).

The energy balances for a conventional electric geyser and for two different SWH types are compared in the figure below. Most of the electric geysers in SA have storage tanks rather than heating the water directly. The hot water storage decreases the total efficiency level of electric water heating to about 70% due to storage losses but the hot water storage might shift the electricity demand to off peak periods and consequently reduce the peak demand. The electric energy required for heating 1 litre of water with an electric geyser is 285 kJ. On average, flat plate SWHs can save 60% of the electricity consumption compared to the conventional electric geyser. The evacuated tube system may achieve a higher average saving of about 63% (Dobbins et al., 2009). As a result the electricity requirements for heating 1 l of water are 114 for a flat plate system and 105 kJ for an evacuated tube solar water heater.



Target group and sector	Residential sector
Resource and Energy Potential	The technical potential of SWHs was shown to be at least five times higher than the hot water demand.
Energy issues addressed	The utilisation of SWHs helps to reduce the peak electricity demand of a household by up to 70%. This reduction could be a significant contribution to demand side management in Gauteng. Using an economic analysis, SWHs prove to be an appropriate technology for water heating in Gauteng since their use results in the lowest annual expenditure and their payback period is between 3 and 4 years for the mid and high income groups.
CO_2 reduction potential	When compared to the reference technology (i.e., electric geyser), SWHs could reduce GHG emissions by up to 60%. The GHG abatement cost calculation shows that SWHs are the most cost effective technology for mid and high income groups to mitigate GHG emissions.
References, sources of information	Dobbins, A., Tomaschek, J., Özdemir, E. D., Goyns, P., Fahl, U., Eltrop, L. (2009) Role of energy models in local energy planning to support the roll-out of solar water heaters in Gauteng, South Africa, paper presented at UPE8-Parallel Patterns of Urban Growth and Decline Symposium, 23-26 March 2009, Kaiserslautern, Germany Özdemir, E. D., Marathe, S. D., Tomaschek, J., Dobbins, A., Eltrop, L., 2012: Economic and Environmental Analysis of Solar Water Heater Utilization in Gauteng Province, South Africa. Journal of Energy

South Africa has allocated R4.7 billion ZAR over three years to support the installation of solar water heaters (SWH) in the country. This funding was exclusively allocated to Eskom as the program implementer. However, a process of allocating systems to municipalities is also under way.

See: ESKOM Solar Water Heating Rebate Programme on www.eskom.co.za

Key Area 4: Transport and mobility - integrating the Needs

Present Situation and Entry Point

In South Africa transportation plays a crucial role in order to assure the mobility of the population. Giving a high proportion of transport in the overall energy consumption in Gauteng, the sector requires high attention to the energy and, correspondingly, to air pollution problems related to the conventional fuel consumption. Currently the transport sector is characterized by:

- Responsibility for about 35% of Gauteng's Final Energy Consumption
- High dependency on fossil fuels: oil and coal
- High growth potential
- Minibuses are the backbone of the public transport system
- Fragmented services
- Accessibility and security as barriers, little information and low transparency
- (very) old vehicles are still in use

In the future, as shows the results of the EnerKey research, transport demand will grow continuously. For this reason, new transport concepts and technologies shall be elaborated and integrated with the overall energy strategies.

Proposed Actions

	Potential for Economic develop.	Potential for climate protection
A) Activities and measures with a high priority and impact: + (for details see following chapter)		
4.1. <u>More stringent emission standards</u>: Faster implementation of Euro 5 and Euro 6 emission standards for new vehicles	×	+
4.2. <u>Re-fuelling the transport sector</u>: Decreasing transport GHG emissions by utilizing alternative fuels and vehicle powertrain concepts	+	±
4.3. <u>Integrated public transport</u>: Maximise benefits from existing systems and make new ones perform better	+	+
B) Activities and measures with a medium priority and impact: ×		
1. Promote the production and the research of second generation biofuels (e.g. biomass-to-liquid (BTL) or lignocellulosic ethanol)	×	+
2. Development of freight hubs, to bundle service demands, increase load factors and to more easily allow shifting freight modes from road to rail.	×	+
3. City coach buses (between cities) with the link to other public transport hubs with low-carbon technologies and with the link to the park and ride system.	×	×

4. Prohibition of access of private transport to particular zones of the cities based on either on the emission concept of the vehicle (e.g. Euro 2 or higher) or time regulation of vehicle access (such as access for a group of vehicles with particular properties, such as vehicle number) | × | + |

5. Establish rail access for large industrial areas | + | × |

C) Activities and measures with a lower overall priority: ±

1. First generation biofuels from energy crops as "start-now" option (e.g. biodiesel from canola or ethanol from sugar cane) | × | ± |

2. Promotion of public transport. These can be achieved on the short-term through awareness training, TV, publications, PR | ± | × |

+ high priority and impact; ×: medium priority and impact; ± lower priority and impact

Key Actions with high priority in Area 4 "Transport and mobility"

Detailed descriptions

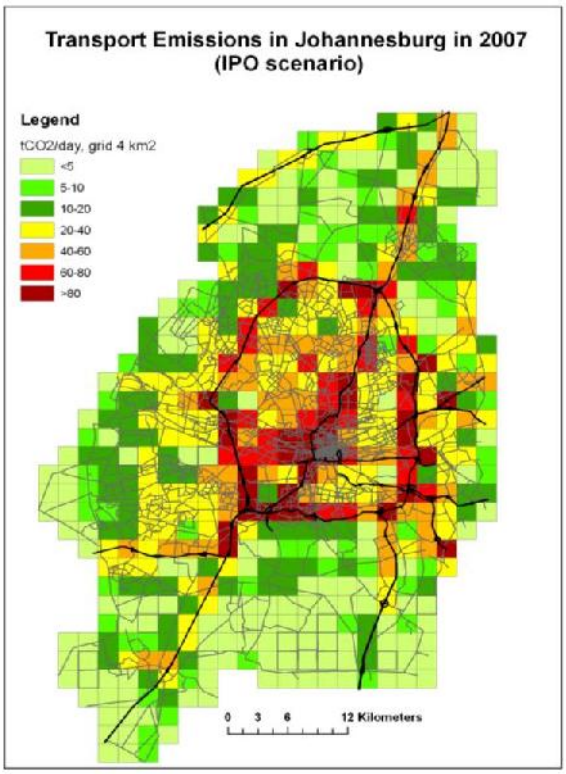
Key Action 4.1: More stringent emission standards: Faster implementation of Euro 5 and Euro 6 emission concepts for new vehicles

Proposed actions:

- Stricter emission regulation
- Replacing older vehicles
- Higher penetration of hybrid vehicles

Based on the information that transport was one of the main emitting sources in the Gauteng area, it makes sense to improve the emissions standards in the vehicle technology faster than it was planned. At the moment all new homologated vehicles which will be registered in South Africa must fulfil the EURO 4 standard. The technical equipment for a higher emission standard EURO 6 existed in the automobile industry and it does not need any more additional investment cost because the car industries produced world-wide cars with this standard.

Based on this information and the results from the TIMES model for different scenarios for the future development of transport (vehicle kilometre, vehicle stock, etc.), it was possible to make a calculation for the improvement of the car fleet earlier to the EURO 6 standard.



Target group and sector	Government

Resource and Energy Potential	Transport was responsible for roundabout 27% of final energy demand in South Africa. In this context petroleum products represented 97% and electricity 3% of energy demand in this sector. Road transport represents 84% of energy use (DME, 2005). Thus, the transportation sector plays very important role in the total energy consumption distribution. Environmental degradation through vehicle emissions is a dire reality in South Africa, especially in urban metropolitan areas. Dominant or a major air pollutant relating to CO_2, CO, NO_x and NMVOC (Non-methane volatile organic compounds).
CO_2 reduction potential	Following models and output results were used for the calculation of the stringent emission standard EURO 6 for passenger cars for the starting year 2015 to 2020. The Transport Emission Modelling Tool (TEMT) emission model generated real-world emission factors, to establish emission inventory for mobile sources and to visualise transport emissions spatially for Gauteng province and the TIMES GECCO model with the output results for the vehicle stock and vehicle kilometre for the scenario years. The calculation with the models show that the CO_2 emissions in the vehicle fleet can be reduced of roundabout 150.000 t of CO_2 per year if only the new registered passenger cars fulfil the emission standard of EURO 6. For the scenario time from 2015 to 2020 the CO_2 emission can be reduced by 800.000 t.
Recommendation:	Stricter emission regulation for older vehicles in the fleet would have a direct positive impact and the air quality in the cities. Furthermore, replacing older vehicles would decrease the specific energy consumption in the transport sector. Gauteng could for example subsidise the retrofit of older vehicles or extend carbon taxes to existing vehicles. Furthermore, car rental company and company vehicles provide opportunities for higher penetration of hybrid vehicles.
References, sources of information	Tomaschek, J.: Long-term optimization of the transport sector addressing greenhouse gas reduction targets under rapid growth – Application of an energy system model for Gauteng Province, South Africa. Dissertation Volume 114. Stuttgart: University of Stuttgart, IER, 2013. Tomaschek, J.; Dobbins, A.; Fahl, U.: A regional TIMES model for application in Gauteng. In: Proceedings of the 31st International Energy Workshop (IEW), Cape Town: 2012. Tomaschek, J.: The role of the Transport Sector for Reducing CO_2Emissions in Gauteng Province, South Africa - An analysis using the energy system Model TIMES. Conference Proceedings "Future Megacities in Balance", Young Researchers' Symposium in Essen, 2010 Department of Local Government and Housing (2010) Gauteng Integrated Energy Strategy [Internet]. Johannesburg; 2010 [cited 2010 Mar 7]. Available from: http://www.dlgh.gpg.gov.za/Documents/Energy%20Stratergy/GIESPart1Part5FinalWeb25Mar10%5B1%5D.pdf. Goyns P. (2008), Modelling real-world driving, fuel consumption and emissions of passenger vehicles: a case study in Johannesburg, PhD Thesis. University of Johannesburg, Unpublished, 223p.

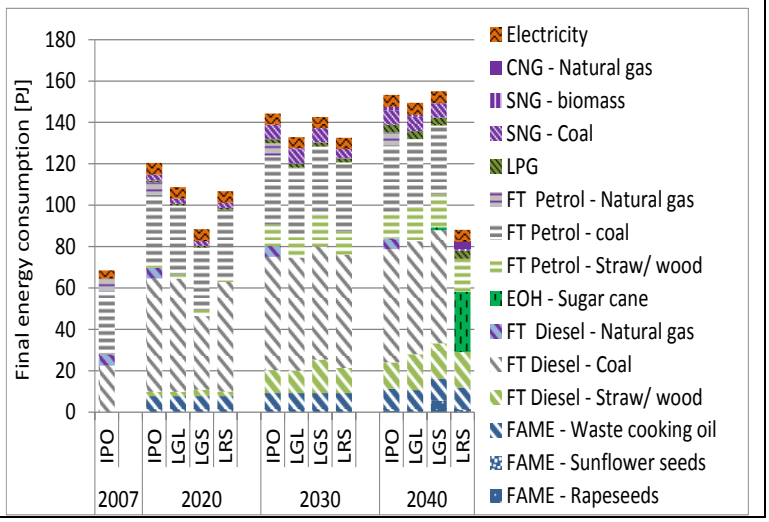
Key Action 4.2: Refuelling the transport sector: Decreasing transport GHG emissions by utilizing alternative vehicle fuels and powertrains

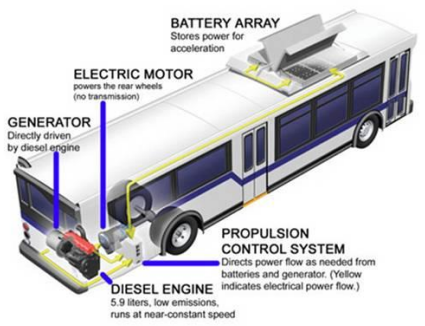
Proposed actions:

- Biodiesel production based on waste cooking oil
- Use hybrid powertrains for public busses and minibuses as showcases
- Investigation and support of on second generation biofuels using cellulosic biomass as feedstock
- Start and run a vehicle fleet with bio-gas from landfills and biowaste2energy biogas plants

By using biofuels like biodiesel made from waste cooking oil and hybrid vehicles for those vehicles which have long annual driving distances like busses the transport sector can contribute to achieve the Provinces target of increased energy efficiency and reduced greenhouse gas emissions.

Further measures available for refuelling the transport sector include (stronger) emission regulations for older or used vehicles, hybrid vehicles for car rentals or company vehicles and second generation biofuels using cellulosic biomass as feedstock (straw or wood) in the long run.





Target group:	Government, private sector, civil society
Resource Potential:	<u>Biodiesel from waste cooking oil:</u> Biodiesel can be blended into the current diesel fuel without need for new fuel stations or changes into the vehicles. The fuel can be provided locally at comparable low costs. The potential is limited by the amount of waste cooking oil available, which is currently used as animal food. <u>Hybrids for public busses / minibuses:</u> Public busses and minibus taxis offer best feasibility for application of hybrid powertrains due to their comparable long annual driving distance. Hybrid electric engines offer reductions in specific fuel consumption of about 20-30% in an urban environment (for mild and full hybrid concepts). Compared to other alternative vehicle powertrains the additional costs in comparison to a "conventional"

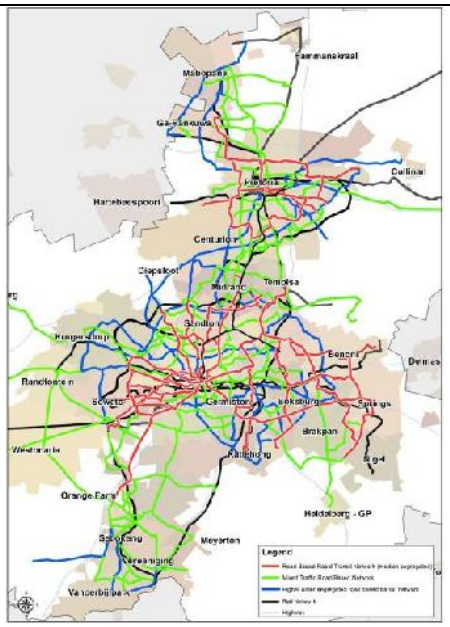
	vehicle are relatively low for mild and full-hybrid vehicles, unlike other concepts like pure battery electric vehicles.
CO_2 reduction potential:	Biodiesel from waste cooking oil: Moderate GHG reduction potential at comparable low mitigation costs. Hybrids for public busses / minibuses: Low GHG reduction potential (if only applied to busses) at moderate mitigation costs. Bio-methane, biogas and substitute natural gas (SNG): Methane is a very efficient and clean vehicle fuel. It can be obtained from both, fossil (natural gas) and renewable sources (biogas). Recently large amounts of natural gas were found in Southern Africa (SA, Mozambique, etc.). Also the biogas potential in South Africa is not exploited at all. The cleaning and gas upgrading technology is widely available in the world. First implementations are also taking place in SA. A breakthrough is needed in this sector to kick-start this promising fuel.
Recommendation:	Biodiesel from waste cooking oil Initially, waste cooking oil supply has to be ensured, as available resources are currently used for animal food. Here it is important that a certain quality and quantity of oil supply is ensured and that there must not be a possibility or incentive to mix water into the waste cooking oil. At first, the fuel can be used for governmental vehicles to demonstrate feasibility. A by-law or blending quota can be the legal basis for a large scale roll-out. Furthermore, an awareness and communication campaign will ensure the communal and public support for the new fuel. Hybrids for public busses / minibuses Initially a showcase for public buses can be created, especially where investments in new vehicles are undertaken anyways, e.g. for the bus rapid transit (BRT) systems. An incentive programme can be the basis for implementation of hybrid vehicles for minibuses. This could probably be combined with the recapitalisation programme for minibuses which aims at replacing older vehicles and guaranties financial support. A financing mechanism could be initiated which covers the higher investment costs and splits the savings due to reduced fuel consumption between operators and financers. Biogas and bio-methane as substitute natural gas (SNG) in the transport sector Start an upgrading facility for biogas and run a vehicle fleet with this fuel. Run a biogas plant at suitable locations e.g. at the food and vegetable market, biowaste collection points or industrial food processing with a large amount of residues. Further actions: Additionally, second generation biofuels using cellulosic biomass as feedstock (straw or wood), should be further investigated for future application. Thus, research in the field of Fischer-Tropsch (Biomass to liquid) fuels and ethanol from cellulosic biomass should be supported. First generation biofuels could be an option for near term up scaling of a biofuel production and provision infrastructure. On a national level, South Africa could investigate the option of reducing the contribution of fossil Fischer-Tropsch fuels, which production goes in hand with significant GHG emissions.
References:	Tomaschek, J.: Long-term optimization of the transport sector to address greenhouse gas reduction targets under rapid growth – Application of an energy system model for Gauteng Province, South Africa. Dissertation Volume 114. Stuttgart: University of Stuttgart, IER, 2013.

Key Action 4.3: Integrated public transport: Maximise benefits from existing systems and make new ones perform better

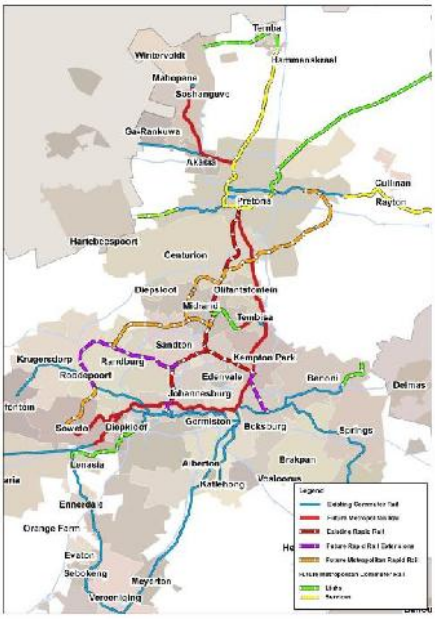
Proposed actions:

- Strengthen minibus network
- Integration of minibuses in public transport network
- Integrated ticketing supporting all public transport modes.

By integrating minibus taxis services into a coordinated and accessible public transport system the performance of all other public transport systems would be improved as well. The share of individual motorized transport could be reduced and the need for investments in new roads should be limited. This integration would go hand in hand with better service quality, shorter travel times as well as with environmental benefits.



Proposed public transport network.
Source: DPTRW (2013)



Proposed Railway network.
Source: DPTRW (2013)

Target group:	Civil society, Department of Transport, taxi associations, private sector
Resource Potential:	Moderate impact potential. Minibus taxis, the Rea Vaya Bus Rapid Transit (BRT) system, the Gautrain light railway system and commuter bus services in Gauteng (Metrobus, Putco) are currently independently operated services which are not coordinated between each other. By combining the existing structures into one public transport network the performance of the whole public transport system would be increased and the aim of reducing private passenger transport would be achievable.

CO_2 reduction potential:	The proposed action goes hand in hand with significant improvements of the public transport services (multiple benefits). The GHG reduction potential is moderate at reasonable GHG mitigation costs. However, an integrative transport system goes in hand with further benefits and advantages and can help to make the transport system to cope with future requirements.
Recommendation:	To make the minibus public transport system accessible for broader parts of the society and to implement it into an integrated public transport system, minibuses should be legalized and standardized to ensure safety, security, reliability, availability as well as quality standards. Round tables should be initiated to negotiate possible routes for minibuses to serve as feeder and as distribution system for the BRT, Gautrain and commuter busses which provide for longer distance travel opportunities. The new integrated public transport system will be based on a harmonized network plan which ensures services to be available where needed and departure and arrival times to be coordinated. Integrated ticketing is an important part of the new system which allows using all services which one single permit. An accompanying information campaign will demonstrate the advantages of the new systems (e.g. shorter travel times, lower costs, easier use, and environmental benefits) to the public society and will increase the acceptance.
References:	Tomaschek, J.: Long-term optimization of the transport sector addressing greenhouse gas reduction targets under rapid growth – Application of an energy system model for Gauteng Province, South Africa. Dissertation Volume 114. Stuttgart: University of Stuttgart, IER, 2013. Gauteng Department of Public Transport, Roads and Works (DPTRW), 2013. 25-Year Integrated Transport Master Plan, Draft Plan, Johannesburg. Tomaschek, J.; Dobbins, A.; Fahl, U.: A regional TIMES model for application in Gauteng. In: Proceedings of the 31st International Energy Workshop (IEW), Cape Town: 2012. Tomaschek, J.; Haasz, T.; Dobbins, A.; Fahl, U.: Energy related greenhouse gas inventory and energy balance Gauteng: 2007-2009.

Bus Rapid Transport System - Reya Vaya in Johannesburg

The term Bus Rapid Transit (BRT) stans for a series of public transport systems which attempts to achieve a higher quality standard than regular bus lines through developing the infrastructure and technical improvements and a new schedule of processes. The first BRT system was the Rede Integrada de Transporte ('Integrated Transportation Network') in Curitiba, Brazil, which was started in 1974. This inspired many similar systems, such as TransMilenio in Bogotá, Colombia, which opened in 2000.

BRT systems normally include most of the following features:

- Dedicated lanes
- Busway alignment
- Off-board fare collection
- Intersection management
- Platform-level boarding

Johannesburgs BRT-system is called "Rea Vaya". It started running in 2009, with a trunk route operating between Ellis Park in Doornfontein and Thokoza Park in Soweto, covering 325 kilometres of special lanes and intersections. Feeder and complementary buses carry passengers to the trunk route stations. Today Rea Vaya extends over several city areas and has created a number of very vibrant city quarters with good access and less traffic. See also: www.reavaya.org.za.

Key Area 5: Industry – using Best Available Technologies and creating a dedicated agency

Present Situation and Entry Point

The industrial sector comprising of manufacturing and mining is an important contributor to South Africa's and Gauteng's GDP. Furthermore, industry is a major employer and thus a source for future wellbeing. However, industry is also responsible for approximately 50% of Gauteng's Final Energy Consumption which results in similar shares of greenhouse gas emissions. Therefore, measures should be taken to reduce the energy intensity of mining and manufacturing which would have positive effects on the sectors greenhouse gas emissions. Additional benefits of these measures can be expected if energy carrier prices increase in future by securing the sector's competitiveness in a global market.

- Industry is responsible for about 50% of Gauteng's Final Energy Consumption
- Best Available Technologies are suitable for energy intensive sectors
- High energy saving and GHG reduction potential
- Application of cross-cutting technologies is possible across all sectors
- Many measures in industry can be characterised as low hanging fruits
- Support by an agency

Proposed Actions

	Potential for Economic develop.	Potential for climate protection
A) Activities and measures with a high priority and impact: + (for details see following chapter)		
5.1. Best available technologies (BAT): Use of efficient technologies, especially in energy intensive sub-sectors and industrial technology efficiency standards, and improve the cycle pathways	+	+
5.2. Establish a Gauteng energy efficiency and climate protection agency (GEECA): Coordination, information and awareness through an energy efficiency and climate agency	+	+
B) Activities and measures with a medium priority and impact: ×		
1. Three-chamber pipe feeder systems (feasibility study for specific mines)	×	+
2. Using existing programs extensively in Gauteng, e.g. Eskom DSM, REEBIT	+	×
3. Support for ESCos through capacity building programs	+	×

C) Activities and measures with a lower overall priority:

4. Showcases for a single technology in a specific industrial subsector ± ± ±

+ high priority and impact; × : medium priority and impact; ± lower priority and impact

Key Actions with high priority in Area 5 "Industry"

Detailed descriptions

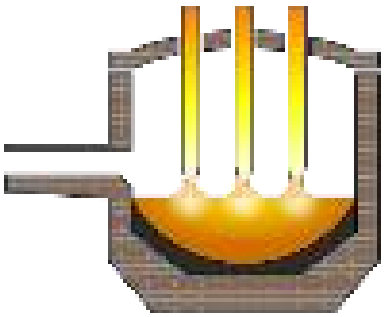
Key Action 5.1: Best available technologies (BAT): Use of efficient technologies, especially in energy intensive sub-sectors and industrial technology efficiency standards, and improve the cycle pathways

Proposed actions:

- Foster the implementation of BAT in energy intensive industries and energy saving cross-cutting technologies in non-energy intensive industries
- Training for awareness and capacity building

Industry specific technologies are usually applied in energy intensive industrial sectors (e.g. iron and steel, aluminium, chemicals, cement, glass, pulp and paper) and can hardly be transferred to other sectors. Best practice technologies represent processes which have the lowest specific energy intensity and are applied at least once globally. Beyond technologies the energy intensity of a product also dependents on the process route. For example, secondary steel uses scrap opposed to iron ore as feedstock for the production of steel and is produced in electric arc furnaces (EAF). Secondary steel is less energy intensive as primary steel and thus is suitable to reduce industry's energy consumption and simultaneously expenditures on energy. In order to ensure a sufficient scrap supply the cycle pathways in industry should be improved.

Cross-cutting technologies (e.g. fans, compressors, motors, pumps, lighting) are not sector specific but applied in various sectors across a wide variety of processes. Cross-cutting technologies usually have little influence on existing production processes and are therefore implementable without having to adapt current processes significantly.



Target group:	Energy intensive industries (e.g. iron and steel, aluminium, chemicals, cement), recycling industry, industry associations, mining companies, worker unions, government
Resource Potential:	Best available technologies (e.g. Electric Arc Furnaces)

	Best available technologies (BAT) for secondary steel production require only about 25% of energy per tonne of product in comparison to BAT for primary steel making. Furthermore, industry claims that up to 50% of South Africa's yearly steel production could be produced through the secondary route which would have a significant impact on energy consumption and greenhouse gas emissions. Cross-cutting technologies (e.g. Composite Fibre Fans) Fans are used for example in mine ventilation systems. Previous designs applied thin steel plates as blades. Composite fibre fans use carbon composite materials instead. Through weight savings, aerodynamic optimisation and improved motors significant energy savings are possible. In addition, composite fibre fans offer noise reductions, too.
CO_2 reduction potential (2040):	Electric Arc Furnaces: High greenhouse gas mitigation potential but generally high upfront investments required for BATs. Cross-cutting technologies: As a single measure they offer only low greenhouse gas mitigation potential. However, associated costs are also low and in many cases these measures are already economically viable. The aggregated greenhouse gas mitigation potential of cross–cutting technologies is high.
Recommendation:	Best available technologies (e.g. Electric Arc Furnaces) • Information campaign • Scrap collection scheme • Voluntary agreement or industry commitment Cross-cutting technologies (e.g. Composite Fibre Fans) • Information campaign • Showcases (supported through local energy efficiency agency) • Eskom DSM support
References:	Haasz, T., Tomaschek, J., Fahl, U.: South Africa's iron and steel industry – An evaluation of energy and greenhouse gas emission reduction potentials in Gauteng Province. Proceedings of the 16th IUAPPA World Clean Air Congress. Cape Town. Mining Weekly: Company suited to replacing inefficient mine ventilation fans. http://www.miningweekly.com/article/company-suited-to-the-replacement-of-mine-ventilation-fans-in-line-with-dsm-rebate-system-2012-10-19. Tomaschek, J.; Haasz, T.; Dobbins, A.; Fahl, U.: Energy related greenhouse gas inventory and energy balance Gauteng: 2007-2009.

Key Action 5.2: Establish a "Gauteng energy efficiency and climate protection agency" (GEECA)

Proposed actions:

- Ensure financing for the start-up phase for GEECA
- Provide information & communication on energy efficiency (e.g. online portal, newsletters, recommending certified experts, summaries on political and economic frameworks, information on economically viable energy savings, overview on existing initiatives)
- Advise decision makers in industry and commerce on energy efficiency opportunities
- Training and capacity building (e.g. politicians, on-site staff, ESCos)

Energy efficiency as one of the most cost effective ways to achieve a sustainable and low-carbon energy future. However, significant potentials for energy savings especially in the industrial and commercial sectors are not realized. Even large industrial companies hardly realize the full potential of energy efficiency measures. Thus, the implementation of the Gauteng Energy Efficiency and Climate protection Agency (GEECA) would raise the needed awareness for energy efficiency measures, conduct showcases that demonstrate the feasibility of energy efficiency projects and build necessary capacities.

http://www.saee.org.za/

http://www.energieagentur.nrw.de/

Target group:	Industry, commerce, associations, ESCos, Eskom, government, universities and research institutions
Impacts	• inform and raise awareness for energy efficiency and climate protection • support training and capacity building • advise decision makers in industry and commerce on energy efficiency opportunities
Resource Potential:	The establishment of an energy efficiency and climate protection agency would not directly influence greenhouse gas (GHG) emissions and energy consumption but it indirectly promotes measures to reduce energy consumption as well as GHG

	emissions through showcases, information campaigns and capacity building activities.
CO_2 reduction potential (2040):	The agency itself will not have a direct impact on GHG emissions but the implementation will be an important step towards a low-carbon sustainable development in Gauteng Province.
Recommendation:	• Implementing GEECA • Funding schemes: GEECA could provide incentives such as free initial audits for small and medium size enterprises, sponsoring case studies, information on tax incentive schemes, creation of own or joint financial products • Conducting an analysis on highlighting the importance of energy efficiency in the local context. Best practice showcases across various industrial and commercial sectors will provide insights into technical and economic considerations of the specific measures.
References:	Eckhardt, T, Wehnert, T: Energy Efficiency in the Industrial and Commercial Sector of Gauteng, South Africa - Trends, Barriers and Success Factors. http://www.enerkey.info/images/stories/intern/module2/IZT_EnEff_IndustryCommerce_March10.pdf Knoll, M, Rupp, J, Eckardt, T, Fahl, U, Heyden, E, Lambauer, J: Development of GEECA – Gauteng Energy Efficiency and Climate Agency for Industry and Commerce, Final report.

Key Area 6: Energy supply systems – taking advantage of regional and renewable resources

Present Situation and Entry Point

South Africa has a high level of solar radiation and is thus very suitable for taking advantage of solar energy in its various forms and technologies. This is particularly true also for Gauteng, where other forms of renewable energies are rather scarce or absent, such as wind, hydro or ocean energy. Solar energy technologies can be used for all kinds of energy services, such as electricity provision from small to large scale through photovoltaic cells or concentrated solar thermal power plants, hot water generation through solar collector systems and also heating and cooling e.g. through solar cooling or heat pump systems.

Proposed Actions

	Potential for Economic develop.	Potential for climate protection
A) Activities and measures with a high priority and impact: + (for details see following chapter)		
6.1. Install renewable energy capacity and energy efficient technologies: Income-based renewable energy solutions for households and other sectors.	+	+
6.2. <u>Mobilising (bio-) waste as a municipal resource</u> and creating a mind-shift from "waste" to "resource"	+	+
6.3. <u>A regional regulatory framework for small scale renewables in Gauteng</u>: Setting up a "Gauteng Renewable Energy Independent Power Producer Procurement Programme" (GREIPPPP)	+	+
B) Activities and measures with a medium priority and impact: ×		
1. Better economic incentives for the promotion of SWH	×	+
2. Training and capacity development or maintenance of SWH	+	×
3. Clean cooking stoves for the low income sector	×	×
4. Establish an effective passive solar settlement, e.g. like iEEECO™ for the poor	+	×
5. Thermal energies heating and cooling, especially also CHP	×	+
6. Solar cooling in hotels and office buildings	×	×
7. Grid-based technologies especially for solar heaters and backup electricity	×	+

8. Replacing coal fired power plants trough renewable energy (e.g. CSP, wind energy and PV); coal fired power plants with CCS or nuclear energy (if considered). Furthermore, electricity from upgrading gas from landfill sites and sewage treatment plants can allow for smaller additional emission reductions. × +

9. Replacing synthetic fuel provision from CTL through conventional crude oil based fuels or biofuels × +

10. Biodiesel from waste cooking oil offers a low cost option and a significant mitigation potential for fuel provision. × +

11. In the long run, second generation biofuels based on wood residual and straw over significant potential for further GHG mitigation. × +

12. Establishing a dense network of, public available, easily accessible weather measurement sites inside Gauteng (see also Solar irradiation data measurement by Uni Stellenbosch) × ×

13. Public available digital potential and energy yield atlas (web tool) for renewable technologies × ×

C) Activities and measures with a lower overall priority: ±

1. For very high mitigation targets the establishment of a hydrogen economy should be considered. ± ×

2. Implementation of a Gauteng Renewable Process Heat/Cooling Programme ± ×

+ high priority and impact; ×: medium priority and impact; ± lower priority and impact

Key Actions with high priority in Area 6 "Energy supply systems"

Detailed descriptions

Key Action 6.1: Install renewable energy capacity and energy efficient technologies: Income-based renewable energy solutions for households and other sectors

Proposed actions:

- Realise the large potential and portfolio of renewable energy technologies
- Take advantage of the solar resource potential
- Mobilise municipal waste as energy resource, increase recycling
- Uplift the potential of today's economic viable energy options (lighting, SWH, etc.)
- Provide renewable energy solutions to low income households and people

The potential of renewable energies in SA is large. A high number of technologies are available. The economics of these technologies is still diverse. Cost efficient technologies already exist. They need to be integrated into energy policy and the existing energy system (grid, network, etc.).

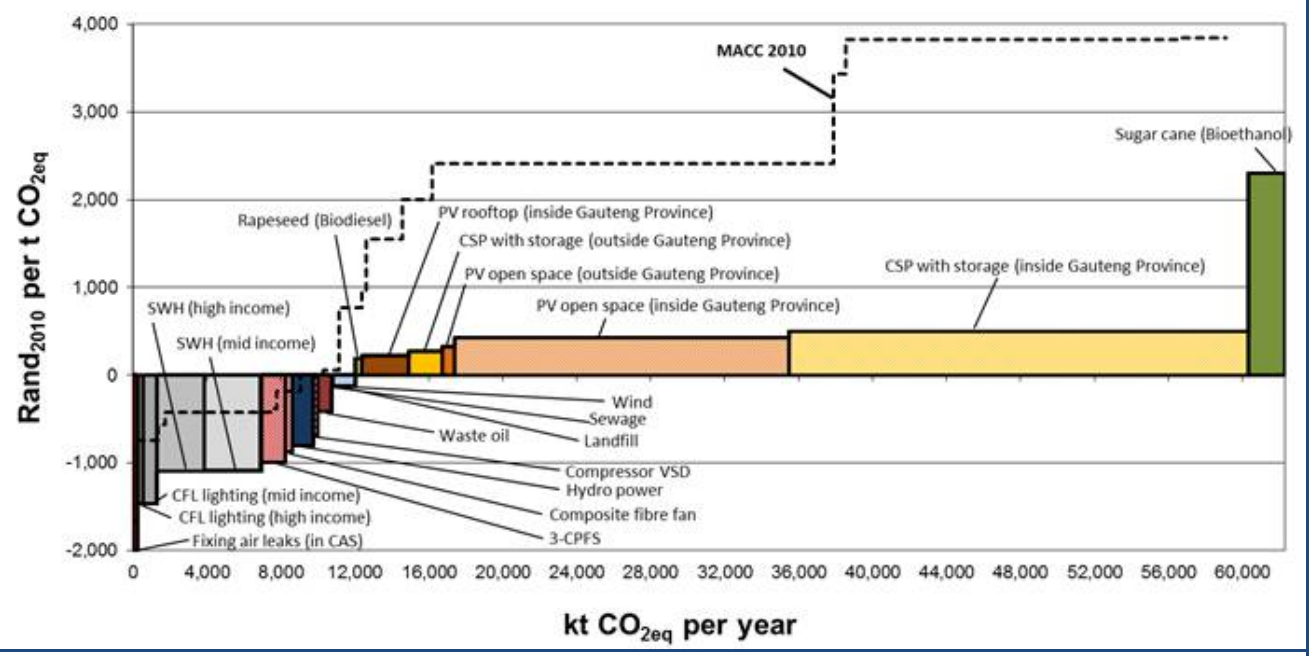
The installation of renewable energy sources can be realised in all different energy consuming and producing sectors. On the energy supply side this includes the installation of renewable electricity generating technologies inside and outside the province boundaries. Moreover technologies implemented at the residential and industrial sector can significantly reduce CO_2 emissions at a comparably low cost.

Among the technical feasible options with a large resource and GHG reduction potential, solar energy (PV and CSP) is most promising. Biofuels are still a costly option with only a small overall potential. There are a number of technologies, which are economically feasible already today, especially SWH and CFL lighting.

The Marginal GHG Abatement Cost Curve (MACC) (for 2040)

A marginal abatement cost curve or MAC curve is a set of options available to an economy to reduce pollution. They are valuable tools in understanding emissions trading, driving forecasts of carbon allowance prices, prioritizing investment opportunities, and shaping policy discussions.
Typically, MAC curves cover emissions reduction opportunities across a number of sectors in an economy including power, industry, waste, buildings, transport, agriculture, and forestry.

Target group and sector	Government, private sector
Resource and Energy Potential	High resource potential and comparably low for industrial and residential technologies. Renewable electricity generating technologies are most show a high resource potential inside and outside Gauteng Province and significant cost reduction potential in future. Lower resource potential for biomass and biofuels. Biodiesel from waste cooking oil offers a low cost option for fuel provision.



The graph shows the marginal GHG abatement cost potential curve (MACC) for GHG mitigation measures and technologies in Gauteng for 2040 including renewable electricity generation potential inside Gauteng Province. (source: Telsnig et al. 2014)

Energy issues addressed	The installation of renewable energy technologies is considered with the goal to reduce the CO_2 emissions in different energy producing and consuming sectors. The following renewable or energy efficient technologies and their respective sectors were identified as suitable CO_2 mitigation options: • Fixing air leaks in compressed air systems (Mining/Industry) • Three chamber pipe feeder systems (3-CPFS) (Mining/Industry) • Composite fibre fans with high efficient motors (Mining/Industry) • CFL lighting (Residential) • Solar Water Heater (Residential) • Electricity from sewage or landfill gas (Electricity) • Wind converters (Electricity) • Solar technologies inside and outside Gauteng Province (Electricity) • Biofuels (Fuels)
CO_2 reduction potential	By implementing all investigated measures a total of 17,200 kt CO_{2eq} can be mitigated per year (Figure 1) which accounts for about 14.1% of Gauteng´s overall emissions. If the additional renewable electricity technologies (PV open space and CSP plants) inside Gauteng Province are considered the CO_2 abatement potential is extended the significantly. By implementing all investigated measures including the additional PV and CSP capacities inside Gauteng Province in 2007 (see figure above) about 48.5% of Gauteng´s overall emissions of 122,000 kt CO_2eq/a can be mitigated.
References, sources of information	Eltrop L.; Telsnig T.; Fahl U. 2013: Energy and Sun – Sustainable Energy Solutions for Future Megacities, Future Megacities Book Series, Vol. 1 Telsnig T.; Özdemir E.D.; Marathe S.D.; Tomaschek J.; Eltrop L. 2013. Solar Energy Technologies – GHG Abatement Costs and Potentials for Gauteng, South Africa. Book Series Future Megacities Vol. 1: Energy and Sun – Sustainable Energy Solutions for Future Megacities (Editors: Eltrop L.; Telsnig T.; Fahl U.), August 2013 Telsnig T.; Tomaschek J.; Eltrop L., 2014: GHG abatement costs and potentials for Gauteng, South Africa. in: The EnerKey book, chapter 9.2. (Editor: Eltrop L.), February 2014.

Key Action 6.2: Mobilising (bio-) waste as a municipal energy resource and creating a mind-shift from "waste" to "resource"

Proposed actions:

- Develop a waste collection and waste separation system (at source)
- Explore and mobilise the biogas potential of municipal waste landfills
- Use the biogas potential of food markets and food processing industries
- Explore the option of generating a fuel from biogas (bio-methane)

Biogenic waste forms a large and important fraction of solid waste in municipalities. In many regions, in particularly in urban metropolitan areas, most of municipal solid waste is still dumped on landfill sites, which causes an enormous burden for the environment and livelihood of the people today and in the future (climate-relevant greenhouse gas emissions, leachate emissions causing pollution of surface waters and aquifers) in the vicinity of the landfill sites.

It is estimated that from one ton of municipal solid waste 120 to 300 m³ land-fill gas is generated during a period of 20 to 30 years' time. However, bio-waste dumped on these landfills can also be considered as a "resource" and an important and accessible "energy carrier". The potential for this new energy source is enormous and largely untapped in the region of Gauteng. In this region alone, the number of landfill sites is estimated at around 87, whereas 60% of these are not licensed.

Biogas for transport

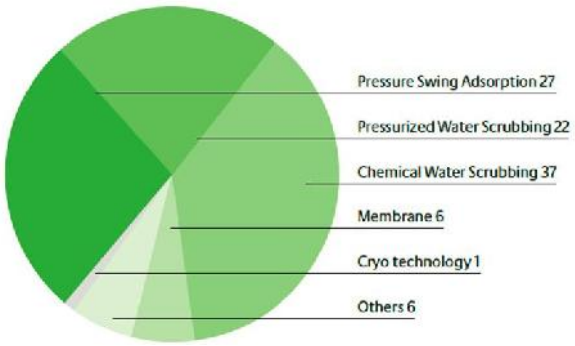
Strengthening the use of alternative fuels in the transport sector and biogas in particular can provide an alternative to fossil fuels and as a result contribute to a reduction of the otherwise increasing dependency on oil imports. In addition, the upgrading of biogas to SNG leads to a highly flexible energy carrier. The utilization of biogas in the power sector provides an important alternative. However, due to insufficient possibility of thermal heat utilization and low electricity prices this is considered as competitive only under certain condition.

The landfill gas potential in the Gauteng Region is estimated at about 9 PJ per year. That means that theoretically about 15% of the current passenger car fleet in Gauteng could be operated with the upgraded landfill gas used as an SNG fuel (own calculation). Further mobilization of the biogenic waste fraction from the food industries as well as from a separate collection of the biogenic fraction of waste in the municipal sector could additionally increase the potential for green SNG fuel.

Upgrading technologies for biogas

method	process	Experiences with biogas (few – many)
Phys. Adsorption	Pressure Swing Adsorption	
Phys. Absorption	Pressurized water scrubbing	
	Selexol-/Genosorb process	
Chem. Absorption	Chemical washing	
Membrane gas separation	Membrane separation	
	Wet low pressure membrane	
Kryogenic Gas separation	deep temperature rektification	
	freezing	

Gas upgrading technologies in Europe



source: DENA 2011

Target group and sector	Transport sector
Resource and Energy Potential	The use of waste as an energy source in Gauteng will help to reduce fossil energy use, which is directly coupled with high amount of greenhouse gas emissions, on the one hand, and creates an opportunity to reduce, reuse and recycle the produced waste in the province on the other hand. Furthermore, the implementation of these technologies in Gauteng is expected also to contribute poverty alleviation by creating new jobs.
Energy issues addressed	The South African Department of Minerals and Energy proposed a National Biofuel industrial Strategy to address those issues It proposes a total use of at minimum 2% (vol.) of biofuels which corresponds to 84 million litres of ethanol (total petrol consumption is about 4.2 billion litres) and 46 million litres of biodiesel (total diesel consumption is about 2.3 billion litres). However, the strategy focuses only on biodiesel and bioethanol from energy crops, which are coupled with requirements of agricultural land area and water for irrigation. Agricultural land use requirement is criticized due to the possible competition with food production. Furthermore, South Africa is identified as a country under water stress. Therefore, it is important to focus on production of biofuels from biogenic wastes rather than using energy crops.
CO_2 reduction potential	High potential of CO_2 reduction if the project is implemented successfully.
References, sources of information	Funke T, Strauss PG & Meyer F.: Modelling the Impacts of the Industrial Biofuels Strategy on the SA Agricultural and Biofuel Subsectors. Agrekon 48(3): 223-244 Tomaschek, J.: Long-term optimization of the transport sector addressing greenhouse gas reduction targets under rapid growth – Application of an energy system model for Gauteng Province, South Africa. Dissertation Volume 114. Stuttgart: University of Stuttgart, IER, 2013.

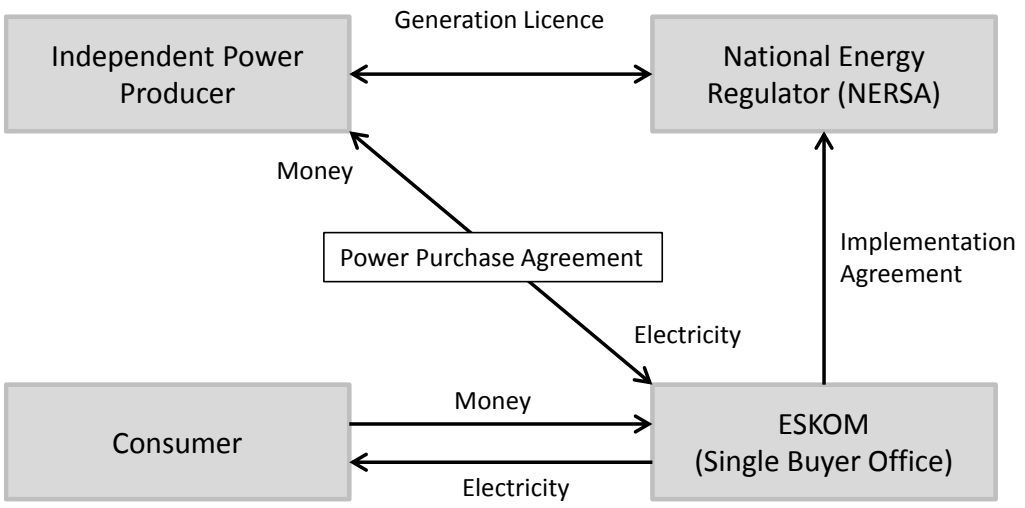
Key Action 6.3: A regional regulatory framework for small scale renewables in Gauteng: Setting up a "Gauteng Renewable Energy Independent Power Producer Procurement Programme" (GREIPPPP)

Proposed actions:

- Setting up a regional REIPPP, supporting small scale regional renewable projects
- Consider more biogas projects and the right standards for small scale projects
- Convert this bidding scheme into a half-yearly roll-out programme

The Renewable Energy Independent Power Producer Procurement programme (REIPPPP) launched by the Department of Energy (DOE, 2013) for the National state level has shown its feasibility as suitable tool for implementing renewable electricity into the existing grid. The fact that especially large power plant projects have been the scope of this programme, resulted in projects being located outside Gauteng at locations offering the best natural resources.

The proposed measure for a Gauteng Renewable Energy Independent Power Producer Procurement programme (GREIPPPP) should encourage investing in Gauteng Province into small renewable energy projects which would be easier implemented inside the province boundaries and realised by local manufacturers.



Allocated capacities of RES in the SA National REIPPP program [MW]				
Technology	Initial Determination	First bidding round	Second bidding round	Third bidding round
Onshore wind	1 850.0 MW	634.0 MW	562.5 MW	787.0 MW
Solar photovoltaic	1 450.0 MW	631.5 MW	417.1 MW	435.0 MW
CSP	200.0 MW	150.0 MW	50.0 MW	200.0 MW
Small hydro ≤10 MW	75.0 MW	0.0 MW	14.3 MW	0.0 MW
Landfill gas	25.0 MW	0.0 MW	0.0 MW	18.0 MW
Biomass	12.5 MW	0.0 MW	0.0 MW	16.0 MW
Biogas	12.5 MW	0.0 MW	0.0 MW	0.0 MW
Total	**3 625.0 MW**	**1 415.5 MW**	**1 043.9 MW**	**1 456.0 MW**

Key Action:	Setting up a Gauteng REIPPP explicitly addressing small capacity projects
Applicable Sector(s) and target group:	Small electricity producing entities, industry and commercial buildings
Resource Potential:	High resource potential for renewable energy projects inside Gauteng province predominantly in the sector of solar and biomass.
Energy issue addressed:	The programme is structured similarly to the REIPPP, with regular bidding rounds for a given amount of renewable energy capacity. Bids can be placed for the following renewable technologies : • PV open space • PV rooftop • CSP w/o storage • CSP with storage • Biomass & Bio-waste technologies The maximum capacity for a project is 5 MW_{el}. As in the REIPPP the buyer of renewable energy will be ESKOM Single Buyer office.
CO_2 reduction potential (2040):	Taking as a basis the land use inside Gauteng province and calculations on the available rooftop area CO_2 mitigation potential can be estimated. For technologies which are placed on open space land area such as Open space PV and CSP plants a total of 18.1 Mt CO_2/a and 24.9 Mt CO_2/a can be mitigated. PV installations on rooftops are found to have a mitigation potential of 2.5 Mt CO_2/a. The implementation plants generating electricity from landfill gas or sewage gas has a combined CO_2 reduction potential of 0.08 Mt CO_2/a.
Recommendation:	Setting up a Gauteng REIPPP explicitly addressing small capacity projects. Convert this bidding scheme into a half-yearly rolling programme.
References	DoACE 2004. Department of Agriculture, Conservation and Environment (2004). Gauteng State of Environment Report 2004. Gauteng Provincial Government. DOE 2013: Renewable Energy Independent Power Producer Procurement Programme. http://www.ipprenewables.co.za/ Telsnig T.; Özdemir E.D.; Marathe S.D.; Tomaschek J.; Eltrop L. 2013. Solar Energy Technologies – GHG Abatement Costs and Potentials for Gauteng, South Africa. Book Series Future Megacities Vol. 1: Energy and Sun – Sustainable Energy Solutions for Future Megacities (Editors: Eltrop L.; Telsnig T.; Fahl U.), August 2013.

Key Area 7: International cooperation – strengthening the 'Global City Region'

Present Situation and Entry Point

The aim of the event was to develop a new legally binding international climate treaty by 2015 for the post-2020 time period. At COP 15 already a Green Climate Fund (GCF) was established. At COP 18 the parties endorsed the consensus decision of the GCF Board to select Songdo, Incheon, Republic of Korea as the host of the GCF. At COP 19 the parties established the independent GCF secretariat and provided initial structures to the GCF

The main outcomes of the conferences were:

- Continuation of the Kyoto Protocol (2nd commitment period: 2013-2020) including: e.g. South Africa, EU, Australia, Switzerland, Norway. However, USA, Japan, Canada, Russia, New Zealand and some other countries have not joined 2nd commitment period of the Kyoto Protocol (KP2)
- A "fast start finance" track was established (2010-2012) of at least US$ 10 billion per year to be continued until 2015 under the roof of the GCF.
- The CDM is now restricted to the Least Developed Countries (LDC), meaning that SA is not eligible for the CDM anymore.

As result, currently the trend in emission trading and climate change policies lies in the elaboration of bilateral carbon trading schemes. CDM will continue, but giving the oversupply of the CDM credits on the market and low CER prices, it will play only a minor role, at least on the short –term. As alternative, finances form international donor institutions, like Climate Change Fund, can be an attractive source of finances for the elaboration of climate change actions in South Africa.

Proposed Actions

	Potential for Economic develop.	Potential for climate protection
A) Activities and measures with a high priority and impact: + (for details see following chapter)		
7.1. <u>Research and innovation</u>: Strengthen international research projects and innovation based demonstration projects	+	+
7.2. <u>CDM and new emission trade instruments</u>	+	+
B) Activities and measures with a medium priority and impact: ×		
1. Concentrated efforts on the development of National Mitigation Action Plan for South Africa. In line with the NAMA on national level, on the provincial level in Gauteng also action plan can be adopted, like GAMA.	×	+
2. Elaboration of trading national or regional emission trading schemes, in order to reduce emissions more effectively.	±	+
3. South Africa, and Gauteng province as well shall participate more actively in the international climate change negotiations	±	+

+ high priority and impact; × : medium priority and impact; ± lower priority and impact

Key Actions with high priority in Area 7 "International cooperation"

Detailed descriptions

Key Action 7.1: Research and innovation: Strengthen international research projects and innovation based demonstration projects

Proposed actions:

- Step up to international collaboration projects in research and technology transfer
- Initiate and monitor innovative demonstration projects
- Participate more actively in the European Research Framework, e.g. Horizon 2020, establish a regional contact office

Energy resource mobilisation, energy technology implementation and climate protection is a highly integrated international business. Knowledge on technology is increasing fast, but major developments are happening often abroad.

Since 2008 South Africa and especially also Gauteng as the economic hub was facing a major challenge in the energy sector. The country is experiencing electricity outages and a sharp increase in fuel prices. At the same time the GHG emissions are still rising and not showing a sign of decrease.

The problems in the energy market are only manageable through an intensified international cooperation and trans-disciplinary collaboration of stakeholders in science, business and public administration.

2012 I 2013
German-South African Year of Science
Deutsch-Südafrikanisches Jahr der Wissenschaft

The EnerKey project is an example of this inter- and transdisciplinary approach, where innovations are developed and motivated and skilled students and employees are trained and educated. Other examples are the Biota-Africa project (www.biota-africa.org) and the SASSCAL initiative (www.sasscal.org).

EnerKey

SASSCAL
Southern African Science Service Centre for Climate Change and Adaptive Land Management

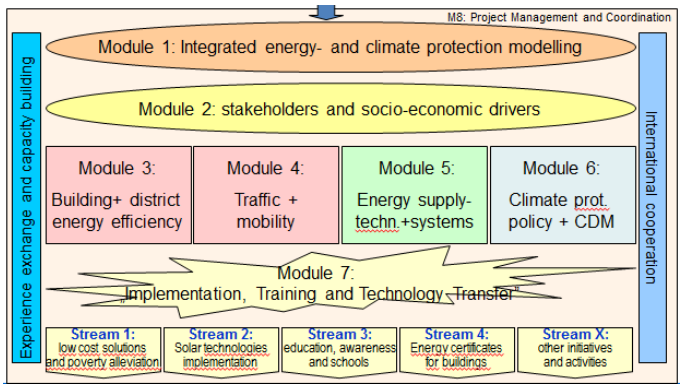
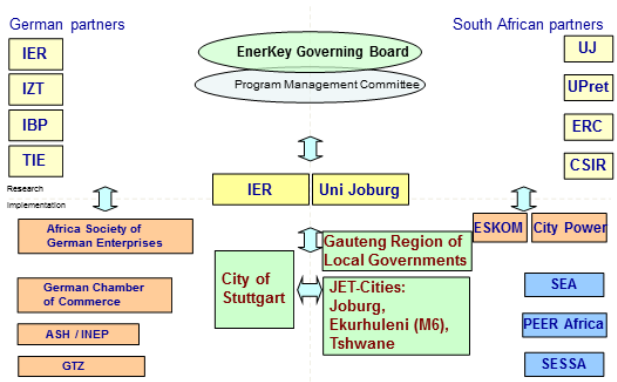
The EnerKey Project

The EnerKey-Project was a South-African German collaborating project under the roof of the BMBF Future Megacity Program (www.future-megacities.org). The project was aiming to contribute to a more sustainable transformation of the Gauteng urban area by

- developing an integrated program and action plan for an efficient, environmentally friendly and climate protecting system of energy supply and utilisation,
- improving structures and approaches in how to handle energy and climate protection issues in the city environment, and
- by demonstrating solutions for energy efficiency, sustainable energy supply and climate protection through praxis-oriented technology and project implementation

The project ran from 2008 to 2013 and was characterised by the transdisciplinary approach putting stakeholders from Academia and Universities together with decision makers from municipal administrations, from business and the civil society and non-governmental institutions. The project was funded through a bilateral agreement between the German and the South African Research ministries and institutions.

Results and more information can be gathered from the project website www.enerkey.info

Project working modules	Project consortium
	

Target group and sector	Research supporting and funding institutions, National, regional and local ministries for energy, economy, land use and environmental studies Universities, independent research institutes cities, businesses, NGO, civil society
Resource and Energy Potential	Energy technology innovations, global energy resources, energy economics and energy markets, emission reduction protocols and agreements
Energy issues addressed	Mobilisation of own and renewable energy resources, knowledge transfer of innovations in technologies and governing/financing schemes, global energy emission treaties
CO_2 reduction potential	substantial
References, sources of information	Eltrop, Ludger et al. 2014: The EnerKey Book. Report to the BMBF on the work achieved in EnerKey. IER, 2014 Eltrop, Ludger et al. 2014: The Liliesleaf Action Plan. Recommendations for a sustainable energy system in Gauteng, SA. IER, 2014 Eltrop, Ludger; Telsnig, Thomas; Fahl, Ulrich 2013 (Editors): Energy and Sun. Sustainable Energy Solutions for Future Megacities. 246 p. Jovis Verlag, Berlin www.enerkey.info

EnerKey local partners in Gauteng

EnerKey and Local Government

An alliance of the University of Johannesburg and local authorities for service delivery in energy efficiency and climate protection

Key Action 7.2: CDM and new emission trade instruments

Proposed actions:

- A Make use of the existing mechanisms especially CDM
- B observe the market, new instruments for international climate policies will come up and become relevant

Various Post Kyoto instruments were discussed for the reduction of GHG (greenhouse gases) in South Africa, but two instruments were mainly discussed in the past. One of the main instruments was the carbon tax instrument which puts a limit on the amount of emissions and allows the market to determine the price for the emissions by trading. The other main instrument was a Cap-and –trade system instrument which determines the price and leaves it to the market to determine the amount of emissions.

Target group and sector	Government, local authorities, NGO's and industries
Resource and Energy Potential	The establishment of an post Kyoto mechanisms for example Cap-and-Trade system or Carbon Tax have directly influence of the greenhouse gas (GHG) emissions and energy consumption in the country. Both instruments stimulated the market to reduce the GHG and reduce the energy consumption in the country, but also both instruments have some risk for the economic, if the energy tax to high or the emission certificates have no market.
Energy issues addressed	The GHG instruments have a direct impact on GHG emissions and energy consumptions, because it stimulates the market in the field of renewable energy technologies.
CO_2 reduction potential	• The CO_2 reduction potential is linked to the high of tax or cap of the emission • Promoting of energy efficient technologies and renewable energy systems • Support and promotion of industries sectors in the field of new efficient technology and renewables • More investigation at the universities and industries in the field of energy supply technologies for example PV, CSP and conventional power plants.
References, sources of information	Carbon Share: Cap and Trade vs. Carbon Tax. http://www.carbonshare.org/docs/capvscarbontax.pdf (Accessed May 7th, 2012)

Key Area 8: Land use and urban development – keeping a balance

Present Situation and Entry Point

Since its formation in 1994, Gauteng's urban area, along with its population is expanding rapidly. Being an economical hub, Gauteng attracts more migrants than any other province in South Africa, putting more stress on already inefficient infrastructure. Crime-laden city centres were deserted due to safety issues, forcing people to live far away from their jobs in gated communities. This has resulted in a haphazard growth/development of Gauteng. A smarter compacter city development will help Gauteng reduce its carbon footprint and help people lead a happy healthy life close to their workplace.

Proposed Actions

	Potential for Economic develop.	Potential for climate protection
A) Activities and measures with a high priority and impact: + (for details see following chapter)		
8.1. Enforce stricter spatial planning regulations: Limit urban sprawl through compacter city development	+	×
8.2. Integrated urban development: Support urban development along transport corridors; promote mixed income communities	+	×
8.3. Implement sustainable social housing projects: Include environmental aspects in RDP tendering and install (iEEECO™) showcases	+	+
B) Activities and measures with a medium priority and impact: ×		
1. Compacter city planning: Restrict future urban developments within today's urban edge, City extension in transport oriented areas, Protect conservation areas and restoration of wetlands	×	±
2. More income integrated communities (with single houses, row houses and high rise buildings)	×	±
3. Relocation of informal settlement in an area with an easy access to public transportation	+	×
4. Create more job opportunities near residential areas and vice versa. (Integrated city development)	+	×
5. Stronger& efficient public transportation near employment centres	×	×
6. iEEECO™ settlement development with passive solar design	+	×
7. Make city centres more attractive & safer for residents	×	±
8. Availability of infrastructure and basic needs (water, sanitation) for economically backward income group	×	±

C) Activities and measures with a lower overall priority: ±

1. Legalising informal settlements within the urban edge ± ±
2. Strengthening NG/LPG infrastructure within the current city limits × +
3. Make the politician and people aware of Gauteng's global footprint × ±

+ high priority and impact; ×: medium priority and impact; ± lower priority and impact

Key Actions with high priority in Area 8 "Land use and urban development"

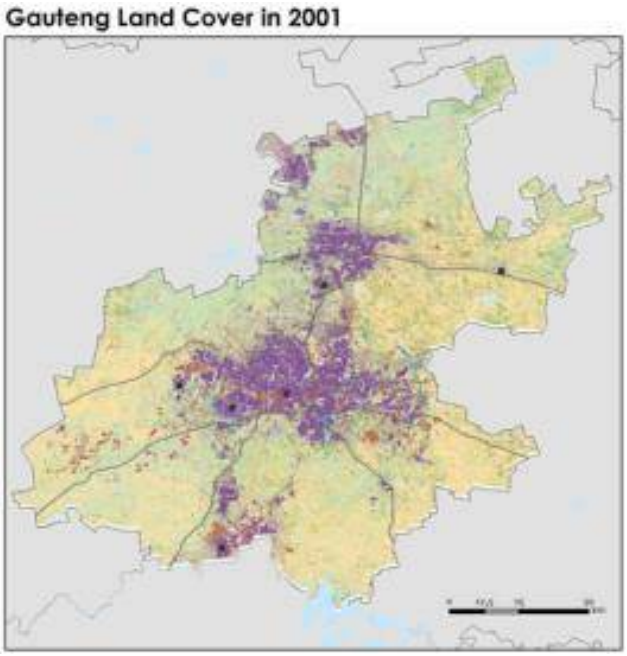
Detailed descriptions

Key Action 8.1: Enforce stricter spatial planning regulations: Limit urban sprawl through compacter city development

Proposed actions:

- Restrict future urban development within Gauteng's urban edge boundary
- Protection of conservation land and wetlands through new regulations
- Involve locals in planning at community level

Since its formation in 1994, Gauteng's population and its urban footprint has been growing continuously. Enforcement of apartheid laws since 1949 led to Gauteng's sprawling spatial pattern. After the end of apartheid era, attempts are made to improve the situation. After 1994 different spatial-related laws have been approved, mainly to address and support minority interests. This led to a confusing environment for planning, which resulted in more chaotic urban development. The current South African land use management system is guided by national and provincial government, but effectively operates at local government level. Emphasis should be given to promote energy efficient spatial pattern in order to address the mitigation issues.



Target group and sector	Government, city planners, urban developers.
Resource Potential	Moderate to high impact potential based on the enforcement of spatial planning regulations. By following an integrated approach, more possibilities exist to create energy and climate efficient spatial patterns. To achieve this, different policies and measures to mitigate GHG emissions should be incorporated in the national, regional and local level land-use bills. Encouraging job opportunities near residential sector or creating urban settlements near employment centres would not only reduce travel time, but also address energy

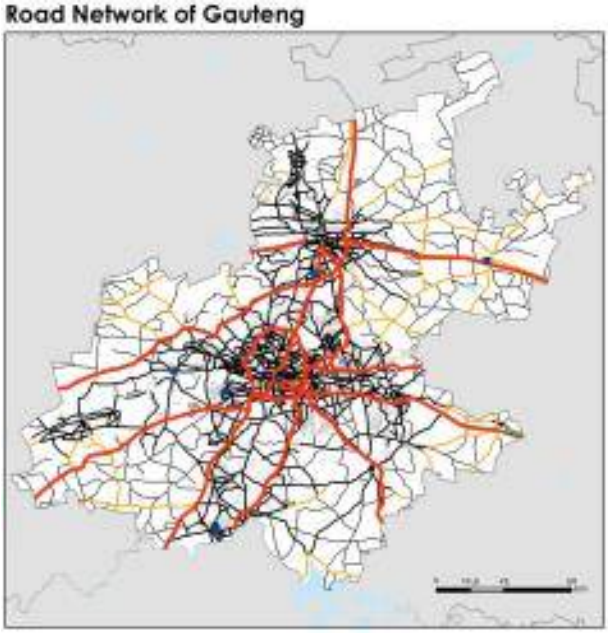
	and GHG mitigation issues. Along with efficient city planning, spread of BRT and increased number of Gautrain routes will help in reducing private vehicle flow.
CO_2 reduction potential	The GHG reduction potential through better spatial planning is moderate at reasonable GHG mitigation costs. The proposed action goes hand in hand with better transportation system, which will help in developing public-transport oriented urban development.
Recommendation	To achieve a compact spatial structure, it is important to restrict urban growth to today's urban boundary, i.e. no further urban development in the outer zones together with protection of conservation areas and by enforcing wetland restoration. The local government should prioritise the problem areas. Locate the problem areas in Gauteng and put more emphasis on those areas (e.g. SOWETO, Alexandra, Orange farm, etc.) as most of these areas house most of the population with no access to water, sanitation, electricity, and public transportation. It is important to involve the locals in planning at community level which will help in achieving sustainable communities.
References, sources of information	Marathe, S.D: Recognising the Change in Land-Use Patterns and Its Impacts on Energy Consumption and Emissions. Unpublished PhD Thesis. Stuttgart: University of Stuttgart, IER, 2013 MALA 2001: Ministry of Agriculture and Land Affairs (MALA), White Paper on Spatial Planning and Land Use Management. Verna, N., 2009: Department of Urban and Regional Planning, University of the Free State, Bloemfontein, South Africa: Land use management and lower carbon emissions (lecture on the 45th ISOCARP Congress.

Key Action 8.2: Integrated urban development: Support urban development along transport corridors; promote mixed income communities

Proposed actions:

- Encourage mixed (various income groups) residential development
- Emphasis on redevelopment of infill[2]- and brown[3]-field development
- Strengthen existing public transport network, especially in economically backward areas

Sustainable and energy efficient spatial planning is not a common priority in Gauteng or South Africa. In most of the spatial planning related bills and regulations, environmental issues are not treated as top priority. The south African (including Gauteng and local government) needs to consider affordable sustainable and energy efficient urban development along with putting their focus on the low-income housing development. Integrated urban development approach mainly focuses on urban renewal. Through integrated urban development emphasis is given on making existing settlements a better living place by making it sustainable and energy efficient.



Target group and sector	Government, city planners, urban developers, housing sector
Resource Potential	Integrated urban development concepts with a focus on energy efficient refurbishment are useful on all levels of municipal planning. Although the focus is on a relatively small scale planning level for residential areas, it will be beneficial to see integrated urban development concepts focusing on energy efficiency and climate protection in a broader picture. The revitalisation of existing inefficient

[2] Infill development means using land within a built-up area for further construction.
[3] Brownfield development uses land previously used for industrial or commercial purposes for property development

	neighbourhoods will lead to lesser energy consumption and CO_2 emissions with reduced traffic. This will help in reducing ecological footprint of the region. At the provincial level, an integrated urban development concept for the whole region with an explicit focus on energy efficiency and sustainability is needed. This concept can then be set as a mandatory concept for the local level planning.
Recommendation	Integrated urban development includes following measures: • Achieving ***mixed development*** through the creation of neighbourhood units consisting of different housing categories with a variety of housing typologies and densities, suitable for various income groups • Building ***cluster housing***, which consists of sustainable houses, e.g., north facing houses/passive houses that consume less energy. • ***Public transport corridors*** within an activity corridor would move at a speed adjusted to the active and mixed environment with frequent stops to achieve convenience and accessibility. • Realisation of ***nodal development/polycentric structure*** through the creation of central nodes surrounded with high density housing, commercial and social service, and businesses. • ***Urban Agriculture*** should be encouraged by supporting people to grow vegetables and other produce on site. Besides food security, potential benefits from urban agriculture include self-sufficiency for families, ecological restoration, urban greening, water recharge, and urban renewal. • ***Pedestrian/Cycle paths*** as a network should connect housing clusters with primary service facilities, employment areas, and public transport nodes. • ***Higher densities and mixed-use development*** in residential areas lead to an efficient use of infrastructure, an increase in transport efficiency and lower transport costs • ***Intensification and infilling***, for instance, lead to higher densities, it can achieve spatial integration, increase the population threshold, and reduce land consumption. This can be supported by reducing the property size in new developments or as a renovation measure. • Besides better spatial planning policies, more opportunities should be created for the production of ***renewable energy*** from various sources.
References, sources of information	Marathe, S.D: Recognising the Change in Land-Use Patterns and Its Impacts on Energy Consumption and Emissions. Unpublished PhD Thesis. Stuttgart: University of Stuttgart, IER, 2013 Marathe. S.D. and Eltrop. L. 2014: Gauteng: Sustainable Solutions in Mega City Book Series: Space, Planning, Design. (in press) White Paper, 2001: Ministry of Agriculture and Land Affairs: White Paper on Spatial Planning and Land Use Management, 2001

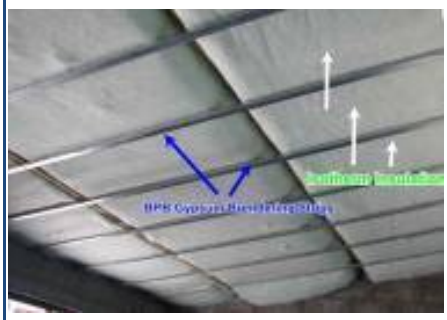
Key Action 8.3: Implement sustainable social housing projects: Include environmental aspects in RDP tendering and install (iEEECO™) showcases

Proposed actions:

- Upgrading of existing settlements towards sustainable communities
- Implement iEEECo™ energy efficient settlements in Gauteng
- Encourage use of SWH and PV-installations for households
- Involve locals in social housing projects

The political transformation to a democratically-elected government in 1994 was accompanied by extensive migration from South Africa's rural hinterland into urban centres, as well as an influx of documented and undocumented migrants seeking economic advancement or fleeing political instability elsewhere in Africa.

In response to this challenge, the new democratic government commenced a vigorous programme of social housing. Numerous small scale demonstration and pilot projects, undertaken in the preceding decade, have demonstrated that passive energy features, water savings and energy efficiency interventions can be incorporated successfully in low-cost housing.



Target group and sector	Low-income and poor income groups, residential sector.
Resource and Energy Potential	Energy optimisation through passive energy efficiency techniques and water recovery methods provide the householder with an effective energy, health and safety subsidy for the life of the building. The passive house is expected to have reduced carbon emission that cannot be easily subverted. Additional energy efficient features may be

	made available to enable the household to benefit from essential and life enhancing energy technologies while remainning within the 10% limit for energy services. This includes energy efficient cook stoves (solid, liquid or gas fuelled combustion stoves, or electrical stoves), lighting and refrigeration. Currently, inefficient second hand appliances are recycled into poor households, who can least afford the higher operating costs.
Energy & other issues addressed	The local societal benefits to be derived from energy savings measures are far greater. These benefits include reduced need for indoor space heating, and reduced emissions of smoke (particulate matter) and carbon monoxide from cooking fires. Reduced exposure to household air pollution is thus a significant health benefit. Risk of fire and cooking related accidents is a serious burden borne disproportionately by the low-income sector
References, sources of information	Guy, D., Annegarn, H., Eltrop, L., 2013: Sun Energy, Empowerment and Sustainable Housing – A South African Case Study, published in Energy and Sun (Ed. Eltrop, L., Telsnig, T., Fahl, U.), Book Series Future Megacities vol. 1. Jovis Verlag. http://www.energy.gov.za/cop%2017/CopFiles/COP17_iEEECO_Flagship_Methodology.pdf http://www.uj.ac.za/EN/Newsroom/News/Pages/UJlaunchesSustainableenergyTechnologyandResearch(SeTAR)Centre201003231.aspx

IER