THE SUSTAINABLE ENERGY SECTOR
A Global and National Industry Analysis

Draft Situational Report for eThekwini Municipality
EXECUTIVE SUMMARY

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This Situational Report provides an analysis of global and national sustainable energy industries. The market trends in energy efficiency and renewable energy are summarised in order to assist in formulating recommendations on how to create an enabling environment for the development of the sustainable energy sector going forward.

The sustainable energy (SE) sector encompasses so many different industries that overlap with existing industries, therefore this report has analysed the different trends in various energy efficiency industries and renewable energy industries.

ENERGY EFFICIENCY

Energy efficiency is a global imperative to reduce GHG emissions and improve productivity per unit of energy consumed (R/kWh). A conservative estimate of the potential for energy efficiency globally is modelled in the Efficient World Scenario, where "the growth in global primary energy demand to 2035 would be halved" (IEA 2012) if the best available technologies were adopted. When compared to potential reductions in GHG emissions among climate mitigation measures such as renewable energy and carbon sequestration, energy efficiency in end uses accounts for 45% of potential emission reductions. (Kaygusuz 2012).

Industrial Energy Efficiency Industry

A major driver in industrial energy efficiency is the opportunity to save money and reduce input costs. Local companies such as Toyota-SA have been able to invest in energy efficiency measures with a pay-back period of less than two years. Toyota-SA saved 13,845 MWh over 2 years from a R4,9 million investment in over 50 energy system optimisation initiatives. These interventions are the low hanging fruit, which can achieve major savings at scale with little capital investment and much behaviour change and appropriate energy management practises. Although the total savings, investments and potential in this sector is not quantified, there is still substantial potential for greater industrial energy efficiency with best available technologies and appropriate incentives such as the energy savings allowance and 12I tax allowance incentive.

Agricultural Energy Efficiency Industry

The agricultural energy efficiency industry is advancing in light of increasing oil prices affecting input costs of fertilizer and motorized machinery such as tractors. The energy intensity of different farming methods in different regions varies considerably, requiring case-specific strategic interventions. The major drivers for agricultural energy efficiency are energy security and cost. Biofuels that can be produced and consumed at the source are attractive from an energy security point of view. Biogas digesters that can generate natural gas, electricity and fertilizer are also attractive in the agricultural industry. The energy

intensity of the South Africa's agricultural industry is high compared to the rest of the world, meaning that less income is generated per unit of energy consumed.

Energy Efficiency trends in Transport

Energy efficiency measures in the transport industry can be categorized by fuel and technology efficiency and modal shifts in both freight and passenger transport. Measured in litres of gasoline equivalent (lge) per 100 km, the fuel economy of passenger vehicles in OECD countries has improved by -2.7% between 2008 and 2011 and by -0.6% in Non-OECD countries. These efficiencies are not enough to abate for the increasing levels of motorisation (ownership of personal vehicles) in developing countries. Public transport is known to achieve greater passenger km per litre of fuel than private use of passenger vehicles.

About 74% of South African households are 1-15min walking distance from a taxi service but have no access to a train service (Ryneveld 2008). To address the need for better public transport, the South African government has initiated large scale infrastructure investments: R4.2 Billion has been allocated by the Government to the state-owned Passenger Rail Agency of South Africa (PRASA), and two bus rapid transport systems have been established. ReaVaya in Johannesburg and My City in Cape Town are in the process of expansion. New systems are being introduced in Tshwane, Nelson Mandela Bay, Rustenburg and eThekwini, which are expected to begin construction of their systems shortly (Treasury 2013).

Energy efficiency in the South African transport sector is of paramount importance because the high dependence on imported crude oil at ~70% of primary energy for liquid fuels (RSA 2013) renders the sector vulnerable to external price shocks, supply constraints and insecurity. Vanderschuren, Lane and Wakeford (2010) project that road transport in South Africa can achieve up to 25% energy savings across passenger and freight transport by 2030. Similarly, rail can achieve up to 10% in energy savings by 2030 and air transport up to 25% by 2030.

Energy Efficiency in Electricity Generation

The energy efficiency in electricity generation industry is fairly standard per technology. Coal fired electricity generation has an efficiency of 35% on average, which means that only 35% of the calorific value of raw coal is processed into useful energy in the form of electricity generated with a portion of the energy generated used in the generation process. Supercritical coal fired generation are said to achieve efficiencies of 43% or even as much as 50% but this technology is very costly (Sims, et al. 2008). In comparison, electricity generation from solar, wind and small hydro is 100% energy efficient, converting all of the renewable resource into useful energy.

Energy Efficiency in Buildings

The built environment has been identified as the sector contributing to the most GHG emissions, producing approximately 50% of all emissions globally. Linked to urban planning, population density, architectural design, and consumption behaviour, the opportunities for improved energy efficiency and reducing emissions in built environment are diverse.

Integrated planning, monitoring, and management are essential systems to promote greater energy efficiency. Green star rated buildings and LEED rated buildings are recognised internationally as standards for energy efficient and low carbon buildings.

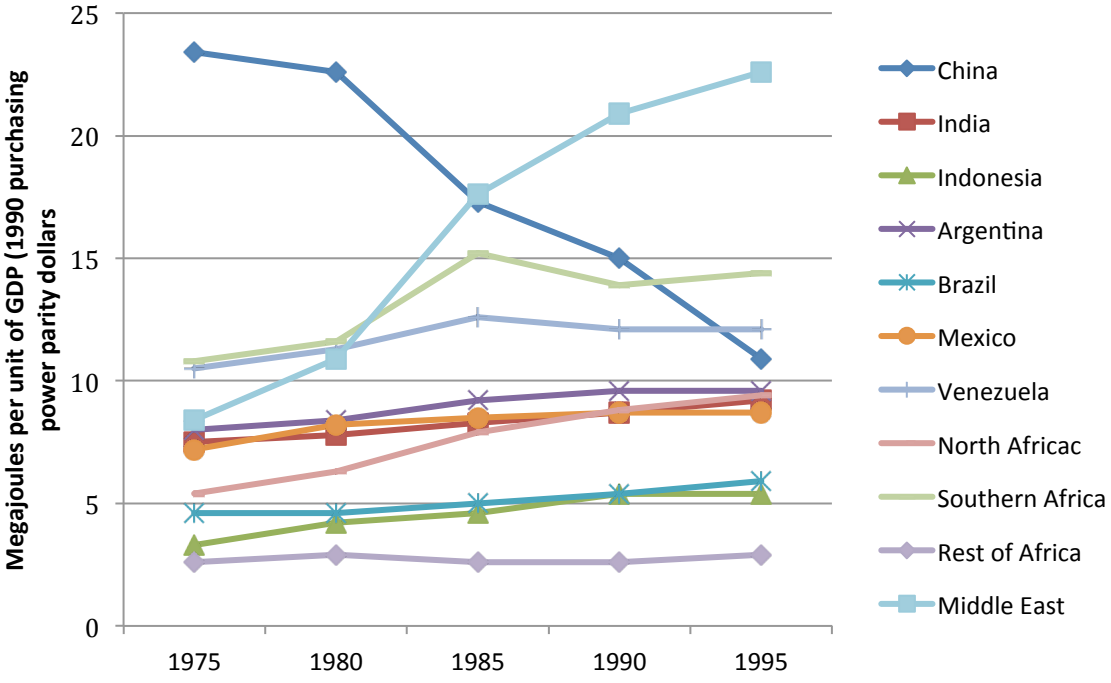
Residential Energy Efficiency Industry

Residential energy consumption and end-use efficiency varies widely between households of different income groups, climatic regions and levels of industrialisation or economic development. Many advances have been made in improving and standardising the energy efficiency of appliances with appropriate labelling. However, energy is a normal good, as incomes rise, more energy is consumed, which can explain the rebound effect.

A phenomenon in modern societies is the *energy efficiency gap*, which is commonly understood as the gap between the potential for energy savings and the actual uptake of/investment in energy efficiency measures. Consumption behaviour and consumer education are critical in improving residential energy intensity. Modelling residential energy efficiency therefore takes only a portion of total potential savings to accommodate the gap.

As a whole, South Africa consumes more energy to produce income and has an energy intensive economy compared to other regions as shown by the figure below. Attention to productivity and energy consumption across all sectors is important for development.

Ratios of Primary Energy to GDP in Developing Countries, 1975–95



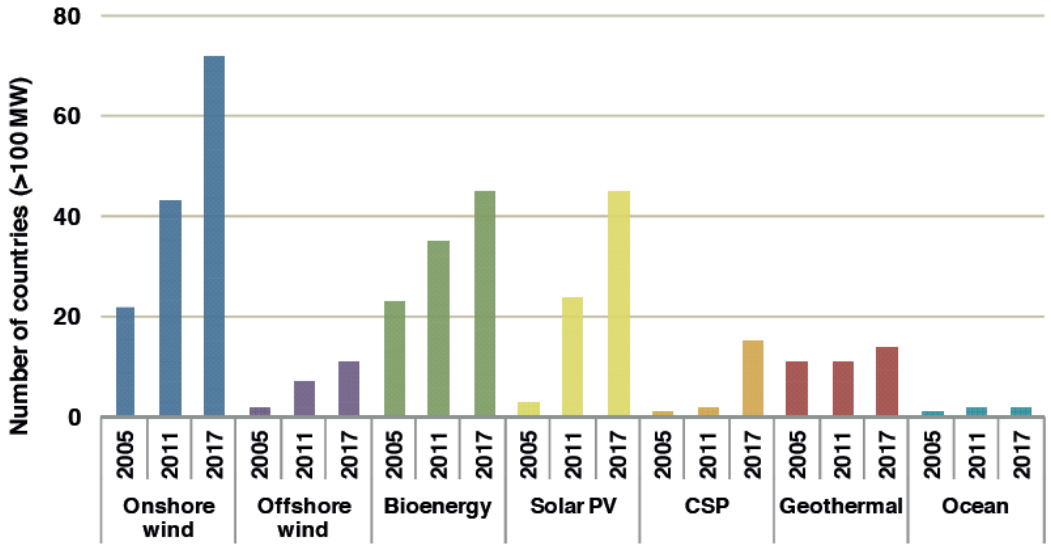
Southern Africa includes the ratios of energy to GDP are for Nigeria, South Africa, Zambia, and Zimbabwe. Source: (Jochem 2000)

RENEWABLE ENERGY

Renewable energy technologies (RETs) have proved to be cost competitive and efficient in generating centralised and decentralised electricity, as well as direct energy services such as heat, gas for cooking and liquid fuels. Although global primary energy consumption is still heavily dependent on fossil fuels, the net investment in new generation capacity from renewable energy (excluding large hydro) has exceeded investment in conventional generation capacity for three consecutive years (Bloomberg New Energy Finance 2013).

While certain countries lead by significant margins with large portions of total installed capacity, the graph below shows how more and more countries already have and plan to have sizeable (over 100MW) installed renewable energy capacity (not including hydro capacity).

Number of countries with non-hydro renewable energy capacity above 100MW (IEA 2012a, 12)



Renewable Energy for Electricity Generation

The increase in renewable energy capacity globally is largely attributed to utility scale renewable electricity generation plants using wind and solar technologies. The solar PV industry has experienced the fastest growth rates of all renewables with cumulative capacity increasing by 54% on average per year from 2005-11 (IEA 2012a, 159). With 30% reductions in the price of solar PV, the level of new investment decreased in 2012 by 11% for the first time while actual new capacity increased by 29% to 100 GW in 2012 (REN21 2013).

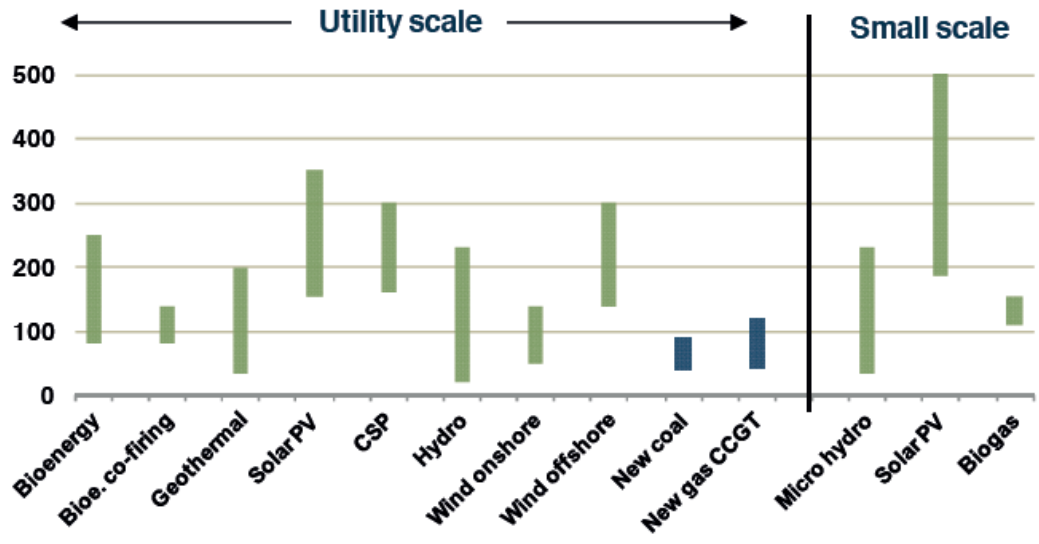
Onshore wind power technology is also proven and mature technology like Solar PV and is also cost competitive with conventional energy generation. Installed capacity has increased at an average growth rate on 26,5% since 2005 (IEA 2012a). This total installed capacity of onshore wind increased to 230GW in 2012 (REN21 2013).

Conversion technologies such as cogeneration, Combine Heat and Power (CHP) and Anearobic Digestion are widely used to generate electricity, heat energy, and natural gas from biomass. Total global bioenergy (electricity generated from biomass) exceeded 300 TWh in 2011 (IEA 2012a). The main driver of electricity generation from bioenergy is reliable feedstocks such as wood, agricultural residues, waste biomass (or underutilised biomass) and organic municipal waste. The wood pellet industry, in particular, has steadily grown as a major biomass feedstock; with total consumption in 2012 reaching 22,4 million tons (REN21 2013). In addition to the well-established sugar industry in KZN and use of baggase in cogeneration to power the sugar mills, new bioenergy industries such as organic waste and wastewater streams are emerging.

Geothermal electricity generation is another mature technology suitable for locations near tectonic plates. South Africa does not have any identified potential in this regard. There is however considerable opportunity for Ocean Energy power utilising the Agulhus current (estimated 1212MW potential) on the east coast (Roberts 2012) and wave potential on the cape coastline at 2,5m/sec.

In addition to centralised utility scale plants, renewable energy is also suitable for decentralised and embedded electricity generation. The market for mini- micro- and off-grid renewable energy has increased with the fall in technology, battery and inverter prices. The global statistics for privately installed rooftop PV installations or rural solar home systems in the region of 10 – 200 watts are not available, however in Bangladesh more than 2.1 million [solar home] systems had been deployed by March 2013." (REN21 2013)

Levelised cost of power generation (USD per MWh) (IEA 2013a, 168)



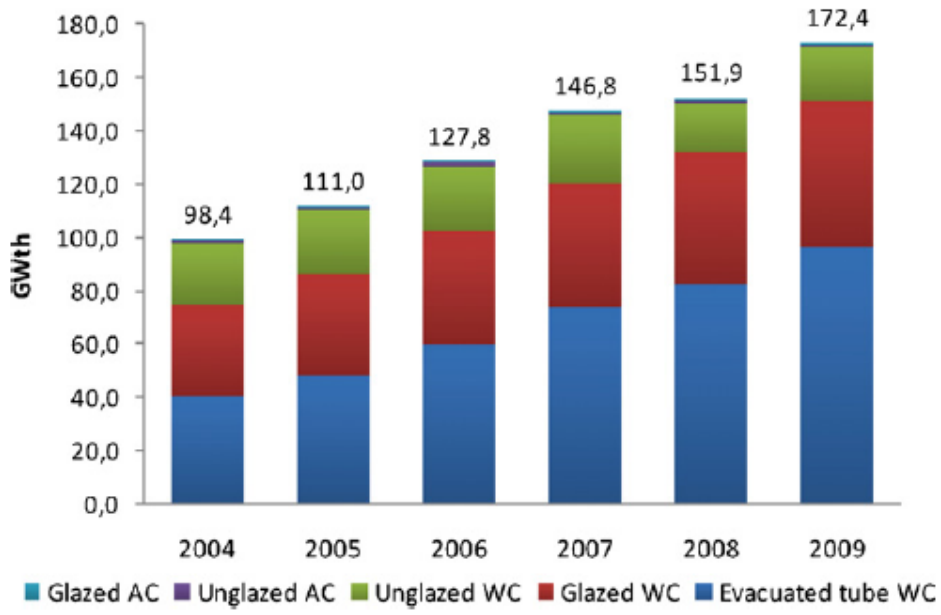
Small hydropower is another mature and cost competitive technology suitable for decentralised generation that can be applied on small dams, in run-of-river, inter basin water transfer schemes and municipal water distribution systems without having a negative impact upon the environment. The levelised costs of power generation per technology in the figure above, show that micro-hydro and biogas at a small scale are cost competitive with utility scale power plants.

Although levelised costs of electricity for centralised generation are generally lower than decentralised generation due to economies of scale (see solar PV for example), there are benefits for the end user and price taker. Customers and even local authorities are end users and price takers. They are able to generate electricity for own use at a lower cost than that which they can import in the long term.

Solar Thermal Energy

In a class of its own, solar thermal energy can provide hot water as well as space cooling and heating for various residential and industrial applications. As a demand side management measure, Solar Water Heaters can replace as much as 24% of household electricity consumption. The market for solar thermal water heating is responsible for most of the industry in growth as can be seen in figure below – see unglazed, glazed and evacuated tube water collectors (WC) make up the bulk of growth since 2004. However the market for solar thermal space heating and cooling is starting to emerge especially in Europe.

Installed Capacity of Solar Thermal Systems from 2004 – 2009. WC is water collector and AC is air collector. (Timilsina, Kurdgelashvili and Narbel 2012)



Beyond 2009, the total global solar water heating capacity alone increased from 195 GW_{th} in 2010, to 223 GW_{th} in 2011, to 255 GW_{th} in 2012 (REN21 2013).

China is responsible most of the recent growth in the SWH industry, such that SWH are now cheaper than electrical water heaters. South Africa is following the progress of the leading countries with the implementation of rebates and Energy Efficiency Building Regulations in 2011 that make it mandatory for new buildings to supply at least 50% of annual hot water by non-electrical means.

Renewable Energy and Liquid fuels

South Africa's dependency on crude oil imports impact negatively on the national balance of payments (DoE 2013). Although the heavily susbsidised coal-to-liquids programme makes Sasol one of the largest carbon emitting companies in the world, it also ensures some supply diversity and local production capacity, which improves energy security in the liquid fuels sector and lessens the trade deficit.

To improve energy security and lessen the dependence on oil imports or depleting oil reserves, many countries have implemented mandatory blending rates. Long established markets like Brazil, can accommodate higher blending rates up to 50% due to a market with flexi-fuel engines, whereas emerging markets typically aim for E10 (10% ethanol) rates. "The global demand for liquid biofuels more than tripled between 2000 and 2007. Future targets and investment plans suggest strong growth will continue in the near future… Driven by supportive policy actions of national governments, biofuels now account for over 1.5% of global transport fuels (around 34 Mtoe in 2007)." (Sims, et al. 2008)

Although the IPAP recognises the potential to create 125,000 jobs at 10% mandatory blending rates (DTI 2012), the *Regulations regarding the Mandatory Blending of Biofuels with Petrol and Diesel*, which were ratified in 2012, require a minimum of 5% biodiesel blending with diesel and 2-10% bioethanol blending with petrol. This can be provided by licensed capacity of over 1000 million litres per annum.

Renewable Energy in Rural and Developing Markets

Accessibility and affordability are important drivers for promoting renewable energy in rural and developing markets. Development objectives and social welfare imperatives across the world have sought to provide more affordable and cleaner energy carriers for basic energy needs. Gel fuel, a processed biofuel, has been introduced to the market as an affordable substitute for fuel wood; and fuel efficient stoves that create much less smoke and use up to 90% less wood/twigs, have also been introduced.

In rural areas of China, India, Nepal, Vietnam and Bangladesh, Anaerobic Digestion in the form of small scale biogas digesters use organic waste to generate gas for cooking and electricity for lighting (Greben and Oelofse 2009). REN21 estimate that "48 million domestic biogas plants have been installed since the end of 2011… in China (42.8 million) and India (4.4 million), and smaller numbers in Cambodia and Myanmar" (REN21 2013, 83). The economic viability of biogas digesters in rural homesteads in South Africa have a positive benefit to cost ratio of 4.83, however if only financial benefits are measured against financial costs, the ratio is 0.98 (Smith 2012).

Ahlfeldt (2013) identifies the off-grid residential PV Solar Home System market in South Africa as "the biggest growth opportunity in the long-term with over 10 GW potential". "In Bangladesh, for example, more than 2.1 million systems had been deployed by March 2013." (REN21 2013)

The social, economic and environmental value of renewable energy deployment in rural and developing markets has attracted much donor support for such initiatives. Without subsidies, technical support, micro-credit, and favorable lending, the capital investments required are a major challenge for low-income households. Even the fast growing market for solar lanterns with a relatively low per unit cost, faces the challenge of affordability (Lighting Africa 2011).

Compared to diesel generators used by rural customers who can afford to, renewable energy technologies are fast becoming cost competitive (REN21 2013). Biogas, solar PV and wind in particular can generate electricity for own use off-grid or it can be fed into mini-, micro-grids to enhance the welfare and access to modern technology for a community or village. Community Property Resources (CPRs) have proven effective models for the deployment and maintenance of micro-grids powered by renewable energy in Kenya (Chaurey and Kandpal 2010). Decentralised distribution grids (DDG) powered by biogas digesters have also been strongly promoted in India (IEA 2012a, 118).

PRIORITIES AND POTENTIAL FOR LOCAL SE INDUSTRIES

Taking into account all relevant national policies, the objectives of the Draft Integrated Energy Plan include (DoE 2013):

1. Security of energy supply
2. Minimise cost of energy
3. Increase access to energy
4. Diversify supply sources and energy carriers
5. Minimise emissions by energy sector
6. Improve energy efficiency
7. Promote localization, technology transfer and job creation
8. Water conservation

These objectives permeate the tax incentives for energy efficiency, and the allocation of 3725 MW to renewable energy projects in the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) informed by the Integrated Resource Plan for electricity. In KwaZulu-Natal (KZN) however, the REIPPP has only attracted one 16,5MW biomass project, recently announced in the third bid window.

There is potential for KZN to be a fast follower in a number of suitable industries: industrial energy efficiency, SWH, solar PV embedded generation, cogeneration at a utility and industrial scale, anaerobic digestion to generate electricity, gas and liquid fuels from agricultural waste streams, municipal wastewater and waste to energy technologies such as (already a leader in landfill gas), wood chip production for export and use in CHP industries, bioethanol and biodiesel production, and micro-hydro power solutions for on site consumption.

There is also potential for KZN to be a first mover in second-generation biofuels from algae, ocean current energy generation, and in the deployment of renewable energy in rural and informal markets.

The major job creation industries in the sustainable energy sector identified by the 2011 Green Jobs Report are in installation, maintenance and manufacturing of Solar PV, installation and manufacturing of SWH, materials recovery facilities in Waste to energy industry, biofuels production, cogeneration, public transport and construction of new generation plants.

The outcomes of the Sector Survey and Manufacturing Baseline Study will be discussed within this context at a Stakeholder Meeting with representatives from eThekwini Energy Office, Economic Development and Investment Promotion Unit, and the Electricity Department. The purpose of the meeting is to receive preliminary presentations on the manufacturing survey and the sector survey and to assist in formulating recommendations on how to support sustainable energy manufacturers and the broader sustainable energy sector going forward.

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