SUSTAINABLE ENERGY SECTOR REPORT
For eThekwini Municipality

FINAL REPORT

Final Report
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1. Introduction

The KwaZulu-Natal Sustainable Energy Forum (KSEF) is a not-for profit company. The mission of KSEF is to facilitate the development and growth of the sustainable energy sector in KwaZulu-Natal, South Africa through information dissemination, the facilitation of networking within the sector, and the implementation of enabling projects.

This report on the Sustainable Energy Sector in eThekwini and KwaZulu-Natal combines the executive summary of a situational report, and the sector survey findings 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 Situational Report provides an analysis of global and national sustainable energy industries, focusing on the market trends in energy efficiency and renewable energy. And the purpose of the sector survey was to understand the size and nature of the local sector, as well as local businesses' experience of market barriers, failures, instruments, and policies in the sustainable energy sector in eTM and KZN.

The insights into the challenges experienced by the existing base of key manufacturers in the eThekwini Municipal area provided by the Manufacturing Baseline Study will be incorporated into the final recommendations, along with input from key eThekwini stakeholders.

2. Acknowledgements

KSEF would like to thank the Energy Office of eThekwini Municipality for funding this report. Furthermore, we would like to thank officials from the Energy Office and the Economic Development Unit of eThekwini Municipality, Trade and Industry KZN and the Provincial Department of Economic Development and Tourism for advice regarding the research process. We would also like to thank all the business respondents who gave up their time to be interviewed and/or to complete the online survey for this report. Their experience and views are vital in providing an evidence-based process for the development of a Sector development strategy that is appropriate to the potential growth of this.

3. Methodology

This Sector Report includes 1) a summary of the Situational Report: A Global and National Industry Analysis, 2) the findings of the Sustainable Energy Sector Survey of businesses listed on KSEF business directory and 3) the input of key stakeholders from eThekwini Municipality.

Identified as a priority sub-sector of the Green Economy, the Sustainable Energy sector is identified by eThekwini Municipality and KZN Provincial government to have significant economic growth, employment and equity potential. This prioritisation of sub-sectors is the first of nine steps defined by the Trade and Industry South Africa (TISA) *Customised Sector Programme Development Methodology* to develop a sector strategy:

1. Select Sub-sectors/Industries with Potential
2. Research Sub-sectors
3. Interpret Research
4. Formulate Sub-sector vision
5. Identify levers
6. Economic Evaluation of Levers
7. Develop Strategic Objectives and make Strategic Choices
8. Customised Sector Programme
9. Monitoring and Evaluation

The global and national industry analysis presented in the Situational Report, and summarised in this Sector Report involved desktop research guided by step 2 of the TISA methodology to answer the following questions:

- What is the current and anticipated state of the global economy?
- What are the global industry trends?
- Critical success factors: what are the minimum conditions for profitability in this sector?
- What are the domestic market trends in this sector?
- What is the size and structure?
- What is the geographic location?
- What are SA's competitive advantages and disadvantages?
- Who are SA's investment and export competitors?
- Which industries and products have the highest value-added and fastest export growth rates?

A combination of journal articles, industry and government reports were analysed to understand the market trends and critical success factors of multiple industries within the Sustainable Energy sector. The following markets/industries were analysed:

Energy Efficiency (EE) Industries:	Industrial EE Industry
	Agricultural EE Industry
	EE in Transport Industry
	EE in Buildings
	EE in Electricity Generation
	Residential EE

Renewable Energy (EE) Industries:	RE for Electricity Generation
	Solar Thermal Energy
	RE and Liquid Fuels
	RE and Natural Gas
	RE in Rural and Developing Markets

Since the SA sustainable energy sector is relatively new and emerging, further research was required to understand the size and structure of the local sector, the geographic location, the competitive advantages and disadvantages, the investment and export competitors and the comparative value-added and fastest growth rates.

A survey was therefore developed to investigate the nature of the local businesses active in renewable energy and energy efficiency industries in KwaZulu-Natal and to understand their experience of market barriers and opportunities. Initially a test survey was drafted based solely on the barriers for penetration of Renewable Energy Technologies (RETs) identified by Painuly (2001) and market barriers for EE implementation by Sarkar and Singh (2010).

Nine respondents, who attended a KSEF event regarding Solar Thermal Energy on 8th October 2013, completed the test survey. The general feedback of the respondents was that due to their various levels of experience in the sector, they were only able to partly comment on the comprehensive market barriers identified. The survey was therefore restructured to allow for respondents to describe their own level of activity and experience in the SE sector and open ended questions allowed respondents to list or describe the most prominent challenges faced by their own business.

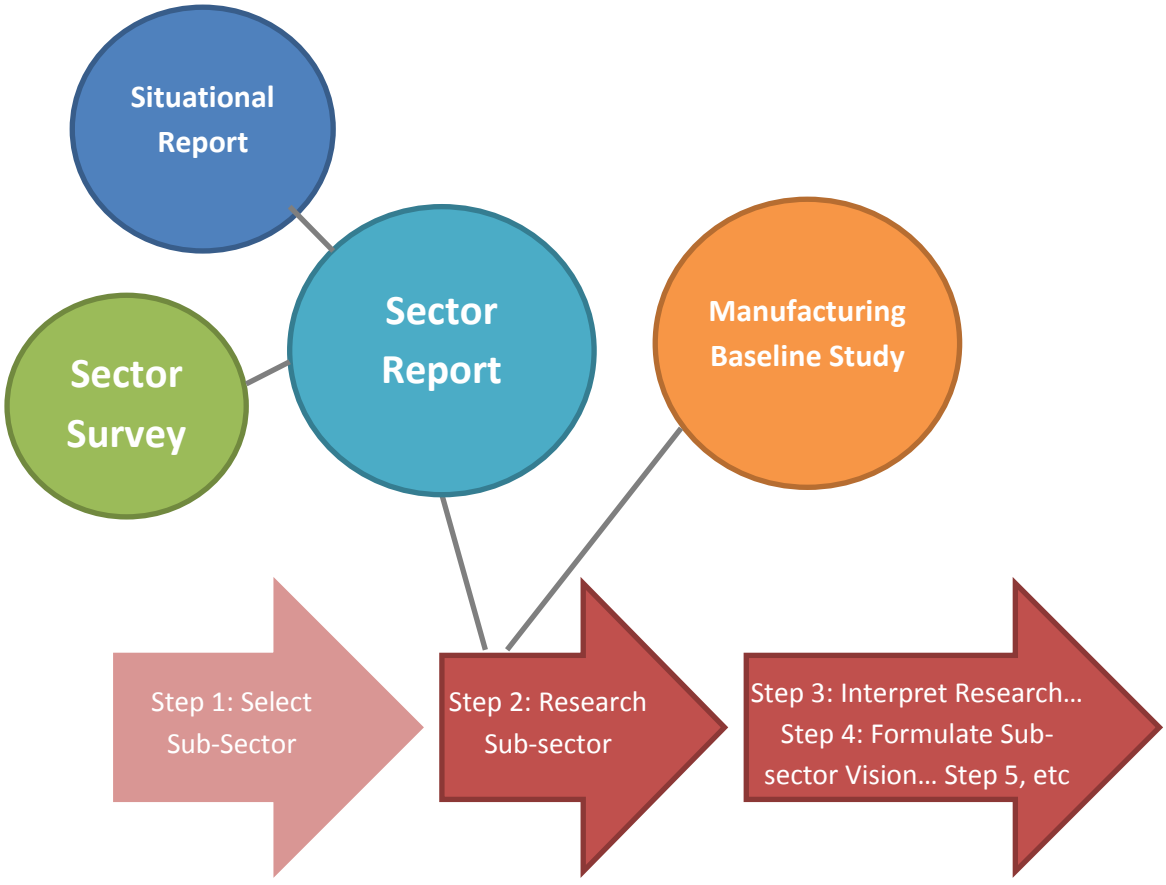
The online survey was shared via email with all businesses listed on the KSEF business directory, totalling 120 at the time. After 22 responses were recorded in the first week, reminders were sent to the remaining business that had not yet responded. During this process, it was noted that ten email addresses 'bounced'. In total 41 responses were recorded, however there were two repeat entries by the same companies, therefore the final tally of responses was 39. The sample is thus 35% of the defined population.

The KSEF Business Directory is a free service for all businesses in the sustainable energy sector. It has not been advertised extensively but visitors to the website over the last three years have elected to list their business. This self-selected list of businesses is not exhaustive of all businesses active in the KZN SE sector, however it does capture an adequate population sample for the purposes of this study.

eThekwini stakeholder input was obtained during a Stakeholder meeting on 26 November 2013, where the research findings were presented along with the research findings of the KSEF Manufacturing Baseline Study. The Baseline Study gave special attention to the manufacturing sector, which cuts across a number of technologies and sub-sectors of the sustainable energy sector. It is a separate study to this sector research but the findings and recommendations discussed at the Stakeholder meeting have relevance for both research.

This Sector Report alongside the Manufacturing Baseline study serves as the research required to develop an evidence based sector development strategy. Policy makers are invited to proceed with next steps defined by the TISA methodology to ultimately develop a vision for the sustainable energy sector and a customised sector programme to realise the identified growth, employment and equity potential of the sector.

Figure 1: Visual Flow Diagram of Research Input in Sector Development Process



4. Overview of Sustainable Energy sector

The sustainable energy (SE) sector encompasses many different industries that overlap with existing industries, such as biomass with agriculture, and Solar Water Heating with plumbing. This section provides an overview of the international and national market trends in the multiple energy efficiency industries and renewable energy industries with relevance to South Africa, KwaZulu-Natal and eThekwini Municipality.

4.1. Energy Efficiency

Energy efficiency is regarded as 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

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 12L tax allowance incentive[1].

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

[1] The 12L tax allowance has only recently come into effect with no proven case studies or experience of how it works. The regulations were published in December 2013 and can be downloaded here. Unfortunately an in depth understanding of the requirements and expectations is not included in this report.

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. In parallel to these voluntary rating systems, building regulations can be applied. The South African Energy Efficiency Building Regulations adopted in 2011 apply similar standards for buildings appropriate to the region and climate.

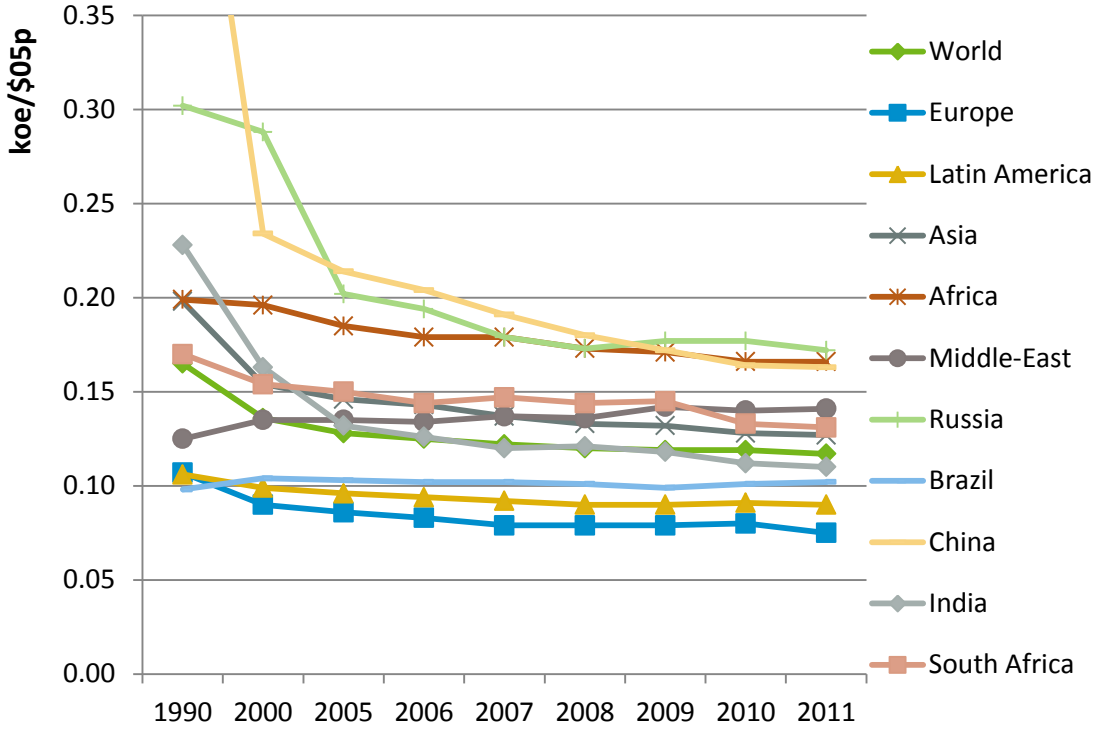
Residential Energy Efficiency

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 Brazil, India Europe and Latin America as can be seen in the figure below.

Figure 2: Ratios of Total Final Energy Intensity per region and BRICS countries from 1990 - 2011



Source: http://www.worldenergy.org/data/efficiency-indicators/

The energy intensity of an economy is measured here as ratio of final energy consumption to GDP. Knowledge economies or tertiary sectors will tend to be less energy intensive than agricultural economies or primary sectors. China and Russia are more energy intensive that South Africa but have both shown large improvements in energy efficiency since 1990. The Middle East is the only region shown in the figure above to have become less energy efficient over or more energy intensive since 1990.

Critical success factors for Energy Efficiency

Direct monetary and cost savings for the consumer are commonly the most effective incentive for energy efficiency. However, even when financially viable, many market barriers/failures, and information and behavioural problems are cited for the poor uptake of energy efficiency (Sarkar and Singh 2010) (Gillingham, Newell and Palmer 2009).

From international experience reviewed in the preceding sections, the following factors are critical for successful uptake of energy efficiency and promotion of the industry:

- **Awareness** about technology benefits, costs, policy incentives, etc among consumers across all sectors to enable informed decision making
- **Accurate data capture** to set baseline for energy consumption, monitor performance, improve energy management and achieve relevant targets
- **Energy management** to ensure implementation of appropriate systems to monitor, evaluate, verify and manage energy consumption
- **Performance based incentives** such as tax incentives

- **Non-performance based incentives** such as rebates/subsidies, attractive micro-finance & lending schemes, and mandatory compliance regulations/quotas
- **Sector specific incentives** for different industries, end-use applications and markets
- **Integrated site specific planning** to avoid one-size-fits-all and blanket approaches
- **Integrated Value Chains** for the reliable manufacture, supply, operation and maintenance of energy efficiency measures
- **Removing perverse incentives** such as subsidies for conventional energy intensive products, services and economic activities
- **Appointing responsibility** for energy savings and energy consumption is critical in all sectors involving landlord and tenant situations where no incentive to save energy exists for either party. Appointing responsibility to leading government agents, departments and line functions is also important from an institutional perspective.

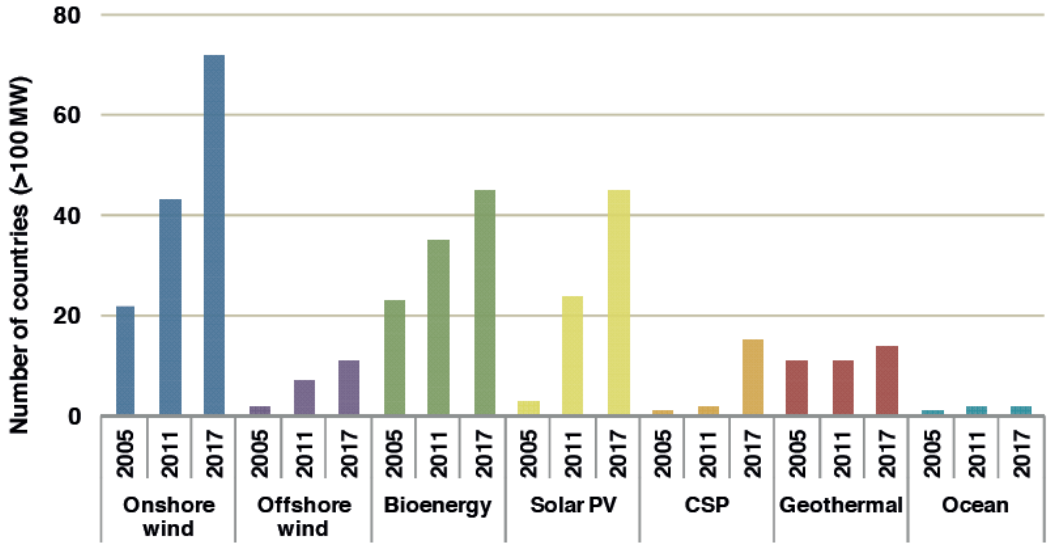
These are critical success factors for an enabling environment for free market enterprise, which promotes behaviour change that can save energy and money. Additional factors should be considered in order to achieve other possible objectives such as protection of local manufacturing from international exports for example.

4.2. 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 such as China, USA, Brazil, India and EU 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).

Figure 3: 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).

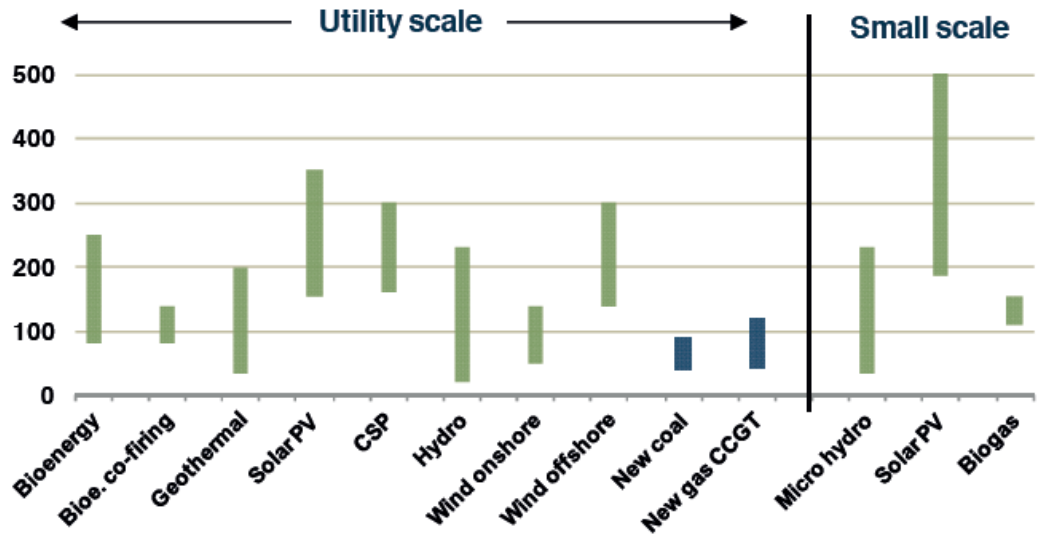
Conversion technologies such as cogeneration, Combine Heat and Power (CHP) and Anearobic Digestion are widely used to generate electricity, heat energy, and natural gas from biomass. Total global bioenergy (electricity generated from biomass) exceeded 300 TWh in 2011 (IEA 2012a). The main driver of electricity 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 bagasse 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 considerable opportunity for Ocean Energy power utilising the Agulhus current (estimated 1,212MW potential) on the east coast of South Africa (Roberts 2012) and wave potential on the cape coastline at 2,5m/sec. However, technology for the exploitation of ocean energy is not fully developed and in many cases still in research phase.

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 for example more than 2.1 million [solar home] systems had been deployed by March 2013." (REN21 2013)

Figure 4: 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.

Levelised costs of electricity for centralised large-scale generation are generally lower than small-scale generation due to economies of scale (see solar PV for example). However, the cost of transmission infrastructure and losses are dependent on the location of the generation plant relative to the end user and existing infrastructure. Decentralised generation, closer to the end-user or even operated by the end user can therefore prove more cost effective. Furthermore, embedded generation has 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.

Critical Success Factors for Centralised RE Electricity Generation

The critical success factors for renewable electricity generation at a utility scale are:

- **Competitive levelised cost of electricity** for geothermal, biomass, solar and wind technologies, have proven to attract investment in renewable energy. Feed in tariffs and subsidies have worked to spur market demand for renewable energy that can thereafter be faded out.
- **Long-term commitment** in the form of Power Purchase Agreements (PPAs) and economic stability is essential for capital investments that only begin to realise returns on investment in 10 – 15 years, with a plant lifespan of 30+ years.
- **Capacity to compliment peak demand** makes any electricity generation plant attractive in terms of dispatchability
- **National RE capacity targets** ensure that a portion of national generation mix comes from renewable energy
- **Competitive bidding processes** have proven to achieve greater price competition and share the investment risk between the purchasing authority and the power producer. The focus on lowest price per kWh can however ignore potential economic benefit of other generation such as decentralised generation.
- **Financial preparedness** is important to ensure the smooth implementation of utility scale projects and broad participation of financial institutions.
- **Appropriate localisation requirements** can have optimal impact upon local economic development if developed appropriately. REIPPP projects are the only new generation plants required to meet localisation requirements in South Africa, other new generation capacity, such as new gas powered plants (OCCGT) are not required to achieve localisation that can cost more than sourcing cheaper capital, expertise, technology and components internationally. Localisation requirements must therefore be applied to all new generation plants.
- **Strategic market response** is important for responding to international market factors. A “first mover” approach emphasises Research and Development of emerging technologies from concept development to commercialisation, whereas a “fast follower” approach emphasises skills and capacity development for market integration of services along the entire value chain. A fast follower approach is therefore relevant for mature technologies such as solar whereas a first mover approach will be effective in industries such as ocean power, and second-generation biofuels.

Critical Success Factors for Decentralised RE Electricity Generation

The critical success factors for renewable electricity generation in the form of embedded generation, micro and mini grids as well as off grid applications are:

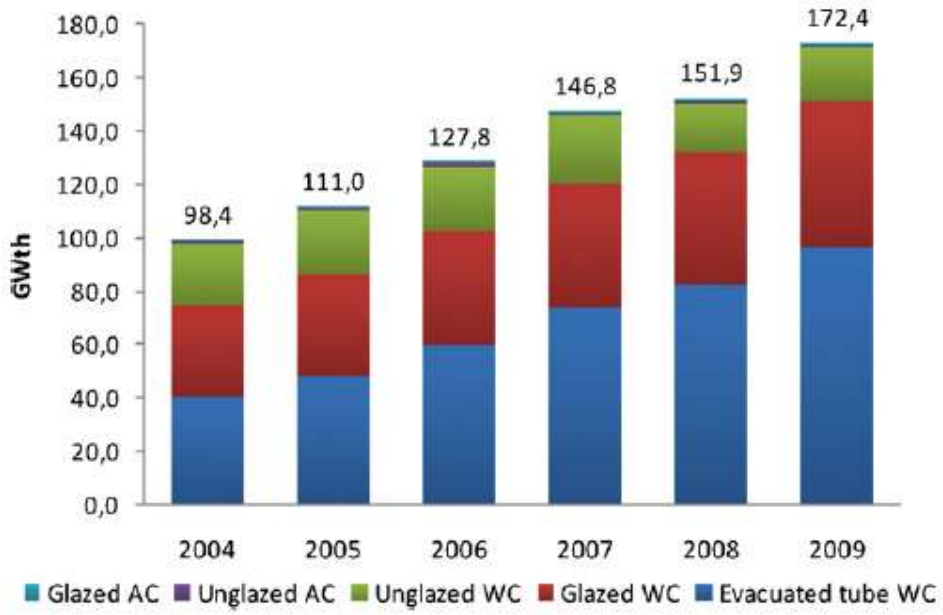
- **Local Government participation** to create an enabling environment for decentralised generation opportunities
- **Legislation, by-laws and standards** to ensure compliance with safety requirements and quality of electricity supply

- **Infrastructure for decentralised electricity generation** in the form of suitable grid connections and appropriate metering
- **Power Purchase Agreements** between local authorities and embedded generators is important for private investments even at a small scale (also experience long payback period and lifespan over 20 years) to achieve general investment security and bankability.
- **Competitive levelised cost of electricity** for geothermal, biomass, solar and wind technologies, have proven to attract investment in renewable energy. Feed in tariffs and subsidies have worked to spur market demand for renewable energy that can thereafter be faded out.
- **Capacity within local government** to manage grid connections, maintenance of reticulation networks and new applications for embedded generation is critical
- **Awareness among private developers** about the opportunity for embedded generation whether outsourced, or self-operated can be increased to stimulate rapid uptake of financially viable opportunities in embedded generation.

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.

Figure 5: 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 for most of the recent growth in the SWH industry, and as a result 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 (published in 2011) that make it mandatory for new buildings to supply at least 50% of annual hot water by non-electrical means.

Critical Success Factors for Solar Thermal Energy

The Solar Thermal Technology Platform in South Africa (STTP-SA) offers a suitable reference for critical success factors in the development of the solar thermal energy industry, since their activities and objectives are geared to mobilise the transition from energy intensive, fossil fuel based energy supply to a more sustainable supply. The following critical success factors are derived from the STTP-SA focus areas:

- **Market awareness** to promote transition to sustainable energy solutions
- **Capacity building and skills training** through Centres of Competence for solar thermal applications and Solar Thermal Technology as well as extensive training courses ranging from practical hands-on training to University level courses.
- **Practical demonstration and pilot projects** strategically located in highly visible areas with private sector participation. The beneficiaries of these demonstration systems are social institutions and small and medium enterprises.
- **Full value chain planning** such as assistance to manufacturers and support for a solar thermal testing centres

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 for bioethanol and biodiesel. 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 Industrial Policy Action Plan (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 existing South African companies with licensed capacity of over 1000 million litres per annum (Modise 2013).

Critical Success Factors for RE and Liquid Fuels

Downstream and upstream market considerations are important for the successful supply chain integration, such as the upstream local production of biofuels and secure feedstocks, and the downstream capacity within automotive repairs and maintenance services.

Securing feedstocks are as important as quotas or mandatory blending requirements to ensure supply meets demand at a profitable price for the investor. In the same way that PPAs in the electricity generation sector secure bankability, long-term contracts with suppliers are required for biofuel projects.

Critical success factors for the Brazilian bioethanol market include: "existing know-how and infrastructure for sugarcane production, the involvement of all players along the value chain, the competitiveness with fossil fuels due to high production efficiency, the ability to make use of co-products, and the introduction of flex-fuel vehicles (FFV) guaranteeing a long-term ethanol demand." (Lamers, et al. 2011, 2660)

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).

Critical Success Factors for RE in Rural and Developing Markets

Low interest finance, programmes for information sharing, consumer awareness, as well as local skills training to prepare maintenance and repair services along the market value chain are important for the successful deployment of renewable energy in rural and developing markets.

This sector is unique in that there is a social welfare imperative and driver for the accessibility and affordability of cleaner, healthier energy carriers in the form of renewable energy. The trends in development have therefore combined donor and public funding with market-orientated policies (Kolk and Buuse 2012). This requires extensive stakeholder engagement to understand local demand, affordability and capacity to service and install

renewable energy technologies (Chaurey and Kandpal 2010) as well as consumer education to share information on true benefits and costs.

It is uncertain how profitable this sector can be. In an analysis of four large private companies with successful market orientated programmes, all depend on some sort of concessionary finance schemes or market share (Kolk and Buuse 2012).

5. Survey Findings of Sustainable Energy Sector in eThekwini

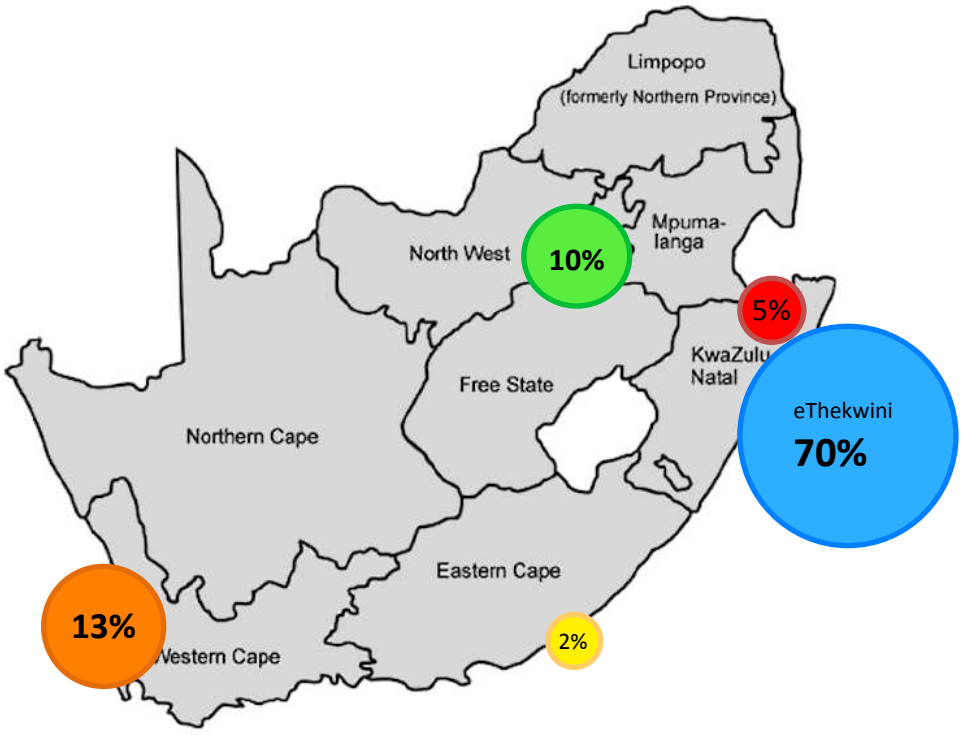
5.1. General

Since the sustainable energy (SE) sector in eThekwini is new and emerging, many businesses do not operate solely in the SE sector. Some engineering firms for example offer general civil engineering services as well as engineering services relating to renewable energy and energy efficiency. Of the businesses that operate solely in the SE sector, only a few earn 100% of their income from this sector. As the sector and market demand grow, these businesses may be able to afford to specialise on full-time basis.

5.2. Location of KSEF Businesses

27 of the 39 respondents have businesses located in eThekwini with another two located in KZN (one in Hilton and the other in Howick). Five of the respondents are Cape Town businesses offering services in KZN via the KSEF Business directory, as well four in Johannesburg, and one in Port Elizabeth. The figure below shows the location of respondents.

Figure 6: Location of businesses offering sustainable energy services in KZN

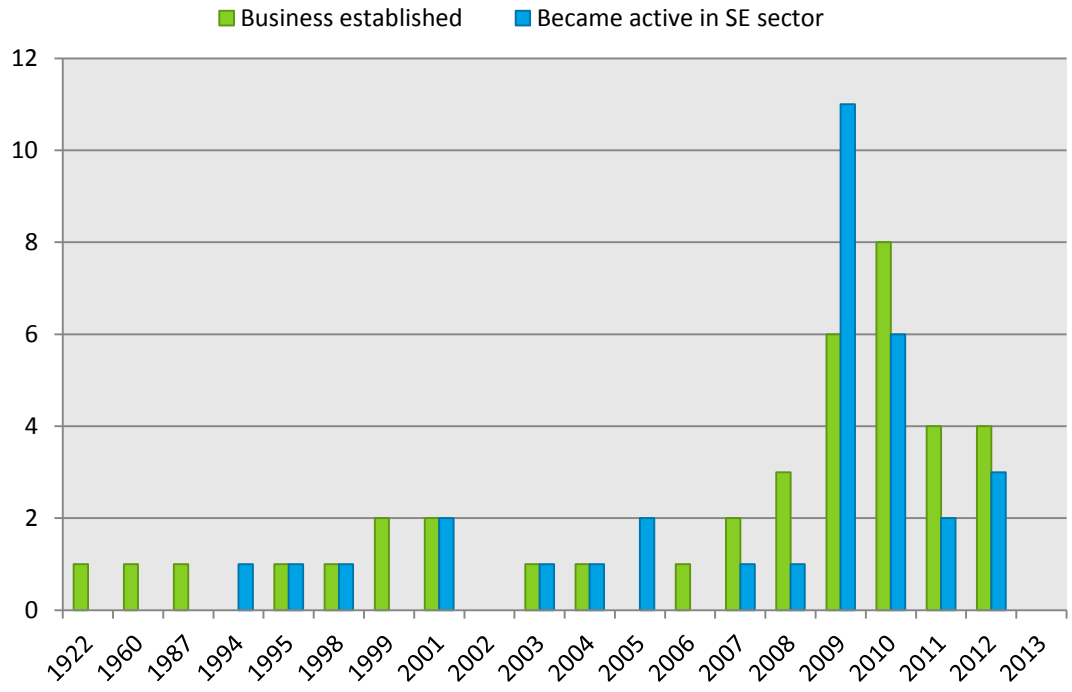


5.3. Timing of Market Entry

The timing of Market Entry is interesting to observe in emerging sectors with shock factors such as the 2008 black outs, the South African electricity price increases, the international decrease in cost of Solar PV, etc.

The figure below shows the number of businesses, which were established in various years as well as the number of respondents who showed interest, or began to actively participate in the sustainable energy sector in various years. Twelve (31%) businesses were established in the same year that the respondent showed interest or began to actively participate in the sector, four of which were established in 2009 and three in 2010.

Figure 7: Number of respondents to establish businesses and become active in SE sector per year



Before and during 2008, twelve businesses (31%) were established before the respondents showed interest in or began actively participating in the sector, whereas after 2008, nine businesses (23%) were established a year or more after the respondents showed interest in or began actively participating in the sector. Five respondents did not indicate when they began actively participating in the sector.

The notable peak in interest is in 2009 as a result of the nationwide blackouts, which began in 2008. It is interesting to observe that many businesses established before 2008 were established before the respondent had shown interest in the SE sector and as a result, evolved to offer services in the SE sector a year or more later. Only one business established after 2008 only began actively participating in the SE sector a year later. All other businesses

established after 2008 were established during the same year, or a year or more after the respondent had shown interest in the SE sector.

5.4. Stage of Business Development

Respondents were asked to indicate at which stage of development their business was in. The following groups were specified:

1. Start-up (eg. new businesses, few clients)
2. Survival (eg. just enough clients, covering expenses)
3. Successful (eg. profitable turnover, sustainable business)
4. Growth (eg. profitable and now accessing/mobilising greater investment in resources)
5. Matured (eg. full return on investment, well established profitable company)

Start-up: Six respondents indicated that their businesses were new with few clients, generating between R1 – 10 million in annual turnover and employing between 1 – 10 people.

Survival: Ten respondents indicated that their businesses had just enough clients and were covering expenses; nine of which employ between 1 – 5 people and only one employs 5 – 10 people. Annual turnover for these businesses is spread between R0 – 10 million.

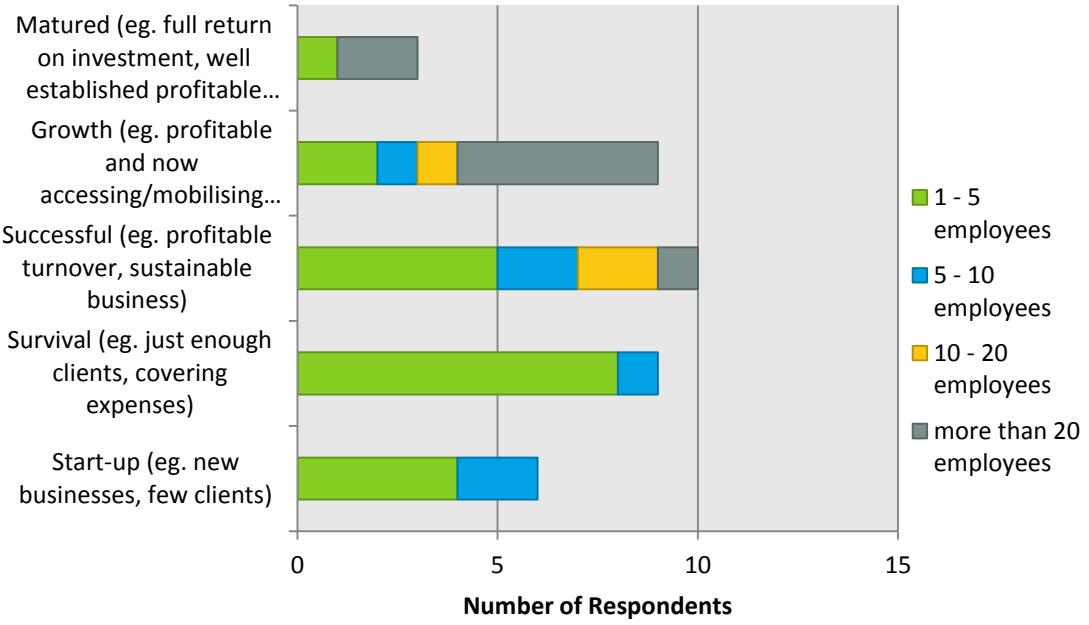
Successful: Another ten respondents, being the most, indicated that their businesses were generating a profitable turnover and at a sustainable stage. Interestingly, five of these businesses employ 1-5 people, with two employing 5 – 10 people, another two employ 10 – 20 people and one employs more than 20 people. This suggests that the number of employees is not an indicator of success in the SE sector but rather a trend linked to business development and growth. The figure below shows that as businesses in this sector develop and become more profitable and sustainable, they can also afford to expand and employ more people.

Turnover in this sector is more an indicator of the type of services the business offers rather than the stage of business development. For example a new business that constructs/installs large-scale Solar PV installations may not be profitable for a number of years, although it exhibits a high annual turnover due to the scale and cost of the project.

Growth: Nine respondents indicated that their businesses were profitable and now accessing or mobilising greater investment in resources. More than half of these businesses employ more than 20 people, and three respondents indicated annual turnover between R1 – 5million while five state that their turnover is confidential.

Matured: Only three out of 39 respondents indicated that their businesses earn full return on investment, and are well established and profitable.

Figure 8: Stage of Business Development and Number of Employees



Since the meaning of confidential annual turnover does not necessarily imply turnover greater than R10 million, it is not possible to determine the correlation between business development and annual turnover shown in the figure below. The graph above shows a correlation between the stage of business development and number of employees, whereas there was no such correlation stage of business development and annual turnover.

Despite this spread in the development stages of the businesses in this sector, all except two businesses indicated that they are Small to Micro- and Medium enterprises (SMMEs).

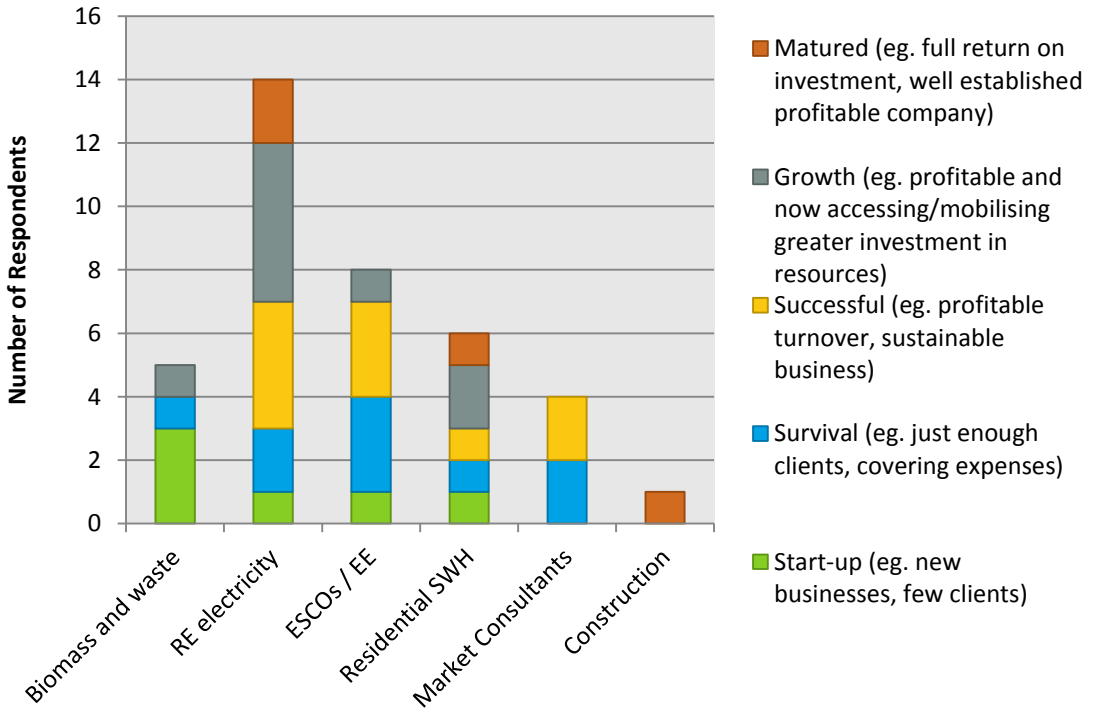
5.5. Main sub-sectors identified

According to the brief business descriptions provided by respondents, the following main sub-sectors were identified:

Number of respondents	Main sub-sectors	Business activities include:
5	Biomass and waste	Biofuels production and waste to energy
13	RE electricity generation	Large scale wind and solar PV, as well as rooftop and home systems
9	Energy Service Companies - ESCOs	All energy efficiency solutions, energy auditing, metering and monitoring
6	Residential SWH	Manufacturing and installation
4	Market consulting	Engineering and development consultants
1	Construction / building	

Majority of the businesses in these sub-sectors are service providers, while only 4 of the respondents manufacture sustainable energy products such as biofuel gel, SWH and vertical axis wind turbines. Many of the respondents in the RE electricity generation sub-sector however, offer construction, installation and operation and maintenance. There is a mix of new, surviving, successful, growing and matured businesses among these prominent sub-sectors, as can be seen in the figure below. This can be explained by the variety of businesses entering in the sustainable energy sector at different stages of development, as explained in section 5.3. Timing of market entry.

Figure 9: Stage of Business Development by sub-sector



The Biomass and waste sub-sector has similar characteristics as the RE electricity sub-sector in that they both operate in the electricity generation market whether for own use or export. This would explain why both sub-sectors experience a range of annual turnover from R0 – 10 million and both employ range of people from 1 to over 20 people. Notably, about 60% of both subsectors have 1-5 employees, about 20% of both have 5-10 employees and the remaining 20% of both have more than 20 employees.

Nearly 80% of ESCOs employ as few as 1-5 employees and majority have a low annual turnover between R0 – 1 million. The low annual turnover is not necessarily and indicator of low profitability but rather of low transaction and capital costs..

Figure 10: Annual Turnover by sub-sector

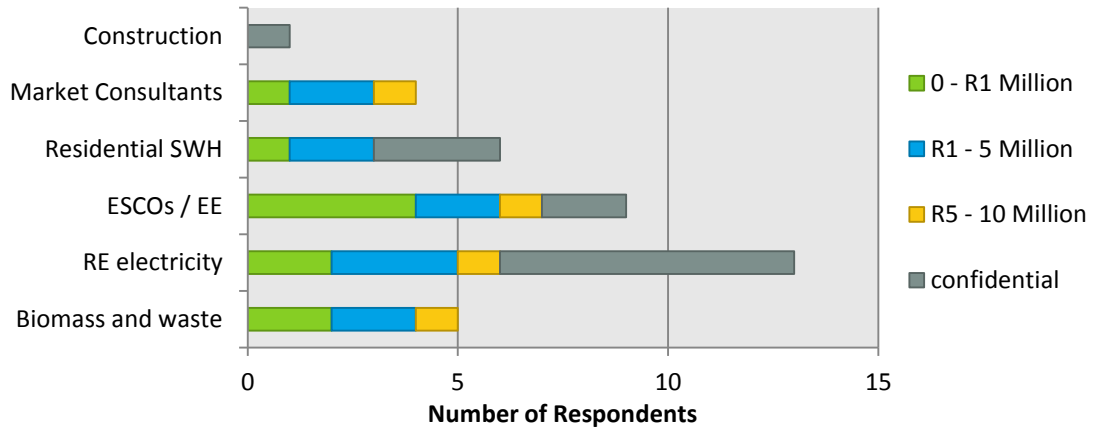
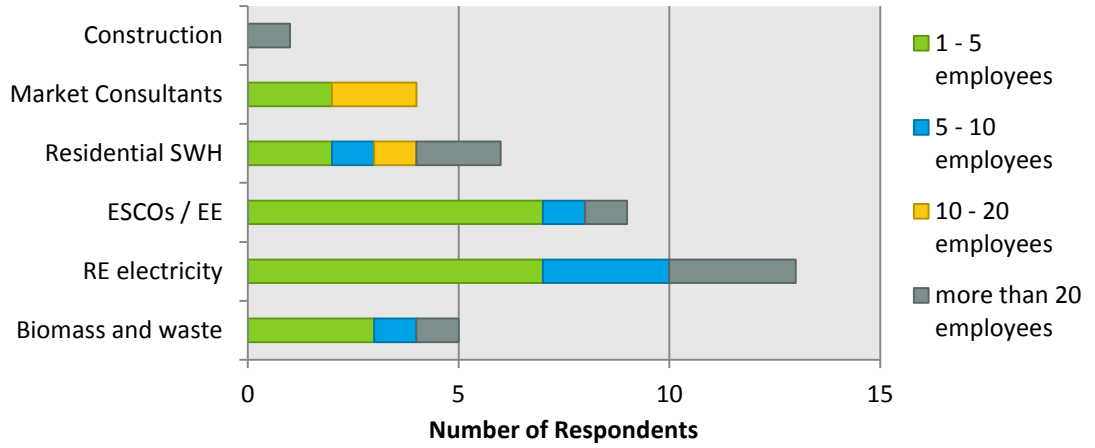


Figure 11: Number of employees by sub-sector



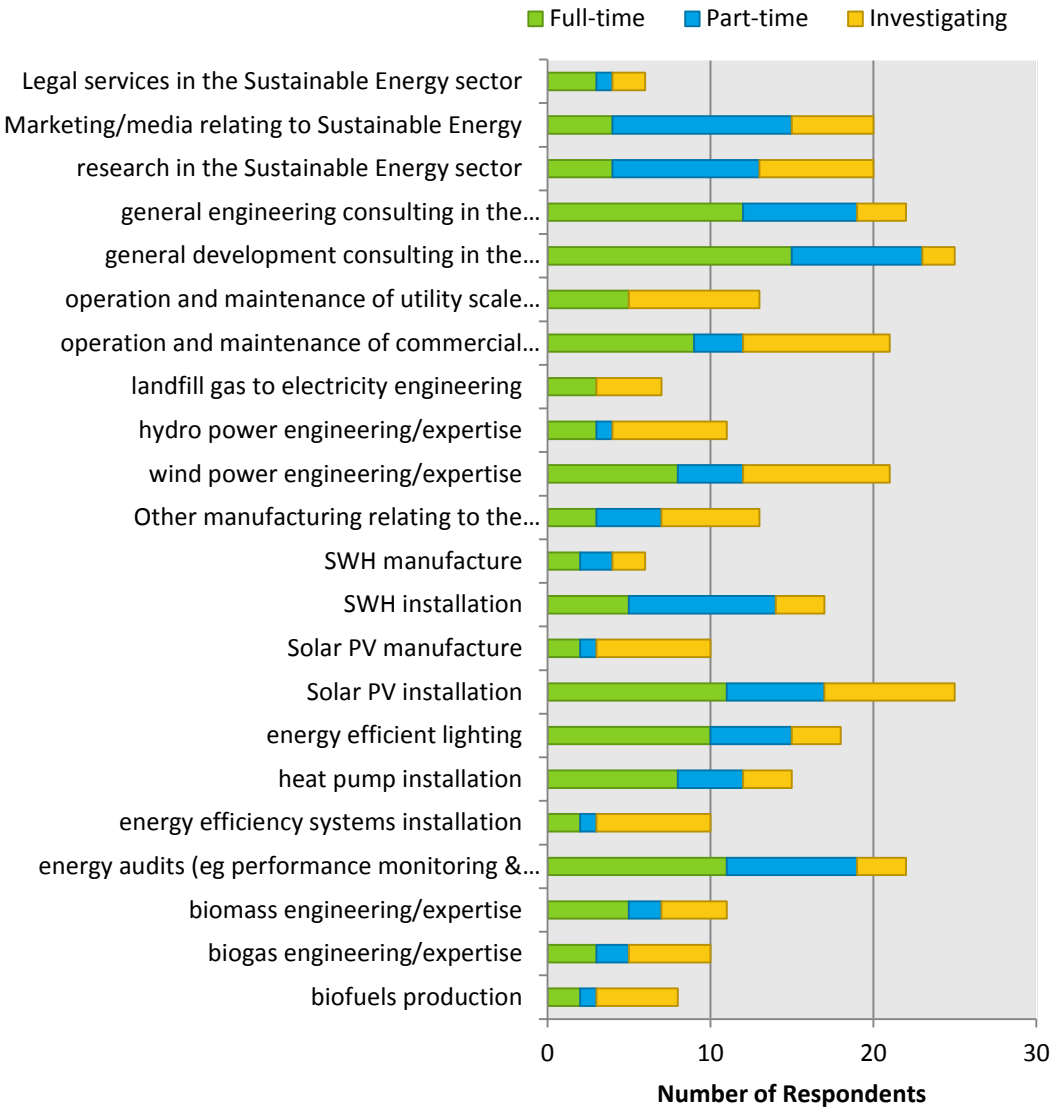
A third of the Respondents in the residential SWH sub-sector employ more than 20 people, which is the greatest proportion among the other sub-sectors. This affirms that there is great employment potential in the SWH industry.

5.6. Most Common Business Activities

The most common full time business activity or service in the SE sector is general development consulting, followed by general engineering consulting, Solar PV installations and energy audits. Since market demand is still in its early stages of development, most businesses cannot afford to specialise completely and need to offer a variety services. Generalists do well to adapt to market demand in these early stages.

Due to dramatic decreases in the cost of Solar PV installations, this business activity serves a fast growing market demand rooftop PV from industrial, commercial and residential sectors. This activity has attracted the most attention from businesses interest whether full time, part time or just investigating.

Figure 12: Level of involvement by business activity in SE sector

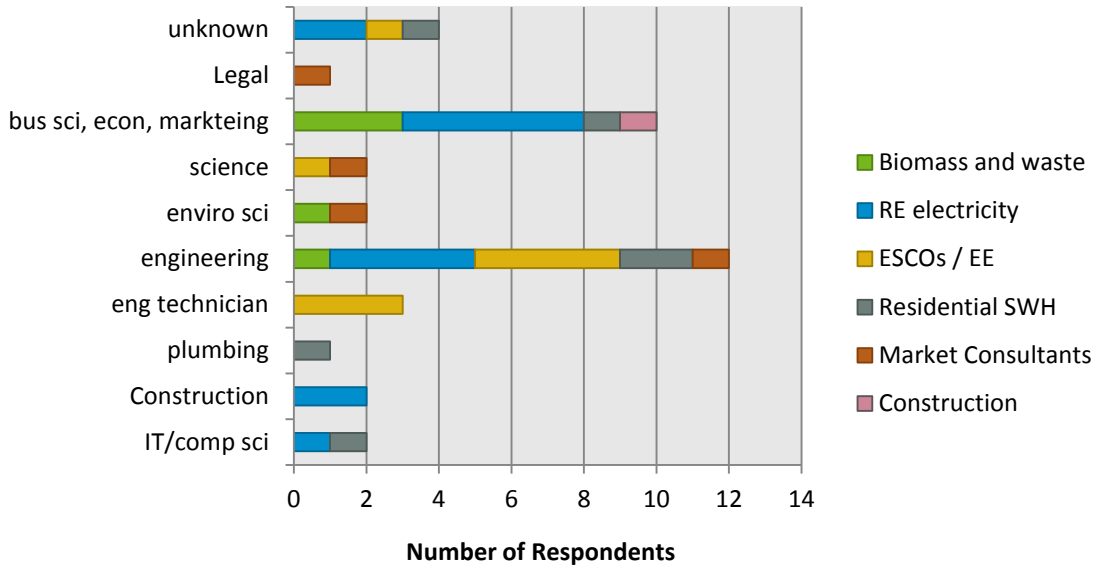


The most part-time activity is allocated to marketing and media related business activities in the SE sector. This indicates that businesses spend much of their time marketing renewable energy and energy efficiency to educate the consumer before they are able to sell their services. This corresponds with one of the main identified challenges - Lack / low level of awareness, inadequate information on product or services (section 5.8).

5.7. Trends According to Professional Background & Skills

The most numerous professionals were found to be engineers and commerce professionals (including business science, accountants, economists, and marketing specialists). Engineers and commerce professionals are spread scattered across the subsectors.

Figure 13: Number of respondents with professional background/training per sub-sector



A clear skills match exists between plumbing and residential SWH, yet only one respondent has a plumbing background in this sub-sector. Other professionals from a variety of backgrounds have entered this market. Interestingly all three of the engineering technicians are active in ESCOs, perhaps due to the skills match between electricity quality measurement, fault detection and energy auditing, monitoring, management and energy efficiency. More electricians could enter this subsector as the market grows.

When asked an open-ended question whether there is a strong skills or production match with their sub-sector and another sector/industry, four respondents articulated that engineering skills were relevant. One in particular stated that mostly electrical engineering suited Solar PV and Environmental/Civil/Mechanical Engineering suited Wind Power.

One respondent explained that the new interest in the ESCO and energy efficiency subsector from different professionals “has lead to misinformed decision making”. This links to the main challenge perceived by the respondent in the RE electricity sub-sector: “Unprofessional solutions, incorrectly specified and/or designed damaging the sectors integrity and ultimately costing clients more in the long run.”

Four respondents articulated the opportunity to create employment and provide training to employees in SWH and Solar PV installations. Three respondents said that there are no strong skills or production match with their sub-sector. One RE project developer stated, “The country is still lacking skilled personnel for this sector”.

However three respondents indicated that there are links with manufacturing; in particular: “Heat pump - HVAC SWH - PV panel manufacturing” and “Boat manufacturing for blade manufacture similar process".

5.8. Main Challenges

Respondents were first asked an open-ended question about what they found to be the main challenges in their sub-sector. Unsurprisingly, the main challenge faced by most respondents is funding and finance – access to funding, lack of financial instruments, “most financiers don't consider carbon tax or carbon credits bankable”, paid work and funding for initiatives, and capital outlay.

This was closely followed by price and costs – price of PV panels, cheap cost of electricity, capital costs, non-cost-effective supply chain and costs of installations.

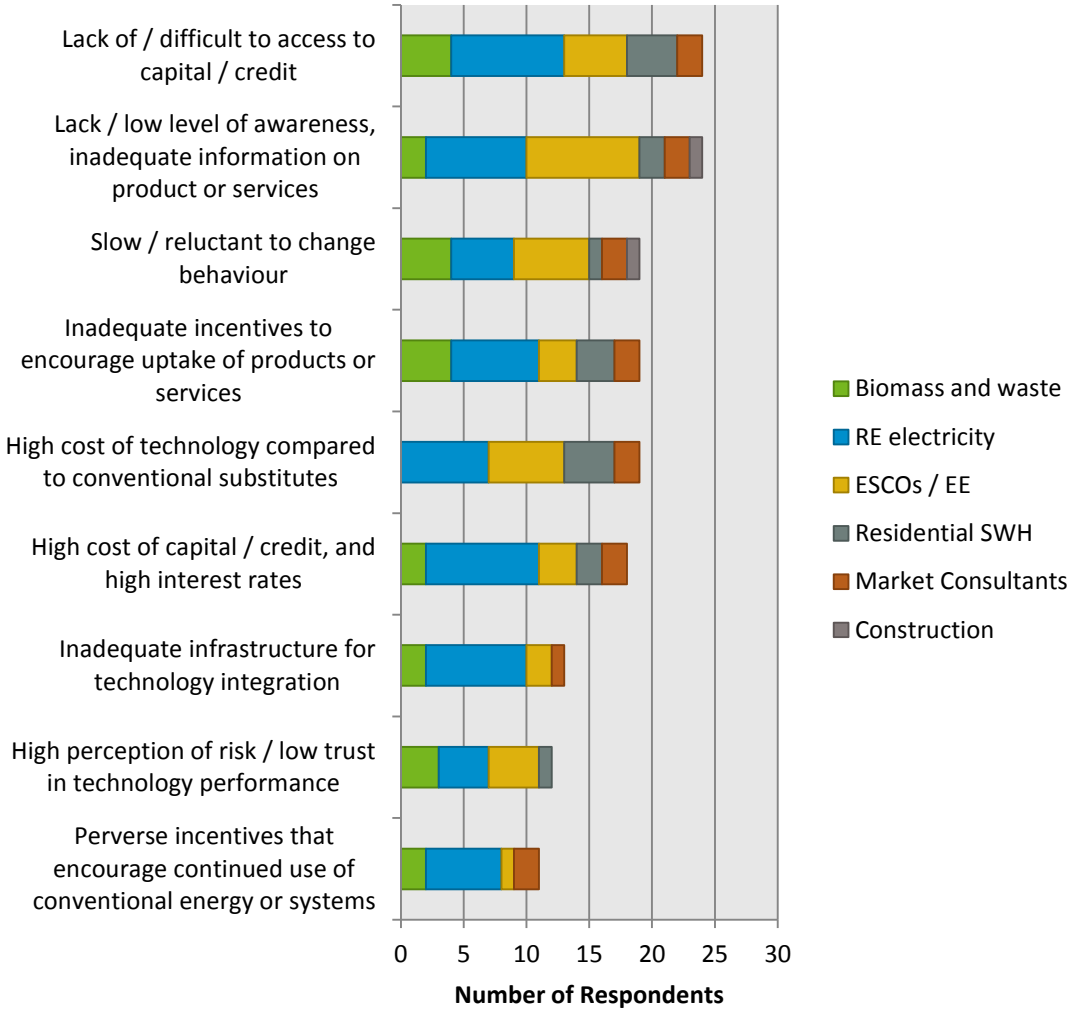
Government processes, government support and implementation, and local government legislative environment were another common set of challenges. Another respondent stated, “Legislation, regulation, bureaucracy, red-tape as well as a non-interested energy parastatal creating too many hurdles through IPP and PPA requirements.”

Two respondents also cited Eskom’s inconsistency regarding rebates to be a challenge; another just stated, “Eskom”.

Respondents were also asked to select which of the following challenges were applicable to their area of expertise or sub-sector. The challenges were derived from the market barriers identified in both renewable energy and energy efficiency industries (Painuly 2001) and (Sarkar and Singh 2010).

The most common challenges for all sub-sectors were access to capital or credit and low levels of awareness and information on products and services in the sector (which did not feature in the open-ended questions). Most challenges faced by the SE sector are common to all sub-sectors, however there are two exceptions to note in Figure 10.

Figure 14: Main challenges identified by respondents by sub-sector



Specific differences that emerged for sub-categories include: firstly, respondents in the biomass and waste sub-sector did not select high cost of technology compared to conventional substitutes as a main challenge because the levelised cost of electricity generation from biomass and waste is competitive with conventional generation plants. And secondly, respondents in the market consultants sub-sector do not find the high perception of risk / low trust in technology performance as a main challenge because consulting services are fairly generic and do not depend on new or unknown technology.

5.9. Investment levels and income generated

Most respondents earn either less than 20% or they earn 100% of their income from the SE sector. Only a few respondents indicate that they have earned more than 20% and less than 100% of their income from the SE sector before 2010 and during 2010, 2011 and 2012. This reveals that nearly half of the businesses in the SE sector are active but have not yet reaped profitable earnings.

Figure 15: Proportion of income earned from SE sector before 2010 and during 2010, 2011, 2012

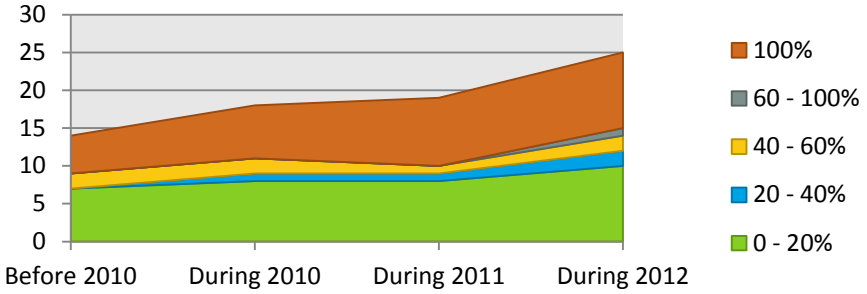
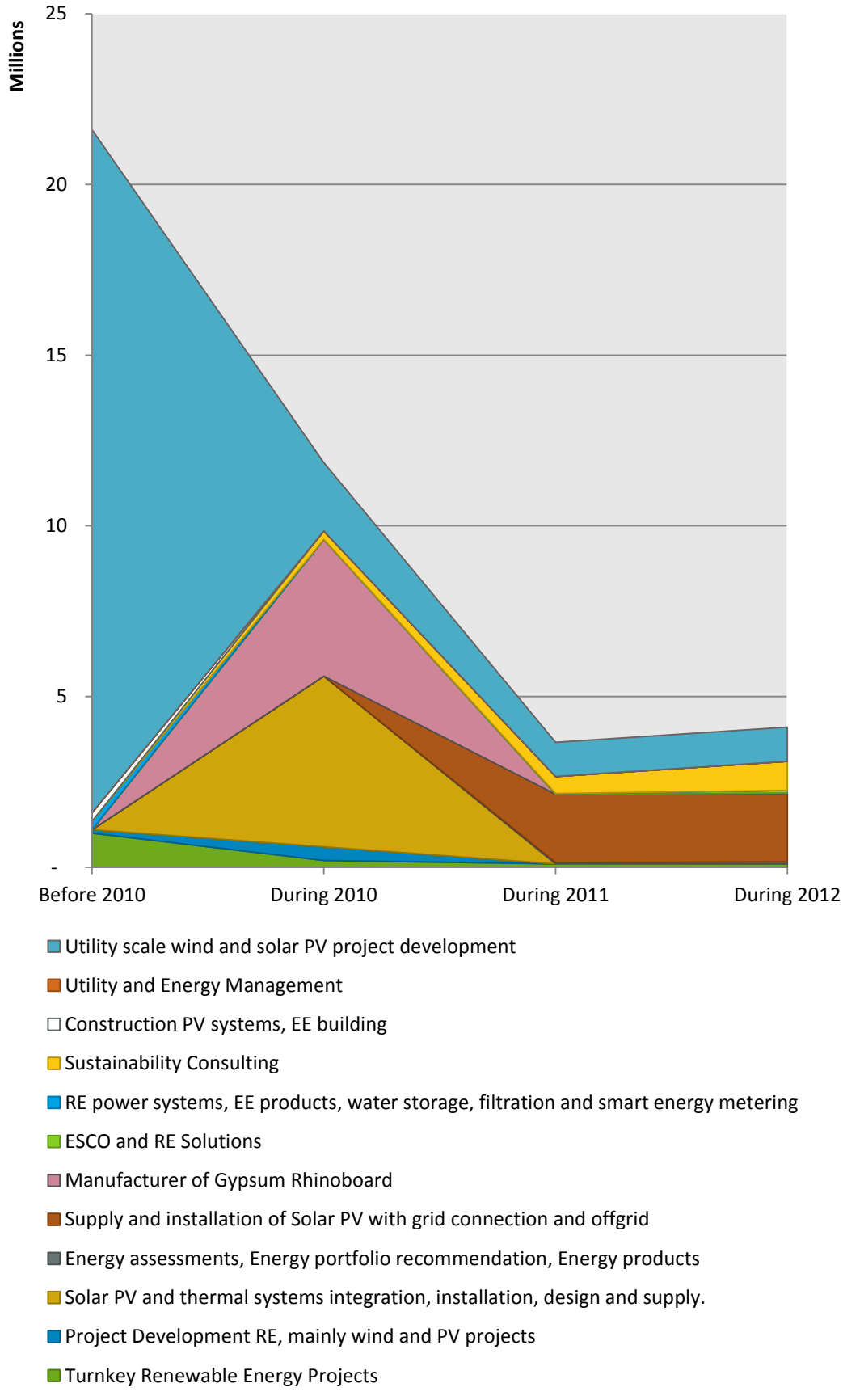


Figure 15 shows that twelve businesses invested in the SE sector before 2010, during 2010, 2011, and 2012. A utility scale wind and solar PV project developer made the largest investment of R25 Million before 2010. A manufacturer of Gypsum Rhinoboard and a business providing Solar PV and thermal system integration made the next largest investments during 2010: R5million and R4million respectively.

Although dwarfed by these large investments, there fifteen investments below R1million compared to the nine investments above. The median investment value is R350,000.

Figure 16: Investments in SE sector before 2010, during 2010, 2011, 2012 (ZAR million)



Since investments in the renewable energy technologies in particular are known to have long payback periods and technology lifetimes, the return on investments are expected to be low in the early years of this market development.

Figure 17: Number of respondents indicating ROI before 2010, during 2010, 2011, 2012

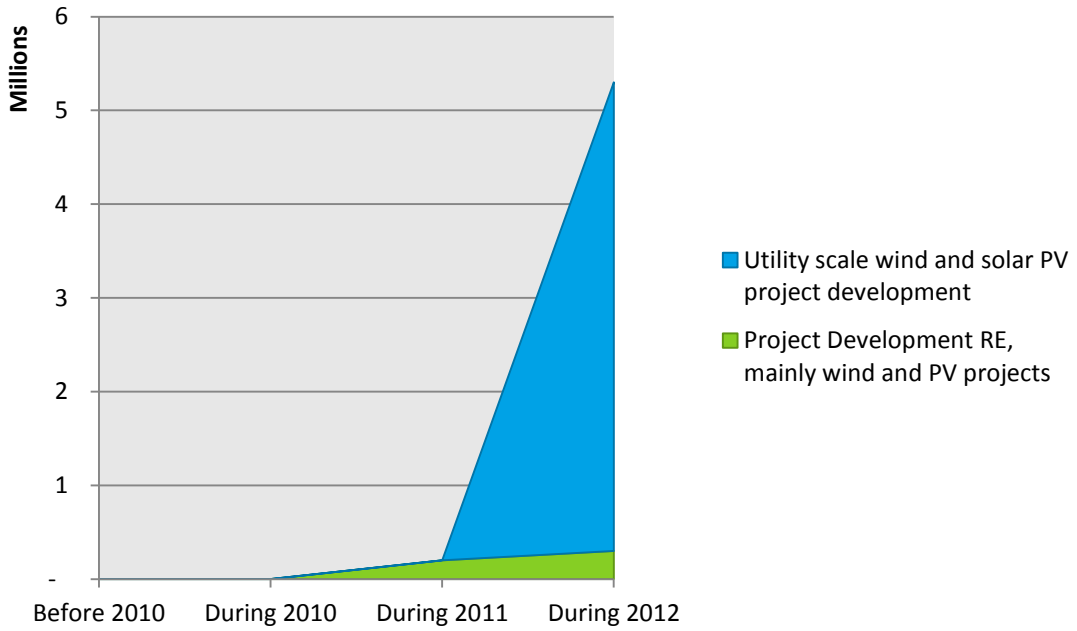


Figure 13 shows that a utility scale wind and solar PV project developer indicated returns on investment of R5 million in 2012. Another RE project developer indicated returns on investment of R200,000 and R300,000 in 2011 and 2012 respectively.

6. Recommendations

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 3,725 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.

The REIPPPP has a limited allocation and a narrow focus on electricity generation technologies. A more comprehensive regional strategy is needed to prioritise and promote the multiple sub-sectors of the sustainable energy sector.

6.1. Priorities And Potential for Local SE Industries

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 landfill gas, wood chip production for export and use in CHP industries, bioethanol and biodiesel production, and micro-hydro power.

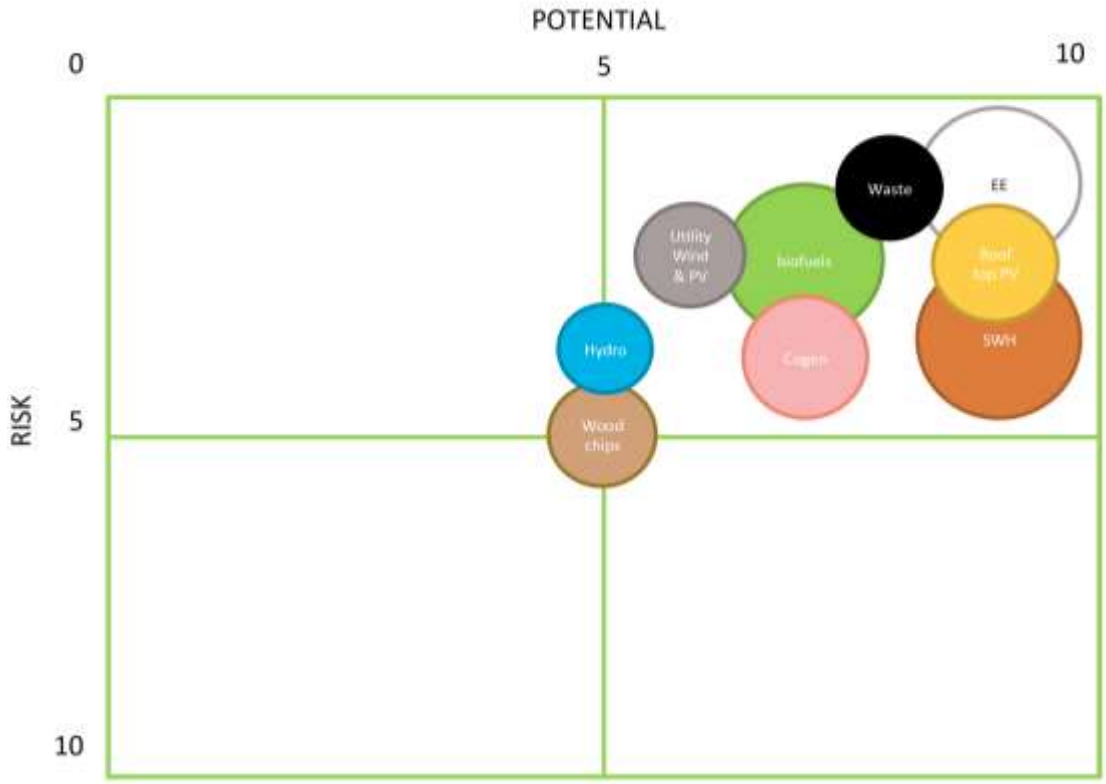
There is also potential for KZN to be a first mover in second-generation biofuels from algae, ocean current energy generation, and in the deployment of renewable energy in rural and informal markets.

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 (Maia, et al. 2011).

Priority sub-sectors of the sustainable energy sector according to TISA methodology, should demonstrate significant size, high potential and low difficulty of change (risk). Although this

research has not evaluated the capacity of government to promote the identified subsectors, a first evaluation of economic potential of subsectors and industry institutional conditions is shown in the figure below.

Figure 18: Sub-sector Prioritisation by Potential Risk and Size



This graphic representation of market size, economic potential and risk/ease of realising change or growth, has not been tested or compared against other sector prioritisation exercises, and does not include comparable sectors such as nuclear power generation or fracking for natural gas. It is simply a first estimation based on the matrix to follow.

		Economic potential in KZN/eThekwini: 1=very low; 10=very high potential							Institutional conditions: 1=low risk/very easy to realise; 10=high risk/difficult to realise				
	Sub-sectors	**Market growth**	**Profitability**	**Technology**	**Input cost & availability**	**Employment**	**Equity**	**Score**	**Organisation**	**Industry willingness to change**	**Policies & legislation**	**Govt's ability to enable**	**Score**
	Solar PV roof top elec generation	High but slow	Good	Local manufacture, cheap imports	Ample solar, affordable techn, high cost of storage /grid tie costs	High for installations	SMME	9	SANEA, SAPVIA	High	Grid tie possible in few munics	High	3
	Wind and solar utility elec generation	Medium	High	Own and aquired	High transaction costs (tenure, licenses, etc)	High for construction, low for operation	Local content require-ment	6	SANEA, SAWEA, SAIPPA	High	Only REIPPPP, wheeling, IPAP	High	3
	Energy Efficiency, audits, monitoring, etc	High but slow	Good	Own and acquired	Negative costs = savings	Medium for assessments	SMME	9	SANEA,	PSEE, high	EE Building Regs, IPAP	High	2
	Residential SWH	High but slow	Marginal	Local manufacture, cheap imports	Affordable	High for installations	SMME	9	STTP,	High	IPAP	Medium	4
Biomass and waste	Biofuels production	Medium depend on regulations	High	Own and acquired	Ample farmed biomass	Very High	Licensed produc-tion	7	SASSA,	Low	IPAP, Biofuels Regs	High	3
	Woodchips for export	Medium depend on int'l market	Marginal	Own and acquired	Ample farmed biomass	High in agric	unknown	5	NTC	Unknown	None	Unknown	5
	Cogeneration	High but oligopoly	High	Own and acquired	High transaction costs (tenure, licenses, etc)	High in agric	Few new entrants	7	SASSA, KSEF	High	Own use, REIPPPP, wheeling	Medium	4
	Municipal waste and waste water to energy	High but red tape	Marginal	Acquired	Ample availability	High for MRF	Govt procure-ment	8	SANEA,	Growing interest in munics	Unknown	High	2
	Micro-hydro	High but slow	Marginal	Own and aquired	High transaction costs (tenure, licenses, etc)	Low	Few new entrants	5	SANEA,	Unknown	Unknown	Unknown	4

6.2. Stakeholder Input Summary

As summarized in the Manufacturing Baseline Study, eThekwini Stakeholders gave input on the types of interventions that would be feasible for local government to implement in order to promote the SE sector. How this input relates to specific subsectors is shown in italics. Potential support mechanisms that would be most viable for supporting the local sustainable energy sector in eThekwini Municipality are listed below:

1. **A well-networked and informed sector:** A well-networked sector where local businesses are able to easily connect with both potential clients and suppliers and are informed on potential opportunities and general developments in the sector provides a good foundation for supporting sector growth. This service is already partially provided by the KSEF, which is funded by eThekwini municipality. *All sub-sectors benefit from information sharing and networking.*
2. **Local procurement by government:** Government is already a major buyer of sustainable energy goods and services in the local economy. *eThekwini Municipality has already taken the lead by implementing energy efficiency measures such as efficient street and traffic lighting. It is recommended that greater effort be made to adopt comprehensive internal energy management solutions for all public buildings and facilities. Similarly, eThekwini Municipality has also taken a lead in municipal waste and wastewater to energy projects. These can be scaled up to promote regional excellence, giving local service providers a competitive advantage. Lastly, local government has a role in procuring electricity. This role with regards to embedded and decentralised generation needs to be clearly defined at a national level, in order to instil confidence in the private sector and promote the growth of this sub-sector.*
3. **Access to finance for customers:** In the case of larger spend items (for instance Solar Water Heaters) access to finance for customers who can't afford the initial capital layout has the potential to unlock a large number of sales. *It is recommended that partnerships be developed with local banks to provide appropriate financing mechanisms for a suite of sustainable energy products.*
4. **Marketing Support:** Since most sustainable energy products are poorly understood by potential customers business have to expend considerable effort explaining the general product category prior to being able to make a sale. eThekwini Municipality already provides marketing support for the Solar Water Heater industry through the Shisa Solar Programme. This programme markets the concept of Solar Water Heaters to eThekwini residents. Residents can request quotes through the programme and has a pre-screened panel of service providers are then provided with the opportunity to quote. *It is recommended that further marketing support mechanisms for other categories of products be considered such as a permanent exhibition centre or sustainable energy show room.*

5. **Business Support:** Emerging business can benefit from a range of support mechanisms such as access to legal and financial expertise, linkages to financing opportunities and general business advice. *eThekwini Municipality has recently commissioned a feasibility study for the establishment of an SMME incubator for the sustainable energy sector.*
6. **Reduced wheeling fee:** One mechanism of promoting local renewable energy generation is to allow renewable energy generators to supply customers with electricity through the local eThekwini Municipality grid. This practice is referred to as wheeling and depending on the fee charged for wheeling through the grid can promote the emergence of renewable energy. *It is recommended that an investigation be conducted into the possibility of allowing wheeling at a reduced fee through the eThekwini grid for renewable energy projects.*

The following list outlines other support mechanisms that were considered by the focus group, but were not identified for implementation at a local level for a variety of reasons:

1. **Access to business finance:** There are a number of potential financing channels that exist in South Africa for business. These include some grant financing from government as well as various opportunities for loan financing. Considering the cost and complexity of creating an additional financing channel and the fact that other mechanisms already exist, it is not recommended that a new financing mechanism be created.
2. **Subsidies:** Subsidies are often implemented by national government programmes, which require full-support of National Treasury. This is not a viable form of support at a local level in eThekwini Municipality.
3. **Protection:** Many countries impose levies and other protectionist mechanisms to support their local manufacturing industries. These mechanisms are not viable to implement at a local level where there is no active control of import and export from the local area and as a result protection mechanisms are more appropriate for national implementation.
4. **Mandatory implementation of energy efficiency or renewable energy:** The new energy efficiency building regulations, mandatory biofuels blending requirements, REIPPPP, and 12I tax incentives have been established at a national level to promote the uptake of EE and RE. It was agreed that this is more appropriate for implementation at national level.
5. **Sustainable Energy Development Zone:** Establishing a specific zone for a particular category of businesses with benefits such as reduced rentals and services, as well as the benefit of synergies of location next to similar industries, is promoted by the Provincial Growth and Development Plan and Strategy.

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8. Appendix

See xl spread sheet with all survey data here:

http://www.kznenergy.org.za/download/publications/Appendix%20Survey%20data.xlsx