South Africa

A case for biomass?

Belynda Petrie

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Belynda Petrie is OneWorld's CEO. Belynda is an expert in regional and international climate change adaptation and mitigation, energy, socioeconomic development and human security. She has led several medium- to large-scale projects, including the Southern African Regional Climate Change Programme (RCCP) funded by the UK's Department for International Development – a vast programme that aims to help equip the region's leaders, decision makers, scientists, economists and other experts to adapt to the impacts of climate variability and change. Other significant projects include the development of a Uganda water resources climate change vulnerability assessment and strategy and the internationally acclaimed Western Cape Climate Change Strategy and Action Plan (South Africa). She acts as the project lead on several critical research projects, including providing technical and strategic support to the African Group of Negotiators (AGN) to the COP, and her extensive knowledge spans diplomacy, policy and global governance, adaptation and resilience to climate change, climate finance, and transboundary water management.

Belynda has pioneered a systematic analysis approach, drawing on economic, social and ecological learnings in the search for solid sustainability solutions to complex transboundary issues. She sees stakeholder engagement as a pillar of all attempts to find durable and resilient solutions to the complex challenges facing Southern African leaders. She has been instrumental in facilitating the shaping of a science-policy-institutional–finance dialogue, which contributes directly to developing practicable responses to key climate change issues.

Acronyms and abbreviations

AES	Associated Energy Services (Pty) Ltd
CDM	Clean Development Mechanism
DWAF	Department of Water Affairs and Forestry
Eskom	Electricity Supply Commission
EU	European Union
GWh	gigawatt hours
IDC	Industrial Development Corporation
IEA	International Energy Agency
IPPs	Independent Power Producers
LTMS	Long Term Mitigation Scenarios
MJ/L	megajoules per litre
MWe	megawatt electric
PPAs	Power Purchase Agreements
ProBEC	Programme for Basic Energy and Conservation
REBID	Renewable Energy Bid Programme, SA
REC	Renewable Energy Certificate, SA
REFIT	Renewable Energy Feed-in Tariff, SA
REIPPPP	Renewable Energy Independent Power Producers Procurement Programme
ROC	Renewable Obligation Certificate, UK
SA	South Africa
SAWEA	South African Wind Energy Association
SESSA	Solar Energy Society of South Africa
TIS	Technological Innovation System
UNFCCC	United Nations Framework Convention on Climate Change

Executive summary

South Africa needs more energy. The government, and the primary national utility ESKOM, cannot keep up with demand for electricity, while many rural communities lack access to affordable and accessible energy. Heavy reliance on large-scale coal-fired power stations and the centralised grid adds further complexity to issues related to energy and power solutions – especially given the current climate change predictions, and the fact that South Africa is ranked in the world's top 20 carbon emitters and has a prominent role in multilateral climate negotiations. Biomass energy potentially offers a sustainable solution for generating electricity, powering industry, and for domestic use. Biomass is already the largest renewable energy source in the domestic energy mix, though in the form of gathered fuelwood for cooking and heating, which brings its own environmental and health concerns. There have been a significant number of failed attempts in the last decade to set up plants producing wood pellets, a more efficient and sustainable form of biomass fuel, as well as to generate electricity from biomass. In order to understand why these attempts have failed, and how a thriving biomass sector could be developed in South Africa, this paper looks at two cases of such plants – one producing wood pellets as biomass fuel, and one generating electricity from biomass – the Howick wood pellet plant and the Tsitsikamma biomass plant. Both provide instructive case studies. Their eventual failure was mostly due to stand-offs in agreeing power purchase agreements (PPAs) with Eskom, and the difficulties of establishing a viable local market – not insuperable technological difficulties.

More coherent incentives for biomass innovation systems are needed within South Africa, both for more efficient wood pellet stoves at a household level, and for biomass-produced electricity, if South African citizens – particularly its poor – are to have secure energy access.

The way to unlock South African biomass development potential is to enable biomass innovation systems to thrive. Although there are sustainability concerns and raw material production still needs to be better organised, fuel is readily available. Putting an enabling environment in place is an urgent priority, including robust regulations and mechanisms as well as institutional arrangements. Both the Tsitsikamma and Howick operations described in this case study demonstrate this in different ways. In both examples, enabling market mechanisms and institutional arrangements to support these were either inadequate or absent. The Howick operation in particular proved that technology could be used at optimally efficient levels, reliably supplying the European market while meeting stringent production standards. Although establishing a local market at scale has seen little advancement, it is evident from both the literature and the case study examples that this is not specifically because technology is not available or because there is lack of local uptake. Rather it is a problem of not having the necessary enabling environment.

The biomass innovation systems that are needed across South Africa require three components to be in place: actors, networks and institutions. This paper shows that while some of these are present, the institutions are the weakest link.

The actors include South African biomass entrepreneurs who have set up wood pellet production plants. These entrepreneurs know where to source the technology, from Swedish wood stove design to pellet plant factory lines adapted from South African technology. Other actors include academic institutions, such as the Universities of the Western Cape (Sustainable Energy Centre), Stellenbosch (energy solutions and technology innovation) and Cape Town (Energy Research Centre), all offering strong research capabilities and well established energy institutions. Government needs to offer these actors a suite of renewable energy policies and procurement programmes. Job creation, skills development objectives, and the more recent integration of energy and development objectives, as outlined in the National Development Plan, already create support towards an enabling environment.

Networks that link suppliers with users, competitors and research institutions are critical for sharing knowledge and influencing perceptions of future feasibility. For new technologies to gain ground, such specific coalitions are essential. There are broader coalitions such as the National Business Initiative, the Climate Justice Network – a coalition of NGOs and civil society organisations that influence national climate policy; and technology specific platforms that include the South African Wind Energy Association (SAWEA) and the Solar Energy Society of South Africa (SESSA). These networks argue for enabling environments in support of their industry development in this country and create a robust and effective platform for partnerships across South Africa; a more specific biomass energy network now needs support.

However, it is within institutions where South Africa lacks most progress. For example, the renewable energy target set in 2003 for achievement by 2014 is far off its target. This is not due to a lack of entrepreneurial activity, supporting academic institutions, inadequate technologies or even lack of government policy – but rather because the enabling institutions are not in place and the industry has little support. Competing organisations seldom collaborate, fighting for scarce resources and markets. Government bodies responsible for legal and regulatory environments need to do a much better job of putting policy into practice, and regulating interactions between actors. There is currently an overarching misalignment of long-term government vision with entrepreneurial initiatives in the renewable energy sector. Effectively, this means that the numerous entrepreneurs prepared to take the risks and develop the market have never really enjoyed full government support.

Recommendations

- South Africa's high per capita energy consumption requires a more coherent and enabling policy environment for the development of biomass energy capacity
- Policy makers should work much more closely with biomass entrepreneurs from an early stage of market development and build initiatives from the 'bottom up' to strengthen mechanisms that will stimulate desired market activity and foster success. There are examples to draw on of industry-policy collaboration that has effectively built major industries in South Africa, such as mining and the motor industry.
- Incentives to develop domestic markets for biomass energy are urgently needed for more efficient wood pellet stove technologies and modern biomass electricity generation.
- Government would do well to align policy incentives with the potential for job creation and enterprise development available from a thriving biomass industry that feeds both local and export markets. Jobs and enterprise opportunities are available across the biomass industry value chain, particularly in the distribution of products to consumers across South Africa's extensive rural and peri-urban markets.

- Two recent near successes for biomass electricity at Howick and Tsitsikamma show how innovative systems have emerged – but have failed due to inadequate support from Eskom and lack of government incentives for taking the product to market. PPAs that favour biomass electricity providers are crucial, both to make biomass electricity financially viable and to supply the national grid with much-needed additional power. Additionally, policy incentives are needed from government to ensure private sector stability and market growth, particularly in the domestic market.
- A formal network of biomass actors, on equivalent footing to SESSA and SAWEA, needs to be established with government support.

This report aims to raise awareness of opportunities related to diverse energy options, both at household and industry level, and draw attention to the incentives needed to support the development and take-up of these options. This is a key aim of the CHOICES project (funded by REEEP and implemented by IIED and OneWorld Sustainable Investments), which supported the report through exploring the feasibility of alternative, renewable energy sources that create investment opportunities and foster partnerships between communities and private actors.

1
The biomass energy sector in South Africa

1.1 Overview of the sector

Biomass is biological material derived from living (or recently living) organisms. It can be used as a renewable energy resource, either directly via combustion to produce heat, or indirectly, after conversion into various forms of semi-processed biofuels (such as wood pellets or ethanol). Wood is still the world's largest biomass source (87 per cent of the global total), either harvested directly as a fuel, or collected from wood waste streams such as wood chippings, forest residues or sawdust from sawmills. Other sources include oil crops, sugar and starch crops, biodegradable wastes (including animal dung) and photosynthetic microorganisms such as algae.

Biomass could be an important contributor in satisfying South Africa's growing energy demand, and already makes an important contribution in meeting current demand. Biomass is also the biggest contributor to renewable energy in South Africa. South Africa's economy is energy intensive, with the highest energy per capita consumption in Africa.

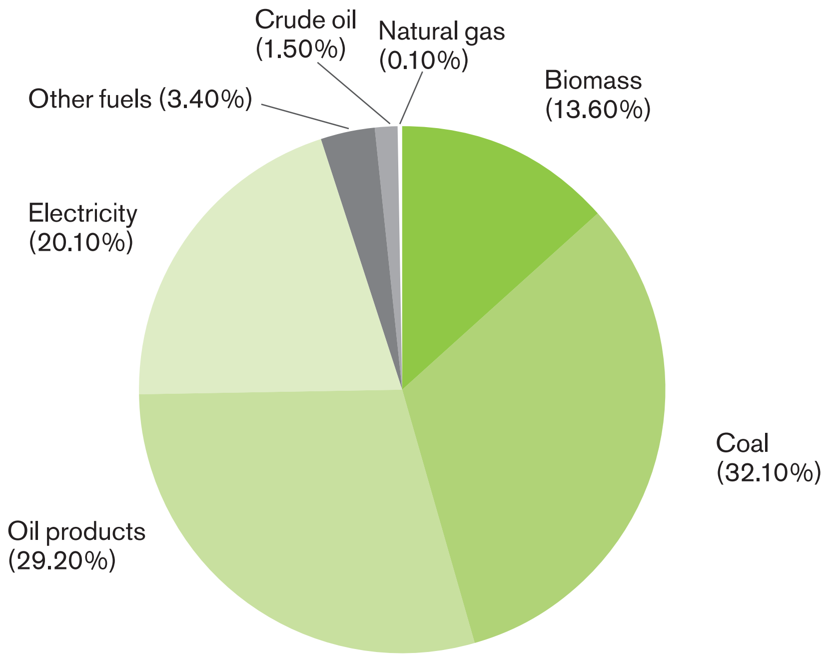
Final demand by fuel figures (2002) for South Africa (Figure 1) show that biomass contributes 13.6 per cent (Banks and Schaffler 2006) – a significant proportion considering the heavy reliance on coal for electricity production. Globally the biomass contribution is significantly bigger (at 21 per cent), while coal is significantly lower at 25 per cent, and oil dominates at 35 per cent.

The purpose of this case study is to review biomass use in South Africa and assess how technologies, markets and institutions have evolved in either supporting or hindering progress towards greater biomass uses. The paper then lays out some conclusions on possible ways forward and the conditions necessary to achieve success.

Global trends and drivers, particularly the growing emphasis on reducing net carbon emissions, are likely to alter future energy options – creating ever greater pressure to replace coal and oil-fired power generation. Policy and financial incentives, driven in particular by European Union renewable energy targets, are stimulating the adoption of biomass pellets, and although there are uncertainties associated with reliance on unpredictable incentives, this trend is likely to continue increasing demand for biomass pellets from supply chains around the world (Pöyry Management Consulting 2012).

In South Africa, biomass is largely disregarded as an outdated source of domestic energy. Biomass use is concentrated where it is a free option, collected from natural forests or as a by-product of a large-scale commercial enterprise. Biomass is therefore an important source of domestic energy, while its contribution to industrial energy production is small – though significant. The sugar industry, for example, has an installed generation capacity of about 245 megawatts (MWe) using bagasse (a byproduct of sugar production) as fuel, while the pulp industry has an installed capacity of 170MWe using sawdust (Winkler 2006). Nonetheless, most of South Africa's biomass consumption comes from the use of fuelwood in households, primarily in poorer areas. Natural woodlands are the main source at 60 per cent,

Figure 1.
Final demand by fuel in South Africa (2002)



supplying around nine to ten million people (ProBEC 2010). While potentially renewable, the widespread lack of formal planning and sustainable management of this sector in South Africa has important implications for the maintenance of ecosystem services and biodiversity.

The prominent role of fuelwood in domestic energy supply is evident in South Africa's renewable energy use statistics: the government's White Paper on Renewable Energy (DME 2003) identifies biomass as an important source of renewable energy along with wind, solar, hydro and other sources. It also identifies that about nine per cent of all energy consumption in South Africa comes from renewable sources, and here fuelwood use is prominent.

Technology is likely to play a decisive role in defining future options for biomass in South Africa. Two main biomass options are available – firstly, through low-tech household primary energy production, ranging from simply making a fire to more sophisticated, efficient and clean stove technologies that address some of the obvious criticisms of biomass use, such as domestic health concerns and pressure on natural woodlands. Secondly, emergent high-tech industrial electricity production from biomass is now widely available in most industrial nations. In part because of South Africa's formidable industrial capability, recent studies have shown that it has the highest potential in Africa for developing industrial uses of biomass, although a fuller feasibility study is recommended (Banks and Schaffler 2006).

While not on a scale comparable with other sub-Saharan African countries, South Africa is also a significant producer of charcoal, using plantation wastes, thinnings, and timber products from the Working for Water Programme's alien vegetation removal processes; and small-scale commercial enterprises which use their own resources. The charcoal production industry has evolved as competition, rising production costs and the high expense of transporting a light but bulky product has made simple charcoal production uncompetitive. Once again, technological advances are possible, not least through the use of more efficient kiln technologies for charcoal production.

1.2 The potential for biomass use in South Africa

As noted, biomass is not yet widely used in South Africa for commercial purposes or by high-energy household consumers (for instance in wood pellet boilers or heating systems). However, the sugar industry uses biomass energy at an industrial scale, buying up from producers and sawmills. Annually South Africa's sugar industry produces about two million tonnes of sugar from about 20 million tonnes of cane. Approximately seven million tonnes of bagasse is burnt in boilers to make steam for electricity generation and process heat (Haw and Hughes 2007). The sawmills in turn use their own sawdust biomass for kilns. Between the paper and pulp mills in South Africa, biomass-generated electricity is estimated at a capacity of 170MWe (Haw and Hughes 2007).

Despite the considerable potential, Eskom, the national electricity utility, does not use biomass as a source of electricity production and, currently, there is only a very small local market for wood pellets, as discussed below. Most South African produced pellets are exported, primarily to European markets, as they respond to incentives and pressure to reduce coal-based electricity generation.

Garden waste destined for landfill, including cut trees, is another component of total biomass production. The quantity of this fraction differs greatly from place to place. In Europe and Canada, where this type of waste goes straight to plants for recycling or for use in commercially viable energy production, there is no landfill-based biomass available. In South Africa, fairly substantial landfill biomass is available and is disposed of at high cost.

South Africa has a sizeable agriculture sector and all of the country's agricultural waste could be used for energy. Some waste, however, has important functions. For instance, plant litter maintains and improves soil carbon, and soil mulches reduce soil evaporation and the erosive power of heavy rainfalls. These are all critical functions of agricultural waste, and soils are probably one of the most important non-renewable resources for the next 10,000 years (this being the length of time it takes to regenerate a soil). Therefore, not all agricultural waste can go into biomass production.

In South Africa a lack of agricultural waste is not the problem; in fact, it is often the case that too much plant or forest waste tends to be left behind, increasing the risk of fire. The consequences of more intense forest fires are severe, not only in terms of lost vegetative growth but also because of the damage to soil structure and nutrient levels, with resultant soil erosion and land degradation. Insurance companies are expected to become increasingly interested in this risk as the frequency, intensity and cost of wildfires increases. There is obvious scope to improve the handling of agricultural biomass: by opening new opportunities for biomass energy production. The numbers involved tell an important part of the story, and provide an interesting perspective on industry potential: an estimated three million tonnes of agriculture waste is produced per year in South Africa.

There are also crops that can be grown quickly just to produce energy. However, these crops introduce new environmental considerations and concerns. One example of an energy-producing crop suitable to South Africa's growing conditions is the poplar tree, which also has a high calorific value. However, these trees are not indigenous to South Africa and some species are invasive. They grow best along watercourses and are significant water users in the summer months, and are also implicated in bank erosion during floods if toppled by surging water.

In principle, the faster the plant grows, the more water it uses. This characteristic of fast-growing biomass is of considerable concern to water resource managers. It is one reason why the forest industry was declared (in 1999) a 'stream-flow reduction activity' by the then Department of Water Affairs and Forestry (DWAF) and is controlled, while other plantation types such as sugar cane have resisted that same appellation.

Thus, while the value of the biomass sector is not yet entirely clear, there is evidence of potential for scale – although not without significant barriers to overcome, including that of transport logistics. There are also some major advantages of biomass if managed with ecological sustainability in mind, not least its labour intensity and job creation potential (see Macqueen and Korhalliler 2011) – a key concern in a country where jobs are desperately needed, particularly in the poorer provinces such as the Eastern Cape, where biomass dependence is significant.

A key consideration should be that biomass is a much lower source of carbon emissions than coal, which dominates South Africa's energy production and consumption. This is particularly so given South Africa's role in the multilateral climate negotiations and its place in African and global terms as a high carbon emitter. It is the highest emitter in Africa, as well as globally in terms of absolute emissions, ranked among the top 20 global emitters by the National Treasury and the 13th highest globally by the International Energy Agency (IEA).

Biomass is also potentially easily accessible to local communities and households and there is a range of technologies that are affordable, at least at the household level. However, the market foundation for household biomass still needs to be put in place. The paraffin industry, by contrast, is able to make its fuel accessible through a wide range of rural and urban outlets. Although paraffin stoves are unsafe, they are affordable, readily available and have a high energy content – approximately 34 megajoules per litre (MJ/L),[1] whereas wood pellets offer slightly less than half on a volume basis, at about 16MJ/L. Much of the development of liquid fuels has been achieved because subsidies have been available to this industry for many years, and because liquid fuels are easy to use. Developments for the efficient use of biomass energy, on the other hand, have not yet received concerted support.

Commercially, there are an increasing number of encouraging examples to draw on from around the world. The UK has introduced fiscal incentives (see Section 2.2) that are leading to the conversion of all but one coal-fired power station to biomass by 2025 (Macqueen and Korhalliler 2011), a noble objective that does, however, raise questions about reliability of power generation – or intermittency. Germany has 5000 biomass energy companies. Sweden, as the biggest global producer and user of biomass per capita, has a very well developed market with a mix of consumers, from large-scale heating plants and power plants to small boilers in single family houses, as well as a range of delivery modes from ship-borne bulk down to truck loads and bags of 16–25 kilograms.

1 MJ/L is a measure of energy density or the amount of energy that can be obtained from a fuel or power source

1.3 Policy paralysis is hampering biomass energy development in South Africa

Opportunities for biomass production and market uptake are as yet underexploited in South Africa. Producers, too, hold this view. Government has yet to display significant interest; as well as a lack of discussion about biomass, the country still does not have the policies, subsidies and related incentives needed to galvanise the sector into action. This is in spite of studies (Marrison and Larson 1996; Lynd, *et al.* 2003) that point to the viability of South Africa's biomass production capacity. Indeed, government itself has looked into biomass (see for example DME-Eskom- CSIR 2001; DME and CaBEERE 2004), but there is no indication as to what it is thinking now about the sector's role and potential. While this may seem surprising given the cabinet's acceptance of the Long Term Mitigation Scenarios (LTMS) just over two years ago, agreeing an economic growth model with carbon constraints, there are concerns and as yet unanswered questions about developing the biomass sector. These have to do with water production, competition with other land use types, biodiversity and security of ownership. There are also institutional ownership issues and potential for confusion about who is responsible; it remains unclear as to whether the sector's development should fall under the direction of the Ministry of Energy, Water, Environment or Agriculture, Forestry and Fisheries. Most producers and analysts refer to the apparent lack of government interest as the biggest barrier to biomass making a meaningful contribution to growing local energy demand.

What comes up repeatedly in interviews with the private sector is that specific incentives are needed for investment into production and market development, as well as for logistics such as road and rail infrastructure (discussed later), given that logistics make up about 65 per cent of the cost of biomass production and distribution.

Today, as much as 97 per cent of South Africa's commercial biomass production is exported. This is because the local market lacks support, and because the energy yield from biomass is so small in relation to its estimated potential. Bagasse from sugarcane is estimated to yield 5500 gigawatt hours (GWh), timber biomass waste 2722GWh, sawmill waste 2122GWh, and pulp and paper 2542GWh (DME and CaBEERE 2004). This is potential yield and the actual figures are substantially lower. The export market is not ideal, however, as the associated logistical costs are high and the international price squeeze leaves little margin for cost rises. Near-viable biomass plants have been forced to close as a result, such as the plant in Howick, KwaZulu Natal, discussed in more detail later. Operating costs increased in the Howick plant by 26 per cent from 2009, a rise that increasing export prices did not accommodate. However, neither government nor its agencies established for this purpose, such as the Industrial Development Corporation (IDC), have directly evaluated the costs of producing the low-grade coal typically burned in industries and households in South Africa against the costs of producing wood pellets. Coal prices do not fully incorporate the related costs of production, including the costs to the environment (air quality, water pollution, waste and so on). In other words, South African biomass production is still not being evaluated in terms of the whole value chain, or its wider impact – and is only evaluated in terms of comparative price to a low-grade, cheap alternative. This is an issue that has been felt across the fledgling renewable energy sector, which could not compete with Eskom's historically low-priced electricity generation without significant incentives.

Within the LTMS, which highlights South Africa's dangerous dependence on fossil fuels, it is worth noting that biomass constitutes less than 13 per cent of South Africa's total energy production and consumption (Damm and Triebel 2008). To put this in a global perspective, in Sweden 21 per cent of the country's energy comes from biomass. To be fair, Sweden has the largest biomass-energy ratio in the world (in relation to total energy demand) and many other European Union (EU) countries, such as Italy and France, are making progress toward reaching related EU targets. What is important to note here is the *quality* of the biomass production industry in Sweden – a developed country with a biomass market that is well established and covers a range of commercial and industrial applications, while South Africa's use of biomass is mainly fuelwood for households in poor areas.

The private sector provided the main sources of information and key players approached for this study. This is because this sector typically drives the main actions such as raw material analysis, and associated value chain analysis (assessing opportunities and barriers across the biomass industry from raw material to distribution of consumable products), exploring alternatives to existing raw material, assessing what technologies to introduce to the country, and the economics associated with the contribution of biomass to South Africa's grid capacity. Other opportunities that the private sector is exploring include biomass as an alternative for steam production, and biomass as a displacement of gas or coal used directly in industries – such as the work done by SAB Miller in the brewing industry.[2]

2 SAB Miller, the world's second largest brewing company and South African grown, continues to explore alternatives to grid-based electricity use in its South African production facilities. Various alternatives have been explored, concentrating on direct fuel sources such as natural gas, biomass and steam. Steam is commonly used in co-generation facilities and the industry has seen natural gas uptake in the Gauteng plants, located near the Mosal gas line, and supplying natural gas from Mozambique.

2
The policy environment in South Africa

2.1 The policy framework in which biomass energy might develop

As noted in the previous section, there are virtually no supporting government policies or subsidies in place to support the biomass sector's development in South Africa. Given the potential importance of this sector, this lack of support can only be described as astounding. Also, supporting government policies or subsidies to prevent land degradation are either not in place or are difficult to implement. Specifically, the conservation of natural forests is failing due to a disconnect with the reality on the ground and what the policy is attempting to achieve; while policies surrounding land degradation often face obstacles in implementation. Europe, on the other hand, applies penalties for using fossil fuels throughout the EU. If 70 per cent of European countries install biomass plants, 50 per cent of the related investment cost is recoverable from government.

In the 2003 White Paper on Renewable Energy, South Africa identified a target of producing 10,000GWh from renewables by 2013. This is a cumulative target, representing approximately 1000GWh per year (DME RED 2009: 12). The White Paper refers to biomass, wind, solar and small-scale hydro as principal energy sources and focuses on larger and economically viable projects rather than small-scale electrification programmes, even though electrification is seen as an especially pressing issue in poorer rural areas. The government has also set targets for increasing the use of renewable energy by 2020. To achieve these targets, it has committed to strengthening competition in the electricity market, emphasising the need to create an enabling environment for independent power producers (IPPs) that use renewable energy sources. The White Paper also committed to developing a strategy on renewable energy, to 'translate the goals, objectives and deliverables set out herein into a practical implementation plan' (DME 2003: xiii). This strategy has not materialised, with less than 10 per cent of the targeted new renewable energy capacity achieved to date (Trollip and Marquard 2010), despite renewable targets being integrated into national Energy and Development Plans.[3]

One of South Africa's most significant attempts at creating incentives was the Renewable Energy Feed-in Tariff (REFIT), which ostensibly had favourable tariffs for biomass. Unfortunately, the corresponding institutional arrangements were not extensively considered and the REFIT has consequently failed to materialise. There is a replacement approach, now colloquially known as the Renewable Energy Bid Programme (REBID), but in its current form, REBID will not provide a platform for the biomass industry to flourish. Like the REFIT programme, the problem is widely recognised as being a misalignment between REBID and other relevant legislation such as the National Environmental Management Act (NEMA), through failure to establish the correct

3 Integrated Resource Plan for Electricity 2010–2030, published in 2010, and the National Development Plan-2030, published in 2013.

regulatory and institutional structures that would support the industry. Enabling policies and incentives in South Africa must take into account logistics such as fuel, road transport and shipping. For example, South Africa has one of the most expensive port charges in the world; reductions would aid the viability of the wood pellet export market for local producers. An enabling policy environment would also include incentives for doing something useful with raw materials that otherwise go to waste (such as an 'environmental benefit reward') as well as rebates on power, such as those currently afforded to the mining industry.

Accordingly, there is no pricing regulation in this market. This unstructured situation has parallels with other markets, including in Europe, which are self-regulating and tend not to be very structured. However, South Africa's paraffin industry is regulated – an industry which biomass could and should displace for safety, environmental and local pollution reasons – giving it an unfair competitive advantage.

2.2 Global benchmarks

Policy frameworks in international markets that support biomass consumption by industry can provide useful benchmarks for South Africa. In the UK, Drax Power Limited owns and operates the Drax Power station, the last coal-fired power station built in the UK, producing 1500MW of power from six generators of 300MW each (Drax Power, 2014). In 2002 the UK's Department for Energy and Climate Change (DECC) introduced Renewable Obligation Certificates (ROCs), to provide incentives for the deployment of large-scale renewable electricity. Generators can sell ROCs to suppliers or traders, providing a source of income additional to wholesale electricity prices. This policy instrument has provided the incentive for Drax to convert three of its generators to biomass. The other driver at play is the UK government's commitment to decreasing domestic carbon emission levels, adding pressure for companies such as Drax to use a more sustainable, low emissions source of energy.

Biomass producers in South Africa also consider subsidies important. One example is Mondi, a major player in the paper industry. If they were able to access a subsidy per metric tonne of biomass used, Mondi could use up to 800,000 tonnes of wood pellets per year, making them one of the largest potential industrial consumers of biomass in the country. Without some incentive to enable this and other industries to expand their biomass consumption and reduce their reliance on dirtier fossil fuels, these industries will continue to automatically default to the cheapest, most easily accessible source of energy available, often coal – and in some cases even oil.

South Africa does currently have a carbon tax mechanism aimed at reducing the country's emissions, to be implemented in 2015 if it passes public scrutiny and consultation processes. This mechanism would act as a proxy for subsidies by incentivising heavy users of fossil fuels to switch to alternate sources of energy, such as biomass. At present, only internationally owned companies operating in South Africa are being offered incentives to switch to alternate sources of energy. This is particularly the case for European owned multinationals with industrial-scale manufacturing bases in South Africa, who are being pressured by their European masters to switch to cleaner fuel sources with European incentives and penalties for high carbon emissions.

3 South African examples of modern biomass energy development

3.1 Overview of new commercial biomass developments

The emergence of private sector investment in the South African biomass production sector is indicative of the belief in the potential for South Africa to both develop local markets and respond to export markets for products such as wood pellets and other forms of biomass for energy production. That many of these ventures have failed is not due to low market potential, but is primarily due to inadequate government support and unsophisticated market mechanisms. While market mechanisms exist, such as the Renewable Energy White Paper, the suite of supporting and enabling regulations and mechanisms, such as the carbon tax, are not yet in place. This is a very different situation to the policy development situation in, for example, South Africa's labour market, where South Africa is recognised by the International Labour Organisation (ILO) and others as having some of the most sophisticated labour policies, regulations and related skills development mechanisms in the world, often used as benchmarks in other developing countries. These are considered sophisticated in that they are well integrated with clear institutional arrangements, and although there remain challenges in implementation, a lot of thought and work has gone into ensuring that all the bases are covered for developing skills and supporting employment opportunities in the labour market.

Over the past decade, six wood pellet production plants have opened and shut – 'mothballed', closed, or auctioned as part of a liquidation procedure. These were mostly located close to commercial forestry operations to ease access to raw material supply, or in industrial ports, facilitating access to export markets. They were situated in: (1) the Richards Bay Harbour, (2) in the Coega Industrial Development Zone and harbour in the Eastern Cape (near Port Elizabeth), (3) in Howick, (4) in the forest-rich midlands of KwaZulu Natal, (5) in the Sabie area of Mpumalanga, also forest and plantation-rich, and (6) in George in the southern part of the Western Cape Province, also close to a raw material supply base. Other than Howick, these plants were all installed and operated at a relatively low tonnage output and did not reach the optimal operational scale of 80,000 tonnes per annum – the point at which scale efficiencies are considered to make production viable (or ten percent lower, which is also deemed acceptable by the industry).

These wood pellet plants are among the most important commercial biomass market developments in South Africa in recent years, along with the MTO Forestry sawmill,[4] and until recently, the biomass plant located in Tsitsikamma, Western Cape. They are certainly among the most important developments since the sugar, pulp and paper biomass generation capacity installations, some of which date back 60 years.

4 A subsidiary of Cape Timber Resources

Two of these plants are looked at in more detail in the case studies below: (1) the Howick pellet plant (2) and the sawmill and biomass plant in Tsitsikamma. Both case studies present interesting opportunities and challenges. Our assessment helps to define both the opportunities in commercial biomass markets and the barriers that need to be overcome. The case studies also provide a snapshot of two very different markets. Howick, while exploring local markets, was exporting almost 100 per cent of its product; whereas Tsitsikamma used biomass to generate a local energy supply for the plant, with a long-term view to exporting surplus energy to the national grid. Both accessed local raw material, mostly sawmill waste, although the Howick plant originally accessed forest waste from local forests and plantations. Both were private sector operations and investments. The differences in these operations, the potential of each and the barriers experienced, are expanded on below.

3.2 Howick wood pellet plant

Overview

Biotech Fuels, a private South Africa-based energy company, established a wood pellet manufacturing plant in the industrial area of Howick, KwaZulu Natal in 2006, with investment from GAM UK, an active asset management company. In addition to commissioning a modular pellet manufacturing plant, the initial project design included a five-megawatt biomass plant to generate sufficient electricity for the wood pellet plant, with surplus energy to sell to neighbouring industries and/or the national power utility, Eskom. Biotech appointed Associated Energy Services (Pty) Limited (AES) to build and operate the energy plant adjacent to the wood pellet plant.

The pellet plant was successfully installed. Unfortunately, however, the power plant installation was never fully commissioned because Biotech and AES were unable to secure a favorable PPA from Eskom for the surplus electricity. This was surprising, given Eskom's urgent need for increased energy installation capacity and their corresponding call for industry-based co-generation projects across the country at the time – in order to take advantage of excess useful heat produced in the generation of electricity at coal-fired power stations and improve efficiency in energy generation systems. In the absence of finalised government incentives to develop the renewable energy market, Biotech explored the possibility of subsidising the project's overall electricity generation costs between 2007 and 2008 via the Clean Development Mechanism (CDM).[5] However, in 2008 Biotech decided to postpone the installation of the power plant component until suitable agreements could be reached with the government and Eskom. The resulting outcome was a pellet production plant that eventually exported 97 per cent of its product, drawing on scarce grid-based electricity, instead of generating a renewable energy source that would also have supplied the national grid. That most of the product was exported (with increasing price constraints), due to unfavorable local market conditions, is the factor that ultimately led to the closure of the plant.

5 The CDM was established as a financial instrument under the United Nations Framework Convention on Climate Change (UNFCCC), whereby Annex B – mostly developing countries – can apply to implement emission-reducing projects that can earn saleable carbon credits, or certified emission reduction credits (CERs). CERs are tradeable on international markets and supported by the UNFCCC and Kyoto Protocol framework.

Production, raw material, staffing and maintenance

Plant capacity and production efficiency reached 60,000 tonnes per annum at 85 per cent efficiency within three years (by 2012). To become profitable, further investment was required to bring the plant's capacity to 72,000 tonnes per annum, the point at which economies of scale would have been maximised. However, these further investments were not forthcoming. Moreover, the significant upfront capital investment and consequently highly geared balance sheet meant that borrowings had exceeded the equity and made Biotech extremely vulnerable to economic downturns. This ultimately led to its liquidation in early 2013. In the three preceding years, Biotech had developed technical skills to operate the plant aligned with local conditions, learned about the vagaries of the export market and came to grips with local raw material supply and logistical challenges, resulting in world-class levels of efficiency and production. It is evident in the production efficiency statistics of this plant over the 2012–2013 period that these lessons were well learned and applied.

Producing an output of 60,000 tonnes of wood pellets requires 160,000 tonnes of raw material or wood waste. This is based on the ratio of each 1-tonne pellet using on average 2 tonnes forest/wood waste, with an average moisture content of 55 to 60 per cent; part of the production process is reducing moisture content to 8 per cent to produce a fuel efficient wood pellet. In the original project design, it was anticipated that the bulk of raw material would come from surrounding forests and plantation wood waste, all within a 50-kilometre radius. By the time the plant reached 60,000 tonnes and 85 per cent efficiency almost all of the raw material came from sawmills, furniture and pallet producers in the area, averaging a distance of 97 kilometres from the plant. Around 36 suppliers provided the plant's raw material, sometimes – but not often – including plantation and forest operators such as Mondi and Sappi. Sawdust is considered the best raw material as the transportation costs are minimal (it is light and compact) and it can more or less go straight into the production line.

The lifetime of the plant technology and the life cycle of raw material available in the plant's location (within a 50-kilometre radius of the plant) is 15 years. The raw material life cycle is based on the assumption that other factors don't impede the growing of raw material and that it can compete with other uses (for example producing wood pallets, a viable industry in the Howick area). Competition also comes from the market for pellet tonnes as raw material, such as demand from the European market.[6] Here, price comparisons are indicative of some of the differences between the European and South African markets. European wood pellet producers pay their suppliers for raw material at around EUR80 per pellet tonne. The environment for South African producers differs in that they do not pay suppliers of raw material, but still incur significant costs – mostly through handling: road haulage, cleaning, and drying of raw material. These direct costs calculate at approximately EUR22 per pellet tonne, or 200 South African rand (ZAR). Not included in this figure are the higher labour costs incurred by the condition of raw material in South African plants, which requires more intense handling operations, and related maintenance needs.

The technology used in the Howick plant is a conventional pellet line imported from Europe. It includes a conventional drying line and a direct flue gas drying line. Although pelletising line technology was initially developed in the United States, it really took off in Europe, mostly in the Scandinavian countries. The drying line is the

6 A 'pellet tonne' is wood waste as clean raw material with reduced moisture content.

same as that used for sugar, clay, and paper production – a common technology in any industry that has to dry material. However, in the Howick plant these two processes of pelletising and drying took place on one production line, an integration that significantly increased efficiency levels. The skills to achieve this integration were effectively imported from Sweden, in the form of a plant manager who had gained experience there.

Local jobs were also created, and local capacity was built. The levels of production described required four shifts per day, with each shift employing four production technicians. In total, 42 people staffed the plant, including management. Although additional temporary staff were required on occasion, this was infrequent. The maintenance team made up a significant portion of the permanent staff. While this is considered excessive by European standards, it was necessary in this case due to the lack of wood pellet production 'know how' and low skills base in the area – and the training needed as a result. Unlike Europe, where contract staff are readily available and maintenance is often contracted out, the Howick plant found that it needed maintenance people permanently at hand. This meant that mechanics, fitters, boilermakers and electricians, as well as a workshop assistant, shipping line and logistics staff, had to be trained to the specific requirements of wood pellet production and retained so as to be present when needed – significantly driving up the costs of production.

Having qualified maintenance staff is also critical because of the specific maintenance issues found in South Africa as opposed to Europe. In South Africa, raw material arrives at the plant unclean, containing a lot of metal (by-product metal produced in cutting timer, such as broken saws and metal from tools and plants). Primarily, waste comes from sawmills and timber industry plants and to a lesser extent from timber plantations that feed the paper mills. The Howick plant manager said, hyperbolically, that 'enough metal has been extracted from the first three years of supply to build an entire new plant'. The presence of metal raises the costs of maintenance, as metal missed in the cleaning process creates high wear and tear to machinery, burning out equipment at three times the rate of equivalent European plants, where raw material is not nearly as contaminated. The fact that Europeans pay for their raw material and South Africans do not is also relevant. Europeans are able to pass the responsibility of raw material quality control onto the supplier, reducing their maintenance costs substantially. However, if South African companies attempted this it would raise the cost of raw material, which is currently free. It is also unlikely that raw material would arrive in as pristine a condition as it does in Europe, even if the supplier were accountable; South Africa's regulatory environment is typically not as well enforced.

Critical success factors

Getting to grips with local raw material supply was crucial because of this specific issue. Handling areas in South Africa need to be more sophisticated than anywhere else in the world because of the presence of so much other matter in the raw material that cannot go into a pelletisation plant. The Howick plant manager stated that out of the approximately 300 pellet plants in operation around the world, the Howick plant is one of very few that can handle any type of wood waste. It is hardly surprising that this plant took three years to reach acceptable levels of efficiency. It is also a remarkable achievement that the plant passed the scrutiny of a European sustainability and production standards audit, conducted in 2011. The audit was carried out because the bulk of the plant's produce was being exported to Europe to satisfy the EU's drive to reduce carbon emissions.

Challenges and barriers

Initially, the fact that the plant was exporting as much as 97 per cent of its product to Europe was a benefit. In fact, investments in the plant were forthcoming because a viable, and stable, European market was presumed to exist. Unfortunately this situation changed dramatically with the global economic downturn that began in 2007. Europe's demand for the product did not wane – in fact it increased, with more and more customers such as Drax and Tesco placing orders. However, a financial squeeze came into play through pricing, as the European market curtailed the price it was prepared to pay, an issue exacerbated by availability of cheaper pellets from elsewhere. This was where South African local market conditions became a challenge. Export markets remained stable, but at prices which were not viable.

By mid 2012, at a price of EUR125 or ZAR1200 per tonne, exporting pellets brought straight losses to the Howick plant. This price was lower than the cost of production which, at the time, amounted to EUR130 per tonne. The major European buyers began exploring supply options from the Brazilian and Central American markets that were cheaper than South African sales prices. As a South Africa based producer, Biotech could not readily afford to reduce its sales price because of the costs of production. These costs, including maintenance and logistics, were relatively fixed and changes were prohibitive. The mathematics is both simple and indicative. In 2012, maintenance was costing Biotech ZAR90 per tonne; handling raw material and producing pellets came to ZAR400 per tonne; and running costs (excluding overheads) cost 500 ZAR per tonne. Noting exchange rate and fuel price fluctuations in a plant where 65 per cent of the costs lay in logistics (shipping and road transport), this left around ZAR200 per tonne for overheads, fluctuations and profit. The more these margins were being squeezed, narrowing to less than nothing, the greater the imperative to develop a local market, where logistics costs would be much lower, the market scale potentially greater, and related opportunities, such as supplying pellet stoves for domestic use, more diverse. The local market however has not been developed, primarily because it needs policy incentives to stimulate it.

By early 2013 GAM became nervous and called in their investment, which resulted in the plant's liquidation in April 2013. The liquidators have just sold off the equipment, but not the land yet (which has limited use rights) and the equipment is being dismantled and used for other purposes.

3.3 Tsitsikamma biomass plant

Overview

Soon after the post-1994 democratic elections in South Africa, the government embarked on a community and sustainable forestry model intended to be more inclusive of the people, through privatisation. Sections of South African forests and plantations and their operations were made available for sale through a competitive bidding process. MTO Forestry (Pty) Limited (a subsidiary of Cape Timber Resources) was thus established in accordance with the black economic empowerment criteria of the bidding process.

MTO owns sawmills in three locations in the Cape, including Tsitsikamma, which sits on the border between the Western and Eastern Cape. The inclusive and sustainable forestry model envisioned by the government is being realised in MTO operations. This involves sustainable forest audits conducted regularly to ensure that MTO meets international standards in silviculture, fire protection practices and conservation. It also involves investing in people through local partnerships. Sponsorships are a central focus, mostly to create jobs; for example MTO sponsors the Grabouw food garden that sees local community members trained to grow and sell vegetables through the municipality there. In 2005 MTO diversified some of its operations, including the use of waste from the adjacent sawmill and similar operations in the George area in the Southern Cape, to produce a renewable source of electricity through a five-megawatt biomass power plant in Tsitsikamma, operated by Associated Energy Services (AES). At the time of AES taking over the plant and upgrading its output capacity, there was no Eskom electricity connection line available to the plant. An Eskom line was installed about a year later, and until recently, connection fees were paid but the line was unused.

Production, raw material, staffing and maintenance

Until early 2013, AES operated the biomass plant. The plant, with an installed capacity of six megawatts, used biomass from the adjacent sawmill and imported the deficit of waste material needed from surrounding areas for generating steam and electricity. This output supplied both the plant and the neighbouring communities with steam and electricity. This was at no cost to the communities, who had had no source of electricity supply until this plant was upgraded and operated by AES eight years ago. In addition, many of the households enjoyed income from employment in the energy plant, sawmill and the related forestry operations. Notwithstanding these local benefits, the plant was closed in December 2012 due to a takeover of the plant. Swartland, a private sector company that mainly produces doors and window frames from their sawmill operations, saw the MTO-operated sawmill as unfair competition and disputed the longstanding initial bid award to MTO. The Competitions Board resolved this dispute in 2012, and MTO passed the sawmill and its related operations to Swartland – including the AES-operated biomass plant – as part of the settlement. Swartland has a very different business model to MTO. They are a family-owned business focused on core operations and profit generation, while MTO – although also profit-oriented – has a strong community focus and consequently higher diversity of operations in its business model. Swartland also prefer mechanisation to labour intensity. Their immediate actions included closing the electricity production side of the biomass plant, relying only on the steam generated from the plant and using the Eskom line for electricity. The communities no longer receive free electricity. Furthermore, AES had to retrench its employees, and Swartland, with their tendency toward mechanisation, shed a significant number of jobs in the sawmill and forestry operations. Around 2000 jobs have been lost in this competitive streamlining process.

Under MTO the bulk of the raw material used in the biomass plant had been sawdust, with a reliable supply from steady production at the sawmill. This changed when Swartland took over and upgraded the sawmill to improve its efficiency, resulting in reduced waste material. AES, now under Swartland, therefore began to bring in the necessary waste material by road from other sawmills, increasing their production costs through expensive road haulage.

This case differs in two important ways from the Howick example. Since AES used only sawmill waste – the cleanest material available – handling raw material was much more straightforward at the Tsitsikamma plant, with simplified maintenance considerations. Also, until the Swartland takeover the logistics costs were substantially lower; both because raw material was available and accessible (until sawmill efficiencies were improved) and because the electricity generated was supplying immediate operations at the sawmill, as well as community households. Permanent jobs on this plant were greater than at Howick; the Tsitsikamma plant employed 56 full-time staff, running four shifts a day to meet 24/7 energy and steam generation requirements.

It is worth noting that an Eskom electricity line (already established in the area but not connected to the plant) was available to the Tsitsikamma plant. It was technically able to both supply electricity to the sawmill and channel surplus electricity from the biomass plant to the grid. However, when Eskom installed the energy plant in 2006, they did not believe at the time that they would need additional electricity over and above the amount they were producing, and did not facilitate this process. AES consequently decided it was not worth investing ZAR8 million in the switchgear needed to supply the grid. Now, eight years later, this facility is not in place and demand for electricity outstrips supply. Swartland want to focus on their core business and see the power plant as a distraction and an inefficient operation; it operates at very low efficiency levels of seven per cent. These low levels are attributable to the plant's 60-year-old equipment, originally imported from what was then Northern Rhodesia (now Zambia), to generate steam and electricity. A significant investment would have been needed to upgrade this plant, an investment hard to justify given the plant's low income levels. This could have been very different if Eskom had had the foresight, eight years ago, to purchase soon-to-be-needed surplus power from Tsitsikamma and other plants like it in South Africa. In future, they will need greater awareness of biomass's potential – as well as improved planning foresight.

Critical success factors

In Tsitsikamma, the main factors contributing to its success included having a consistent and readily accessible supply of raw material, and using the existing solid in-country expertise – in renewable fuel use, equipment and process application and optimisation, biofuel use, waste energy recovery, fuel switching, waste stream use and energy efficiency. The costs of energy production were confined to equipment, maintenance and production costs. The cost of logistics was low, with almost no transport costs, zero shipping costs and few related labour costs.

Challenges and barriers

The main challenge was an extraneous factor relating back to the original bidding process for these operations and forest use. Two main bidders competed at the time and although MTO operated the sawmill, plant and forest operations for eight years, the ongoing dispute raised by Swartland resulted in MTO handing the sawmill and biomass plant back to Swartland. As discussed, the two organisations have different business models. Also, the original energy plant equipment was outdated to start with, making more efficient output levels impossible without major investment. This in turn was not seen to be viable as Eskom were not facilitating the sale of surplus electricity back into the grid, even though the electricity line was installed. The plant therefore had no direct income stream available to it and so it is not surprising that a more profit-oriented organisation would see the biomass plant as an unnecessary distraction and therefore close it. Swartland is now only drawing on this plant for its own direct needs: steam production, something the old technology can sustainably handle.

3.4 Immediate conclusions

A number of factors are clear from an analysis of these two recent South African examples, both of which have been closer to success than any other new biomass commercial venture in this country. It is evident that progress has been made and that both examples could have proved commercially viable with more support. The Howick plant is the only one of its kind in this country that has reached acceptable levels of production efficiency, has met international production standards and has reliably supplied an export market. The Tsitsikamma plant, although much more closely aligned with traditional models of commercial electricity production from biomass, has seen a small enterprise being able to use a localised renewable energy resource to generate electricity. This has in part been enabled by more favourable energy policies, such as the Renewable Energy White Paper, and is one of the few – albeit small-scale – examples available that demonstrates that the more recent Renewable Energy Independent Power Producers Procurement Programme (REIPPPP) could achieve its overall target for renewable energy power integration into the local energy supply mix.

There are some clear lessons to be drawn from the barriers that caused the eventual closure of both plants. Logistical costs associated with production and distribution of the decentralised biomass supply are prohibitive, including, for example, the sourcing of material to make pellets. As well as this, selling exclusively to an export market presents severe limitations. Once faced with increasing logistical costs and restricted purchasing power from Europe, the Howick plant could not nimbly turn to alternative markets, although current South African rand exchange rates may have altered this picture. It was not able to create a local market and related distribution chains quickly enough, and struggled to compete with increasing competition in the export market from South and Central America.

The biggest potential local market for wood pellets as fuel is among low-income households in peri-urban and mainly rural areas. Sustainability, health and safety, and price provide the three most compelling reasons to develop this market:

- **Sustainability:** households often access wood fuel from surrounding areas faster than it can grow back
- **Health and safety:** people often use cheaply available, subsidised paraffin for space heating and cooking, causing severe local pollution and safety consequences. Paraffin causes tangible pollution in densely populated, high consumption areas such as Soweto and Daveyton, large peri-urban areas surrounding South Africa's economic hub of Gauteng; and the use of cheap, unsafe stoves is a major cause of rural home and shack fires across the country. (This is not to say that similar problems do not affect the use of inefficient wood fuel stoves.) Globally, stoves that can burn wood pellets are becoming more and more readily available, with production facilities emerging in parts of Asia (Malaysia and India) and Africa (Kenya). These stoves stand up well to safety tests when compared to paraffin-burning equivalents and also have an almost zero polluting factor.
- **Price:** the uptake of efficient wood stoves is dependent on a steady supply of accessible and affordable fuel. Wood pellet plants across South Africa are closing rapidly due to weak legislative support, leaving nothing to supply the local market or develop its potential. The Howick operation had started selling wood pellets to nearby rural villages through a local intermediary just before its liquidation. The intermediary bought small truckloads for cash and distributed directly to these villages. Biotech also bought a shipment of stoves from Malaysia and had begun to test different business and distribution models in the local low-income markets.

The Howick story also demonstrates that renewable energy policies that define generation targets are necessary to stimulate the market, but cannot stand alone. Enabling policies and mechanisms as well as institutional arrangements are needed to make it possible to reach these targets. Many major industries in South Africa were kick-started or supported by enabling policies, subsidies and mechanisms. These include the paraffin, motor manufacturing, centralised electricity generation and mining industries, all of which have enjoyed long standing government support. The biomass sector will need something similar if it is going to either successfully export its product and/or sustainably supply a local market.

In both the Howick and Tsitsikamma stories, albeit in different ways, government policy and practice has been the major barrier. By the time Howick was liquidated, attempts made by Biotech to save the plant had shown that there was no structure or other support available from government and their agencies. The Industrial Development Corporation (IDC) was established to promote economic growth through playing a catalytic role in promoting partnerships across industries, and has a mandate to provide finance for industrial development projects. Yet the IDC appears to have written off commercial biomass production as a viable investment, based on their investment experiences in Coega and Mpumalanga. Plants in both locations (and others) failed, largely because these were often either not located close to raw material supplies and/or to markets or market access points, such as harbours).[7] Also, subsidies in the form of logistics costs or to stimulate local markets, as used in the paraffin industry, were not available to this operation and others before it. In the case of Tsitsikamma, Eskom's reluctance to purchase surplus energy proved to be a barrier to investing in the plant and making it more productive – ultimately resulting in the plant being shut down. Even now that South Africa has experienced an energy crisis and still does not have adequate generation capacity, a barrier remains to channeling surplus energy into the national grid – experienced primarily through unfavorable power purchase agreements for the supplier.

7 Coega is an example of a plant located in a harbour and close to significant potential domestic markets (and an Industrial Development Zone) but at significant distance from raw material supply bases, making input costs high. Mpumalanga based plants on the other hand are located close to raw material supply (and to potential domestic markets) but are at a distance to the export market routes, namely harbours.

4
Current biomass energy use in the Eastern Cape

Eastern Cape in the national context

Over 80 per cent of rural households across South Africa use fuelwood as their primary source of energy, at an estimated value of ZAR20oo per household per year (Damm and Triebel 2008). Despite the dramatic increase in rural and urban electrification since 1992, fuelwood continues to be a reliable, available source of cheap energy that also has traditional value. It is expected that the demand for fuelwood will continue for decades to come (Damm and Triebel 2008).

Biomass consumption, although widespread across the country, varies depending on location and households' socio-economic situation. Differences in consumption patterns are based primarily on two factors:

- availability of alternatives – fuelwood tends to dominate in rural households, particularly where there is no access to grid electricity
- availability of resources – fuelwood consumption is determined by how readily available it is.

The 1996 census showed that around 44 per cent of South Africa's population lives in rural areas. The provinces of Limpopo, KwaZulu Natal and the Eastern Cape have the largest density of rural, or non-urban, populations; approximately half of these have access to grid-based electricity (Damm and Triebel 2008). While this is indicative of high market potential for structured, sustainable biomass, such as wood pellets and stoves, these households are widely distributed and large-scale surveys that detail energy demand have yet to be conducted. At present, market demand analysis is dependent on data derived from small-scale surveys across relatively few villages. There are, however, other known patterns of consumption that indicate where the demand for fuelwood is most concentrated. Coal is also used directly by poorer households, particularly where these are located close to coal mines, and primarily among peri-urban and urban low-income households. The majority of these coal mines are in the provinces of Gauteng, Mpumalanga, KwaZulu Natal and the Free State. It can therefore be assumed that the mostly rural, poorer populations of Limpopo and the Eastern Cape are more dependent on fuelwood, of which there is an abundance in these provinces.

An analysis of residential energy consumption by fuel type and province by the Department for Minerals and Energy (DME) in 2002 corroborates this. The province of the Eastern Cape is shown as one of the highest biomass users in the country, relying primarily on fuelwood for energy. Based on the DME analysis, out of a total 26,317 terajoules (TJ), Eastern Cape households are shown to consume 21,962TJ from biomass, 6363TJ from paraffin and 4820TJ from electricity, with the balance of 471TJ supplied by liquid petroleum gas (LPG) and no contribution from coal use.

Although the electrification process will continue, the current Eskom limit for electrification is 50 households per square kilometre – meaning that many rural households will continue to rely on fuelwood (Damm and Triebel 2008). In any event, most rural households cannot afford the appliances needed to use electricity nor high monthly electricity bills, limiting electricity use to lighting and continuing to rely on fuelwood and paraffin for cooking and space heating. One result of electrification is the diversification of fuels used by households; and this is an opportunity for a sustainable biomass market model.

Eastern Cape Energy Survey

In the absence of large-scale surveys, it is useful to look at the analysis available from smaller surveys that have been conducted in provinces with a concentration of rural households. The Eastern Cape, which has zero reliance on coal at a household level and uses fuelwood and paraffin instead, is a particularly useful example in considering biomass potential and challenges in South Africa. An energy survey was conducted across three communities in the Blue Crane District in the Eastern Cape under the community energy project, CHOICES, and sheds some light on how households in these impoverished communities understand their energy consumption patterns and their ability to control them. Box 1 highlights the key findings of this survey.

Implications for local market developments

The case of the Howick plant illustrates that a local market is desirable from a supply side perspective. This plant demonstrated its ability to reliably and consistently supply wood pellets, with the sustainable use of a raw material supply. That there is a demand for additional, low-emission energy sources across the country is evident in this case study analysis and elsewhere. The current delays in constructing South Africa's latest large-scale (coal-fired) power plant, Medupi, does not bode well for either a reliable electricity supply for existing customers, or for meeting growing demand. Even with the Medupi power plant – followed by a further large-scale power plant coming on line at Kusile – the government will still not keep up with demand. At an installed capacity of 4800MW each, the combined output of these two plants would represent about 25 per cent of South Africa's power generation capacity. Although both are currently under construction, the Medupi power plant is more advanced in terms of construction and finance. There is uncertainty as to how the government is going to finance Kusile, given that caps have been imposed by the electricity regulator on electricity price increases, which are having a substantial impact on industrial competitiveness in South Africa.

In terms of the demand side of biomass, it is evident that more plants similar to the Tsitikamma model are needed across the country. These co-generation opportunities, exploited for some time now – for example in sugar, paper and pulp industries – and proven to be viable if the right scale is achieved, are significant and could make a useful dent in national energy demand. At the same time, this would take the pressure off government to find finance for large-scale investments. Moreover, it is a way of getting energy to rural households where the cost of connection to the central grid is exorbitant and is hard to justify. It appears though that plants based on the Howick model will really only be viable if a local market for wood pellets can be feasibly established. Analysis here and cases such as the Tsitsikamma and Howick plants strongly indicate that a local market does exist, for supplying what is possibly a more sustainable resource to the existing fuelwood markets. This also creates an opportunity to displace unsafe paraffin and highly polluting coal.

We now know that there are many potential buyers of wood pellets and that these buyers are likely to be there for decades to come. But can a Howick-type plant supply these buyers, who are mostly low-income households, with affordable and accessible fuel? Are the technologies available as cheap as simply making a fire outside a hut, or using a paraffin stove, however unsafe? Can a plant located in KwaZulu Natal distribute pellets into provinces like the Eastern

Box 1.
CHOICES Energy Survey Analysis in the Blue Crane District, Eastern Cape

Three small towns and rural communities were surveyed in the Blue Crane District, encompassing the towns of Somerset East, Cookhouse and Pearston. High unemployment characterises these communities, on top of which the municipality is unable to provide energy to meet industrial needs for current or future demand. Some industries, notably the dairy industry in Cookhouse, is thinking of relocating. There are large-scale renewable energy developments in this area, mainly wind, where the energy will go straight into the national grid to produce electricity that may still not meet local demand. Investments that will meet community energy and development needs are critical, based on these and other survey findings:

- 37 per cent of the people surveyed have no access to grid electricity.
- 12 per cent make do with the government's Free Basic Electricity grant of 50 kilowatt hours (KWh) per month.
- 11 per cent use 100 kWh per month.
- 37 per cent have more access to electricity than this, but everybody is finding electricity very expensive at the time of the survey (2013).
- Electricity is preferred because of its convenience factor, particularly for lighting
- 88 per cent of households surveyed have at least one child at school and electric lighting is preferable for studying.
- There is a high reliance on fuelwood, even where electricity is available. Fuelwood and paraffin are used for space heating and cooking because it is cheaper – both in terms of the appliances used, and because heating for space and cooking typically takes a household beyond the Free Basic Electricity grant of 50KWh per month currently available in South Africa. 87 per cent of households surveyed run out of their 50KWh allocation within three weeks and find it financially difficult to purchase more.
- Switching to alternate forms of energy and balancing the fuel mix in households will make more energy more affordable and improve socio-economic conditions.
- Community households are not fully aware of their energy options and enhanced awareness is needed to achieve a sustainable and affordable energy mix per household.
- There are job and enterprise opportunities linked to the energy options available to these communities. These include installation and maintenance opportunities to support various technologies such as low-cost biomass stoves and solar water heaters.

The relative lack of access to modern forms of energy seen in these communities is representative of many rural areas of South Africa, causing substandard levels of service provision and decreased efficiency. It also results in higher costs and low levels of socio-economic development for the inhabitants.

Cape, or will logistic costs prove as prohibitive as the costs experienced in supplying the export market? These are the critical questions that need to be answered soon to enable further investments in new developments like Howick in the South African biomass market.

Another issue worth examining further, although already explored to some extent, relates to the specifics of a biomass supply chain business model. The components to consider – in addition to sustainable supply and efficient processing – are efficient end use and technology distribution (Damm and Triebel 2008). Furthermore, it is important to know how efficient wood stoves can penetrate the market. Competition with the paraffin industry is an issue; this industry has successfully ensured that cheap paraffin stoves are available everywhere in their target markets. The cost is not in the stove but in the fuel, which in turn is subsidised. The issue, therefore, does not appear to be whether or not clean and safe wood stoves are available: fuel affordability is the challenge that needs to be overcome, and there are a number of contributing factors, such as the costs of distributing the fuel, the lack of subsidies in the current environment and the fact that no locally manufactured technology to enable end use (such as wood stoves) is currently available at any kind of scale.

5
Options for developing community-driven biomass energy

What we have learned from recent national biomass developments

The MTO biomass-powered electricity plant is an interesting example of what is possible in community-based forestry enterprises that aim to diversify their products and realise direct local benefits. More of this is possible in the short term; there are other sawmill operations in the forestry-rich areas of South Africa, such as KwaZulu Natal and Mpumulanga. Such projects are further enabled by the policy environment already in place (such as the Renewable Energy White Paper and the REIPPPP) and by the relevant skills base that exists in private sector organisations such as AES. What is still needed is the facility for these types of biomass plants to sell surplus energy produced directly to local industry and/or to the national grid, on favourable terms. The Howick operation was unable to secure a licence or PPA to do either, and so no investment in the energy plant was made. Securing either of these remains a challenge in South Africa and the government and Eskom have yet to implement a suite of enabling institutional frameworks that will make these investments viable.

On the other hand, the Howick plant – like others before it – produced a direct household fuel source from biomass that has yet to see widespread distribution into local markets. In addition to the relative labour intensity of these plants, the community-based opportunities lie primarily in opening up the distribution channels for both the fuel and the available stove technologies in the medium term. Today, the stoves must be sourced abroad; and since the Howick operation went into liquidation in 2013, efficient wood fuels such as wood pellets must be sourced outside of South Africa, probably making this an unviable option. Therefore, medium to longer-term opportunities that must still be thoroughly explored include establishing production facilities and distribution chains in widespread rural markets, and manufacturing wood stoves locally; this would be possible in nodal manufacturing or assembly plants (plants located in nodes that have raw material supply but that only produce to a certain point before transporting semi-finished products to a central final production facility). Again, a full feasibility study is necessary to better assess viability, but primarily to establish the most sustainable production, distribution and manufacturing models for these markets.

The Howick operation produced pellets from a varied source of raw local material. It may therefore be possible to establish smaller scale community-operated pellet plants that use locally available fuelwood more efficiently. Sustainability of small plants is however questionable; it is likely that the Howick plant would have survived had it achieved a consistent production of 72,000 tonnes or more earlier. Yet there are some good, established reasons for considering smaller community plants, despite such plants having less competitive economies of scale – ranging from the fact that biomass is traditionally accepted as a source of energy, to the need to boost the economic competitiveness of wood pellets against liquid fuels in an established market, as well as creating market scale, diversity and lower operating costs.

The case for community-based biomass options

Fuelwood is an established and traditional energy source and, as such, has associated cultural value for communities that make use of it (Damm and Triebel 2008). The efficiency with which biomass resources are used needs to be given more explicit attention. To reduce pressures on the resource, fuelwood consumers need more efficient wood burning options, such as pellets. Sustainable management of biomass resources also requires greater consideration so that consumers can have access to cheap, available wood without worrying about where their future supply is going to come from. Overuse of fuelwood, and the issues associated with deforestation, also have implications for ecosystems and water: issues that concern national and local governments.

South Africa's fuelwood resource is valuable and accessible, and according to the 2008 Damm and Triebel study (funded by the Programme for Basic Energy and Conservation (ProBEC) among others) represents an estimated value of between ZAR4.5 and 5.5 billion in terms of measureable direct use value or socio-economic benefit to rural households. Wooded ecosystems, or areas of biological diversity, are also where most of South Africa's rural poor populations are concentrated (Damm and Treibel 2008), providing relatively easy access to this valuable resource. However, indigenous resources need to be protected for environmental sustainability and security; fuelwood should instead come from managed woodlots and invasive tree species. In addition, state and privately owned forest and plantation operations discard a significant amount of wood, such as those in the vicinity of the Howick plant. These wasted resources need to be used responsibly in an energy-hungry country.

Using South African biomass can help mitigate climate change because growing trees for fuelwood (or other purposes) creates a carbon sink that could help South Africa offset its high carbon emissions from coal-based electricity generation. Furthermore, the sustainable use of biomass provides a renewable source of energy as an alternative to fossil fuels.

Community-based biomass could create jobs in rural areas characterised by high levels of unemployment, where a suitable forest or other resource exists. Harvesting, transporting fuelwood and producing a more efficient burning fuel from local raw material all offer job opportunities. There is also the possibility that nodal manufacturing of simple wood burning stoves could create jobs, as could their distribution.

Technology uptake does not present the primary challenge – biomass fuel technologies tested to date have provided safer and cheaper energy production than paraffin or electric alternatives, and people are used to burning wood fuels. It must be noted, however, that tests have been relatively few; there are still questions about efficiency and emission levels, for example. Development and manufacturing of simple, more efficient and safer stove technologies are on the increase, and South Africa has the technologies and skills needed to establish stove manufacturing plants. South Africa is also demonstrating the ability to innovate with existing technologies and adapt these to local conditions. These innovations have included improvements to fuelwood consumption by available technologies, thus increasing efficiency. The Howick plant manager adapted a Malaysian stove for the size of pellets being produced by the plant so that the stove could burn these more efficiently. Other improvements have included adding chimneys that are easy to install in low-cost housing or huts, reducing the health hazards associated with smoke emissions and inhalation in confined spaces.

Challenges for community-based biomass options

Reduced access to fuelwood supplies as urban areas continue to expand in many parts of the country. Also, in some areas, there are localised shortages of fuelwood (Damm and Triebel 2008) because of unsustainable harvesting and high population density with little access to alternate fuel sources.

High logistical costs where fuelwood is only available at a distance from the consumer base. As evident from the Howick example, transporting fuelwood over long distances is expensive and unprofitable.

Some local market conditions need to be better understood to consider the feasibility of establishing a local market at scale, supported by government policy. What exactly is the supply potential of wood pellets in South Africa? What is the best way to distribute them to markets in far-flung areas? What are the most suitable business models, for example in manufacturing and distributing cheap stoves? Is it possible to produce pellets and stoves in community nodal operations, viably and sustainably? How best can government support these developments and through what mechanisms and institutional arrangements? These are among the questions that need a full analysis, rather than mere speculation. The viability of biomass is not in question, but how best to establish favourable local market conditions. For example, an interviewee from SAB-Miller – the international brewing giant with South African origins – gave some insights on the question of distribution. SAB-Miller, originally South African Breweries, has needed robust distribution models to get their product to local and global markets to ensure business viability. Their strategy department says that South Africa is the only country they operate in that has such a prominent 'middle-man' – or intermediary – in the distribution value chain. While this system effectively gets their product to widespread rural and urban markets, it is expensive, and limits community opportunities in distributing and transporting beer.

6 Enabling innovative biomass solutions

Innovative biomass models and solutions need to be enabled – and to thrive – in order to unlock South African biomass development potential and community-based opportunities. Entrepreneurial activities such as Biotech's pellet plant have been developed from the 'bottom up', bringing new technology to the market, meeting local needs, and creating employment opportunities for communities. However, these entrepreneurial activities have little chance of success without the formation of a supporting or enabling system (Bergek *et al*. 2007).

Although there are sustainability concerns, and raw material production still needs to be better organised, fuel is readily available. This is a lower ranking challenges likely to be easily resolved if some of the bigger issues are put in place, such as an enabling policy and institutional environment. There are other examples of lower ranking challenges: technologies are improving for large-scale production of both efficient biomass products and biomass-based electricity, as well as stoves; and mass-market uptake is not seen as the main barrier to establishing local markets at scale. There is a sizeable population who already use biomass as a primary energy source and who can support a large-scale biomass market. Other drivers also exist that enhance viability – through safety, sustainability, energy efficiency and job creation. Market conditions on the whole are exciting and worth investing in. However, the enabling system is not firmly in place, including robust regulations and mechanisms as well as institutional arrangements, making it an unsupportive environment for investment.

Both the Tsitsikamma and Howick operations demonstrate this in different ways. In both examples, enabling market mechanisms and the institutional arrangements to support these are either inadequate or absent. It is true that other Howick-type investments have failed, such as the plants located in Richards Bay and Coega IDZ harbours; and other plants located close to raw material supply at Howick, George and Sabie in Mpumalanga. Some failed because the operators were not able to use the technology at an optimal, efficient production level. But the Howick operation has since proved that this can be done, achieving 85 per cent efficiency and even able to increase production yield. The Howick business also demonstrated the ability of a South African operation to reliably supply the European market while meeting stringent production standards. Although establishing a local market of scale has seen little advancement, it is evident from both the literature and the case study examples and locations analysed here that this is not specifically because technology is not available or because there is a lack of local uptake. Rather it is a problem of not having the necessary functions, or components, in place.

Three components need to be in place for any Technological Innovation System (TIS) to work: actors, networks and institutions (Bergek *et al*. 2007). These aspects are not necessarily technology-specific, but may be shared across the system that a particular technology functions in. This paper shows that while some of these aspects are in place for a biomass market in South Africa, the institutions are the weakest link.

Actors are defined as the organisations in the system that design and manufacture technology (Bergek *et al*. 2007). The South African biomass market either knows where to source the technology, such as Swedish pellet plant technology and Malaysian and Kenyan designed wood stoves; or can redesign and reproduce from South African based technology – the drying line in the Howick pellet plant was adapted from similar factory lines in South Africa, and Malaysian imported wood stoves have been modified to include chimneys, to suit South African conditions. Actors also include academic institutions and governments. In the South African context these exist alongside universities, such as the Universities of the Western Cape (Sustainable Energy Centre), Stellenbosch (energy solutions and technology innovation) and Cape Town (Energy Research Centre), all offering strong research capabilities and well established energy institutions. Government also provides policies and targets to create a market stimulus, and is active across the energy sector with a suite of renewable energy policies and procurement programmes. Further, job creation and skills development objectives such as the Industrial Policy and Action Plan and the Skills Development Act provide an enabling environment, as well as the more recent integration of energy and development objectives as outlined in the National Development Plan by the National Planning Commission.

Networks link suppliers with users, competitors and research institutions; they are critical for sharing knowledge and influencing perceptions and expectations of future feasibility (Bergek *et al*., 2007). The literature argues that for new technologies to gain ground, such specific coalitions are essential. There are robust examples demonstrating that networks are alive and effective in South Africa across the spectrum of society. Broader coalitions include the National Business Initiative, a private sector and public partnership platform primarily concerned with energy development, and the Climate Justice Network, a coalition of NGOs and civil society organisations that influence national climate policy, particularly the position South Africa takes to the multilateral negotiations and the African Common Position on climate change. Technology specific platforms include the South African Wind Energy Association (SAWEA) and the Solar Energy Society of South Africa (SESSA). Both promote technologies and argue for enabling environments in support of their industry's development in this country.

Institutions to do with legal and regulatory environments are probably the weakest link in the South African biomass sector. They need to do a much better job of putting policy into practice and the associated rules that regulate interactions between actors, formally or informally. Institutional change, and the rate at which it happens, is central to the success of establishing a functioning innovation system and to the adoption of new technologies (adapted from Bergek *et al*. 2007). It is evident from literature and recent developments in South Africa that entrepreneurs and policy makers should work together from an early stage of market development and build initiatives from the 'bottom up' to strengthen mechanisms that will stimulate desired market activity and foster success, at the same time as removing or at least mitigating the blockages that hinder that success. That this is missing in the South Africa biomass market is neither peculiar to this sector or the country. However, there are examples of industry/policy collaboration that has effectively built major industries, such as mining and the motor industry.

Indeed, the motor industry has a substantial established manufacturing capacity and is also geographically distributed to meet the job creation objectives of the government. This is the result of investor-government cooperation exemplified by the Motor Industry Development Plan (MIDP), which, established in 1995, still supports this industry today. Solar investment, often by entrepreneurs, is an example of a sector that has not enjoyed as much collaboration between competing industry players and with government, and which has consequently not been as successful in growing the industry. Solar concessions grew and were almost as quickly closed in the 1990s, and more recently, Eskom have been subsidising the installation of approved solar water heating systems. Both interventions stimulated technology uptake and market development for some time, but neither was implemented at any scale; and private sector collaboration has been minimal relative to other, more successful, initiatives.

Other mechanisms have also come and gone in the absence of supporting institutional arrangements that triangulate across participant actors. Renewable Energy Certificates (RECs) emerged as a means of enabling South Africa to achieve its annual 10,000GWh renewable energy target after a similar, internationally tradable mechanism was successfully used to supply green energy to two of the three World Summits on Sustainable Energy (WSSD) venues in 2002. Here, RECs were traded (TRECs), enabling a green energy supply. This functionality was made possible by the National Energy Regulator creating the institutionalised trading platform, thus successfully establishing institutional arrangements appropriate to enabling TRECs. However, although local energy suppliers both in the private and public sectors, notably Eskom and municipalities that distribute electricity, have clarified, tested and agreed roles in the implementation of this mechanism, it is some time now since RECs have been effectively traded in the South African energy market.

Of the three structural processes described here – the entry of organisations, formation of networks and institutional alignment, the third is where South Africa is currently lacking progress and has been for some time. For example, the Renewable Energy target was set in 2003 to achieve by 2014; at the time of writing in mid-2013, we are still far off the target. This is not due to a lack of entrepreneurial activity, supporting academic institutions, adequate technologies or even government policy – but rather because the enabling institutions are not in place and the industry hardly has a voice. Competing organisations seldom collaborate, fighting for scarce resources and markets, and the government interface and institutional change is not apace with entrepreneurial developments and market needs.

The specific causes of the blockage are easily attributable to some of the factors already discussed, such as low consumer awareness (definitely true of this potential market) and weak influencing ability of entrepreneurial and investor organisations (also true and possibly attributable to lack of in-industry cooperation and organisation). However, there is an overarching misalignment of long-term government vision with entrepreneurial initiatives. Effectively, this means that the numerous entrepreneurs prepared to take the risks and develop the market have never really enjoyed full government support, and South Africa's integrated energy and development plans do not identify this collective as a major player in realising the country's energy and development objectives. It is also fair to say that 'bottom-up' players – in this case primarily the entrepreneurs – have fallen short in helping government develop a feasible long-term vision of sustainable energy as integral to meeting overall energy demand.

References

Banks, D., and Schaffler, J. (2006), *The Potential Contribution of Renewable Energy in South Africa*, draft update report, prepared for Sustainable Energy & Climate Change Project / Earthlife Africa, Johannesburg.

Bergek, A., M. Eckert and Jacobsson S. (2008), *Functions in Innovation Systems: A framework for analyzing energy system dynamics and identifying goals for system-building activities by entrepreneurs and policy makers*, RIDE/IMIT Working Paper No. 84426-008, Institute for Management of Innovation and Technology, Göteborg.

Damm, O. and Triebel, R. (2008), *A Synthesis Report on Biomass Energy Consumption and Availability in South Africa*, ProBEC and LHA Management Consultants, Pretoria, South Africa.

DME (Department of Minerals and Energy) (2003), *White Paper on Renewable Energy*, DME, Government of South Africa, Pretoria. See http://unfccc.int/files/meetings/seminar/application/pdf/sem_sup1_south_africa.pdf.

DME and CaBEERE (Capacity Building Project in Energy Efficiency and Renewable Energy (2004), *Assessment of Commercially Exploitable Biomass Resources: Bagasse, Wood & Sawmill Waste and Pulp, in South Africa*, CaBEERE Report No. 2.3.4 – 29, Government of South Africa, Pretoria.

DME, Eskom and CSIR (Council for Scientific and Industrial Research) (2001), South African Renewable Energy Resource Database, CSIR. See www.csir.co.za/environmentek/sarerd/contact.html.Drax Power (2014), Drax Power website. See www.draxgroup.plc.uk.Haw, M. and Hughes, A. (2007), *Clean Energy and Development for South Africa: Background Data*, Energy Research Centre, University of Cape Town, Cape Town, South Africa.

Lynd, L.R., H. Von Blottnitz, B. Tait, J. De Boer, I. S. Pretorius, K. Rumbold, W. H. Van Zyl (2003), 'Plant Biomass Conversion to Fuels and Commodity Chemicals in South Africa: A Third Chapter?' *South African Journal of Science* 99: 499–507.

Macqueen and Korhalliler (2011), *Bundles of Energy: The Case for Renewable Biomass Energy*, Natural Resource Issues 24, IIED, London, UK. See pubs.iied.org/pdfs/13556IIED.pdf.

Marrison C.I. and Larson E.D. (1996), 'A preliminary analysis of the biomass energy production potential in Africa in 2025 considering projected land needs for food production', *Biomass and Bioenergy* 10, 337351, 337–351.

Pöyry Management Consulting (2012), 'Biomass imports to Europe and global availability', presented at IEA 2nd Workshop on Cofiring Biomass with Coal, 27–28 March 2012, Copenhagen.

ProBEC (Programme for Biomass Energy Conservation) (2010), *Efficient Household Biomass Energy Consumption in South Africa*, ProBEC, Pretoria, South Africa.

Trollip, H. and Marquard, A. (2014), 'Prospects for renewable energy in South Africa', Heinrich Boll Stiftung website, 3 February 2014, www.za.boell.org/web/climate-change-614.html (accessed 17 February 2014).

Winkler, H. (ed) (2006), *Energy Policies for Sustainable Development in South Africa*: *Options for the future*, see www.erc.uct.ac.za/publications/Energy%20policies%20for%20SD.pdf.

Knowledge Products

Research report

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Sustainable markets

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South Africa badly needs more energy. The government cannot keep up with demand for electricity and many rural communities lack adequate power. Heavy reliance on large-scale coal-fired power stations and a centralised grid is no solution – especially given that South Africa is ranked in the world's top 20 carbon emitters, and has a prominent role in multilateral climate negotiations. Biomass energy potentially offers a sustainable solution, and it is already the largest renewable energy source in the mix; but mostly in the form of gathered fuelwood for cooking and heating, which brings its own environmental and health concerns. Burning wood pellets in wood stoves is a more efficient and non-polluting use of biomass, yet this technology is virtually unavailable, and recent significant attempts to generate biomass electricity or to manufacture wood pellets as biomass fuel have failed.

How can a thriving biomass sector be developed in South Africa? This paper looks closely at two attempts to develop wood pellets as a biomass fuel and biomass electricity: the Howick wood pellet plant and the Tsitsikamma biomass plant. Both plants eventually failed, but provide instructive case studies about the barriers and opportunities for developing the biomass sector in South Africa. The closure of the two plants was mostly due to stand-offs in agreeing purchase agreements with the public energy provider, and the difficulties of establishing a local market – not insuperable technological difficulties. More coherent incentives for biomass innovation systems are needed within South Africa, both for more efficient wood pellet stoves and also for biomass electricity, if South African citizens – particularly its poor – are to have secure energy access.

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