THE BIOENERGY SECTOR
IN SOUTH AFRICA
Market Entry Study for Technology Providers
from the Netherlands

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Agenda

• Brief overview of South African energy landscape
• Bioenergy current state of affairs
• Policy framework & support programs
• Funding, investments and returns
• Bioenergy business opportunities
  – biomass combustion/co-firing,
  – biomass gasification,
  – biomass pyrolysis
  – biomass pre-treatment technologies, in particular torrefaction
  – biogas from anaerobic digestion
  – biofuels for transport (bioethanol & biodiesel)
• SWOT analysis
THE CONTEXT
South Africa’s Energy Sector

- Beginning of 2012: 26MW of renewables online (two wind and two waste-to-energy projects)
- Current energy mix dominated by coal: ~ 74% of primary energy consumption and >90% of electricity supply
- Very high GHG emissions
- Traditionally very cheap electricity -> extremely emission intensive economy
South Africa’s Energy Sector

- Grid access: 70-80%
- Reserve margin running very thin
- Load shedding expected this year

- Rapidly increasing electricity tariffs:
  about 25% per year from 2010 to 2012 & additional average 8%/a over the coming 5 years
  -> wholesale electricity from R65.51c/KWh in 2013/14 up to R89.13c/kWh in 2018
Eskom

- National utility – generates, transmits and distributes electricity
- Installed capacity: > 44 GW
- Provides 95% of electricity used in SA and ~ 45% of electricity used in Africa
- Production centralised in the coal belt of Mpumalanga - > great transmission and distribution losses (almost 22 000 GWh in 2012)

Sasol

- Coal-to-liquids, now also gas-to-liquids & chemicals producer

Department of Energy

- Main government department in charge of developing national energy legislation and programs
- Main implementer of the REIPPPP - carries out the whole procurement process
The Future

• SA needs to:
  – Add at least 29,000 MW of new power demand between now and 2030
  – A further 10,900 MW of old Eskom power stations will need to be retired in the same period
  – Diversify, decentralise and de-carbonise its power supply

• The plan
  – 19 GW of renewable energy capacity by 2030
  – Expand the nuclear program
  – “Explore” unconventional gas sources (shale gas in the Karoo)
  – Import (rather than export) electricity from SADC
Policy Switch to Renewables

- Recognised potential of RE resources in South Africa

- Target of 10,000 GWh RE by 2013 or 4% of electricity demand

**Integrated Resource Plan 2010** (IRP2010)
- South Africa’s 20 year Energy Roadmap
- RP2010 significantly increased the allocation to renewable energy in the overall energy mix plan for the 20 year period
- 42% (17.8 GW) of new generation in IRP 2010 is proposed to come from RE: 8.4 GW from solar PV, 1 GW CSP, 8.4 GW will come from wind
The REFIT

REFIT Programme (March 2009)
- Feed-in tariffs for wind, solar, hydro, landfill gas and CSP (inflation indexed for 20 year PPA)
- NERSA proposed tariffs were intended to cover the cost of generation plus a ‘reasonable profit’ to induce developers to invest”
- Feed-in tariffs were based on a 17% real Return-On-Equity (ROE) after tax for equity investors

REFIT Amendment (March 2011)
- “review REFITs every year for the first five-year period of implementation and every three years thereafter and the resulting tariffs to apply only to new projects”
- NERSA announced reduction in feed-in tariffs
- Capital expenditure proportion of tariffs no longer inflation-indexed

REFIT Scrapped (August 2011) and replaced by a competitive bidding process (REIPPPP)
The REIPPPP - Intro

- Originally intended to be implemented over five rounds (bidding or submission windows), between 2011 - 2013 (realisation: 3 submission windows by 2013)
- Bidders propose a tariff which will fall under a technology-dependent cap
- Preferred bidders enter a 20 PPA with Eskom & generation license with NERSA
- First determination: target capacity 3700 MW to be procured

<table>
<thead>
<tr>
<th>Technology</th>
<th>Target capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onshore wind</td>
<td>1,850 MW</td>
</tr>
<tr>
<td>PV</td>
<td>1,4501 MW</td>
</tr>
<tr>
<td>Solar thermal</td>
<td>200 MW</td>
</tr>
<tr>
<td>Small hydro (&gt; 10MW)</td>
<td>75 MW</td>
</tr>
<tr>
<td>Landfill gas</td>
<td>25 MW</td>
</tr>
<tr>
<td>Biomass</td>
<td>12.5 MW</td>
</tr>
<tr>
<td>Biogas</td>
<td>12.5 MW</td>
</tr>
<tr>
<td>Small projects (&lt; 5MW)</td>
<td>100 MW</td>
</tr>
</tbody>
</table>
The REIPPPP - Process

Part A: Qualification stage
- Compliance
  - Environmental consents
  - Land
  - Economic development
  - Finance
  - Technical
  - Price
  - Capacity

Part B: Evaluation stage
- Economic Development
  - Ownership
  - Management control
  - Preferential procurement
  - Job creation
  - Local content
  - Enterprise development
  - Socio-economic development

- Price

70% final score
30% final score
The REIPPPP – Contractual Arrangement

- **IPP**
  - Power Purchase Agreement
  - Implementation Agreement

- **Eskom**
- **Government**
  - General Framework Support Agreement
The REIPPPP – State of Affairs

- Two submission windows successfully concluded
- Request For Proposals (RFP) for third window issued, closing on 19th August
- Subsequent submission windows not formally confirmed, but expected again mid 2014
- Small Generators Program (projects size 1MW - 5MW) expected end of 2013
- Second determination issued in December 2012, for another 3200 MW by 2020

<table>
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<tr>
<td>Onshore wind</td>
<td>1,470 MW</td>
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<tr>
<td>Solar PV</td>
<td>1075 MW</td>
</tr>
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<td>Solar thermal</td>
<td>400 MW</td>
</tr>
<tr>
<td>Small hydro (&gt; 10MW)</td>
<td>60 MW</td>
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<tr>
<td>Biomass</td>
<td>47.5 MW</td>
</tr>
<tr>
<td>Biogas</td>
<td>47.5 MW</td>
</tr>
<tr>
<td>Small projects (any type RE&lt; 5MW)</td>
<td>100 MW</td>
</tr>
</tbody>
</table>
BIOENERGY IN SOUTH AFRICA
Bioenergy in SA to Date

- Biomass is still the predominant renewable energy resource used, mainly inefficient, traditional household use of biomass.

- “Industrial” scale use of biomass for energy marginal.

- Several recently emerged drivers can boost the sector:
  - REIPPPP (less than hoped)
  - more stringent waste management requirements,
  - increasing prices of imported fuel,
  - renewed interest in uplifting local agriculture
  - reducing companies reliance on Eskom for power provision
  - major players considering large-scale investment in bioenergy
Bioenergy in the REIPPPP

- Does not feature prominently in the REIPPPP; only 25 MW in first determination and 95 MW in second (solid biomass and biogas combined)
- No bids were yet submitted from biomass or biogas developers, but are expected in round 3
- Main reasons for lack of interest by developers:
  - The minimum 1 MW requirement disqualifies many potential projects at single feedstock source
  - Initially proposed tariff caps (ZAR 1 070/MWh for solid biomass and ZAR 800/MWh for biogas) insufficient to offset the initial high sunk costs; new cap for solid biomass is ZAR 1400/MWh (biogas remains at ZAR 800/MWh)
- Future of bioenergy in REIPPPP subject to conflicting info
Funding Bioenergy Projects in SA

- SA capital market well developed
- **Debt**: several major banks interested in funding renewables, but almost no track record in funding bioenergy projects because:
  - Projects tend to be quite small
  - Project developers do not have enough cash/cannot attract sufficient equity
  - Lack of experience
- **Equity**: at first, local equity and DFIs (Development Finance Institutions), now increasingly international private equity and infrastructure financing organisations
- Climate Finance and Carbon Finance
- Average expected returns (project IRR): 14- 17%
## Current Biomass Supply in SA

<table>
<thead>
<tr>
<th>Energy carrier</th>
<th>RSA production mio ton/a</th>
<th>LHV GJ/ton</th>
<th>Thermal power GW&lt;sub&gt;th&lt;/sub&gt;</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>281</td>
<td>28</td>
<td>175</td>
<td>70% internal consumption, 30% exported</td>
</tr>
<tr>
<td>Wood residue</td>
<td>1</td>
<td>12</td>
<td>0.4</td>
<td>From 23 million m&lt;sup&gt;3&lt;/sup&gt; wood produced on 1.2 million ha plantation forest</td>
</tr>
<tr>
<td>Maize residue</td>
<td>55</td>
<td>12</td>
<td>21</td>
<td>Average 2007-2011, from 12 million ton maize produced on 3 million ha agricultural land, assuming cobs contain 18% kernels and 82% residue</td>
</tr>
<tr>
<td>Cane residue</td>
<td>17</td>
<td>12</td>
<td>6.5</td>
<td>Average 2007-2011, from 2 million ton sugar produced on 0.4 million ha agricultural land</td>
</tr>
<tr>
<td>Manure and litter</td>
<td>1.3</td>
<td>15</td>
<td>0.6</td>
<td>Corresponding with 5,500 GWh/year, produced by cattle, pigs and poultry</td>
</tr>
</tbody>
</table>

+ additional interesting feedstock streams (<1 million ton/a): black liquor from the paper and pulp industry, slaughterhouse waste, alien vegetation and residues from other agricultural products that are produced on a smaller scale (soybean, wheat and grain sorghum)
SA is a water scarce country!
COMMERCIAL OPPORTUNITIES IN THE BIOENERGY SECTOR IN SOUTH AFRICA
Opportunities in Biomass Production/Supply

- Water management and irrigation (existing cooperation within the South-Africa – Netherlands Water network)
- Soil improvement – biochar in combination with or to replace compost; could be useful for semi-arid regions such as the Northern Cape province
- Exploitation of until now hardly exploited sources, such as:
  - Alien vegetation; efficient harvesting equipment needs to be developed
  - Dry leaves of hand-cut sugar cane; effective mechanical separation technology needed
- Breeding and genomics to develop drought tolerant plants
- Testing of standards and certification methods for sustainable production of export biomass
• Initially, the sector focused on small-scale (up to 20 m³) household/farm installations
• Beginning 2009: announcement of REFIT program -> the sector started gearing up for possible commercial size projects (>200 kW)
• End 2009: REFIT published, but biogas excluded from program
• 2011: REIPPPP targets 12.5 MW from biogas; not yet tendered for
• Commercial applications slowly starting to develop outside the REIPPPP, mainly in the form of 2-5 MW projects
• Large animal husbandry sector – substantial amount of feedstock available
• Regionally homogeneous horticulture: roll-out of regional plant optimisation
Biogas – Intro (cont)

• No dominant technology
• Commercial installations mainly use imported technology, assembled locally
• Engineering know-how exists locally, but is limited to a small number of companies
• The main end product of biogas in South Africa is electricity
• Economics: Eskom’s current whole-sale buy-back price (R0,5/kWh) insufficient; project profitability best achieved by selling electricity to on-site user or arrange a wheeling construction to a not-too-distant user
• Main pull for new biogas developments in SA: rapidly increasing electricity price & pending waste management regulation
• Beginning of 2013: about 12,5 MW of new capacity in the pipeline
Recent biogas dev. in SA

New plants installed per year

- Small installations
- Medium/large installation

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
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<tr>
<td></td>
<td>1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>50</td>
</tr>
</tbody>
</table>

Environmental & Process Systems Engineering
## Project development timelines

<table>
<thead>
<tr>
<th>Name of Licence/Permit</th>
<th>Responsible Bodies</th>
<th>Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIA</td>
<td>Lodged at the Designated provincial Department</td>
<td>1.5 years</td>
</tr>
<tr>
<td>Land Lease Agreement</td>
<td>Department of Agriculture</td>
<td>6 months</td>
</tr>
<tr>
<td>Municipal Consent of Use License</td>
<td>Responsible Municipality</td>
<td>2 years</td>
</tr>
<tr>
<td>Waste Management License</td>
<td>Department of Environmental Affairs</td>
<td>Up to 6 months</td>
</tr>
<tr>
<td>PPA</td>
<td>Offtaker</td>
<td>Varies</td>
</tr>
<tr>
<td>Generation License</td>
<td>NERSA</td>
<td>Unknown</td>
</tr>
<tr>
<td>Grid Connection and Transmission Agreements</td>
<td>Eskom</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>
Biogas - Opportunities

- Pre-treatment of different types of organic waste -> broaden the feedstock base of the sector
- Plant optimisation for different co-digestate combinations (most of the local experience is based on animal manure alone)
- Recovering nutrients from digestate (currently not sufficiently valorised)
- Realisation of complete farm level biogas installations; local market is far from saturated
- European vs SA installation parameters
Biofuel policy & dilemmas

- Initial momentum to build a biofuel industry mainly based on the need to find other value added for the country’s maize and sugar production surpluses.
- The food crisis of 2007/08 sparked the global food versus fuel debate & prompted the government to cut back on its initial biofuel ambitions.
- **Biofuels Industrial Strategy of the Republic of South Africa** (2007): 2% biofuels in national transport fuel consumption in the next 5 years (400 million litres per year to be based on local agricultural and manufacturing production)
- Clear demand on which kind of feedstock may be used for biofuel production:
  - Bioethanol: sugar cane and sugar beet
  - Biodiesel: sunflower, canola and soya beans
  - Maize and jathropa explicitly excluded as biofuel feedstocks based on food security concerns
Bioethanol – Intro

• Main feedstock in SA and the region: sugar cane
• Food vs fuel: National Biofuel Strategy explicitly excludes maize as a biofuel feedstock
• At the moment there no fuel ethanol plants in operation
• Two industrial scale plants announced:
  – Mabele Fuels in Bothaville, a commercially funded venture to be in operation in 2014, using grain sorghum, and technology providers from China (CHMC) and Australia (Vogelbusch).
  – Government sponsored project in Cradock, in the Eastern Cape; most of the funding is to be provided by the IDC and its aim is to organise the complete value chain under government supervision and support
Bioethanol - Opportunities

- Fermentation reactor technology
- Energy efficient separation technology ranging from heat integrated distillation at the front end and membrane technology for final fuel ethanol dewatering
- Development of enzymes for bioethanol production from lignocellulosic biomass, abundantly available in South(ern) Africa
Biodiesel - Intro

- Lack of a suitable blending regime restricts sector development to “voluntary” uptake of individual companies and their fleets
- Most biodiesel produced from waste cooking oil; already becoming an increasingly scarce commodity
- Biggest producer of biodiesel at the moment is BioGreen (capacity 5000 l/day & expanding)
- Mainly produced using standard trans-esterification process
- At present, price of biodiesel is 1 ZAR/l lower than the wholesale price of conventional diesel
- Amount of waste cooking oil produced in South Africa estimated at 28 mio litres (current use for biodiesel cca 3 mio l)
- New, industrial scale developments: Coega to announce two large plants to produce biodiesel from canola and soya; both for export and local consumption
Biodiesel - Opportunities

• Production of larger quantities from vegetable oil will require imported technology and know-how to cover the complete production chain
• Feedstock pre-treatment & blending
• Logistics of collecting and storing feedstock, and storing and distribution of larger quantities of biofuel
Torrefaction - Intro

- No torrefaction plants in operation in South Africa
- Two large end users potentially interested; Eskom for co-firing and Sasol for co-gasification
  - In 2012 Eskom expressed the ambition of a 60 000 tpa torrefaction plant for co-firing tests at the Arnot coal power station
  - Sasol recently did co-gasification tests with biomass on pilot scale
- Charcoal:
  - Mainly used in the consumer and the metallurgical sectors
  - Tsb Sugar’s charcoal production facility using cane tops and green leaves in cooperation with its small growers
Torrefaction - Opportunities

• Major opportunity: co-firing;
  – first torrefaction plant servicing Eskom’s need for biomass for co-firing could be in operation by 2015
  – replacing 10% of the coal would require ± 15 million ton torrefied biomass per annum or 150 torrefaction plants of 100,000 tpa each
• Eskom and Sasol did not yet announce a final decision on the preferred technology provider
• Characterization of biomass and process optimization in pilot plant facilities
• Production of charcoal briquettes an opportunity at the medium scale
Currently in use on an industrial scale:
- Combined heat and power (CHP) using bagasse in the sugar industry
- Combined heat and power (CHP) using black liquor in the paper & pulp industry

Efficient biomass cooking stoves for domestic use; promoted because they reduce the adverse health effects and environmental hazards of indoor pollution
Future trends
• Co-firing of biomass in coal fired power stations for the national grid
• Improve CHP efficiency by using high pressure biomass boilers
• Increase the number of sugar mills producing electricity

Cooperation opportunities
• Determine fuel properties of South African types of biomass for the Phyllis data base for biomass and waste
• Optimize the co-firing conditions for biomass-coal mixtures at Eskom’s power stations
• Innovate biomass high pressure boilers to increase efficiency and license this to hardware providers
• Monitor the South African Sugar association (SASA) activities for tenders for co-generation at 14 sugar mills
Gasification - Intro

- Sasol is well known for its synfuels produced by large scale coal gasification; biomass application is hardly used in the country.
- Eskom and the University of Fort Hare installed a micro-scale biomass gasifier (300 Nm³/h, 0.15 MW) used to power a bakery in the Eastern Cape.
- A new generation Fischer Tropsch technology developed by the former Centre of Materials and Process Synthesis (COMPS); interesting for the local conversion of biomass into transport fuels.
Gasification - Opportunities

- Gasification market still to be developed
- Opportunities for providers of plants in the range 10-20 MW to start developing a market using agricultural and forestry biomass
- Introduction of biomass gasification in South Africa will require
  i) support by pilot tests in facilities available with Dutch technology developers on specific South African feedstocks, and
  ii) detailed design and costing of the final plant in cooperation between developer, provider and client
Pyrolysis - Intro

• No production sites for bio-oil are currently in operation
• Research at Stellenbosch University in cooperation with Sasol and at the University of Pretoria in cooperation with Sappi
• Potentially interesting:
  – Pyrolysis of biomass fractions, e.g. lignin in the biorefinery or black liquor in the paper and pulp industry
  – The use of excess biochar that is not needed to heat the pyrolysis reactor as soil improver
Pyrolysis - Opportunities

- Opportunities for providers of pyrolysis plants in the range of 1-5 ton per hour to start developing a market for conversion of agricultural and forestry biomass into bio-oil and heat and power.

- Introduction of pyrolysis in South Africa will require:
  i) piloting and
  ii) detailed design and costing of the final plant in cooperation between developer, provider and client.

- Cooperation on the development of pyrolysis technology for biomass fractions such as lignin in the biorefinery or black liquor in the paper and pulp industry.
SUMMARY & CONCLUSIONS
SWOT – All Renewables

**INTERNAL**

**STRENGTHS**
- Good to excellent resource base
- Developed infrastructure
- Relatively stable policy environment (low institutional risk)
- Relatively business-friendly environment

**WEAKNESSES**
- Relatively cheaper and abundant availability of coal
- Economic and social system rely on centralised provision of energy services from conventional sources of energy
- General apathy and resistance to change

**OPPORTUNITIES**
- Effective government support scheme for several types of renewables
- Increasing interest from direct off-takers due to continuous price increases and insecurity of grid power supply
- Technical capacity building in terms of plant design, management, O&M, optimization and construction phase management
- Assistance in developing suitable sector standards and certification

**THREATS**
- Grid stress (limiting access to new generation capacity)
- Municipalities often lack capacity to connect projects to the grid
- Lack of local capacity to solve technical issues linked to adaptation of technology to local conditions
- Slow progress in developing/adapting necessary standards and lack of a local body to certify equipment, components and personnel to provide confidence to lenders and investors
- Lack of specialized, local skilled workers in the market, especially in remote areas
- Lack of O&M operators to satisfy lenders
## SWOT - Bioenergy

### Internal

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Significant waste biomass supply streams in some industries</td>
<td>• Financing vacuum for small projects &amp; insufficient low-cost funding</td>
</tr>
<tr>
<td>• Significant job potential, especially in primary sector (agriculture and forestry, important for SA government)</td>
<td>• Biomass vs coal price: biomass still too expensive to represent a viable alternative to coal at 2-3 times the cost</td>
</tr>
<tr>
<td>• Cost reduction of bio-waste disposal</td>
<td>• No formal, managed approach to optimal resource utilisation and allocation</td>
</tr>
</tbody>
</table>

### Positive

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Some large players considering significant investment into biomass (Eskom, Sasol, sugar industry)</td>
<td>• Government reservations on using food crops for energy purposes, resulting in</td>
</tr>
<tr>
<td>• Some dedicated funding is available</td>
<td>• insufficient government support</td>
</tr>
<tr>
<td>• Government is assessing the potential for bioenergy more seriously (recently commissioned a Bioenergy Atlas for SA)</td>
<td>• weak government bioenergy strategy</td>
</tr>
<tr>
<td>• Substantial demand for co-generation of electricity and hot water</td>
<td>• Sectoral in-fighting limiting further developments</td>
</tr>
<tr>
<td>• Importing biomass from neighbouring SADC countries that do not have water scarcity</td>
<td>• Inefficient use of some biomass streams</td>
</tr>
<tr>
<td>• Improved waste management requirements</td>
<td>• Water scarcity limits substantial increase in biomass production via agriculture and forestry in certain areas</td>
</tr>
</tbody>
</table>
Final Messages

- Bioenergy sector in SA is in its early stages of development
- Positive momentum for several bioenergy technologies, lead times are shortening
- No technological lock-in, leaving room for several technology options
- Opportunities for transfer of technical skills and local capacity building
- Long-term presence and strong relationships with local stakeholders needed -> SA should be seen as a long-term investment opportunity
- Main competition seen so far from Australia and China
THANK YOU FOR YOUR ATTENTION

QUESTIONS?

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## Summary of bioenergy opportunities: biogas

<table>
<thead>
<tr>
<th>Application</th>
<th>Feedstock</th>
<th>Potential partners</th>
<th>Opportunities</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biogas</td>
<td>Municipal sewage</td>
<td>Animal farms</td>
<td>• Pre-treatment of different types of waste</td>
<td>As local manufacturing is at lower cost, the Dutch technology should be superior to be competitive</td>
</tr>
<tr>
<td></td>
<td>Industrial sewage</td>
<td>SALGA</td>
<td>• Plant optimisation for different co-digestate combinations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Waste and process water</td>
<td>Paper &amp; pulp industry</td>
<td>• Recovering nutrients from digestate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manure</td>
<td>Food industry</td>
<td>• Realisation of complete farm level biogas installations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Plant waste</td>
<td>Dairy industry</td>
<td></td>
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<tr>
<td></td>
<td>Indigenous grasses</td>
<td>Abattoirs</td>
<td></td>
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<tr>
<td></td>
<td>Municipal solid waste</td>
<td>Agri SA</td>
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<tr>
<td></td>
<td></td>
<td>Local biogas developers</td>
<td></td>
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</tbody>
</table>
## Summary of bioenergy opportunities: biofuels

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<thead>
<tr>
<th>Application</th>
<th>Feedstock</th>
<th>Potential partners</th>
<th>Opportunities</th>
<th>Risks</th>
</tr>
</thead>
</table>
| Fuel ethanol | Grain sorghum (now and mid-term) Agricultural and forestry residues (future) | Mabele Fuels Sugar industry Coega Industrial Development zone | • Fermentation reactor technology  
• Energy efficient separation technology  
• Enzymes for bioethanol production from lignocellulosic biomass | No national blending policy for B-fuels (yet); Food versus fuel dilemma |
| Biodiesel | Waste cooking oil (now), soybean and other seed crops (future) | Agri SA Coega Industrial Development zone Farming coops | • Lack of local expertise in industrial scale production of biodiesel from vegetable oil: opportunity to set industry standard | No national blending standard for B-fuels (yet); Food versus fuel dilemma |
## Summary of bioenergy opportunities: emerging technologies

<table>
<thead>
<tr>
<th>Application</th>
<th>Feedstock</th>
<th>Major partners</th>
<th>Opportunities</th>
<th>Risks</th>
</tr>
</thead>
</table>
| Torrefaction | Agricultural and forestry residues | Eskom IPPs Sasol Sugar industry | • Pilot tests at 100 kg/h and plant design  
• 50-100 kt/a torrefaction plants  
• Pre-treatment for co-firing and for co-gasification  
• Charcoal production | International competition of technology providers  
Biomass availability on 100-200 kt/a scale |
| Gasification | Agricultural and forestry residues | Eskom IPPs Sugar industry Agri SA | • Pilot tests and plant design  
• 10-50 kt/a gasification equipment for off-grid electricity and process heat  
• Gas purification units | International competition (globally) |
| Pyrolysis | Agricultural and forestry residues | Eskom IPPs Crude oil refineries Paper industry | • Pilot tests at 50 kg/h and plant design  
• 10-50 kt/a pyrolysis plants for off-grid electricity and process heat production  
• Black liquor pyrolysis | International competition (from USA and Finland) |
## Summary of bioenergy opportunities: combustion

<table>
<thead>
<tr>
<th>Application</th>
<th>Feedstock</th>
<th>Potential partners</th>
<th>Opportunities</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustion</td>
<td>Agricultural and forestry residues</td>
<td>Paper and pulp industry</td>
<td>• Determine fuel properties of new types of biomass for the Phyllis data</td>
<td>Expertise on commercial biomass combustion technology is limited in NL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sugar industry</td>
<td>• Optimize the co-firing conditions for biomass coal mixtures</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Eskom</td>
<td>• Innovate biomass high pressure boilers to increase efficiency</td>
<td></td>
</tr>
</tbody>
</table>
## Technical Criteria for Biomass and Biogas Projects Under the REIPPPP

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Proven Technology</th>
<th>Energy Resource Certainty</th>
<th>Generation Forecast</th>
<th>Developer and Contracting Company Capability</th>
<th>Project Schedule</th>
<th>Grid Connection</th>
<th>Water Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biomass</strong> 1 MW – 10 MW</td>
<td>Key plant items must have been in use for at least 12 months each in 2 different commercial projects. Technical Availability of at least 75% for 12 months.</td>
<td>Provide a fuel supply agreement to confirm the availability of fuel to meet the facility’s demand for the first 2 years of operation</td>
<td>Bidder must state the average annual forecasted energy yield [MWh/year] on an annual basis for the first 20 years of operation</td>
<td>This must be proven through the provision of their experience</td>
<td>A project timeline must be provided, with commercial operation date by June 2014 (for First Bid Phase) and end 2016 (for any other Bid Phase)</td>
<td>Ability to comply with Grid Codes. Time and cost for grid connection must also be provided</td>
<td>Water consumption requirement must be provided</td>
</tr>
<tr>
<td><strong>Biogas</strong> 1 MW – 10 MW</td>
<td>The proposed anaerobic digestion concept must have been in use for at least 24 months in two different commercial projects. Technical Availability of at least 80% for 12 months.</td>
<td>Provide a fuel supply agreement to confirm the availability of fuel to meet the facility’s demand for the first 2 years of operation</td>
<td>Bidder must state the average annual forecasted energy yield [MWh/year] on an annual basis for the first 20 years of operation</td>
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