THE BIOENERGY SECTOR IN SOUTH AFRICA

Market Entry Study for Technology Providers from the Netherlands

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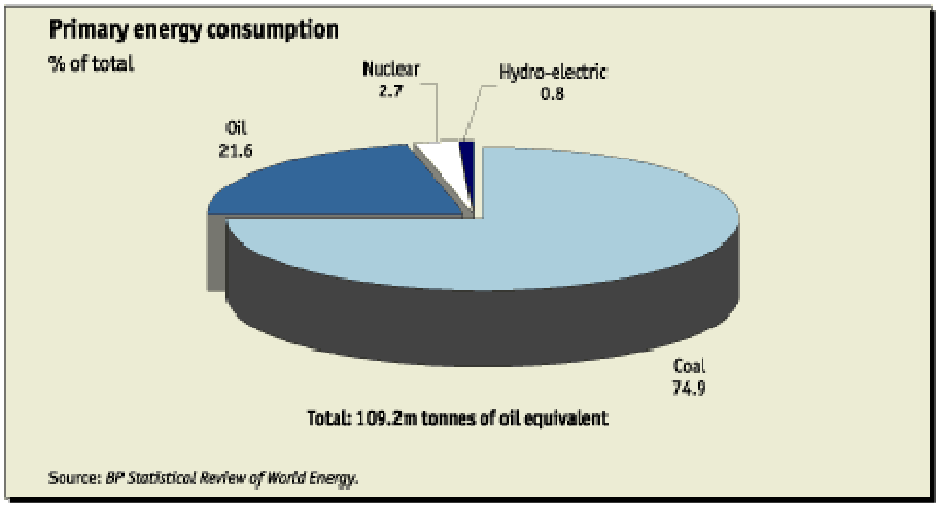
Agenda

- 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)

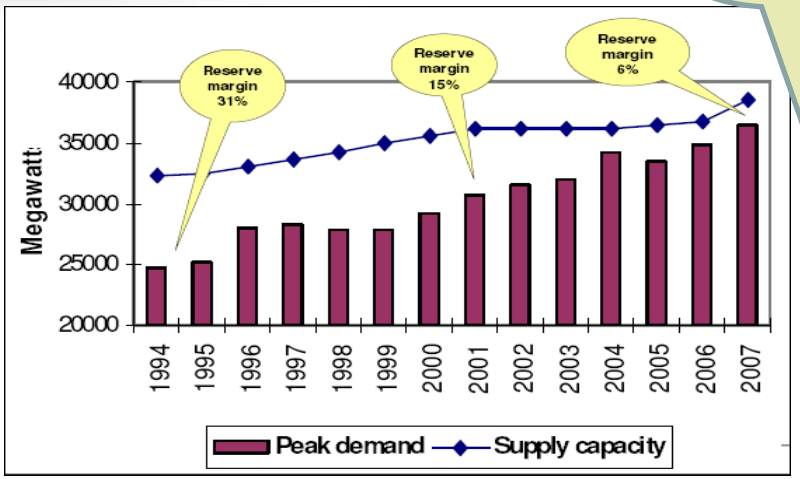


- Current energy mix dominated by coal: ~ 74% of primary energy consumption and >90% of electricity supply
- Very high GHG emissions

- 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

Main Players

- 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)

- 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 10,900MW 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

White Paper on Energy (1998)

- Recognised potential of RE resources in South Africa

White Paper on Renewable Energy (2003)

- 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

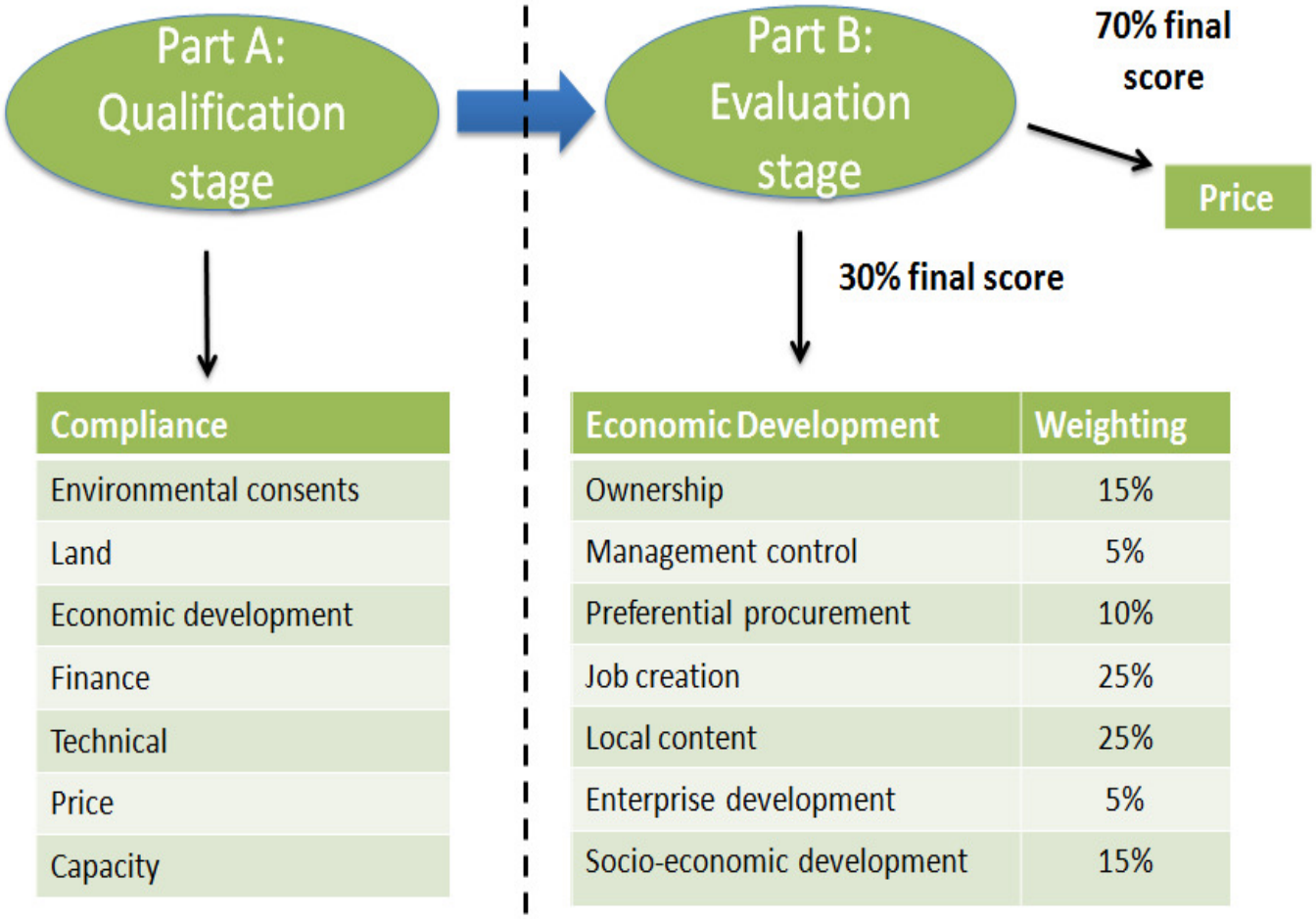
REFIT Scrapped (August 2011) and replaced by a competitive bidding process (REIPPPP)

The REIPPPP - Intro

- **Renewable Energy Independent Power Producer Procurement Program** (REIPPPP) introduced in 2011
- 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

Technology	Target capacity
Onshore wind	1,850 MW
PV	1,4501 MW
Solar thermal	200 MW
Small hydro (> 10MW)	75 MW
Landfill gas	25 MW
Biomass	12.5 MW
Biogas	12.5 MW
Small projects (< 5MW)	100 MW

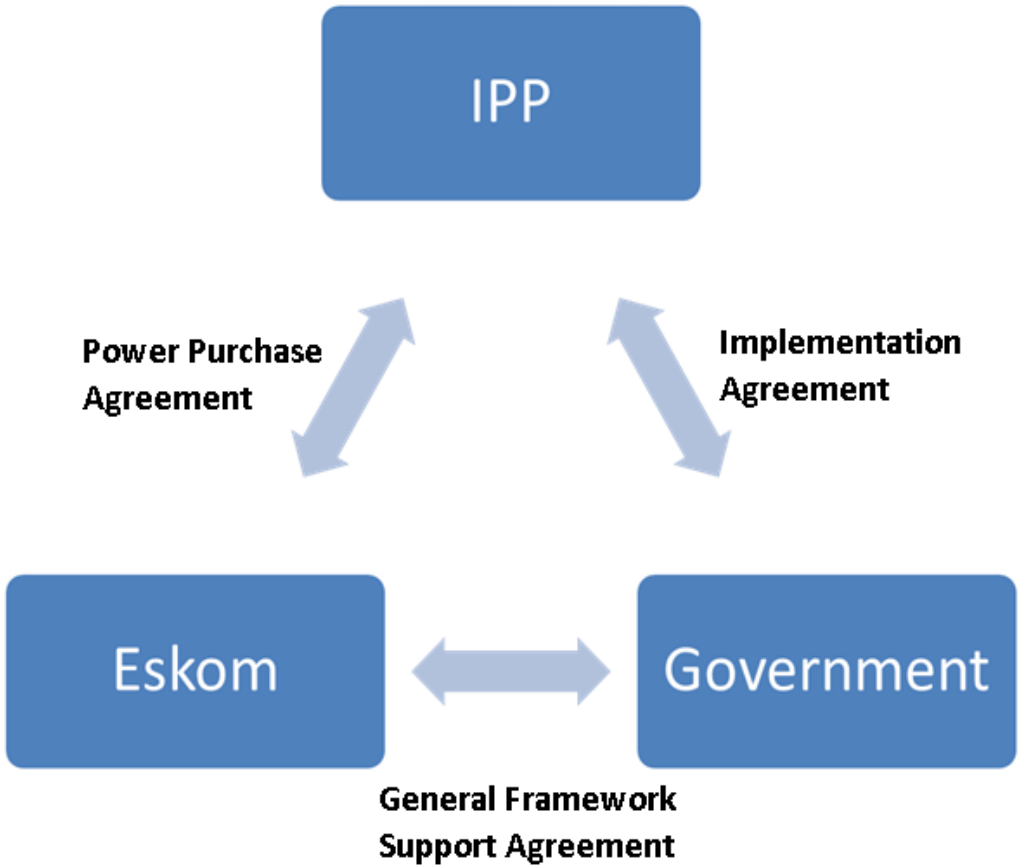
The REIPPPP - Process



Compliance
Environmental consents
Land
Economic development
Finance
Technical
Price
Capacity

Economic Development	Weighting
Ownership	15%
Management control	5%
Preferential procurement	10%
Job creation	25%
Local content	25%
Enterprise development	5%
Socio-economic development	15%

The REIPPPP – Contractual Arrangement



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

Technology	Target capacity
Onshore wind	1,470 MW
Solar PV	1075 MW
Solar thermal	400 MW
Small hydro (> 10MW)	60 MW
Biomass	47,5 MW
Biogas	47,5 MW
Small projects (any type RE< 5MW)	100 MW

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%

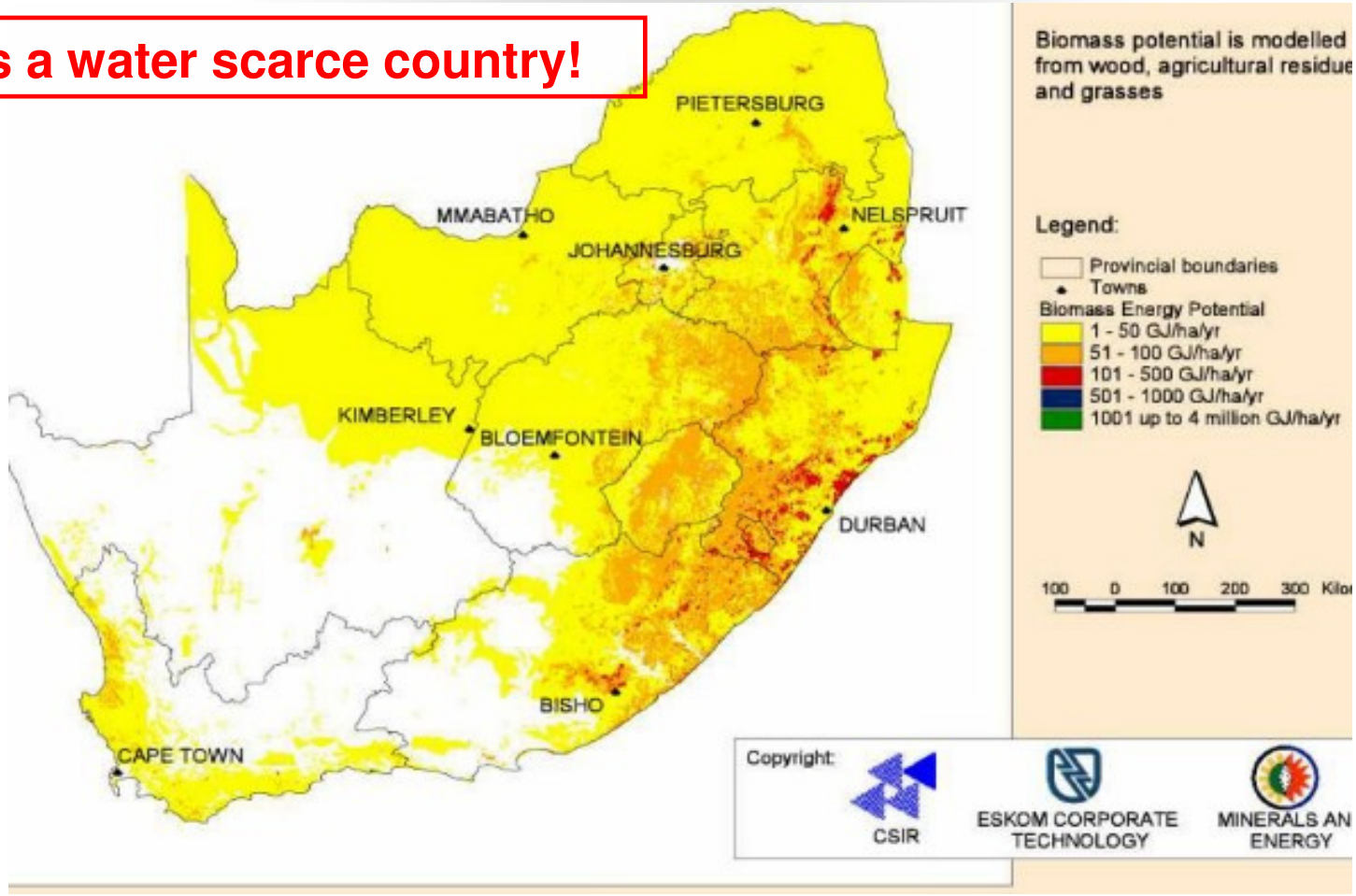
Current Biomass Supply in SA

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

+ 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)

Biomass Production Potential

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 Waternetwork)
- 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

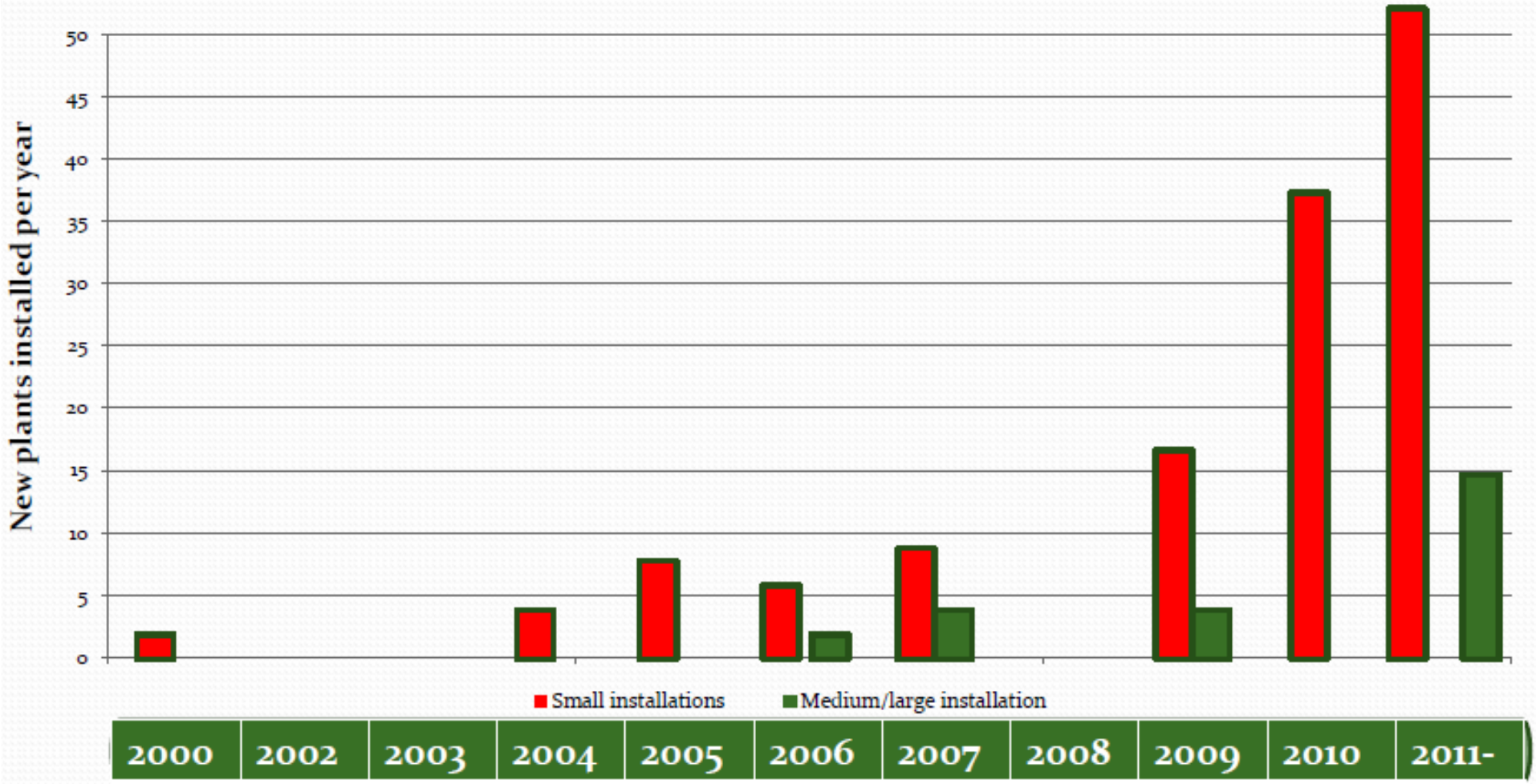
Biogas - Intro

- Initially, the sector focused on small-scale (up to 20 m^3) 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



Project development timelines

Name of Licence/Permit	Responsible Bodies	Timeframe
EIA	Lodged at the Designated provincial Department	1,5 years
Land Lease Agreement	Department of Agriculture	6 months
Municipal Consent of Use License	Responsible Municipality	2 years
Waste Management License	Department of Environmental Affairs	Up to 6 months
PPA	Offtaker	Varies
Generation License	NERSA	Unknown
Grid Connectionn and Transmission Agreements	Eskom	Unknown
…		

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 biodeisel 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

Combustion - Intro

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

Combustion - Opportunities

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 Nm^3/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

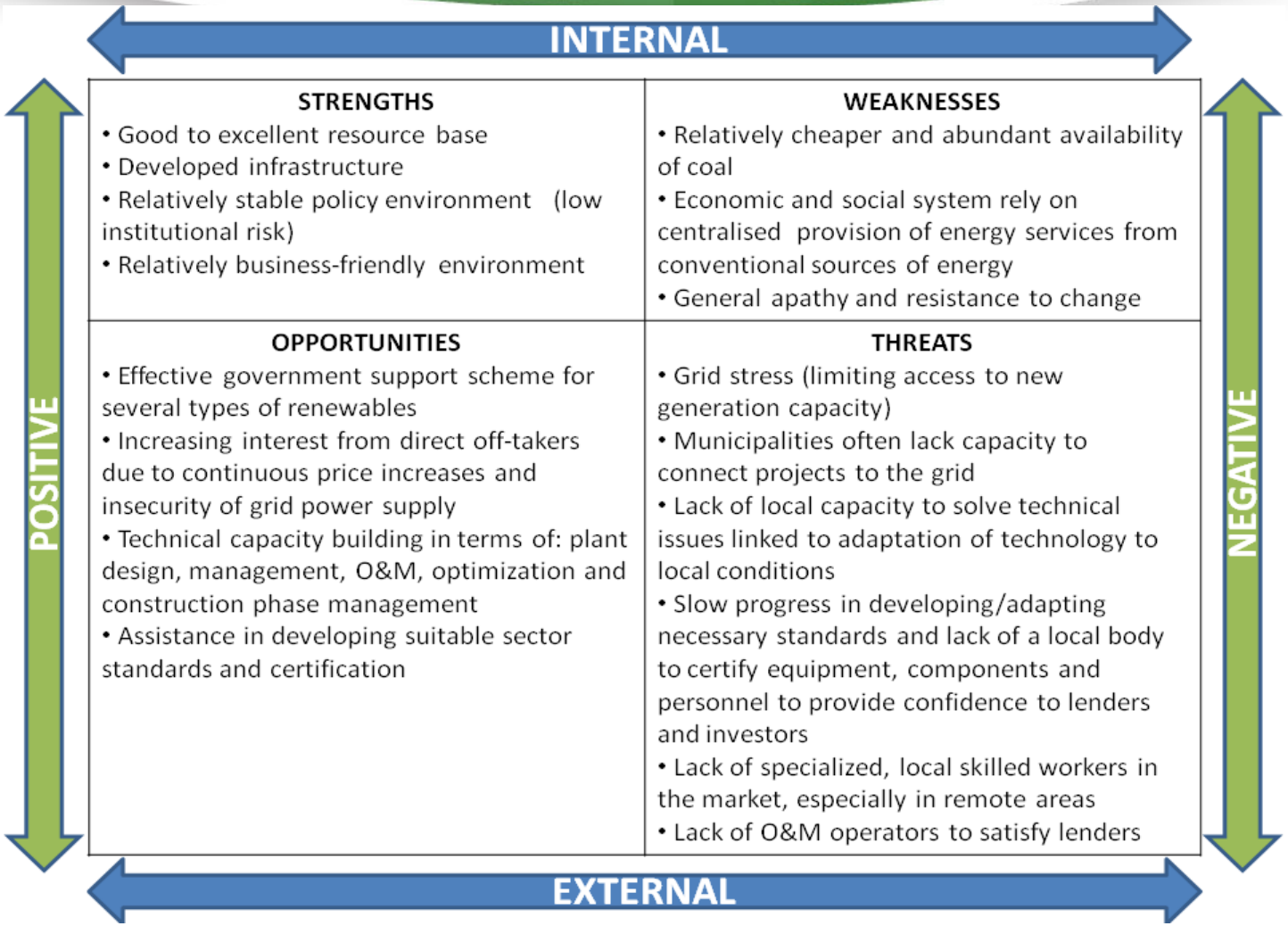
- Opportunities for providers of pyrolysis plants in the range of 1-5 ton per hour to start developing a market for conversion of agricultural and forestry biomass into bio-oil and heat and power
- Introduction of pyrolysis in South Africa will require

  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

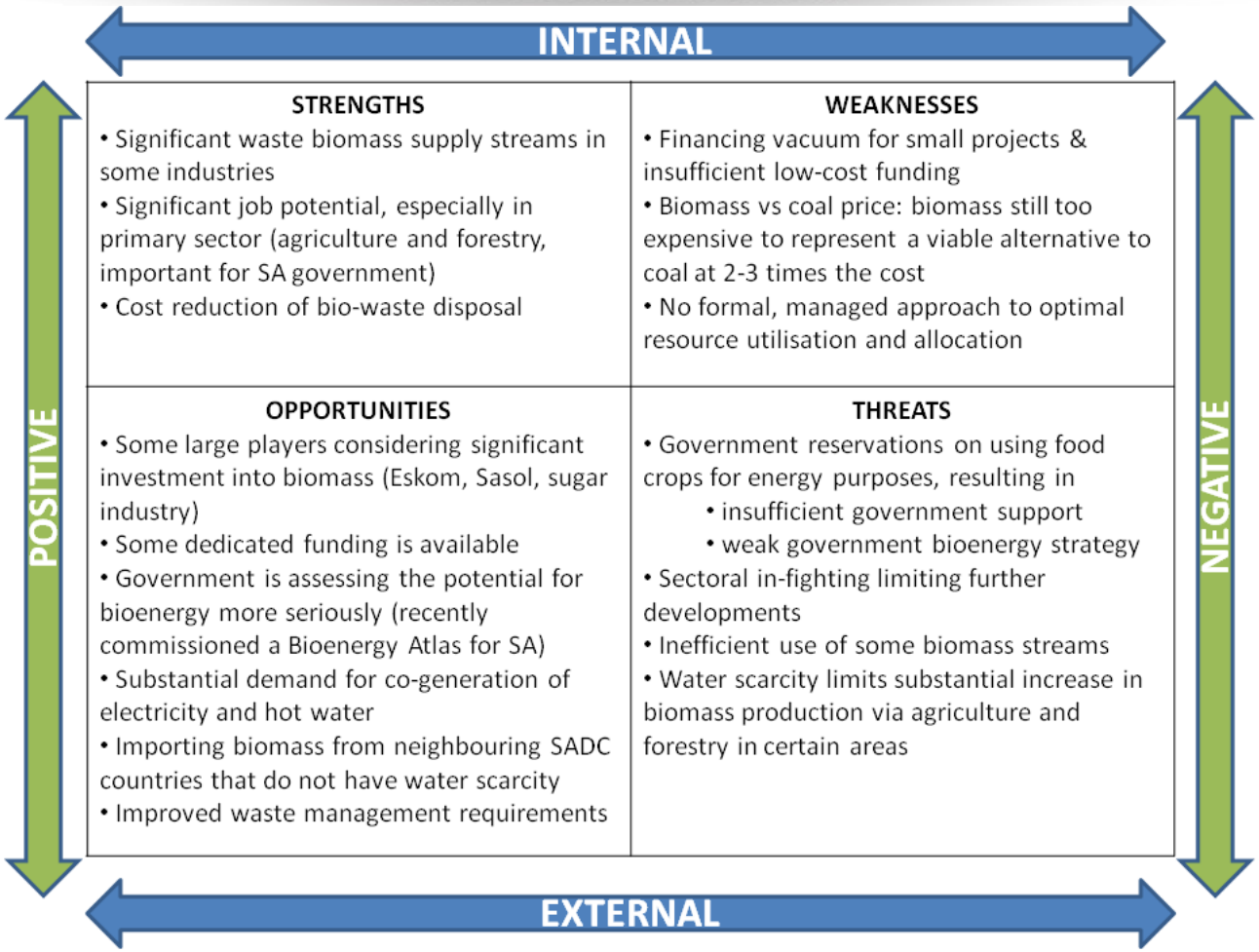
SUMMARY & CONCLUSIONS

SWOT – All Renewables



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

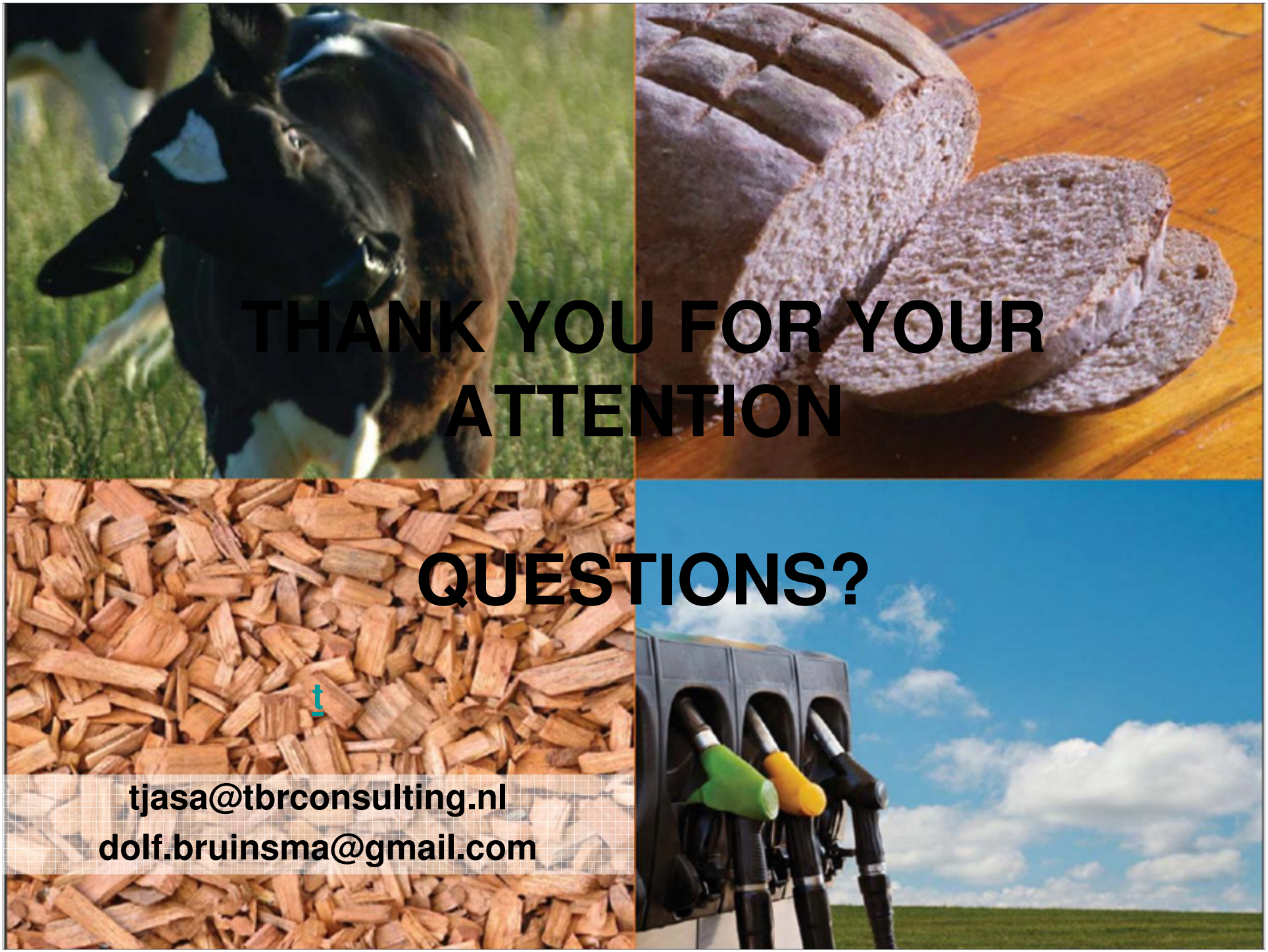


STRENGTHS	WEAKNESSES
• Significant waste biomass supply streams in some industries • Significant job potential, especially in primary sector (agriculture and forestry, important for SA government) • Cost reduction of bio-waste disposal	• Financing vacuum for small projects & insufficient low-cost funding • Biomass vs coal price: biomass still too expensive to represent a viable alternative to coal at 2-3 times the cost • No formal, managed approach to optimal resource utilisation and allocation
OPPORTUNITIES	**THREATS**

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

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



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Summary of bioenergy opportunities: biogas

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

Summary of bioenergy opportunities: biofuels

Application				
	Feedstock	Potential partners	Opportunities	Risks
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

Application				
	Feedstock	Major partners	Opportunities	Risks
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

Application				
	Feedstock	Potential partners	Opportunities	Risks
Combustion	Agricultural and forestry residues	Paper and pulp industry Sugar industry Eskom	• Determine fuel properties of new types of biomass for the Phyllis data • Optimize the co-firing conditions for biomass coal mixtures • Innovate biomass high pressure boilers to increase efficiency	Expertise on commercial biomass combustion technology is limited in NL

Technical Criteria for Biomass and Biogas Projects Under the REIPPPP

	Capacity	Proven Technology	Energy Resource Certainty	Generation Forecast	Developer and Contracting Company Capability	Project Schedule	Grid Connection	Water Consumption
Bio mass	1 MW – 10 MW	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.	Provide a fuel supply agreement to confirm the availability of fuel to meet the facility's demand for the first 2 years of operation	Bidder must state the average annual forecasted energy yield [MWh/year] on an annual basis for the first 20 years of operation	This must be proven through the provision of their experience	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)	Ability to comply with grid codes. Time and cost for grid connection must also be provided	Water consumption requirement must be provided
Bio gas	1 MW – 10 MW	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.	Provide a fuel supply agreement to confirm the availability of fuel to meet the facility's demand for the first 2 years of operation	Bidder must state the average annual forecasted energy yield [MWh/year] on an annual basis for the first 20 years of operation	This must be proven through the provision of their experience	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)	Ability to comply with Grid Codes. Time and Cost for Grid Connection must also be provided	Water consumption requirement must be provided