INDUSTRY-MEETS-SCIENCE SERIES

WASTE RDI ROADMAP

2014

BIOMASS- AND ORGANIC-WASTE

SEEKING ALTERNATIVE SOLUTIONS TO DISPOSAL

WORKSHOP PROCEEDINGS

science & technology
Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

INDUSTRY meets SCIENCE Waste Sector

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All documents are available online at *http://www.wasteroadmap.co.za*

Cover photographs courtesy of Dr Linda Godfrey (CSIR)

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1 Introduction

This report summarises the findings of a two-day Industry-meets-Science workshop, held in Durban on the 26-27 November 2014. The workshop, focussed on biomass- and organic-waste, was aimed at highlighting the key issues facing industry with respect to these waste streams, and to showcase current research, development and innovation (RDI) being undertaken by South African Universities and Science Councils.

1.1 Defining the waste stream

Organic waste was identified by stakeholders during the development of the national Waste Research, Development and Innovation (RDI) Roadmap as one of five priority waste streams for inclusion in the Roadmap (DST, 2014). Organic waste was noted by these stakeholders to include –

- Municipal and commercial organic waste (e.g. food waste, garden waste, retail)
- Animal waste (e.g. manure, abattoir waste)
- Sewage sludge
- Industrial and agricultural biomass (e.g. forestry, sugar, food processing, pulp & paper processing)

Neither the Waste Act nor Waste Amendment Act defines the term 'organic waste'. The national Waste Information Regulations (DEA, 2012) include '*organic waste*' as one of 17 categories of general waste, consisting of garden, food and wood waste. However, the national Waste Information Baseline study (DEA, 2012a), which adopted the categorisation system of the Waste Information Regulations, reported on only 'garden' and 'food' waste under the category of 'organic waste', while commercially exploitable biomass resources (including forest biomass, sawmill biomass, sugarcane biomass, abattoir waste) were reported on against the category of 'Other'.

The definition of waste was amended in the National Environmental Management: Waste Amendment Act (RSA, 2014) to mean "*any substance, material or object, that is unwanted, rejected, abandoned, discarded or disposed of, or that is intended or required to be discarded or disposed of, by the holder of that substance, material or object, whether or not such substance, material or object can be re-used, recycled or recovered and includes all wastes as defined in Schedule 3 to this Act*". The definition of waste is further extended in the Waste Amendment Act to also include the sector in which the waste is generated. According to Schedule 3 of the Amendment Act, sectors likely to generate organic waste include –

- Wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing, food preparation and processing
- Wastes from wood processing and the production of panels and furniture, pulp, paper and cardboard
- Food wastes
- Domestic wastes

The terms '*biomass waste*'[1], '*biomass-based waste*', '*biomass-derived waste*', '*waste agricultural biomass*', '*agricultural or forestry residue*' and '*industrial co-products*' are frequently used locally and internationally to refer to these '*organic waste*' streams.

> IEA Bioenergy (2013) defines '**biomass**' as "*the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste.*"
>
> UNEP (2009) defines '**biomass waste**' as including "*agricultural wastes, such as corn stalks, straw, sugarcane leavings, bagasse, nutshells, and manure from cattle, poultry, and hogs; forestry residues, such as wood chips, bark, sawdust, timber slash, and mill scrap; municipal waste, such as waste paper and yard clippings*."
>
> JIE (2008:12) defines '**biomass**' as encompassing "*a wide variety including not only agricultural crops, timber, marine plants, and other conventional agriculture, forestry, and fisheries resources, but also pulp sludge, black liquor, alcohol fermentation stillage, and other organic industrial waste, municipal waste such as kitchen garbage and paper waste, and sewage sludge.*"

There are reference documents that refer to 'biomass' as only plant-based material (Doelle, 2003; McKendry, 2002), while others include both plant and animal sources (directly or indirectly) (IEA, 2013; JIE, 2008). There are documents that suggest that biomass and organic waste can be used interchangeably, while others refer separately to biomass and to organic waste, suggesting that they are different things.

In the absence of a consistent definition for biomass and organic waste, and given the lack of clarity on whether they refer to the same thing, for the purposes of this report, the terms 'biomass- and organic-waste' referring to the non-hazardous, organic waste streams derived from agricultural, industrial and municipal processes has been used.

2 Workshop

2.1 Purpose of the workshop

South African waste policy promotes the waste hierarchy, which requires that waste be reduced, reused, recycled or recovered, before it can be considered for disposal to landfill. Given the constraints on available landfill airspace, the costs associated with disposing of high volumes of biomass- and organic-waste to land, and the energy-security issues facing South Africa, industry is exploring alternative technologies, including Waste-to-Energy (WtE). However, there are currently a number of constraints to this, including the geographically dispersed nature of these wastes, high costs, and off-take agreements into the national grid. Universities and Science Councils, on the other hand, are currently undertaking research on innovative alternatives to biomass- and organic-waste, including amongst others, biorefineries, bioplastics and low-temperature WtE.

[1] The Bio-economy Strategy refers to "biomass waste" (DST, 2013)

The Department of Science and Technology hosted an 'Industry-meets-Science' workshop from the 26-27 November 2014 at the University of KwaZulu-Natal, in Durban. The aim of the workshop was to bring industry and science together, to share ideas which will lead to –

- Identifying the key issues facing industry with respect to biomass- and organic-waste
- Jointly scoping new RDI projects
- Increased RDI collaboration between industry and research community, and
- Uptake of RDI outputs by local industries.

2.2 Workshop programme

Speakers were invited from Industry, Universities and Science Councils to present at the workshop. Day 1 focussed on current initiatives of industry and national government. The brief given to speakers from Industry was to provide –

- An overview of the specific biomass- or organic-waste stream(s) that the company, or sector (for Sector Associations), manages
- The nature and magnitude of the biomass- or organic-waste generated
- Current initiatives by the company or sector in finding alternative solutions for the biomass- or organic-waste generated
- Specific issues or problems which you feel are gaps in research (to guide future R&D)

Day 2 of the workshop focussed on current R&D initiatives of the research community. The brief given to speakers from Universities and Science Councils was to provide –

- The rationale for targeting the specific biomass- or organic-waste stream(s) being researched – i.e. nature and magnitude of the problem
- The rationale for researching your specific technology solution(s) – i.e. why this as opposed to other technologies
- Overview of your current R&D initiative(s) in addressing the targeted waste stream(s)
- Indication of the technology readiness of your current R&D initiative(s)

The workshop programme outlining the speakers and presentation topics is attached as Annexure A.

3 Opportunity waste streams

The following waste streams were identified by industry as providing opportunities for valorization (i.e. alternative value-add opportunities other than landfilling) –

- Timber and sawmill industry
    - Plantation residues from silvicultural practises and clear felling
        - Pruning's and thinning's
        - Clear Felling Residues
    - Sawmill residues and by-products
    - Established woody biomass resources within local communities
    - Possible establishment of renewable energy crops

- Sugarcane processing industry
    - Vinasse
    - Bagasse
- Food and fruit waste (field, packhouse)
- Abattoir waste

The following section provides some insight into current challenges facing various industries producing biomass- and organic-waste, current initiatives to increase utilisation of these waste streams, and identified R&D opportunities. The list is by no means comprehensive, but provides a summary from industry representatives present at the workshop. The full set of presentations is available online, together with this report (www.wasteroadmap.co.za).

3.1 Timber and sawmill industry

According to Industry, there are currently no (or limited) markets for plantation residues (pruning's and thinnings, and clear felling residues) (**Table 1**). Opportunities do exist, and are being further explored, for Sawmill residues and by-products (**Table 2**).

Table 1. Current activities and opportunities for plantation residues

Plantation residues from silvicultural practises and clear felling	
Pruning's and thinning's	**Clear Felling Residues**
• Branches, tree-tops, and rejected tree trunks • *Currently no market for these* • Currently these are left to rot on the plantation floor • This practice adds volume to the fuel loading in the plantation • Risk of HOT fires is increased • Fire-fighting and insurance costs are increased	• Branches, tree-tops, and rejected tree trunks • *Currently no market for these* • Currently these are burnt in the plantation • This practice increases the risk of uncontrolled fire in the plantation • Re-establishment costs are loaded with this expense

Table 2. Current activities and opportunities for sawmill residues and by-products

Sawmill residues and by-products (Bark, sawdust, wood chips, wood shavings)		
Bark	**Sawdust**	**Wood chips and shavings**
• Currently sold as nuggets or as compost	• Used for process steam generation	• Sold for chipboard • Sold for use as chicken litter and horse bedding
• Briquetting to be sold as furnace fuel to industry • Pelletizing for sale as fuel • Conversion to charcoal for domestic and industrial use • Conversion to liquid fuels • Power generation		

3.2 Sugarcane processing industry

The following opportunities in the sugarcane processing industry were identified –

Table 3. Current activities and opportunities for plantation residues

Sugarcane processing				
Cane Trash	**Liquid effluent**	**Ash**	**Vinasse**	**Bagasse**

• Burned in the field
• Potential source of fibre/energy
• Challenges associated with collection
	• Usually treated on-site using aerobic / anaerobic wastewater treatment	• May be applied to cane fields to increase pH of acid soils
		• Often disposed of in ash dams
			• Evaporative concentration,
			• anaerobic digestion,
			• membrane filtration,
			• incineration
			• CMS Concentrated molasses solubles
			  ○ Fertiliser
			  ○ Animal feed additive
				• Burned to raise steam to power factory
				• Furfural extraction and residue burned
				• Fibre board manufacture

The sugarcane processing industry identified the following challenges/potential opportunities –

- Vinasse valorisation, treatment and disposal, potassium recovery
- Ash beneficiation
- Bagasse valorisation – integrates with energy efficiency
- Trash energy/fibre valorisation

3.3 Food and fruit industry

The agriculture sector is considered a large and constant supplier of organic waste. In terms of end-use solutions, composting remains one of the best options due to high fertilizer costs but there are still gaps in knowledge (role for R&D). With the rising electricity prices and unsecure supply in South Africa, industry is exploring bio-energy production (**Table 4**).

Table 4. Potential opportunities for biomass from the food and fruit industry

Food and fruit industry
• Bio-energy investigation (anaerobic digestion, pyroloysis, gasification, combustion)   ○ Depending on technology solution varying success with regards to economic viability • Compost production

3.4 Meat industry

Typical waste streams include –

- Solid waste (rumen / stomach content; manure (lairages); condemned material / trimmings)
- Blood
- Effluence and wastewater (including bloody water)

Current initiatives to find end-use applications include –

- Biofuel and biogas (incineration, hydrolysis, plasma converters)
- Fertilizer (composting, vermi-composting)

- Animal feed

Gaps in research include:

- Risk of pathogens after treatment options e.g. composting / biogas / alkaline hydrolysis
- Utilization of animal by-products as organic compost
- Cost effective options for smaller plants
- Centralized communication / technology transfer on effective utilisation of organic waste

4 Issues facing industry

A number of technical, business, and legislative challenges were raised by industry regarding the implementation of alternative solutions to the disposal of biomass- and organic-waste (Annexure 2). The following section summarises specifically those challenges highlighted by industry relating to alternative technologies.

4.1 Technology challenges

Challenges with regards to technology implementation, as raised by industry during the workshop, were clustered into five high-level themes (Figure 1). While identified as challenges, these issues provide opportunities for directed R&D and innovation (See Section 5).

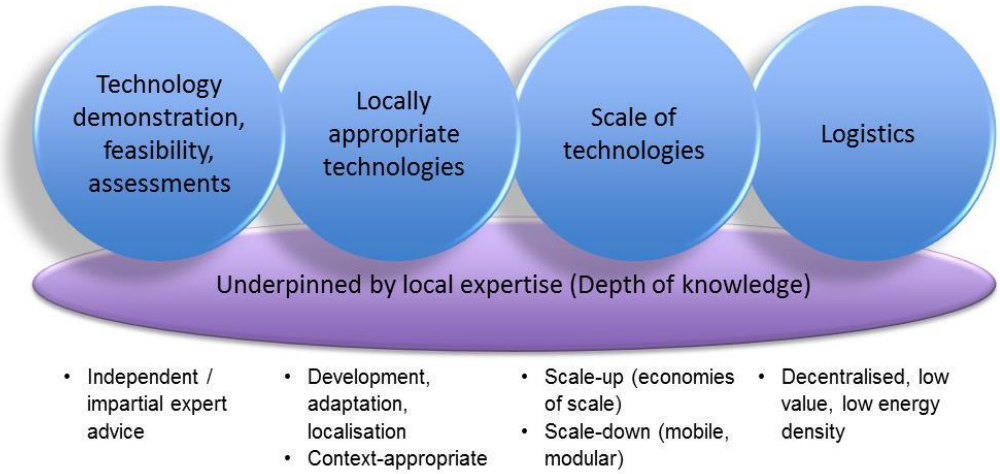

Figure 1. Needs of industry with respect to alternative technologies for biomass- and organic-waste

4.1.1 Technology demonstration, feasibility assessments

The lack of independent, impartial *expert advice* on new technologies was highlighted. This was also raised by industry in Section 5 as a role that they see Universities and Science Councils being able to play, supporting industry through independent technology evaluation.

The lack of *facilities* or mechanisms to demonstrate new technologies was noted. Raising *funding* for technology demonstration is a concern and industry noted that if technology providers are serious about their technologies they should co-invest in demonstration or feasibility assessments, which can require sizeable budgets.

4.1.2 Locally appropriate technologies

Industry noted that imported technologies are expensive, both to purchase and maintain, and are not always suitable to local conditions. While South Africa does not have the required R&D budget to invest on re-developing technologies that have been developed elsewhere, it is recognised that there is a place for local solutions. This also highlights the need for demonstration and localisation of technologies, as captured in Section 5.

4.1.3 Scale of technologies

There was much discussion in the breakaway session regarding the scale of alternative technologies. While biomass is generated in large volumes in South Africa, it is typically dispersed over large geographical areas making transport to large, centralised facilities expensive and often uneconomical. Industry could implement large, centralised facilities that provide economies of scale, or scale-down to mobile, modular units for on-site waste treatment, especially for smaller industries. This issue requires further research (See Section 5).

4.1.4 Waste logistics

The issue of waste logistics relates directly to the challenge faced by industry regarding the scale of technologies. As noted in Section 4.1.3, transporting biomass- and organic-waste over large distances to centralised facilities often makes these projects uneconomical – what industry refers to as the "*logistics of decentralised biomass feed*". This creates opportunities for the development of densification technology in support of centralised facilities, mobile, modular units for on-site waste treatment, and further research of waste logistics to improve efficiencies and reduce costs of transport.

4.1.5 Underpinned by local expertise

Industry expressed concerns over the lack of local expertise in both the operation of alternate technologies, as well as the science behind certain processes (e.g. microbiology in anaerobic digestion and composting). There is a need for both –

- A pipeline of technically skilled graduates (by international standards) (i.e. future employees in industry)
- Expertise in Universities and Science Councils who can advise and support industry (See Section 5).

4.2 Other challenges

Industry also raised the following issues which must be taken into consideration when addressing the challenges facing technology development or deployment. South Africa is not seen by industry to have a culture of innovation. Government is seen as being risk averse when it comes to innovation, both in terms of funding and in the policy environment.

5 Role of Universities and Science Councils

During the workshop break-away sessions, industry was invited to outline the role that they expect the Universities and Science Councils to play in addressing the biomass- and organic-waste issues facing South Africa. Figure 2 summarises the five priority areas where the research community is expected to provide support. The detail behind each high-level theme is provided in Annexure 2.

Figure 2. Industry expectations of the R&D community

5.1 Technology development

A smaller role in new technology development was expected, given that proven technologies are available from international sources. The focus on technology development was around –

- Scaling-down technologies to mobile, modular units for on-site waste treatment
- Developing low-technology solutions with high impact
- Improving technology efficiencies (e.g. costs, performance)
- Taking laboratory or demonstration scale technologies to full-scale, suitable for industry (with a focus on waste streams or conditions unique to South Africa)

5.2 Technology evaluation

Industry saw a strong role for Universities and Science Councils in evaluating local and inbound technologies. This included –

- technology assessment, demonstration and localisation
- technology adaptation and integration (local conditions and waste streams)
- advisory role to industry on new and emerging technologies

Industry emphasised the need for *discussion forums* between industry-government-academia to discuss problems and scope solutions.

5.3 Developing and maintaining capability

Universities and Science Councils were seen as playing an important role in developing and maintaining highly skilled, cutting edge local capability that could support industry, either through a specialist advisory role (e.g. on technologies), or by providing a pipeline of graduates for uptake by industry. This would require that –

- Staff remain current and highly trained (*service*)
- Training graduates to international standards (*pipeline*)

5.4 Needs-based research

In addition to technology development, adaptation and localisation, there is a need for Universities and Science Councils to also undertake R&D in the field of biomass- and organic-waste. Examples given by industry included R&D on waste logistics (large volumes but dispersed), data collection on tonnages and locations of biomass- and organic-waste (data incomplete and outdated).

However, it was felt that this research should be –

- Needs driven – based on, or aligned with, the issues and priorities facing industry
- Collaborative – Universities and Science Councils working together with industry to address real issues, as well as working with each other to reduce duplication in R&D activities

The DST presented on the Technology Localisation Programme (TLP) and the Industry Innovation Fund (IIF) Programme, in particular the Sector Innovation Fund (SIF). The SIF projects are being driven by Sector Industry Associations. Of the nine successful SIF projects for 2014 (**Table 5**), eight are directly aligned with activities that generate biomass- or organic-waste. Co-investing government and industry funding, through industry associations, provides a means of ensuring that research is needs driven, and addresses the priority issues facing industry and the sector.

Table 5. Current Sector Innovation Fund (SIF) initiatives (2014)

Industry Association	Proposed Initiative
Forestry South Africa	Future Plantation Forests for the South African Bio-economy
Sugar Milling Research Institute	Sugarcane Bio-refinery Research Programme
Paper Manufacturing Association of South Africa	Paper Manufacturing
Citrus Research International	Research for Citrus Export
Marine Finfish Farmers' Association of South Africa	South African Marine Aquaculture Research Centre
Fresh Produce Exporters' Forum	Post-harvest Innovation Programme
Marine Industry Association of South Africa	Marine Manufacturing innovation
Wine Industry Network of Expertise and Technology	Wine Industry Innovation
South African Minerals to Metals Research Institute	Mineral Processing

6 Role of Intermediaries

Intermediaries were seen to include consulting companies, and local and international technology providers typically involved in the selling of services or technologies to industry.

During a breakaway workshop session, participants were asked to discuss the role of intermediaries and their relationship with the R&D Community and with Industry (generators)?

- Industries rely heavily on intermediaries, but there is a level of mistrust
- Intermediaries provide an important means of introducing new technologies to industry
- Little to no relationship between R&D community and intermediaries
- Role for R&D community to advise industry on these technologies, and to work with intermediaries to validate, localise or scale-up technologies

It was interesting to note that "*Very few intermediaries that have approached industry or HEIs unsolicited have led to successful collaboration*".

7 Way forward

The Industry-meets-Science workshop on biomass- and organic-waste provided a further step towards strengthening the research, development and innovation relationship between industry and the R&D community. Activities will continue to be supported through the DST Bio-economy Strategy and the Waste RDI Roadmap.

In addition, the following medium-term outputs are expected from the workshop (within 6 months):

- Organic waste research plan (from industry issues and research questions), in support of the Waste RDI Roadmap Implementation Plan from 2015 (for Roadmap priority waste stream: Organic Waste – with a focus on the Roadmap Technology Cluster)
- Scientific publication (special edition journal, or a book) *(option)*

Opportunities provided through the Sector Innovation Fund (SIF) for the existing, as well as possible new, projects will be explored, to assist in directing R&D to real industry problems, and to leverage government and private sector funding for R&D in biomass- and organic-waste.

8 References

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ANNEXURE 1: INDUSTRY-MEETS-SCIENCE WORKSHOP

"Technology solutions for addressing biomass and organic waste"

Date: 26-27 November 2014

Venue: Unite Building, School of Engineering, University KwaZulu-Natal, Howard College, Durban

Day 1 (26 November 2014) will be focussed on input from generators (industry/business) of large volumes of biomass or organic waste. Outlining –

- The *size* of the problem
- Current *initiatives* by industry in addressing the waste stream, and
- Potential *opportunities* for maximising value recovery

Time	Name	Organisation	Focus area
9:00 – 9:30	**Arrivals (Tea / Coffee)**		
9:30 – 9:40	Dr Henry Roman	DST (Welcome)	Waste RDI Roadmap
9:40 – 9:50	Dr Linda Godfrey	CSIR (Background and outcomes)	Waste RDI Roadmap
INDUSTRY SESSION – "THE SIZE OF THE PROBLEM AND CURRENT INITIATIVES"			
9:50 – 10:05	Mr Mike Nash	PAMSA – Director Processing Research	Forestry/Fibre
10:10 – 10:25	Mr John Urban	CJ Rance	Timber/Sawmill
10:30 – 10:45	Mr Steve Davis	Sugar Milling Research Institute NPC	Sugar industry
10:50 – 11:05	*Questions and Discussion*		
11:10 – 11:40	**Tea / Coffee Break**		
11:40 – 11:55	Dr Bombiti Nzanza	ZZ2	Agricultural sector
12:00 – 12:15	Dr Gerhard Neethling	Red Meat Abattoir Association	Abattoir industry
12:20 – 12:35	Ms Sunita Kalan	DST	Industry Innovation
12:40 – 13:00	*Questions and Discussion*		
13:00 – 13:35	**Lunch Break**		
13:40 – 13:55	Mr Saliem Haider	Stellenbosch Municipality	Municipality
14:00 – 14:15	Mr Riaz Jogiat	uMgungundlovu Municipality	Municipality
14:20 – 14:30	*Questions and Discussion*		
14:30– 16:00	**Breakaway:** • Main challenges facing generators of biomass or organic waste (wrt alternate solutions) • Research priorities of industry (wrt biomass or organic waste) • Role of Universities and Science Councils in developing, adapting or implementing alternative solutions • Role of intermediaries (technology service providers / consulting engineering companies)		
16:00	End of Day 1		

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Day 2 (27 November 2014) is focussed on the R&D community and the technology solutions they are developing, adapting, or localising to address large volumes of biomass / organic waste. Outlining –

- The rationale for targeting specific biomass or organic waste *streams*, and specific *technology solutions*
- *Current R&D initiatives* in addressing targeted biomass or organic waste streams, and
- The *technology readiness* of current R&D

Time	Name	Organisation	Focus Area
8:00 – 8:30	**ARRIVALS (TEA / COFFEE)**		
8:30 – 8:40	Dr Linda Godfrey	Recap from Day 1 – Challenges facing industry	
8:40 – 8:55	Mr Thabang Bambo	DST	Bioeconomy Strategy
	SCIENCE SESSION – "CURRENT RDI TO FIND ALTERNATIVE SOLUTIONS" (TECHNOLOGY FOCUSSED)		
9:00 – 9:15	Prof Cristina Trois	University KwaZulu-Natal Dean of Engineering	Anaerobic digestion
9:20 – 9:35	Prof Bret Pletschke	Rhodes University Professor of Biochemistry	Bioconversion of agricultural residues and biobased waste streams
9:40 – 9:55	Dr Bruce Sithole	CSIR (NRE) Group Leader: Forest and Forest Products	Biorefinery, beneficiation of organic waste
10:00 – 10:10	*Questions and Discussion*		
10:10 – 10:30	**COFFEE / TEA BREAK**		
10:30 – 10:45	Prof Emile van Zyl	Stellenbosch University Senior Chair of Energy Research: Biofuels	Production of biofuels from cellulosic industrial waste streams
10:50 – 11:05	Dr Kate Haigh	Stellenbosch University Researcher: Process Engineering	Technologies for valourisation of organic waste and industrial biomass
11:10 – 11:25	Dr Linda Linganiso	CSIR (MSM) Senior Researcher: Materials Science & Manufacturing	Biodegradable biocomposites from agricultural and marine wastes
11:30 – 11:40	*Questions and Discussion*		
11:45 – 12:00	Prof Kugen Permaul	Durban University of Technology	Chitinous waste bioprocessing
12:05 – 12:20	Prof Mike Heydenrych	University of Pretoria Associate Professor: Chemical Engineering	Pyrolysis of biomass
12:25 – 12:40	Dr Rob Pott	University of Cape Town	Bioprocess Engineering
12:45 – 13:15	*Questions and Discussion*		
13:15 – 13:20	Henry Roman	Closure	
13:20 – 14:00	**LUNCH BREAK**		
14:00 – 15:30	**Tour of Research Facilities**		
15:30	End of Workshop		

ANNEXURE 2: WORKSHOP BREAKAWAY SESSIONS

1. Main challenges facing INDUSTRY (as generator of biomass or organic waste) (with respect to alternate solutions / technologies)	

Technical challenges	• Technology demonstration, feasibility, assessments
	  ○ Investment for demonstration of current technology
	  ○ Need for independent/impartial expert advice on technology solutions
	  ○ Too much focus on energy products – chemical products?
	  ○ Context specific, also explore similar countries
	  ○ Need for technology to be demonstrated locally
	  ○ Methods – what technology is most appropriate?
	  ○ Validation/testing of alternative methods – suitability of the technology
	  ○ Funding for pilot / demonstration plants NB (R20-R50m)
	  ○ Need technologies demonstrated on real feedstock / waste streams
	  ○ Not proven in terms of integration into industry specific system
	  ○ Move from low-tech to advance manufacturing process
	• Locally appropriate technologies (development, adaptation, localisation) (context appropriate)
	  ○ Imported technologies are expensive, and maintenance lengthy and expensive – local solutions limited
	  ○ Technologies suitable for local climate / environment
	  ○ Need for local manufacturing
	  ○ Imported technology can be overly complicated, e.g. too much automation in conflict with job creation
	  ○ Cost of imported technology
	  ○ Need integrated solutions – most research projects focus on only one technology or product
	  ○ Need locally appropriate solutions
	  ○ New product development, e.g. niche, high value (missing technical business expertise of new market)
	• Strengthening local expertise (depth of knowledge)
	  ○ Need for local experts/knowledge/skills
	  ○ Fundamental understanding of microbiology in anaerobic digestion and composting
	  ○ Expertise (O&M), capacity building
	  ○ Expertise in alternate technologies
	  ○ Skills/engineering capacity (e.g. high pressure boilers)
	• Scale of technologies
	  ○ Small scale projects being “uncommercial” not economically viable

	○ Economies of scale (2) ○ Scales of economy ○ Scale of technologies – especially for smaller industry ○ Scale down to mobile, modular units for on-site waste treatment ○ Scale up issues – risk associated with moving from lab to plant scale • Logistics ○ Logistics of decentralised biomass feed – development of densification technology ○ Logistics – collecting distributed waste, transport ○ Low energy density of some organic wastes ○ Servicing small industries that are widely spaced – cost of transport for centralised facilities ○ Logistics and costs are main challenges
Business / Economic Challenges	• High return on investment required by investors • Bankability of projects – to sell electricity, need a PPA and 20 year contract • Challenge to obtain capital investment funding – includes grant funding • Want quick solutions – not always best in long-term • Techno-economics (2) • Cost of capital • Competition for capital • Market risk of value added products • Opex unknown • Lack of long-term supply agreements • Risk appetite of business
Legislative Challenges	• Legislative barriers ○ Manage governmental regulations against company interest and viability ○ Can't deal with mixed fuels ○ Selling electricity back into the grid ○ Fragmentation between provinces and their methods / legislation ○ Existing legislation needs to be reviewed and to be aligned with the technology, e.g. feed grade sterilisation methods currently applied to animal waste composts ○ Flexibility in reaching the end point ○ Bioenergy – lack of long-term pricing and tariff agreements – preventing investment decisions • Bureaucracy ○ Bureaucratic systems, plethora of departments doing similar jobs ○ Years to get permits, impact assessments ○ Lack of cohesion

	○ Timeframes and lack of clarity – permits, authorisations, etc. ○ Strategy good – implementation slow and disorganised
Other Challenges	• Innovation culture ○ Do not have an innovative culture, bureaucratic systems, hurdles ○ Culture – risk aversion (government) ○ Fear of investing then not achieving results • Collaboration ○ Need better understanding between business, R&D, Universities ○ Consortium of similar businesses sharing technology solutions (sector associations) ○ Sector characterisation of raw materials – separation technologies ○ Need discussion forums between universities-government-science councils-industry to discuss problems and solutions • Research funding in a mature industry – limited for innovative research
2. Research priorities of INDUSTRY *(to be led by industry)*	
1. Opportunity biomass and organic waste streams for alternative solutions	• Specific ○ Abattoir / animal waste streams (2) ▪ Mixed stream – combination of blood, condemned material, carcass remnants, etc ○ Municipal solid waste ○ Pulp & Paper Mill sludge ○ Agricultural waste (3), e.g. residues ▪ Sugar to fuel ▪ Sugar industry - vinasse ○ Multiple value add ▪ Chemical ▪ Fertilisers/chemical/extraction/bio-composites ○ Co-digestion and inorganics ○ Bioplastics ○ Industry specific – areas of synergy exist, e.g. energy densification ○ Flyash – handling and disposal ○ Sludge from effluent treatment plants ○ (Not forestry waste – this will happen anyway if climate is right) • Environmental criteria ○ Waste streams which have the most deleterious effect on the environment ○ Cleaning environment, job opportunities, entrepreneurial opportunities • Economic criteria ○ High value organic waste for energy generation

2. Alternative Technology Opportunities
 	
a. Process improvements
b. Technology development
c. Technology adaptation
d. Technology localisation
	Where are the opportunities for R&D intervention?
	• Technology development (*scale-up, context-appropriate, reduced cost*)
	  ○ Upscaling technologies for the "real world"
	  ○ Scale of a process – scale down to mobile, modular units for on-site waste treatment
	  ○ Focus on technology solutions at different levels of complexity, e.g. composting (low tech), pyrolysis, gasification (high tech)
	  ○ Low tech products + low-key solutions
	  ○ Low tech high impact
	  ○ Separation technologies
	  ○ Reducing cost of technology, e.g. enzymes, separation technology (membranes)
	• Technology adaptation
	  ○ Adapting existing technologies to local conditions
	  ○ Adapt to local situation
	  ○ Technology adaptation for recalcitrant waste streams, e.g. pulp & paper, biogas and compost
	  ○ Integration of known technologies with various feedstocks
	  ○ "Funnel and bridge" especially research institutes / technology adaptation / adapt to local situations
	• Technology localisation
	  ○ Understanding the effects of new technology on local conditions, jobs, etc.
	• Evidencing
	  ○ Resource mapping of industry – waste/feedstock/products
	  ○ Analysis of feedstock availability and composition, processes and products
	  ○ Validation of content and safety of the products of processing a waste stream by composting, biogas digest tank and alkaline hydrolysis, e.g. abattoir waste
	  ○ Market analysis – market size and opportunities
	• Specific technical
	  ○ Gasification of municipal organic waste – difficult, but seems like a good option for diverse waste streams
	  ○ Composting abattoir waste – need to investigate persistence of pathogens
	  ○ Long-term maintenance of anaerobic digestors
	  ○ Energy balances over suggested processes, e.g. how much diesel does it take to collected distributed waste for energy generation? Is there a positive net return?
	  ○ Sugar industry – technology for green can harvesting, trashing, energy recovery
	  ○ Vinasse from bioethanol – capturing potassium out of vinasse

3. Role of Universities and Science Councils in developing, adapting or implementing alternative technologies?	

Role of research community	• Technology development
	  ○ Developing new technologies
	  ○ Developing flexible technology solutions, e.g. for seasonal feedstock

(Universities & Science Councils)	○ Identify opportunities outside of core business ○ Identify "value-add" opportunities • Technology evaluation and advisory role ○ Advice on which technologies to pursue ○ Process validation – independent opinion on whether technology works ○ Expose conflicts of interest within legislation/policy ○ Analysis of processes and products ○ Fill holes in knowledge about immature technologies – need advice from industry to identify which gaps to fill ○ Spin-off consulting companies from universities to advise industry ○ Technology assessment – by the researchers – to provide best/most appropriate methods and or technology options to industry ○ Context-appropriate technology solutions to assist with industry problems • Developing and maintaining highly skilled, local capability ○ Keeping abreast of technologies that are being modernised – maintaining the knowledge base ○ Keep current with technologies available, alternative solutions, feasible options ○ Training graduates to global standards – human resource development ○ Ensure staff remain current and highly trained – continuity of skilled staff ○ Human resource development for industrial processes – upskilling ○ Sustained effort in specific areas by researchers (depth, expertise) ○ Knowledge transfer – training, capacity building • Industry-driven research ○ Industry needs to guide academic research, ensures alignment ○ Industry to make problem statements available to researchers ○ Applied research that responds to needs of industry ○ Applied research – should be realistic, applied, deal with the real challenges of practical environment ○ University needs to understand industry context, while industry needs to understand that universities need time to develop solutions – requires long-term partnerships ○ Research must be contextualised to deliver relevant outputs for SA ○ Coordinate research into areas of common needs, e.g. energy densification, core technology ○ Work via industry body (e.g. SMRI for sugar industry) – filter out less effective stuff ○ Work in key / strategic areas as identified by industry ○ Present data, experimental work that is applicable to the industry – risks associated clearly identified • Collaborative R&D for impact (*impact, relevance, reduce duplication*) ○ Work with universities as a team – actively fund teams to work to a common purpose ○ Work together with consultants/international groups to provide local information / expertise ○ Knowledge transfer partnerships – people employed partly by company and partly by university to facilitate transfer of knowledge

	○ Need international collaboration ○ Multi-disciplinary research teams ○ Big R&D infrastructure at Science Councils (improved funding model) (Industry - Industry+University - Science Council)
4. Role of intermediaries (e.g. local and international technology service providers / consulting engineering companies)	
Role of intermediaries And their relationship with the Research Community and with Industry (generators)?	• Industry works directly with intermediaries • Guides and vets solutions / handling / solving of problems – preliminary work • Demonstration of efficacy of solutions – team work (university) • Intermediary tend to play industry off against academics • Industry googles intermediaries or finds them at trade shows and starts talking to them • Takes a lot of time and research to sift good from bad • Industry rely on intermediaries heavily, but have to be careful who to trust • Would be useful to have opinions from academia, but can't always afford • R&D community sometimes work alongside/provide services or validation for intermediaries, usually because they approach a university group for assistance or enhance their credibility • Don't work with them often – would like R&D community to work with them • For R&D purely a service provider – very limited • Intermediaries bring attention to potential solutions / technologies • Can facilitate communication and contact between industry and research • Need references – track record – scientific basis of technology • Technology providers must show commitment to fund trials if they believe in technology • Need to ensure that intermediaries are aware of industry and problem context – often not and this can dismiss them quickly • Very few intermediaries that have approached industry or HEIs unsolicited have led to successful collaboration • They are generally very secretive, unwilling to share information – motive is to sell to make money – not really to promote technology • Known technologies – close working relationship. New technologies or products – via industry research body. Would like to share some risk, e.g. off-take agreements and performance • Case specific – if no in-house skills then use intermediaries more • Future role – possibly have intermediaries as partners in new product ventures