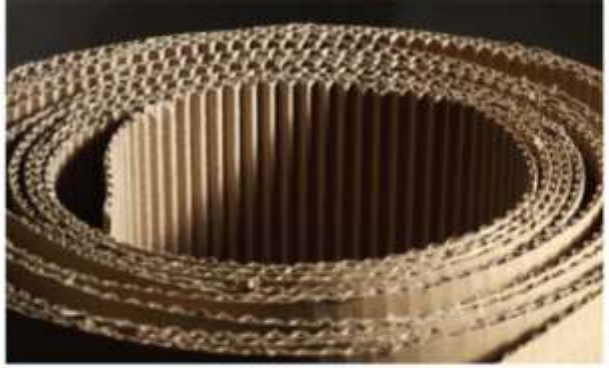

Mike Nash

Waste beneficiation in Pulp and Paper industry

PAMSA
Process Research Unit

DST Science-meets-Industry Workshop
Technology solutions for addressing organic waste
| 26-27 November 2014

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Waste beneficiation

- Low value organic residues generated during typical pulp and paper manufacturing processes.
  - plantations
  - pulping process
  - conversion process

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Plantations

- 600 million trees across one million hectares are grown for use in pulp and paper manufacture.
- 10% harvested annually and replanted within same year.
  - Industry plants in excess of 260,000 trees every single day.

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Plantations

- Thinned, pruned and harvested trees are debranched = vast amount of biomass which traditionally remained in situ.
  - Approx. 25 and 30% biomass remains in plantation (26 to 46 BD tons/Ha (depending on species).
- Further losses at mills during chipping and screening.

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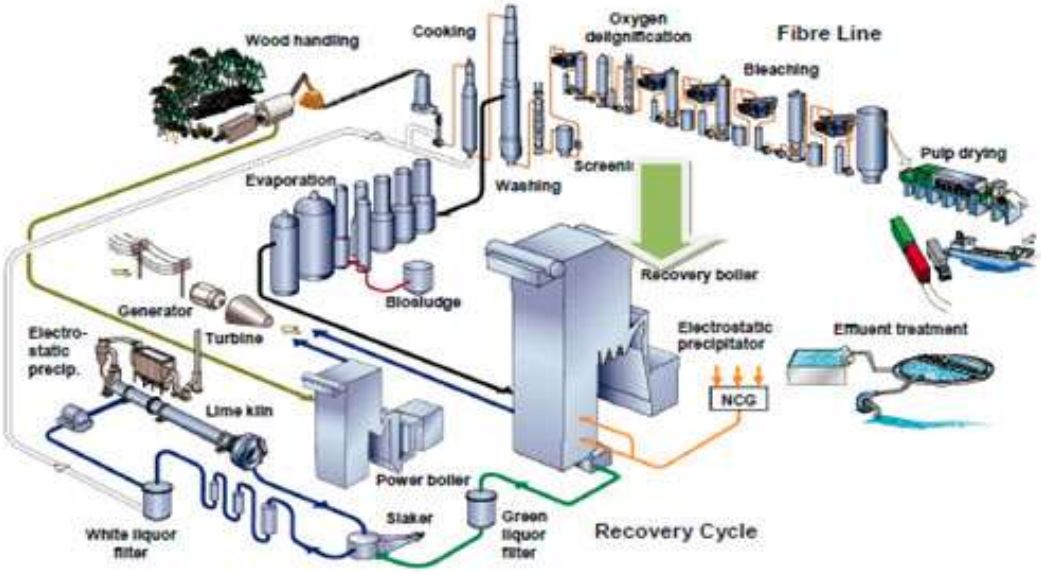
Pulping



- Cellulose separated from wood matrix by dissolving organic matter (lignins), with either alkali or acid reagents.
- Lignin-rich aqueous stream is recovered, concentrated and fired in recovery furnace to recover inorganic salts for recycling while energy generated is used for steam/power generation.
- Potentially valuable organic compounds lost to furnace.

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Converting

- Cellulose fibre washed, refined and finally diluted with water to enable sheet formation on moving wire screen for conversion to paper.
- Aqueous carrier stream cleaned of contaminating fibre fragments and recycled back to paper machine
- Thickened fibre recovered from machine carrier water is currently landfilled.

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Solutions

Two main topics to be discussed will be the challenges posed by:

- Plantation waste (low value bio-mass) poses a fire threat and carbon source
- Paper sludge waste to waste dumps
- Pulp and paper sector is well schooled in recycling bulk of process streams to recover energy and chemicals as part of basic design.
- SA industry is well aware of move to bio-refinery concepts
  - Extracting most value from raw material input
  - Explore use of low value residue from operations rather than use its primary feedstock to generate new product streams

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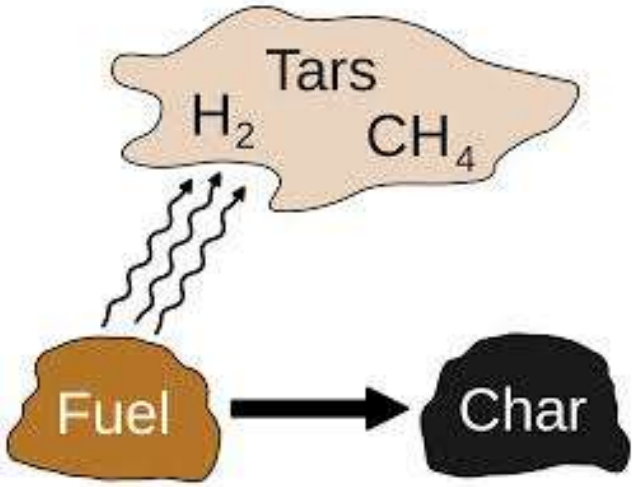
Pyrolysis – definition

“the thermal decomposition of organic substances at high temperatures in the absence of oxygen”

- Old and understood thermal process
- Converts organic biomass into 3 separate products
  - Solid char – “bio-char” – soil improvement additive
  - Condensable oils and tars – “bio-fuels”
  - Non condensable gases – “bio synthesis gas”
- Number of pyrolysis techniques exist
  - Fast pyrolysis – hi heat flux/temp lo residence time – high oil proportion
  - Slow pyrolysis – lo heat flux/temp – longer time – similar proportions of products
  - Vacuum pyrolysis – vacuum conditions, lower temps, longer residence times



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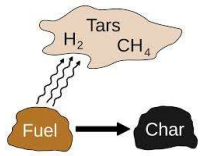
Pyrolysis – research objective



"to develop a modular and portable system using pyrolysis techniques to process plantation biomass into bio-char, (charcoal) and oils "
alternatively to "process organic mill residues into bio-char and oils"

Research Status

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University of Pretoria

- Projects initiated at universities of Pretoria and Stellenbosch to:
  - Characterize local organic feedstock and pyrolysis products when using pyrolysis techniques fast, slow and vacuum.
  - Design, build and commission a scalable dual fluidized bed fast pyrolysis reactor and characterize and optimize products using locally obtained feedstock.
- Derive first order estimates of economical viability.

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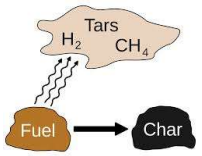
Pyrolysis – the gaps



The research projects have shown that use of fast pyrolysis as a low grade biomass beneficiation technique is sound.

- Process is *sustainable*, generally *easy to operate* and produces a *consistent product* (at lab scale).

However :

- Oil CVs are generally low 12-16MJ/kg due to oxygen content of contained compounds, pH values are low.
  - Can be improved by oxygen scavenging – in situ catalyst
- Bio-char quality is generally good
  - However a quantity is lost to vapour stream in fluidised bed – requires improved separation equipment
- Plant can be made modular
  - However portability is likely to be a challenge.

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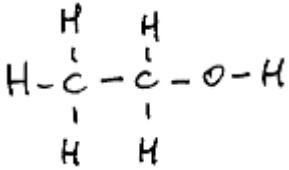
Ethanol – manufacture



Traditionally “green” ethanol was made from corn thus displacing its use as a food crop and chasing up commodity prices!

However:

- Paper sludge waste is produced by various pulping/recycling facilities in SA:
  - At a rate of 15 to 50 tons (dry weight) per day per facility.
  - Typically contains 70% moisture, thus representing a significant amount of water going to landfill.
  - Decomposition rate of anaerobically stored cellulose fibre is slow thus reducing the lifetimes of the waste facilities
- Typical commercial project would produce up to *four million litres of ethanol per year*, and have a capital investment of R35m to R70m, depending on the scale of production.

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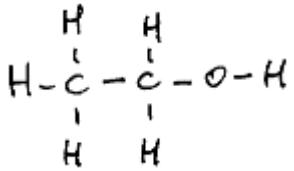
Ethanol – research objective



- PAMSA interested in conversion of paper mill sludge produced by facilities pulping virgin wood, and those recycling paper/cardboard, into ethanol.
- Sludge contains significant amounts of fibrous plant material that can be converted into ethanol using a low-cost proprietary yeast technology.
- Ethanol product would serve as fossil fuel replacement
- Typical commercial project has “double” environmental benefits
  - Avoided landfill which also reduces amount of water in sludge going to landfill.
  - Fossil fuel replacement with renewable source.

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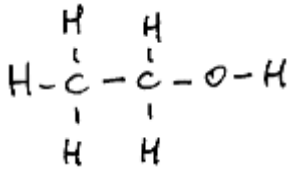
Ethanol – Project status



- Recruitment of MSc. students for ethanol project is complete
  - Work on design and construction of portable pilot plant to commence in 2015.
  - Plant will be housed in 40ft container.
  - Self sufficient to allow moving between mills to collect data.
- Process has been lab tested on plant sludge and shows promise for scale up to commercial size.
- Data will be used to optimise process parameters with regard to conversion efficiencies and plant configuration.

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R& D on a sector basis

- Member companies within a sector face same challenges regarding control of processes and impact on environment.
- Sector members should where possible work together with relevant government departments
  - Pool resources (both human and material).
  - Betterment of their industry as a whole when dealing with common problems not related to competition and IP.
  - Waste cooperatives could significantly reduce entry level costs of bio-refinery type investments – ethanol conversion, bio-mass based mini power plants, etc.
- Upliftment of technical skills and development of entrepreneurs = natural outflow of technical development undertaken by sectors
- Government funding/co-funding of projects will not only solve real problems but also develop real people.

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Thank you

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