



# Biomass Gasification: Recent Activities in Australia

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Energy & Carbon

# Overview

- Biomass gasification in Australia
  - Commercial biomass gasification
  - Recent R&D activities in the field
- Future outlook
  - Financial drivers and incentives for biomass-based renewables



# Commercial Projects and Activities



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# Commercial Projects and Activities

- Operating commercial plant
- Proposed commercial plant
- Equipment vendors



# Operating Plant?

- No “commercial” biomass gasification plant currently operating in Australia (March, 2011).
- There are a number of demonstration and test facilities associated with commercial entities.
- There are a number of commercial biomass gasification projects at various stages of development.
- Some of these will likely result in commercial biomass gasification plant installations in the next few years.



# Recent Proposed Plant

- D&R Hendersons, Benalla
- Coskata (plasma gasification)
- Syngas (ASX: SYS)
- Knetic Renewables / Into Green Energy
- Real Power Systems Gasifiers



# D&R Henderson, Benalla (Vic.)

- Thermal gasification plant proposed
- Waste sander dust gasified to produce a fuel gas to run burners for providing heat in chip drying
- Benefits:
  - Natural gas savings (200,000 GJ/yr)
  - Landfill diversion (6,000 t/yr)
  - GHG reductions (10,000 tCO<sub>2</sub>e/yr)
  - Net savings >\$200k/yr
- Project cost: \$1.95M (50% Vic govt support)



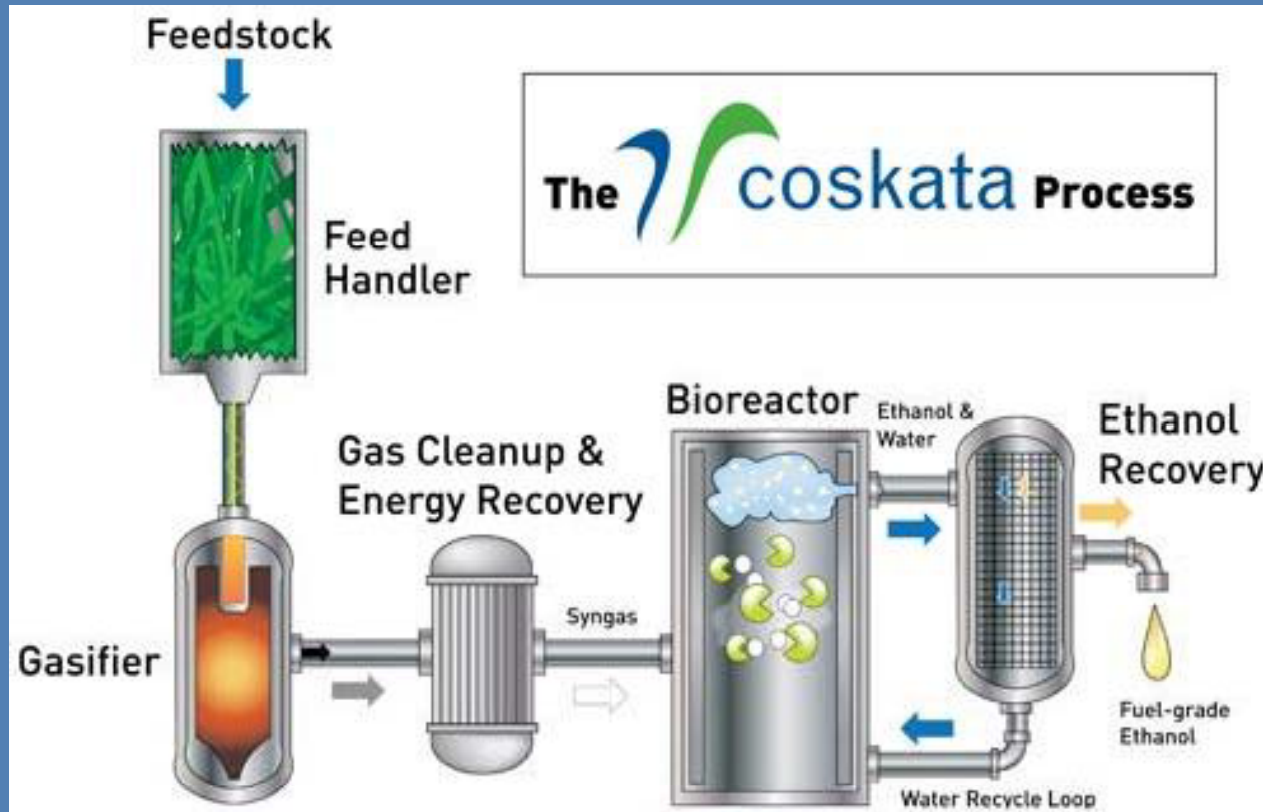
# Coskata Inc.

- Novel plasma gasification to ethanol process
- Ethanol Consortium and MoU signed with Holden, Caltex Australia, Veolia, Mitsui and Coskata for a \$400M facility in Victoria.
- Feedstock: MSW, woody biomass waste streams and residues
- Output: 225 ML/yr bio-ethanol for blending into Australian Standard fuels.
- Technology: dual plasma gasification (Alter NRG) - fermentation technology
- Proved at pilot plant scale in Madison, PA (USA); full-scale commercial plant design underway.





# Coskata Technology Concept



# Coskata Inc.

- SPV (Special Purpose Vehicle) established to take project to next stage
- Undertaking feedstock-specific trials at demonstration facility
- Preliminary front-end engineering design and site infrastructure planning
- Preliminary environmental and community impact assessment.

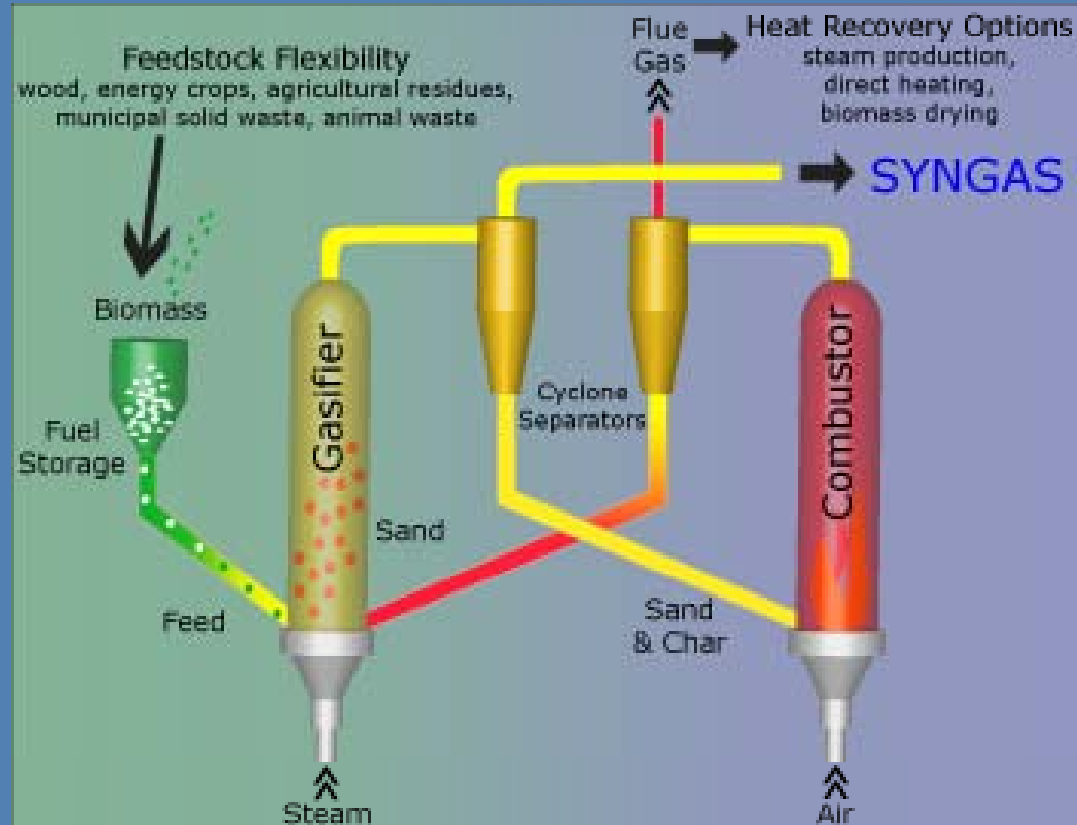


# Syngas

- ASX-listed company developing coal and biomass gasification projects in Australia
- MoU signed with US company Rentech for a biomass-to-liquids technology involving gasification “Rentech Silvagas” followed by a proprietary FT process
- First in line appears to be a 3MW biomass-to-power plant under consideration for Wagga Wagga (NSW), which is undergoing BFS at present
- Plant capex expected to be approximately \$13M
- Proposed feedstock is municipal and demolition wood waste
- Other biomass opportunities are being actively investigated
- Also undertaking biomass logistics field trials with Yorke Peninsula Alkaline Soils Group (SA) with grant funds (\$300k) from RenewablesSA



# Rentech “Silvagas”



# Into Green Energy Ltd

- Purchased 15kWe “Tasman” gasifier and spark ignition genset from Gasification Australia in 2009 for development work.
- Partnered with Power Systems Australia on the development of a 200kWe wood gasifier system for Ballarat Timbers.
- Anticipated project delivery timeframe, 6 to 9 months away
- Focussing on novel gas scrubbing technology using fuzzy logic control.
- Potential larger-scale project involving peachstones as feedstock (Shepparton) currently delayed due to change in project scope (increase in system scale requiring additional engineering design).



# Into Green Pilot Plant

Youtube:

<http://www.youtube.com/watch?v=s3vR0DqFYM4&feature=related>



# Real Power Systems Gasifiers

- 5 projects have approval in principle, are already funded for bioenergy component and have commenced final planning &/or construction.
- Projects to be deployed in 2011:
  - Hamilton (Vic) sewage sludge & wood chip for energy & biochar (Wannon Water). 100kWe capable + thermal + biochar production. Initial trials very successful.
  - Seed Drying – Cogeneration using forest pruning's – 50kWe + 300kWth (char capable).
  - Sawmill – Cogen for onsite energy needs using waste sawdust & low grade chip, 200kWe + 500kWth + char production for market testing.
  - Poultry litter hybrid power & char plant with integrated dead bird disposal for improved bio-security. 200kWe +500kWth + biochar.
  - Small industrial site using waste pallets. 100kWe grid connected for testing.



# Ararat Rural City

- Small thermal gasification plant envisaged for indoor heated pool complex in Ararat (Vic).
- Feedstock is woody waste diverted from local landfill.
- Natural gas costs for pool heating ~\$40,000 per year.
- Project is driven by the Shire rather than a technology specialist.
- Initially evaluated feasibility and technology options with Gasification Australia (2007) for a cogen solution.
- Purchased GEK (Gasifier Experimenters Kit) in 2010 for own trials.
- Looking to purchase a 60kW Ankur gasifier to produce syngas to provide around half the pool's heating.
- Total capital cost: gasifier, new syngas suitable boiler, automated feed in system and storage expected to be around \$100,000.



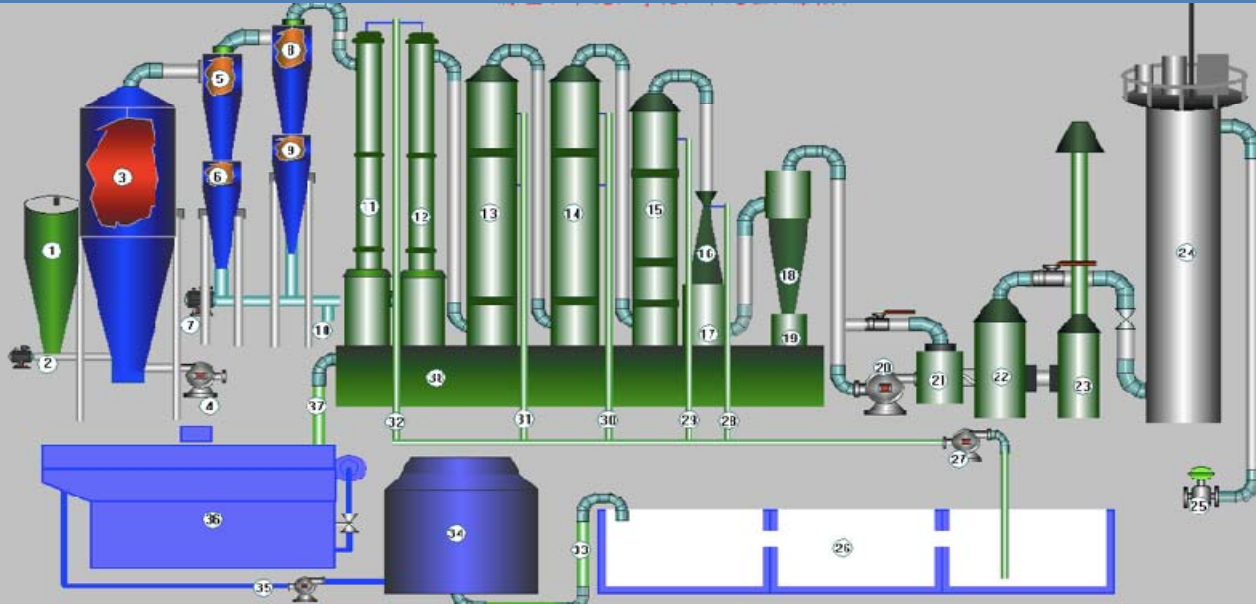


# The ACT Group

- Relatively recent Australian market entrant (Melbourne based).
- Gasification systems based on a modular 350 kWe fluidized bed (CFB) technology.
- Feedstocks such as corn stover, straw, rice hulls, grasses and cereal crop waste.
- 50 plants operating worldwide some for over 20 years.
- Wet gas scrubbing with recycle to minimise water use
- Produces engine-grade gas for reciprocating engines



# ACT Group CFB Technology

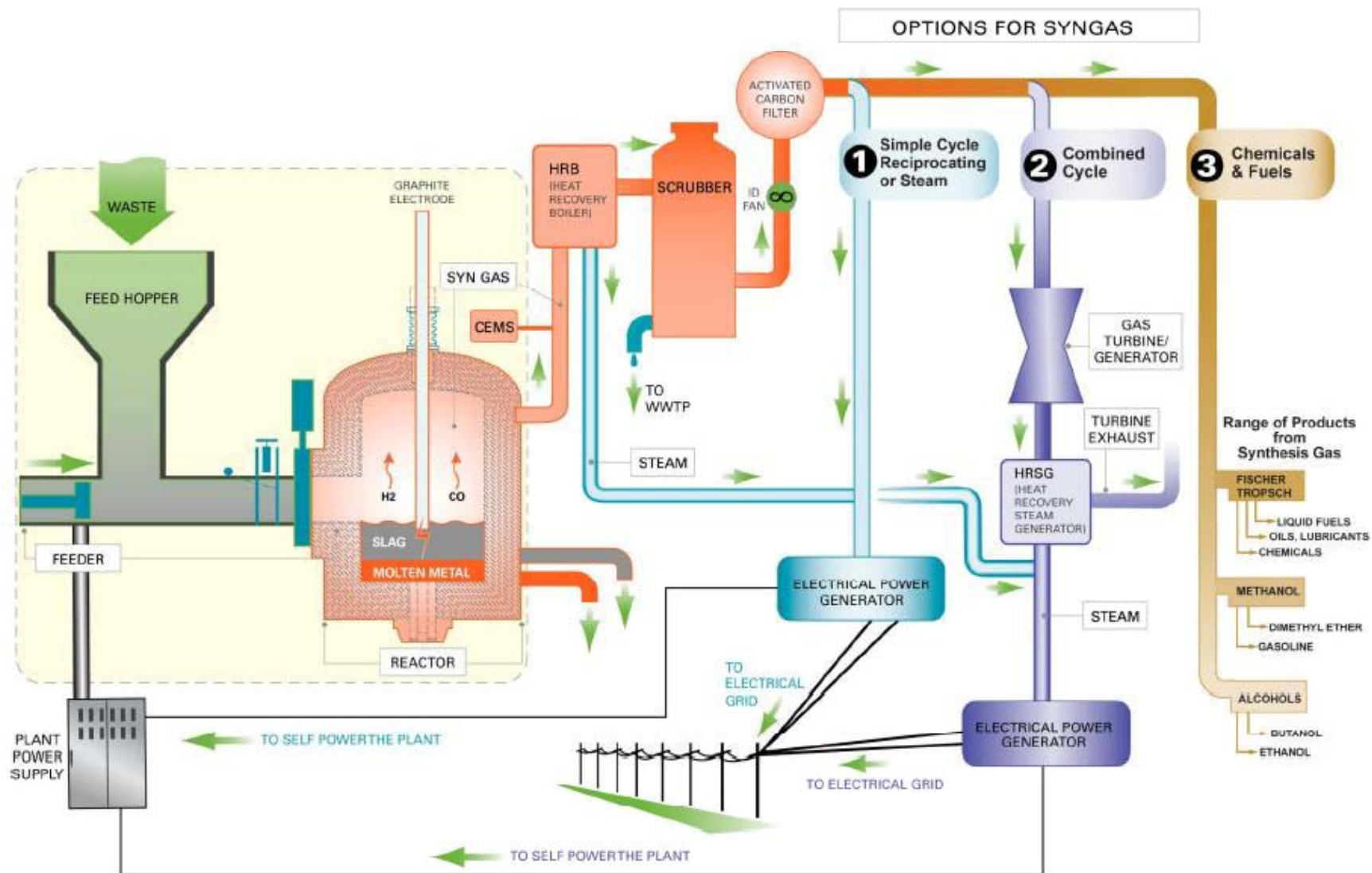


# Zenergy Australia

- Plasma gasification technology based on a graphite arc (not plasma torch)
- Technology is from PWR (Plasma Waste Recycling) in the US
- PWR is currently in the process of initiating commercial projects and is represented in Australia by Zenergy.



# PWR Process



# RenewdUnder

- Australian agent for Ankur Scientific gasifiers (India)
- Ankur offers downdraft gasification technology of 2 basic types:
  - WBG for woody feedstocks
  - FBG for fine feedstocks
- “Combo” units can be changed over from one feedstock type to the other.
- Systems produce engine-grade gas
- Unit sizes range from 3 kWe to 850 kWe
- Only example of an Ankur unit in Australia (so far) is a WBG-40 unit (40 kWe) installed by Forestry Tasmania

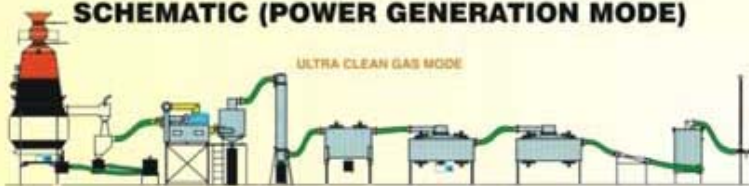


# Ankur Scientific Technology

## WORLDWIDE TECHNOLOGY LEADERS - SMALL AND MEDIUM RATING BIOMASS GASIFIERS

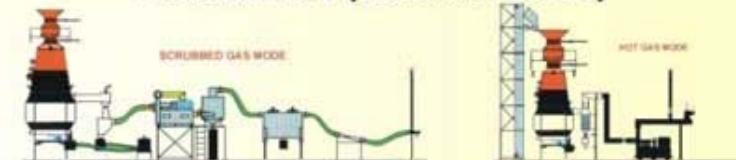
### "ANKUR" BIOMASS GASIFIER SYSTEM

#### SCHEMATIC (POWER GENERATION MODE)



### "ANKUR" BIOMASS GASIFIER SYSTEM

#### SCHEMATICS (THERMAL MODE)



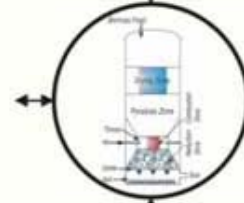
#### RANGE OF APPLICATIONS

##### THERMAL

- 1) Dryers
- 2) Hot Air Generators
- 3) Kilns / Furnaces
- 4) Ovens
- 5) Thermic Fluid Heaters
- 6) Boilers etc.

##### POWER

- 1) Captive Power
- 2) Grid Feeding
- 3) Village Electrification
- 4) Irrigation / Pumping
- 5) Simultaneous Power & Charcoal Production
- 6) Any Other Power Application



#### BIOMASS / FEEDSTOCK

##### WBG SERIES

- 1) Firewood
- 2) Wood Waste
- 3) Branches / Twigs
- 4) Coconut Shells etc.
- 5) Corn Cobs

##### FBG SERIES

- 1) Rice Husk
- 2) Threshed Mustard Stalks
- 3) Groundnut Shells

- o Combo Models can use both types Feedstocks with a simple one-day changeover
- o Other agricultural residues could be used after proper size reduction, resulting in a minimum bulk density of 125 kg/m<sup>3</sup>
- o Prototype testing for specific feedstock can be taken up by the company for a nominal charge.

#### AVAILABLE RATINGS

##### WBG

- Available Ratings: 20 kW to 2200 kW / 50,000 Kcal/hr to 5 million Kcal/hr
- Some indicative ratings
- WBG-20 •WBG-600
- WBG-100 •WBG-750
- WBG-200 •WBG-850
- WBG-300 •WBG-1100
- WBG-350 •WBG-1500
- WBG-400 •WBG-1800
- WBG-500 •WBG-2200

##### FBG

- Available Ratings: 40 kW to 600 kW / 1,00,000 Kcal/hr to 15,00,000 Kcal/hr
- FBG-40 •FBG-200
- FBG-80 •FBG-250
- FBG-100 •FBG-300
- FBG-120 •FBG-335
- FBG-150 •FBG-350
- FBG-400 •FBG-500
- FBG-600

##### COMBO

- Available Ratings: 40 kW to 600 kW / 1,00,000 Kcal/hr to 15,00,000 Kcal/hr
- The COMBO series is governed by the FBG series and thus, in the COMBO series, the same ratings as the FBG series are available

##### 100% GAS

- Available Ratings: 11 kW to 710 kW
- GAS-11 •GAS-120
- GAS-22 •GAS-160
- GAS-32 •GAS-180
- GAS-40 •GAS-250
- GAS-70 •GAS-710
- Larger Ratings through internationally available engines



#### SALIENT FEATURES

##### THERMAL

- Typically, a liter of liquid fuel can be saved with only 4 kg of woody biomass or 5 to 6 kg of rice husk.
- Flame temperature of >1200°C
- Full Oil/LPG replacement for applications requiring upto 1000°C
- Higher temperatures through dual fuelling

##### POWER (DUAL FUEL)

- Replacement of 65-75% diesel in DG sets with Dual Fuelling
- Specific fuel consumption of less than 1 kg of wood or 1.4 kg of rice husk along with upto 90 cc of diesel
- Wide turn-down ratio
- Both WBG as well as FBG series systems available

##### POWER (100% GAS)

- Limited start-up power for a short period
- Specific wood consumption of only around 1.3 kg/kWhr
- Wide turn-down ratio
- Excellent variable load response
- WBG mode for stand-alone application and WBG/FBG series for Grid Connected Mode

# Gasification Australia

- Australian licensee for Fluidyne (NZ) downdraft gasifier technology.
- Offers 15 kWe (Tasman) and 30 kWe (Pacific) gasifiers
- Compact system for clean engine-grade gas
- Feedstock is blocky wood material (15 to 50 mm).
- Australian sales are through Flow Force Technologies.



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# Corky's Carbon Consultancy

- Have undertaken an extensive and systematic gasification technology development program since mid 2000's.
- This has included development of gas scrubbing technology, an extensive emissions testing program and proving of condensate water cleanup technology.
- Development of modular gasification plant from 1 to 4.4 MW in size.
- This is the basis of GS Energy's "Waste to Energy – Power and Waste Management Stations
- Have a comprehensive gasification test facility (NSW) for trials at a meaningful scale.





# Corky's – Gasification Facilities



# VISY – Waste Boilers

- VISY operates two bubbling fluidized bed boilers with an in-bed bottom gasification stage for heat and power production:
  - Tumut (NSW) 60 MWth, operating for 10 years on woody waste materials
  - Brisbane (Qld) 25 MWth, operating for 12 years on waste material and paper fiber from paper recycling process
- These boilers are in effect a two-stage combustion system with the gasification stage occurring within the bed and combustion occurring via secondary air at the top of the bed and in the freeboard.
- Electricity production is via steam cycle.



# Biochar Plant Developments

- A number of pyrolysis processes, principally developed for biochar production, also produce usable quantities of fuel gas for thermal or power generation applications.
- Though it could be argued that they are not strictly “gasification” processes, they are included here as they share many similarities
- Biochar companies with technology that produces gas for energy include
  - The Crucible Group
  - Pacific Pyrolysis
  - BIG Char
  - Anthrotterra



# The Crucible Group

- Project Rainbow Bee Eater (Near Kalannie, WA)
  - Converting wheat and straw waste to biochar and “biogas”
  - First unit to be commissioned early 2011; gas initially flared, then to be used in power generation (grid feed)
- Vales Point Demonstration Facility
  - Hosted at Vales Point PS
  - 1MWe scale, also to be commissioned early 2011
  - Feedstock testing and demonstrations



# Pacific Pyrolysis

- Facilities for pyrolysis and gasification trials (incl gas production for power generation)
- Present projects underway include:
  - MOU for project development with Ballina Shire Council
  - MOU for project development with Norske Skog
  - MOU for project development with Transfield Services
  - Shortlisted for Victorian Government Sustainable Energy Pilot Demonstration Program grant
  - Tendered as part of consortium for Dunedin City Council project
  - Extensive participation in collaborative biochar research



# Pacific Pyrolysis

- Pyrolysis and gasification facilities:



Daisy ~10kg batch dry biomass



C4Hr Demonstration Plant – Somersby NSW



# BiGchar

- The BiGchar process is in essence, an updraft gasification one.
- However, gas production for power generation via gas-engines is only seen as a feasible approach at the small scale, BiGchar are looking at other technology alternatives for larger-scale cogeneration.
- Currently, BiGchar are progressing on 3 full-scale biochar production sites to be commissioned this year.



# AnthroTerra

- Provider of pyrolysis and torrefying equipment, biochar and related products such as Biochar Mineral Complexes
- The suite of technology scales includes:
  - Mobile equipment (150 kg/hr)
  - Relocatable equipment (350 kg/hr)
  - Fixed integrated or standalone plant (500 – 2000 kg/h)
- Byproduct gases from processing are combusted in process.
- Heat can be exported or utilised in external heat engine (eg ORC)
- Gas is not used in engines directly





# AnthroTerra



# Recent R&D Activities



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# R&D Activities

- Generally speaking, there is only a relatively small amount of research work being conducted on biomass gasification topics in Australia at present.
- There was some difficulty in obtaining responses from all the research institutions that were contacted for information.



# University of Adelaide

- Extensive range of fluidized bed gasification equipment and test facilities (small to medium scale)
- Recent work has included:
  - Gasification trials on grape marc for the Australian Wine Research Institute
  - Fundamental experimental studies on gas properties and evolution vs bed materials for redgum wood chip and commercial wood pellet feedstocks



# University of Adelaide



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# Other University Studies

- Griffith University – study on whether gasification yield can be improved with the addition of coal to the biomass feedstock (ie co-gasification); fundamental study involving TGA testwork
- University of Sydney – development of ceramic membranes (via chemical vapour deposition) for the selective permeation of hydrogen from the product gas (ie to produce a higher-purity hydrogen product stream)



# CSIRO

- Recent biomass gasification work at CSIRO occurred via a number of different activities in various business units:
- DAFF funded project: “Assessment of the environmental and economical opportunities and constraints associated with bioenergy production from forest biomass resources in two prospective regions of Australia”
- The study included techno-economic modeling of a range of bioenergy scenarios, two of which included a gasification step:
  - Biomass to liquids via gasification and synthesis (F-T)
  - Biomass gasification to electricity
- Externally-funded study for Melbourne Water including economic assessment of a scenario where algal biomass was gasified to produce electricity.
- Some fundamental experimental studies involving volatile yields and intrinsic char reactivity at a variety of heating rates (QCAT) with visiting researcher from UBC



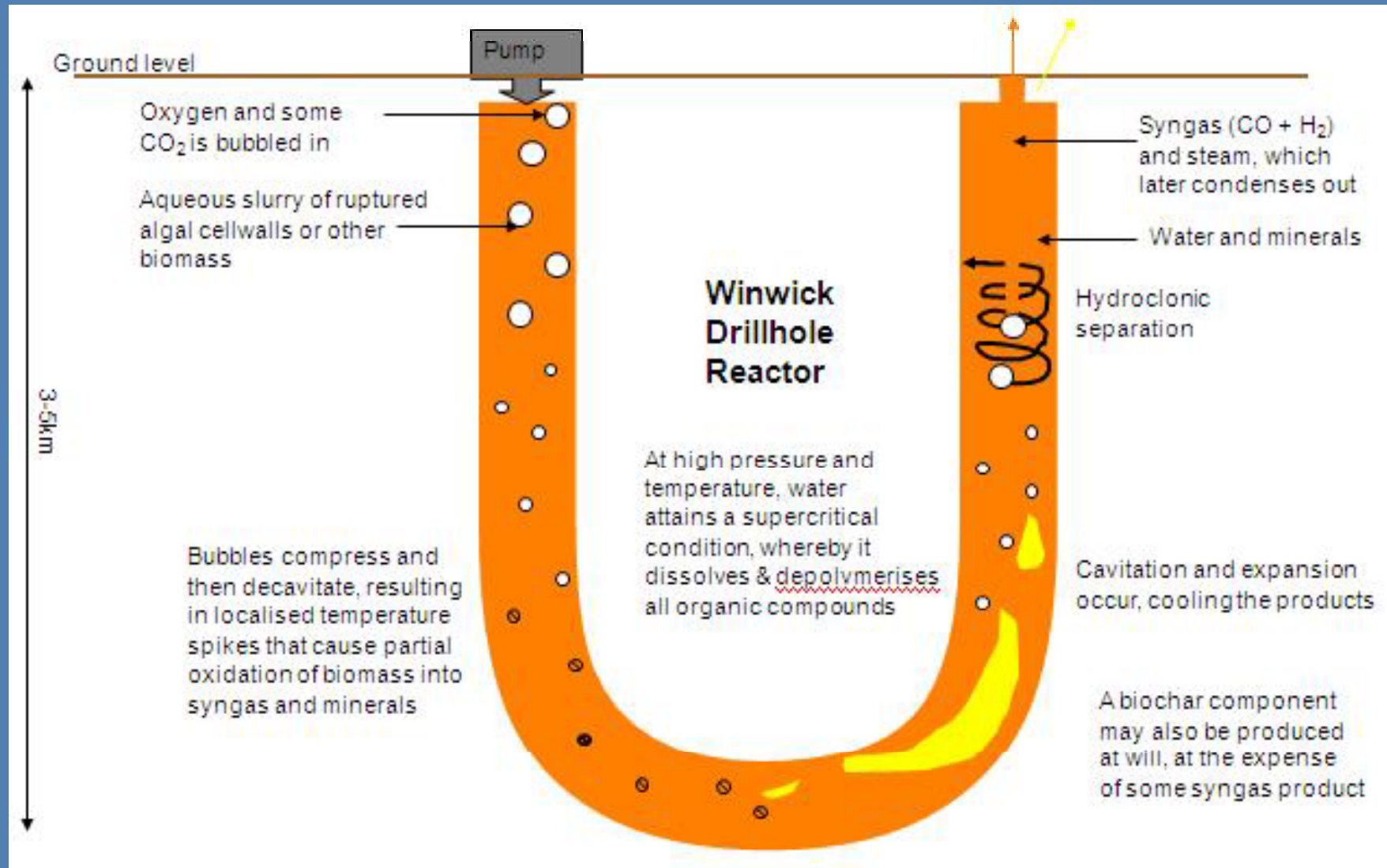


# Winwick Drillhole Concept

- Includes a supercritical fluid gasification process utilising drillholes to provide containment and develop the high reaction pressures necessary (due to height change).
- Part of a suite of technology elements for renewable energy and chemicals production from biomass under development by a private individual (Sev Clarke)
- Currently at conceptual / patent stage.
- Requires staged test-work to prove concept.
- R&D / commercialisation partners sought.



# Winwick Syngas Production



# Drivers and Incentives



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# Drivers and Incentives

- Key drivers in Australia are
  - the Large Scale Renewable Energy Target (41000 GWh/a by 2020).
  - A possible future carbon price
  - Increasing costs of landfilling that serve to encourage diversion opportunities
  - Funds and grant schemes (though there is nothing *specifically* targeting the bioenergy sector, funds targeting regional development, innovation, emissions reductions, reduced energy use, waste minimisation, farm and forest industry etc are all fair game)
- Victoria is the only state that has feed in tariffs for bioenergy (1 for 1 at up to 100 kWe)
- RECs may be generated from bioenergy processes



# In Conclusion

- No commercial biomass gasification plant currently operating in Australia.
- Some projects “in the pipeline” which may yield commercial biomass gasification installations in the near future.
- Limited activities in biomass gasification research in Australia at present.
- No funding “specific” to the bioenergy sector, but the activity fits within a number of sectors for which funding schemes exist...
- It is likely a combination of avoided waste costs plus income from energy production will be the key drivers for bioenergy processes such as gasification in the near to medium term.



# Websites

<http://www.esenergy.com.au/>

<http://coskata.com/>

<http://www.syngas.com.au/>

<http://intogreen.com.au/>

<http://www.plasma-wr.com/>

<http://www.renewdunder.com/>

<http://www.gasificationaustralia.com/>

<http://www.corkys.net.au/>

<http://www.thecrucible.com.au/>

<http://pacificpyrolysis.com/>

<http://www.bigchar.com.au/>

<http://anthroterra.com.au/>



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