

The Australian Wine Research Institute

Renewable energy options for the wine industry

Planning for business sustainability



AWIEC
23 September 2009

Dr Richard Muhlack
Process & Environmental Engineer



The Australian Wine Industry is under intense pressure on many fronts...

Economic downturn



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Market plunges on gloomy World

By Online business reporter Michael Janda
Posted 3 hours 19 minutes ago
Updated 3 hours 5 minutes ago

ABARE forecasts commodity export slide

Philip Hopkins
June 23, 2009 - 12:33PM

Farm exports will rise in the next two financial years, but Australia's total commodity exports are forecast to fall by 16 per cent to \$160 billion in 2009-10 due to the global financial crisis, latest figures show.

Latest news

Banks unlikely to pass on any more official rate cuts

Water Shortage & Climate change



Water Shortage & Climate change

Map of Australia showing temperature variations.

Graph showing precipitation trends.

Carbon footprint, emissions, food miles



Carbon footprint, emissions, food miles

Carbon Footprint

PRECIPITATION

DATE CH

REVIEW

Energy security & Peak Oil



World Oil Reserves by Region

Region	Percentage
Middle East	36%
North America	16%
South America	10%
Europe	10%
Asia & Oceania	10%
Other	18%

World Production

Figure 3. World Marketed Energy Use by Energy Type, 1980-2030

History Projections

Quadrillion Btu

Oil, Coal, Natural Gas, Renewables, Nuclear

Source: History: Energy Information Administration (EIA), International Energy Annual 2003 (May-July 2005), web site www.eia.doe.gov/html. Projections: EIA, System for the Analysis of Global Energy Markets (2006).



A climate of **change**...

...**uncertainty**...

...**opportunity**...?



Transition to the low-carbon economy

- Resources need to be managed in the most efficient way possible to maintain sustainability
- 'Low-tech' solutions and *existing* process improvement strategies to provide the transitional answer
- Ongoing development of new and alternative energy technologies ('high-tech' solutions)



Potential Energy Efficiency Improvements

- Refrigeration, air conditioning and heat exchange systems
- Waste heat recovery
- Hot water generation and reticulation
- Compressed air systems
- Pumps and drives
- Pipe design
- Tank, cellar and office insulation
- Lighting
- Wastewater treatment
- Power factor
- Electrical load balancing to reduce peak demand



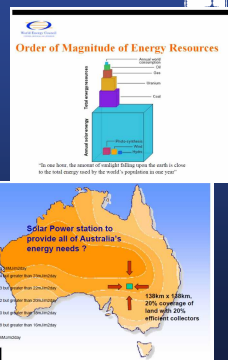
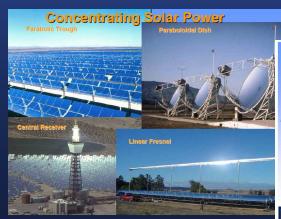
Emerging technologies for a carbon constrained world

- Biomass Energy
- Solar Thermal
- Microalgae



Solar Thermal

- Electricity Generation
- Process Heating and Cooling (Absorption Refrigeration)



Source: Keith Lovegrove, Solar Thermal Group, ANU



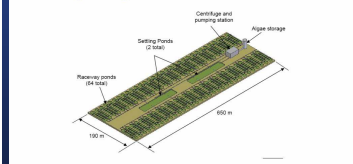
Microalgae

Current systems



Research Institute for Climate Change & Sustainability Clean Energy Technologies: Biofuels

Conceptual system



Refer: Climate 2030 seminar series

Biomass Energy



- Combustion/Gasification: Electricity, liquid transport fuels, co-firing with coal in existing conventional power station
- Ligno-cellulosic bioethanol
- Biogas via anaerobic digestion



Macadamia Nut Shell Project – Gympie Qld 1.5 MW pinhole grate unit



Source: Ergon Energy

Bioenergy Australia



Rocky Point Sugar Mill – Qld -30 MW



Condong Sugar Mill – NSW - 30 MW

Australian Examples of Grate Boilers

Bioenergy Australia

Alhomens Kraft 550 MW_{th}, 240 MW_e CFBC plant

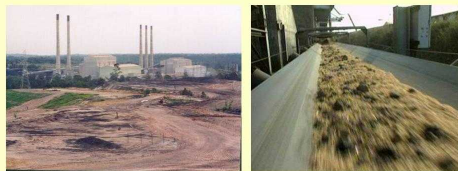


Slash bundles – part of fuel supply

source: Timberjack

Bioenergy Australia

Co-Firing Biomass with Coal



Biogas at Swanbank Power Station, Queensland

Wood waste/sawdust – Wallerawang Power Station, NSW

Bioenergy Australia

Australian Wine Industry context



- Australian crush: 1.7 million tonnes in 2009 (Source: AWBC)
 - Over 120,000 tonnes (dry) of grape marc
- Grape marc calorific value: ca 19-21 MJ/kg
- Cellulose / hemicellulose / lignin: unknown
40-55% / 25-40% / 15-25% (for other biofuels)

Energy from grape marc biomass



Grape marc is a Second Generation Biofuel

- Does not impact negatively on resources for food production and supply
- No land encroachment or biodiversity risks



Advantages of grape marc over other 1st Gen and 2nd Gen biofuels

- Existing waste material from the wine industry
 - ∴ No additional energy/water resource for cultivation and harvest of the biofuel crop
- Marc is already transported central processing facilities
- Marc is already granular, so additional milling or size reduction likely to be unnecessary
- Wine Industry already has some capital equipment and expertise required for biofuel conversion

Grape marc has the edge over other biofuels



Grape marc Bioenergy: Products and Process Options

- **Electricity**
 - Gasification/digestion followed by combustion – Gas Turbine or IC Engine
 - Direct combustion of solid fuel – Steam Cycle Turbine
- **Biodiesel**
 - Gasification/digestion followed by Fischer-Tropsch synthesis (Gas-to-Liquids)
- **Bioethanol**
 - Lignocellulosics and biorefining

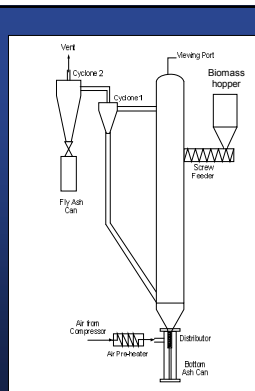


Gasification of Grape Marc in a CFB

- Fluidized bed conversion of solid fuels well established and widely used technology
- Suited to biomass applications
- Industrial configuration – gas turbine or internal combustion engine coupled to generator

Aim:

- determine gas compositions from fluid bed gasification
- Investigate potential for ash related problems

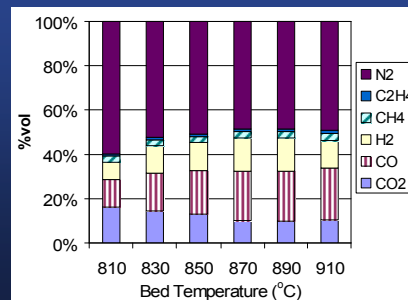


Lab-scale Circulating Fluidized Bed Gasifier

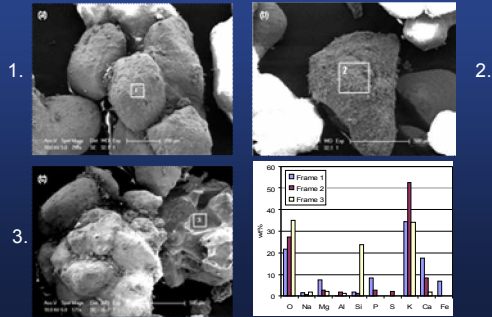
University of Adelaide
Centre for Energy Technology



Gas composition versus Gasification Bed Temperature



Ash analysis by SEM and XRD



Gasification of Grape Marc in a CFB



Conclusions

- Promising gas compositions and carbon conversions at relatively low temperatures
- High potassium levels in ash layer indicate that agglomeration within the fluid bed will be likely in a large-scale system (an issue common to many other biomass systems)
- Research is ongoing to develop and verify mitigation strategies

Ligno-cellulosics - Bioethanol



- Conversion via hydrolysis and fermentation
- Cellulose / hemicellulose / lignin: unknown 40-55% / 25-40% / 15-25% (for other biofuels)
- Relevant capital infrastructure, systems, in-house industry process knowledge
- Scientific expertise within industry
- Ongoing research and recent developments at AWRI and its partner organisations that may assist to fast-track development

Biogas



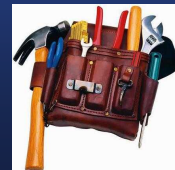
- Anaerobic digestion of biomass
- Main biogas components: methane and carbon dioxide
- Anaerobic digestion processing plants - range of sizes and complexities
- Most anaerobes unable to digest lignin, which may be a limiting factor in effective use of this technology with winery waste.
- Pre-treatment of marc may be required



Anaerobic Digestion – combustible biogas



Tools to position us for the challenges of tomorrow





The Australian Wine Research Institute

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AWRI

WINE'S NEWS

- AWRI Seminar and Networking
- From Oltresella Valley, Italy
- 2009-10 Agri-Science Outlook
- Agricultural Commodities for the Export of Australian Wine

Welcome

Since 1950, The Australian Wine Research Institute has been supporting Australian grape and wine producers with the development and adoption of innovative practices. Working alongside producers, we aim to develop grapegrowing and winemaking practices for quality.

AWRI Environment Portal

Follow links from www.awri.com.au




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- AWRI Industry Applications Team
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- Tarac Technologies
- Bioenergy Australia

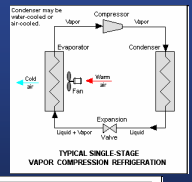
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Refrigeration

- Efficient temperature control and heat transfer to wine
- Review wine and brine temperature set points
- Effective tank mixing
- Appropriate refrigeration compressor settings and plant operation
- Effect of environmental variables – ambient temperature & RH, peak vs off peak operation
- Site placement – ventilation, solar loading
- Absorption refrigeration



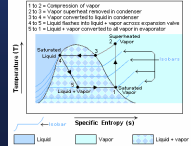
CONDENSER: This is the water-cooled or air-cooled.

EVAPORATOR: This is where the wine is cooled.

COMPRESSOR: This is where the vapor is compressed.

EXPANSION VALVE: This is where the liquid and vapor expand.

TYPICAL SINGLE-STAGE VAPOR COMPRESSION REFRIGERATION

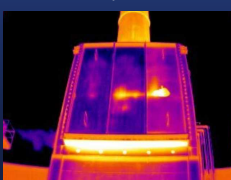


1-2 = Compression of vapor
 2-3 = Vapor condensed to liquid in condenser
 3-4 = Liquid formed and liquid refrigerant expands through expansion valve
 4-1 = Liquid + vapor converted to all vapor in evaporator

Legend: 1 = Vapor, 2 = Vapor, 3 = Liquid + Vapor, 4 = Liquid + Vapor

Hot Water and Waste Heat Recovery


- Boiler type
 - LPG/NG, diesel, electric, solar, heat pump
- Feedwater preheating:
 - Boiler economiser (suitable for larger installations)
 - Recovery of heat from “spent” sterilisation water



$$\eta_{th} \equiv \frac{\text{What you get}}{\text{What you pay for}}$$

Air Compression

- Reduce air leaks - which may account for up to 30% of compressor output
- Eliminate inappropriate uses of compressed air:
 - Eg venturi vacuum generation, open blowing, sparging
- Reduce air intake temperature (increase air density/mass flow rate)
- Isolate idle and decommissioned equipment
- Reduce overall system pressure



Wastewater



- Aeration
- Mixing
- WWT Microflora health
- Control of Fugitive CH₄ emissions



Potential Water efficiency Improvements



- High pressure water for cleaning
- Transfer line 'pigging' (inserting a solid plug [or 'pig'] into the pipeline to separate wine from water during transfers)
- Water pinch analysis / Cleaner Production strategies
- Capture and reuse of transfer push-through water, wash water, filler sanitation water and cleaning chemicals
- Reuse of transfer or stormwater for cooling tower use
- Vineyard irrigation practices
- Wastewater for irrigation of vineyards, site gardens, (biomass or high-value crops) ?

