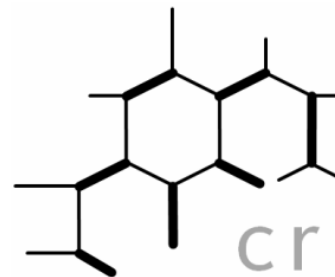


**BIOCHAR IN MORE
DETAIL:
WHAT IS IT?
WHAT IS IT USED FOR?
WHAT IS IT WORTH?**

Presentation to
Timber Queensland Conference
Bio-energy under the microscope: fact or fiction

1 July 2010

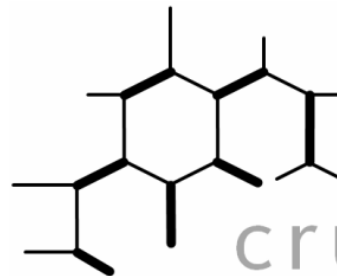
Matthew Warnken
Managing Director
Crucible Carbon Pty Ltd



cruciblecarbon
pyrolysis

OVERVIEW

- introducing Crucible Carbon Pyrolysis
- biochar explained
- pyrolysis as key to bioenergy equation
- Crucible Carbon Pyrolysis breakthrough
- technology current status
- biochar markets
- biochar value-in-use



cruciblecarbon
pyrolysis

pyrolysis_n

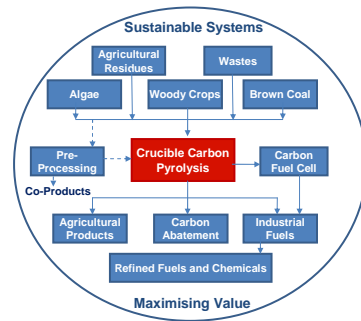
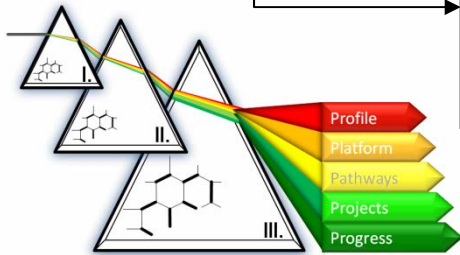
INTRODUCING CRUCIBLE CARBON

Consulting:
helping businesses
adjust and innovate to
become carbon ready

Research:
invention from scientific
first principles to proof
of concept

Innovation:
commercialising
breakthrough
technologies

Ventures:
business development
around specific
commercial
opportunities



insight → invention → innovation → implementation

Turnbull talks up biochar

THE enormous potential of biochar to capture and store carbon was being overlooked by the Federal Government, Opposition Leader Malcolm Turnbull said.

Mr Turnbull yesterday toured Crucible Carbon, which is developing technology for the mass production of biochar, at Newcastle.

Biochar, a charcoal produced from biomass, has the potential



Malcolm Turnbull: big opportunity

forestry, and of course, organic soil carbon," he said.

"We have an enormous opportunity here in Australia to absorb millions of tonnes of carbon dioxide from the atmosphere, store it safely as carbon, and put it back into the soil and increase the productivity and the health of our own landscape.

"A win-win. A win for jobs, a win for the environment, a win

ATTENTION ON BIOCHAR

Biochar is a high fixed carbon content product that is manufactured through the pyrolysis of biomass.

Essentially, pyrolysis + biomass = biochar

There are three main market applications:

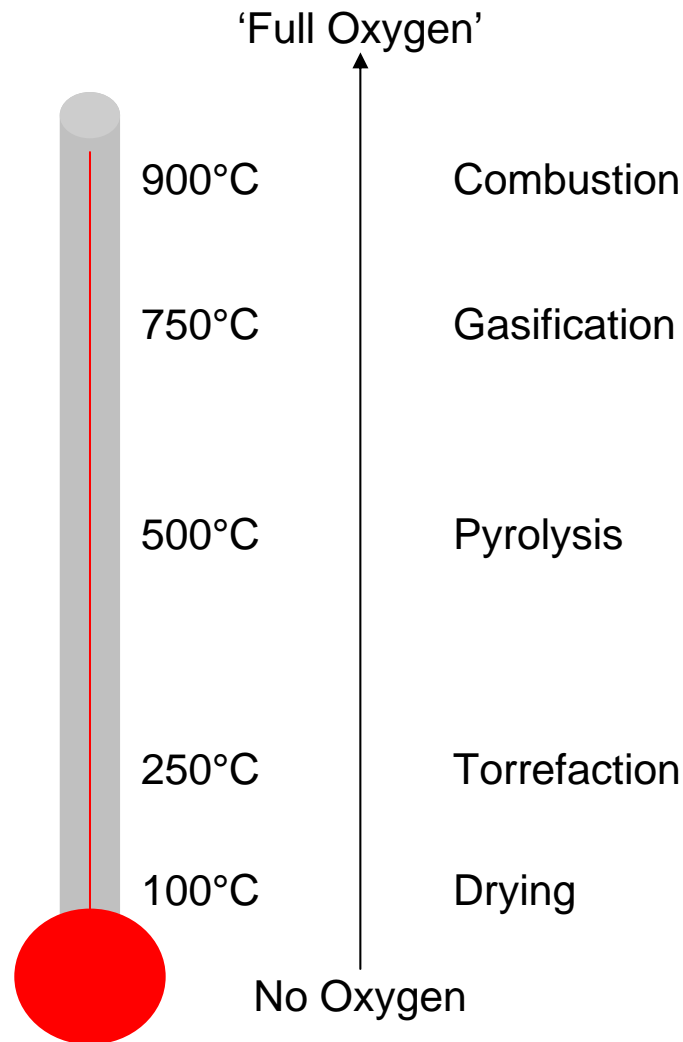
- agriculture: to improve soil structure, productivity and carbon sequestration
- metallurgy: use as a reductant and to replace some coal uses, for example pulverised coal injection in steel making
- thermal: replacement of thermal coal in power station and boiler applications

Burn, bury and bargain with it: biochar ticks the green boxes

Paddy Manning
May 30, 2009



RENEWABLE ENERGY AND BIOCHAR



Pyrolysis is the technology of biochar – plus more. Pyrolysis:

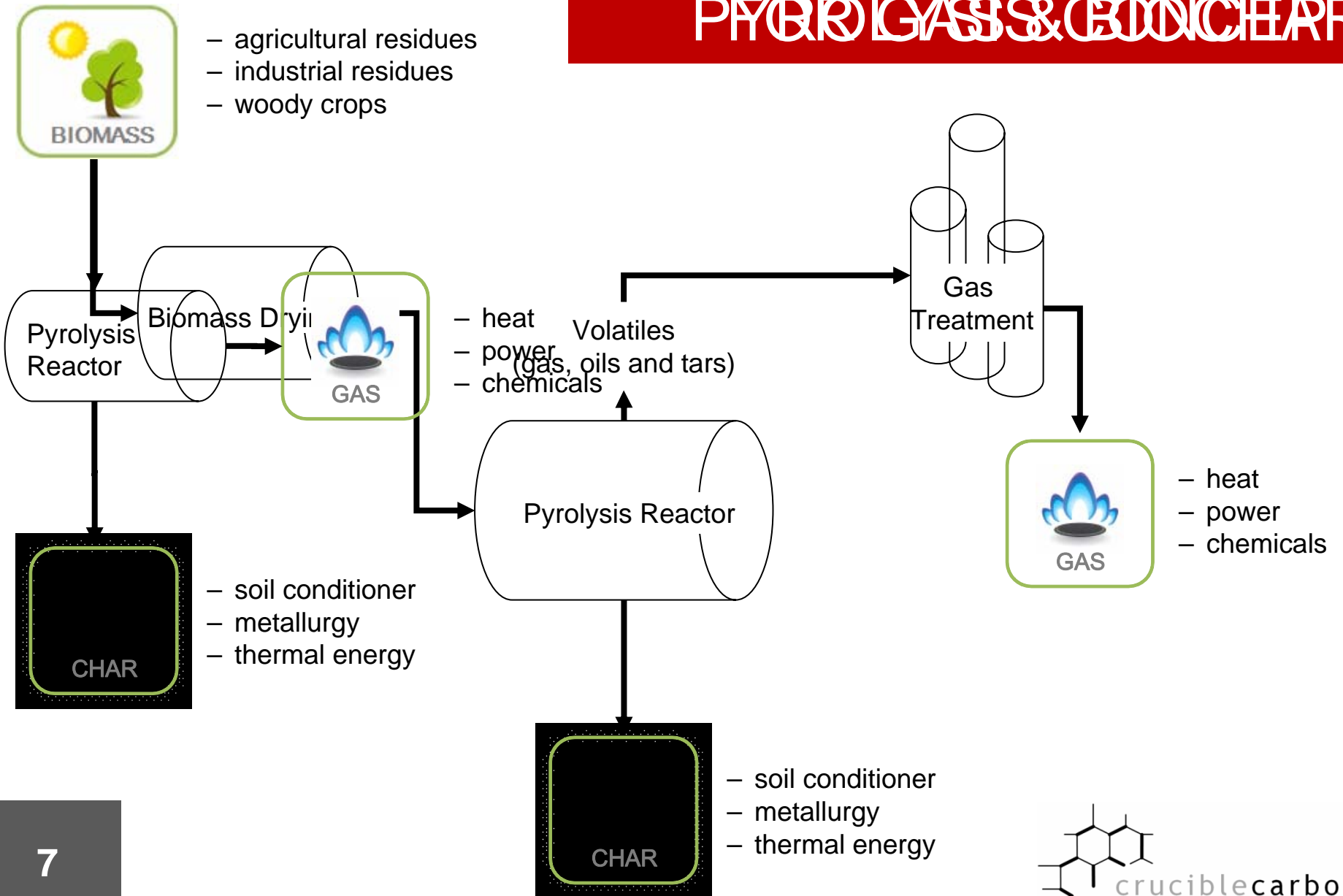
- heating biomass in the absence of oxygen
- thermal decomposition breaks biomass down into:
 - biochar
 - biogas
 - biocrude.

Essentially pyrolysis does in real time what nature had produced over millennia.

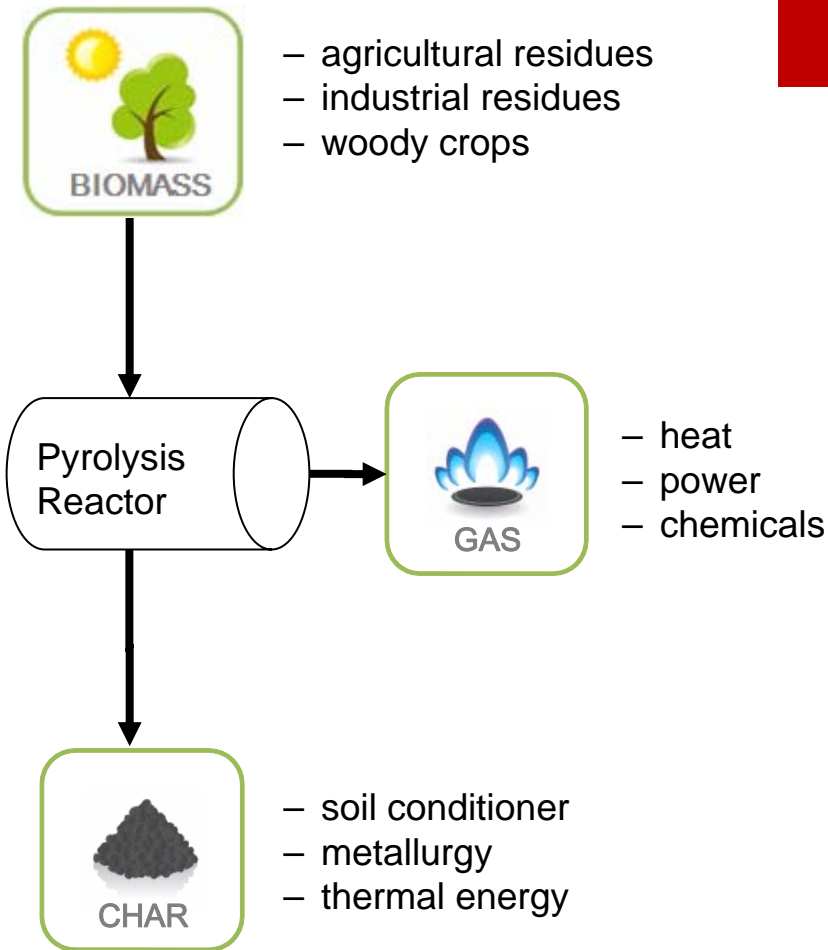
THE STRATEGIC ADVANTAGE OF PYROLYSIS

Renewable Energy Technologies	Features and Outputs							
	Renewable	On-Demand	Heat	Electricity	Gas	Liquid	Solid	Chemicals
Wind	✓			✓				
Hydro	✓	✓		✓				
Solar Thermal	✓		✓	✓				
Solar Photovoltaic	✓		✓	✓				
Wave/Tidal	✓			✓				
Geothermal	✓	✓	✓	✓				
Biomass Combustion	✓	✓	✓	✓				
Bio. Anaerobic Digestion	✓	✓		✓	✓			✓
Bio. Frmntn/Oil Extrctn	✓	✓				✓		✓
Biomass Gasification	✓	✓	✓	✓	✓			✓
Biomass Pyrolysis	✓	✓	✓	✓	✓	✓	✓	✓

CONVERTIBLE CARBON PYROLYSIS & BIOCHAR



CRUCIBLE CARBON PYROLYSIS CONCEPT

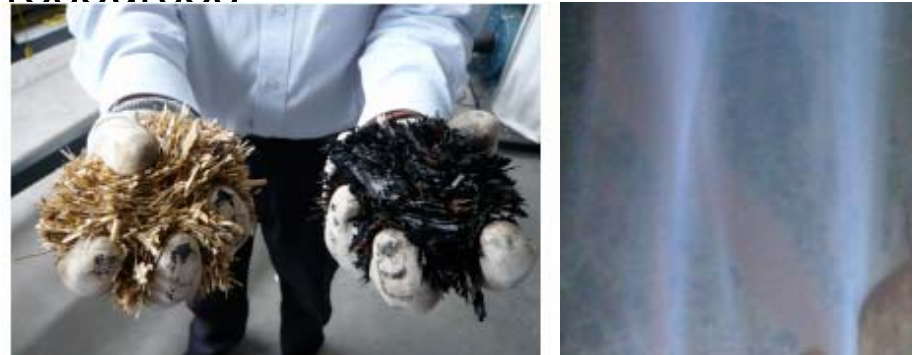


The process:

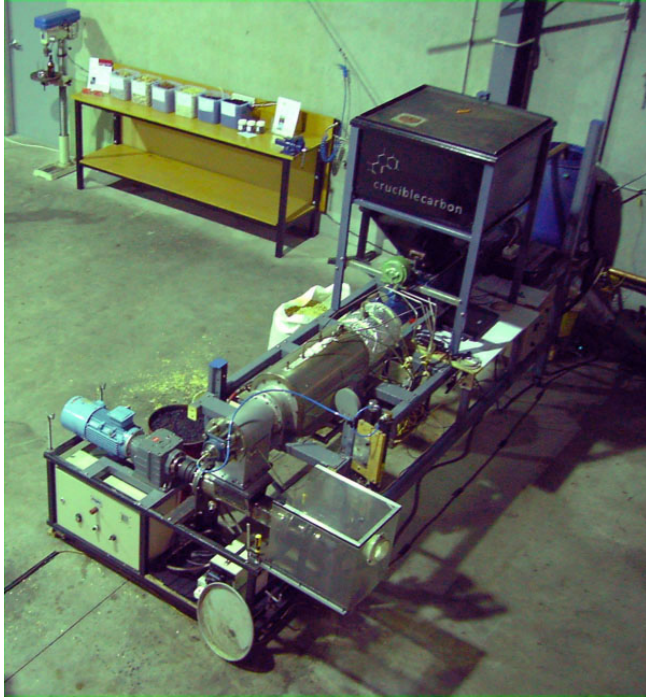
Conversion of organic matter into gas and biochar

The business opportunity:

Renewable energy and biochar products from waste biomass and other undervalued resources



UNIQUE BENEFITS OF CRUCIBLE CARBON PYROLYSIS



An Australian Government Initiative

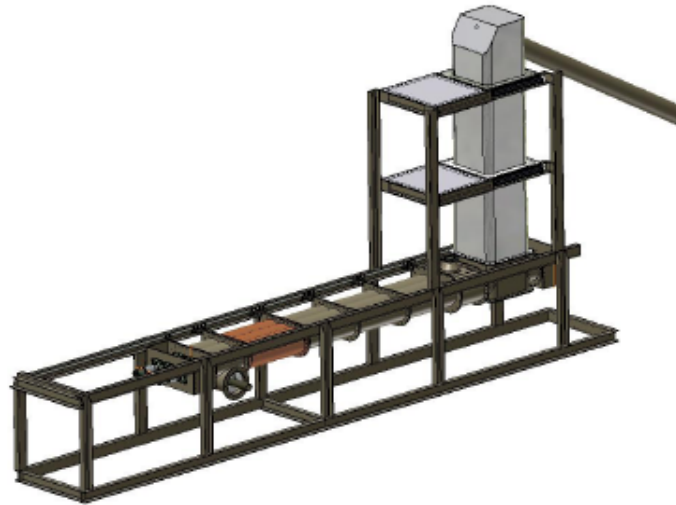
AusIndustry

*'Proof of concept' completed with assistance
from the Australian Government through
Commercial Ready. Provisional International
Patent lodged.*

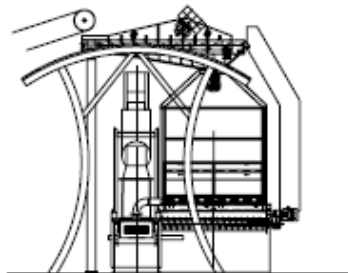
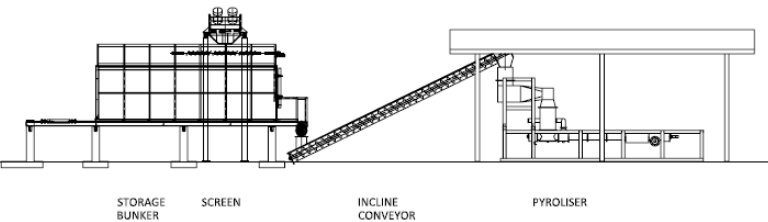
- economically viable now
 - capital costs and payback period
- no pre-drying
 - increased energy efficiency and production
- gas mode: no complex gas handling
 - simpler operations and better safety
- multiple product streams and feedstock
 - biogas and biochar from variety of inputs
- strong technology base
 - 30 novel and inventive claims in patent
- flexible technology with 2nd generation liquid fuels potential



TECHNOLOGY CURRENT STATUS



- fabrication commenced
 - 12 week production time
- identified demonstration project site in the lower Hunter Valley
- capital costs on target
- turn down capacity
 - can run at approx 10% of capacity
- low char mode: more gas and less char
 - approx 1.8 MWhe-/dte
- Brightwater engineering partnership formalised
- first customer on wheat straw
- sawmill residues demonstration project started – commissioning later in 2010



THE STRATEGIC ADVANTAGE OF WOOD

Biomass Source		Hydro-carbon (Fats, Oils)	Carbo-hydrate (Protein)	Carbo-hydrate (Sugars/ Starch)	Carbo-hydrate (Ligno-cellulose)
Annual Crops	Grassy Crops			✓	✓
	Oilseed Crops	✓	✓		✓
Perennial Crops	Grassy Crops				✓
	Oil Tree Crops	✓	<i>sp. Dpndt</i>	<i>sp. dpndt</i>	✓
	Lignocellulosic Tree Crops	✓			✓
	Multispecies Native Assemblages				✓
Residues and Wastes	Green Waste				✓
	Animal Waste	✓	✓		✓

BIOMASS SOURCES: WOOD IS GOOD

Feedstocks need to be sustainable and not compete with food production. Potential sources of lignocellulosic (eg. woody) biomass include:

- sawmill residues
- purpose grown woody crops for example, interspersed mallee in wheat country
- agricultural residues such as straw and bagasse
- municipal garden organics
- plantation forestry residues
- urban wood residues (eg. demolition)
- pulp and paper residues
- other organic and industrial residues.

BIOCHAR MARKETS

Product	Comment	Scale
Agricultural Biochar	Newly developing market, good crop yield results in literature, needs demonstration	If used with fertiliser at least 10M tonnes demand
Metallurgical Biochar	Can be used to replace pulverised coal injection (PCI) in steel making	Total Australian use of PCI approx 1.5M tonnes
Thermal Biochar	Ideally suited to replacement of black coal as no materials handling changes required	Total Australian use is approximately 55M tonnes
Biogas for Electricity	Total demand expected to be 438,000 GWh by 2020	Renewable electricity 45,000 GWh by 2020
Biogas for Process Heat	Significant and wide spread process heat requirements over many industries.	AU cement industry uses 25 PJ of process heat
Biogas for Chemical Precursors	Gas used extensively in plastics industry and in fertiliser to make ammonia	Est. 20 PJ of gas used in AU ammonia production

WHAT IS BIOCHAR WORTH?



Value in use equation for 1 tonne biochar:

- all applications gain a carbon sequestration benefit of $3\text{tCO}_2\text{e}$
- agriculture relates primarily to mineral content in biochar and productivity gains
 - replacement fertiliser \$150 (15% ash in biochar and fertiliser @ \$1,000)
 - productivity gains, hard to estimate
- metallurgical relates to replacement value compared to coal
 - \$200-\$250t prior to GFC
- thermal relates to replacement value of coal, plus RECs, environmental gains and handling
 - domestic black thermal coal c. \$50t
 - 2.5 RECs at c. \$50/REC (27GJ/t. 35%e-)
 - potential lower SOx and NOx
 - avoided infrastructure upgrades

Note: summary is provided from internal Crucible Carbon analysis and is indicative only.

SUMMARY

- Crucible Carbon Pyrolysis technology is modular and scalable, and delivers distributed baseload power with biochar as a beneficial co-product
- biochar can be used in agricultural, thermal and metallurgical markets, with potentially 67.5 million tonnes of demand
- estimated value in use ranges from \$100-\$500t for agriculture, \$200-\$250t for PCI replacement and \$150-\$250t for thermal coal replacement (excludes carbon benefit from each tonne of \$90t @ \$30tCO₂e)
- Crucible Carbon Pyrolysis breakthrough lowers capital costs, increases energy availability, and reduces operating expenses
- competitive and technological advantage means improved returns, ease of project start-up, and improved replicability in growing energy markets
- pyrolysis has potential to deliver mega-tonnes of carbon abatement and peta-joules of renewable biogas energy generation in Australia alone



Corporate Office
Sydney, Australia



Crucible Carbon Technology
R&D Centre
Newcastle, Australia

FOR MORE
INFORMATION

Matthew Warnken
Managing Director

t +61 2 9571 4511

f +61 2 9571 4522

info@cruciblecarbon.com

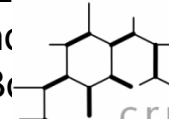
www.cruciblecarbon.com

Suite 88 Jones Bay Wharf
26-32 Pirrama Road

Pyrmont

PO Box

Glebe



cruciblecarbon
pyrolysis