



Ian Kraemer
Thiess Pty Ltd

**Exergen's Continuous HydroThermal
Dewatering (CHTD) of Brown Coal**



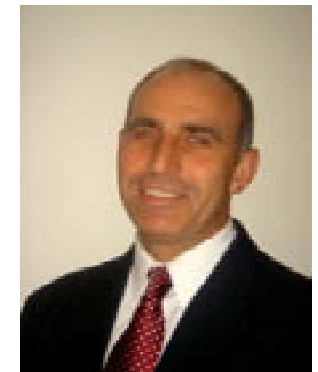


Presentation Outline

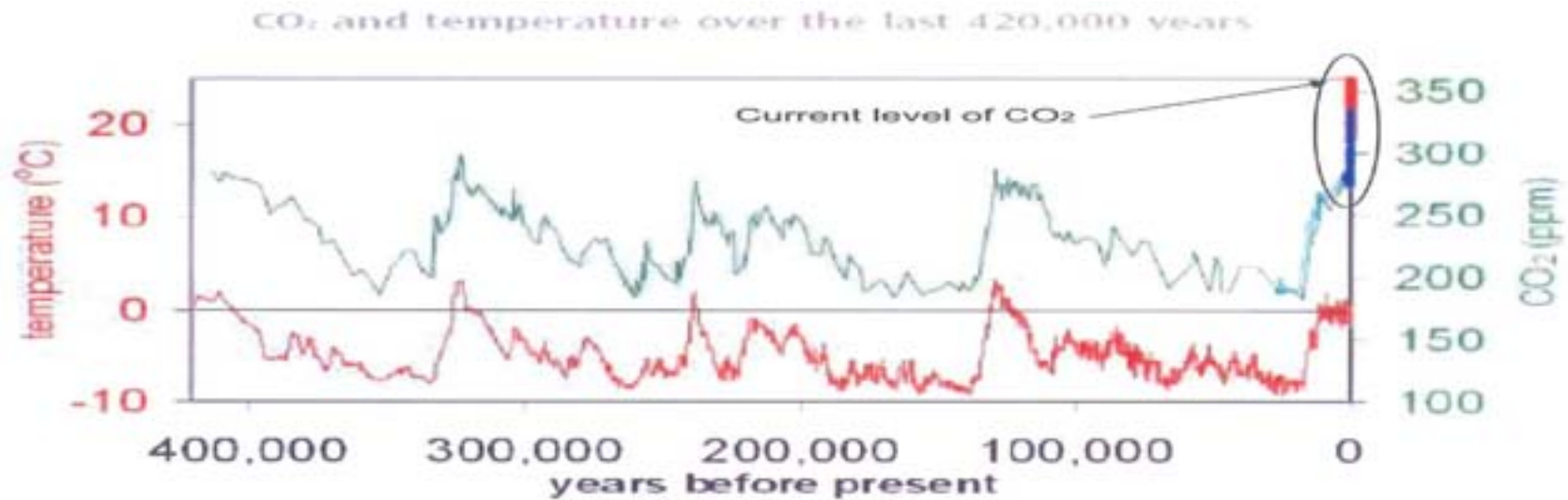
- > GreenHouse Gas (GHG) and Global Climate Change
- > Coal Fired Power Generation and Carbon Dioxide (CO₂)
- > The Albatross of Water and Dewatering Brown Coal
- > Exergen's Continuous HydroThermal Dewatering (CHTD)
- > Pathway to Sustainable Brown Coal Utilisation

Introduction to Thiess and Exergen

- > Thiess Pty Ltd and Exergen Pty Ltd
- > Beaconsfield and Burnie, Tasmania Australia
- > Professor Don Nicklin, AO
 - > Emeritus Professor and Ex Pro-Vice Chancellor, University of Queensland
 - > Exergen Pty Ltd Chairman and Co-Inventor Exergen CHTD Technology
 - > Independent Consultant, Principal of Niche Consulting Services
- > Mr Ian Kraemer
 - > Thiess' Resource Development Group, Business Development Manager
 - > Seconded to Exergen Pty Ltd as Group Project Manager
 - > Surface and Underground Coal Mine Manager



CO₂ Vs Temperature – Last ½ Million Years



(Source: International Panel on Climate Change -IPCC)

Upsala Glacier Argentina

(Source: Greenpeace)



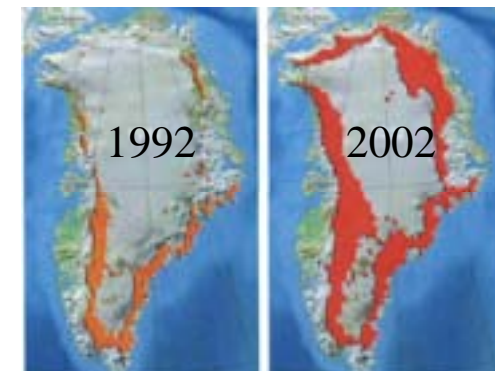
Great Ocean Conveyor Belt

(Source: IPCC)



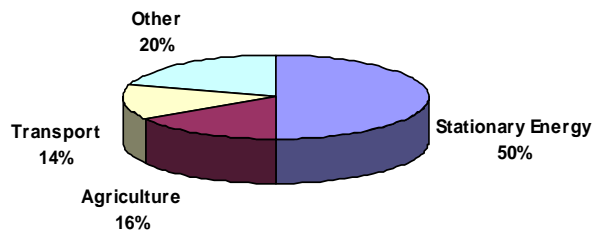
Greenland Ice Melt

(Source: ACIA)

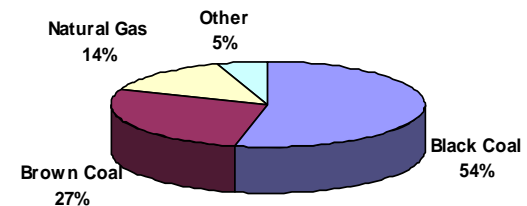


Sources of GHG – Specifically CO₂

Australian GHG Emissions by Sector 2005
(Source - AGO)



Australian Electricity Generation by Fuel 2005
(Source - ABARE)



Power Generation Emissions Intensity

Avg. tonnes CO_{2e} / MWhr_(sent out)

Brown Coal

1.2

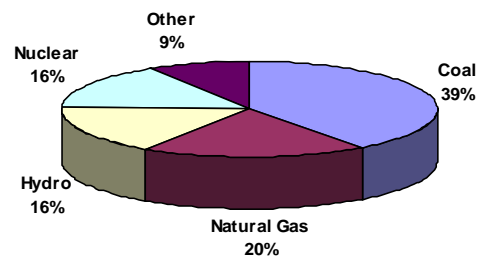
Black Coal

0.8

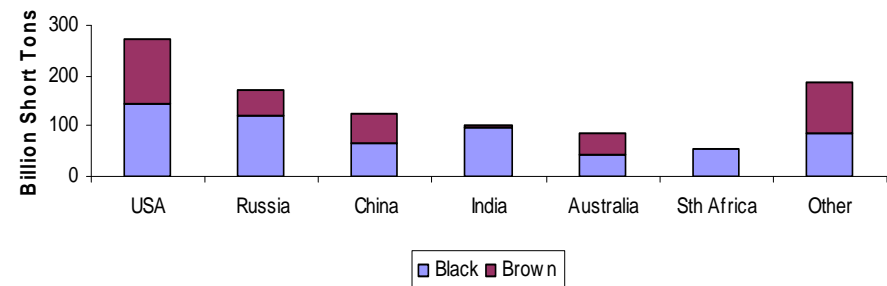
Natural Gas

0.4

Global Electricity Supply by Fuel 2004
(Source - EIA)



Global Coal Reserves 2005
(Source - EIA)



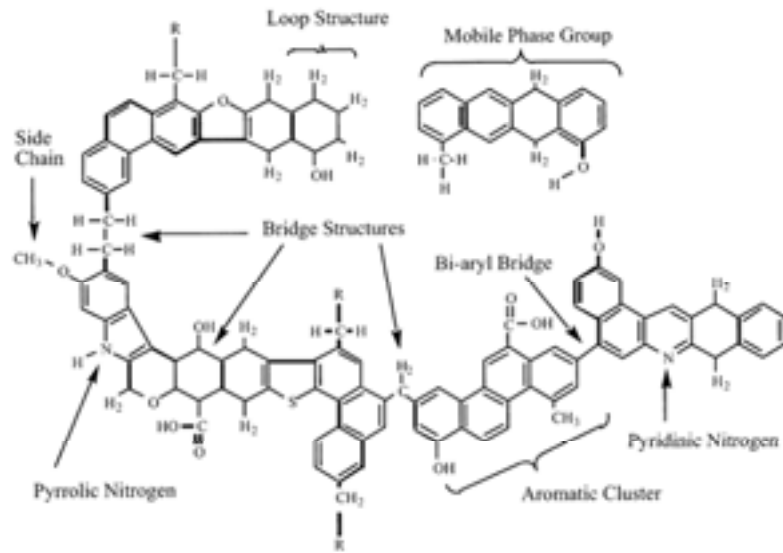


Macro Coalifaction - Decarboxylation

- > Carboniferous age trees pull CO₂ from laden atmosphere
- > Trees were progressively laid down as buried peat swamps
- > Gradual pressure converts peat to brown coal (30 to 70% water)
- > Depth pressure and temperature convert to black coal (5 to 30% water)
- > Progresses to Anthracite plus coal seam gas (CH₄ and CO₂)

Micro Coalifaction - Decarboxylation

Coal Structure



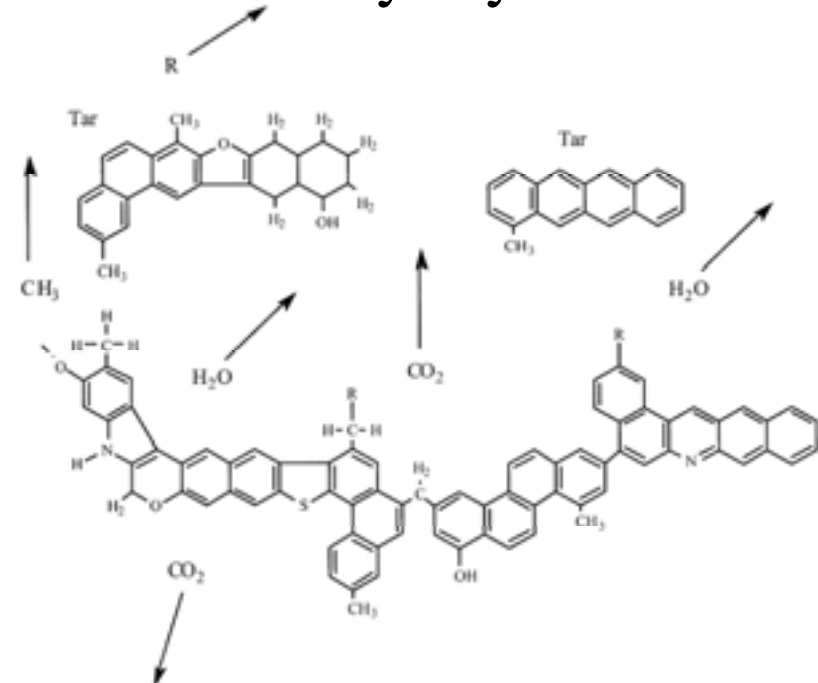
Peat



Lignite



Coal Pyrolysis



Bituminous



Anthracite



Brown Coal Vs Black Coal Power Stations



Heilbronn GER



Janschwalde GER



Herne GER

Benefits of burning Black Coal Vs Brown Coal for Power Generation	
Less energy to evaporate coal moisture	Smaller boiler required to burn coal
30% less GHG emissions	30% saving in capital cost of power station



Gladstone AUS



Liddell AUS



Jeffrey UK



Order of Magnitude Economic Comparison

- > 1000MW Black Coal Fired Power Station Capex = approx \$1.7 Bn
- > 1000MW Brown Coal Fired Power Station Capex = approx \$2.5 Bn
- > 1000MW Matched Capacity Exergen Predry Capex = approx \$0.3 Bn

- > Retrofit station reduces GHG emissions by 15% (assuming no changes to the steam cycle)

- > Retrofit station has potential to raise more power by adding steam turbines

- > New station can reduce GHG emissions by 30% by either a smaller station burning less coal or a same sized station raising more electricity

- > New station emissions benefit from less coal burned (15%) and higher heat efficiency due to higher temperature/pressure steam cycle (15%)



Historical Brown Coal Dewatering R&D

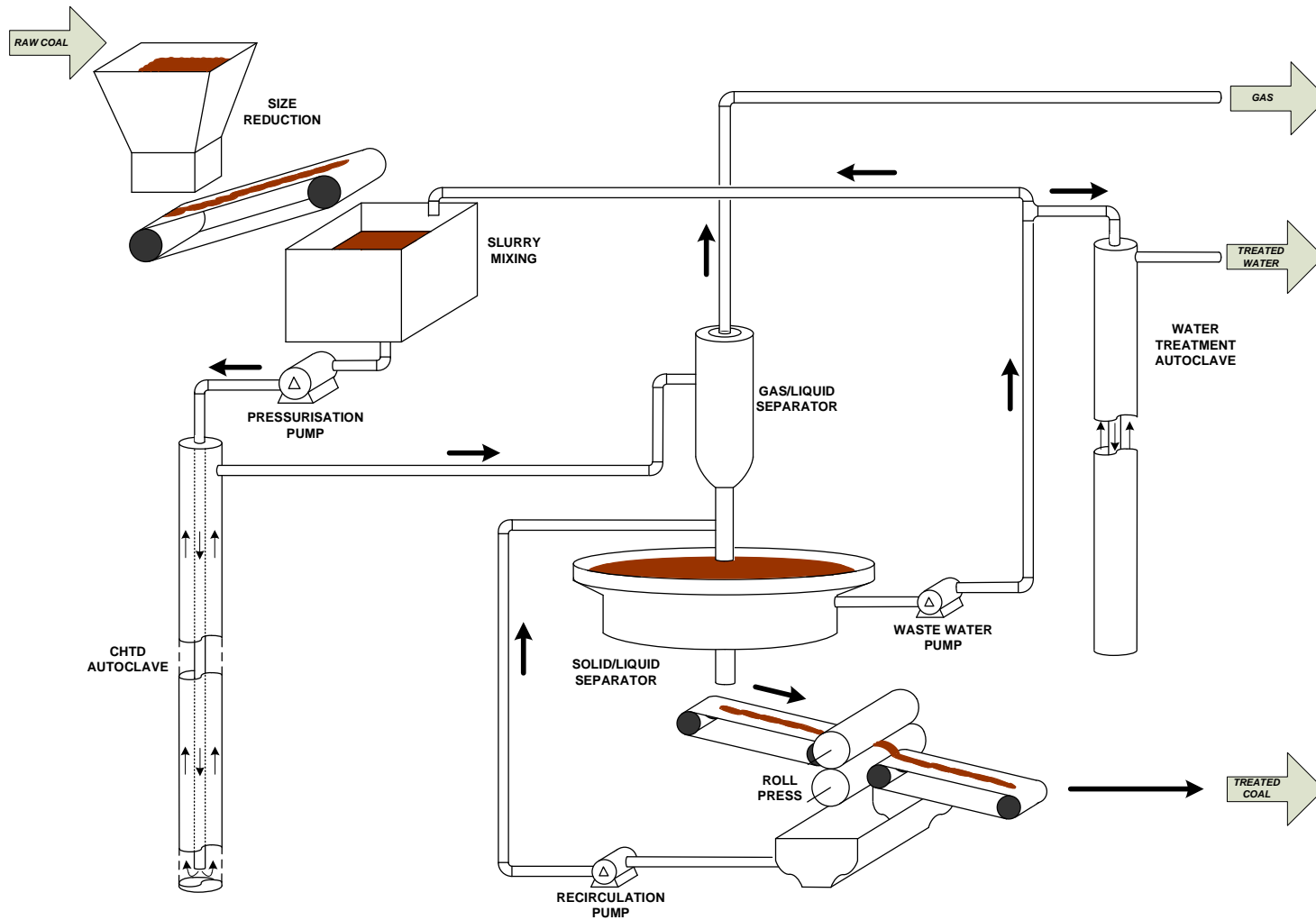
- > Brown coal is difficult to burn owing to high moisture content
- > 100 years and well over \$1Bn spent globally trying (unsuccessfully) to develop a commercially economic brown coal dewatering method
 - Exergen CHTD was originally conceived just 6 years ago, in 2001
 - Reached “Proof of Concept” at pilot plant in 2004/05 for initial \$6 million
 - Complete system demonstrated at pilot level by 2007/08 for additional \$6 million
- > Brown coal is under-utilised despite large deposits close to the surface
- > Brown coal remains as massive on-shore resources close to infrastructure
- > Only expensive to mine black coal, oil and natural gas resources are left
- > Brown coal is only 1/10th the cost of mining black coal (\$4/t Vs \$40/t)
- > Brown coal is low in ash and low in impurities, but very high in moisture
- > Dried brown coal will feed PF & IGCC Power Stations & CTL plants
- > Only the “Albatross” of moisture content holds brown coal back



Brown Coal Dewatering Technology

- > Global efforts since the early 1900's including work in the USA (UNDEERC), in Europe and Australia (SECV) have developed the following:
 - Direct Contact Drying – simple, evaporative, no GHG benefit
 - Waste Heat Briquetting – requires integration, evaporative, no GHG benefit
 - Steam Fluidised Bed Drying (SFBD) – requires integration, evaporative
 - Hydrothermal Dewatering (HTD) – required efficient continuous autoclave
 - Mechanical Thermal Expression (MTE) – batch process, difficulty up-scaling

Exergen Process Schematic





Exergen's Continuous HTD Autoclave

- > Uses hydrostatic pressure (gravity) to suppress boiling at the temperature necessary for hydrothermal treatment of brown coal
- > Pressure is applied continuously to coal slurry by circulating it through a vertical autoclave located in a deep (1000m) shaft
- > Combination of high temperature and pressure (300°C and 100bar) generated at the bottom of the shaft decarboxylates the coal
- > Decarboxylation ejects CO₂ from the coal structure in a concentrated stream suitable for geosequestration
- > When CO₂ is ejected the coal physically shrinks, expelling liquid water from its interstices in the process



Basis of the Exergen Technology

- > Decarboxylation removes Oxygen and in the process changes the product coal from Hydrophilic (water attracting) to Hydrophobic (water repelling)
- > Hydrophobic coal has reduced propensity for spontaneous combustion – e.g.: probable transportable, export quality, upgraded coal
- > The Decarboxylation reaction is exothermic and contributes energy to the process thereby reducing the need for process heat
- > A substantial proportion of the process heat requirements is derived directly from the cheap brown coal as opposed to being provided from expensive electrical power
- > Very high thermal and electrical efficiency. Electrical consumption less than savings in the power stations

Stage 1 Pilot Plant R&D 2002 - 2005

(\$6 million incl. \$2.6 million Gov't Grants and leveraged \$25 million mine infrastructure)



Coal Sample Trials (at 280°C & 70 bar)	Latrobe Valley	Otway Basin
Initial Coal Moisture Content	61%	47%
Moisture Content after Processing	48%	26%
Proportion of original water removed	41%	61%





Benefits from the Exergen Technology

- > Removes water in the liquid phase providing >40% of power station process and cooling water demand
- > Proportional removal of soluble salts (sodium and potassium) content of the coal has been demonstrated
- > The process cleans organics (mainly ultra fine coal) from the removed water by settlement
- > A 12% reduction in coal sulphur content has been achieved (up to 40% with the addition of lime)
- > Enables up to 30% reduced emission coal fired power generation (new and retrofit), coal gasification, liquefaction and export coal production



Stage 2 Pilot Plant R&D in 2006 - 2008

(Additional \$6 million investment including \$2 million Australian Government Grant)

- > High temperature/pressure pilot plant upgrade to operate at 300°C and 100bar (completed early 2007)
- > CHTD trials on various coals (Otway Basin & Latrobe Valley from Victoria, currently Indonesian and New Zealand coals) to determine performance
- > Continuous roll press dewatering shows ability to provide low-cost incremental dewatering and a compacted product for easy handling (moistures <20% have been demonstrated on Mulia coal from Indonesia)
- > Advanced designs and costs for various throughputs at 100 – 3500 tph (in progress)
- > Transportability, dried coal combustion, gasification and boiler modelling studies
- > Wastewater treatment studies and pilot plant demonstration trials



Current Development and Application

- > Batch pressing tests have shown the ability to produce CHTD coal of moisture content <20%
- > Traditional direct contact air drying has demonstrated production of a stable product of moisture content <9% (c.f. >12% for non-treated coal)
- > Continuous roll pressing is being developed as a more effective means for solid liquid separation
- > Exergen CHTD coal delivers advantages to all downstream uses such as advanced steam cycles, gasification for power generation or for production of liquid fuels and other domestic and export coal end uses
- > Simple and effective waste water treatment systems have been tested successfully providing confidence that this valuable resource will be harnessed

Stage 2 Pilot Plant in 2006 - 2008



Coal Sample Trials (at 300°C & 100 bar)	Latrobe Valley	Otway Basin	Indonesia
Initial Coal Moisture Content	65%	45%	35%
Moisture Content after Processing	31%	19%	16%
Moisture Content after Drying	9%	9%	9%
Proportion of salts removed	60%	70%	
Proportion of Sulfur removed	26%	40%	





Pathway to Sustainable Brown Coal

Stage 1: Construction of a proof-of-concept pilot plant with a capacity of 4tpd at a cost (including associated R&D) of \$6 million

This stage has been completed

Stage 2: Upgrade the pilot plant to full operating conditions (300°C and 100bar) required for a commercial demonstration plant and complete downstream water treatment and other technology improvements for \$6 million

The upgraded pilot plant is now being used to test various coals

Stage 3: Construction and operation of a 200 – 350 tph demonstration dewatering plant in the Latrobe Valley situated on an allocated coal resource of a size capable of supporting a +1000MW power station development

Feasibility design work is ongoing based on pilot plant outcomes

Stage 4: Construction and operation of power generating equipment of the latest proven technology (initially 200 – 350MW, expanding to +1000MW). This power station, with integrated dewatering, will represent the first low emission next generation power station in the Latrobe Valley

Thiess & Exergen thank you - Questions?

