Coal Pyrolysis

a sustainable option for

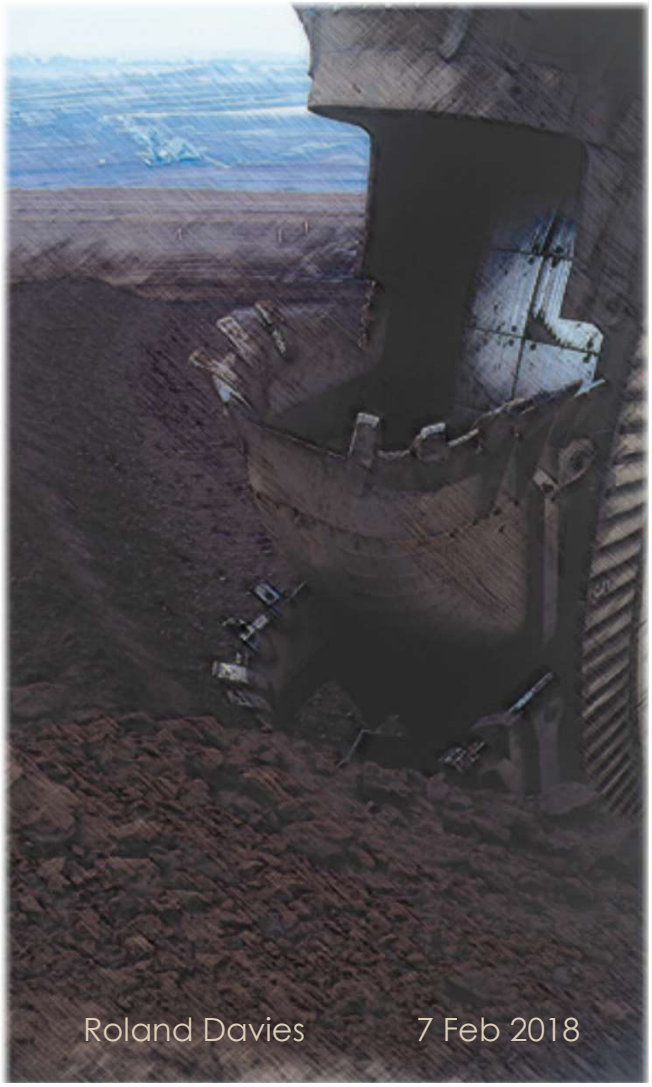
Victorian Brown Coal

in a carbon constrained world

- *Sustainable Prosperity: The 5-P's*
- *Energy Policy Perspective*
- *Energy Evolution & Innovation*
- *Australia's Energy Resources*
- *Key Brown Coal Characteristics*
- *The Size of the Prize*
- *Coal Energy Australia*
- *CarbonTech Project*
- *Pyrolysis Wrap*

BROWN COAL INNOVATION AUSTRALIA

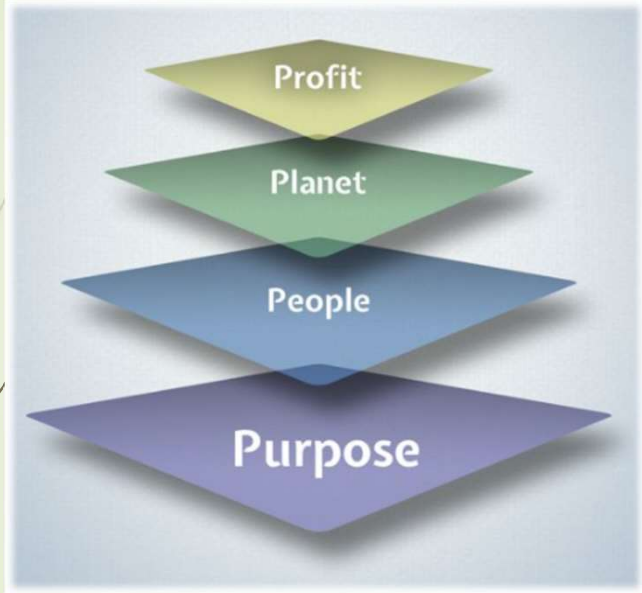
BCIA - Carbon to Products Seminar



Roland Davies 7 Feb 2018

Quadruple Bottom Line

Achieving Sustainable Prosperity - The 4-P's that grew to 5-P's



- People – Quality of Life
- Profit – Competitive Productivity
- Planet – Sustainable Ecosystems
- Purpose – Raison d'être
- Progress – Adaptive Innovation

The Pyrolysis of Victorian Brown Coal can achieve Sustainable Prosperity from Victoria's abundant Brown Coal Resources for the benefit of the Region

Energy Policy Context

The Hon Ian Macfarlane MP
Minister for Energy. Foreword,
BREE: Energy in Australia 2014

"Australia's economy and prosperity are built on access to secure affordable and reliable energy.

Our energy diversity is one of Australia's natural strengths and one of our best competitive advantages.

This diversity provides Australian homes and businesses access to the energy needed to build our industries and our communities.

The depth of the Australian energy resource base will support continued energy production well into the future."

By 2017, BREE messaging had changed to: "The type of energy we use and how we use this energy is changing, as new technologies are adopted, as our economy changes in structure and as our awareness of our energy use grows".

Australian Energy Status

Something Went Terribly Wrong . . . . .

Turnbull warns Australia is "in the middle of an Energy Crisis"

Weatherill slams the Federal Government's plan to expand the Snowy Hydro scheme, which he labelled a "$2 billion insult"

"I'm not some rampant greenie who thinks there's no place for fossil fuels in our energy mix".

1. 50% renewable target by 2030
2. Reduce emissions across the economy by 45% by 2030
3. Labor joins with Greens in the Senate to pass a motion to "encourage" the closure of coal fired power stations

Energy Policy

Energy Industry View (*My Perspective*)

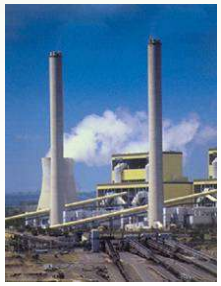
- Australia is moving into a carbon constrained future, which provides a pathway for the gradual decarbonisation of energy by 2050.
- Fossil Fuel and Renewable energy resources will continue to make a significant contribution to Australia's Energy mix in the intervening period.
- The community expects safe, reliable, affordable and sustainable energy options to be available.
- The energy industry has a key role to play in gradually reducing emissions while continuing to provide secure and affordable energy for Australian households and businesses.

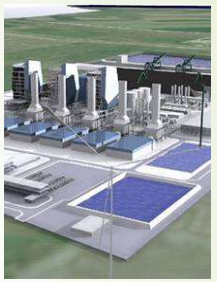
Victoria has abundant natural energy resources that can be leveraged in a sustainable way, to bring significant economic value, employment and prosperity to the Region

Energy Evolution & Innovation

1900's – 1970's	1970's – 2000's	2000's – 2050's








- Fossil Fuel and Renewable energy technologies have been evolving for over 100 years to meet the worlds energy needs
- Australia has been a valuable contributor to global energy innovation
- The future outlook for coal is for a broader range of energy products with greater focus on the environmental impact and sustainability of projects

Fossil Fuel resources still provide over 80% of Australia's Electricity needs

Community expectations are always met over time!

Australia's Energy Resources

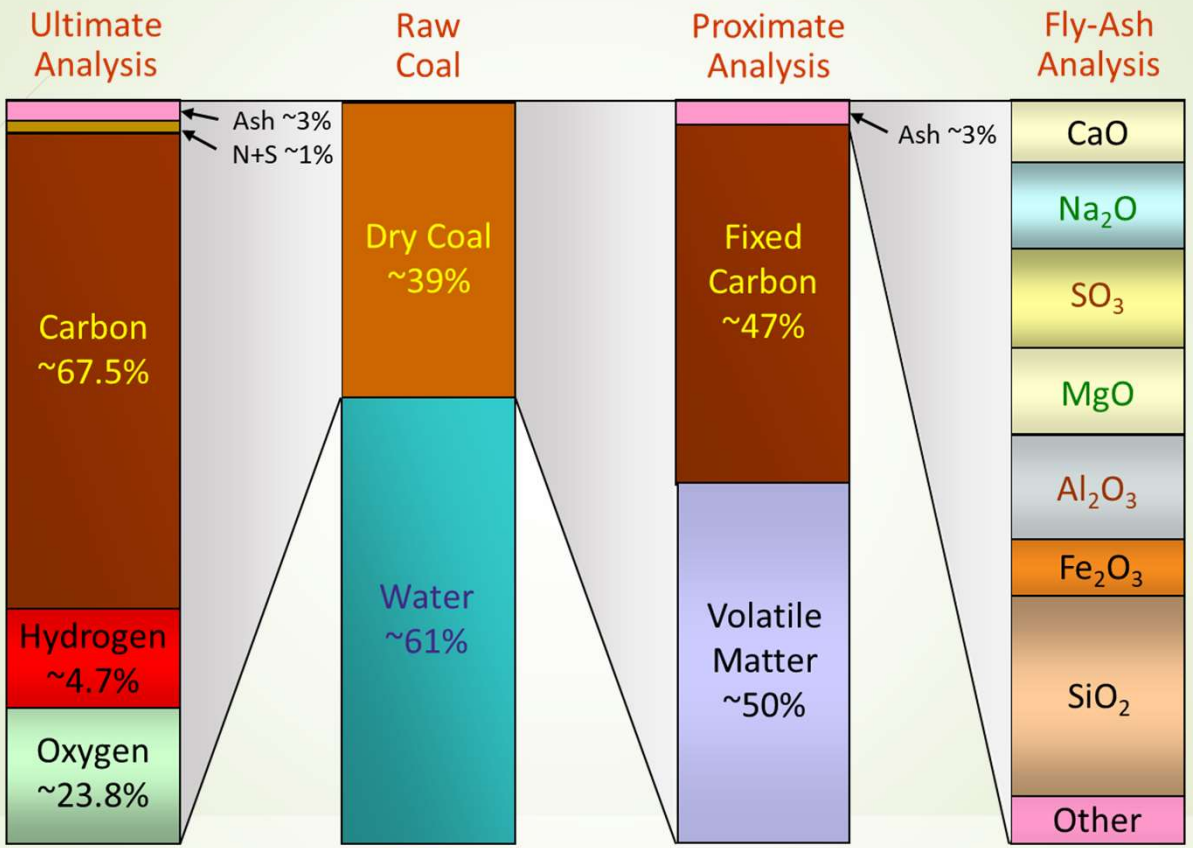
	Resource	Unit	Energy (PJ)	World Share	Australian Share	Resource to Production*
Coal	Brown Coal	44 Gt	454,889	22.0%	15.6%	510 Years
	Black Coal	62 Gt	1,691,468	9.0%	57.9%	110 Years
Oil	Crude	856 Mbbl	5,038	0.2%	0.2%	7-10 Years
	LPG	959 Mbbl	4,118	na	0.1%	16 Years
	Condensate	1,938 Mbbl	11,403	na	0.4%	25 years
Gas	Conventional	2.83 tcm	110,120	1.6%	3.8%	51 Years
	Coal Seam gas	1.16 tcm	45,013	na	1.5%	150 Years
Uranium		1167 Kt	601,005	34.0%	20.6%	170 Years

*R to P based on 2012 production

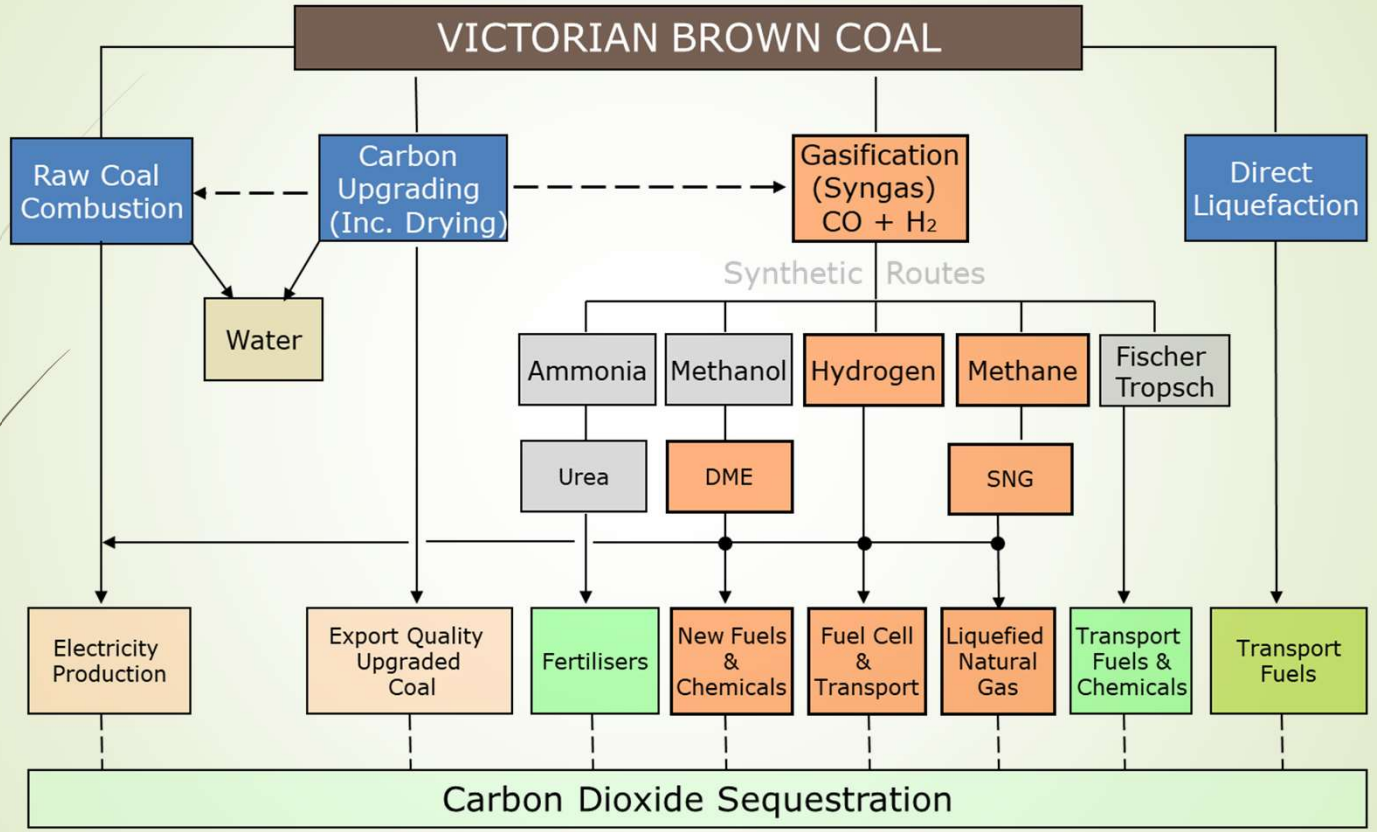
Source: BREE Energy in Aust - 2014

The Region has abundant Energy Reserves to underpin future Coal Developments

Brown Coal Key Characteristics



Brown Coal Product Pathways



Brian Davey
ALDP 2012

The Size of the Prize

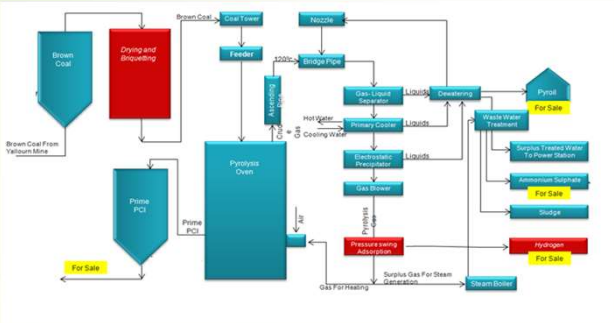
Diverse Range of Energy Products Possible

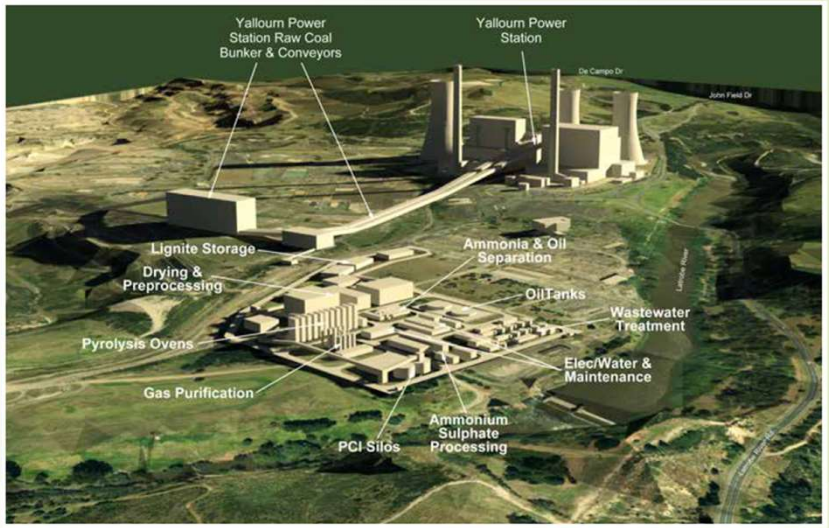
1 Mtpa Coal	GSP $/t-coal	GATE PRICE	PRODUCTION	GSP	INVESTMENT @1Mtpa Rate	GSP : Capex Ratio
Raw Coal	$ 13/t-coal	$ 13/t	1.00 Mt/a	$ 13 M	$ 50 M	26%
Briquette	$ 73/t-coal	$ 175/t	418 Kt/a	$ 73 M	$ 50 M	146%
Char	$ 83/t-coal	$ 475/t	175 Kt/a	$ 83 M	$ 145 M	57%
Activated Carbon	$ 141/t-coal	$ 1,350/t	104 Kt/a	$ 141 M	$ 260 M	54%
Electricity	$ 100/t-coal	$ 100/MWh	1 TWh/a	$ 100 M	$ 400 M	25%
SNG	$ 72/t-coal	$ 8.00/GJ	9.0 PJ/a	$ 72 M	$ 335 M	21%
Diesel	$ 98/t-coal	$ 0.63/Litre	156 ML/a	$ 98 M	$ 500 M	20%
UREA	$ 110/t-coal	$ 275/t	400 Kt/a	$ 110 M	$ 400 M	28%
Average	$ 97/t-coal	* (Excl Raw Coal)		$ 97 M *	$ 299 M *	47%
Total Average GSP value of Victoria's 33Bt of coal =			$ 3,191 Bn			

* If Raw Coal is included - Average $/t = $86.20 and Total Avg GSP = $2,844 Bn

Coal Energy Australia

- CEA has been developing the ALDP Coal Pyrolysis Project since 2012.
- Extensive knowledge has been gained about the Resources, Processes and Markets for the Pyrolysis of Victorian Brown Coal.
- The ALDP Project is framed to convert 2.7 Mt of low-value Victorian Brown Coal into high value commodities for domestic and international markets:
  - High Quality Semi-Coke (PCI);
  - Pyrolysis Tars & Oils;
  - Coal Gas; and
  - Ammonium Sulfate.

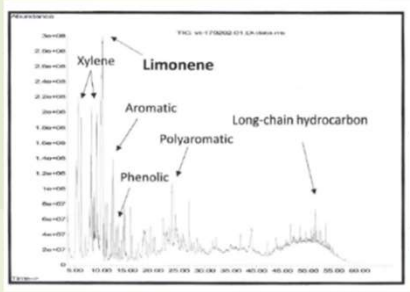


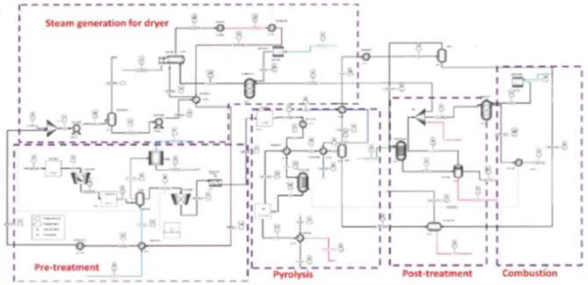


Science & Innovation

CEA has invested in innovation through a portfolio of R&D working in conjunction with leading Research Institutes and Universities:

- Evaluation of options for the production of low cost CO_2-free Hydrogen by pyrolysis of Victorian brown coal (BCIA Grant).
- Development of non-polyamide-based polymer membranes for efficient water processing (ARC Grant).
- Brown Coal Spontaneous Combustion - Critical Ignition Testing.
- Post-Doctoral Works (CEA):
  - Co-Pyrolysis of Brown Coal and Scrap Tyres; and
  - Novel Hybrid Membranes (Photothermal Membrane Distillation).Briquettes, using enhanced existing technologies;





CEA Product Optimisation Workshop

Key Findings

A range of perspectives were presented at the POW, which provided guidance as to the types of markets, key product characteristics and specific requirements and constraints (CSR, CRI, Volatiles, Sulphur, Ash, Phosphorous, Volatiles, Size, etc):

Briquettes	Char	Activated Carbon
› Industrial boilers	› Re-carburising	› Pollution control
› Char Feedstock	› Magnesium	› Water treatment
› Power Stn Aux Fuel	› Ferro alloys	› Gas Clean-up
› Domestic fuel	› Silicon and FeSi	› Gold processing
	› BBQ fuel Feedstock	› Mercury Removal
	› Metallurgical Apps	› Food and Medical
	› Calcium Carbide	› Pharmaceutical

CarbonTech Project

Coal Energy Australia – Gippsland Infrastructure

CarbonTech Project

Project Overview

CarbonTech will see the re-establishment of Drying and Briquetting operations at the Energy Brix Site in Morwell.

The project will incorporate new pyrolysis technology to produce a range of valuable carbon products to meet existing and projected market needs:

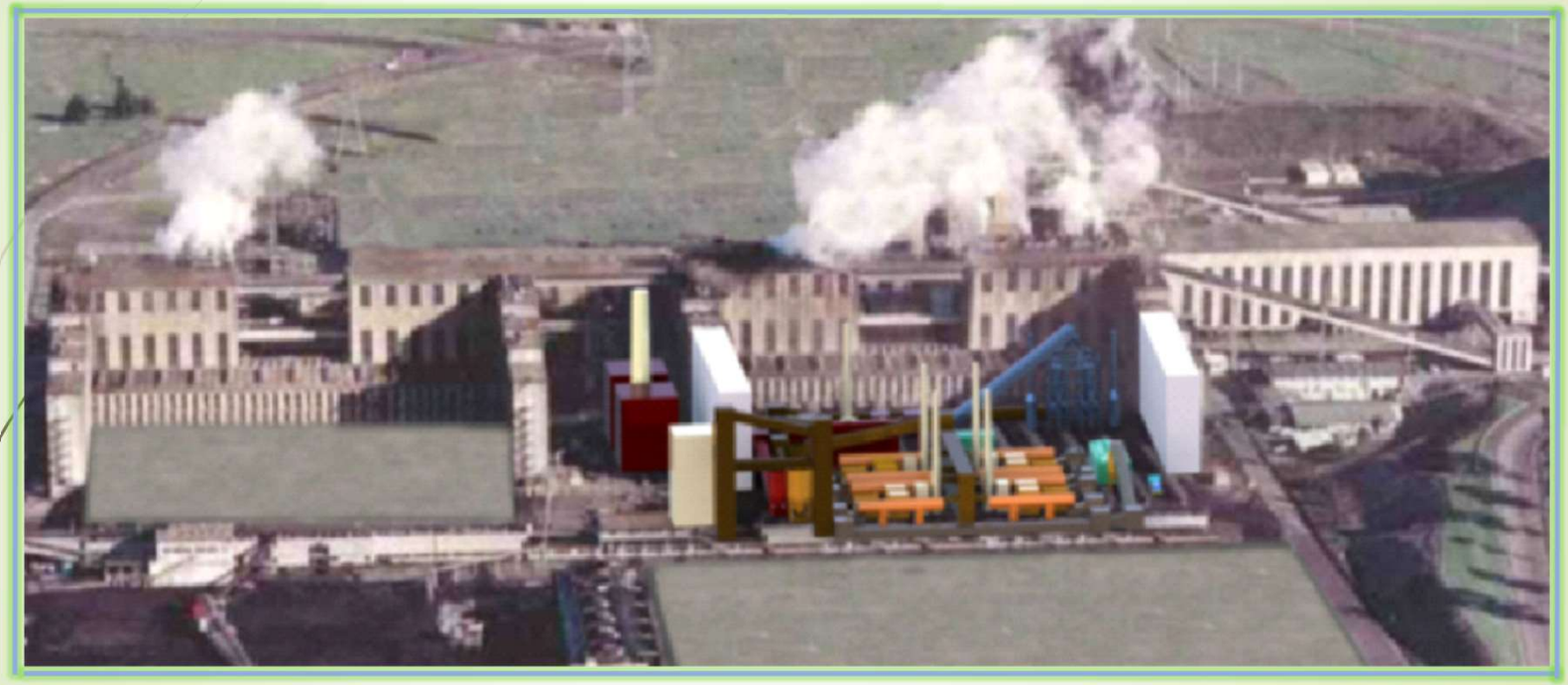
- Briquettes;
- Low Volatile Char; and
- Activated Carbon.

Long-term sustainability is a strategic imperative for the site, including the:

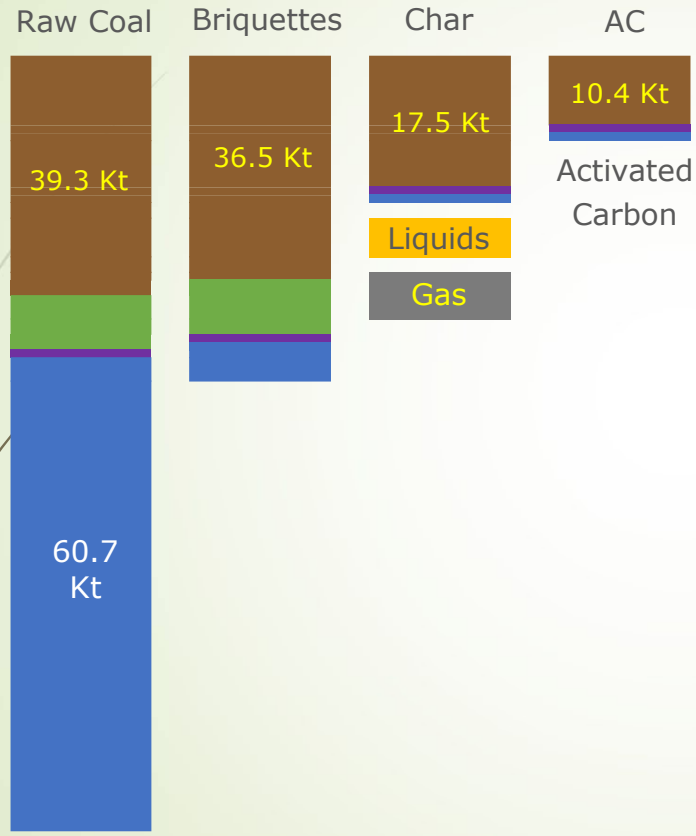
- Beneficial use of Process By-products;
- Integration of Renewables; and
- Development of Emission Reduction Technologies.

CarbonTech Project

Coal Energy Australia – Gippsland Infrastructure



Pyrolysis Product Yield



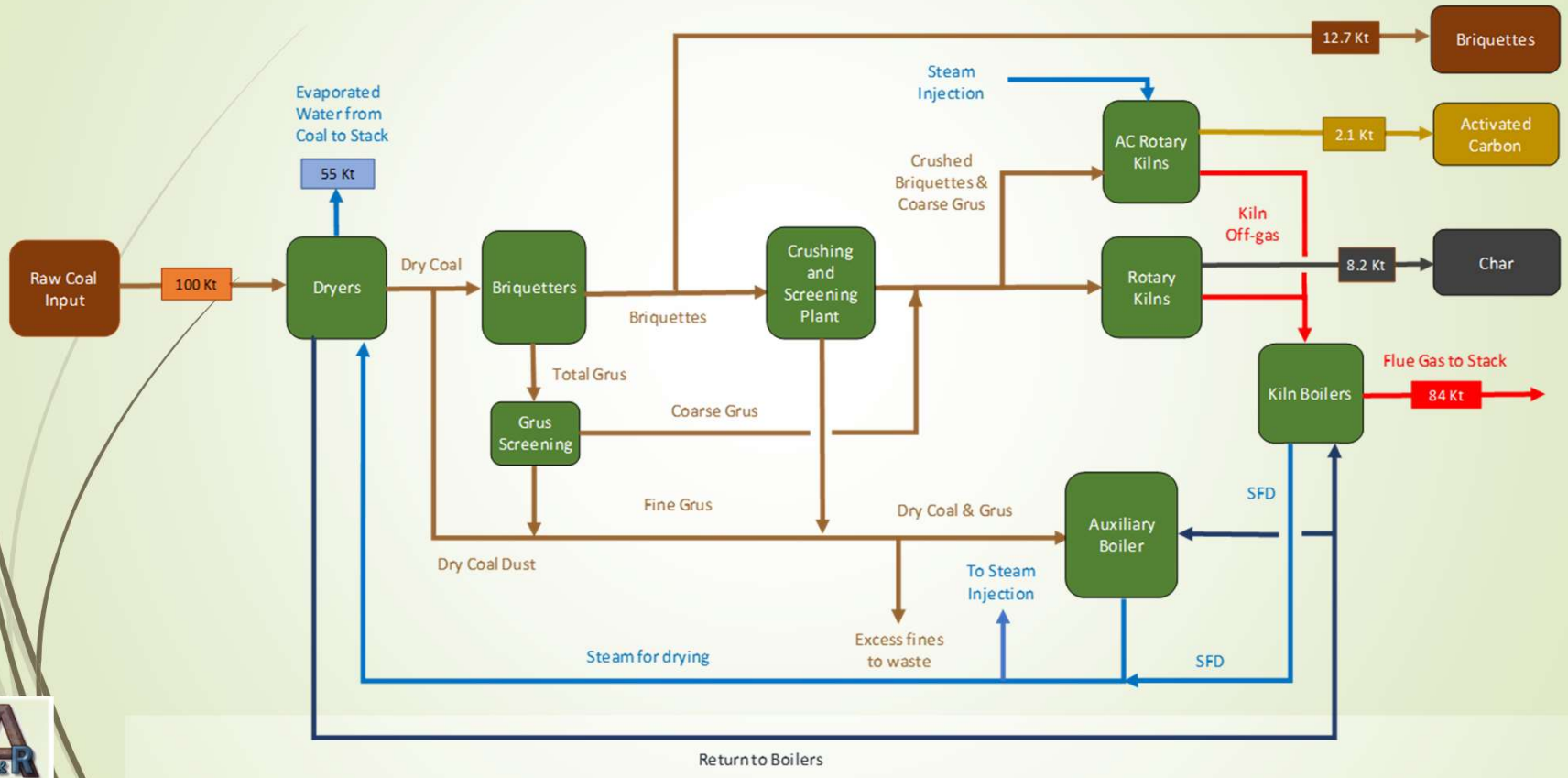
Tar & Liquid Products

- Penatnone-Hydrox-Methl
- Phenol
- P-Cresol
- Napthalene

Coal Gas Products

- Methane
- Hydrogen] ~30%
- Ethylene
- Ethane
- Carbon Dioxide
- Carbon Monoxide ~33%

CarbonTech Process Flow



Pyrolysis Wrap – A 5-P's Snapshot

The Latrobe Valley has abundant Coal Resources able to underpin coal based projects for decades (33 Bt).

The Economic Value available from those resources "Potential Value Add" exceeds $ 3,000 Bn ($3 Trillion).

Substantial knowledge already exists on Brown Coal and its Utilisation, but new Research & Development is needed to underpin the "***Adaptive Innovation*".**

Pyrolysis is an attractive pathway to achieve "***Sustainable Prosperity*"** from Victorian Brown Coal.

The CarbonTech Project:

- Will leverage proven Drying & Briquetting technologies at Energy Brix;
- Is well researched and has a clear "***Purpose***" to deliver contemporary Energy Products from Victorian Brown Coal;
- Will deliver Investment and Jobs Outcomes for the Region "***People***"; and
- Will achieve the Victorian Government Coal Statement Standards "***Planet***".