DEVELOPMENT AND USE OF VICTORIAN BROWN COALS

LOCATION AND DISCOVERY

Many isolated discoveries of brown coal were made around Victoria from 1860, many as a result of drilling for gold, black coal or water. The most significant were in the Latrobe Valley from 1873 to 1900 when more systematic exploration was undertaken by the Mines Department.

HISTORY OF DEVELOPMENT OF MINES AND MAJOR PLANTS

1888-1963	**Great Morwell Coal Mine / Yallourn North Mine**	Intermittent production 5 kt/yr to 1.5 Mt/yr
1922 ⇨	**Yallourn Mine**	Capacity up to 18 Mt/yr
1924-1971	Yallourn Briquette Factory	Peak capacity 700 kt/year
1924-1968	Yallourn A Power Station	12 Chain grate boilers total 75 MW
1932-1970	Yallourn B Power Station	10 Chain grate boilers total 100 MW
1954-1985	Yallourn C Power Station	6x20 MW First pulverised fuel boilers
1958-1987	Yallourn D Power Station	6x20 MW
1961-1989	Yallourn E Power Station	2x120 MW
1973-1982	Start up Yallourn W Units	2x350 MW and 2x375 MW First boilers with separation firing
1956 ⇨	**Morwell/Hazelwood Mine**	Capacity up to 20 Mt/yr
1956-1970	Gas & Fuel Corp Lurgi Briquette Gasification Plant	700,000 m^3/day town gas
1959-2014	Morwell Briquette & Power Complex	1.2 Mt/yr briquettes and cogen PS 170 MW (8x25MW units)
1964-1971	Start up Hazelwood PS Units	8x200 MW
1970-2014	Australian Char Pyrolysis Plant	80 kt/yr char from 180 kt briquettes
1956-1988	**Yallourn North Extension Mine**	Production up to 1.5 Mt/yr
1959-2015	**Anglesea Mine**	1.1 Mt/yr
1969-2015	Anglesea Power Station	1x150 MW
1984 ⇨	**Loy Yang Mine**	Capacity up to 30 Mt/yr
1985-1987	Start up Loy Yang A PS Units	4x500 MW with separation firing
1992-2003	Lurgi Steam Fluid Bed Drying Plant	Design Capacity 125 kt dry pf/yr
1993, 1996	Start up Loy Yang B PS Units	2x500 MW with separation firing

OTHER SIGNIFICANT DEVELOPMENTS

1967-1999	Bulk briquette exports to Japan and Korea
1985-1991	Operation of NBCL brown coal liquefaction pilot plant
1992 - 1994	HRL 1 t/h slurry HTD pilot plant (also at CRC and JGC)
1993-1995	Privatisation of SECV
1997-1999	HRL 10 MW IDGCC Development Facility operation
2004 -	Exergen 4 t/hr CHTD drying pilot plant in Tasmania
2008-2009	MTE 15 t/hr Coal Drying Demonstration Plant at Loy Yang
2008 -	CSIRO Carbon Capture pilot plant at AGL Loy Yang
2009 -	CO2CRC Carbon Capture pilot plant at GDF-Suez Hazelwood
2014 -	Advanced Lignite Development Program successful bidders announced
2015 -	Direct Injection Coal Engine trials on brown coal feedstocks

DEVELOPMENT OF OPEN CUT MINING TECHNOLOGY

To 1921	Pick and Shovel with delivery by wheel barrows and horse drawn wagons
1922	Mechanical Shovels, with horse drawn wagons and ropeways to surface,
1929	Bucket Chain dredgers introduced in combination with shovels and narrow gauge electric railways on benches
1950	Bucket Wheel dredgers introduced, operating in combination with bucket chain dredgers. Shift to movable conveyor belts
From 1960	New dredgers all of bucket wheel design. The Loy Yang mine has 4 dredgers digging up to 3,750 t coal/hr delivering 30 Mt/yr of coal to the raw coal bunker with about 19 hrs capacity to supply Loy Yang A & B power stations. Transport is by 2 m wide conveyors travelling up to 7 km at 5.2 m/s
2002	Bulldozer Mining, pushing coal down the slope and feeding to in-line crushers and conveyors - replacing dredgers at Yallourn Mine

DEVELOPMENT OF POWER GENERATION TECHNOLOGY

1924	6 - 10 MW Chain Grate Boilers	Yallourn A & B Stations
1954	20 MW Pulverized Fuel (PF) Boilers with milling/drying in recycled flue gas from the furnace	Yallourn C&D and Morwell Stations
1961	120 MW PF Boilers with flue gas drying	Yallourn E Station
1964	200 MW PF Boilers with flue gas drying	Hazelwood Station
1973	350-375 MW PF Boilers with separation firing	Yallourn W Station
1984	500 MW PF Boilers with separation firing	Loy Yang A & B Stations
1997	10 MW Integrated Drying Gasification Combined Cycle (IDGCC) Development Facility	HRL
2015	DICE trials at 1MW scale	Joint with overseas parties

CARBON CAPTURE AND STORAGE

2008 Active programs of Post Combustion Carbon Capture R&D at Loy Yang A and Hazelwood commenced

2008 Otway CO_2 storage trial by CO2CRC (65,000 t)nd

2009 CarbonNet Project - Exploration for and assessment of suitable storage locations, with Gippsland Basin very prospective. CarbonNet aims to draw this activity together for a 1-5 Mt CO_2/yr demonstration program currently at the feasibility study stage.

DRYING TECHNOLOGY

65 Mt/yr of brown coal has been dried in flash mill entrained flow drying with hot recycled flue gas, the technology used in all current Latrobe Valley power stations. Entrained flow drying was also used in the raw brown as a component of HRL's IDGCC advanced power generation development plant.

Up to 5 Mt/yr of brown coal was dried in the 2 briquette factories in rotary steam drum driers with 'coal in tube' for enhanced safety and control.

Steam fluidised bed drying was demonstrated in Lurgi's plant at Loy Yang with a design capacity of 125 kt/yr. The plant supplied auxiliary start up fuel to Loy Yang B PS through a 3 km long 50 mm diameter pipe.

OTHER PILOT PLANT DEVELOPMENTS INVESTIGATED:

Oil slurry drying as at NBCL pilot plant Morwell and UBC briquetting plant

HydroThermal Dewatering in batch lump system (Fleissner Process - University of Melbourne Kawasaki - DK process), and slurry processing (SECV/HRL, Lignite CRC, JGC/Japan COM, Exergen)

MTE (Mechanical Thermal Expression) demonstrated in 15 t/hr pilot plant at Loy Yang by Lignite CRC.

BRIQUETTING

The Yallourn (1924-1971) and Morwell (1959-2014) Briquette Factories used German Exter extrusion press technology and produced a combined peak of over 2 Mt/yr in 1966 before the introduction of natural gas. Briquette quality and plant performance was sensitive to lithotype, ash content and composition, optimum particle size distribution and optimum moisture content. The process could produce an export quality product, which has not been matched by attempts to reduce costs with other briquetting technologies such as double roll presses.

GASIFICATION

FIXED BED GASIFICATION

Gas & Fuel Corporation built and operated an oxygen blown Lurgi plant at Morwell from 1956-1970, to produce town gas from briquettes. It required several years development for the commercial plant to overcome unexpected problems with ash behaviour in the reactors. However, the plant closed due to the introduction of cheap natural gas.

FLUID BED GASIFICATION

The HRL IDGCC plant successfully demonstrated fluidised bed air blown gasification of crushed brown coal, adapted from High Temperature Winkler (HTW) gasification. Attention was needed to prevent local high temperatures where air was injected into reactor which could produce ash agglomerates.

ENTRAINED FLOW GASIFICATION

Several trials have been conducted on Victorian brown coals in Germany to simulate Shell/Siemens type entrained flow gasification for proposals to produce liquid fuels and chemicals from brown coal. A commercial development is still awaited. The potential for sodium to volatilise in the reactor and deposit in the gas cooler needed to be addressed.

CARBONISATION/PYROLYSIS

Commercial pyrolysis experience with moving bed shaft retorts at Australian Char and Gippsland Cement and Lime P/L.

Research on fluid bed pyrolysis and flash pyrolysis at CSIRO in 1980's..

LIQUEFACTION

- Direct hydrogenation (NBCL, Rheinbraun)
- Solvent extraction (KOMINIC, Mitsui SRC)
- Gasification and synthesis studies (Monash Energy and others)
- Pyrolysis tars from Australian Char, CSIRO Research, Eastern German proposals

ACTIVATED CARBON

- Local pilot testing on a range of activated carbon grades, including gold recovery carbons by Coal Corp Victoria. Trials also by Auschar
- Trial production of steam activation of briquettes in old Colonial Gas Co coal gasification plants in Victoria
- Pilot trials with low ash Loy Yang briquettes in Japan by major activated carbon producers - technically successful.

AGRICULTURAL PRODUCTS

Brown coal is a source of humates, slow release fertilisers and soil conditioners. Omnia Australia produces a range of humate products at Morwell and humates were previously produced in Japan by 'Japan Metals and Chemicals' from imported Victorian brown coal briquettes.