The Coal Research Forum. 18th Annual Meeting and Advanced Power Generation Divisional Meeting.

"Zero Emissions Power – Current Developments". Rugeley Power Station, Wednesday 20th June 2007

International Power's CCS Initiatives.

Andrew Sinclair

Operations and Engineering

About International Power

- 1990 – National Power created out of the break-up of the CEGB by the privatisation of the UK electricity industry.
- 2000 – Demerged UK generation and retail business from National Power as Innogy (now RWE nPower) and renamed company International Power (IPR).
- 2007 – 40 operational assets in 19 countries, 34 GW gross with three additional plants under construction in the Middle East.
- In the UK, International Power own and operate 4 GW net of generation with plants at Dinorwig, Ffestiniog (pumped storage), Deeside, Saltend (CCGT), Indian Queens (OCGT), Derwent (CoGen) and Rugeley (Coal).

International Power Coal Fleet

Operational

- Rugeley, UK – 2 x 500 MW units – operational 1970
- Pego, Portugal – 2 x 314 MW units – operational 1993
- Opatovice, Czech Republic – 6 x 60 MW units
- Paiton I, Indonesia – 2 x 615 MW units – operational 1999
- Hazelwood, Australia – 8 x 200 MW units – operational 1964
- Loy Yang B, Australia – 2 x 505 MW units – operational 1993
- Coleto Creek, USA – 1 x 632 MW unit – operational 1980

Under development

- Paiton III, Indonesia – 1 x 800 MW supercritical
- Mmamabula, Botswana – 3 x 900 MW supercritical

IPR - Carbon Reduction Review

- Biomass co-firing – Immediate CO_2 reductions, rapid implementation.
  - Rugeley 2003 – 2006, commercial scale installation.
  - Hazelwood 2005 – 2006, pilot plant and small-scale commercial.
- Cycle optimisation – Immediate CO_2 reductions, short-term implementation.
  - Hazelwood 2030, new turbines, flue gas heat recovery and coal drying.
  - Rugeley 2008, new HP turbines.
- Dedicated Biomass – Reduced CO_2 , new generation.
  - IPR Opatovice, 100MWe CFB with 100% biomass capability.
  - “Biox”, developing portfolio of small-scale bio-fuel generating plant.
- Post Combustion CO_2 Capture.
  - Hazelwood 2030, 25tpd pilot plant with 16tpd chemical sequestration.
  - Investigating cryogenic separation of CO_2 using LNG re-gasification facility integrated with CCGT.
- Other:
  - 34% owner of the ISAB IGCC in Italy (refinery residues rather than coal), gaining valuable operational data on IGCC plant

International Power, Hazelwood

Hazelwood Power Station

Latrobe Valley, Victoria, Australia.

1,635 MW gross

8 x units (non-reheat)

Brown coal supplied by integrated open cast mine

Hazelwood 2030 Project

- Package of CO_2 reduction measures at Hazelwood Power Station, Victoria, Australia.
- Part-funded through Australian Federal and State grants.
- Cycle optimisation on earliest two units (1964 and 1966), including new turbines and installation of feed heating surface after the precipitators (replaces HP heaters removed due to reliability problems in early 90's).
- Retrofit of pre-combustion coal drying to the oldest unit [RWE developed WTA process] and installation of new low-NOx burners with over-fire air and flue gas recirculation – sized for 50% BMCR heat input.
- 25 tpd post combustion capture, to be run on commercial basis, with possible expansion to 50 tpd. Includes 16 tpd sequestration in calcium carbonate.

Hazelwood 2030 – Why Hazelwood?

- Greenhouse Intensity – 1.549 te CO_{2e} / MWh s.o.
- Oldest of the Latrobe Valley Base Load Stations with Unit 1 commissioned in 1964.
- Small, relatively inefficient, units (200MWe, 28% cycle efficiency LHV basis), requiring significant ongoing investment.
- Various forward curves suggests new base-load generation required early to mid next decade. Legislative environment will require 0.8te CO_{2e} /MWh s.o. or better.
- Current clean coal technologies such as IGCC not commercially proven for low-ranked coals (61 – 68% water total moisture content).

Hazelwood 2030 Objectives – Part 1

- Demonstrate and commercialise the technologies required for the next generation of reduced-carbon, base-load lignite generation (0.7 – 0.8 te CO_{2e}/MWh s.o.) – when combined with ultra-supercritical technology.
- Demonstrate Carbon Capture technology on a commercial basis
- Demonstrate that the technologies can be retrofitted to existing stations, so as to facilitate immediate large-scale reductions.
- Reduce CO2 emissions by > 10.0Mt per annum, for the Australian stationary generation sector, by 2020 (assuming that the technologies are taken up, subject to commercial drivers being in place).

Hazelwood 2030 Objectives – Part 2

- Unit 1: Reduction in G.I. - 21% from current for 50% dried coal retrofit [100% dried coal retrofit would give Unit G.I. of 1.20 te CO_{2e} / MWh s.o.]
- Unit 1: Increase in cycle efficiency – 7.5% (LHV).
- Unit 1: Additional Output – 15MWe. **
- Unit 2: Reduction in G.I. – 15% from current.
- Unit 2: Increase in cycle efficiency – 4.5% (LHV).
- Unit 2: Increase in Output – 20MWe. **

** New output is available “through-year” due to improved condenser performance, reduced fouling and increased fan margin.

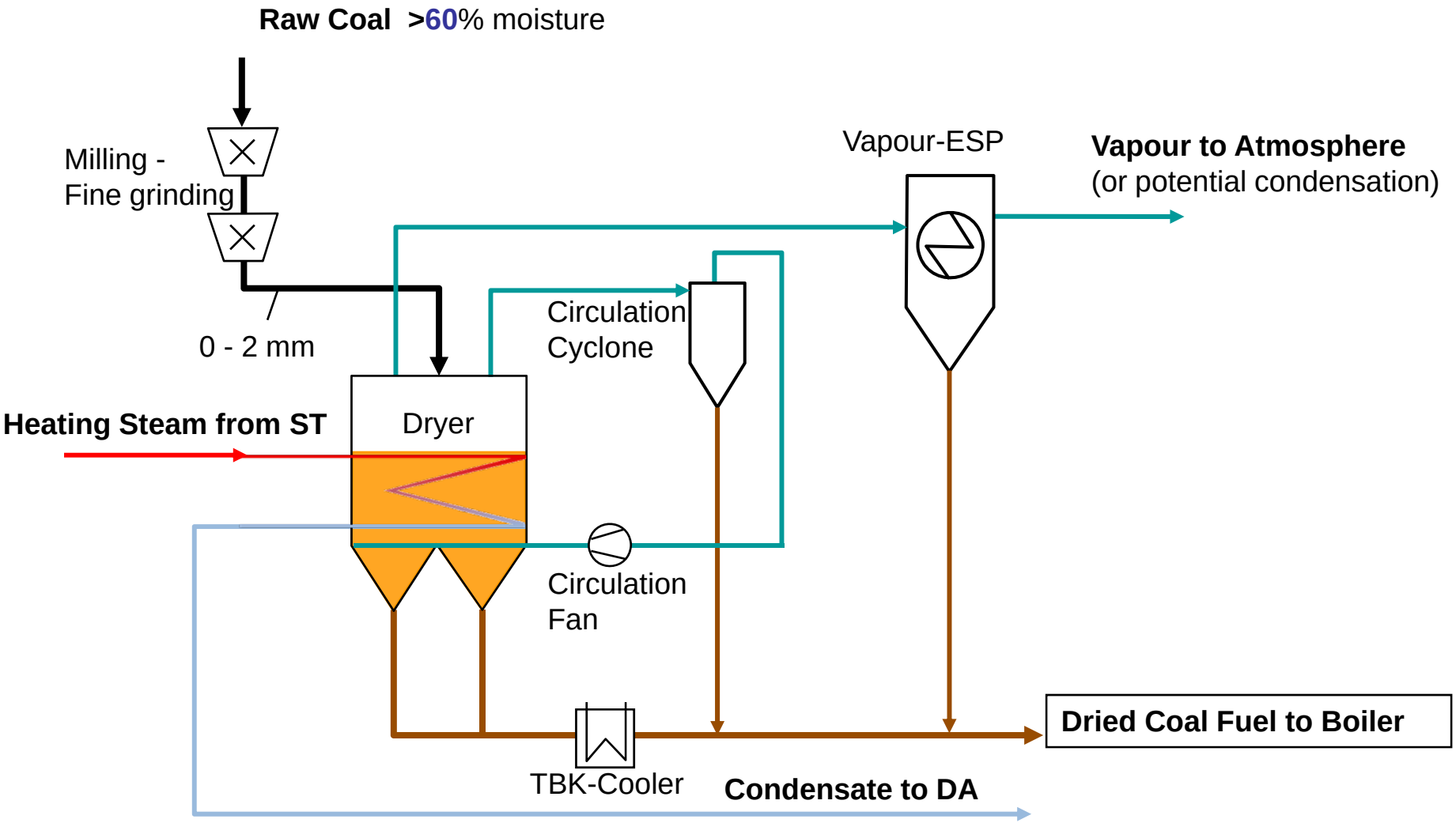
Hazelwood 2030 Schedule

- Limited Notice to Proceed (LNTP) for early start – Q2 2007
- Extensive coal testing: (1,500te) December 2006 - Jul 2007
- CO2 capture plant: Operating by Q2 2008
- WTA Design Issued: April 2008
- Unit 2 outage: May – Jul 2009
- Unit 1 outage: Aug – Nov 2009
- Unit 1 commissioning: Sep – Nov 2009
- Optimisation: Nov 2009 – Jan 2010
- Full maintenance cycle: Dec 2009 to Dec 2012
- Desktop studies for ultra-supercritical application
- Preparation for new baseload plant to commence in 2009/10 (permitting, consortium & technology selection)

Hazelwood 2030 – Scope of Work

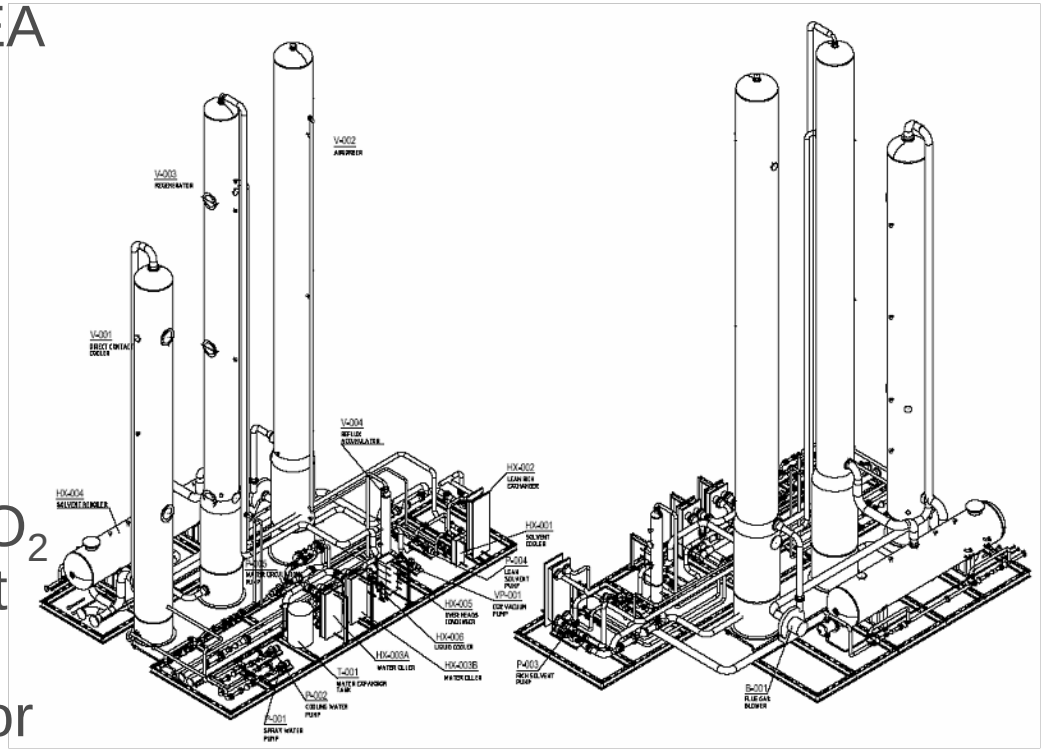
- Turbine - replacement of existing turbine with new two-cylinder machine; HP and combined IP/LP (Units 1 & 2).
- Installation of “HRSG style” finned-tube heat exchanger between precipitator and chimney (Units 1 & 2).
- Installation of 70 tph evaporative capacity WTA coal drying system, sized to provide 50% of the BMCR heat input (Unit 1 only).
- Installation of 6 low NOx PF burners, supplied from dedicated PF silo, sized for 50% BMCR and used for start-up via integral LPG torches [6 out of 8 existing ROM coal burners retained, sufficient for at least 80% BMCR].

WTA – Fine Grain Coal Drying



Carbon capture project.

- CO_2 capture using BASF MEA process.
- Slipstream capacity for 50 te/day with first process stream rated at 25 te/day.
- Approximately 16 te/day sequestered as limestone in PFA via reaction between CO_2 and calcium hydroxide in wet ash system purge water. Remaining production sold for industrial use.



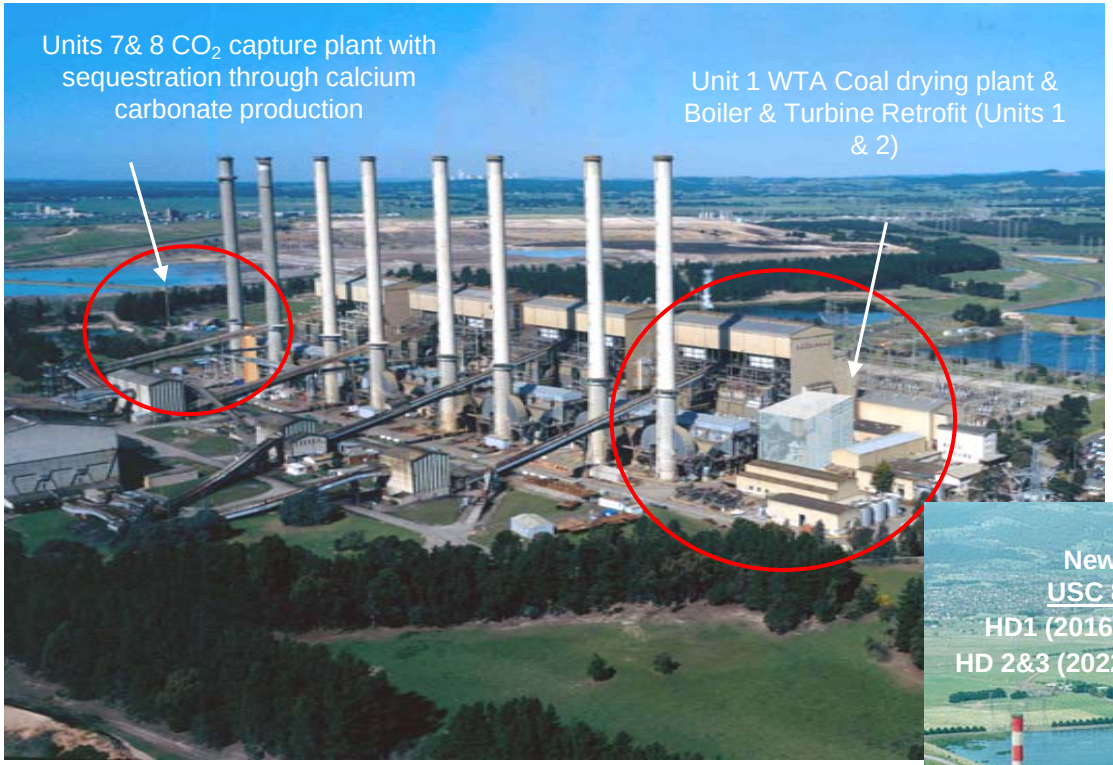
Hazelwood 2030 vision.

- To demonstrate a package of improvements that will deliver a clean coal pathway through a combination of new-build ultra-supercritical base-load generation and the retrofit of existing assets.
- To continue to utilise the abundant, but high moisture, brown coal within the Latrobe Valley (~100 billion te). Thus ensuring continued availability of cost-competitive generation for Eastern Australia, whilst significantly reducing emissions.
- To provide a realistic alternative to IGCC in the near and medium term.

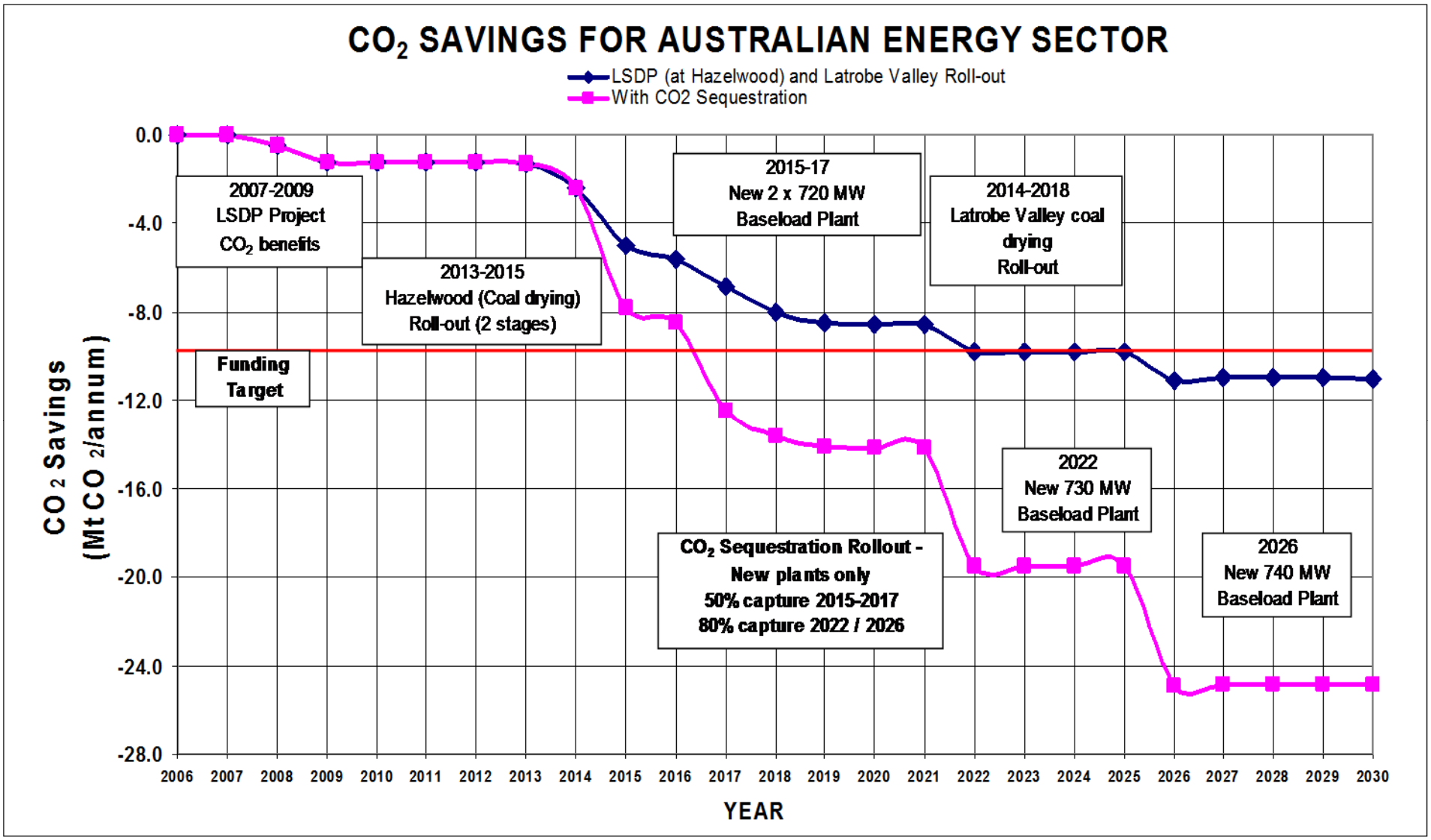
Hazelwood 2030 – Post Project

- Phase 1 - Roll-out of pre-combustion coal drying to Units 2 to 4.
- Phase 2 - Hazelwood Unit 9 – 800MWe ultra-supercritical unit with pre-combustion coal drying.
- Phase3 – Demolition of existing units 7 & 8 (Stage 4) and construction of Unit 10 – 800MWe ultra-supercritical unit with pre-combustion coal drying.
- Phase 4 – Roll-out of technology to other Latrobe Valley generators.
- Phase 5 - Demolition of existing units 5 & 6 (Stage 3) and construction of Unit 11 – 800MWe ultra-supercritical unit with pre-combustion coal drying.

Hazelwood 2030 - Pathway to Commercialisation



Hazelwood 2030



Notes: Assessment by Burns & Roe Worley. Roll-out requires value for CO_2 abatement Roll-out & Scheme duration – 2006 to 2030 (up to 2030 to meet 9.5 MtCO_2e pa) 154Mt cumulative abatement by 2030 assuming commercialisation roll-out occurs.

Thank you

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