

Re-energising Resources – A Bridge to a Lower Carbon Future



**Catalytic Hydrothermal Upgrading
for the
Advanced Lignite Demonstration Program
(*Cat-HTR for ALDP*)**

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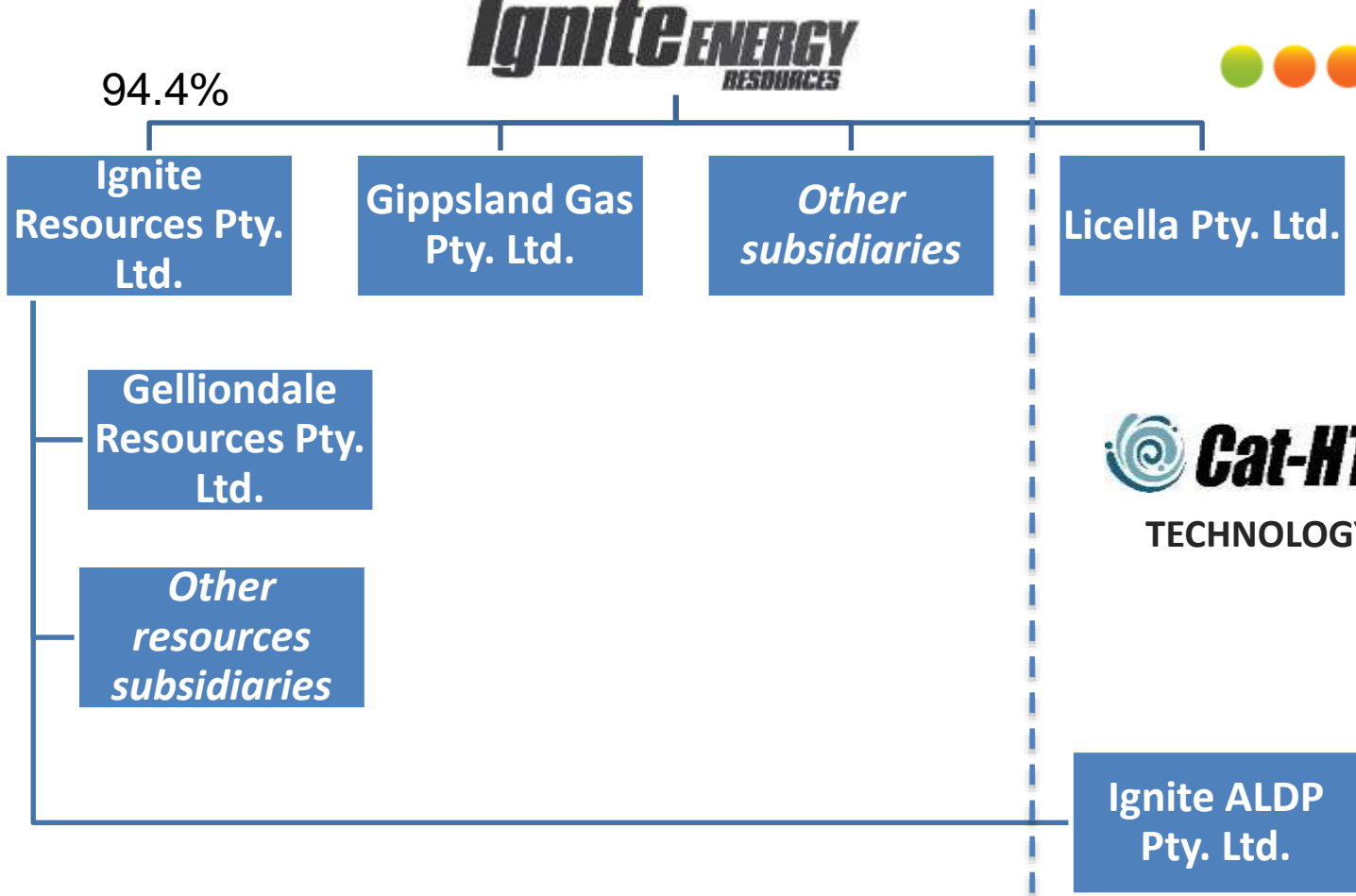
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Structure - Resources & Technology



Developing Our Own World-Class Lignite Resources - IRPL

- Lignite resources within tenements held by the IER Group (EL4416 and RL2013 in SE Victoria)
- 16.4 billion tonne lignite resource¹, represents 44% of Australia's and 8% of the world's economically recoverable lignite²
- Low in sulphur, ash, salts & heavy minerals

Location of EL4416:



EL4416 JORC-Compliant Lignite Resources (billion tonnes)¹

Deposit	Measured	Indicated	Inferred	Total
Gormondale	2.30	1.66	2.16	6.12
Gelliondale	0.28	2.98	2.94	6.20
Stradbroke	-	2.58	1.49	4.07
Total	2.58	7.22	6.59	16.39

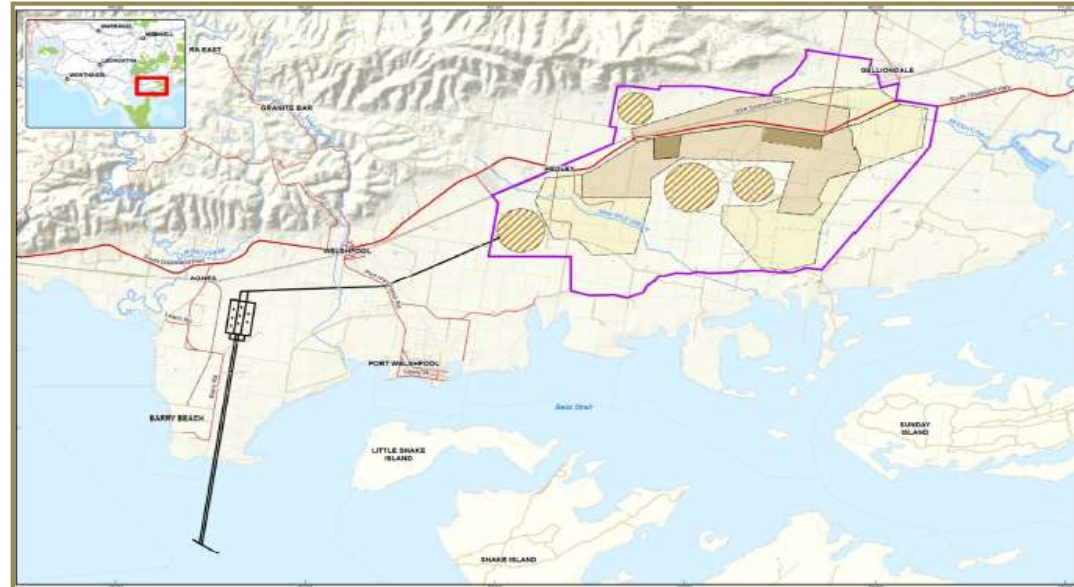
1. AMC Technical Report on EL 4416, 2010. 2.6bn tonnes measured, 7.2bn tonnes indicated, 6.6bn tonnes inferred

2. World Energy Council 2013

Retention License Granted on Gelliondale

- Retention licence RL2013 recently granted by Victorian government
- Joint development with PT Bukit Energi Investama (PTBEI). Allows IRPL 7 years for evaluation activities
- Clear path to mining license within 17km of existing port
- Gelliondale area represents 6.2 billion tonnes of JORC resource OR 927M barrels (3C) via applying Cat-HTR¹

GELLIONDALE – MINE PLAN



Clear path to a mining licence with longer tenure

1. Gaffney Cline resource report on the Gelliondale lignite resource, Cat-HTR project, 2014. Estimated 3C contingent resource of 927mm bbls

Gippsland Gas – World-class Natural Gas Resource

- Exploration for gas within deeper lignite seams on EL4416
- Seeking to carry out further exploration
- Strictly adhering to legislation, with appropriate environmental management plans

EL 4416 Biogenic Coal Seam Gas Resources, tcf

	Low (P-90)	Best (P-50)	High (P-10)
Contingent	0.657	3.727	9.147
Prospective	0.227	1.269	3.477
Total (OGIP)	0.884	4.996	12.624

Contingent Resources: MHA have not applied a recovery factor OGIP: original gas in place.

1. Source: MHA Petroleum Consultants (Dec 2011)

EXPLORATION

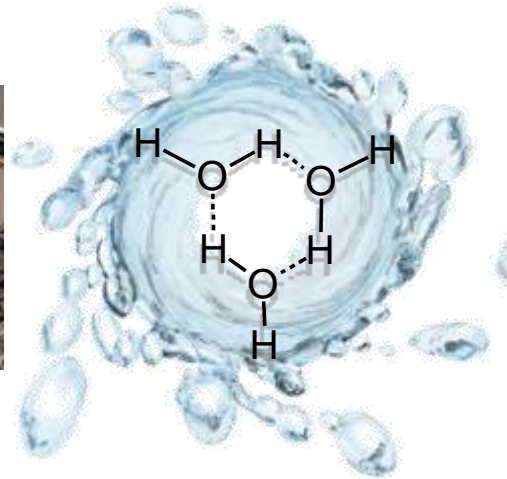
- No impacts to ground water
- Exploration wells comparable to the over 20,000 drill holes previously drilled
- Negligible impacts, target lignite seams are hundreds of metres below licensed aquifers
- No fracking

Cat-HTR™ - Catalytic Hydrothermal Technology



**Lignite
(Brown Coal)**

~ 17 MJ/kg
as mined
65% water



Biomass

Waste wood
~17 MJ/kg dry

Syncrude

**Micronized
Refined Carbon
(MRC)**

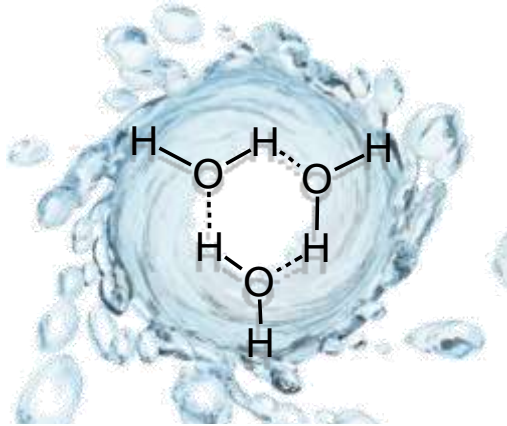


Biocrude

Cat-HTR™ - Catalytic Hydrothermal Technology

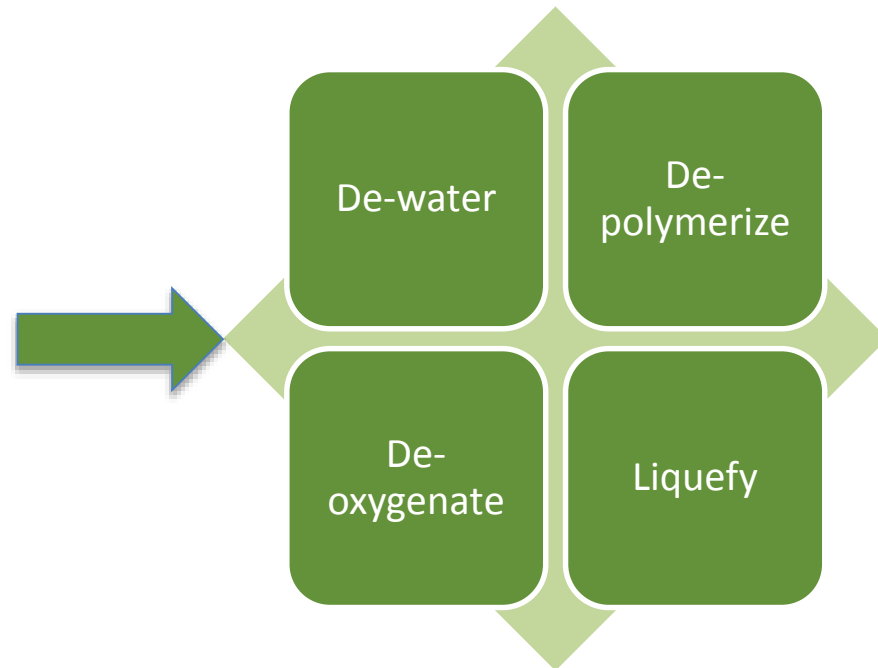


Lignite



Biomass

High water content
Low bulk density
Low energy density
High Oxygen
Biopolymers
Low Sulphur



All in one Step!

Advanced Lignite Demonstration Program



- Initiative of Victorian & Commonwealth Governments in Australia
- Accelerate development of pre-commercial brown coal upgrading technologies via large scale demonstration projects
- Competitive submission process evaluated by national and international experts
- IER granted \$20 million for the development of an \$84.3 million pre-commercial plant



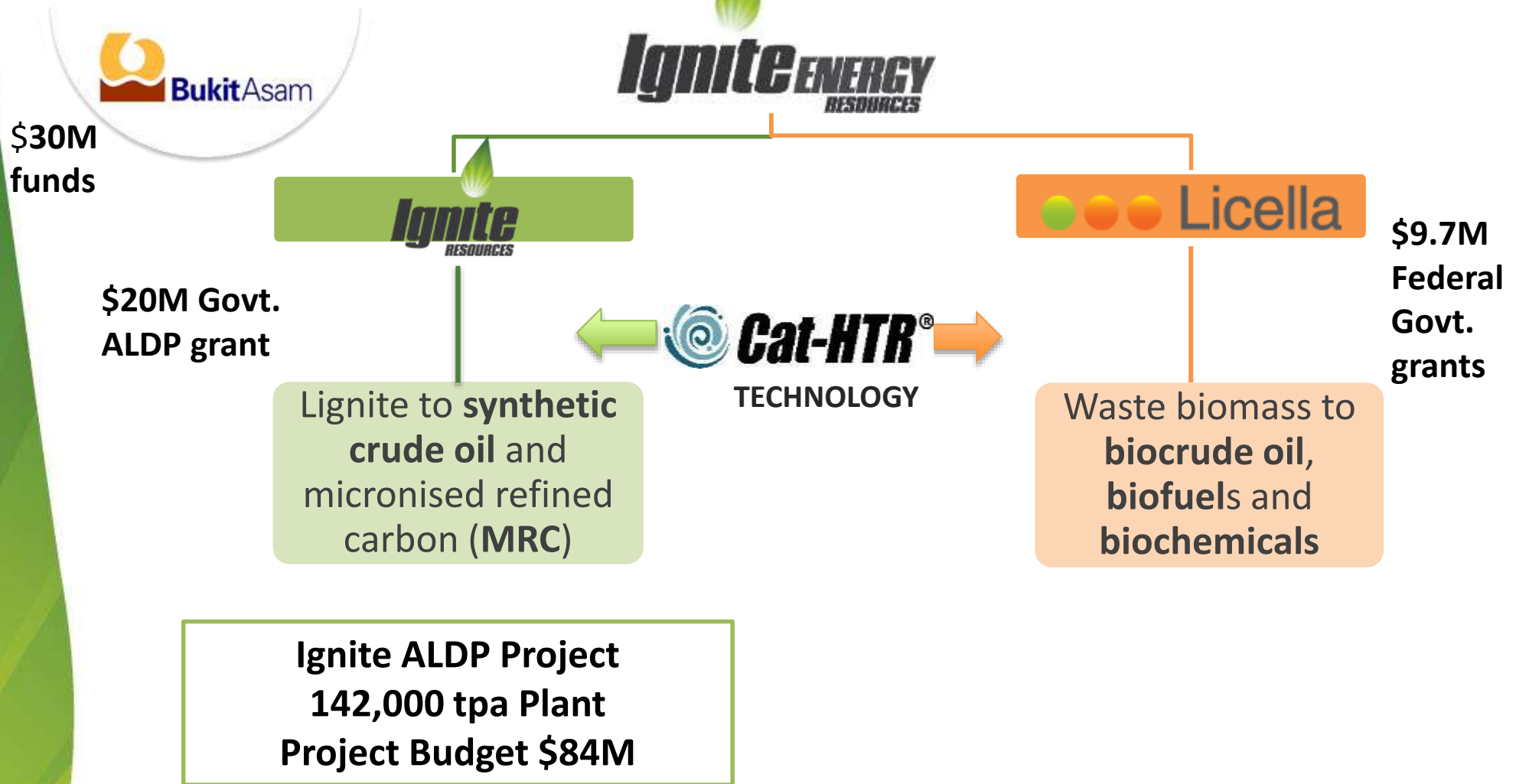
IER's ALDP Project



- Project funding secured by IER with additional funding from Macquarie Bank (AU\$22 million) and strategic partner, PT Bukit Energi Investama (PTBEI) (AU\$30 million), a subsidiary of PT Bukit Asam
- PTBA is the largest holder of coal in Indonesia and 65% Government owned
- PTBA's Indonesian coal has been successfully converted at IER's pilot plant and is planned to be trialled further in the ALDP project



Company Overview - Technology



Federal Government Grant Support

- Federal Minister for Resources, Energy and Tourism, Martin Ferguson, opening plant at Somersby, NSW on 4/12/2011
- IER/Licella has successfully delivered on 3 Government grants \$9.7M, with total project costs of over \$21M



Pilot Plant – Somersby, NSW, Australia



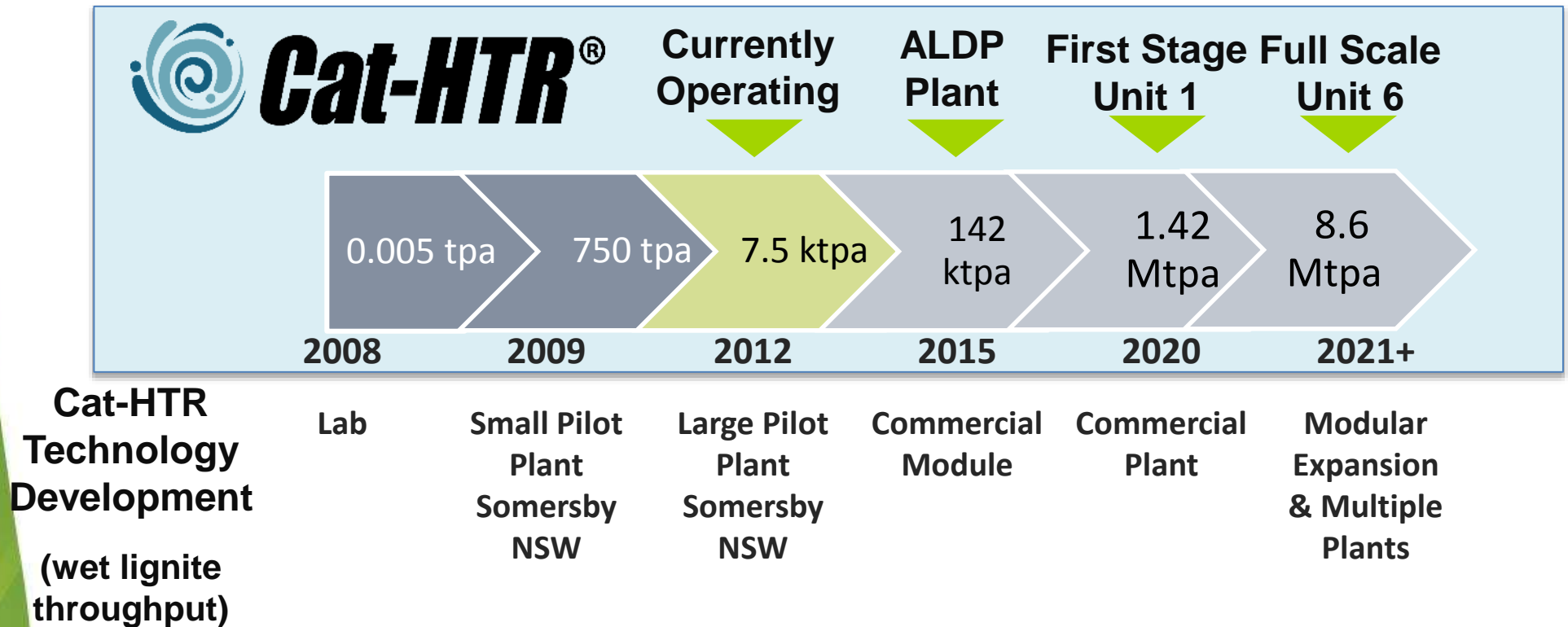
Pilot Plant – Somersby, NSW, Australia

- IER has been running Cat-HTR™ pilot plants at Somersby, NSW since 2008
- Pilot has been scaled-up three times (2, 4, 12 inch)



Reactor Progression	Plant	Construction	Reactor diameter scale up
1st Generation	Small Pilot	2009	-
2nd Generation	Large Pilot	2011	x 2
3rd Generation	Large Pilot	2012	x 2
4th Generation	Commercial	2016	x 2

Cat-HTR Commercialisation Plan



Cat-HTR Commercialisation Plan



Plant	Syncrude Production (bbl pa)	MRC Production (tonnes pa)
ALDP	Up to 40,000 bbl pa (total production including ramp-up 18 months)	Up to 25,000 tpa (total production including ramp-up 18 months)
Commercial (Stage 1)	500,000 bbl pa	283,000 tpa
Commercial (Full Scale)	3 million bbl pa	1.7 million tpa

Introducing
Ignite Energy Resources Ltd



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Project Schedule

Major Project Elements	2015			2016				2017				2018				2019	
	Jul	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
PLANNING PERMIT APPROVAL																	
ENVIRONMENTAL MANAGEMENT PLAN																	
EPA RD&D PERMIT APPROVAL																	
ESTABLISH ENGAGEMENT FUNCTIONS																	
STAKEHOLDER MEETINGS																	
COMMUNITY ENGAGEMENT SESSIONS																	
ENGINEERING																	
PROCUREMENT																	
CLEAR/ESTABLISHMENT/EARTHWORKS																	
CONSTRUCTION																	
OPERATION																	
FINAL EVALUATION																	

Community Engagement & Key Stakeholders

- Two Community Engagement drop in events planned in Morwell in Nov 2015.
- Key Stakeholder meetings occurring in the lead up to Community Engagement.

Key Victorian & Local Stakeholders



Cat-HTR™ – Catalytic Hydrothermal Upgrading

- Uses water in feedstock as `green` solvent and reactant
- Above critical temperature and pressure, 374°C and 218 bar, no liquid phase of water exists
- Near-critical conditions – liquid with solvating power of organic solvent - ability to diffuse rapidly through materials
- Enhanced acidity and basicity compared to ambient temperature water
- Use these properties to depolymerize complex biopolymers in the feedstock
- Add catalysts to increase reaction rates (especially for biomass)

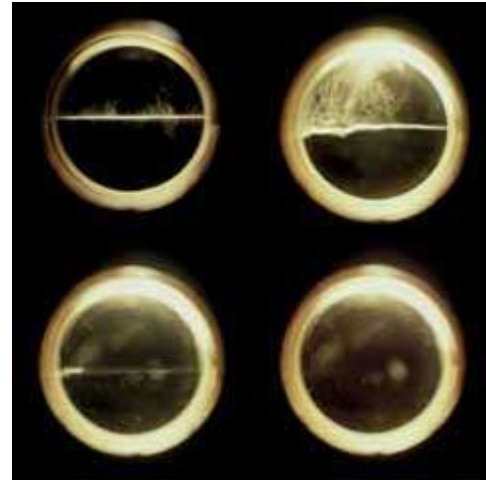
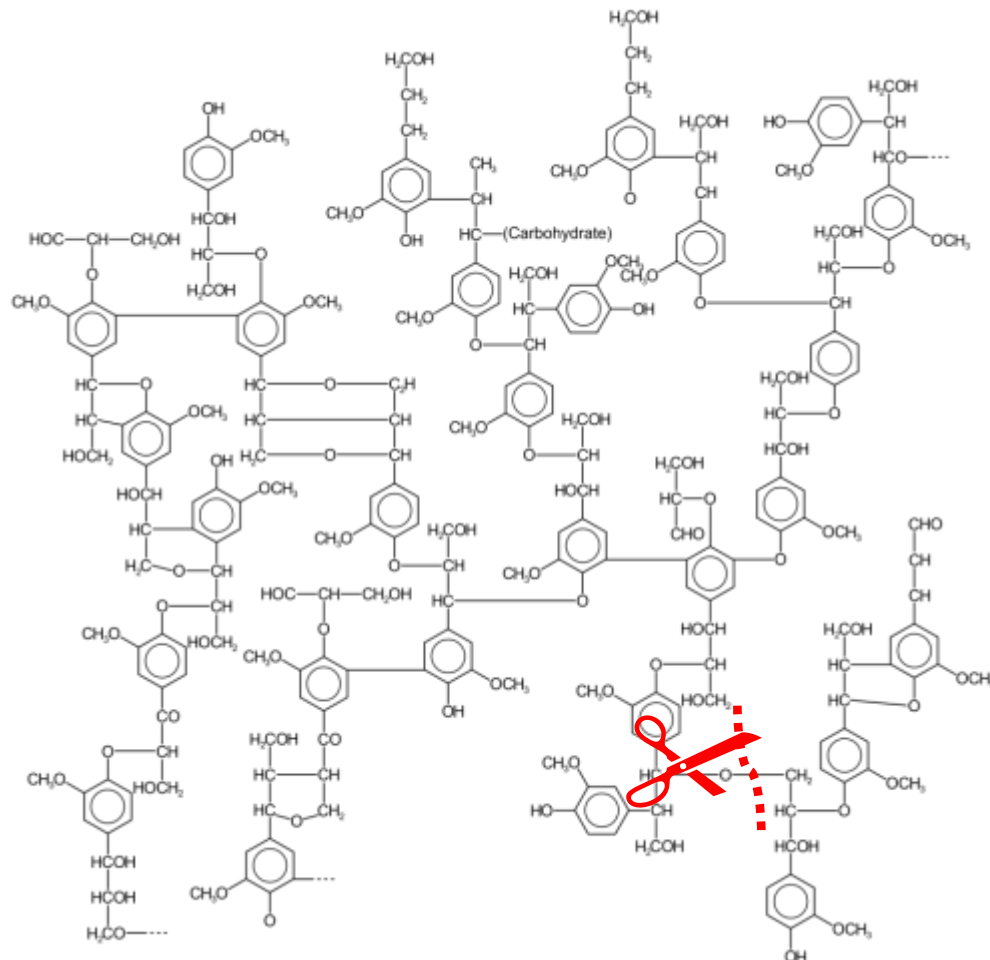


Image source: Royal Society of Chemistry

<http://www.rsc.org/education/eic/issues/2008November/SupercriticalProcessing.asp>

Hydrothermal Chemistry



Depolymerisation

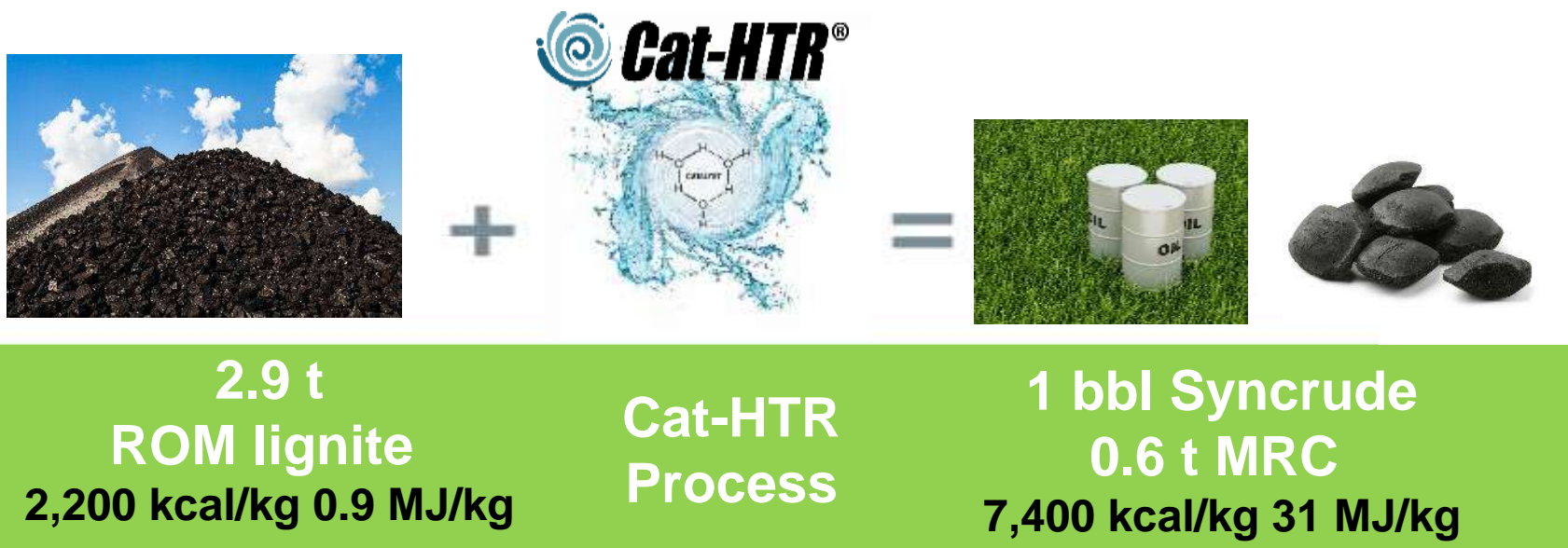
- Hydrolysis - *cleavage of carbon-oxygen bonds e.g. ethers to alcohols*

Removal of Oxygen – Energy Densification

- Dehydration - *loss of water*
- Decarboxylation - *loss of CO_2*

Cat-HTR Products

- Cat-HTR projected to produce syncrude for ~ US \$34 per barrel and micronised refined carbon (MRC) product for ~ US\$42 per tonne



- The process accelerates nature**, uses the water in the lignite plus cheap catalysts to upgrade (no pre-drying required)
- Best of breed energy efficiency** and carbon emissions as only 15% of energy contained in the lignite is used for conversion

Syncrude Properties (Typical, from Victorian Lignite)

Property	Value
Appearance	Brown, waxy, VGO-like
Sulphur	0.2 %
Boiling range	Mainly Light Cycle Oil and Vacuum Gas Oil ranges 120 -500 °C
Energy Content (HHV)	39 MJ/kg

- Hydroprocessing example – blend of straight run kerosene and syncrude hydroprocessed using commercial catalyst in fixed bed configuration
- Cloud point of product $<-61^{\circ}\text{C}$ – shows facile cracking of waxy components



Micronised Refined Carbon (MRC) Properties (Typical, from Victorian Lignite)

Property	Value (dry basis)
Gross Calorific Value	7,400-7,500 kcal/kg 31-31.5 MJ/kg
Ash	3-4%
Volatile Matter	20-22%
Fixed Carbon	75-76%
Total Sulphur	0.2-0.3%

Ash Fusion Temperature	Value (Oxidizing and Reducing)
IDT	>1500 °C
HT	>1500 °C
FT	>1500 °C

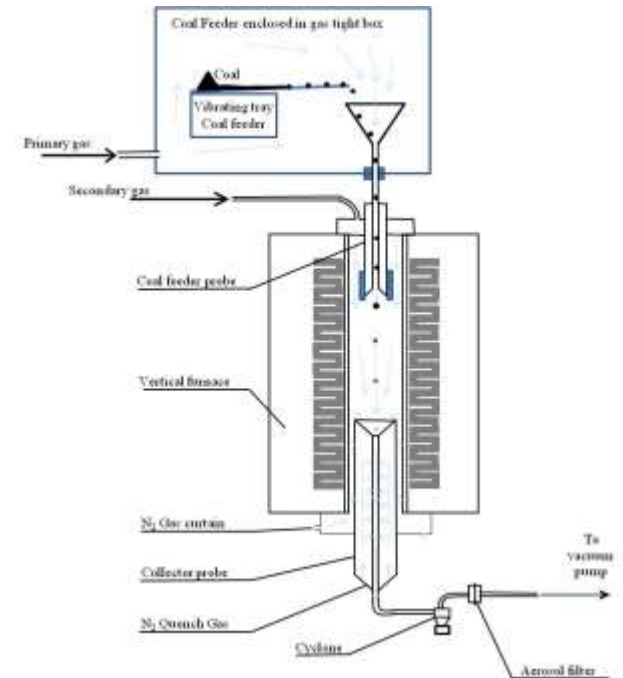
Typical as received total moisture contents of MRC are very low, ca. 1-4%

Property	Value (dry ash free basis)
Carbon	84%
Hydrogen	3.2%
Nitrogen	0.9-1.0%
Oxygen	~12%
Chlorine*	0.01%
Phosphorus*	0.002%

* As received basis

Micronised Refined Carbon (MRC) Properties (Typical, from Victorian Lignite)

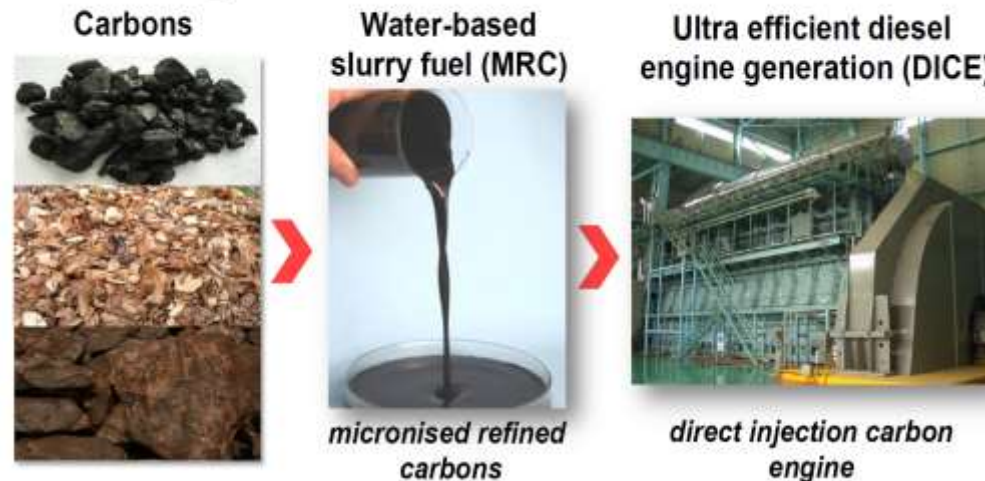
- With favourable characteristics of high carbon content and calorific value, and low VM, ash and Sulphur contents MRC can be expected to show high coke replacement ratio in pulverized coal injection
- Tests in drop tube furnace have shown very good burnout characteristics
- Pilot PCI test studies are planned in 2016



Vision: ALDP- Part of Our Lower Carbon Future

Reduce CO₂ from Electricity Production, Support Renewables Roll-out in Australia

DICE fuel cycle

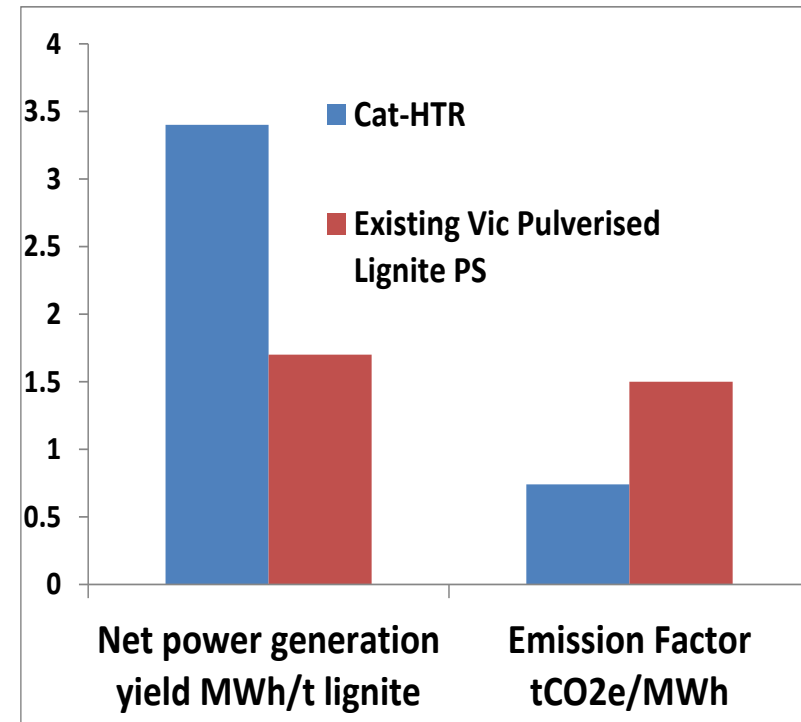


- Reduce electricity related CO₂ emissions in Latrobe Valley **by up to 50% from average 1.34t CO₂ /MWh (2013)**
- 100 MWh DICE units that can be ramped up & down efficiently to support rollout of intermittent renewables
- Chair DICENET – CSIRO, BCIA, MAN, industry to prove DICE by 2020

Life Cycle Analysis

Scenario:

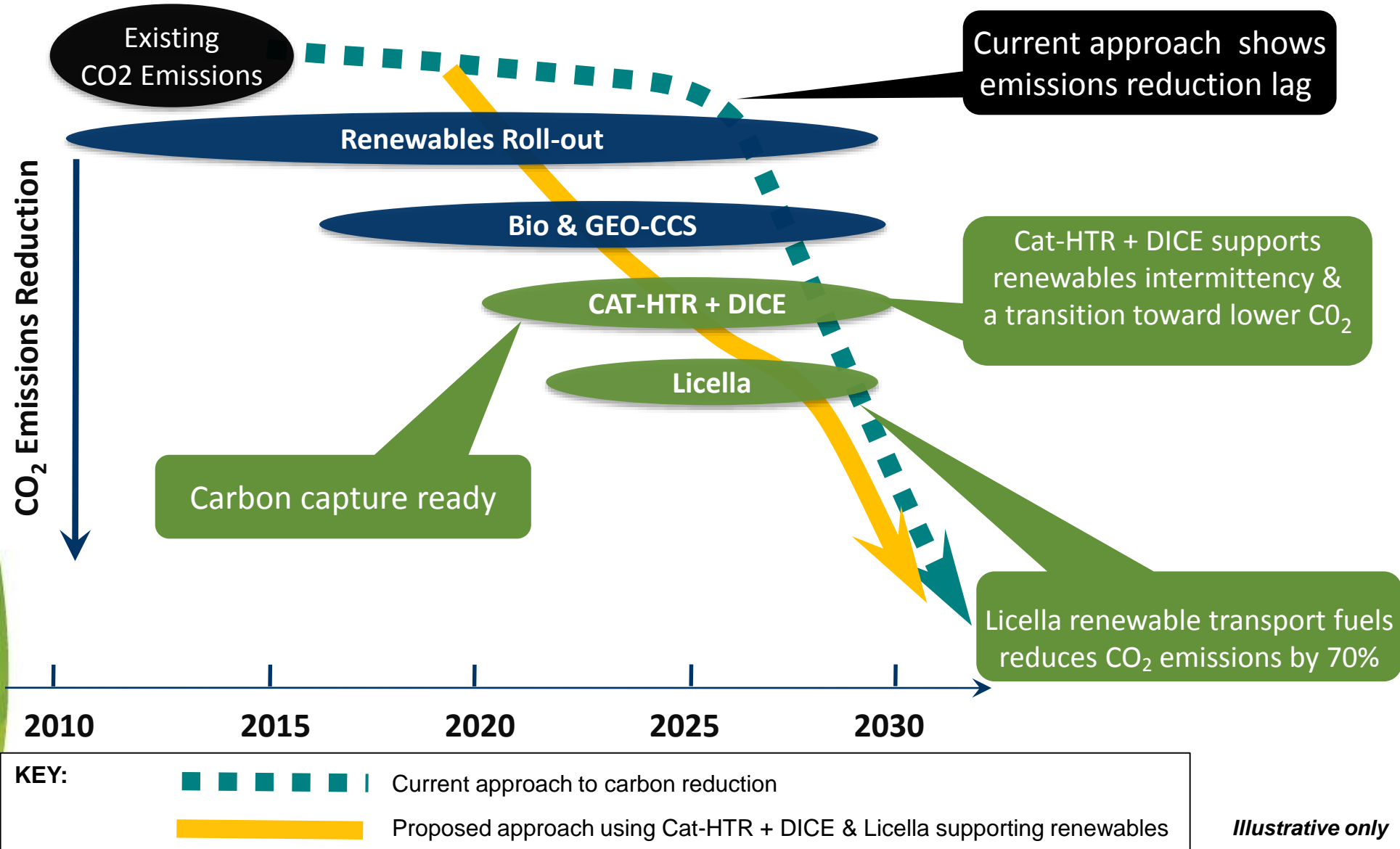
- Power generation by combustion of Micronized Refined Carbon (MRC) in Direct Injection Carbon Engine (DICE) and Syncrude in Combined Cycle Gas Turbine (CCGT)



Source: Talent with Energy 2013.

Life-cycle energy and GHG emissions assessment. Prepared by Talent with Energy for Ignite Energy Resources, March 2013.

Vision - Accelerate the Pathway to a Lower Carbon Future: Zero Net CO₂ Emissions



Product Markets

Cat-HTR Product	Industry
Micronised Refined Carbon (MRC)	<ul style="list-style-type: none">• Pulverised Coal Injection (PCI) type product for blast furnaces for steel manufacture• Fuel for ultra supercritical boilers for low emission power generation• Fuel for Direct injection Carbon Engine (DICE) - potential low emission power generation
Syncrude oil (lower CO ₂ emissions transport fuel with biomass blending)	<ul style="list-style-type: none">• Refinery to upgrade to diesel and petrol• Refinery to produce chemical products• Blend and co-refine with waste oils & recycled oils



Acknowledgements

Colleagues at IER and Licella

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Questions?