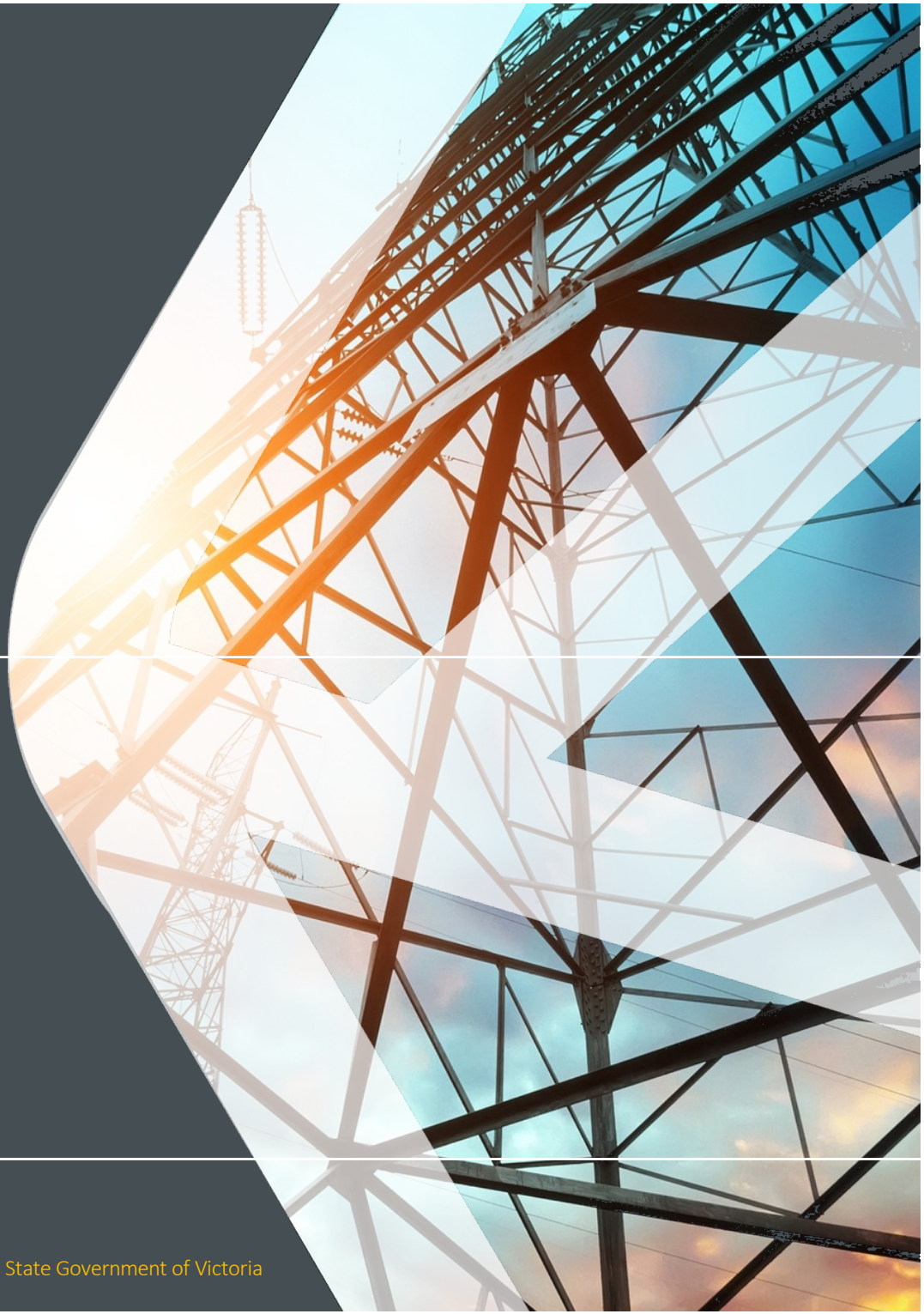
ENVIRONMENTAL CLEAN TECHNOLOGIES LIMITED

排出のない亜炭の化学に向かって

Capturing the chemistry of lignite without the emissions

“Bridging the gap between today’s use of resources and a zero-emissions future.”

May 2019



Prepared for JOGMEC and Department of Economic Development, Jobs, Transport and Resources, State Government of Victoria

ENVIRONMENTAL CLEAN TECHNOLOGIES LIMITED

始めまして

Nice to meet you

１９９１年に１年間富山県の石動高校で勉強させて頂きました。
In 1991 I attended Isurugi High School in Toyama prefecture as an exchange student for 1 year.

それまでは日本語が全く話せなかったのに、その時に出来た彼女のおかげで覚えた日本語は、少し「田舎臭い」富山弁とよく言われました。
Since then, I haven't had much of a chance to use Japanese but Japanese people often say that my pronunciation is excellent although with a strong country dialect.

日本で過ごした１年は、私の人生にとって非常に大切な経験です。日本・オーストラリアの関係兼ビジネスをより円滑に行わせたいと思っています。
The year I spent in Japan has been very influential on my life and I look forward to an opportunity where I can unite Australian and Japanese mutual interest through ECT's technologies.

よろしくお願いいたします。
Best regards.

Glenn Fozard　グレン・フォザード
Chairman　ECT代表取締役社長
Environmental Clean Technologies Ltd.

Overview

Targeting lignite for its valuable chemical constituents

褐炭・亜炭からより価値のある化学物質を作る

1

THERMAL FUEL

Coldry TRL 8-9

低コスト褐炭・亜炭を使った排出量ゼロアップグレーデーションテクノロジー。

化学業界に最も適切兼安価な原料。

2

HYDROGEN

COHgen TRL 2-3

褐炭・亜炭から水素を抽出する低排出テクノロジー。

炭素のガス化を抑えたまま水素を抽出。二酸化炭素の回収・貯留が不要。

3

26 $3d^6 4s^2$
Fe
Iron
55.847

IRON & STEEL

Matmor and HydroMOR TRL 6-7

低品質鉄鉱石と褐炭・亜炭を原料とした低排出・低温テクノロジー製鉄。

高品質な鉄鉱石と無煙炭に代わる原料。

4

DIESEL

Waste-to-Energy TRL 5-6

水分を取り除かれた褐炭とリサイクルごみを利用したディーゼル製造技術。

可燃ごみを利用した低温・低圧「発エネルギー」テクノロジー　＝　世界で最低排出量のごみからエネルギーへのテクノロジー。

Overview

Targeting lignite for its valuable chemical constituents

褐炭・亜炭からより価値のある化学物質を作る

1

THERMAL FUEL

Coldry TRL 8-9

Mechanical and chemical process of de-watering high moisture content lignite. Coupled with access to low-grade waste heat, delivers a zero net emission solution to essential upgradation of brown coal for more efficient downstream usage. This is ECT's "Gateway" solution.

2

HYDROGEN

COHgen TRL 2-3

Coupled with Coldry, the process produces a composite pellet that combines a unique catalyst with lignite. These pellets are fed into a vertical retort to produce a hydrogen heavy syngas, leaving most of the carbon fixed in the pellet. Low carbon emission production of hydrogen aims to eliminate Carbon Capture and Storage.

3

26 $3d^6 4s^2$
Fe
Iron
55.847

IRON & STEEL

Matmor and HydroMOR TRL 6-7

Coupled with Coldry, the process produces a composite pellet that combines lignite and waste iron ore sources. These pellets are fed into a vertical retort to produce a Direct Reduced Iron product suitable for the melt stage of steel production. The process operates at considerably lower temperatures and the use of readily abundant, low-cost feedstocks delivers superior economic returns in comparison to conventional primary iron processes.

4

DIESEL

Waste-to-Energy TRL 5-6

Currently finalising a HOA for the acquisition of this type of technology, ECT is aiming to develop a unique and continuous process for the low-temperature and low-pressure catalytic depolymerisation of Coldry pellets combined with other waste feedstocks like construction wood and end of life plastics to produce diesel, bitumen and asphalt. Lignite's chemical properties, once converted to Coldry, act as a feedstock stabiliser in the conversion of waste streams to transportation diesel.

1 | Coldry Process: cost-effective lignite drying

- → Low temperature
- → Low pressure
- → 60% moisture to <15%
- → Zero direct CO_2 emissions

"One distinct advantage of Coldry is the relative low heat requirements in the drying process, allowing for the opportunity to make use of waste heat from an industrial facility or power plant."

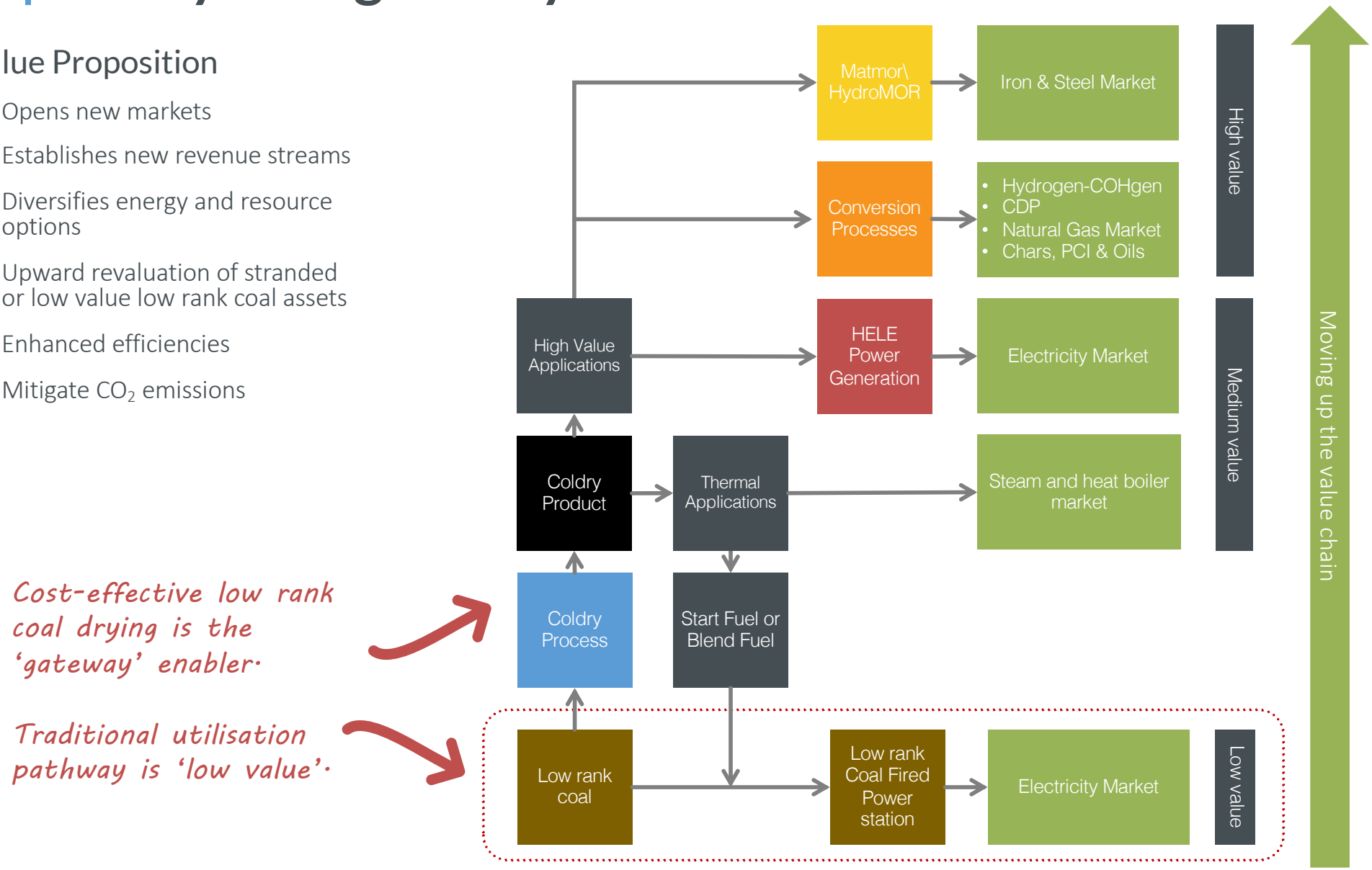
Dr Victor Der

Former Assistant Secretary for Fossil Energy, US Dept. of Energy
General Manager, North America, Global CCS Institute

1 | Coldry: the 'gateway' solution

Value Proposition

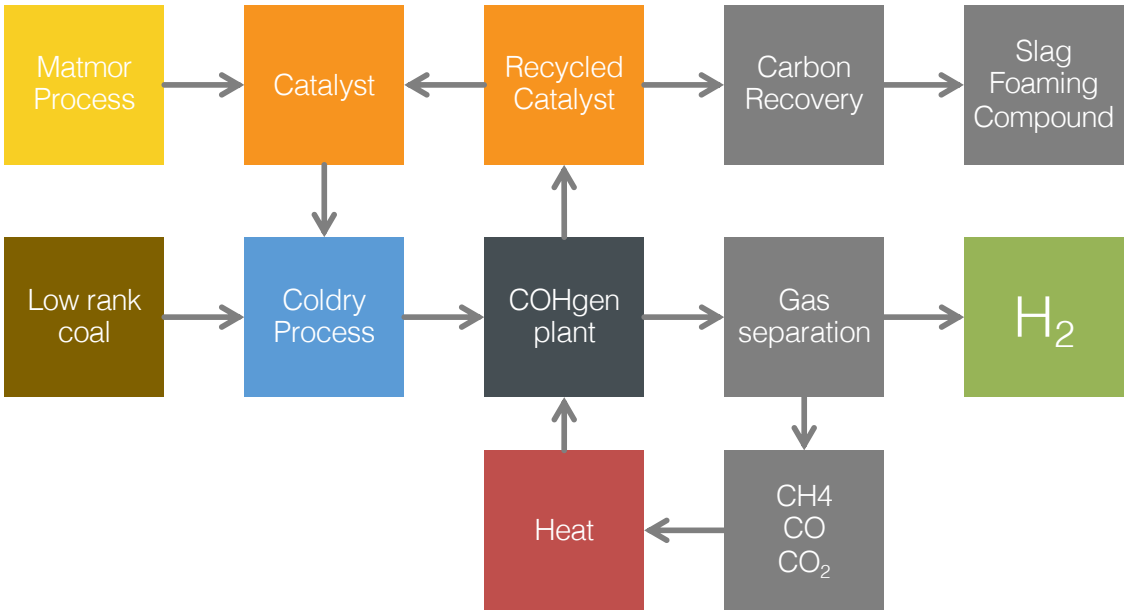
- Opens new markets
- Establishes new revenue streams
- Diversifies energy and resource options
- Upward revaluation of stranded or low value low rank coal assets
- Enhanced efficiencies
- Mitigate CO_2 emissions



2 | COHgen Process: hydrogen production

Features

- Low temperature
- Lower CO_2 emissions than natural gas steam reforming process
- >50% H_2 concentration in gas stream
- Low cost feedstock - lignite
- Replace natural gas
- Scalable
- Cheap, abundant catalyst
- Catalyst reusable
- Majority of carbon captured in solid form



3 | Matmor Process: primary iron production

Matmor employs a hydrogen-based chemical reduction pathway, making it the world's **first** and **only** low temperature, low rank coal-based iron making process.

Inputs

Iron ore waste streams

Low-rank coal

3 | Matmor Process: benefit comparison

- **Lower Temperature**

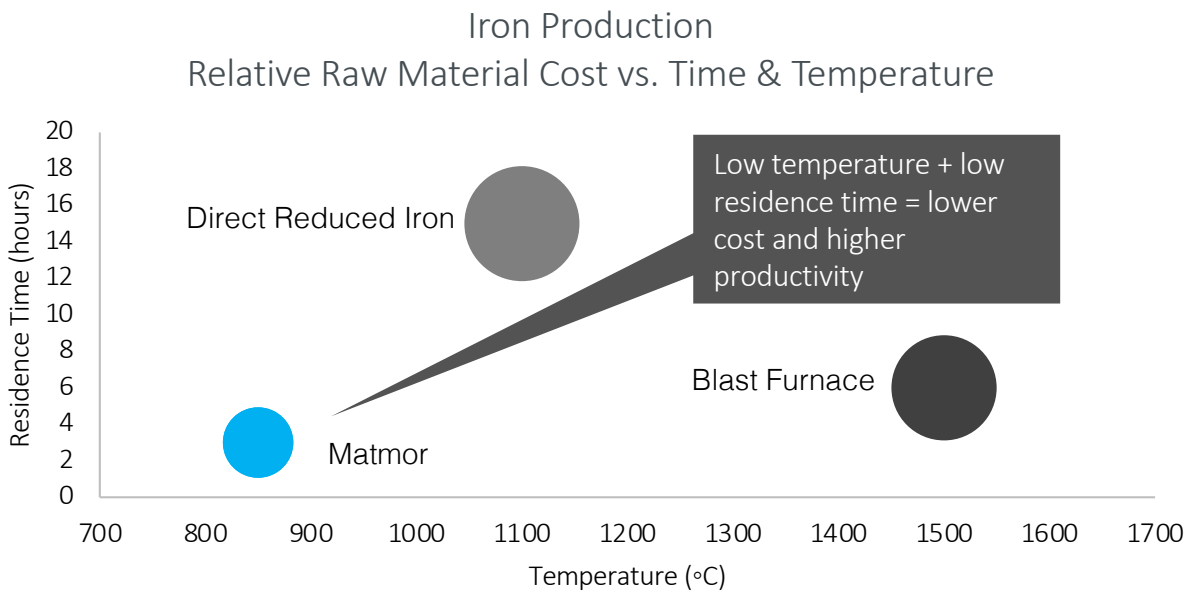
  Temperature is a proxy for asset capital intensity

- **Lower residence time, higher productivity**

  Residence time is a proxy for asset productivity

- **Lower Cost Inputs**

  Bubble size represents 'Relative Raw Material Cost'

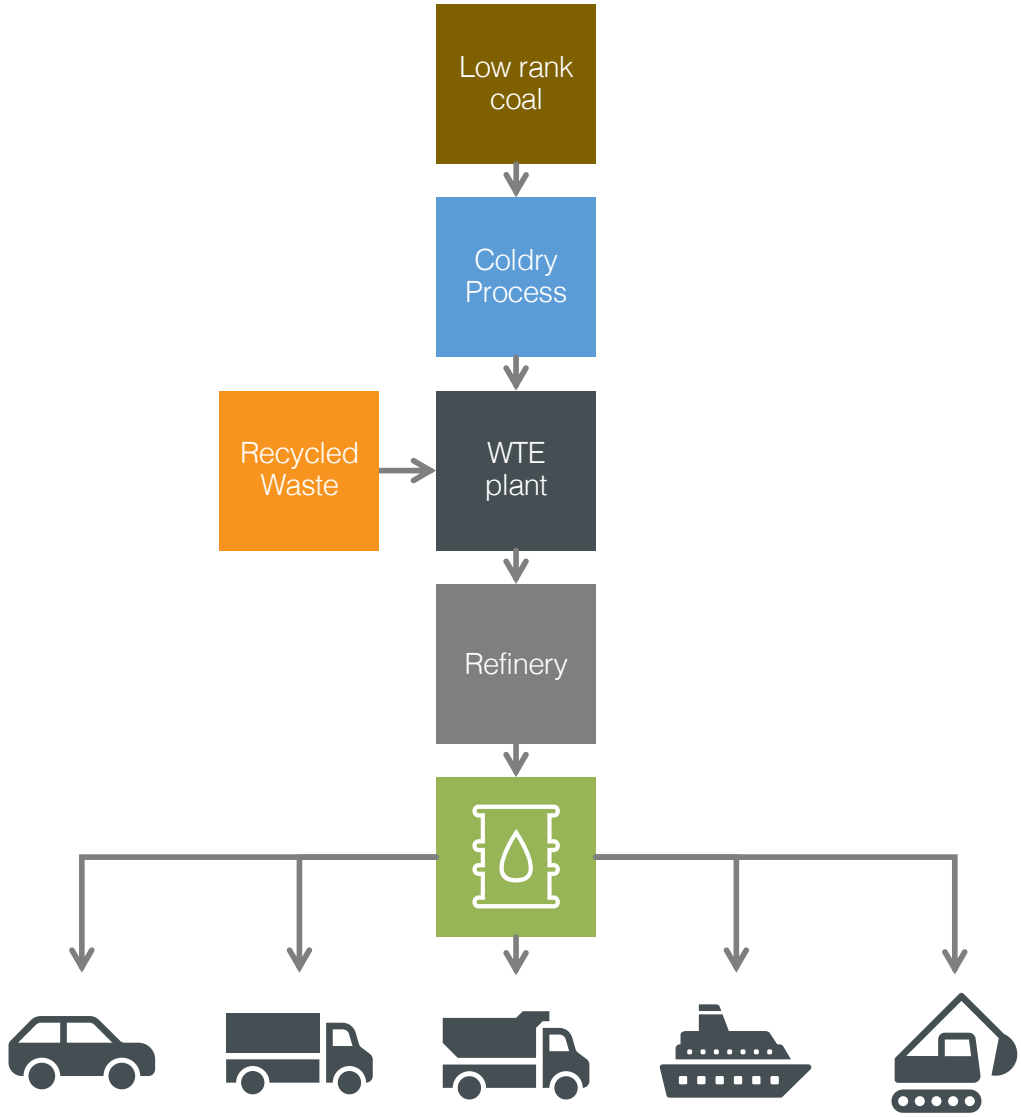


	India - Traditional	India - Alternative	ECT
	Blast Furnace Basic Oxygen Furnace	Coal based Direct Reduced Iron Kiln Electric Arc Furnace	Coldry & Matmor Electric Arc Furnace + power generation
Case/Scenario	Base Case	Base Case	Mid Case
CAPEX (Index)	100%	90%	64%
OPEX (Index)	100%	106%	86%
SALES (Index)	100%	109%	104%
ROI (Index)	100%	130%	250%

4 | Waste-to-Energy (WTE)

As part of the feasibility of the Latrobe Valley project, ECT is exploring a unique continuous process for the low-temperature and low-pressure depolymerisation of Coldry pellets combined with other waste feedstocks, like construction wood and end-of-life plastics, to produce diesel, bitumen and asphalt.

Prospectively, lignite's chemical properties, once converted to Coldry, act as a feedstock stabiliser in the conversion of these other waste streams into transportation diesel.



Projects

ECT is pursuing a multi–staged approach to the research, development and commercialisation of its unique technologies.

COHgen is currently proceeding through laboratory testing and patent preparation.

Coldry, W2E and Matmor are targeting commercial-scale demonstration:

Coldry Pilot Plant & R&D Facility

High Volume Test Facility and domestic solid fuel sales up to 35,000 tpa

Bacchus Marsh, Victoria, Australia

- ✓ Local steam, hot water and process heat industry
- ✓ Optimisation of fuel mix
- ✓ Maximise boiler efficiency
- ✓ Multi-feedstock flexibility
- ✓ Inbuilt fuel security
- ✓ Reduce CO_2 emissions
- ✓ Reduce total cost of operation
- ✓ Reduce business disruption
- ✓ On going R&D capability

Integrated Coldry-WTE Commercial Demonstration Plant

Development of a 170,000 tpa Coldry with downstream Waste-to-Energy

Latrobe Valley, Victoria, Australia

Integrated Coldry and waste-to-energy (WTE) process

- ✓ Enhanced process synergies
- ✓ Higher-value outputs
- ✓ Better environmental outcomes
- ✓ Liquid fuel sales
- ✓ Solid fuel sales
- ✓ Zero-emission lignite drying via Coldry

Integrated Coldry-Matmor Demonstration Plant

Partnership with NLC India Limited and NMDC Limited for the scale up and commercialisation of the worlds only lignite-based, hydrogen-driven iron making process

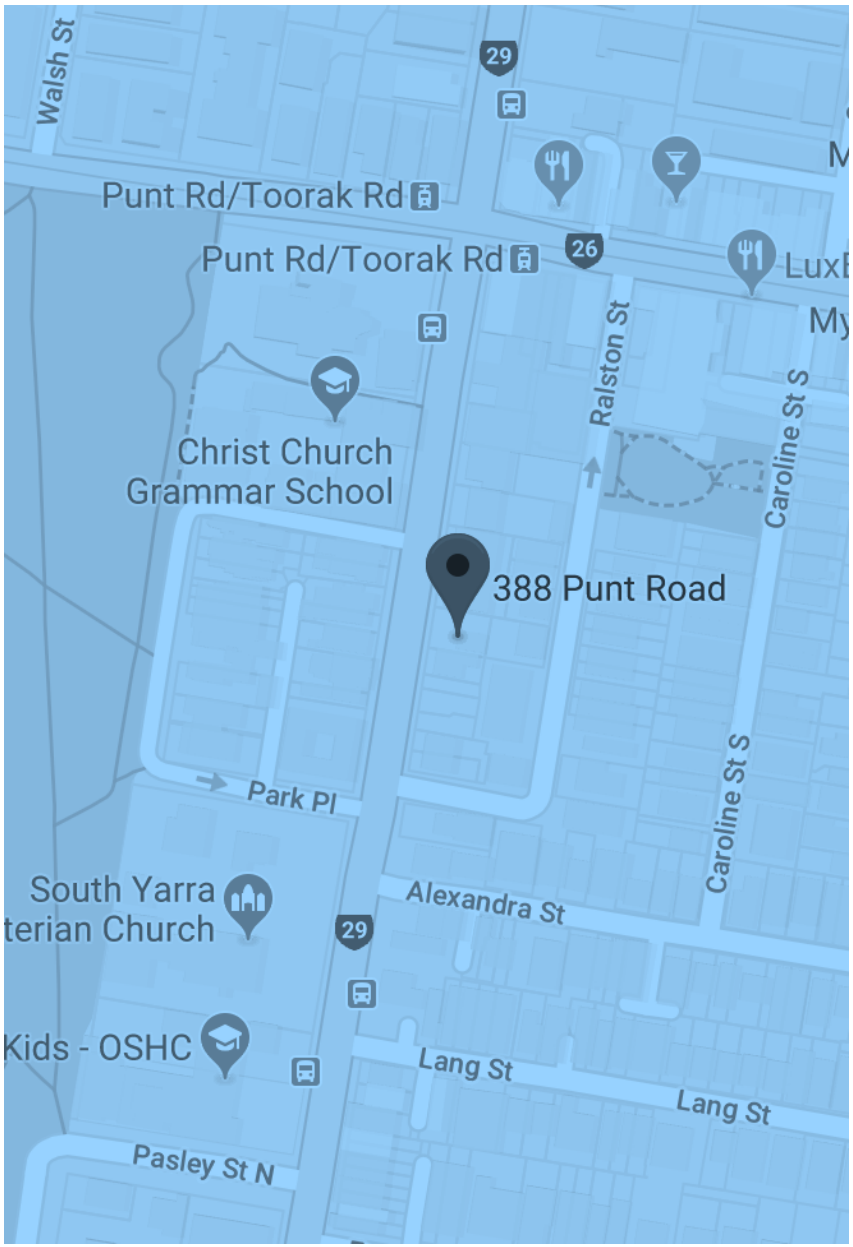
Neyveli, Tamil Nadu, India

Phase 1: R&D stage

- ✓ AUD35 million
- ✓ Largest ever R&D project between Australia and India

Phase 2: Commercial stage

- ✓ Initial 500,000 tpa integrated steel plant
- ✓ AUD300 million
- ✓ International flagship project



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Reference #1 | Technology Readiness Levels (TRL)

As originally developed by NASA, technology readiness levels (TRL) are a method of estimating technology maturity of Critical Technology Elements (CTE) of a technology.

They are determined during a Technology Readiness Assessment (TRA) that examines program concepts, technology requirements, and demonstrated technology capabilities.

TRLs are based on a scale from 1 to 9 with 9 being the most mature technology.

The use of TRLs enables consistent, uniform discussions of technical maturity across different types of technology.

TRL	Maturity Stage	Where work is done	Funding level required (conservative)
TRL 1	Basic technology observation and research	Universities, Research Labs	At least $10K
TRL 2	Basic Technology Research – Research to prove feasibility	Universities, Research Labs	$10K - $100K
TRL 3	Research to prove feasibility – Technology development	Universities, Research Labs	$10K - $100K
TRL 4	Various stages of technology development	Universities, Research Labs, Development Service Providers	Up to $100K
TRL 5	Late technology development – Technology demonstration	Development Service Providers Production Foundry, Assembly/Test House	Up to $1M
TRL 6	Technology demonstration – System/subsystem development	Development Service Providers Production Foundry, Assembly/Test House Product Company	$1M to $10M
TRL 7	Final technology demos to system/subsystem development	Development Service Providers Production Foundry, Assembly/Test House Product Company	$1M to $10M
TRL 8	System/subsystem development to early stages of system proven through test, launch & operations	Production Foundry, Assembly/Test House Product Company	Up to $10M or more
TRL 9	System proven through test, launch & operations	Production Foundry, Assembly/Test House Product Company	>$10M

Reference #2 | What's in a name?

Coldry

Coldry is the combination of the words, Cold and Dry. Given the relative low-grade waste heat used (i.e. <50℃) the Coldry process dries lignite economically and continuously. A feat that typically uses large amounts of paid thermal energy and/or pressure.

Matmor/HydroMOR

The “MOR” in both names refers to “Metal Oxide Reduction”. The transition from Matmor to HydroMOR, reflects our increased knowledge of the key chemical processes occurring to reduce the metal. Namely, the decomposition of hydrocarbons into a hydrogen-rich syngas which allows for a more efficient and lower emissions reduction process.

COHGen

COHGen is short for, **C**atalytic **O**rganic **H**ydrogen **Gen**eration. We are the pre-patent stage of this technology’s development so no more can be divulged at this time.

Waste-to-Energy

At this stage, we cannot disclose the proprietary name given to this technology. ECT is investigating the acquisition of this technology and further updates will be forthcoming.