PITT STREET RESEARCH

Environmental Clean Technologies

Clean sweep in hydrogen

Share Price: A$0.001

ASX: ECT

Sector: Commercial & Professional Services

8 December 2020

This company's leading technology, Coldry, allows the transformation of low-grade brown coal into a product with qualities closer to high-grade black coal. A related technology called HydroMOR allows primary iron to be made using lignite instead of coking coal. ECT is also entering the waste-to-energy space where there is potentially a shorter lead time to commercialisation and higher finished product margin.

Currently addressing near-term cash flow

During 2015–2019, ECT collaborated with two Indian federal government majority-owned companies to set up an integrated Coldry demonstration and Matmor pilot plant in India. However, the collaborations failed to materialise and ECT had to withdraw from the projects. ECT is currently executing an alternative strategy outlined in September 2019 which involves expanding and upgrading the Bacchus Marsh facility for end products such as Coldry solid fuel, Char and Syngas. The upgrade project will be executed in two phases, with the first phase being completed by mid-2021 which is expected to generate positive cash flow. We think the shift in strategy to focus on near-term operational profitability will be welcomed by investors once ECT executes this project successfully.

Promising play in the hydrogen market

Hydrogen industry development is the next big emerging play, especially for Victoria's lignite resource. ECT believes that Coldry can be useful in preparing feedstock for the standard hydrogen production route known as steam reforming. However, its newer COHgen technology may provide a low-cost, lower CO_2 emission alternative to the steam reforming route to produce hydrogen from brown coal, if scaled successfully. We see potential for this technology to find a valuable commercialisation partner in the near term.

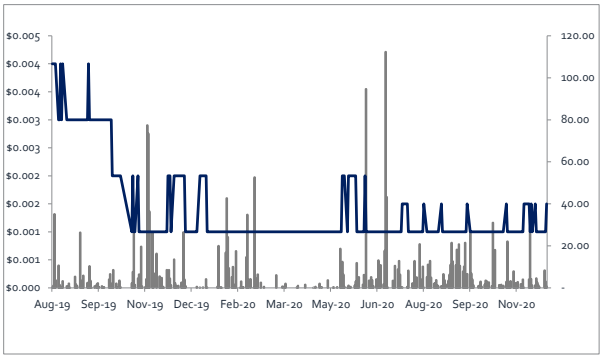
Valuation range of 0.30 – 0.41 cents per share

ECT is sufficiently funded for its plant upgrade project and our intrinsic value for the stock based on just this project indicates a significant upside potential. In our view, the stock price is being dragged down by the disappointment over the India collaboration not working out and investors have still not factored in the potential benefits of the change in the company's strategy.

Market Cap. (A$ m)	9.6
# shares outstanding (m)	9,601.0
# share fully diluted (m)	11,475.0
Market Cap Ful. Dil. (A$ m)	11.5
Free Float	77%
12 months high/low ($)	0.002 / 0.001
Average daily volume (m)	7.0
Website	ectltd.com.au

Source: Company, Pitt Street Research

Share price (A$) and avg. daily volume (m, r.h.s.)



Source: Refinitiv Eikon, Pitt Street Research

Valuation metrics	
DCF (cents)	0.30 – 0.41
WACC	13.9%
Assumed terminal growth rate	None

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Introducing Environmental Clean Technologies

Environmental Clean Technologies (ASX: ECT) is a Melbourne-based company developing a suite of technologies designed to upgrade waste and low-grade resources with low carbon emissions. The company's leading technology, called Coldry, allows a zero net emissions transformation of low-grade brown coal into a product with qualities closer to high-grade black coal. Coldry provides the base technology platform upon which its other technologies are then integrated. ECT has developed a Coldry pilot plant at Bacchus Marsh in outer Melbourne and has looked to develop commercial-scale plants in Australia and India. The company also has technology which produces low-emission/low-cost primary iron and low-emission hydrogen production technology.

ECT in its current form has largely been built on Coldry and Matmor/HydroMOR. The company's work on Coldry began in 2006[1] with the acquisition of Asia Pacific Coal and Steel Pty Ltd, which held the rights to the Coldry technology, and a related iron-production technology called Matmor[2]. ECT spent the next 12 years largely focusing on developing the Coldry and Matmor technologies, with a goal of establishing commercial-scale Coldry and Matmor plants in Victoria and India for producing high-value solid fuel and primary iron. These commercial projects have completed feasibility and basic engineering design phases.

ECT has also started to move into the waste-to-energy space, where there is potentially a shorter lead-time to commercialisation and higher finished product margin. In July 2019, the company acquired a waste-to-energy technology[3]. The technology, called CDP-WTE, has the potential to provide a low-cost way to process wood, end-of-life plastics and other wastes into diesel fuel, particularly when the feedstock is combined with fuel produced from the Coldry technology.

ECT believes it can be cash flow break-even within 12 months

ECT's primary focus in the near term is on generating positive group cash flow from expansion of its existing Coldry pilot plant. A September 2019 market release lays out a plan for the company to be cash flow positive within 12 months, which involves expanding and upgrading the Bacchus Marsh facility for end products beyond coal in addition to the company's move into the waste-to-energy and hydrogen sectors.

If ECT is so good, why is it only capitalised at A$9.6m (US$6.7m)? We believe the current low market capitalisation of ECT is due to disappointment over the India collaboration not working out as planned. However, now that ECT has obtained fresh funding through its rights issue, it can move ahead and execute the value creation strategy outlined in the September 2019 announcement. We believe that ECT's shift in strategy to focus on near-term operational profitability and cash flow is a prudent step and will help support the advancement of its multiple clean-tech opportunities in the medium term. While investors may not have still factored in the benefits of this positive step, we expect the situation to change once ECT's management starts demonstrating success in executing the strategy.

[1] Prior to 2006 the company's main focus was Enersludge, a pyrolysis and gasification-based method for managing sewage sludge. For background on Enersludge see Water Sci Technol. 2004;49(10):217-23. The company worked on Enersludge as 'Environmental Solutions International Ltd' but changed its name to 'Environmental Clean Technologies Ltd' in late 2006 to reflect the change of focus. For many years it retained the old ASX code of ESI but changed this in mid-2018 to ECT.

[2] See ECT's 10 February 2006 market release headlined '*ESI enters into an agreement to acquire 100% of Asia Pacific Coal and Steel Pty Ltd*'.

[3] See the company's 7th and 13th June 2019 market releases.

Coldry continues to hold promise as one of the better 'clean coal' technologies available

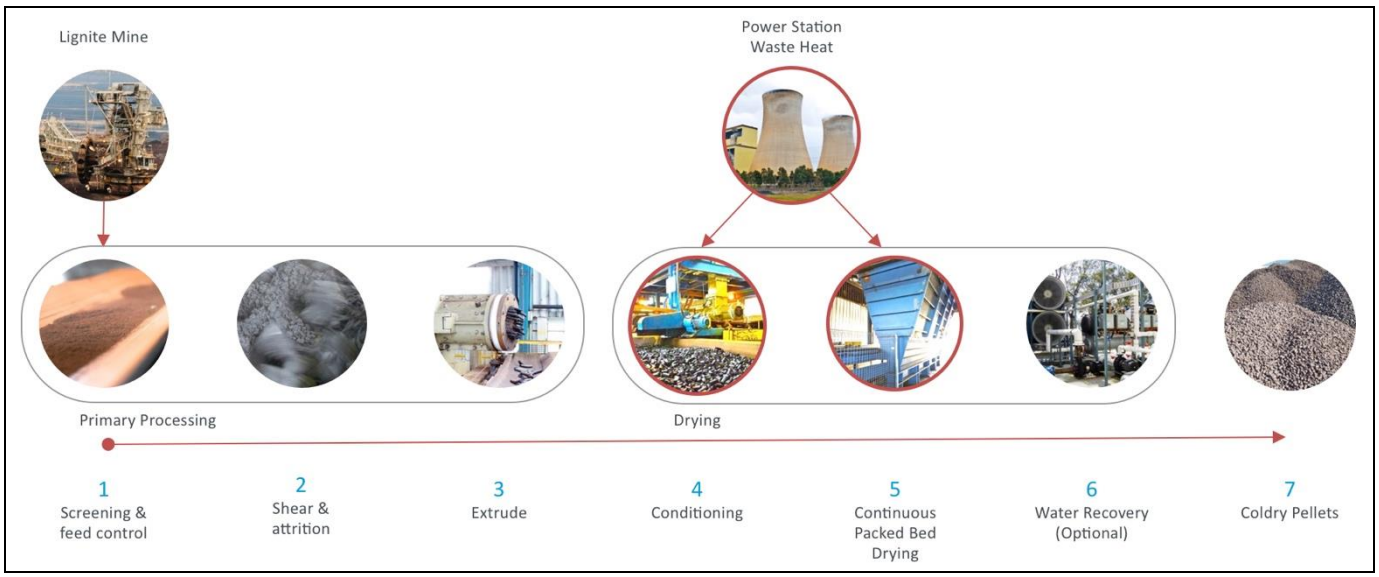
Coldry can convert brown coal to black coal equivalent. First developed in the 1980s, Coldry allows lignite, that is, brown coal, to be processed into a coal product similar in properties to higher-grade black coal. Lignite is considered a low-grade coal because it has a high moisture content which means that it produces less energy and more carbon emissions compared to black coal when it is combusted, typically for use in electricity generation. Upgrading lignite to a black coal equivalent using Coldry will result in reduced carbon emissions because less coal will be required for the equivalent level of power generation, while the potential price of the black coal equivalent product will likely be much higher than raw lignite because of the higher calorific value per tonne. Since power stations are significant users of lignite around the world, particularly in Australia, Germany, India, Poland, Russia, Turkey and the US[4], ECT has until recently focused on developing Coldry to integrate as part of power station coal supply, targeting a reduction in overall emissions. While there are various technologies for drying high-moisture coal in order to upgrade it[5], Coldry is the world's first low-temperature, low-pressure drying method capable of producing a black coal-equivalent product via a low-cost process that has zero carbon emissions.

ECT has operated a Coldry pilot plant in Melbourne since 2004

Coldry works by reducing the moisture content of lignite. Coldry was first developed by Professor R.B. Johns and colleagues at the University of Melbourne, working with the mining company CRA[6], in the early 1980s[7]. The Coldry process (Figure 1) involves 'attritioning' of raw lignite to a mean particle size of approximately 10 µm, which initiates a low-pressure extrusion and densification process that releases >85% of the water contained within the porous coal structure. Coldry pellets are able to be produced, conditioned and dried to a resultant moisture content of <15%, as opposed to the ~60% level of typical lignite[8], and a calorific value of ~24 Mj/kg, equivalent to black coal, as opposed to the standard 8 Mj/kg of brown coal[9]. A major benefit of the technology is the low level of heat required in the drying process, which means that waste heat from a nearby power plant or industrial facility can be integrated for this purpose. In June 2009, ECT acquired the intellectual property related to Coldry, which it had previously used under license.

[4] Source: Geoscience Australia.
[5] Such as steam tube drying, brown coal briquetting and hydrothermal dewatering.
[6] A Rio Tinto precursor.
[7] See *Upgrading solid fuels*, US Patent 4,758,244, issued July 1988, priority date 17 February 1983. See also Johns et. al. (1899*), The conversion of brown coal to a dense, dry, hard material*, Fuel Processing Technology, Volume 21, Issue 3, March 1989, Pages 209-221. A Wikipedia article headlined '*Densified coal*' describes the Coldry technology.
[8] See the company's market release dated 31 July 2007 and headlined '*Overview of Coldry process*'.
[9] The Coldry pellets burn at 1,350-1,400 degrees C versus 700-800 degrees C for untreated brown coal.

Figure 1: The Coldry process



Source: Company

ECT has operated a Coldry pilot plant in Melbourne since 2004. Asia Pacific Coal and Steel Pty Ltd commissioned a 10,000 tpa Coldry pilot plant at Bacchus Marsh in 2004 to demonstrate the technical viability of the technology in batch processing. This plant was upgraded to continuous processing in 2007[10] and to a 15,000 tpa capacity in 2016[11]. ECT calls the Bacchus Marsh operation a HVTF, that is, a High-Volume Test Facility. There was a fire at the facility on 21 October 2019 which caused an estimated A$2.0-2.5m damage but this will be covered by insurance[12].

ECT has been seeking to build a commercial-scale Coldry plant in Victoria's Latrobe Valley

ECT has been seeking to build a commercial-scale Coldry plant in Victoria's Latrobe Valley. The Latrobe Valley, in the Gippsland region east of Melbourne, is noted for its large deposits of lignite[13], (which potentially constitute a quarter of the world's total), as well as three lignite-fired power stations – Loy Yang, Hazelwood[14] and Yallourn. ECT has long sought to develop a commercial-scale Coldry plant in the Latrobe Valley, using local lignite as the principal feedstock[15]. The company completed preliminary feasibility studies for such a plant in 2009 and by 2013 had completed the design work[16]. ECT had hoped that it would receive government grants to develop Coldry under the Advanced Lignite Demonstration Program initiative of the Australian and Victorian governments[17], however it was not successful[18]. Feasibility and scoping for basic engineering design of this proposed commercial plant was completed during 2018–2019.

ECT is now adapting the Bacchus Marsh HVTF for uses beyond power station coal. The company is currently developing a Char product (for use as a smokeless fuel[19] and a carburiser for specialty metallurgical applications) and

[10] See the company's market release dated 13 September 2007 and headlined '*Completion of the Coldry Process production trial*'.
[11] See the company's market release dated 16 December 2016 and headlined '*High Volume Test Facility upgrades complete*'.
[12] See ECT's market release dated 8 November 2019 and headlined '*Company update*'.
[13] With measured deposits of 65 billion tonnes - see earthresources.vic.gov.au.
[14] Decommissioned in March 2017.
[15] ECT's Bacchus Marsh HVTF sources lignite from the mine next door to the Yallourn Power Station.
[16] See the company's market release dated 20 August 2013 and headlined '*Coldry demonstration plant construction ready*'.
[17] The Advanced Lignite Demonstration Program (ADLP), announced in August 2012, was designed to promote development of lignite beneficiation technology. It commenced in May 2014. A company called Coal Energy Australia has received a grant of A$30m to develop a technology based on a pyrolysis process to generate up to four products from lignite, including high-quality PCI Coal, pyrolysis oil, ammonium sulphate and coal gas.
[18] See the company's market release dated 3 January 2014 and headlined '*ADLP outcome and fast tracking India*'.
[19] That is, of the kind use to fuel barbeques.

is also looking to produce Syngas from Bacchus Marsh that can be used for steam or electricity production or in some cases, as chemical feedstock in the synthesis of more valuable products. Additionally, ECT is working to create a service business from Bacchus Marsh where its engineers can consult in the development of steam and hot water systems[20]. ECT argues that this approach can lead to economic returns on Bacchus Marsh in the near term for relatively low capital inputs.

ECT's September 2019 recovery plan

ECT is now going after near-term cash flow opportunities. The company is adapting the Bacchus Marsh HVTF for uses beyond power station coal. This is part of a broader plan generated by ECT following the failure of the 2015–2019 Indian collaboration, where the emphasis was on later-stage opportunities. While the market may initially be wary of the company's claim to be in a position to achieve 'positive cash flow inside 12 months', we think the plan has merit.

- **Bacchus Marsh** – There are ample customers available in close proximity to Bacchus Marsh for the Char and solid fuel products, as well as for the steam and boiler consulting team. The state of Victoria, traditionally the heartland of Australian manufacturing, still has a ~A$28bn manufacturing sector across ~13,000 businesses employing ~9% of the state's workforce[21].
- **Domestic opportunity in the Char market** – Following the cessation of briquette manufacturing in Victoria in 2014 which put an end to coal-based Char production, imports have been substituting and filling in the supply gap. This makes the situation favourable for local manufacturing, considering the impact of freight and forex on landed cost of imports. ECT will aim to position itself as a contract manufacturer to establish Char brands in order to leverage this opportunity.

Priority focus on upgrading Coldry project

Coldry upgrade project to help generate earnings to support other programmes in the medium term

ECT, as per its recovery plan, will be working on a three-tiered approach targeting operational earnings that will involve organic growth, acquisitions and corporate restructuring. Tier 1 of the strategy will focus on upgrading the Coldry HVTF at Bacchus Marsh, ECT's largest physical asset, to support the expansion of solid fuel and its foray into the Char market. The upgrade includes capacity improvement of the Coldry plant and the addition of new plant and equipment to produce high-value Char. The project aims to increase Coldry's capacity to 25,000 tpa with total revenue and operating cash flow target of ~A$6m and A$2.5m, respectively. The product or segment level targets of the project are as follows:

- Steam and boiler systems (solid fuel) – 5,000 tpa; A$1m revenue p.a.; A$250k EBITDA p.a.
- Char products – 10,000 tpa; A$5m in revenue p.a.; A$2.5m EBITDA p.a.
- Syngas – 10,000 tpa (equivalent).

To minimise technical and financial risks, the execution of the project will be in two phases. The first phase will concentrate on scaling up the Coldry process and aim for target completion by April 2021, and the second phase of

[20] For background here see the company's 3 November 2017 market release headlined *'Boiler trials and Coldry logistics and sales agreements'*.
[21] Source: '*Victorian government press release dated 1 February 2018 and headlined 'Victoria's manufacturing sector records 12 months of growth'* at connection.vic.gov.au.

Char plant construction and commissioning will follow if the first phase is successful. The final full capacity of the plant is expected to be 35,000 tpa, by 2023–2024. The management's eventual goal is to realise sufficient operational earnings to keep the potential of HydroMOR, COHGen and CDP-WTE technologies intact as well as support the feasibility of a larger Coldry plant in the Latrobe Valley.

The total capital outlay for the upgrade project is estimated to be over A$5m, including the effects of the disruption from the COVID-19 pandemic. As per the latest update by ECT, business is coming back to normal and work on Coldry upgrades has been resumed.

Sufficient funding available through multiple channels

The majority of funds for financing the Coldry upgrade project will come from the proceeds of the rights offer that closed on 10 May 2020. ECT raised ~A$4.8m through its non-renounceable rights issue which saw one new share being offered at 0.1 cent per share for every one share held, together with two options for every five new shares issued. The options are exercisable at 0.3 cents per share at any time until 17 February 2023. Besides supporting the Coldry plant upgrade, the financing will be utilised for debt payment including loans and creditors.

Funding in place to support ECT's plans for cash flow breakeven

In addition to the funds raised through the rights issue, ECT has access to more capital through non-dilutive alternatives such as project and equipment finance, R&D tax initiatives, government grants, cost containment measures, and reduced or deferred capital expenditure. The Coldry upgrade project is eligible for R&D tax incentive from the Australian government and it can claim up to ~A$2.2m on the upgrade project plus other eligible expenses. The R&D tax incentive also extends to ECT's other technologies, including HydroMOR, COHgen and CDP-WTE. The other means of financing originates from the federal government's COVID-19 stimulus measures. The instant asset write-off measures that now extend through to December 2020 will allow ECT to accelerate the write-off of several capital items and benefit in advance from the R&D tax incentive on depreciation. ECT has also been awarded an A$50k grant from the Commonwealth Government Department of Industry, Science, Energy and Resources which relates to its HydroMOR technology. Moreover, the company is expecting to receive additional proceeds of A$2-3m as insurance claim relating to the fire which took place last year in the Bacchus Marsh facility.

Further, during the COVID-19 lockdown, the management implemented several cost containment measures such as reducing the remuneration of directors and executives by over 50%, to preserve funds for the Coldry project.

We believe that the company has sufficient funds and alternatives in place to support its near-term growth plans and the management has some headroom to deal with any more unexpected events during the course of this year.

Market for ECT's end products

ECT's three key end products are Coldry, Char and Syngas (Figure 2). The primary end market for Coldry comprises power steam boilers, the global market size of which is set to surpass US$21.6bn by 2023, compared with US$17.7bn in 2018, as per research firm MarketsandMarkets. The global coal market is under pressure as economies turn towards greener sources of energy, and Coldry is a lower-emission alternative. ECT will mainly supply Coldry to commercial and industrial (C&I) heat applications, and thermal power generation plants.

C&I heat applications include a range of industries that require large volumes of heat such as dairy processing, timber drying and abattoirs. As per the Australian Renewable Energy Agency[22] (ARENA), natural gas is the largest existing source for industrial heat, followed by black coal. However, over the past three years, prices of natural gas have been increasing. In our view, if this upward trend continues, industrial customers might start looking for alternatives, offering opportunities to ECT. Another alternative available to industrial customers is biomass but its availability is seasonal and limited in total volume.

A potential application for ECT's Coldry is in the form of a front-end drying solution for coal-to-hydrogen production

Another potential application for ECT's Coldry is in the form of a front-end drying solution for coal-to-hydrogen production. In May 2020, the Morrison government introduced the A$300m 'Advancing Hydrogen Fund' to underpin hydrogen production, with a view to make Australia a hydrogen superpower. This was followed by a new legislation to support the production of hydrogen from brown coal and lay the foundation for future carbon capture and storage developments. Further, ECT is a member of the Future Energy Exports Cooperative Resource Centre, which is focused on Australia's hydrogen capability development. In our view, ECT is well-positioned to leverage its membership to take advantage of the growth opportunities presented by favourable policies for hydrogen production.

Figure 2: Images of Coldry, Char and Syngas

Source: Company, Pitt Street Research

Although coal currently fuels ~40% of global power production, its prospects as the primary source of power may not hold promise in the long term, and this could impact the potential for Coldry as well. ECT is banking more on the potential of its high-margin by-product, Char, which is expected to become the highest revenue contributor and highest-margin product for the company over the next 3–5 years.

[22] Report commissioned by ARENA in November 2019 and prepared by ITP Thermal Pty Ltd; *'Renewable Energy Options for Industrial Process Heat'*.

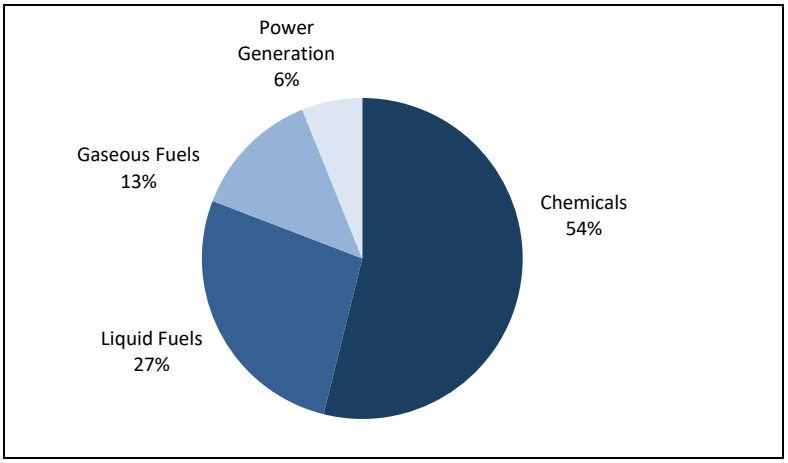
Global charcoal market is estimated to grow at a 4.2% CAGR over 2019–2027

Char has diverse applications, including as feedstock in barbeque briquettes, carburiser in the steel industry and soil conditioner in the agriculture sector. The global charcoal market was worth ~US$6.9bn in 2018 and is projected to grow at a steady CAGR of 4.2% to reach ~US$9.9bn by 2027, as per estimates by Research and Markets. The key drivers for this market will be growing demand for barbequed food and increasing use of charcoal as a filtration agent for air and water purification. The fastest growth in terms of geography is expected to be in the Middle East and Africa. ECT is focusing its marketing efforts on the barbeque briquette market and is in active discussions with off-take parties.

Bulk of demand for Syngas is expected to originate from Asia Pacific

The third key product, Syngas, generates heavy demand from the chemical industry due to its application in production of fertilisers, solvents and synthetic materials (Figure 3). It is used for producing Synthetic Natural Gas (SNG), which is used in the form of Liquefied Natural Gas (LNG) and Compressed Natural Gas (CNG) in rail, marine and road transportation. According to Mordor Intelligence, the global Syngas market is forecast to grow at a 10% CAGR during 2020–2025, with the bulk of demand originating from Asia Pacific, followed by North America and Europe. Within Asia Pacific, China, India and Australia will be the leading markets for Syngas.

Figure 3: Global Syngas market by application, 2019



Source: Mordor Intelligence

Matmor/HydroMOR and COHgen allow other valuable products to be made from lignite

Matmor allows primary iron to be made using lignite instead of coking coal. This technology works by mixing recycled or low-grade iron bearing materials (ores, millscale, etc.) with lignite, processing that mixture as per the Coldry process, and then running it through a specialised furnace (vertical retort) that produces metal from the lignite/iron pellet via a reduction reaction. Matmor was developed in the early 2000's[23] by the Calleja Group, owner of the Maddingley Brown Coal Mine at Bacchus Marsh near which ECT's Coldry pilot plant is located[24]. ECT acquired the Matmor intellectual property in December 2014. Matmor was the world's first and only technology to allow iron to be made using low-grade coal at relatively low temperatures (i.e., only 850-1,050 degrees C), superseded by the company's own HydroMOR process.

HydroMOR is 'Matmor 2.0'. The original Matmor process relied on a carbon-based reduction reaction and used an oxygen lancing step in which oxygen was injected into the vessel at the base of the retort, allowing metal to be separated from the slag prior to casting. ECT superseded the 'Matmor' process in late 2016 following research breakthroughs that led to a new hydrogen-based reduction technology which the company called HydroMOR. The new technology works faster than Matmor[25], and at a lower temperature (<900 degrees C). The oxygen lancing step was replaced by a new discharge method enabling multiple product options, either in DRI-form[26], or hot metal, or solid iron.

ECT knows how to extract various valuable products from lignite

HydroMOR has notable advantages against other iron production technologies such as rotary kiln or conventional blast furnace production, most notably the faster speed of production at markedly lower temperatures and the ability to utilise alternative raw materials, effectively decoupling iron making from the high-cost coking coal and premium iron ore markets. It is worth noting that the HydroMOR technology can be used to produce other metals, such as nickel or manganese.

The path ahead for HydroMOR may involve India. Although ECT took the decision in June 2019 to withdraw from its partnership with National Mineral Development Corp of India, the company continues to keep ties with NLC India Ltd (NLCIL). As of January 2020, ECT plans to continue to work with NLCIL towards the commercialisation of HydroMOR in India. To this extent, ECT has already completed a market research on potential steel industry partners in India. We see potential for HydroMOR to be partnered with a more aggressive private sector iron and steel company in India but only in the medium term.

COHgen allows hydrogen production from lignite, the COH standing for 'Catalytic Organic Hydrogen'. ECT first told the market about the technology in 2017 but we understand that patent applications related to this technology are yet to be published. COHgen involves a composite pellet that combines lignite with a catalyst which, inside a retort, produces a hydrogen-rich Syngas and fixes most of the carbon in the pellet[27]. Hydrogen is frequently talked of these days as a fuel source[28] but the key is always cost of production and

[23] The technology's inventor was David Wilson, who was also a co-inventor of the Coldry process - see WO/2005/028977, *Dryer, drying method and drying plant*, invented by David Wilson, priority date 25 September 2003.
[24] See maddingleybrowncoal.com.au.
[25] *See* WO/2018/094453, *Low temperature direct reduction of metal oxides via the in situ production of reducing gas*, priority date 23 November 2016. Invented by Keith Henley-Smith, Adam Giles, Lachlan Bartsch and Ashley Moore.
[26] That is, Direct Reduced Iron, a common feedstock to steel making where iron ore is directly reduced to iron by a reducing gas or elemental carbon produced from natural gas or coal.
[27] See the company's May 2019 presentation entitled '*Capturing the chemistry of lignite without the emissions'*.
[28] See, for example, *Hydrogen fuel cell ferry moves closer to reality* by Dan Rosenheim, Bay City Beacon, 25 September 2019.

storage. The apparent simplicity of COHGen may attract commercialisation partners in future.

CDP-WTE's acquisition has enabled ECT to move into the promising waste-to-energy sector

CDP-WTE was acquired in July 2019. This technology, originally developed by a company called CDP Innovations Pty Ltd, allows a range of waste products to be converted to fuels such as diesel. CDP stands for 'Catalytic Depolymerisation Process' and WTE refers to 'Waste-to-Energy'. CDP Innovations was placed in liquidation in late 2018 and ECT acquired the technology from the liquidator in July 2019[29].

A 'Catalytic Depolymerisation' technology. In chemistry, polymers are simply large molecules composed of repeating structural units connected by chemical bonds. Many complex organic hydrocarbons are polymers which, if broken down, can yield simple hydrocarbons that can be used to produce energy. The Catalytic Depolymerisation technology which ECT has just acquired uses special catalysts to create these simple hydrocarbons. The technology, which originated from work performed at the University of Queensland's School of Chemical Engineering, is covered by a 2017 patent application made by CDP Innovations' founder[30].

ECT intends to build a CDP pilot plant. Prior to its dissolution, CDP Innovations developed a demonstration unit for CDP in Qingdao, China, and that plant, whose nominal capacity was a 100L/hr, successfully converted waste timber to a heavy petroleum oil. ECT proposes to build a second, larger pilot plant at Bacchus Marsh where the Coldry process would be used to enhance the waste and biomass feedstock going into the plant, improving efficiency and oil yield.

ECT may not require much capital to develop a CDP-WTE pilot plant

The CDP-WTE technology may provide a rapid commercialisation pathway. A great deal of work has already gone into both Coldry and CDP-WTE. ECT therefore believes relatively little capital would be required to go from pilot plant to commercial-scale plant with the technology, particular given the available waste deposits that the CDP-WTE plants could access.

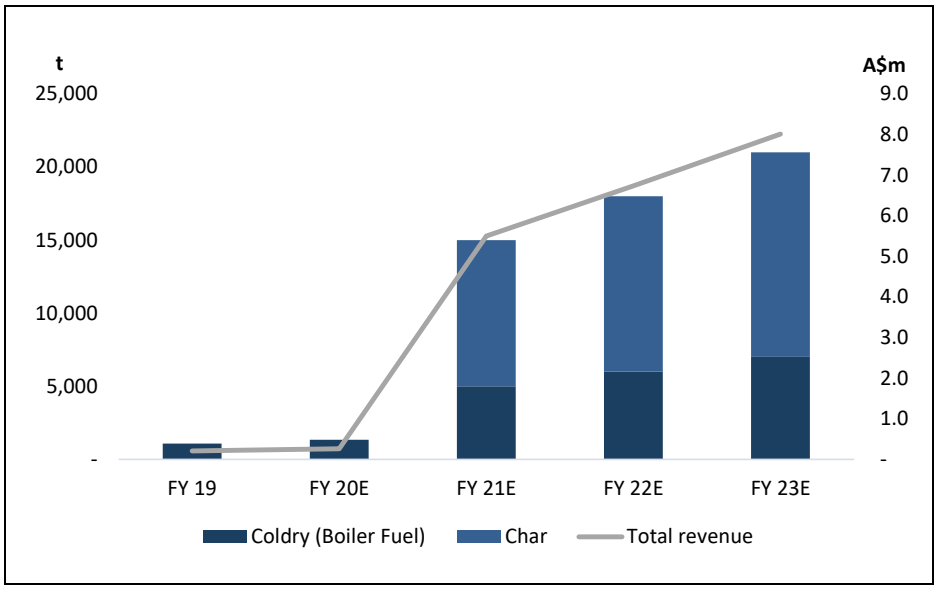
[29] See the ECT presentation entitled '*ECT CDP Waste2Energy*', available at ectltd.com.au.
[30] See WO/2018/000014, *A method for the production of diesel*, priority date 27 June 2016, Invented by Philip Major and Jimmy Jia.

Valuation

We value ECT at 0.30 cents per share base case and 0.41 cents per share optimistic case. Our basic valuation approach is as follows:

- We built Discounted Cash Flow (DCF) models of the Bacchus Marsh HVTF project based on the assumptions provided in tier 1 of the company's September 2019 recovery plan. We have assumed a WACC of 13.9%[31] and plant lives of 20 years base case and 25 years optimistic case, respectively.
- Guided by the company, we have modelled divisional revenue and earnings for each of the company's product lines (Figure 4). Further, we have assumed that Syngas will be largely consumed internally to offset production cost.
- We assumed ECT to complete the Bacchus Marsh HVTF project upgrades by end of FY2020, with first production to commence in FY 2021, sequentially ramping up towards full plant capacity of 35,000 tpa by FY 2023.
- We assumed initial selling prices for Coldry and Char to be in line with company guidance for the base case, while our optimistic case factored in an additional premium specific for each product to reflect a more robust pricing outlook.
- We assumed ECT to receive a fixed and ongoing R&D tax incentive of A$1.5m in the first half of each financial year from FY 2021.
- We assumed a 27.5% corporate tax rate.

Figure 4: Production and sales outlook



Source: Pitt Street Research

Coldry and Char pricing. Based on the revenue and volume guidance provided for each product, we have re-engineered a Coldry price of A$200/t, and a Char price of A$450/t and have subsequently utilised those as initial selling prices in deriving our base case valuation (Figure 5). For the purpose of this project, it has been assumed that Syngas will offset internal costs by acting as an alternative to natural gas, rather than generating revenue. Also,

[31] RFR 0.9%, MRP 6.9% and beta 1.27.

we have assumed base case prices to inflate by 2% p.a. over the life of the Bacchus Marsh plant.

For our optimistic case, we have applied an additional premium to the base case price of each product, with the Char product attracting an additional 11% premium, thereby arriving at a Char price of A$500/t. As noted earlier in this report, due to the diverse application of the Char product ranging from its usage as a smokeless fuel to a carburiser for specialty metallurgical applications, we expect the price outlook for Char to remain robust. Moreover, with Char being the highest-margin product (EBITDA margin of ~56%), the resulting effect from its role as the largest revenue contributor and increases in its selling price will significantly enhance the company's operating profit margin.

Figure 5: Initial selling prices

	Base Case	Bull Case
Coldry Price (A$/t)	200	250
Char Price (A$/t)	450	500

Source: Pitt Street Research

Operating costs. Based on the divisional revenue and EBITDA guidance, we have worked out operating costs for the Steam & Boiler, Char and Syngas divisions to be A$150/t, A$200/t and A$25/t, respectively; we assumed them to be initial operating costs for FY 2021. Post FY 2021, we assumed the Bacchus Marsh HVTF to sequentially ramp up towards its 35,000 tpa full capacity by FY 2023. As production volumes increase, we expect production cost per tonne to reduce due to scale benefit and operating leverage.

Our DCF valuations have been summarised below (Figure 6) with our base case scenario returning a value of 0.30 cents per share, while our optimistic case increases this to 0.41 cents per share.

Figure 6: DCF valuation for ECT's Bacchus Marsh HVTF

Valuation (A$M)	Base Case	Bull Case
Value of Bacchus Marsh HVTF	**31.1**	**42.3**
Net debt (cash)	2.6	2.6
Equity value	**28.5**	**39.6**
Share outstanding (m, FY20E)	9,601	9,601
Implied price (cents)	**0.30**	**0.41**
Current price (cents)	0.10	0.10
Upside (%)	*196.5%*	*312.8%*

Source: Pitt Street Research

Re-rating

ECT is currently trading below our base case valuation. We believe the current low share price is the result of an unsuccessful India collaboration as the Indian project was regarded by investors as a key growth opportunity for the company. However, we also believe that the later-announced September 2019 corporate strategy looking at commercialising in the domestic industrial market will yield significant upsides for investors should it be successfully executed. Importantly, we modelled above that the inclusion of those upsides will result in a valuation range of 0.30 – 0.41 cents, with our bull case representing over 300% upside from the current share price level.

Moreover, we see three factors helping to re-rate the stock into our valuation range.

- Signing of new offtake agreements for the Char product;
- On-time completion of the Bacchus Marsh HVTF project upgrades; and
- Potential for value accretive acquisitions where ECT's technologies can be leveraged for better value.

Risks

Four main risks related to ECT's investment thesis include the following:

1) Production risk. Projected production levels may not be achieved due to firm-specific risks such as the fire incident in the past that caused disruption to the production of Coldry pellets for ECT's steam and boiler business.
2) Pricing risk. Coldry pricing may become unfavourable, should the demand growth for coal reduce due to increased climate risk associated with the burning of coal for power generation.
3) Contract risk. Although ECT has made progress in negotiating offtake arrangements for the range of products supplied through the proposed upgrades at its Bacchus Marsh site, these offtake contracts are currently yet to be finalised. Sale of products will be affected if those contractual relationships do not get formalised.
4) Commercialisation risk. Implementation of the proposed expansion to the Bacchus Marsh HVTF may not be successful; continued difficulties in finding additional partners in India for implementation of a pilot scale Matmor project; delay in the completion of integrated Coldry-CDP Latrobe Valley project.

Companies to watch in the 'clean coal' tech space

We note two companies that are comparable to ECT (Figure 7).

White Energy (ASX: WEC). WEC is the exclusive licensee of a patented technology known as Binderless Coal Briquetting (BCB). This technology is capable of upgrading low cost, low rank coals and coal finds into more valuable, higher energy yielding briquettes. Tests have been conducted on a number of Chinese and South African coals. WEC is now in the process of finalising a contract to commence construction of its BCB plant in China. In addition to coal technology, WEC is involved in the evaluation of mining exploration assets over various parts of the world from Australia to the US.

Clean Coal Technologies (OTCQB: CCTC). CCTC is a US clean coal tech company owning Pristine M™, a coal dehydration technology that places lower ranked coal through a gasification process, removing moisture to create stable, dust-free coal. The refined coal produces less emissions when burned, including carbon dioxide, sulfur and mercury. The technology has undergone testing phase processing 2 tons per hour. CCTC expects to generate revenue through the sale of patent licences and by-products extracted from coal.

Figure 7: Pure-play clean coal tech companies

Clean Coal Tech Pure Play Companies	Ticker	FY-end	Key technology	Market Cap (A$ m)	Cash (A$ m)	Debt (A$ m)	EV (A$ m)
ENV Clean Tech	ASX: ECT	6/30/2019	Coldry	9.6	0.4	3.0	12.2
White Energy Company	ASX: WEC	6/30/2019	Binderless Coal Briquetting	108.4	4.4	33.0	137.0
Clean Coal Technologies Inc	OTCQB: CCTC	12/31/2019	Pristine-M	4.1	0.1	14.6	18.5
AVERAGE				**56.3**			**77.8**

Source: Pitt Street Research

Appendix I – ECT's Intellectual Property

Coldry – WO/2004/001319 *Dryer, drying method and drying plant*, priority date 25 September 2003. Invented by David Wilson.

Matmor – WO/2001/038455 *Retort*, priority date 26 September 2000. Invented by David Wilson.

HydroMOR – WO/2018/094453, *Low temperature direct reduction of metal oxides via the* in situ *production of reducing gas*, WO/2018/094453, priority date 23 November 2016. Invented by Keith Henley-Smith, Adam Giles, Lachlan Bartsch and Ashley Moore.

CDP-WTE – WO/2018/000014, *A method for the production of diesel*, priority date 27 June 2016. Invented by Philip Major and Jimmy Jia.

Appendix II – Glossary

Attrition – In coal processing, the grinding of coal material by rubbing or friction, as opposed to impaction of crushing.

Brown coal – See lignite.

CDP-WTE – Short for Catalytic Depolymerisation-based Waste-to-Energy, an ECT technology to produce diesel fuel from low-value resources.

Char – Coal where the coal gas and tar have been removed by combustion. Char is used as a smokeless fuel as well as a carburiser in specialty metal applications.

COHGen – An ECT technology for producing hydrogen from brown coal. The COH stands for 'Catalytic Organic Hydrogen'.

Coldry – An ECT technology allowing lignite and some sub-bituminous coals to be converted to black coal equivalent.

HydroMOR – An ECT technology that uses lignite-derived hydrogen to produce primary iron.

Lignite – Also called 'brown coal', lignite is the coal with the lowest energy content, it being formed from naturally compressed peat.

Matmor – An ECT technology that uses lignite to produce primary iron.

Retort – An airtight vessel in which substances are heated, typically with the aim of producing a chemical reduction reaction. Product gases may be collected in a collection vessel.

Syngas – A synthetic gas produced by gasification of a carbon-containing fuel.

Appendix III – Analyst Qualifications

Stuart Roberts, lead analyst on this report, has been covering the Life Sciences sector as an analyst since 2002.

- Stuart obtained a Master of Applied Finance and Investment from the Securities Institute of Australia in 2002. Previously, from the Securities Institute of Australia, he obtained a Certificate of Financial Markets (1994) and a Graduate Diploma in Finance and Investment (1999).
- Stuart joined Southern Cross Equities as an equities analyst in April 2001. From February 2002 to July 2013, his research specialty at Southern Cross Equities and its acquirer, Bell Potter Securities, was Healthcare and Biotechnology. During this time, he covered a variety of established healthcare companies such as CSL, Cochlear and Resmed, as well as numerous emerging companies. Stuart was a Healthcare and Biotechnology analyst at Baillieu Holst from October 2013 to January 2015.
- After 15 months in 2015 and 2016 doing Investor Relations for two ASX-listed cancer drug developers, Stuart founded NDF Research in May 2016 to provide issuer-sponsored equity research on ASX-listed Life Science companies
- In July 2016, with Marc Kennis, Stuart co-founded Pitt Street Research Pty Ltd, which provides issuer-sponsored research on ASX-listed companies across the entire market, including Life Science companies.

Cheng Ge is an equities research analyst at Pitt Street Research.

- Cheng obtained a B.Com in Finance and LL.B from University of New South Wales, in 2013, and has passed all three levels of the CFA Program.
- Prior to joining Pitt Street Research, he has worked for several financial services firms in Sydney, where his focus was on financial advice.
- He joined Pitt Street Research in January 2020.

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