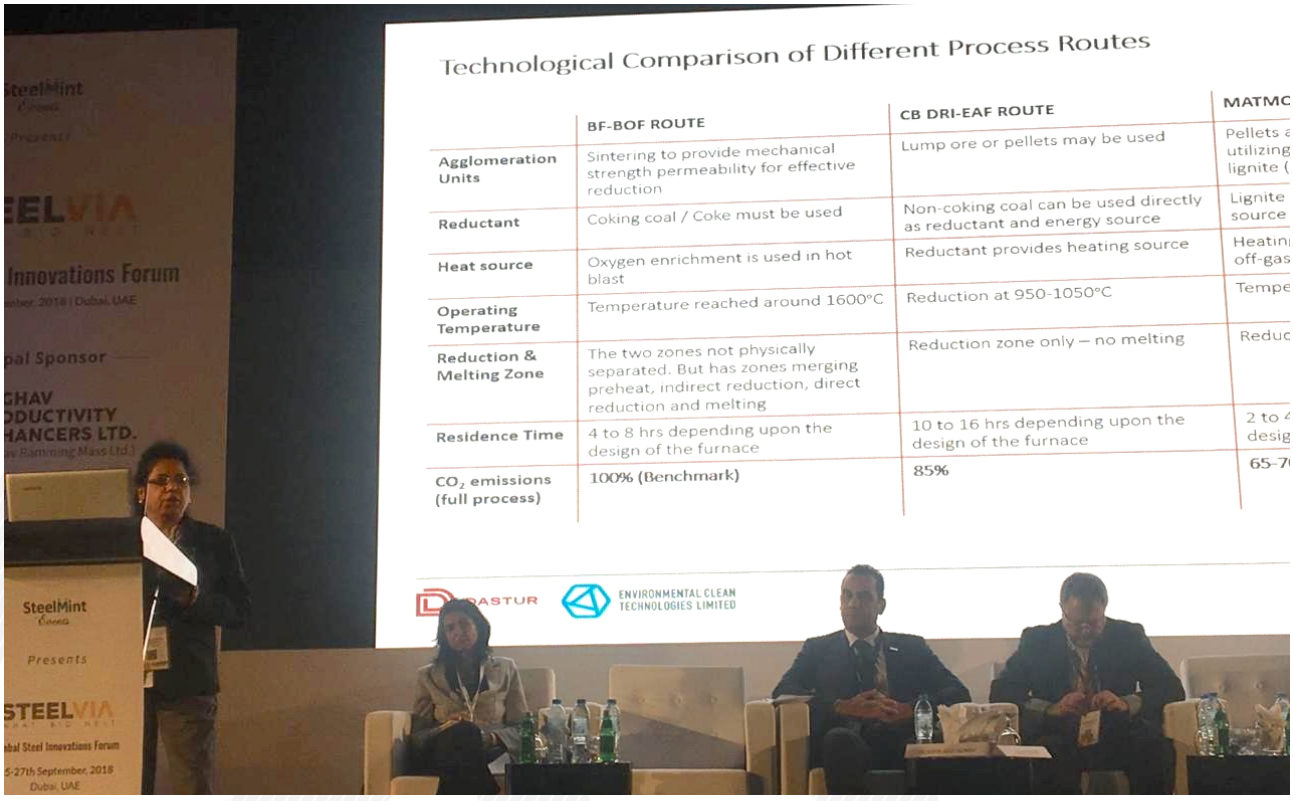
ENVIRONMENTAL CLEAN TECHNOLOGIES LIMITED

Matmor technology presented at the Global Steel Innovation Forum

3 October 2018: Environmental Clean Technologies Limited (ASX: ECT) (ECT or Company) presented its Matmor technology at the Global Steel Innovations Forum, held in Dubai last week.

Key takeaways:

- Largest-ever R&D collaboration between Australia and India
- Matmor is the only lignite-based iron making technology in the world, eliminating the cost of both thermal and coking coal used in other processes
- Matmor utilises iron ore fines, utilising this lower-priced resource
- Addresses 8/10 of India's strategic, high priority steel industry research targets
- Potential for significantly better return on investment (ROI) potential vs. blast furnace and coal-based DRI kilns
- Ideally placed to support India's 200 million tonne steel capacity growth ambitions by 2030



Above: Ms Aditi Tarafdar (left), Technical Director and Head of Process Metallurgy at MN Dastur and, ECT India CMD Mr Ashley Moore (right).

Attracting over 500 steel industry delegates from around the world, the Global Steel Innovation Forum provided a platform to showcase disruptive and cutting-edge technological innovations in the steel and associated sectors, targeted at delivering improvements in operational efficiency, cost-effectiveness and emissions profiles to drive industry processes to the next level.

Last week (Wednesday 26 September 2018), ECT India Chairman-Managing Director, Mr Ashley Moore presented the Company's Matmor technology to an audience comprised of steel industry delegates from around the world.

Co-presenting with Ashley was Ms Aditi Tarafdar, the highly regarded Technical Director and Head of Process Metallurgy at MN Dastur.

The presentation stood out at the event as the world's first and only lignite-based primary iron making process, highlighting the features and benefits associated with decoupling the steelmaking process from expensive metallurgical coal and premium grade lump iron ore and other high-cost inputs such as premium grade non-coking coal and natural gas.

For the technically minded, the Matmor process relies on a unique chemical pathway involving the in-situ gasification and catalytic thermal decomposition of hydrocarbons to drive a hydrogen-based reduction reaction at low (<900°C) temperatures, with the hydrogen in the process recycled via beneficial co-reactions.

For the layman, this means iron ore is reduced to iron at a lower temperature, using cheaper, alternative raw materials. Lower temperatures mean the plant can be made of 'lighter' materials, reducing the capital intensity. The use of cheaper, alternative raw materials decouples the iron making process from expensive coking coal and premium grade lump iron ore.

Ms Tarafdar provided an overview of how MN Dastur and ECT have approached the development of the technologies, including the techno-economic feasibility study, the basic engineering and design process and the underlying process chemistry.

Of key interest to delegates was slide 27:

Benefits vs Other Ironmaking Processes

Decoupling from traditional raw materials strengthens a business' resistance to inherent price volatility

TEF Study basis:
2015/6 average RM costs & Sales prices

	Traditional	Indian Alt	ECT
	BF - BOF	CB DRI - EAF	C/M - EAF
	Blast Furnace - Basic Oxygen Furnace	DRI Kiln – EAF	Coldry / Matmor - EAF + Power Generation
Case / Scenario	Base Case	Base Case	Mid Case
CAPEX (Index)	100%	90%	64%
OPEX (Index)	100%	123%	103%
SALES (Index)	100%	108%	103%
ROI (index)	100%	70%	160%

TEF model updated using
2018 Sep RM costs & Sales prices

	Traditional	Indian Alt	ECT
	BF - BOF	CB DRI - EAF	C/M - EAF
	Blast Furnace - Basic Oxygen Furnace	DRI Kiln – EAF	Coldry / Matmor - EAF + 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%

Inherent strength – Lower Capex, plus ability to use lower cost raw materials:

- Coking coal (~$US 85 FOB)
- Non-coking coal (~$55 FOB)

2018 current pricing:

- Coking coal >100% increase
- Non-coking coal >25% increase
- Lignite flat pricing
- Fe Ore fines ~flat
- Steel >30% increase

DASTUR ENVIRONMENTAL CLEAN TECHNOLOGIES LIMITED [27]

Ms Tarafdar highlighted the compelling business case for the Matmor technology, noting the table on the left shows the projected return on investment (ROI) based on 2015-16 prices for coal and iron ore, running at 160% of blast furnace returns, despite the historic low prices for coking coal at that time.

The table on the right is updated to reflect the current higher coal, iron ore and steel pricing. The result is an improved level of economic superiority for the Matmor process compared to the original economic analysis, driving the case for project acceleration.

Following the presentation Mr Moore was approached by a range of delegates interested in discussing the adoption of the Company's technologies following successful completion of the research and development (R&D) phase, establishing qualified interest from substantial parties.

The ~AUD35 million R&D project in India seeks to establish an integrated Coldry and Matmor pilot plant capable of supporting the design scale-up to commercial size, de-risking investment for future production plants.

The presentation included a brief animated 'flythrough' of the project, which may be viewed on the Company's website – www.ectltd.com.au.

For further information, contact:

Glenn Fozard – Chairman *info@ectltd.com.au*

About ECT

ECT is in the business of commercialising leading-edge energy and resource technologies, which are capable of delivering financial and environmental benefits.

We are focused on advancing a portfolio of technologies, which have significant market potential globally.

ECT's business plan is to pragmatically commercialise these technologies and secure sustainable, profitable income streams through licensing and other commercial mechanisms.

About Coldry

When applied to lignite and some sub-bituminous coals, the Coldry beneficiation process produces a black coal equivalent (BCE) in the form of pellets. Coldry pellets have equal or superior energy value to many black coals and produce lower CO_2 emissions than raw lignite.

About MATMOR

The MATMOR process has the potential to revolutionise primary iron making.

MATMOR is a simple, low cost, low emission production technology, utilising the patented MATMOR retort, which enables the use of cheaper feedstocks to produce primary iron.

About the India R&D Project

The India project is aimed at advancing the Company's Coldry and Matmor technologies to demonstration and pilot scale, respectively, on the path to commercial deployment.

ECT has partnered with NLC India Limited and NMDC Limited to jointly fund and execute the project.

NLC India Limited is India's national lignite authority, largest lignite miner and largest lignite-based electricity generator.

NMDC Limited is India's national iron ore authority.

Areas covered in this announcement:

ECT (ASX:ESI)	ECT Finance	ECT India	India Project	Aust. Project	R&D	HVTF	Business Develop.	Sales

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Matmor:

Innovation in India for the Steel Industry

Prepared for:
SteelVia – Global Innovations Forum
Dubai, 26th September 2018

"Bridging the gap between today's use of resources and tomorrow's zero-emissions future"

ECT:
Ashley Moore
CMD ECT India / Project Head

MN Dastur:
Aditi Tarafdar
Technical Director / HoD Metallurgy

Disclaimer

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This presentation contains "forward looking statements" which involve known and unknown risks, uncertainties and other factors which may cause the actual results, performance or achievements of ECT, industry results or general economic conditions, to be materially different from any future results, performance or achievements expressed or implied by such forward looking statements. In particular, certain forward looking statements contained in this material reflect the current expectations of management of the Company regarding among other things: (i) our future growth, results of operations, performance and business prospects and opportunities; (ii) expectations regarding the size of the market and installed capacity of our Coldry and Matmor plants; (iii) expectations regarding market prices and costs; and (iv) expectations regarding market trends in relation to certain relevant commodities, including benchmark thermal coal and metallurgical coal prices and foreign currency exchange rates.

Forward looking statements are only predictions and are not guarantees of performance. Wherever possible, words such as "may," "would," "could," "will," "anticipate," "believe," "plan," "expect," "intend," "estimate," "aim," "endeavour" and similar expressions have been used to identify these forward looking statements. These statements reflect the Company’s current expectations regarding future events and operating performance, and speak only as of the date of this material. Forward looking statements involve significant known and unknown risks, uncertainties, assumptions and other factors that could cause our actual results, performance or achievements to be materially different from any future trends, results, performance or achievements that may be expressed or implied by the forward looking statements, including, without limitation, changes in commodity prices and costs of materials, changes in interest and currency exchange rates, inaccurate geological and coal quality assumptions (including with respect to size, physical and chemical characteristics, and recoverability of reserves and resources), unanticipated operational difficulties (including failure of plant, equipment or processes to operate in accordance with specifications or expectations, cost escalation, unavailability of materials and equipment, delays in the receipt of government and other required approvals, and environmental matters), political risk and social unrest, and changes in general economic conditions or conditions in the financial markets or the world coal, iron and steel industries.

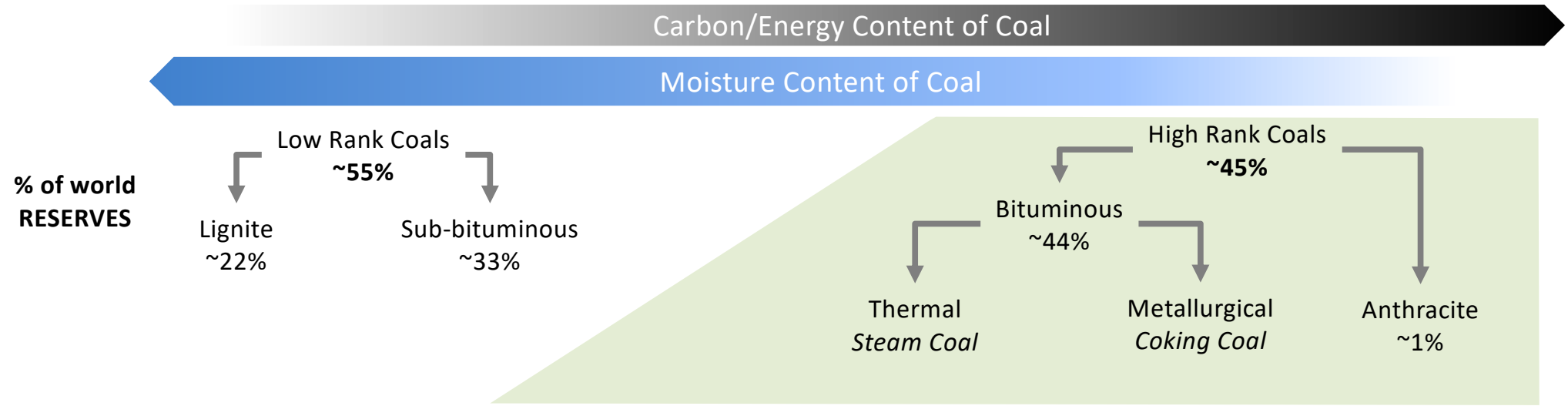
The materiality of these risks and uncertainties may increase correspondingly as a forward looking statement speaks to expectations further in time. Although the forward looking statements contained in this material are based upon what the Company believes to be reasonable assumptions, the Company cannot assure investors that actual results will be consistent with these forward looking statements. These forward looking statements are made as of the date of this material and are expressly qualified in their entirety by this cautionary statement. We do not intend, and do not assume any obligation, to update or revise these forward looking statements, unless otherwise required by law. Prospective purchasers are cautioned not to place undue reliance on forward looking statements. This presentation is for information purposes only and does not constitute an offer to sell or a solicitation to buy the securities referred to herein.

Presentation Outline

- **Lignite introduction**
- **About ECT**
- **New technologies**
- **Project**
- TEF Study
- Process Route Comparison
- Matmor – How it works
- Basic Engineering
- Concluding remarks

What is Lignite?

Types of Coal



Coal Type	Age (million years)	Energy value (kcal/kg)	Moisture	Volatile Matter	Fixed Carbon	Organics	Extraction cost	Price
Lignite	20-50	As low as 2000	**High** Up to 65%	Up to 50%	**Low** 40% to 60%	**High** Hydrogen & Oxygen	**Low** Soft Open cast	As low as USD10/t ex-mine
Coking coal-Anthracite	Up to 360	As high as 7000	**Low**	Low <10%	**High** Can reach 90%+	**Low** hydrogen & oxygen	**High** Hard Underground	~USD194/t FOB*

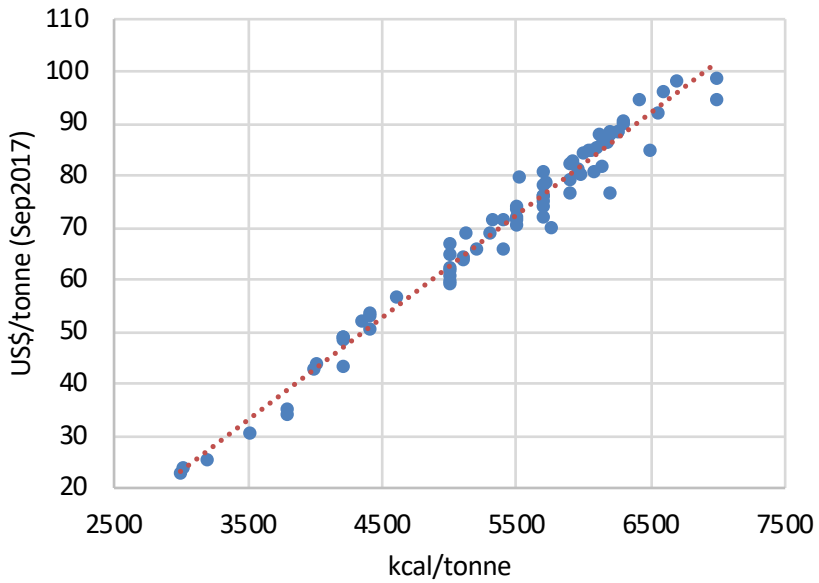
*11 Sept 2018

Reserves and Consumption

Reserve/consumption imbalance result in different price pressure between the segments:

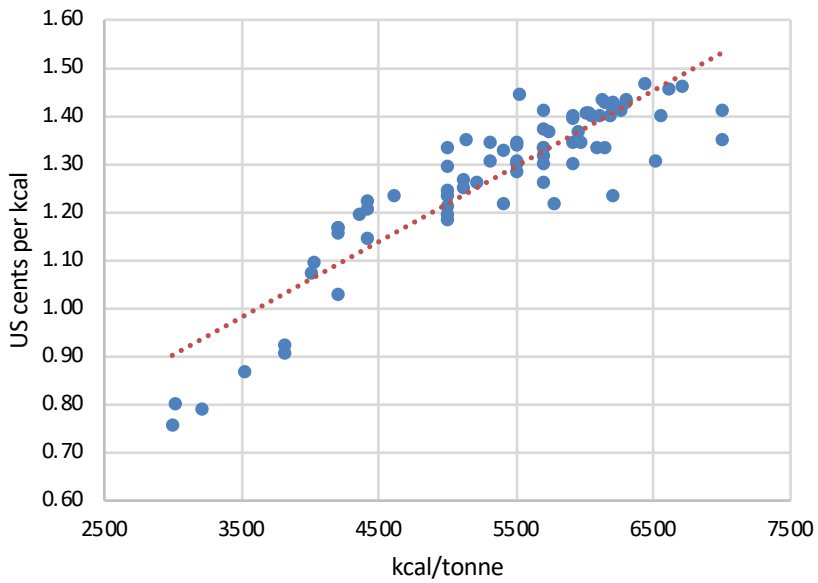
- Upward price pressure for higher grades of coal
- Less price pressure for lower rank grade of coal

Chart 1 - Price per tonne vs. Energy



Price per tonne increases with increasing energy content

Chart 2 - Price per kcal vs. Energy



- Price per unit of energy decreases with lower kcal coals
- Up to 50% lower cost per unit of energy via lower rank coals

Source – Indonesian Government published HBA data, Sep2017

Environmental Clean Technologies Ltd

- Australian based, Stock exchange listed
- Technology development & commercialisation
- Energy & Resources focus
  - Home state of Victoria is blessed with abundant brown coal / lignite deposits ~ 25% global reserves
  - Traditional uses have mine mouth power generation, which is emissions intensive
  - ECT started its corporate life aiming to improve utilisation technologies, and now pursues this more broadly

Corporate Strategy

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Purpose

We bridge the gap between today's use of resources and tomorrow's zero-emissions future

Mission

The company commercialises innovative technologies to increase the economic and environmental benefits derived from low grade, low rank and waste resources (Targeted Resources)

Vision

We are recognised as a leader in the commercialisation of innovative technologies, providing increased economic and environmental benefits from the utilisation of Targeted Resources

Core Technology Solution

Innovative resource upgrading and conversion technologies

Minerals processing technologies focused on **transforming** low-value resource streams into higher grade, **valuable** products delivering positive **economic, energy, resource** and **environmental** security outcomes.

H_2O

Unique low rank coal drying technology - Coldry

- IP owned 100% by ECT and protected in all major markets
- World's most efficient pre-drying process for high moisture content coals
- Enables low-rank coal use in downstream conversion process for high value products and applications
- Outstanding environmental credentials including a zero net CO_2 footprint from the process
- Construction-ready designs for first commercial scale plant ready to go

Fe

Primary iron processing technology – Matmor

- Intellectual property owned 100% by ECT
- Integrates with Coldry which acts as the feedstock preparation stage
- Reduces manufacturing costs by ~65% through use of low cost, abundant raw materials
- Reduces energy costs through innovative thermo-chemical pathway (impact embedded in manufacturing costs above)
- CO_2 emissions reduction helps deliver lower emissions intensity

Current Company Projects

Australian High Volume Test Facility (HVTF)

- Facility to support continuous improvement, further R&D, with capacity targeting up to 25,000 tpa Coldry pellet output for enhanced R&D program data collection at large pilot scale
- Output able to be utilized in SME utility heating systems

India Integrated Pilot Plant

- Large Government of India owned partners, NMDC and NLC for integrated Coldry & Matmor plant
- Techno-Economic Feasibility study (June 2016), followed by Project Agreement (May 2018)
- Now preparing for Financial close and commencement of EPC program

Victoria Large Scale Coldry Demonstration Plant

- Feasibility Study Commenced
- ~170,000 tonnes per annum target finished product
- Industrial solid fuel & downstream value add markets

India Industrial Plant (future project)

- Partnerships with NLC and NMDC for a ~500,000 tpa billet steel plant utilising Coldry & Matmor technologies
- Subject to successful completion of the integrated Coldry+Matmor demonstration-pilot plant
- In-principle agreement on pathway to commercialisation

Our Partners

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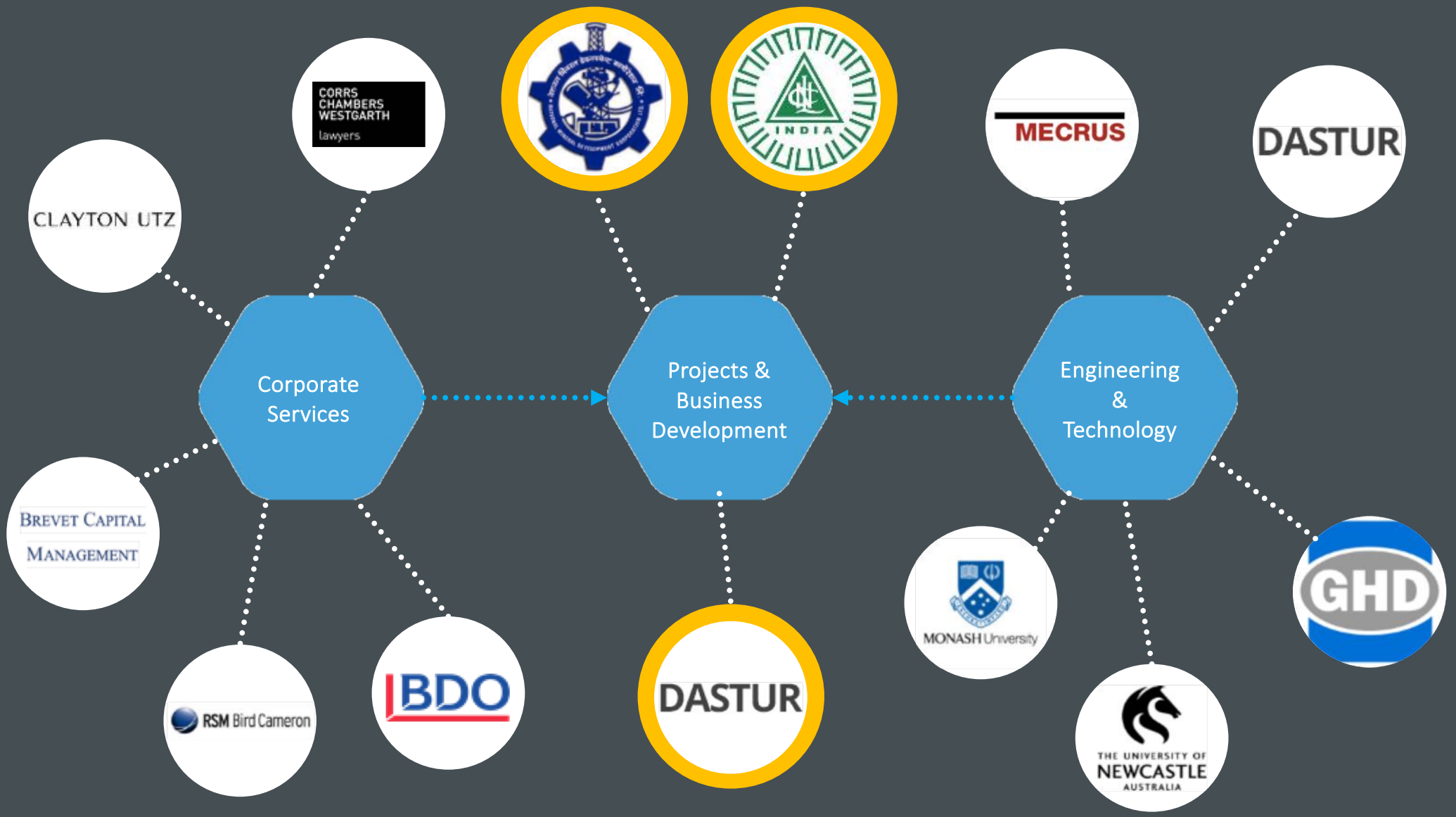

Our Technologies

- Coldry
  - Value Proposition
  - Process
- Matmor
  - Value Proposition
  - Process
  - Benefits vs. Incumbent technologies

Coldry Value Proposition

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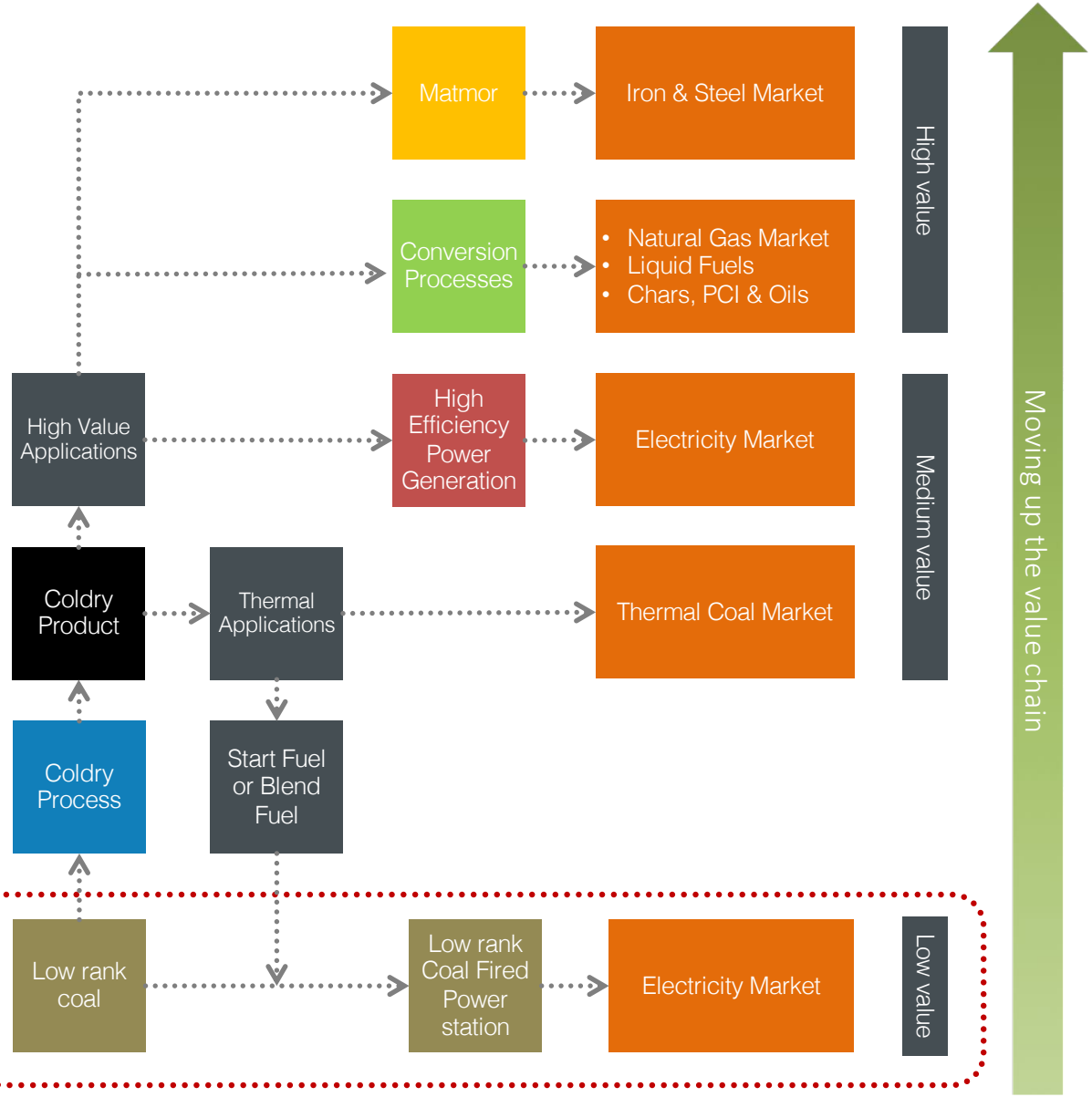
Lignite / Brown coal upgrading:

- Opens new applications and creates new revenue streams
- Diversifies energy and resource options
- Upward revaluation of low value resources
- Enhanced efficiencies and Reduced CO_2 emissions

Cost effective low rank coal drying is the 'gateway' enabler.

Traditional utilisation pathway is 'low value'.



Coldry Process

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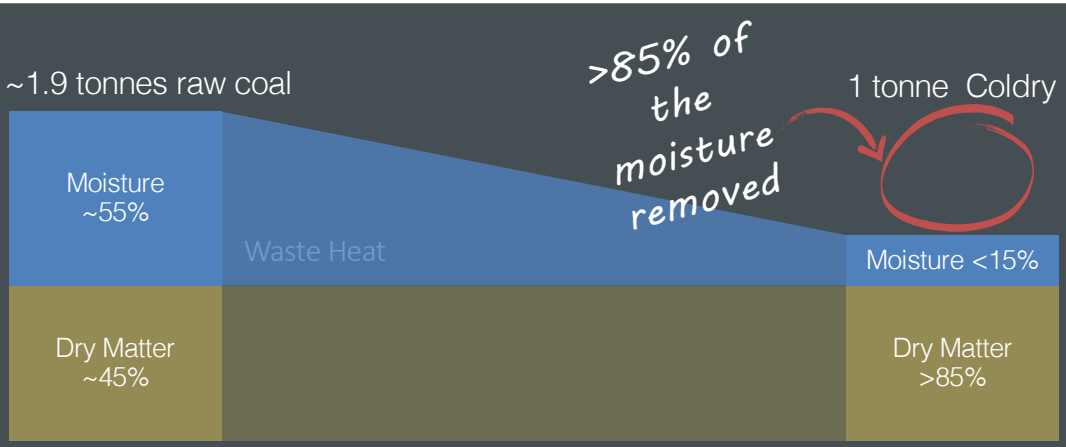
"One distinct advantage of Coldry is the relative low heat requirements in the drying process, allowing for the opportunity to make use of waste heat from an industrial facility or power plant."

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



1 Screening & feed control

2 Shear & attrition

3 Extrude

4 Conditioning

5 Continuous Packed Pad Drying

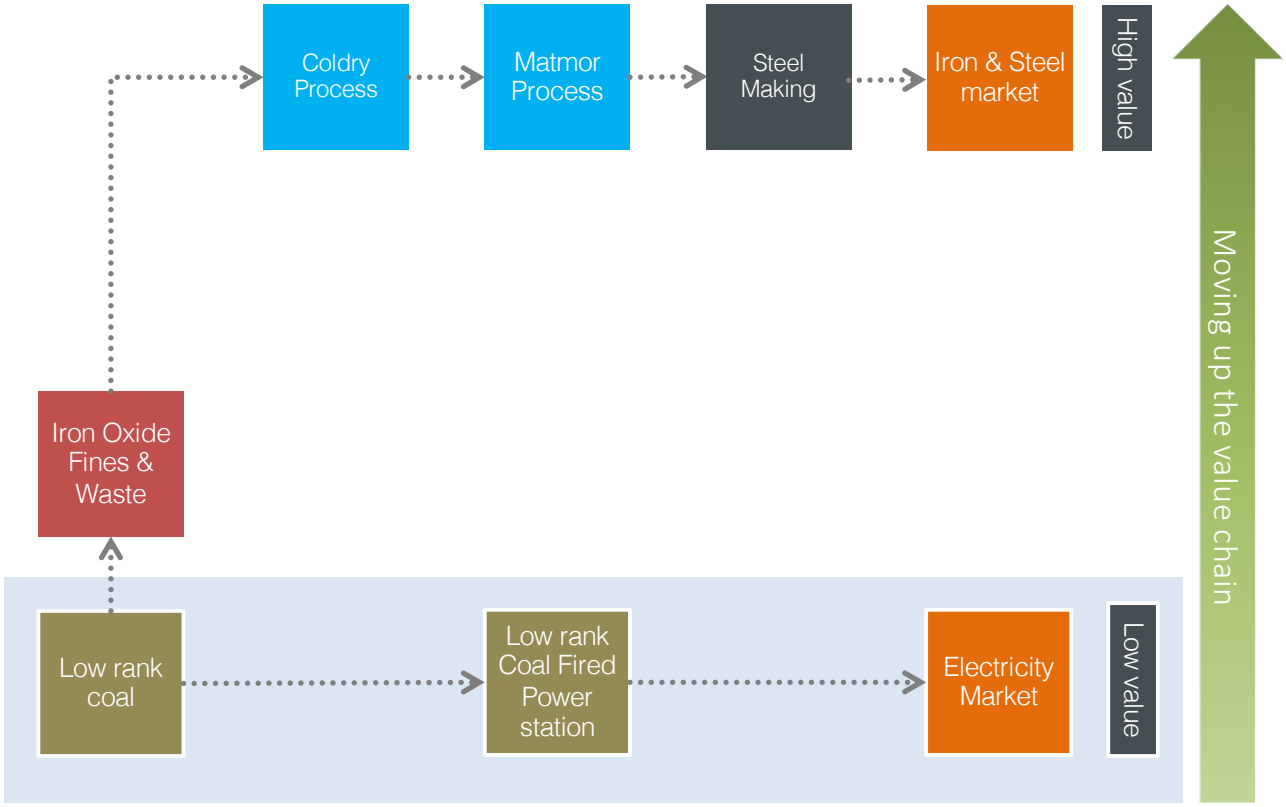
6 Water recovery (optional)

7 Coldry Pellets

Matmor Value Proposition

- Lower cost raw materials
- Lower capital cost plant
- Lower emissions
- Higher value products
- Resource diversity & security
- Waste remediation solution
- Coldry provides essential feed preparation step

Business-as-usual use of lignite is relatively low value. Matmor allows lignite to be used to produce high value metal products.



Matmor Process

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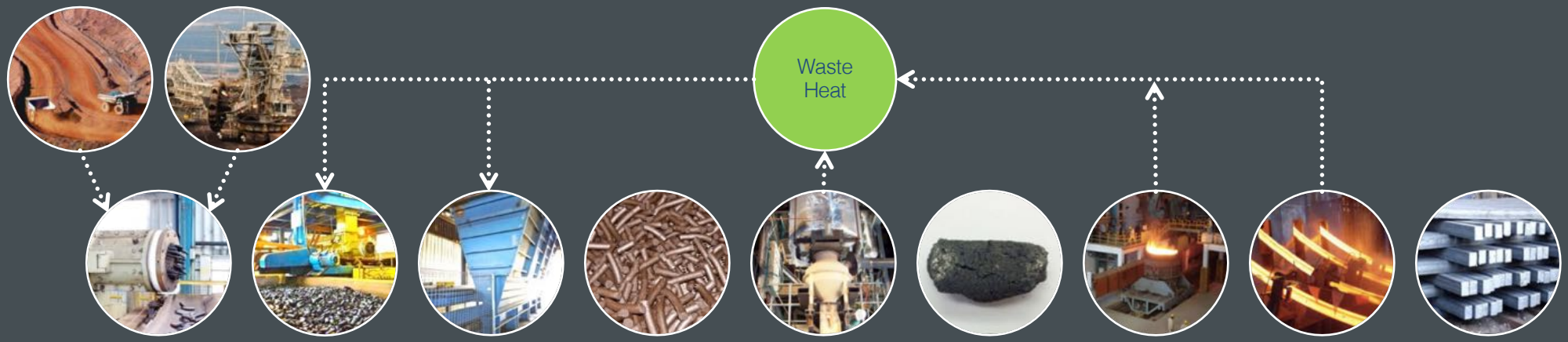
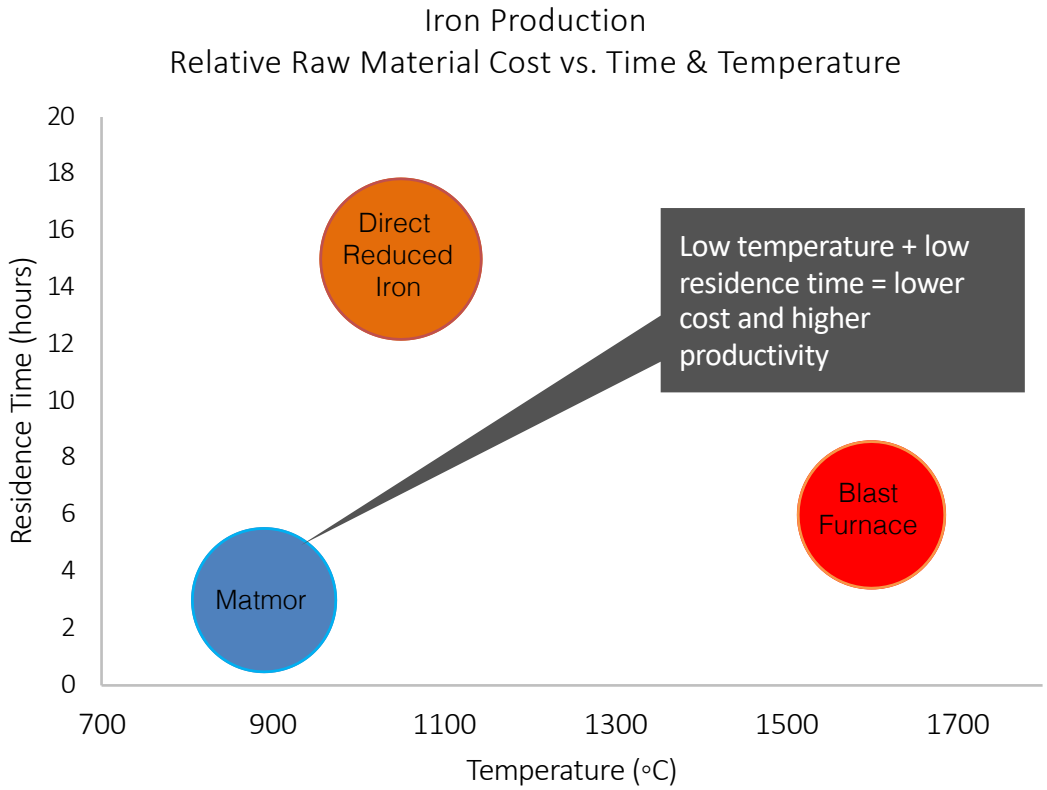


Matmor employs a different chemical pathway, making it the world's first and only low temperature, low rank coal-based iron making process.

Benefits vs other methods

- Lower Temperature
- Lower residence time, higher productivity
- Lower Cost

ECT Matmor Test Plant Melbourne, Australia



- Residence time is a proxy for asset productivity
- Temperature is a proxy for asset capital intensity

Matmor Technology – Key Benefits

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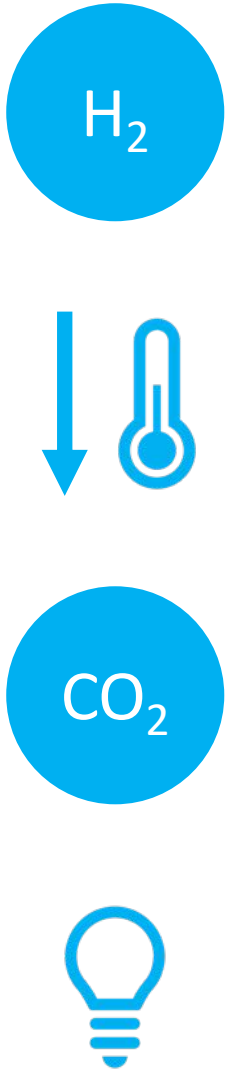
Critical advantages:

- Utilisation of a different chemical pathway, which operates at lower temperature & higher reaction rates delivers:
  - Lower temperatures = less capital to construct
  - Faster reaction rates = higher throughput per footprint
- **Lower temperatures have additional benefits**
  - Greater energy efficiency
  - Lower CO_2 per tonne finished steel*
- **Broader range of acceptable raw materials**
  - Lignite / Brown coal for reductant – significantly lower cost and greater availability
  - Ore feed can be fine particle size, slimes, millscale wastes (or combinations) – raw material saving opportunity
- **Simpler process vs BF and others**



*significant reduction vs. BF/BOF, including deemed emissions via consumed electricity

Project Development History

- Initial engagement - NLC India Limited:
  - ‘Navratna’ level Government of India company
  - Owners & custodians of all Indian lignite resources
- Expanded collaboration - NMDC Limited:
  - ‘Navratna’ level Government of India company
  - India’s largest iron ore miner
- Key drivers for collaboration:
  - Diversification of lignite resource utilisation (NLC)
  - Support for National Steel Development R&D objectives (NMDC)
- Engineering partner:
  - MN Dastur
  - Techno-Economic Feasibility Study completed
  - Basic Design program completed
- Historic collaboration: The project is the largest ever Australia-India joint R&D program

Why India?

Drivers

- Electricity demand growth
- Infrastructure development
- Sustainable development targets

REQUIREMENT	SOLUTION
Coal and other fuels	**Coldry** is able to upgrade domestic lignite for enhanced efficiency utilisation
Increased steel production Target: +200M tonnes per annum by 2030	**Matmor** utilises domestic raw materials, displacing imported coking & high grade non-coking coal required for other process routes
Technologies that decrease CO_2 intensity	Coldry and Matmor decrease CO_2 intensity through enhanced efficiencies

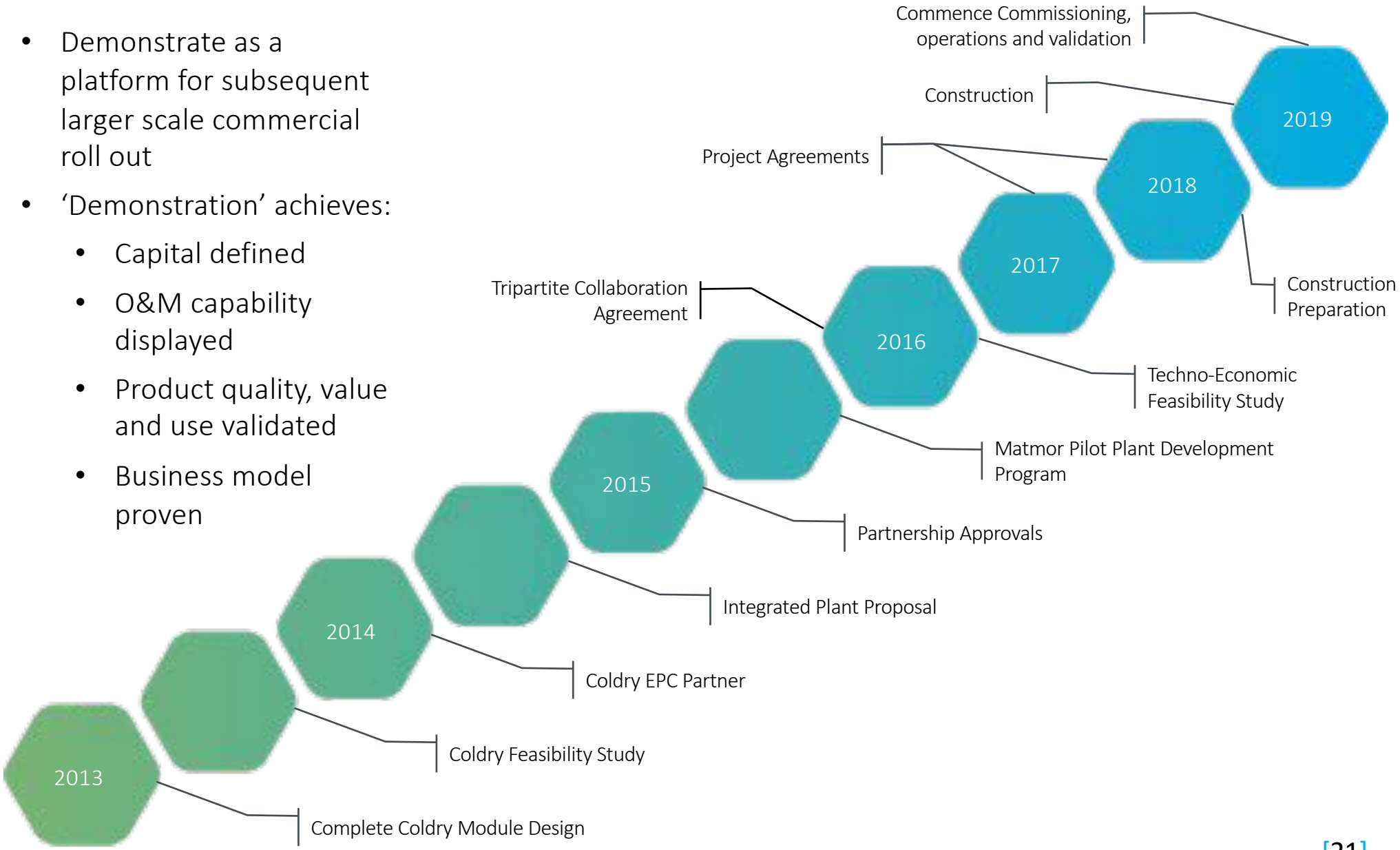
Ministry of Steel / Steel Development Fund Strategic R&D Targets – Eight Out of Ten high priority areas addressed

- ✓ Development of innovative/ path breaking technologies for utilization of Indian iron ore fines/slimes and non-coking coal
- ✓ To pursue R&D projects to address Climate Change issues in line with other countries.
- ✓ Beneficiation/ up gradation of low grade iron ore, coal etc. and agglomeration
- ✓ Development of commercially viable technology for utilization of steel plant and mine wastes including LD/EAF Slag
- ✓ Achieving global benchmarks in Productivity, Quality, Raw material consumption
- ✓ Development of Low carbon technology
- ✓ Development of innovative technology for effective recovery of waste heat in different iron & steel making processes
- ✓ Development of innovative solutions for addressing the challenges faced by the iron & steel industry

Ref: http://steel.gov.in/scheme%20for%20promotion%20of%20research%20&%20development%20in%20indian%20iron%20&%20steel%20industry.htm

India Project Pathway

- Demonstrate as a platform for subsequent larger scale commercial roll out
- 'Demonstration' achieves:
  - Capital defined
  - O&M capability displayed
  - Product quality, value and use validated
  - Business model proven



Project Location – Tamil Nadu – Neyveli

Presentation Outline

- Lignite introduction
- About ECT
- New technologies
- Project
- **TEF Study**
- **Process Route Comparison**
- **Matmor – How it works**
- **Basic Engineering**
- **Concluding remarks**

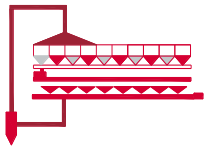
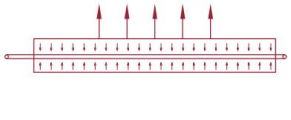
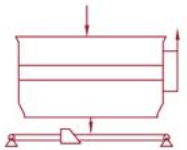
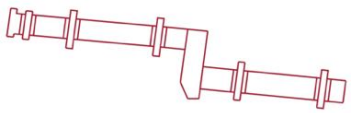
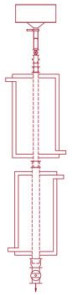
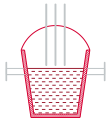
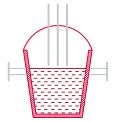
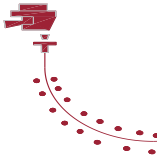
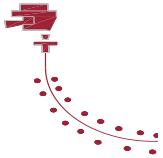
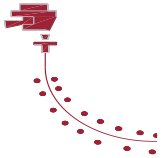
ECT-NLC-NMDC Project – TEF Study

- Site assessment
- Production capacity 0.5 MTPA
- Iron ore sourced from NMDC and Lignite from NLC was be considered
- Benchmark evaluation:
    - BF – BOF
    - Coal based DRI – EAF
    - MATMOR – EAF
- ASP and CPP of suitable capacity on BOO basis was considered
- ECT provided all MATMOR & COLDRY data

Technological Comparison of Different Process Routes

	BF-BOF ROUTE	CB DRI-EAF ROUTE	MATMOR-EAF ROUTE
Agglomeration Units	Sintering to provide mechanical strength permeability for effective reduction	Lump ore or pellets may be used	Pellets are charged that formed from utilizing ore fines (- 2 mm) and lignite (- 10 mm)
Reductant	Coking coal / Coke must be used	Non-coking coal can be used directly as reductant and energy source	Lignite is used as reductant and heat source
Heat source	Oxygen enrichment is used in hot blast	Reductant provides heating source	Heating via combustion of process off-gas, i.e. derived from reductant
Operating Temperature	Temperature reached around 1600°C	Reduction at 950-1050°C	Temperature reached <1000°C
Reduction & Melting Zone	The two zones not physically separated. But has zones merging preheat, indirect reduction, direct reduction and melting	Reduction zone only – no melting	Reduction zone only – no melting
Residence Time	4 to 8 hrs depending upon the design of the furnace	10 to 16 hrs depending upon the design of the furnace	2 to 4 hrs depending upon the design of the furnace
CO_2 emissions (full process)	100% (Benchmark)	85%	65-70%

Technology + Process Route Alternatives

	BF-BOF ROUTE		DRI-IF ROUTE		MATMOR-EAF ROUTE	
Agglomeration Units	 SINTER PLANT	HR COKE OVENS	 PELLET PLANT		 CONDITIONING BELT	 PACKED BED DRIER
Iron Making Unit	 BLAST FURNACE		 ROTARY KILNS		 MATMOR UNIT	
Steel Making Units	 BOF	 LF	 EAF	 LF	 EAF	 LF
Casting Units	 BILLET CASTER		 BILLET CASTER		 BILLET CASTER	
Auxiliary Units	ASP	CPP	ASP	CPP	ASP	

Benefits vs Other Ironmaking Processes

Decoupling from traditional raw materials strengthens a business' resistance to inherent price volatility

TEF Study basis:
2015/6 average RM costs & Sales prices

	Traditional	Indian Alt	ECT
	BF - BOF	CB DRI - EAF	C/M - EAF
	Blast Furnace - Basic Oxygen Furnace	DRI Kiln – EAF	Coldry / Matmor - EAF + Power Generation
Case / Scenario	Base Case	Base Case	Mid Case
CAPEX (Index)	100%	90%	64%
OPEX (Index)	100%	123%	103%
SALES (Index)	100%	108%	103%
ROI (index)	100%	70%	160%

TEF model updated using
2018 Sep RM costs & Sales prices

Traditional	Indian Alt	ECT
BF - BOF	CB DRI - EAF	C/M - EAF
Blast Furnace - Basic Oxygen Furnace	DRI Kiln – EAF	Coldry / Matmor - EAF + Power Generation
Base Case	Base Case	Mid Case
100%	90%	64%
100%	106%	86%
100%	109%	104%
100%	130%	250%

Inherent strength – Lower Capex, plus ability to use lower cost raw materials:

- Coking coal (~$US 85 FOB)
- Non-coking coal (~$55 FOB)

2018 current pricing:

- Coking coal >100% increase
- Non-coking coal >25% increase
- Lignite flat pricing
- Fe Ore fines ~flat
- Steel >30% increase

How does MATMOR work?

Lignite has complex organic chemistry, unlike other coals. Overall process involves several steps:

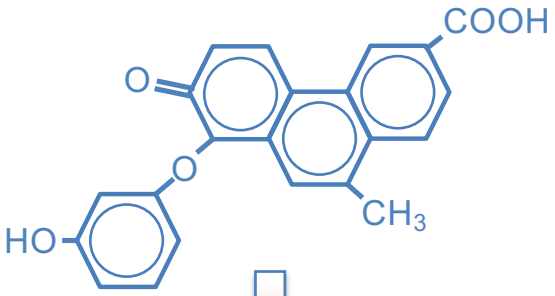
- Heating of reactants
- Pyrolysis reactions (many)
- Gasification reactions (many)
- Hydrogen based reduction (many)

Retort family of reactions

- Combustion reactions (generation of process heating)
- Heat transfer at various points

CO_2 impacts – Reduction Chemistry

Lignite –
complex organic structures, e.g.



Drying

Pyrolysis:
Releasing Light tars
CH_4
H_2 etc

Reduction:
$Fe_2O_3 + 3\ H_2 \rightarrow 2\ Fe + 3\ H_2O$

Gasification of chars:
$2\ C + O_2 \rightarrow 2\ CO$
$C + H_2O \rightarrow H_2 + CO$
etc

Water Gas Shift reaction:
$CO + H_2O \rightarrow CO_2 + H_2$

Beneficial Hydrogen recycling decreases overall CO_2 emissions intensity

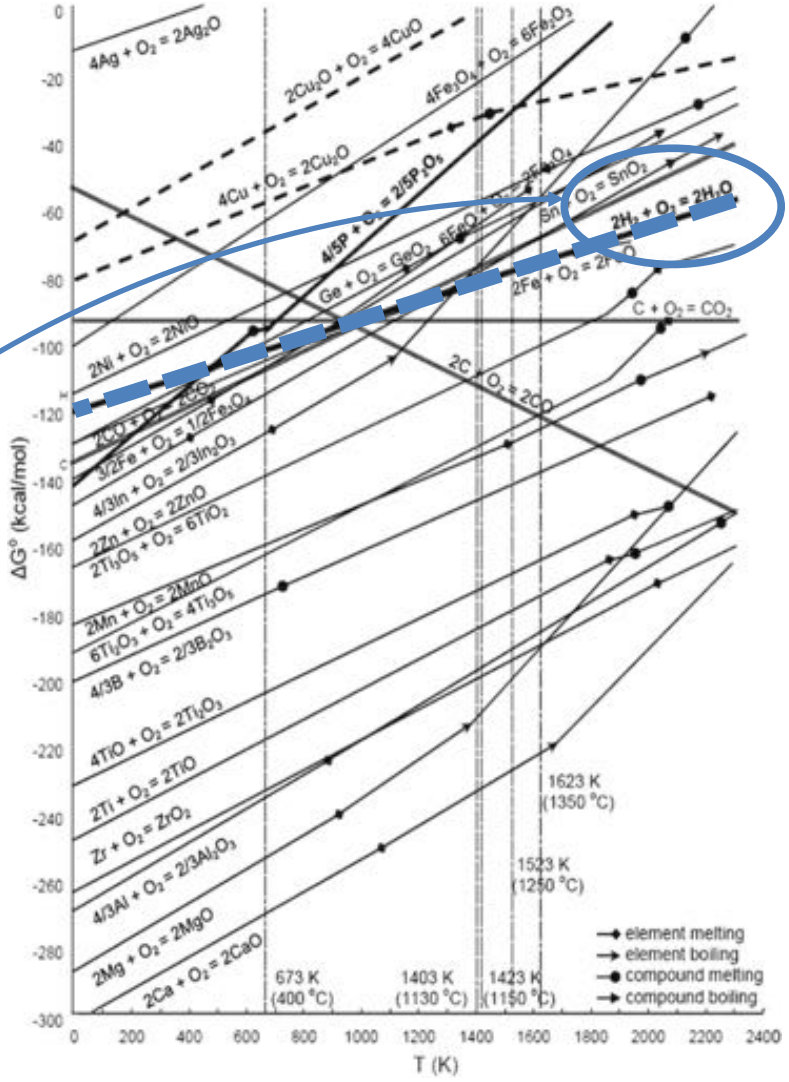
Ellingham Diagram

An Ellingham Diagram is a plot of **ΔG versus Temperature.**

From this diagram, conclusions are:

1. Hydrogen based reduction occurs at significantly lower temperatures
2. Hydrogen reductant is better than CO when temperatures are less than 1000 degC

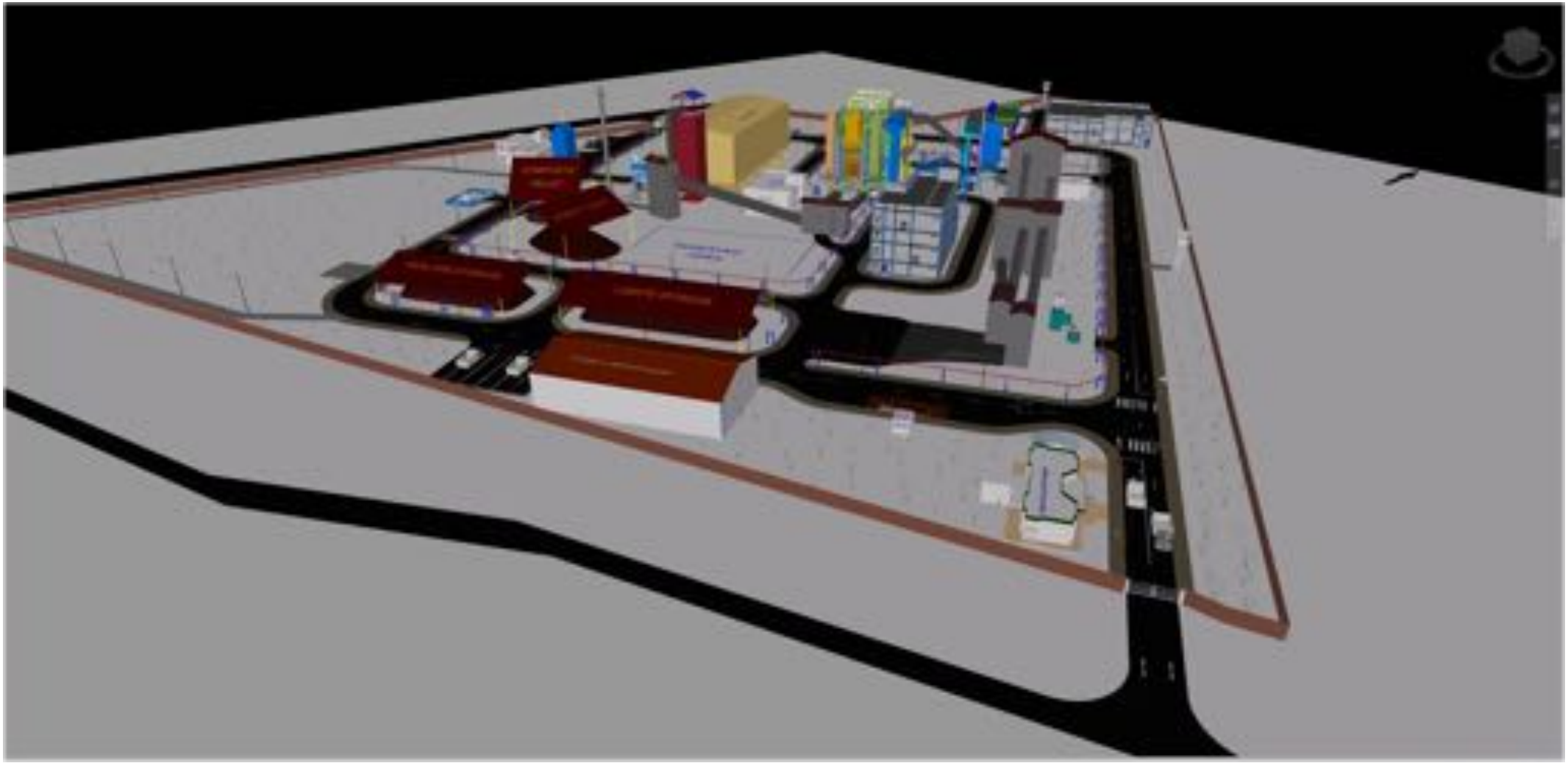
$$2H_2 + O_2 = 2H_2O$$



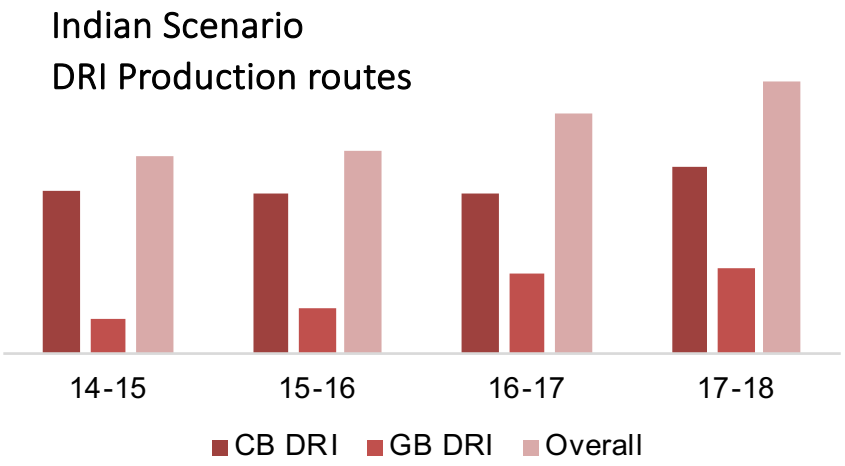
Basic Engineering Program

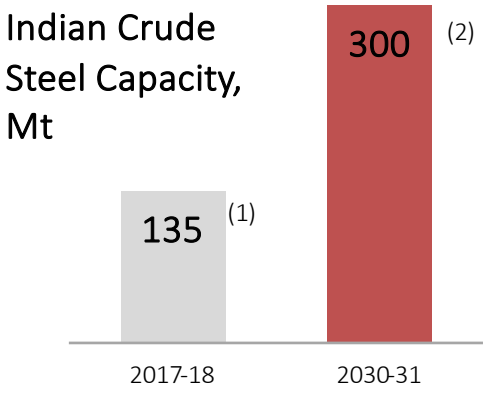
- Complete
- Final reviews in process ahead of commencement of tender program for detailed design and construction

Fly-through of 3D layout – Matmor Pilot Plant



Concluding Remarks





NOTE: (1) IBEF
(2) National Steel policy, 2017

- Increasing demand – Global & India
- Indian DRI production dominated by coal based route
  - C-DR based ~60% of Electric steel making
  - Coal based DRP suffers from environmental issues, limiting its utilization
- Coal based DRI was pioneered in India, with strong support by MN Dastur
  - Now >350 plants nation wide

- Unique challenges in India will drive increased utilisation of DRI production (key issue – lack of domestic coking coal)
- Matmor technology is ideally placed to support this growth

ENVIRONMENTAL CLEAN TECHNOLOGIES LIMITED

DASTUR

Thank you

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