

## **Hexagon's Pedirka Hydrogen Project Pre-Feasibility Study completed. Study identifies the pursuit of clean Hydrogen opportunities in North Western Australia as most commercially attractive for Hexagon.**

### **Key Findings:**

- Hexagon's objective is to secure the most commercial, practical and timely pathway to establish a large-scale decarbonised Hydrogen business in Northern Australia.
- Hexagon has completed a comprehensive Pre-Feasibility Study (PFS) on the Pedirka clean Hydrogen project. This PFS was based on the initial Pedirka scoping study and, through an extended scope, expanded to analyse broader routes to market.
- The completed PFS resulted in the following key findings:
  - The production of Ammonia (as a hydrogen carrier) is more commercially viable than liquid hydrogen due to the capital and operational costs associated with handling and transporting liquid hydrogen as a product. Technology developments will, over time, create shifts that Hexagon will position itself on a commercial basis to capitalise on.
  - Carbon Capture and Storage (CCS) or decarbonisation is a major cost consideration in selecting the project location. Minimising the cost of transporting CO<sub>2</sub> for CCS and being able to tap into multi-user, established infrastructure based business models, to minimise total CCS costs toll charges, is crucial.
  - Minimising gross CO<sub>2</sub> production is a key driver of profitability. The use of low-cost renewables as the source of *energy* in the hydrogen conversion process and on-site CO<sub>2</sub> capture and compression processes, and the potential use of natural gas rather than coal as the hydrocarbon *feedstock*, will significantly lower Hexagon's total CCS costs and requirements.
  - Locating the hydrogen plant at or near a substantial pre-established port facility brings significant commercial benefits to the project in terms of construction costs and ongoing operational expenses (OpEx).
  - Locating the hydrogen plant adjacent to feedstock supply is also critical to minimising raw material logistics costs and, as a result, commercial returns. Low cost access to local process water supply and infrastructure impacts commercial returns, also.
  - Participation in and capitalisation on well-funded hydrogen hub investments that share substantial upfront capital costs (CapEx) will result in improved commercial returns.

### **Lowest Risk, Lowest Capex Way Forward for Hexagon:**

- As a result of these findings and the opportunities identified through the PFS work, Hexagon is now in a position to pursue a lower risk, lower CapEx and OpEx, more rapid and cost-effective route to market in establishing its clean Hydrogen business than the model originally laid out in the Pedirka scoping study. The findings better pave the way for Hexagon to substantially grow as the global clean Hydrogen market emerges.
- Details of the progress that has been made by Hexagon with a clean Hydrogen project in Western Australian will be announced to the market within the coming week.

Hexagon Energy Materials Limited (ASX: HXG; “HXG”, “Hexagon” or “the Company”) has completed the Pedirka clean Hydrogen Project (Pedirka) PFS. This announcement presents the results of the PFS and outlines the Company’s clean Hydrogen plans moving forward.

## 1 Hexagon’s clean Hydrogen Strategic Objectives

Hexagon’s clean Hydrogen strategic objectives are:

***Value creation for shareholders through participation in the large, global, emerging clean Hydrogen market by developing projects that commercially deliver at scale. Hexagon is focused on creating a basis for future growth matched to emerging markets, on the following terms:***

- Lowest possible production risk. By using technically proven-at-scale technologies which have a track record of being successfully (i.e., on time, budget and quality) constructed, commissioned and operated long-term at design capacity.
- Lowest possible cost (in Total life of project CapEx and OpEx terms).
- Most timely/efficient route to production.

These objectives underpinned the expanded PFS scope and review of other Northern Australian locations. Western Australia (WA) was specifically identified as a more attractive project opportunity location, based on the following favourable factors:

- More advanced and cost-effective CCS toll treatment services,
- Low-cost natural gas feedstock, available in the timeframe sought by Hexagon,
- Low-cost renewable energy,
- Low-cost process water, and
- Export/Port facility access.

Figure 1, below, illustrates Northern Australia’s attractions due to existing critical elements for commercial clean Hydrogen project development.

Further details on progress achieved with Hexagon’s WA Hydrogen Project, will be announced over the coming week.

### Hexagon’s Clean Hydrogen Project Development view.



Northern Australia combines Energy availability with well established infrastructure including CCS.

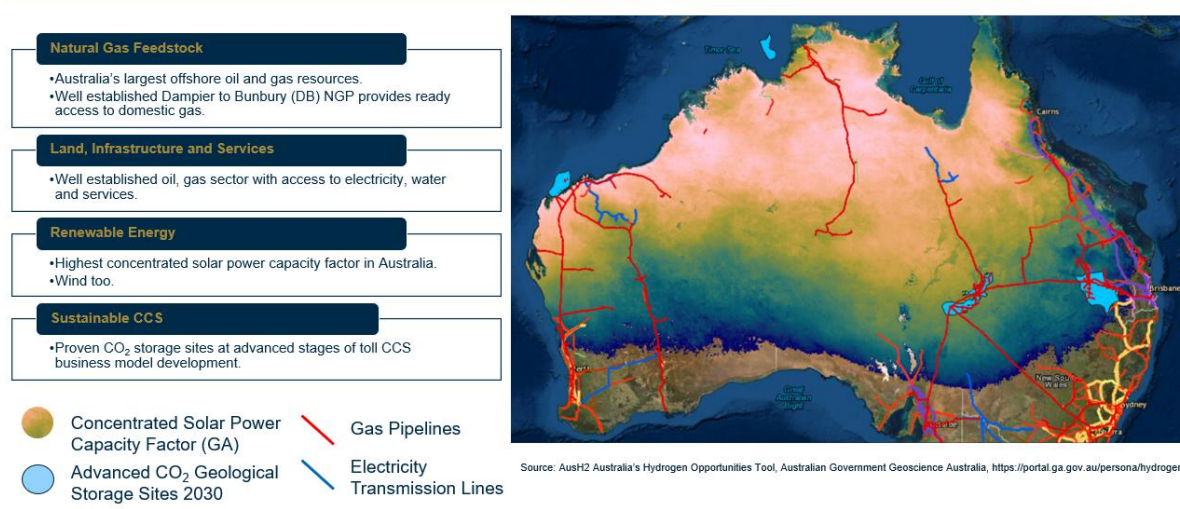


Figure 1 – Northern Australia Infrastructure

## 2 The Next Steps for Hexagon in terms of clean Hydrogen

Hexagon has commenced technical and commercial work including financial modelling, on a WA clean Hydrogen project (WAH<sub>2</sub>). This project significantly leverages the work done on the PFS based on Pedirka and the insights gained.

In relation to CCS, the PFS confirmed the need for Hexagon to leverage *established* infrastructure and low-cost renewable energy to the greatest extent possible. The PFS confirmed natural gas was Hexagon's preferred hydrogen feedstock. This requires Hexagon to be in locations where low-cost access to natural gas over the long term is achievable.

The PFS also clearly demonstrated that, for Hexagon to deliver its clean Hydrogen strategy, coastal sites would be far more attractive and efficient. In accessing CO<sub>2</sub> compression processes, accessing renewable energy and sourcing well established large scale offshore gas field feedstock would be more attractive and efficient than sourcing coal from Pedirka as a feedstock.

Positive initial progress has already been made on the WAH<sub>2</sub> Project leveraging the work and insights gained from the PFS. Around 30% of insights, engineering and modelling have been carried over to the going forward strategy.

Specific progress on WAH<sub>2</sub> to date:

- **Plant location** - An application for over 80 hectares of land available for lease within the Ashburton North Strategic Industrial Area (SIA), which is owned by the WA Government, was lodged 18 January 2022. This is to be expanded to include the Burrup and Maitland SIAs based on discussions held with DevelopmentWA on 14 February 2022. Hexagon will work constructively with all stakeholders to secure an optimal site for WAH<sub>2</sub>.
- **CCS/Decarbonisation** - Negotiations over CCS toll treatment services with third parties have progressed. Firm commercial terms for CCS toll service delivery and the process by which Hexagon can secure an option to access these services are expected next week.
- **Natural Gas supply** - Negotiations around supply are underway through a gas brokerage agreement signed on 18 February 2022. This agreement has been struck to secure, in a timely fashion, the requisite gas feedstock for the contemplated Stage 1 of WAH<sub>2</sub> project, producing 0.25 MTPA of blue Ammonia for export. Stage 2 is expected to expand the production of WAH<sub>2</sub> to 0.8 MTPA. Offers for around 70% of Hexagon's WAH<sub>2</sub> project Stage 1 gas requirements have already been received.
- **Renewable Energy supply** - Discussions to progress the Memorandum of Understanding (MoU) with FRV Australia, announced on 24 January 2022, have commenced in order to reach a specific WAH<sub>2</sub> related development agreement. Hexagon / FRV Australia collaborations in the NT are also expected to continue as part of Hexagon's longer-term NT clean Hydrogen plans.
- **Blue Ammonia Offtake/Sales** - Discussions with blue Ammonia customers and/or trading houses have commenced.
- **Strategic partner/investor** discussions are well underway with multiple parties.

The current work program pertaining to further progressing Hexagon's WAH<sub>2</sub> project can be covered within the Company's existing cash position.

## 3 The Australian / Asian clean Hydrogen opportunity

During the course of the PFS, the scale and certainty of the opportunity for a successful clean Hydrogen (Ammonia) business based on Australia's northern seaboard has become certain.

Multiple industrial sectors in Asia are both advancing and providing greater detail around their decarbonisation plans involving clean Hydrogen and, more specifically in the short term, clean





freight transport activity<sup>2</sup> and around 3% of global greenhouse gas emissions<sup>3</sup>. Shipping transport demand is forecast to increase. By mixing blue Ammonia with current fuels or using 100% blue Ammonia in new engine designs, significant CO<sub>2</sub> emission reductions could be achieved in this sector.

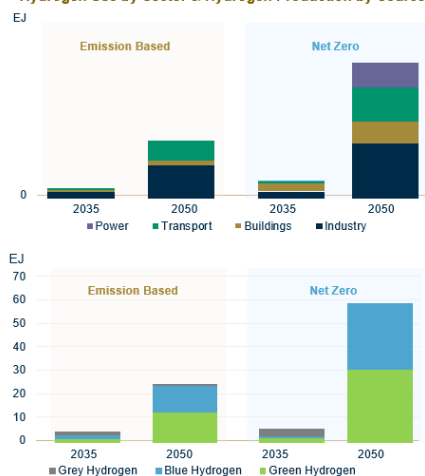
Use of clean Hydrogen across Power/Utilities, Transport, in Building heating and cooling and as a feedstock for Industrial Chemicals, is forecast to grow by a factor of 10 by 2050.<sup>4</sup>

As shown in Figure 4 below, significant growth in the clean (decarbonised) Hydrogen (blue and green) markets is forecast over the next 20 years. Sales revenue of over A\$400 billion globally could be generated by 2050<sup>5</sup>. For Australia alone, clean Hydrogen is forecast to be contributing over A\$10 billion to the economy by 2050.<sup>6</sup>

## The Emerging Clean Hydrogen Market

Hydrogen is a clean, versatile energy source with strong growth in demand forecast.

Hydrogen Use by Sector & Hydrogen Production by Source



Source: BP Energy Outlook 2020, <https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2020.pdf>

- The global clean Hydrogen market is forecast to reach US\$300B (+A\$410B) in sales revenue by 2050\*.
- 70 m.t.p.a. (2020) base to grow by a factor of 10 by 2050\*\*.
- METI\*\*\* predicts Japanese Hydrogen consumption at 5 -10 m.t.p.a. post 2030.
- Clean Hydrogen market to add A\$11B in GDP by 2050\*\*\*\*.
- The current cost of large-scale green Hydrogen production (at +\$3.90/kg) and handling/transportation (+A\$9/kg) precludes rapid expansion\*\*\*\*\*.
- Blue Hydrogen will be key to early market growth and carbon emissions reductions.
- Ammonia as the 'Hydrogen carrier' to reduce engineering and logistical costs.

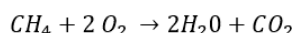
\* Source: Strategy& Part of the PwC Network, "The dawn of green hydrogen" Maintaining the (Gulf Co-operation Council) GCC's edge in a decarbonized world 2020 Report. <https://www.strategyand.pwc.com/m1/en/reports/2020/the-dawn-of-green-hydrogen.html> , FOX Source: xe.com  
 \*\* Source: Depending on whose market forecast you rely upon; BP, Shell, ARENA, Bloomberg NEF, McKinsey or the Australian Hydrogen Centre.  
 \*\*\* Source: Ministry of Economy, Trade and Industry (METI), "Basic Hydrogen Strategy" [https://www.meti.go.jp/english/press/2017/pdf11226\\_003b.pdf](https://www.meti.go.jp/english/press/2017/pdf11226_003b.pdf)  
 \*\*\*\* Source: Australia's National Hydrogen Strategy 2019, the Department of Industry, Innovation and Science COAG Energy Council  
 \*\*\*\*\* Source: Advisian Pty Ltd for the Clean Energy Finance Corporation (CEFC), "Australian Hydrogen Market Study" May 2021 <https://www.cefc.com.au/media/nhnhwku/australian-hydrogen-market-study.pdf>

Figure 4 - Forecast global Hydrogen market growth, by end use and by Hydrogen type

Hexagon's blue Ammonia product (**DCAmmonia**) end market focus is on two specific sectors and uses:

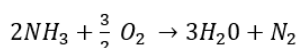
1. In coal-fired power stations (co-fired with coal), to decarbonise power station emissions. Ammonia does not emit Carbon Dioxide (CO<sub>2</sub>) when burned. The chemical formulae below set out the reactions that take place within this application.

Typical coal combustion reaction:



Methane + Oxygen → Water + Carbon Dioxide

Ammonia combustion reaction:



Ammonia + Oxygen → Water + Nitrogen

**Ammonia does not  
emit CO<sub>2</sub> when burned**

To accommodate Ammonia, relatively minor modifications of existing coal-fired power stations are required. (For more information visit Hexagon's website, [www.hxgenerymaterials.com.au](http://www.hxgenerymaterials.com.au), where a more detailed description of this application is provided).

As shown at the right in Figure 2 above, total cost (price) of 60% blending or co-firing of ammonia with coal could deliver similar to current electricity prices for customers whilst also delivering

<sup>2</sup> International Energy Agency. (2021). International Shipping. International Energy Agency. Paris. <https://www.iea.org/reports/international-shipping>

<sup>3</sup> International Maritime Organisation. (2021). Fourth IMO Greenhouse Gas Study 2020 – Full Report. International Maritime Organisation.

<https://www.imo.org/en/OurWork/Environment/Pages/Fourth-IMO-Greenhouse-Gas-Study-2020.aspx>

<sup>4</sup> Source: BP Energy Outlook 2020, <https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2020.pdf>

<sup>5</sup> International Energy Agency. (2021). International Shipping. International Energy Agency. Paris. <https://www.iea.org/reports/international-shipping>

<sup>6</sup> Advisian Pty Ltd – 2021 Market Study report for the Clean Energy Finance Corporation

60% reductions in carbon emissions. The potential for 100% ammonia usage is also under assessment.

2. The use of clean Ammonia in maritime shipping compared to the fossil fuels currently used is covered in the formulae below. Clean Ammonia does not emit CO<sub>2</sub> when combusted.

**Diesel combustion reaction:**  $4C_{12}H_{23} + 71O_2 \rightarrow 46H_2O + 48CO_2$

Diesel + Oxygen → Water + Carbon Dioxide

**Ammonia combustion reaction:**  $2NH_3 + \frac{3}{2} O_2 \rightarrow 3H_2O + N_2$

Ammonia + Oxygen → Water + Nitrogen

Work is underway by multiple companies on mixed clean fuel as well as a clean Ammonia only ship engine design.

As shown in Figure 4 above clean Hydrogen/Ammonia fuel is forecast to make up nearly 50% of the fuels consumed by shipping vessels by 2050.

Figure 4 also sets out for certain CCS price assumptions for decarbonised Ammonia, future price estimates. These figures were incorporated into the PFS financial model.

## 4 PFS Process and outcomes

The Pedirka PFS work program undertaken between April 2021 and today has involved a team of appropriately qualified and experienced consultants. It has included discipline experts and specialists. Genesis Energies, part of Technip Energies, engineers and estimators have been involved alongside well known and established Australian logistics company supply chain professionals, geologists, mining engineers, hydrologists and environmental engineers and members of the Hexagon team.

Hexagon's team includes engineers with over a decade's experience in Hydrogen project development, substantively in gasification projects. The PFS expenditure of A\$1.2 million falls within the Board approved budget for this PFS which also included A\$1.65 million for drilling at Pedirka which was not spent for the reasons set out within this announcement.

Managing Director Merrill Gray joined Hexagon in October last year and has since then worked with the full team to compile and analyse all data/information underpinning the financial model of Pedirka versus alternative Hydrogen opportunities. The original scoping study concept centred on construction of a plant at Alice Springs. This has formed the PFS "base case" with various options or scenarios working on improving commercial project returns added and assessed using the commercial data compiled and financial model.

## 5 Fully Integrated Business Review

The PFS has comprehensively reviewed, on a systems basis, project inputs, across multiple sources, and different types of production technologies, as well as end markets/outputs, by unit processes and for the fully integrated business model, as shown in Figure 5 below.

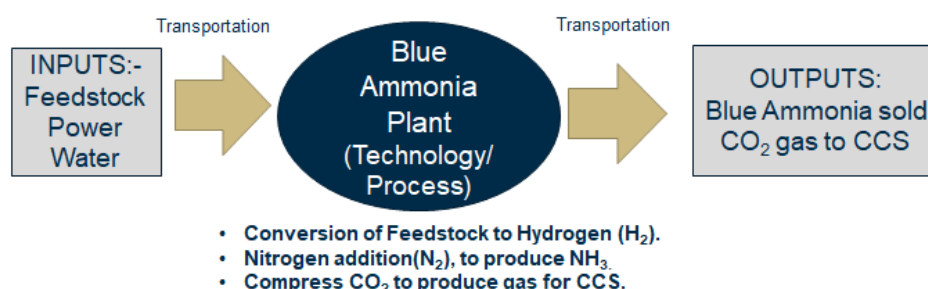


Figure 5 - Fully Integrated Blue Ammonia Project Value Chain

## 6 The Pedirka PFS Scope of Work

The Pedirka PFS has been thorough; involved wide ranging data, information generation and collation, data analysis, review and interpretation and detailed financial modelling.

Figure 6, below, was published in the early stages of the Pedirka PFS (HXG ASX Announcement 9 July 2021). It sets out seven steps or Critical Success Factors (CSF), based on what was known at the time to be critical for the PFS to deliver against. With the ultimate objectives being development of a large scale, commercial clean Hydrogen project, delivering into global export markets.

### PFS Critical Success Factors as set out in 9 July 2021 ASX Announcement



Figure 6 - Early Pedirka PFS Critical Success Factors

As the PFS proceeded, various insights were made, and these CSF whilst essentially maintained, were modified in order to keep the PFS on track to deliver against its intended objective.

Figure 7, below, sets out the Pedirka PFS CSFs as they stood at the completion and close out of the PFS. Figure 7 also shows that the PFS delivered against seven CSF. Drilling and JORC resource delineation at Pedirka was the only item not completed as part of the PFS as this expense could not be justified once other learnings had been accumulated.

### PFS progress versus critical success factors at PFS completion



Figure 7 - Pedirka PFS Close Out/Completion Critical Success Factors

To complete the overall integrated business process review undertaken by the PFS (as summarised by the CSFs set out in Figures 6 and 7 above), location specific knowledge and expertise covering specific Northern Territory locational challenges and established infrastructure availability and costs was also assessed.

## 7 Chronology of Pedirka PFS progression by ASX announcements

Table 1 below lists, in chronological order, the ASX announcements that have been made by Hexagon regarding the Pedirka PFS since it commenced on 30 April 2021, culminating in this announcement.

	Title/Heading	Date of Release
1.	Ebony Energy Ltd Acquisition (Takeover)	21 Dec 2020
2.	Bidders Statement for Off-Market takeover bid for Ebony Energy Ltd	16 Feb 2021
3.	Acquisition of Ebony Energy completed	23 Apr 2021
4.	Hexagon Completes \$6,200,000 (at 11c) Placement to Fund Pedirka	3 May 2021
5.	Pedirka Blue Hydrogen Project Update	19 May 2021
6.	Well-Renowned Technip Energies joins project team developing Hexagon's Pedirka Blue Hydrogen Project	24 Jun 2021
7.	Hexagon Lodges Pedirka Project Mine Management Plan (MMP)	9 Jul 2021
8.	Hexagon Advances PFS during April-June quarter	28 Jul 2021
9.	Substantial Progress Made on Northern Territory (Pedirka) Clean Hydrogen Project Pre-Feasibility Study	14 Dec 2021
10.	PFS Completion Date set for 28 Feb 2022	22 Dec 2021

Table 1 - Pedirka PFS ASX Announcements to date

## 8 Pedirka PFS Work Program Completed

The PFS for Pedirka, as taken over from Ebony Energy Limited (Ebony) in April 2021, has been a primary focus for the Hexagon team over the past 8 months.

The PFS builds on the initial work done by Ebony at scoping study level. With a scope and program of work developed for Pedirka at the PFS outset that would deliver the necessary step change in detail across all aspects of Pedirka as a firm basis for decision making.

### 8.1 Background

As announced by Hexagon on 19 May 2021:

*"On 30 April 2021 Hexagon commenced the (Pedirka) Pre-Feasibility Study "PFS" in partnership with Genesis (Energies), a subsidiary of Technip Energies. The scope of the PFS covers all aspects of the project business case from coal feedstock extraction through transport of product to port. The PFS decision-making process includes consideration of a number of alternatives including:*

- *choice of end product (hydrogen or ammonia)*
- *detailed plant location*
- *transportation alternatives for feedstock and product (rail or pipeline)*

*Drilling down further, a number of targeted studies have been prioritised including:*

- *Construction strategies*
- *Power for the facility (including renewable energy options)*
- *Water supply*
- *Waste and bi-product treatment and management*



- *Finalisation of technology for each process of gasification, air separation and ammonia synthesis*
- *CO<sub>2</sub> Injection locations*
- *CO<sub>2</sub> Transportation*
- *Hydrogen / Ammonia transportation”*

Furthermore, on 24 June 2021 Hexagon announced that:

*“Genesis (Energies) has been tasked with performing a full technical assessment of the potential concepts for development of the Pedirka Project, to identify and/or quantify:*

- *Technical requirements*
- *Project risks and opportunities*
- *Scope for further development*
- *Capital expenditure estimates (as per Association for the Advancement of Cost Engineering (AACE) Recommended Practices).”*

## **8.2 Program of work and Outputs**

The following lists the outputs of the PFS program of work:

1. Plant and Equipment Engineering and Design, namely:
  - High Level energy, mass and carbon balances for: A 1.6 MTPA blue Ammonia producing Coal Gasification plant combined with CCS plant located at Brewer Industrial Estate in Alice Springs, a similar plant located for at Middle Arm, Darwin and a 0.8 MTPA blue Ammonia producing Steam Methane Reformation (SMR) combined with CCS plant located at Middle Arm.
  - CapEx (Equipment list by plant section) and OpEx estimates across all these scenarios.
  - Footprint/Site size (hectares) for each.
2. Specialist Consultant reports were completed for:
  - Water supply options, across multiple plant locations, including at Pedirka itself.
  - Constructability option workshops held (Pre-fab/Modular vs. “Stick build” was assessed).
  - Drill program plans and MMP application (exploration drilling approvals) preparation. (The MMP was lodged with the NT Government in July 2021).
  - Feedstock/Coal quality and potential coal resources.
  - Mine establishment costs and mine plans.
  - Environmental assessments – Drilling, mine and plant/site related.
3. Stakeholder engagement across:
  - The NT Government – multi-agency, including Local Government Authorities.
  - Landholders
  - Indigenous groups
4. Transport Materials Handling and Storage cost estimates. This included across End-Product (blue Ammonia) export supply chains, Coal feedstock and P&E for multiple plant locations. It encompassed new infrastructure CapEx as well as OpEx cost estimates.
5. Decarbonisation (CCS) option identification, assessments and commercial terms of access negotiations.
6. Multi-scenario financial model development. Allowing commercial returns across multiple project options to be compared.

In summary, a technically viable, fully integrated business process; from feedstock through hydrogen conversion (using proven-at-scale and performance P&E data) to end product sales was costed in CapEx and OpEx terms, and matched to project revenue generation potential, in greater details than the scoping study, in the completion of the PFS.

Hexagon's objective throughout the PFS was to establish the most economic and commercially viable Hydrogen project. The Pedirka base case on an absolute and comparative basis, using feedstock from Pedirka, was not determined to be the most commercially viable pathway forward for Hexagon.

Actual Pedirka coal exploration drilling, as envisaged at the outset of the PFS, was not completed due to delays in achieving drilling approvals (the Mine Management Plan or MMP). Approvals were complicated by, amongst other factors, local endangered fauna occurrences at Pedirka, which in turn led to additional approvals requirements being set out for Hexagon which could not be completed before the local geological field season closed for 2021. This resulted in the drilling not proceeding.

All other aspects of the PFS as scoped at the outset of the PFS were advanced. Other aspects of the overall Pedirka business process emerged as being more critical in the commercial assessment of Pedirka than the drilling program outputs and the further delineation of the Pedirka coal deposit.

CCS costs, coal versus alternative feedstock costs, and end product logistics costs were substantial inputs into the overall commercial returns assessments for the Pedirka clean Hydrogen / Ammonia project.

### **8.3 Original basis for the project and subsequent findings and enhancements**

The original Pedirka project targeted commercial production of 1.6 MTPA of blue Ammonia or 300,000 tonnes of blue liquid hydrogen through coal gasification combined with third party CCS. Coal feedstock was to be sourced from a potential new underground mine located at Pedirka, roughly 500 km by road and rail from Alice Springs, under granted tenements EL 29237 and 29239 held by Hexagon which cover an area of 800km<sup>2</sup> under which Permian aged coal in the Pedirka Basin has been intersected during past drilling programs. The end product from the Alice Springs plant was to be railed to Darwin (around 1,500 km) for export.

The PFS base case scenario of an Alice Springs located plant has not met Hexagon's financial hurdle criteria (in NPV and IRR terms) necessary for ongoing investment to be made. The PFS also analysed an alternative option of sourcing coal feedstock from Pedirka and locating the plant at Middle Arm, Darwin, producing blue Ammonia for export markets, using established third party provided CCS toll services. While improving the project economics, this option also did not meet Hexagon's financial hurdle criteria (in NPV and IRR terms) in relation to ongoing investment. A further enhancement was analysed for Middle Arm, to include the use of renewable energy supported by large Battery Energy Storage Systems (BESS) to the greatest extent possible to supply the requisite energy in the hydrogen production process and for CO<sub>2</sub> compression. While this improved the Middle Arm project economics it did not match those of alternatives identified.

Another option assessed involved using natural gas feedstock as input in to Steam Methane Reformation (SMR) and Nitrogen plant to produce NH<sub>3</sub>, combined with third party provided CCS toll services with the plant located at Middle Arm, producing blue Ammonia. Hexagon identified the potential for acceptable commercial return levels to be achieved for this scenario. However, uncertainty at this location around Hexagon's ability to secure timely low-cost natural gas supply/offtake agreements, the lack of adequate low-cost water supply and management systems to support the process and additional infrastructure requirements that could impact CCS toll service costs, combined with considerable Middle Arm port infrastructure investment requirements to support exports, prompted Hexagon to look at other Northern Australian locations.

In the process of identifying alternative superior locations that match Hexagon's "ideal clean Hydrogen project" criteria, identified in the PFS process, Hexagon has found the majority of favourable locations are in WA and this led to Hexagon's WAH<sub>2</sub> project being established.

In January 2022, leveraging insights and findings from the PFS work completed, Hexagon applied to the WA Government (DevelopmentWA) for an 80-hectare site at Onslow in WA, part of the Ashburton North Strategic Industrial Area (SIA). Based on this lease being secured, Hexagon is seeking to build on commercial terms a blue Ammonia plant, using natural gas feedstock (purchased on market under long term contracts) and the SMR process combined with a Nitrogen plant and a CO<sub>2</sub> compression system, to produce blue Ammonia. This plant could produce 0.25 MTPA of blue Ammonia at Stage 1 and be expanded to 0.8 MTPA (or 150,000 TPA of clean Hydrogen) in Stage 2.

Hexagon is also assessing options to lease land at Burrup or Maitland SIAs (at Dampier) where further infrastructure related benefits could accrue to the WAH<sub>2</sub> project.

On 24 January 2022 Hexagon announced that an MoU had been signed with FRV Australia. Hexagon has been working with FRV Australia on clean Hydrogen initiatives in the NT since November 2021. Details of how Hexagon and FRV Australia plan to work together in WA including utilising low-cost renewable energy to the greatest extent possible for Hexagon's clean Hydrogen plants, are expected to be provided to the market soon.

On 18 February 2022 a natural gas brokerage agreement was signed with a party contracted by multiple well known and established gas producers to sell their natural gas in the marketplace, who are capable of supporting Hexagon to secure the quantities of natural gas and prices sought for the WAH<sub>2</sub> project in a timely fashion.

In addition, discussions are underway with a third-party CCS toll services provider who is advanced with plans to access well established infrastructure to geosequester CO<sub>2</sub> in depleted reservoirs in the North West shelf.

Hexagon's WAH<sub>2</sub> project has been designed to leverage well established infrastructure and new investment being spent supporting clean Hydrogen sector growth in WA.

Relatedly, Pilbara Interconnected hydrogen Hub plans were announced in February 2022. The hub is situated between Onslow to Karratha in WA, where Hexagon's WAH<sub>2</sub> project is. Access to well-funded multi-user infrastructure supported by WA Government financial support could significantly add value to Hexagon's WAH<sub>2</sub> project.

Hexagon's WAH<sub>2</sub> project, based on the initial information secured, has been financially modelled as having the potential to deliver attractive returns to Hexagon shareholders. On this early-stage positive indication Hexagon's WAH<sub>2</sub> project is to be progressed as a priority by the Company.

## 8.4 Quantitative summary of findings from the PFS

Pedirka PFS financial model outputs results led to the following insights:

- Blue Ammonia was selected as the preferred end product for the project based on its lower cost of transport for export, relative to liquid hydrogen. Technology developments will, over time, create shifts that Hexagon will position itself on a commercial basis to capitalise on.
- For Alice Springs, P&E, Rail and Road Infrastructure and Mine establishment CapEx were shown to comprise over 20% of total project expenditures over the project's 20 year life. Ongoing CCS costs comprised 40% of total project costs, reflecting the unestablished CCS toll treating business and associated uncertainties in this location's impact on costs. Even for a Middle Arm where CCS costs based on indicative toll treatment prices received from third parties, CCS made up 30% of total project expenditure over the project's 20 year life. CCS costs are both substantial and a key sensitivity in the financial model for Pedirka along with Ammonia prices and P&E CapEx.
- The transportation and materials handling costs of coal feedstock and/or end product (blue Ammonia) to Darwin port made up over 10% of total project expenditures over the Pedirka project's life. Independent of whether the plant was located at Alice Springs or Middle Arm. In addition, for Middle Arm, the cost of transportation and materials handling of the additional

coal required to feed the onsite power plant (to deliver the energy for hydrogen conversion in the gasification process -an endothermic reaction- and also compress the CO<sub>2</sub> produced during hydrogen production, ready for CCS) was modelled as costing A\$8.5 Billion over the life of the project (or over 20% of total project expenditures over the project's life).

## Pedirka PFS raw material & end product logistics review

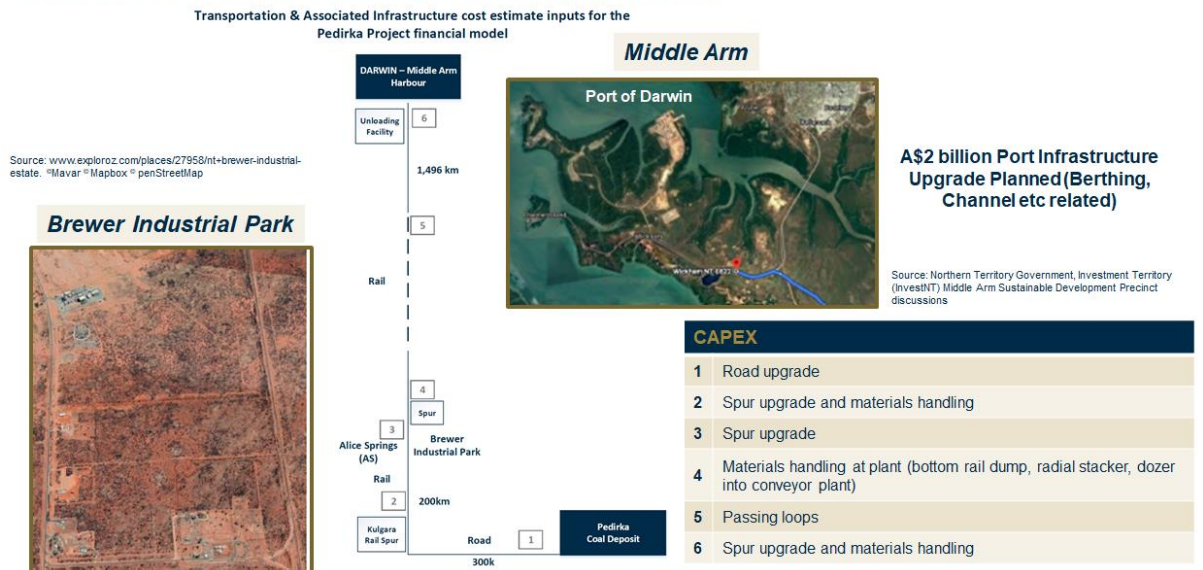


Figure 8 – Pedirka PFS Logistics Review

- Building a plant at Middle Arm reduced construction costs considerably by removing the cost of transportation of P&E to Alice Springs. It also meant that complexities from an OH&S perspective around ammonia transportation, along the Adelaide to Darwin railway, could be avoided.
- Analysis was undertaken to assess the use of renewable energy to power the coal gasification process and thereby lower the transportation and materials handling cost of considerable quantities of coal otherwise required. To this end two agreements to potentially deliver low-cost renewable energy were secured by Hexagon during the PFS – with FRV Australia (ASX Announcement 24 January 2022) and another undisclosed party due to confidentiality.
- Other potentially lower cost options for clean Hydrogen production using Pedirka coal were identified and assessed as part of the PFS. After modelling the use of natural gas in gas turbines to produce the power requirements alone to convert coal feedstock from Pedirka to hydrogen (i.e., for gasification) and to compress the CO<sub>2</sub> produced from this process, it was clear that the quantity of natural gas required for this step alone could result in equivalent tonnages of blue Ammonia end product being produced using a different technology, namely SMR combined with CCS. (Natural gas having 2 times the calorific value or energy content of coal). In addition, only 50% of the carbon emissions would be produced using this option, reducing the CCS tolling costs. This insight led to more commercially attractive options using natural gas as feedstock being developed by Hexagon. Where the securing of low-cost natural gas prices and CCS toll services drive commerciality.
- The challenges around using remote Pedirka based coal also stemmed from the quantum of time that would be needed to secure JORC resource and reserve drilling and potential mine development approvals, not only requiring State but likely Federal regulatory body involvement, in conjunction with wide ranging stakeholder engagement with significant timeframes involved. The usual site/plant development approvals would also be required to allow the more than +A\$3 billion P&E, mine development and infrastructure (rail, road, storage) capital investments to take place.

The conclusion is that the PFS based on utilising Pedirka coal highlighted a number of challenges in relation to Pedirka's further development, challenges significantly impacting Pedirka's potential return on investment, and likely timeframe to reach production relative to the alternatives identified.

More commercially attractive clean Hydrogen opportunities were identified through the Pedirka PFS expanded scope of work, projects with the potential to more rapidly and cost effectively establish Hexagon's clean Hydrogen business and create a solid basis for future growth as the clean Hydrogen market emerges.

## 8.5 Further Analysis - Sensitivities

Key financial model sensitivities for the Alice Springs plant were identified as:

- Clean Ammonia price,
- CCS toll service costs, and
- P&E Capex.

Similarly for the Middle Arm plant:

- Clean Ammonia price,
- Transportation and Haulage costs of coal as hydrogen conversion (gasification) feedstock as well as coal-fired power station feed, and
- CCS toll service costs.

The following were also shown to significantly impact commercial returns:

- a) Energy options and the total costs of their delivery (CapEx and OpEx). A coal-fired power plant at Middle Arm would cost around A\$1 billion to construct (more at Alice Springs), and
- b) Current status and future funding of key public multi-user infrastructure, e.g., port export facilities and process water supply and management.

Insights gained during the Pedirka PFS led to opportunities being identified which are more commercially attractive for Hexagon to invest in at this time than Pedirka.

## 8.6 Risk Management Approach

Table 2, below, sets out how risks were approached and managed throughout the Pedirka PFS. Its cross links to the Critical Success Factors (01 to 07) for the PFS shown in Figures 6 and 7.



<p><b>1. Technical Engineering and Design</b></p> <p>Use of proven at scale, multi-operations performance record (construction and operations wise) technologies</p> <ul style="list-style-type: none"> <li>– Plant and Equipment (P&amp;E) definition and specification on this basis.</li> <li>– Fully Integrated Process Design by experienced engineers.</li> <li>– Experienced Engineering Procurement and Contract Management (EPCM) parties.</li> <li>– Hexagon Owned Infrastructure: <ul style="list-style-type: none"> <li>– Raw Material related.</li> <li>– End Product related.</li> <li>– Utilities Connections.</li> <li>– On-site CO<sub>2</sub> Compression system.</li> <li>– Interconnections/Tie-ins, e.g., CO<sub>2</sub> pipeline to supply to CCS and Port access.</li> </ul> </li> <li>– Third Parties.</li> </ul> <p>CSF: 02, 04, 05</p>	<p><b>2. Environmental &amp; Safety</b></p> <p>Work with regulators to secure development approvals and operational regulatory requirements for the project across:</p> <ul style="list-style-type: none"> <li>– Drilling, as appropriate.</li> <li>– Mining, as appropriate.</li> <li>– Supply of Other Feedstocks.</li> <li>– Processing Plant Development approvals.</li> <li>– End Product Logistics (Handling, Storage, Transportation).</li> <li>– Emissions management.</li> <li>– Waste incl water management.</li> <li>– Noise management.</li> <li>– Workforce/OHS management.</li> </ul> <p>Based on Best Practice at Comparable Projects and Operations.</p> <p>CSF: 01</p>	<p><b>3. Project Development Financing/Funding</b></p> <ul style="list-style-type: none"> <li>a) Establish the funding requirements to proceed through the development cycle into commissioning and long-term operations for the project.</li> <li>b) Establish matching funding strategies.</li> <li>c) Create Options/Optionality.</li> </ul> <p>CSF: 07</p>
<p><b>4. End Markets Raw Materials Including Feedstock. Consumables (Inputs/Outputs)</b></p> <ul style="list-style-type: none"> <li>a) Feedstock e.g., Coal Mine related.</li> <li>b) Consumables (e.g., Electricity, Water).</li> <li>c) End Product – Blue to Green Ammonia – Long term Liquid hydrogen.</li> </ul> <p>CSF: 03, 05, 06</p>	<p><b>5. Stakeholders</b></p> <p>Across the fully integrated value chain multiple stakeholders have been engaged with and continue to be engaged with, including but not limited to:</p> <ul style="list-style-type: none"> <li>– Governments (Federal, State, Local).</li> <li>– Regulators.</li> <li>– Investors.</li> <li>– Service Providers/Businesses.</li> <li>– Community/General Public.</li> <li>– Indigenous Groups.</li> <li>– Customers.</li> <li>– Potential Employees.</li> </ul> <p>CSF: 01, 07</p>	<p><b>6. Delivery of a lowest risk (technical, plant performance and timeframe to operations wise) and lowest cost (CapEx and OpEx) project. With the highest likelihood of value creation, i.e., commercial return delivery for shareholders.</b></p>

Table 2 - Hexagon's Pedirka PFS Risk Management Approach

## 8.7 Conclusions

This announcement builds on the Pedirka PFS ASX Announcement of 12 December 2022, which set out progress made up to that time. It summarises how the Pedirka PFS has been completed and finalised and outlines how Hexagon plans to move forward and deliver against its clean Hydrogen strategy.

Hexagon has concluded through the Pedirka PFS process that proceeding with a clean Hydrogen project using Pedirka sourced feedstock is not in Hexagon shareholders' best interests.

The PFS process provided a range of valuable insights that have led to well informed decision making about the future energy/clean Hydrogen component of Company's growth strategy. Specifically, this has led to a rapidly emerging clean Hydrogen opportunity in North Western WA being developed.

The Company has commenced work to secure a position on a potentially more rapidly realisable and more likely to deliver a commercial return, clean Hydrogen project in the North West of WA.

In parallel with the WAH<sub>2</sub> project Hexagon will continue to monitor the potential for a clean Hydrogen presence at Middle Arm, Darwin in the NT over the longer term.

## 9 Moving forward across Hexagon's asset base/portfolio of projects

An initiative that the Hexagon team has commenced work on will now be focussed on, in relation to exploration collaboration negotiations over its highly prospective Halls Creek Gold and Base metal assets.

Over the 2022 field season Hexagon is planning to drill for Nickel-Copper and PGEs at its McIntosh Project. The results of last season's extensive soil sampling program (ASX Announcement 16 December 2021) are expected to be finalised shortly for market release.

Considerable interest in Hexagon's activities at the McIntosh Project has been received with a range of discussions underway.

### Ends

To learn more please visit: [www.hxgenergymaterials.com.au](http://www.hxgenergymaterials.com.au)

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## ABOUT HEXAGON ENERGY MATERIALS LIMITED

Hexagon Energy Materials Limited (ASX: HXG) is an Australian company focused on future energy project development and energy materials exploration and project development.

Hexagon is developing a business to deliver decarbonised Hydrogen (blue Ammonia) into export and domestic markets, at scale. The Pre-Feasibility Study for the Northern Territory (Pedirka) Hydrogen Project, utilising coal gasification and Carbon Capture and Storage (CCS) is now complete. With Hexagon's WA Hydrogen (WAH<sub>2</sub>) project emerging as a more commercially attractive option and is now being pursued by Hexagon

Hexagon's plan is to use renewable energy in clean Hydrogen production to the greatest extent possible in its projects, transitioning from blue to green Hydrogen production on a commercial basis, over time. Supporting this strategy in January 2022 Hexagon signed a Memorandum of Understanding with renewable energy company FRV Services Australia Pty Ltd (FRV Australia) (51% owned by Fotowatio Renewable Ventures S.L. and 49% owned by OMERS Infrastructure part of OMERS Canadian defined benefit pension plan fund). FRV has almost 800MWdc of Australian PV assets built or under construction in Australia.

Hexagon also owns the McIntosh Nickel-Copper-PGE and Graphite project in Western Australia (WA) and the Halls Creek Gold and Base metals project in WA. On 14 February 2022 Hexagon announced a binding Graphite Mineral Rights Earn-in agreement (up to 80%) had been entered into with Critical Green Minerals Pty Ltd. With McIntosh graphite expected to become part of an ASX Initial Public Offering during 2022. In the USA, Hexagon has an 80 per cent controlling interest of the Ceylon Graphite project located in Alabama, over which South Star Battery Materials Corp. (TSXV: STS) on 7 December 2021 signed an Option to develop and earn-in up to 75% interest.

Hexagon's overarching goal for 2022 is to secure and leverage technical and commercial alliances by commodity across its project portfolio whilst maintaining a core focus on Northern Australian Future Energy Materials and Future Energy project developments, in-house. Figure 9 below summarises Hexagon's Strategy.

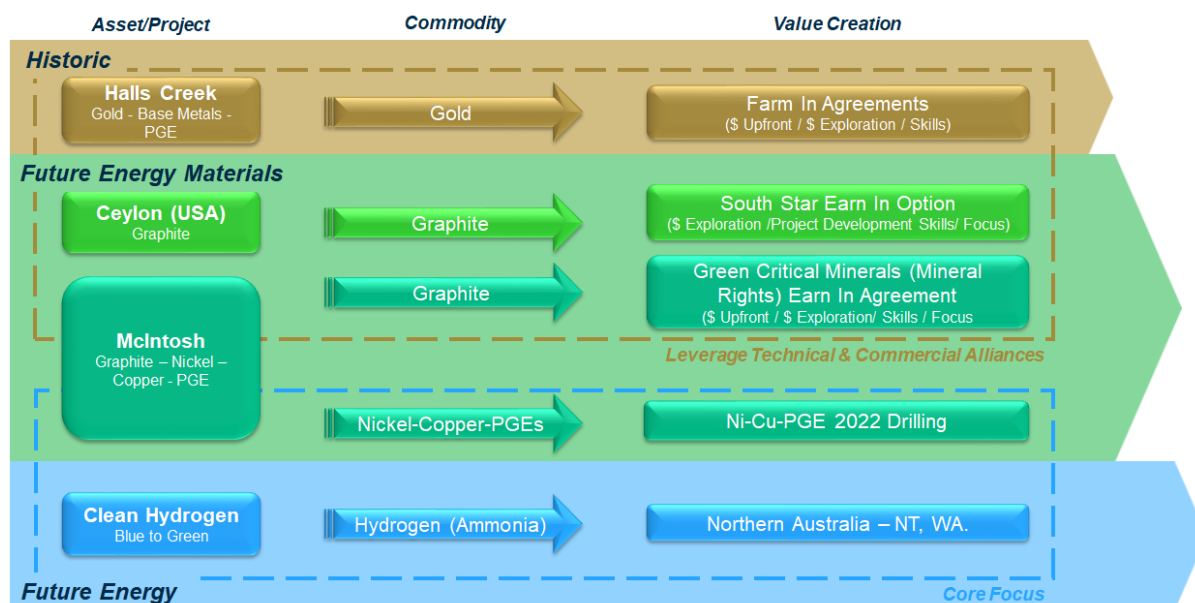
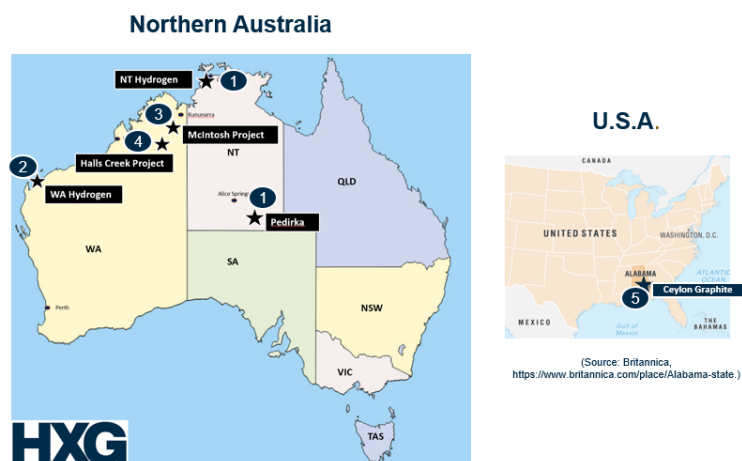


Figure 9 - Hexagon's Strategy

Hexagon is a future energy and energy materials predominantly Northern Australia focussed project development company.



## Future Energy: Northern Australia

1. Northern Territory (NT) Pedirka Clean Hydrogen (Blue Ammonia) Project: *Alice Springs or Middle Arm, Darwin.*
2. Western Australian (WA) Hydrogen Project.

## Future Energy Materials:

3. The McIntosh Project: Graphite, Nickel, Copper and PGEs.
4. Ceylon Graphite Project in Alabama, U.S.A.

## Historic:

5. The Halls Creek Gold and Base Metals Project.

Figure 10 - Hexagon's overall asset base/portfolio of projects

## Authorisation

This announcement has been authorised by the Board of Directors.