Vecco Critical Minerals Project Decarbonisation Plan

Prepared for:

Vecco Group Pty Ltd

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Final

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Abbreviations	Definition
GHG	Greenhouse gas
HPA	High purity alumina
LOM	Life of mine
ML	Million litres
MW	Megawatts
MWh	Megawatt hours
REE	Rare earth element
TOR	Terms of reference
VRFB	Vanadium Redox Flow Battery
Nomenclature	**Definition**
CO_2-e	Carbon dioxide equivalents
V_2O_5	Vanadium pentoxide

EXECUTIVE SUMMARY

This document presents Vecco Group's Decarbonisation Plan for the Vecco Critical Minerals Project. The Plan meets the requirement of the Terms of Reference for environmental approval.

The Vecco Critical Minerals Project will help the Queensland Government achieve the state's targets for renewable energy generation and emissions reduction by providing vanadium oxide (V_2O_5) and other rare earth elements (REE) for the manufacture of vanadium electrolyte in Queensland. V_2O_5 and the other REEs are regarded as critical minerals and their mining and supply will be a key plank in the grid-scale battery strategies of the Queensland and Australian governments for decarbonising the economy.

Grid-scale Vanadium Redox Flow Batteries (VRFB) will have a significant role in the reduction of greenhouse gas (GHG) emissions by enabling the transition to renewable electricity generation and ensuring reliable supply of electricity to the market. Avoided emissions of 2,754,290 t CO_2-e could be achieved by 2030 using the vanadium electrolyte manufactured by Vecco Group in its Townsville factory, in the rollout of VRFB.

Vecco Group's decarbonisation objective is to set the benchmark for the lowest emissions intensity production of V_2O_5 and vanadium electrolyte in Australia. It will do this through the following key result areas:

1. Meet all electricity needs through renewable electricity generation and storage by 2030
2. Meet 20% of process heat requirements through renewable sources including waste heat capture by 2030
3. Mobile plant diesel emissions per annum are 10% less than projected
4. Project staff are engaged in energy efficiency and emissions reduction
5. More efficient means of extracting vanadium from shale in preferred oxidation state are identified and tested
6. New technologies and processes are evaluated for cost-effective emissions reduction.

Potential actions for decarbonisation include, if practicable:

- Construction of a 10MW solar PV farm (with batteries) to provide electricity for the Project
- Waste heat from ore processing and sulphuric acid production will be captured and used for other operational processes, reducing the need for LNG combustion
- Optimisation of vehicles and processes for energy efficiency
- Production of biochar from cleared vegetation.

Vecco Group commits to a process of continuous improvement informed by engaged staff, monitoring, and research and development.

1. INTRODUCTION

The Queensland Government has recently updated the generic terms of reference (TOR) for environmental approvals and environmental impact statements to include the development of a decarbonisation plan that identifies, inter alia, how a project will contribute towards Queensland's emissions reduction and renewable energy targets. The targets are:

i. 30% reduction in GHG emissions on 2005 levels by 2030
ii. 50% of energy will be provided by renewable energy sources by 2030 (70% by 2032)
iii. A zero net emissions economy will be achieved by 2050.

This document provides Vecco Group's Decarbonisation Plan for the Vecco Critical Minerals Project (the Project) in support of its application for environmental approval. It addresses the requirements of the Terms of Reference (Table 1).

Table 1 Locations within decarbonisation plan where TOR are addressed

Terms of Reference	Decarb Plan Section
a. Quantify, describe, and illustrate the project's contribution toward Queensland's emissions reduction and renewable energy targets: i. 30% on 2005 levels by 2030 ii. 50% renewable energy by 2030 iii. zero net emissions economy by 2050.	Section 3, Table 2
b. Explain feasible alternatives that were considered to avoid or reduce the project's emissions as well as the alternative of not proceeding with the proposed project.	Section 4.4
c. Describe: i. Measures (preferred and alternatives) proposed to avoid and/or minimise Scope 1 and Scope 2 GHG emissions of the proposed project ii. Options for avoiding and/or mitigating Scope 3 emissions.	Section 4.3
d. Include: i. Opportunities to reduce greenhouse emissions through renewable energy use and innovation ii. Any voluntary initiatives, such as research into reducing the lifecycle and embodied energy carbon intensity of the proposed project's processes or products iii. Any additional carbon offsetting options for emissions that cannot be reduced (including, but not limited to, through carbon offsets, vegetation management).	Section 4.3, Section 3
e. Quantify the emissions expected to be abated for each avoidance and mitigation measure.	Section 3.3, Section 4.3, Table 4
f. Compare preferred measures for emission controls and energy consumption with best practice International environmental management in the relevant industry sector.	Section 3

Terms of Reference	Decarb Plan Section
g. Describe the practicality, effectiveness and risks for each avoidance and mitigation measure.	Section 4.3
h. Demonstrate that measures have been factored into the economic feasibility of the project.	Section 4.5
i. Describe and commit to: i. Periodic energy audits that measure progress towards improving energy efficiency ii. A process for regularly reviewing new technologies to identify opportunities to further reduce GHG emissions and use energy efficiently, consistent with best practice environmental management iii. Monitoring, auditing and transparent public reporting on: GHG emissions from all relevant activities; the success of mitigation measures; and, the project's contribution to achieving Queensland's 2030 target and achieving net zero by 2050 iv. Ongoing training and capacity building around decarbonisation options, technology and reporting.	Section 4, Table 3

1.1 The Project

Vecco Group Pty Ltd (Vecco Group) is supporting the renewable energy transformation by developing the Project, which involves the mining of high purity vanadium pentoxide (V_2O_5), high purity alumina (HPA), and other rare earth elements (REE) from its mine near Julia Creek, northwest Queensland, and the production of high-grade vanadium electrolyte in its factory in Townsville for use in vanadium redox flow batteries (VRFB).

Vanadium is recognised as a 'critical mineral' by both the Queensland Government[1] and the Commonwealth Government[2]. In addition to its traditional uses, vanadium electrolyte is used in the manufacture of VRFB. Large-scale VRFB will be a critical part of Australia's energy transformation, with the shift from centralised coal and gas generation to distributed and intermittent sources of energy such as wind and solar.

The Project is located approximately 70 km north of Julia Creek township and approximately 515 km west of Townsville in northwest Queensland (Figure 1). The townships of Cloncurry and Richmond are located approximately 125 km west and 145 km east of the Project, respectively.

The Project is a proposed greenfield operation that will consist of a shallow, open-cut mine that will process up to 1.9 Mtpa ROM feed to produce up to approximately 5,500tpa V_2O_5 and 4,000tpa HPA over an operational life of approximately 26 years with 10 years allocated for site rehabilitation. Minor quantities of other REE may present opportunities for saleable byproducts of the process.

The life of mine (LOM) is expected to be approximately 36 years, including construction, operation, and rehabilitation. Ore will be mined to an approximate depth of up to 35m. Processing will occur following on site crushing and screening of the ore. Mineral products will be packed into containers and transported by truck or rail

[1] https://www.resources.qld.gov.au/__data/assets/pdf_file/0005/1726430/critical-minerals-strategy.pdf

[2] https://www.industry.gov.au/publications/australias-critical-minerals-list

to Townsville, for secondary processing into battery electrolyte or export from the Port of Townsville to international markets.

Vecco Group intends to apply international best practice in its mining and ore processing operations and apply a process of constant improvement informed by monitoring, research, and assessment of the most cost-effective means for energy efficiency and decarbonisation of processes where practicable.

1.2 Electrolyte Production

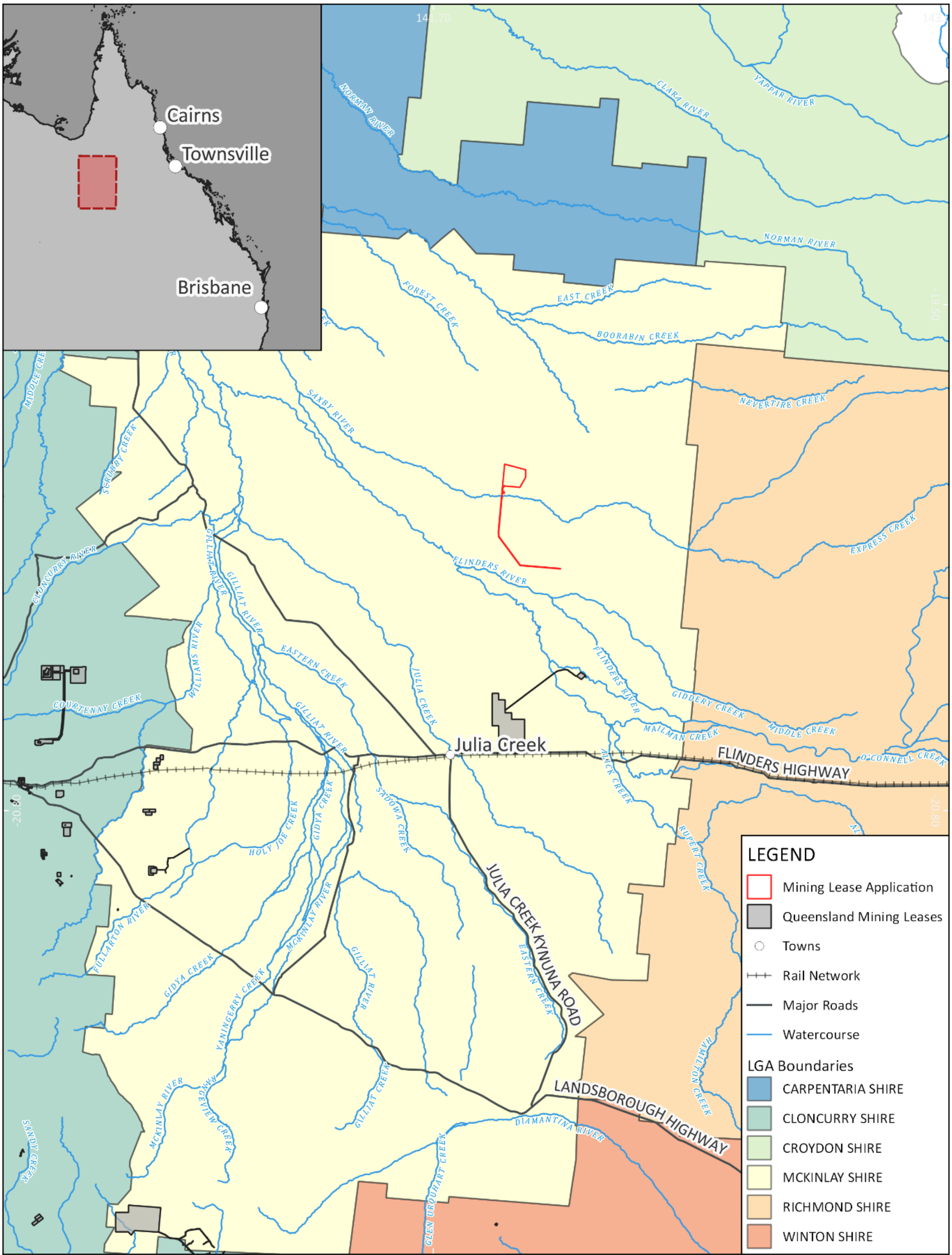
Vecco Group is also developing Australia's first commercial scale vanadium electrolyte manufacturing facility. A pilot facility with the capacity to produce 2 million litres of vanadium electrolyte per year is in operation in Townsville, and full vanadium electrolyte production of 18 million litres (ML) per annum will be online in mid-2025 to utilise supply of V_2O_5 from the Project. The pilot facility currently uses V_2O_5 imported from South Africa.

The Townsville plant at full capacity will produce enough electrolyte annually to support 350 MWh of energy storage capacity per cycle.

1.3 Vanadium Redox Flow Batteries for Grid Storage

VRFB are uniquely suited for grid energy storage for several reasons, including:

- There is no limit on energy capacity
- There is a single charge state across the electrolytes, avoiding significant capacity degradation
- They can remain discharged indefinitely without damage
- The electrolyte is non-flammable
- They have a long charge/discharge cycle life
- They have a low levelized cost of electricity, and
- The electrolyte is indefinitely recyclable.



Project Locality

Debella Critical Minerals Project

Client	VECCO INDUSTRIAL PTY LTD
Date	12-05-2023
Author	L.Morgan
Projection	GDA2020 / MGA zone 54
Scale	1:1300000

0 10 20 30 40 km

arc ENVIRONMENTAL SOLUTIONS

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Figure 1 **Location of the VECCO Critical Minerals Project**

2. THE VECCO CRITICAL MINERALS PROJECT

2.1 Mining Activities

The mining component of the Project will be a typical truck and excavator operation. The ore body is relatively shallow to a depth of 35m below the surface and relatively easy to extract and process compared to most coal or hard rock operations, meaning that the energy required, and the emissions released from the Project are likely to be significantly lower than for those sorts of mining operations. Operations will include:

- Clearance of vegetation and removal and stockpiling of topsoil
- Removal and stockpiling of overburden
- Excavation and trucking of ore to ROM pad and conveyance of ore to processing plant
- Neutralised ore residue and overburden dumped in pit to return mined land to previous surface level
- Topsoil re-laid and site progressively revegetated.

2.2 Ore Processing

The Project has a hydrometallurgical processing plant designed to extract and refine V_2O_5 and HPA and produce a REE concentrate. The plant applies both electrical and heat energy in the process.

The simplified process is as follows:

- Ore is scrubbed to reduce material size and disperse clay material from calcite and other waste material (gangue). This process improves liberation of vanadium from the ore.
- Reverse flotation is used to separate calcite from vanadium-rich concentrate. The calcite-rich concentrate is transported to the process waste treatment facility and used to neutralise process residue. The tail material is concentrated to remove water and conveyed to the roasting plant.
- Vanadium concentrate is dried and roasted at 800°C in a rotary kiln fired with liquified natural gas (LNG). The concentrate is cooled and then leached further via steam-injection process heating.
- The vanadium concentrate is then cooled and leached in sulphuric acid (H_2SO_4) to extract vanadium as a sulphate. Aluminium and iron will also be extracted as sulphates and processed separately. The slurry is filtered to separate the waste solids from the vanadium-rich filtrate (in solution).
- The filtrate is partially neutralised and mixed with solvents to extract the vanadium from solution into an organic phase and then selectively concentrate it into an aqueous phase for precipitation as ammonium metavanadate (NH_4VO_3, AMV).
- The precipitate is flash dried at 100°C and then calcined at 450°C to produce high purity V_2O_5. Ammonia (NH_3) for AMV formation. Calcined V_2O_5 is then shipped for processing into vanadium electrolytes.

2.3 Ancillary Processes

There are several other ancillary processes that will require electrical and/or heat energy.

These are:

- HPA extraction and calcination during the vanadium extraction and calcination process.
- Rare earth leaching, concentration, neutralization, precipitation, and drying.

- Sulphuric acid production, which involves melting and atomization of solid sulphur, catalysis oxidation, and reaction with water. This process is exothermic, i.e., it releases heat energy during the reaction with water. High pressure steam is also produced during this process.
- Waste management, including filtration, neutralization, and disposal of residue.

3. CONTRIBUTION TO QUEENSLAND'S EMISSIONS REDUCTION AND RENEWABLE ENERGY TARGETS

This section describes how the Project will contribute to Queensland's emissions reduction and renewable energy targets. A summary is provided in Table 2.

Table 2 Contribution of the Project to Queensland's emissions and renewable energy targets

Queensland Targets	Project Contribution
30% on 2005 levels by 2030	Avoided emissions of 2,754,290 t CO_2-e by 2030[3]
50% renewable energy by 2030[4] **70% renewable energy by 2032**	Construction of 10MW solar PV farm (with batteries) Process heat capture
Zero net emissions economy by 2050	Critical minerals mining, processing, and electrolyte manufacturing in North Queensland

3.1 Vanadium Electrolyte

Vecco Group is not only mining and refining vanadium oxide ore but has also established a facility in Townsville to produce the electrolyte for use in VRFB and is investing in research to improve the efficiency and environmental aspects of the production process.

Australia is a dominant player in the mining of battery materials, particularly lithium, but to date it is not a significant part of the refining or manufacturing chain[5]. Both the Australian Government and Queensland Governments are consulting on the development of a battery industry strategy[6].

The successful achievement of Queensland's emissions reduction and renewable energy targets will depend on the availability of grid-scale batteries that can provide the firming capacity required by the National Electricity Market (NEM). The national demand for grid stationary storage is expected to be 90 GWh by 2030, with the demand in Queensland being 26 GWh by 2030[7].

The vanadium electrolyte manufacturing facility will have the capacity to produce eighteen megalitres (18 ML) of electrolyte annually, equivalent to 350 MWh storage capacity per cycle when manufactured into Vanadium Redox Flow batteries. This equates to the production of storage capacity of up to 9,300 MWh (9.3 GWh) over the 26 years of active mining.

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[3] At Queensland's current Scope 2 emissions factor of 0.73 and Scope 3 emissions factor of 0.15 for electricity generation and transmission losses

[4] Currently 26% of Queensland's electricity is from renewable sources.

[5] https://fbicrc.com.au/wp-content/uploads/2021/06/Future-Charge-Report-Final.pdf

[6] https://storage.googleapis.com/converlens-au-industry/industry/p/prj21a171171876878840250/public_assets/national-battery-strategy-issues-paper.pdf

[7] https://www.statedevelopment.qld.gov.au/__data/assets/pdf_file/0029/78581/queensland-batteries-discussion-paper.pdf

3.2 Avoided Emissions

Avoided emissions are emissions savings that occur outside of a company's value chain, but that occur because the company's product or service provides a decarbonisation solution. Vecco's electrolyte production could be responsible for 0.056 – 1.55 Mt CO_2-e of avoided emissions per annum, 2.75 Mt CO_2-e in avoided emissions by 2030, and nearly 27 Mt CO_2-e of avoided emissions by 2050. This is based on a scenario where:

- 9 ML of electrolyte produced in the first year and 18 ML of electrolyte produced in subsequent years is used for battery manufacture and application in the year it is produced
- Queensland meets its renewable energy targets, and the emission factor shifts from 0.73 and 0.15 kg CO_2-e/kWh to 0.5 and 0.1 kg CO_2-e/kWh in 2031, 0.25 and 0.08 kg CO_2-e/kWh in 2033, and 0.2 and 0.08 kg CO_2-e/kWh in 2036.
- A battery cycles once per day.

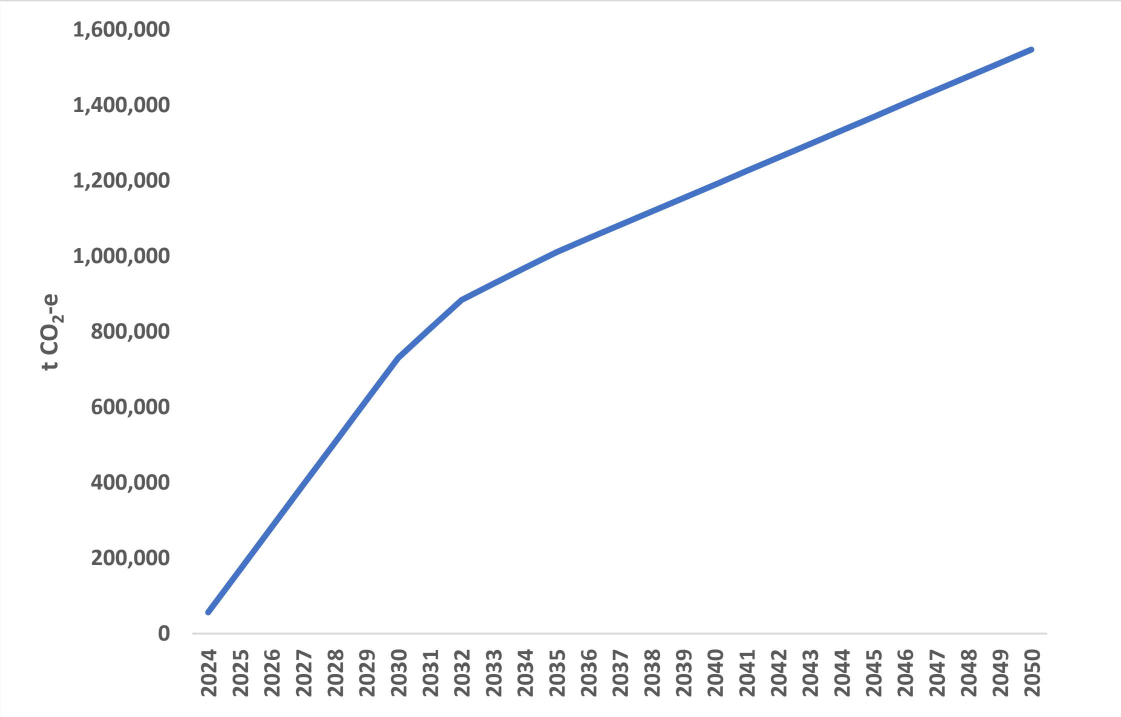

Figure 2 **Cumulative avoided emissions (t CO_2-e) per year over the life of mine due to electrolyte production and including change in emission factors**

3.3 Solar Farm

The mine and ore processing facility will not be connected to the NEM, so Vecco Group intends to develop a 10 MW solar farm, with a projected output based on daily solar irradiance[8] of 18,236 to 27,354 MWh, to power the facility. Batteries may also be part of the farm allowing for the matching of supply and demand.

The alternative is to use diesel generators which would emit 4,609 – 6,913 tCO_2-e per day to supply the same quantity of electricity. The equivalent in Scope 2 emissions would be 16,048 – 24,072 tCO_2-e per day.

[8] https://photovoltaic-software.com/principle-ressources/solar-radiation-databases/australia-bureau-of-meteorology

4. DECARBONISATION PLAN

4.1 Goal

Vecco Group's goal is to support Queensland's decarbonisation transition by integrating the mining of high purity vanadium and alumina with manufacturing of VRFB electrolyte in north Queensland.

4.2 Objective, Key Results, and Actions

Vecco Group's objective is to set the benchmark for the lowest emissions intensity production of vanadium pentoxide and vanadium electrolyte in Australia. Under the National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015, the Clean Energy Regulator (CER) is required to publish information relating to emissions baseline determinations (baselines) as part of the Safeguards Mechanism. As a new industry, vanadium mining and electrolyte manufacture do not yet have a specific baseline determination.

Vecco Group will not be subject to the Australian Government's Safeguards Mechanism as its total annual emissions will be less than 100,000 tCO_2-e per annum. However, Vecco Group intends to be the pre-eminent producer of vanadium oxide and electrolyte in Australia and be the measure other companies are required to meet.

Table 3 Objective, Key Results, and Actions

Objective: To set the Australian benchmark for lowest emissions intensity production of vanadium pentoxide (V_2O_5) and vanadium electrolyte	
Key Results	**Actions**
Key result 1: Meet all electricity needs through renewable electricity generation and storage by 2030	• Establish 10 MW solar farm, including 6 MW battery • Monitor electricity use and time of use • Optimise processes for energy efficiency • Implement energy efficiency control systems and technology • Identify and assess supplementary renewable energy generation technology • Implement new technology and processes if practicable and cost-effective
Key result 2: Meet 20% of process heat requirements through renewable sources including waste heat capture by 2030	• Install most efficient kiln with insulation and control systems to ensure maximum efficiency • Optimise waste heat capture for process heat use • Identify and assess new technology or processes other than LNG combustion for generating process heat or capturing and using waste heat • Implement new technology and processes if practicable and cost-effective

Objective: To set the Australian benchmark for lowest emissions intensity production of vanadium pentoxide (V_2O_5) and vanadium electrolyte	
Key Results	**Actions**
Key result 3: Mobile plant diesel emissions per annum are 10% less than projected in the base case	• Procure heavy vehicles with best diesel use efficiency rating • Optimise mine layout and run of mine for diesel use efficiency • Conduct real time monitoring and control of diesel use efficiency • Investigate and implement new technologies for increased diesel use efficiency if practicable and cost-effective
Key result 4: Project staff are engaged in energy efficiency and emissions reduction	• Energy efficiency and emissions reduction are tied to management and executive KPIs • National Greenhouse and Energy Reporting (NGER) assessments and audits are linked to management and executive KPIs and efficiency/emissions programs • Standard Operating Procedures (SOP) are established for energy efficiency and emissions reduction • Staff are trained in SOPs for energy efficiency and emissions reduction
Key result 5: More efficient means of extracting vanadium from shale in preferred oxidation state are identified and tested	• Conduct research into new efficient processes for extraction of vanadium from shale in the preferred oxidation state and as a vanadium sulphate
Key result 6: New technologies and processes are evaluated for cost-effective emissions reduction	• Scope and evaluate new technologies and processes • Consider cost effectiveness and return on investment in decision making

4.3 Projected GHG Emissions

Vegetation clearance and the combustion of LNG and diesel are the sources of GHG emissions from the Project (Table 4)[9]. This base case emissions projection sets the baseline for which future performance will be measured.

The total worst-case emissions associated with vegetation clearance (36.4 kt CO_2-e) are fractionally offset by site rehabilitation and revegetation (-3.0 kt CO_2-e) in the short term, with the fraction offset increasing over time as the area revegetated expands and the trees mature.

LNG combustion for process heat is the most significant fossil fuel contributor to emissions from the Project at 36 kt CO_2-e per annum.

[9] Trinity Consultants Australia (2023). Debella Critical Minerals Project: Air Quality Assessment

Excavation and trucking are projected to produce 14 kt CO_2-e per annum. This is notably lower than for coal or hard rock mines because the ore body is relatively shallow.

There are no Scope 2 emissions as the Project will not be connected to the national electricity market (NEM; the Grid).

Scope 3 emissions will be produced by the transport of processed ore from the Project site to the Townsville electrolyte plant.

4.4 Mitigated GHG Emissions

By 2030, the decarbonisation plan (Table 3) is expected to reduce annual emissions from the base case by 22 kt CO_2-e (Table 4) and total emissions by 359 kt CO_2-e (24%) over the LOM.

4.4.1 Biochar production

The Intergovernmental Panel on Climate Change (IPCC) has identified Pyrogenic Carbon Capture and Storage (PyCCS) as a Negative Emissions Technology for carbon dioxide removal[10]. PyCCS is achieved through the thermal decomposition of biomass to biochar under low or no oxygen conditions and is usually referred to as pyrolysis or gasification. Weight for weight, pyrolysis can result in 25-50% conversion of wood to biochar, and the conversion of woody vegetation to biochar has the potential to sequester near permanently just over 3 t CO_2-e for every tonne of biochar produced.

Conversion of the Project's cleared woody vegetation to biochar and applying this to rehabilitated soils is an option to significantly reduce the total emissions associated with vegetation clearance (Table 4). There are potential co-benefits with this approach including enhancing revegetation success through improved water and nutrient holding capacity and enhanced microbiological soil activity.

The Project is unlikely to be able to obtain Carbon Credits through the Carbon Farming Initiative (CFI), but may apply CFI methods[11], IPCC methods[12], or other commercial methods[13] to calculate actual abated emissions through biochar production.

4.4.2 Process heat

Reliance on LNG for process heat poses a supply and cost risk to the Project. Practicable alternatives to LNG are not available at present, but Vecco Group will continue to scope for options with fewer emissions over the LOM, including the capture of waste heat generated from sulphuric acid production to apply in other parts of the process chain thereby reducing the need to generate heat from fossil fuel sources, and/or increasing the size of the solar farm to 15 MW to supply.

Vecco Group will ensure that the kiln is the latest most efficient system available, with insulation and controls to minimise heat loss and ensure efficient operation. Maintenance of seals and control of filling and/or venting will be used to minimise fugitive LNG emissions. By 2030, this should result in a minimum of 7.5 kt CO_2-e fewer emissions than the base case (Table 4).

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10 https://www.ipcc.ch/sr15/

11 https://www.legislation.gov.au/Details/F2021L01696

12 https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch02_Ap4_Biochar.pdf

13 https://puro.earth/carbon-removal-methods/

Table 4 Base case and mitigated (decarbonisation by 2030) case sources and quantities of GHG emissions (kt CO_2-e) by activity

Activity	Base Case Maximum Annual Emissions (kt CO_2-e)	Base Case Maximum Life of Mine Emissions (kt CO_2-e)	Mitigated Maximum Annual Emissions (kt CO_2-e)	Mitigated Maximum Annual Emissions ((kt CO_2-e)
Vegetation clearance	36.4	36.4	27.3	27.3
LNG combustion	36.0	936.0	28.8	748.8
Mobile plant diesel combustion	14.0	504.0	12.6	453.6
Water pump diesel combustion	3.0	78.0	0	0
Fugitive LNG emissions	1.4	36.4	1.1	29.1
Stationary mining plant diesel combustion	1.0	26.0	0	0
Light vehicle diesel combustion	0.2	5.2	0.2	4.7
Off-site diesel combustion	0.2	5.2	0.2	4.7
Revegetation	-3.0	-108.0	-3.0	-108.0
Total	**89.2**	**1,519.2**	**67.2**	**1,160.2**

Vecco Group will scope for and apply, if practicable, innovative technologies and processes that can optimally capture and use waste heat for other essential purposes, e.g., trigeneration (Combined Cooling, Heat, and Power) with absorption chillers.

4.4.3 Diesel use

Options for emissions reduction are associated with optimizing mine layout for efficient transport, investment in energy efficient vehicles, and new technology which may improve the efficiency of diesel combustion thereby reducing emissions. Electrification of light and heavy vehicles may be an option, but this will depend on the capacity to recharge vehicles from the solar farm in a timely and efficient manner.

Electricity would typically be provided to isolated mines by diesel generators, contributing to GHG emissions. The Project will use some diesel generators and water pumps (stationary mining plant); however, a significant fraction of electricity generation is intended to be provided by the hybrid solar farm (Section 3.3) and stationary plant such as diesel generators may be retired. Solar water pumps will be used where possible. Total emissions attributable to diesel combustion are expected to be reduced by 5.4 kt CO_2-e by 2030 (Table 4).

Scope 3 emissions will occur due to road or rail transport of ore from the Project site to Townsville; Vecco Group is still determining which is the best option.

4.5 Feasible Alternatives

All feasible and practicable alternatives have been considered to avoid or reduce the Project’s baseline emissions and these are included in the Project’s economic feasibility assessment and/or this decarbonisation plan.

The Project is considered essential for the continuing renewable energy transformation and, therefore, not proceeding with the Project is not considered in the interest of Queensland’s or Australia’s renewable energy and emissions reduction targets.

Vecco Group commits to a process of continuous improvement based on monitoring, audit, research, and investment across its mining, ore processing, and electrolyte manufacture to further reduce emissions where practicable.

5. SUMMARY

The Vecco Critical Minerals Project will help the Queensland Government achieve the state's targets for renewable energy generation and emissions reduction by providing vanadium oxide (V_2O_5) and other rare earth elements (REE) for the manufacture of vanadium electrolyte in Queensland. V_2O_5 and the other REEs are regarded as critical minerals and their mining and supply will be a key plank in the grid-scale battery strategies of the Queensland and Australian governments for decarbonising the economy.

Grid-scale Vanadium Redox Flow Batteries (VRFB) will have a significant role in the reduction of greenhouse gas (GHG) emissions by enabling the transition to renewable electricity generation and ensuring reliable supply of electricity to the market. Avoided emissions of 2,754,290 t CO_2-e could be achieved by 2030 using the vanadium electrolyte manufactured by Vecco Group in its Townsville factory in VRFB.

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1. Meet all electricity needs through renewable electricity generation and storage by 2030
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5. More efficient means of extracting vanadium from shale in preferred oxidation state are identified and tested
6. New technologies and processes are evaluated for cost-effective emissions reduction.

Potential actions for decarbonisation include, if practicable:

- Construction of a 10 MW solar PV farm including 6MW of battery storage to provide electricity for the Project
- Waste heat from ore processing and sulphuric acid production will be captured and used for other operational processes, reducing the need for LNG combustion
- Optimisation of vehicles and processes for energy efficiency
- Production of biochar from cleared vegetation.

Vecco Group commits to a process of continuous improvement informed by engaged staff, monitoring, and research and development.