Project Haber Pty Ltd

Project Haber
Greenhouse Gas Management Plan

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JBS&G Australia Pty Ltd T/A Strategen-JBS&G

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Terms and Abbreviations

Term	Definition
ALARP	As Low as Reasonably Practicable
ASU	Air Separation Unit
ATR	Autothermal reforming
CCGT	Combined Cycle Gas Turbine
Climate Change	As defined by Article 1 of the *United Nations Framework Convention on Climate Change (UNFCCC, 1992)* and meaning: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'.
CO_2-e	"Carbon dioxide equivalent" For any quantity and type of greenhouse gas, CO_2-e signifies the amount of CO_2 which would have the equivalent global warming impact. Determined by the amount of the gas multiplied by a value specified in the regulations in relation to that kind of greenhouse gas (as per the *National Greenhouse and Energy Reporting Act 2007*).
DEF	Diesel Exhaust Fluid
DWER	Department of Water and Environmental Regulation
EIA	Environmental Impact Assessment
Emissions Intensity	The calculated ratio of GHG emissions per unit of production.
Emissions or GHG Emissions	Greenhouse gas emissions expressed in tonnes of carbon dioxide equivalent (CO_2-e).
EP 503	Petroleum Exploration Permit 503
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986*
FID	Financial investment decision
FY2021	Financial Year 2021
Greenhouse Gas or GHG	Gaseous compound that affects the atmosphere's radiative forcing trapping heat in the lower atmosphere (EPA 2019); being the six categories of greenhouse gases covered by the UNFCCC: (i) carbon dioxide; (ii) methane; (iii) nitrous oxide; (iv) sulfur hexafluoride; (v) hydrofluorocarbons; and (vi) perfluorocarbons. More detail concerning (v) and (iv) is given in section 7A of the *National Greenhouse and Energy Reporting Act 2007* (Cth).
GHG	Greenhouse Gas
GHGMP	Project Haber Greenhouse Gas Management Plan, this document.
GTG	Gas Turbine Generators
HRSG	Heat recovery steam generator
ktpa	Kilo-Tonnes per annum
LHV	Lower Heating Value
Mtpa	Million tonnes per annum
NGER	National Greenhouse and Energy Reporting. As described in *National Greenhouse and Energy Reporting Act 2007*.
NWU	Nitrogen Wash Unit
Proposal	Project Haber a 1.4mtpa Urea project described in table 1.1.
Proposal Emissions	GHG Emissions released to the atmosphere as a direct result of an activity or series of activities that constitute the Proposal, calculated in accordance with: a) the *National Greenhouse and Energy Reporting Act 2007* (Cth) and its subsidiary legislation; or b) if that Act or the relevant subsidiary legislation is amended or repealed such that it does not provide a mechanism for calculating the Proposal Emissions, any other Act, regulation or instrument concerning greenhouse gases as specified by the Minister.
Safeguard Mechanism	The Safeguard Mechanism requires facilities emitting more than 100,000 tonnes of CO_2-e per year to have a baseline determined by the Commonwealth Regulator. The responsible emitter who has operational control of the facility must ensure reporting is conducted against the baseline and that the facility's net emissions do not exceed the baseline.
Scope 1 Emissions	Direct GHG emissions released to the atmosphere as a direct result of an activity, or series of activities at a facility level.
Scope 2 Emissions	Indirect GHG emissions released to the atmosphere from the indirect consumption of an energy commodity.

Term	Definition
Scope 3 Emissions	Indirect GHG emissions other than Scope 2 Emissions that are generated in the wider economy. They occur as a consequence of the activities of a facility, but from sources not owned or controlled by that facility's business.
Strike	Project Haber Pty Ltd (the **Proponent**), a fully owned subsidiary of Strike Energy Limited.
T&D	Transmission and Distribution
Tpa	Tonnes per annum
Tpd	Tonnes per day
WBCSD	World Business Council for Sustainable Development
Well to Gate	Includes all upstream emissions associated with the supply of feedstocks, including extraction, processing and transportation as well as emissions incurred during production. It excludes emissions associated with capital goods and downstream emissions. (DISER 2021a).
WRI	World Resources Institute

1. Summary

This Greenhouse Gas (**GHG**) Management Plan (**GHGMP**) has been prepared to support the assessment, approval and implementation of a 1.4 Mtpa urea manufacturing facility – Project Haber (the **Proposal**) under Part IV of the *Environmental Protection Act 1986* (**EP Act**).

A summary of the key aspects of the GHGMP is provided in Table 1.1.

Table 1.1: Summary of the key aspects

Proposal name	Project Haber (the **Proposal**)
Proponent name	Project Haber Pty Ltd (**Strike**)
Ministerial Statement Condition Clauses	The Proposal has been referred to the Environmental Protection Authority (**EPA**) under s.38 of EP Act. No Ministerial Statement is currently applicable to the Proposal.
Location of Proposal	The Proposal is located approximately 280 km north of Perth CBD and 105 km southeast of Geraldton.
Local Government Area	Shire of Three Springs
Purpose of the GHGMP	• To support the assessment, approval and implementation of the Proposal under Part IV of the EP Act; and • Identify management and mitigation measures to ensure that GHG emission impacts associated with the Proposal are aligned with EPA requirements.
Key environmental factor/s and objective/s	• Key environmental factor: Greenhouse Gas Emissions; • EPA objective: *To minimise the risk of environmental harm associated with climate change by reducing greenhouse gas emissions as far as practicable.* (EPA, 2022); and • GHGMP objective: To mitigate 100% of Scope 1 GHG emissions from the operation of the Proposal by 2050.
Key components of the GHGMP	Management actions intended to reduce GHG emissions (Scope 1) from the Proposal through progressive implementation of abatement measures, continual monitoring and reporting, including reporting under National Greenhouse and Energy Reporting (**NGER**) and safeguard mechanism requirements.
Proposed construction and operation dates	• Construction phase: 2024-2027 • Operational phase: 2027-2052

2. Context, Scope and Rationale

2.1 Background

The Proposal relates to the establishment of a urea manufacturing facility in Western Australia's Midwest region; urea is a chemical compound primarily used for fertiliser with other alternate uses including in the manufacture of diesel exhaust fluid (**DEF**; sold as AdBlue® in Australia), to reduce air emissions from vehicles.

Strike's intention is to supply fertiliser predominantly to Australia's agricultural industry to meet its high and growing demand. In 2021-22, Australia consumed 2.59 million tonnes of urea, of which 93.6% was imported[1]; urea usage in 2021-22 was over 70% higher than the amount consumed a decade prior. The rising demand for urea is attributable to its role in promoting additional yields in crop-based farming operations, making these operations comparatively more profitable and enabling growth in Australia's primary agricultural exports.

Strike acknowledges that the Proposal has associated GHG Emissions of 761 thousand tonnes per annum CO_2 equivalent (**ktpa CO_2-e**) emissions (Scope 1) released to the atmosphere as a direct result of the Proposal (**Proposal Emissions**). Currently Australia is dependent on international urea supplied predominantly from the Middle East and China with the only operating domestic urea production facility, Gibson Island, scheduled for closure by the end of 2022 (ABC 2021). International production of urea is associated with areas that have low-cost surplus gas (the US and the Middle East) or areas where GHG considerations are secondary, with urea being manufactured from coal (China). In addition, the international supply of urea has become unstable due to global shortages as a result of the ongoing energy crisis in the northern hemisphere.

Strike aspires to secure a significant portion of the supply of urea to Australian farmers while simultaneously reducing Australia's Well to Gate agricultural emissions by utilising best practice technologies in design to minimise Proposal Emissions. Project Haber urea has roughly a 50% lower carbon footprint compared to imported alternatives and thus immediately reduces the overall footprint of Australian agriculture; Project Haber urea replaces imports from the Middle East, China and Russia. The Proposal will progressively integrate complementary renewable power and other initiatives such as carbon sequestration to drive net carbon emissions to zero by 2050 or earlier should suitable opportunities arise, to minimise Proposal Emissions.

2.2 Proposal

The Proposal is located on a greenfield site currently used for agriculture (grazing and cropping), approximately 105 km southeast of Geraldton. Project Haber Pty Ltd (**Strike**) has purchased 3,500 ha of freehold land (Lot 10710 on Plan 209764 and Lot 1 on Deposited Plan 45660) in the Shire of Three Springs, below which sits a portion of petroleum exploration permit 503 (**EP 503**) held by Strike North West Pty Ltd, a fully owned subsidiary of Strike Energy Limited, and its 100% owned South Erregulla gas discoveries and potential carbon sequestration resources (should further research demonstrate suitability and the statutory framework be put in place).

The Proposal intends to utilise natural gas from Strike North West Pty Ltd's 100% owned South Erregulla gas field in EP 503, where the presence of a conventional gas accumulation in the Kingia Sandstones within the Perth Basin has been confirmed. The natural gas will be converted to urea and the product will be trucked to WA destinations or to the Port of Geraldton for export to other markets (Eastern Australia and overseas, predominantly within Asia).

Additionally, Strike will use the freehold land to create a low carbon integrated energy and industrial manufacturing centre – the Mid West Low Carbon Manufacturing Precinct (the **Precinct**). The Proposal will be located in the Precinct, and Strike will engage potential renewables developers and other low carbon manufacturing collaborators to join Strike in locating developments at the Precinct.

[1] Fertiliser Australia 2022 Statistics (member only access)

2.2.1 Urea Production Process

The production of urea ($[NH_2]_2CO$) involves the use of natural gas (methane [CH_4]), air (O_2 and N_2) and steam (H_2O) as inputs to initially synthesise ammonia (NH_3). Urea is then manufactured via the reaction of NH_3 and carbon dioxide (CO_2), which is generated at high pressure and temperature from the CH_4 during autothermal catalytic reformation. The main sources of GHG emissions from the process arise from the use of natural gas both as a process feed and to generate energy via gas turbines.

Figure 2.1 provides a visual representation of the urea production process while Table 2.1 presents a summary of the process.

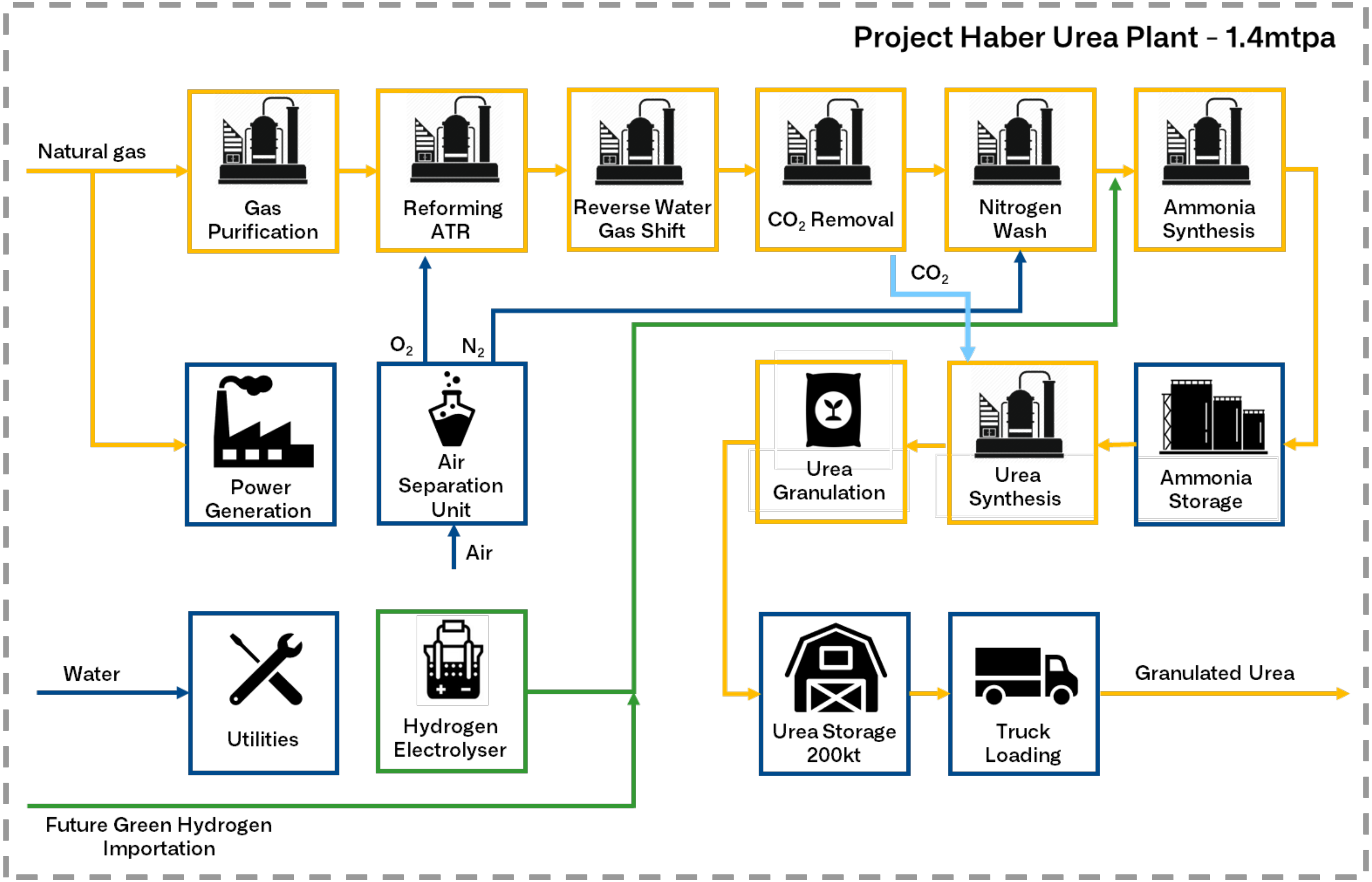

Figure 2.1: Urea production process flow

Table 2.1 Stages of urea production

Stages	Description
Feedstock Gas Purification	The gas purification step will remove sulphur from the natural gas feed, which is predominantly methane (CH_4), to mitigate deactivation of the downstream process catalysts. The natural gas purification process consists of three reactors. A hydrogenation reactor containing a nickel-molybdenum based catalyst to increase the hydrogenation of any sulphur compounds to hydrogen sulphide, and two desulphurisation reactors containing zinc–oxide catalysts. The two zinc-oxide catalysts reactors ensure that the sulphur in the hydrogen sulphide is successfully removed from process feed gas prior to entering the pre-reformer. This reactor setup enables the zinc oxide catalyst to be changed out during normal operation (if deemed necessary by the operator).
Autothermal Reforming (**ATR**)	The reforming of the purified natural gas takes place in two stages: i. Adiabatic pre-reforming: In the adiabatic pre-reformer, all higher hydrocarbons are converted into a mixture of hydrogen, carbon monoxide (CO), carbon dioxide and methane using steam reforming and water gas shift reactions. Pre-reforming uses steam raised using process heat recovery and a proprietary nickel-based catalyst designed for low temperature operation. ii. Topsoe's SynCOR oxygen fired autothermal reforming: The ATR comprises a burner nozzle, combustion chamber (in a refractory lined vessel), and a fixed bed of catalysts in layers consisting of thermally stable noble metal and nickel alloy reforming catalysts. The autothermal reforming process step produces high temperature 'syngas' (hydrogen and carbon monoxide with minimal quantities of other impurities) by reacting oxygen, steam and methane process feed over the catalyst bed in the refractory lined pressure vessel. The high temperature syngas is used to generate high grade steam used for the major drivers in the facility to offset power import. This process step ensures the methane, oxygen and steam process feed is converted into hydrogen and carbon monoxide.
Reverse water gas shift (CO shift)	The syngas is further processed through two exothermic adiabatic catalytic reactors, with intermediate heat recovery, each containing fixed catalyst beds where the reverse water gas shift reaction occurs at different temperatures. The objective of this process step is to maximise hydrogen production through the exothermic reverse water gas shift process by converting steam and carbon monoxide into carbon dioxide and hydrogen. Topsoe uses zinc-aluminium and copper oxide catalysts for the two adiabatic reactors respectively to maximise conversion.
Process Condensate Stripping	Steam in the process is separated from the CO_2 and hydrogen rich mixture, treated and recycled into the process.
Carbon Dioxide Removal	The CO_2 is separated from the process stream by the BASF OASE process which enables capture of high purity CO_2 using a proprietary active MDEA solution (amine wash). The pure CO_2 stream is fed to a CO_2 compressor for pressurisation suitable for the synthesis of urea. The remaining H_2 rich stream of process gas is processed further in the nitrogen wash unit (described below) prior to entering the high-pressure ammonia synthesis loop.
Air separation	In the Air Separation Unit (**ASU**), air is compressed and cryogenically separated into nitrogen (N_2) and oxygen (O_2) to produce the O_2 required as process feed for the ATR, N_2 which is required as process feed for ammonia synthesis, and liquid N_2 process feed for the nitrogen wash unit.
Nitrogen Wash Unit	The Nitrogen Wash Unit (**NWU**) is a final purification step for the process gas to enable cool inert free process gas (make-up gas) to be fed to the ammonia synthesis loop by removing contaminants through cryogenic purification. The feed gas is first cooled down and then 'washed' by a stream of introduced liquid N_2 from the ASU. The make-up gas leaves the NWU as a pure N_2 and H_2 mixture. The mixture is fed to the ammonia syngas compressor in a ratio of 3:1 where is it compressed to a high pressure suitable for ammonia synthesis. The hydrogen rich off-gas stream from the nitrogen wash unit is recycled into the process and used as fuel in the feed fired heater and steam superheater.

Stages	Description
Ammonia synthesis	Gaseous ammonia (NH_3) is produced (synthesised) from the reaction of hydrogen and nitrogen over an iron-based catalyst at favourable pressure and temperatures. The ammonia synthesis reaction generates heat (exothermic) which is used productively to generate high quality steam as the ammonia gas is cooled. The high-quality steam is used as a driving force for rotating equipment and contributes to lowering the energy consumption of the ammonia production facility, consequently lowering Scope 1 GHG emissions. The ammonia gas is processed into a refrigeration circuit, consisting of a compressor unit, a condenser, an accumulator, and a number of chillers. The purpose of the refrigeration circuit is to condense the ammonia gas produced in ammonia synthesis loop until it reaches a cool liquid ammonia product at high purity and quality. Any unreacted hydrogen and nitrogen gas in the ammonia synthesis loop will be recirculated back into the ammonia synthesis converter to form ammonia gas, which is subsequently cooled, condensed and accumulated into a refrigerated liquid product and pumped to storage. The liquid ammonia is pumped to refrigerated ammonia storage tanks where it is used as a process feed for the production of urea. The stored ammonia provides an inventory that can be used in the event of disruptions in the upstream process steps.
Urea synthesis	Liquid ammonia (NH_3) from ammonia synthesis and compressed carbon dioxide (CO_2) from the carbon dioxide removal stage are combined and reacted to form a concentrated (approx. 96%) urea solution for production of granular urea. The reaction occurs in 2 stages: *i. NH_3 and CO_2 are converted to ammonium carbamate (NH_3-CO_2-NH_3)* *ii. Ammonium carbamate is dehydrated to produce urea (NH_2-CO-NH_2) and water (H_2O)* Approximately 90% of the CO_2 formed by the ammonia process (excluding power generation) is used for urea synthesis, while the remaining portion is emitted by the Proposal as a Scope 1 GHG emission. The CO_2 captured in the urea product (approximately 1.03 Mtpa) is not emitted by the Proposal. However, a portion will be emitted when the urea is utilised as a fertiliser; with urea carbon partially incorporated into soil biomass and the remaining CO_2 released as Scope 3 GHG emissions. Water is recovered and cleaned by a stripping process for re-use in the production process.
Urea granulation	The concentrated urea solution is mixed with a granulation aid (typically urea formaldehyde) then granulated and cooled. The granulation uses air as a fluidising and cooling medium. Urea granulation produces a high strength and uniform urea particle which is resistant to crushing and abrasion, minimising dust formation during transport. The exhaust air from the granulator and fluid bed coolers is cleaned via scrubbers to remove any urea dust.
Urea Storage	Urea granules are cooled and stored in a bulk storage and solid handling shed within the Project boundary before they are loaded in bulk into trucks for distribution.
Power generation	Process power requirements will be met with a high efficiency combined cycle gas turbine (**CCGT**) that includes a natural gas-powered turbine and a steam turbine utilising steam excess to the reforming requirements. The gas turbine is a source of Scope 1 GHG emissions. There is currently no suitable grid connection for third party power supply to the Proposal. Future imported renewable power (from a local third-party wind farm) will be required to run a 10 MW green hydrogen electrolyser included in the Proposal.

2.3 Purpose and Scope

The Proposal aligns with the EPA objective "To minimise the risk of environmental harm associated with climate change by reducing greenhouse gas emissions as far as practicable." (EPA, 2022) in that it will abate Australian farmers Well to Gate emissions (DISER 2021a).

The purpose of the GHGMP is to document how Strike will manage GHG emission to achieve the State's aspiration of net zero emissions by 2050 (GoWA, 2019).

The GHGMP applies to Scope 1 GHG emissions or, in other words, emissions that are directly associated with the Proposal and are therefore within the operational control of Strike. The GHGMP sets out the commitments to avoid, reduce, and/or offset these emissions in keeping with the expectation of the EPA for proponents to take best practice measures and apply the mitigation hierarchy to avoid and reduce Scope 1 emissions, as shown in Appendix B.

The base case plant design does not have any associated Scope 2 emissions as the base case does not involve a grid connection. Consequently, the facility does not have any ability to import electricity. Should a grid connection become part of the facility, any Scope 2 emissions would be incorporated into the GHGMP.

The GHGMP also details an approach to determining Scope 3 emissions from the Proposal.

2.4 Environmental Factor

Scope 1 GHG emissions from the operation of the Proposal have been estimated to be 761 ktpa CO_2-e based on a production of 1.4 million tonnes per annum (**Mtpa**) of urea. The GHG emissions inventory for the Proposal is detailed in Section 3.

As the estimated Scope 1 emissions are greater than 100,000 tpa CO_2-e, the environmental factor Greenhouse Gas Emissions is anticipated to be identified as a key environmental factor for assessment by the EPA for the s. 38 Part IV referral (EPA, 2020).

Table 2.2 provides a summary of the Greenhouse Gas Emissions key environmental factor.

Table 2.2: Summary of key environmental factor Greenhouse Gas Emissions

Greenhouse Gas Emissions	
EPA objective	*To minimise the risk of environmental harm associated with climate change by reducing greenhouse gas emissions as far as practicable.*
Key Environmental Factor	Environmental Factor Guideline: Greenhouse Gas Emissions (EPA, 2022).
Relevant policy and guidance	• Greenhouse Gas Emissions Policy for Major Projects (GoWA, 2019); • *National Greenhouse and Energy Reporting Act 2007* (NGER Act).
Proposal activities	• Construction of plant; • Urea production; and • Distribution and export of product.
Potential impacts – Urea Production and Plant Operations	• Scope 1 Emissions: 761 ktCO_2-e per year; • Scope 2 Emissions: zero tCO_2-e per year; and • Scope 3 Emissions: negative 3.2 MtCO_2-e per year (only considering Australian emissions/sequestration).

2.5 Condition Requirements

This GHGMP has been prepared to support the referral of the Proposal to the EPA under s.38 of the EP Act. No Ministerial Statement related to the implementation of the Proposal has been issued at this time.

2.6 Key Assumptions and Uncertainties

Table 2.3 details the key assumptions and uncertainties that Strike has made with respect to the proposed approach to managing GHG emissions.

Table 2.3: Assumptions and uncertainties

#	Aspect	Assumptions and uncertainties
1	State and Commonwealth GHG policy and guidance	Strike has proposed management provisions that have been developed with consideration of the current state of GHG policy in Australia. State and Commonwealth Government policies continue to evolve and key uncertainties remain. These include: • Pending amendments to the safeguard mechanism that: ◦ May result in the Commonwealth using the mechanism as a tool to enforce emission reductions via a declining baseline approach. Such an approach may negate the need for the State Government to use the Environmental Impact Assessment process under Part IV of the EP Act to require proponents to set emission reduction targets; ◦ Will determine the approach to establishing production adjusted baselines for new industry projects using either best practice (top 10% of Australian industry performance) or government set benchmark emissions intensity values representing the average emissions intensity of the sector; ◦ Will determine the headroom and thus the ability to earn safeguard mechanism credits if emissions are less than baseline; • How the State's contribution to Commonwealth targets is considered versus other states; • The setting of sector-specific emissions targets for industry versus other sectors (e.g., power, transport, agriculture, buildings); and • Update of guidance (for example the EPA's factor guideline for Greenhouse Gas Emissions has recently been updated and released in July 2022 as a draft for public comment).
2	Market price carbon emissions	A uniform market price for carbon is not currently applied within Australia.
3	Availability of electrical power transmission infrastructure	Availability of electrical power transmission infrastructure currently restricts the ability to import renewable energy to the Proposal.
4	Cost and/or viability of new technology	There is potential for substantial changes in GHG markets and technology, as well as regional energy infrastructure over the Proposal lifetime, which may influence the reasonableness or practicability of GHG abatement measures. The cost of renewable energy options has changed significantly over the last 10 years and further downward trends are expected but not guaranteed. New technologies for multiple mitigation options are currently under research and development phase.

2.7 Management Approach

The GHG mitigation approach is based on the following principles:

- Alignment with the State Government's Greenhouse Gas Emissions Policy for Major Projects and commitment to help achieve the State's aspiration of net zero emissions by 2050 (GoWA, 2019);
- Alignment with the State Government's Climate policy (GoWA, 2020); and
- Alignment with EPA Guidance (EPA, 2022), through applying the mitigation hierarchy (i.e., considering reasonable and practicable measures to mitigate GHG emissions).

Strike will implement a proposal-specific objective-based environmental management plan involving 'management actions' and 'management targets' in order to achieve the objective of reducing the Scope 1 (and Scope 2 if relevant) GHG emissions associated with the operation of the Proposal down to net zero expeditiously and achieve net zero by 2050.

The management approach includes:

- Consideration of the mitigation hierarchy during the selection of the Proposal location, the design of the plant, and process technology selection to ensure reasonable and practicable measures have been applied to avoid and reduce GHG emissions;
- Determination of Scope 1 emissions for the Proposal following application of the mitigation hierarchy to achieve GHG emissions as low as reasonably practicable from commencement of operation;
- Application for a (Scope 1) baseline under the safeguard mechanism;
- Compliance with relevant State and Commonwealth GHG emission monitoring and reporting requirements, including NGER requirements and safeguard mechanism; and
- Defined management targets and actions to achieve net zero by 2050.

2.7.1 Management Approach Rationale

Strike acknowledges that within the *Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (**Instructions**; EPA, 2021) the EPA expresses a preference for outcomes-based conditions where practical, with outcomes-based management plans designed to ensure that the required environmental outcome is achieved. The outcome-based system preferred by the EPA involves focusing upon monitoring and evaluating specific 'measurable outcomes' which are driven by 'trigger criteria' and 'threshold criteria'. Those trigger criteria are set conservatively at levels that forewarn of outcomes approaching a 'threshold' at which 'significant adverse environmental outcomes' necessarily associated with the breach of the threshold would occur. This forewarning is to trigger appropriate actions well in advance of the threshold being breached, so that the associated significant adverse environmental outcomes can be avoided.

Strike considers that this scheme cannot be applied to Strike's greenhouse gas emissions, which start from inception at the highest level and are then progressively driven down to net zero by 2050 through a series of actions reliant on the technical, legislative, and financial feasibility of implementing what is envisaged and the associated time delays to bring actions to fruition. There is no 'threshold' representing a level of emissions at which significant adverse environmental outcomes necessarily follow and no 'triggers' forewarning of approaching such a level, which would allow an operator to commence an action to prevent reaching this 'threshold'.

The Instructions define an **objective** as "*the proposal-specific desired state for an environmental factor/s to be achieved from the implementation of management actions*" (page 5). The achievement of net zero by 2050 and associated percentage reductions in emissions per period are both 'proposal-specific desired states' for the environmental factor *Greenhouse Gas Emissions*, and thus would fall under an objective-based EMP rather than being environmental outcomes.

Accordingly, Strike proposes management actions and management targets under an objective-based system that utilises a proposal specific reduction in emissions over specified time intervals to achieve net zero by 2050 as outlined in Appendix A and summarised in Table 4.1.

3. GHG Emissions Inventory

3.1 Methodology

Three distinct classes (scopes) of GHG emissions are described in national and international GHG reporting standards that delineate sources and associated responsibilities. The scopes of the GHG emission classes are defined as follows:

- Scope 1 emissions are the GHG emissions released to the atmosphere as a direct result of an activity, or a series of activities at a facility level;
- Scope 2 emissions are indirect GHG emissions from consumption of an energy product (electricity, heat or steam) from a third-party supplier; and
- Scope 3 emissions are indirect GHG emissions other than Scope 2 emissions that are generated in the wider community, which occur because of the activities of a facility, but from sources not owned or controlled by that facility's business (CER, 2021).

Scope 1 emission from fuel consumption have been prepared using methods and emissions factors from the *National Greenhouse and Energy Reporting (Measurement) Determination 2008 (***NGER Determination**), as applicable to 2020-21 financial year (FY2021). Emissions from gas combustion have been calculated using Method 2 for the emissions of carbon dioxide from the combustion of gaseous fuels based on the analysis of the fuel composition (NGER Determination D.2.3.3). Emissions from diesel combustion and flaring have been calculated using Method 1 which specifies the use of designated default emission factors in the estimation of emissions.

3.2 Greenhouse Gas Emissions Sources

GHG emissions from the Proposal include direct Scope 1 emissions from the burning of fossil fuels (for mobile and stationary energy demands), venting of CO_2, and fugitive emissions. GHG emissions inventories have been developed for the Proposal. The inventories consider all potential Scope 1 emissions sources relevant to the construction and operation of the Proposal including:

- Reservoir CO_2 in the process feed gas;
- Combustion of natural gas fuel for electricity and steam generation (including in the ATR);
- Combustion of diesel for site-vehicles and generators during construction;
- Flaring; and
- Loss of biomass associated with clearing native vegetation from no more than 1 ha of land (one off emissions associated with site development; emissions are a minor contributor to overall emissions).

Scope 2 emissions occurring from purchase of electricity are not expected to occur in the primary stages of development as all power requirements will be met by on-site generation capability. If a grid connection is established, Scope 1 and Scope 2 emissions estimates and management will be updated accordingly. A grid connection is not an intention of the Proposal at this time and if available in the future is likely to involve only import of power that has also been generated by renewables, thus should not carry any Scope 2 emissions.

Scope 3 GHG emissions are largely emissions associated with the transportation of product from the Proposal and emissions of N_2O and urea carbon as CO_2, after application of fertiliser to land. However, these Scope 3 emissions are offset by the amount of additional carbon sequestered into crop yield as a result of the application of the urea on farms within Australia.

Emissions excluded from the GHG assessment include:

- Sulfur hexafluoride (SF_6) used in electrical switch gear is assumed to be fully contained and not released to the atmosphere and, therefore, is not expected to contribute to Proposal Scope 1 emissions;
- Emissions during upset and emergency conditions are excluded from the assessment since they are expected to form a very minor contribution to the overall Scope 1 emissions;
- Fugitive emissions of CH_4 and CO_2 (primarily from the urea plant compressor) may occur, however these are considered a minor source of emissions and will be minimised to the maximum extent practicable by stringent maintenance protocols;
- Emissions associated with diesel consumption by site vehicles, including those used for product handling, are excluded from the assessment since they form a very minor contribution to the overall Scope 1 emissions; and
- Scope 3 emissions associated with manufacture and supply of plant and equipment.

3.3 Emissions Estimates

3.3.1 Construction – Scope 1

Construction of the facility is planned to take approximately 3 years. During this time, GHG emission sources will be mainly associated with diesel combustion from both stationary and non-stationary equipment. GHG emissions for construction are detailed in Table 3.1.

Table 3.1: Estimated Scope 1 GHG emissions from construction of the Proposal

Ammonia and urea manufacturing plant GHG source	Estimated annual GHG emissions (tCO_2-e/year)	Duration	Estimated life of Project GHG emissions (tCO_2-e)
Diesel consumption (Vehicles and stationary energy, including generators)	~25,000	3 years	~75,000
Vegetation clearing	~50	One off event	~50

3.3.2 Operations – Scope 1

The key assumptions made for the estimation of Scope 1 GHG annual and total emissions from the operation of the Proposal are:

- Urea production of 1,402 ktpa from 354 days operation per year (production of 2,260 tonnes per day [**tpd**] ammonia and 3,960 tpd urea);
- Consumption of a total of 28.9 PJ/annum from natural gas; process feed 61.5 TJ/day, fired heater fuel 2.7 TJ/day and 17.4 TJ/day Gas Turbine Generators (**GTG**);
- Natural gas lower heating value (**LHV**) of 7,726 kcal/Nm^3 is representative of the natural gas supply;
- A 9.99 % reservoir CO_2 content is representative of the natural gas fuel and process gas feed;
- Pilot flaring of natural gas at 30 Nm^3/h;
- The operational lifetime of the Proposal is 25 years; and
- 90% of the high purity CO_2 emissions from the ATR process, equating to 1.03 Mtpa CO_2, are combined into urea product with the remaining 10% (117 ktpa CO_2) vented to atmosphere.

Process Scope 1 emissions, determined through a materials balance approach, are summarised in Table 3.2.

Table 3.2: Estimated Scope 1 GHG emissions from operation of the Proposal – base case

Ammonia and urea manufacturing plant GHG source	Annual average GHG emissions ($ktCO_2$-e/year)	Contribution to GHG emissions
Fired Process Heater Flue Gas	119	16%
Fired Steam Superheater Flue Gas	130	17%
CO_2 to vent	117	15%
Subtotal Process Emissions	**366**	**48%**
Natural Gas Fuel GTG: Power	197	26%
Natural Gas Fuel GTG: ASU	197	26%
Subtotal GTG Emissions	**395**	**52%**
Pilot Flare	1	0.1%
Total CO_2 Emissions	**761**	**100%**

In future, the dependence on natural gas will be reduced by incorporating and increasing renewable electricity to gradually reduce the Scope 1 emissions associated with natural gas combustion for power generation (Section 4 - Emissions Reduction Targets). Emissions associated with generation of electricity beyond the Proposal boundary (should there be any) will then be accounted for as Scope 2 emissions from the operations.

3.3.3 Scope 2 Emissions

The base case plant design does not have any associated Scope 2 emissions. All electricity required for the operational phase of the Proposal will initially be obtained from the on-site combustion of natural gas via the CCGT.

3.3.4 Scope 3 Emissions

When undertaking an environmental impact assessment for GHG emissions, consideration is required by the EPA (2022) as to:

> *"Whether reasonably practicable measures have been considered for Scope 3 emissions reductions, such as entering into arrangements with third parties to reduce emissions".*

To align with the EPA's standard practice, the consideration of Scope 3 emissions has not been extended beyond the boundary of the Australian domestic market. However, net Scope 3 emissions associated with exported urea are anticipated to be negative as the increased sequestration of carbon associated with increased crop yields would be expected to exceed the carbon released by the decomposition of the urea (and any associated N_2O emissions) after application. Also, the exported urea would be beneficial in displacing urea made through processes that involve roughly double the level of carbon emissions.

Strike has conducted an analysis of potential Scope 3 emissions. The fifteen (15) Scope 3 categories identified within the *GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard* developed by the World Resources Institute (**WRI**) and the World Business Council for Sustainable Development (**WBCSD**) (2013a,b) were considered and subjected to screening based upon:

- Timing of emissions – commencing from when significant Scope 1 emissions commence i.e., during operations;
- Domestic nature – extent to which relevant emissions will be located within Australia and, therefore, from part of national Australian emissions;

- Size – extent to which individual categories of emissions will be significant within the context of overall relevant emissions – on the assumption that overall Scope 1 emissions will be approximately 761 ktpa CO_2-e, a significance is set at 0.5%, which equates to a threshold of approximately 3,800 tpa; and
- Ability to be able to reasonably quantify the size of the emission category concerned.

The results of the screening were as follows:

1. *Purchased goods and services.* Once in production, the emissions within Australia associated with the extraction, production and transportation of goods and services purchased or acquired by Strike within any operating year (excluding categories 2-8 {below}). These emissions cannot be reasonably quantified but are **not expected to be significant** (i.e., emissions are expected to be less than 3,800 tpa).
2. *Capital goods.* Once in production, the emissions within Australia associated with the extraction, production and transportation of capital goods purchased by Strike within any operating year. These emissions cannot be reasonably quantified but are **not expected to be significant**.
3. *Fuel and energy-related activities (not included in Scope 1 or Scope 2).* The extraction, production and transportation of fuels and energy purchased or acquired by Strike not accounted for in Scope 1 and Scope 2 emissions, including:
    1. Upstream emissions within Australia of purchased fuel (extraction, production and transportation of fuel) consumed by Strike. These emissions cannot be reasonably quantified but are **not expected to be significant.** Note that the gas utilised by the Proposal is effectively untreated and the associated GHG emissions would be purely those associated with fugitive emissions which are minimised due to the lack of processing facilities.
    2. Upstream emissions associated with purchased electricity are **expected to be zero** due to absence of purchased electricity.
    3. Transmission and distribution (**T&D**) losses: generation of electricity, steam, heating and cooling that is consumed (i.e., lost) in a T&D system, reported by the end user (i.e., Strike), is **expected to be zero** as all emissions associated with electricity, steam, heating and cooling are already included in Scope 1.
    4. Generation of purchased electricity that is sold to end users (generation of electricity, steam, heating and cooling that is purchased by Strike and sold to end users) – reported by utility company or energy retailers only, is **expected to be zero**.
4. *Upstream transportation and distribution*. Transportation and distribution of products purchased by Strike from Tier 1 suppliers to the Proposal in vehicles and using facilities not owned or controlled by Strike; and transportation and distribution services purchased by Strike, including inbound and outbound logistics and transportation and distribution between Strike's facilities (utilising equipment not owned by Strike). These emissions cannot be reasonably quantified but are **not expected to be significant**.
5. *Waste generated in operations*. Disposal and treatment of waste generated by the Proposal in facilities not owned or controlled by Strike. The only significant volumes of waste potentially requiring disposal outside of the Precinct would be excess salt that could not be disposed of on-site. The emissions associated with transporting such salt for final disposal elsewhere cannot reasonably be quantified at this stage but are **not expected to be significant.**

6. *Business travel.* Transportation of Strike employees for business related activities in vehicles not owned or operated by Strike cannot reasonably be quantified but are **not expected to be significant**.

7. *Employee commuting.* Transportation of employees between their homes and their worksites (in vehicles not owned or operated by Strike). Assuming 150 employees are on-site every day, 365 days per year, and they each commute 100 km (50 km each way) in sole occupancy vehicles with an average fuel efficiency of 1 litre of petrol per 10 km, the overall carbon emissions associated with employee commuting would be approximately 1,300 tpa CO_2-e, on the assumption emissions would be ~2.35kg CO2-e/litre petrol (NTC 2021). However, the employees commuting distances and the fuel consumption of their vehicles could be significantly different, or they could share commuting. At this stage a more accurate estimate cannot be reasonably quantified and in the overall scheme of emissions they are **not expected to be significant.**

8. *Upstream leased assets*. Strike does not expect that it will be leasing any upstream assets and accordingly associated emissions are **expected to be zero**.

9. *Downstream transportation and distribution*. Although the distribution and marketing arrangements are not definitively resolved, there is an expectation that approximately 30% of production will be transported and distributed within Western Australia, approximately 40% will be transported to Geraldton, shipped, and then further transported and distributed within the rest of Australia, and 30% will be transported to Geraldton and subsequently exported.

   i. Urea distributed within Western Australia (~420 ktpa) is likely to be trucked from the Precinct to distribution centres around the State where it would be stockpiled and then further distributed to end users during the crop growing season for final application. It is assumed that 30% of annual production is distributed within the State by truck, that the average aggregate journey equates to a round trip of 800 km, that each truck transports 70 tonnes, and the average fuel consumption for the overall journey distance travelled for each truck is 2.5 km per litre of diesel (40L per 100km [2]). Assuming a carbon dioxide equivalent intensity of 2.7 kg CO_2-e per litre (NTC 2021) for the diesel used, the overall emissions associated with distribution of urea within the State would be approximately 5,200 tonnes CO_2-e per year.

   ii. Urea distributed to the rest of Australia (~560 ktpa) will be trucked to the Port of Geraldton (about 125 km by road) and then shipped to various ports located in Victoria, New South Wales, Queensland and South Australia, where it would again likely be transported by truck to its eventual destinations. Assuming average transport distances of 300 km once landed in Eastern Australia means a total truck movement distance of approximately 850 km per delivery. Using the same assumptions as for the State distribution, this would equate to approximately 7,300 tonnes of CO_2-e emissions per year.

   iii. In addition, assuming urea was transported via sea in Handymax sized vessels containing 40,000 tonnes of urea an average distance of 3,500 kilometres (roughly Geraldton to Melbourne) at an average speed of 15 knots (27 km/hr) with a bunker fuel consumption of 30 tpd and bunker fuel carbon dioxide intensity of 3.11 kg CO_2-e per kg fuel (IMO 2020), the associated annual carbon dioxide emissions would be approximately a further 7,050 tonnes. Moreover, if it is assumed that the vessels travelled the same distance to

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2 Fuel consumption assumption based on use of fleet including some rigid trucks (average fuel consumption of 28.6 L per 100 km) and articulated trucks (53.1 L per 100 km) and fuel consumption from Australian Bureau of Statistics 2020 https://www.abs.gov.au/statistics/industry/tourism-and-transport/survey-motor-vehicle-use-australia/latest-release

Geraldton to pick up the cargo empty, then the full emissions associated with the round trip would be roughly doubled to about 14,100 tonnes CO_2-e per year.

iv. The overall CO_2-e emissions for urea transported to East Coast destinations would amount to approximately 21,500 tonnes CO_2-e per year.

v. Urea exported via Geraldton to overseas markets (~420 ktpa) would simply be trucked the 125 km to Geraldton (250 km for round trip) and then exported from the port. Emissions associated with further transport would be Scope 3 emissions occurring outside of Australia and, therefore, outside the scope of this assessment. Assuming the same fuel consumption and emissions associated with truck transport as above, the overall included emissions would amount to about 1,600 tonnes CO_2-e per year.

vi. Overall, the CO_2-e emissions associated with downstream transportation and distribution within Australia would be approximately 28,300 tpa on the assumption of conventionally fuelled transport systems. However, the intention is to transition local distribution to hydrogen powered trucks once suitable technology (including the required range) is available and local hydrogen manufacturing capability has been fully developed utilising renewable power. This would have the potential to eliminate truck related transport emissions within the State, reducing the calculated emissions by around 8,900 tonnes to approximately 19,300 tonnes CO_2-e per year (representing the emissions associated with transport of the product to the east coast and its further distribution after arrival which will not be amenable to utilising hydrogen supplied from the Precinct).

10. *Processing of sold product*. Most of the urea sold will be in final form for use as fertiliser in farming. A small portion (up to about 60,000 tonnes, representing approximately 4% of expected production) may be processed into diesel exhaust fluid (suitable for use as an emissions suppressant for diesel powered vehicles; sold as AdBlue® in Australia). This processing should not create significant GHG emissions. Overall, Scope 3 emissions associated with downstream processing of urea are **not expected to be significant**.

11. *Use of sold product*. The manufactured urea will be used as a fertiliser on farms in Western Australia (~30%), the rest of Australia (~40%) and within overseas markets (~30%; expected to be predominantly within Asia). Upon application, the urea would be expected to ultimately break down after contact with water into ammonium ions (NH_4^+) and CO_2 (through an intermediate of cyanate). Ultimately, the breakdown of the urea will release all the carbon sequestered within it during its manufacture i.e., 1.03MtCO_2 per year. However, in the context where only carbon emissions within Australia are being considered, this amounts to ~70% (with the remainder having been exported) or ~720 ktCO_2 per year.

i. Although the application of urea to land effectively releases the carbon contained within it, the application also increases the crop yield of the land it is applied to. In the context of its application to wheat farms in WA, the increase in yield (as compared to no application of urea) would be about 700 kg of additional wheat yielded per hectare of application (assuming an application rate of approximately 150 kg of urea per hectare). Where 30% of the Proposal's annual urea production is assumed to be applied in WA at a rate of 150 kg per hectare, resulting in an increased yield of 700 kg of wheat per hectare – a total of 420,000 tonnes of urea would be applied over approximately 2.8 million hectares, resulting in an increase in wheat production of about 1.96 million tonnes of wheat[3]. The carbon content of wheat grain is approximately 40%, meaning that the additional yield would be about 784,000 tonnes of carbon, which equates to about 2.87 million tonnes of CO_2 sequestered within the additional wheat. Moreover, with more than 95% of wheat produced in WA exported (DPRID 2019), the subsequent release of the sequestered carbon in the wheat when consumed as food would occur outside Australia.

ii. For illustration, if it is conservatively assumed that the same assumptions could be applied to urea distributed within the rest of Australia, the CO_2 released from the application of urea within Australia overall (980 ktpa) would be about 720 ktpa as a result of the decomposition of the urea. However, the additional CO_2-e of carbon sequestered in the resulting additional wheat yield would amount to around 6.7 Mtpa. Considered from a purely domestic perspective, the application of 980 ktpa of urea within Australia would lead to net sequestration of about 6 Mtpa tonnes of CO_2.

iii. Nitrous oxide (N_2O) emissions could also result from the application of urea. Nitrification and denitrification are complex in the soil environment and subject to influences from multiple factors e.g., urea application rate, crop, rainfall, irrigation, soil quality, cropping history, growing season length, and, therefore, there is high uncertainty in projecting N_2O emissions. Studies conducted in eastern Australia have shown emissions of 0.1 to 1.6 kg N per hectare during the growing season and 0 to 0.4 kg N per hectare during the fallow season could occur (CSIRO 2016). Assuming an average of 1 kg N per hectare to account for both seasons split equally across the year, then approximately 6,500 tonnes of N could be emitted from the 6.5 million hectares fertilised with urea within Australia. Assuming the emitted N is all derived from the applied fertiliser when converted to N_2O and factored by the N_2O global warming potential of 265 (*National Greenhouse and Energy Reporting Regulations 2008* Part 2, Division 2.2), a conservative estimate of emissions up to 2.7 million tonnes CO_2-e released as N_2O was derived.

iv. The Scope 3 emissions associated with the application of urea from the Proposal within Australia considering both the CO_2 and N_2O released by the breakdown of the urea and the CO_2 sequestered as a result of increased crop yields would be **a net sequestration equivalent to about 3.2 million tonnes of CO_2**.

12. *End of life treatment of sold product.* Emissions associated with the use of urea within Australia were calculated in 11. *Use of Sold Product* (above) through to the release of CO_2 into the atmosphere from the use of urea within Australia and the sequestration of carbon because of the associated increased crop yield. There are **no further significant emissions** within Australia.

13. *Downstream leased assets*. It is not currently envisaged that there will be any relevant downstream leased assets. Associated emissions are therefore **expected to be zero.**

14. *Franchises.* It is not currently envisaged that there will be any relevant franchise arrangements. Associated emissions are therefore **expected to be zero.**

[3] The response to application of urea is variable and will be dependent on numerous influences including, but not limited to, urea application rate and timing, site specific parameters including soil moisture, type and permeability, other nutrient availability and rainfall. Furthermore, increases in response to fertiliser application to wheat is not limited to increased grain yield and grain protein, the subject of most studies, and will also result in an increase in biomass of the whole plant. Information available from DPIRD for the Western Australian context was used to check the assumptions used were reasonable including: Nitrogen management for wheat protein and yield in the Esperance port zone 2007 (https://library.dpird.wa.gov.au/bulletins/78/) and Response to nitrogen fertilisers of wheat, oats, and barley in Western Australia 1980 (https://library.dpird.wa.gov.au/tech_bull/62/).

15. *Investments*. It is not expected that the Proposal will be associated with downstream investments that result in Scope 3 emissions and accordingly they are **expected to be zero.**

Overall, the significant Scope 3 emissions calculated amount to:

- 28 ktpa CO_2-e associated with transportation of finished product to markets within Australia or to the export facility at Geraldton (for product destined for export);
- 720 ktpa CO_2-e associated with the release of CO_2 from the breakdown of urea after application to land within Australia;
- 6,703 ktpa CO_2-e sequestration associated with the absorption of CO_2 from the atmosphere into additional grain production within Australia due to the effect of the applied urea fertiliser; and
- 2,724 ktpa CO_2-e associated with N_2O emissions.

The anticipated Scope 3 emissions are not subject to regulation as Scope 1 or Scope 2 for any entity.

3.3.5 Emissions Summary

Project Scope 1 Emissions are 761 kt CO_2-e per annum.

Project Scope 2 Emissions are zero tonnes CO_2-e per annum.

Project Scope 3 Emissions are negative 3.2 Mt CO_2-e per annum, inclusive of CO_2-e in grains.

3.4 Benchmarking Assessment

A benchmark assessment of emissions intensity of the Proposal has been completed that allowed for:

- Comparison of the Proposal against the safeguard mechanism default emissions intensity;
- Comparison with comparable facilities producing urea product from ammonia synthesised on-site; and
- Comparison with operating Western Australian projects.

The calculated emission intensity for the Proposal is shown in Table 3.3; an initial assessment was made against the Commonwealth safeguard mechanism default emissions intensity published in the Safeguard Mechanism Rule (DISER, 2021b). The details of the production variables are presented in Table 3.4. The calculation of the emissions intensity for the urea production variable (0.566 tonne CO2-e per tonne of 100% equivalent carbamide [urea]) has a notable exclusion of the on-site electricity generation emission intensity and also does not include the ammonia feedstock preparation.

Table 3.3: Proposal emissions intensity

Parameter	Proposal Intensity	Default intensity	Units
Urea production (including ammonia feed stock production and on-site electricity generation), comparable to currently imported urea of >1.0 t CO_2/t urea.	0.542	-	t CO_2/t urea
Urea production excluding on-site electricity generation.	0.26	0.566	t CO_2/t urea
Ammonia production (intermediate in urea process) excluding on-site electricity generation.	0.46	1.87	t CO_2/t ammonia
On-site electricity generation.	0.67	0.539	t CO_2-e/MWh

Table 3.4: Prescribed production variable default emissions intensity

Prescribed production variable	Inclusions	Exclusions	Emissions intensity value tCO_2-e	Default emissions intensity unit
Urea	Reaction of carbon dioxide with anhydrous ammonia to create a carbamide solution and production of finished products through prilling, granulation, drying / conditioning, storage and despatch.	Upstream production of the anhydrous ammonia feedstock; production of carbon dioxide; processes that do not occur within the facility; on-site electricity generation.	0.566	Tonnes of 100% equivalent carbamide.
Ammonia	Chemical transformation of a hydrocarbon feedstock (or other hydrogen feedstock) to hydrogen; extraction of nitrogen from air, where the nitrogen is used for the ammonia production process; removal of carbon dioxide gas prior to the synthesis of ammonia; liquefaction of ammonia product; and transfer and refrigeration of ammonia to/from storage within the facility.	Upstream production of the hydrogen feedstock (such as natural gas extraction and distribution or synthesis gas production); downstream processing of the ammonia into ammonium nitrate, urea or any other product; processes which do not occur within the facility; and on-site electricity generation.	1.87	Tonnes of 100% equivalent anhydrous ammonia.
Electricity	Electricity produced on-site that is used on-site or sent to another location that is not a designated electricity network or to a designated electricity network.	Electricity generated by a vehicle; steam produced on-site that is not used to produce electricity; processes that do not occur within the facility.	0.539	Megawatt hours of electricity generated or exported.

The Proposal emission Intensity for urea (excluding electricity generation but including the ammonia feedstock production) is 0.26 t CO_2-e/t urea. Comparison to a consolidated safeguard mechanism default production variable, including the production of ammonia and urea (but excluding on-site electricity generation) of 2.44 t CO_2-e/t urea, the Proposal's process intensity is approximately a tenth of the production default intensity.

The electricity intensity of the process (0.69 t CO_2-e/MWh) is higher than the default production variable 0.539 t CO2-e/MWh; however, it is comparable to the SWIS emission factor of 0.68 t CO_2-e/MWh (DISER 2021c). The electricity production intensity of the process also under-represents the true GHG efficiency as it only considers the portion of the heat recovery steam that is used to produce electrical power in the steam turbine generator and does not consider the portion of the heat recovery steam that is used to drive the steam driven equipment (e.g., compressors). Furthermore, the Proposal will use un-processed gas; therefore, reservoir CO_2 is accounted for within the power generation GHG emissions and the upstream GHG emissions are minimal when compared to other facilities where gas will have been processed to remove CO_2 prior to entering the supply pipeline. The Management Actions contained in this document are focussed at systematically replacing this power generation with renewables, reducing the CO_2 intensity of electricity generation.

It is worth noting that the Safeguard Mechanism calculates the baseline emissions for urea at 0.57 tCO_2e/t Urea. Under the same accounting mechanism, excluding electricity generation, the Proposal's baseline efficiency is estimated at 0.26 tCO_2e/t Urea. There is no resolution on the basis for the safeguard mechanism production variable (i.e., what technology the production variable was informed by). The lower intensity of the Proposal urea production relative to the default production variable is a result of the efficiencies of the co-located processes enabling CO_2 from the reforming of natural gas to be used downstream in the urea plant, energy from heat recovery from the exothermic ammonia process being harnessed and used within the two production processes, the advantages of the ATR technology over more traditional Steam Methane Reforming (SMR) process and the use of energy efficient best available techniques (BAT).

Strike has used the Commonwealth safeguard mechanism default emissions intensities from Table 3.4 to calculate the annual GHG emissions (CO_2-e) for a "safeguard" facility producing the same volume of ammonia and urea. The power generation has been conservatively assumed to the same as Project Haber; however, without the benefits of an integrated ammonia and urea facility the combined power requirements of individual ammonia and urea facilities is likely to be significantly higher. A comparison of Project Haber total emissions to the equivalent safeguard mechanism default total emissions is presented in Figure 3.1 below.

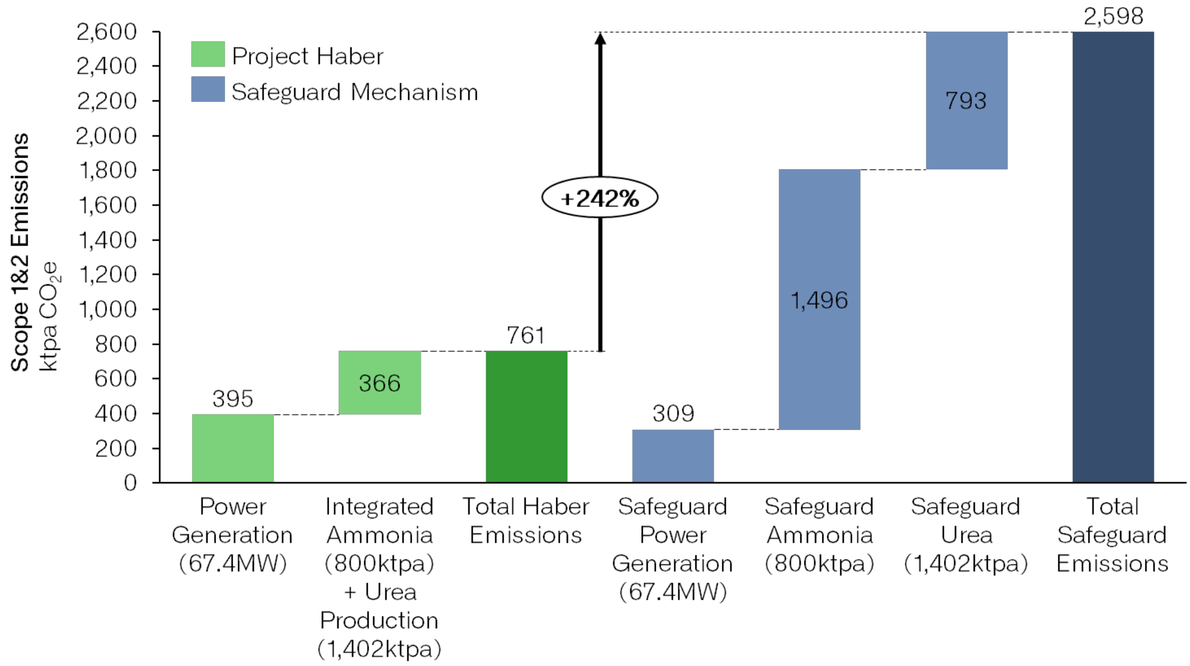
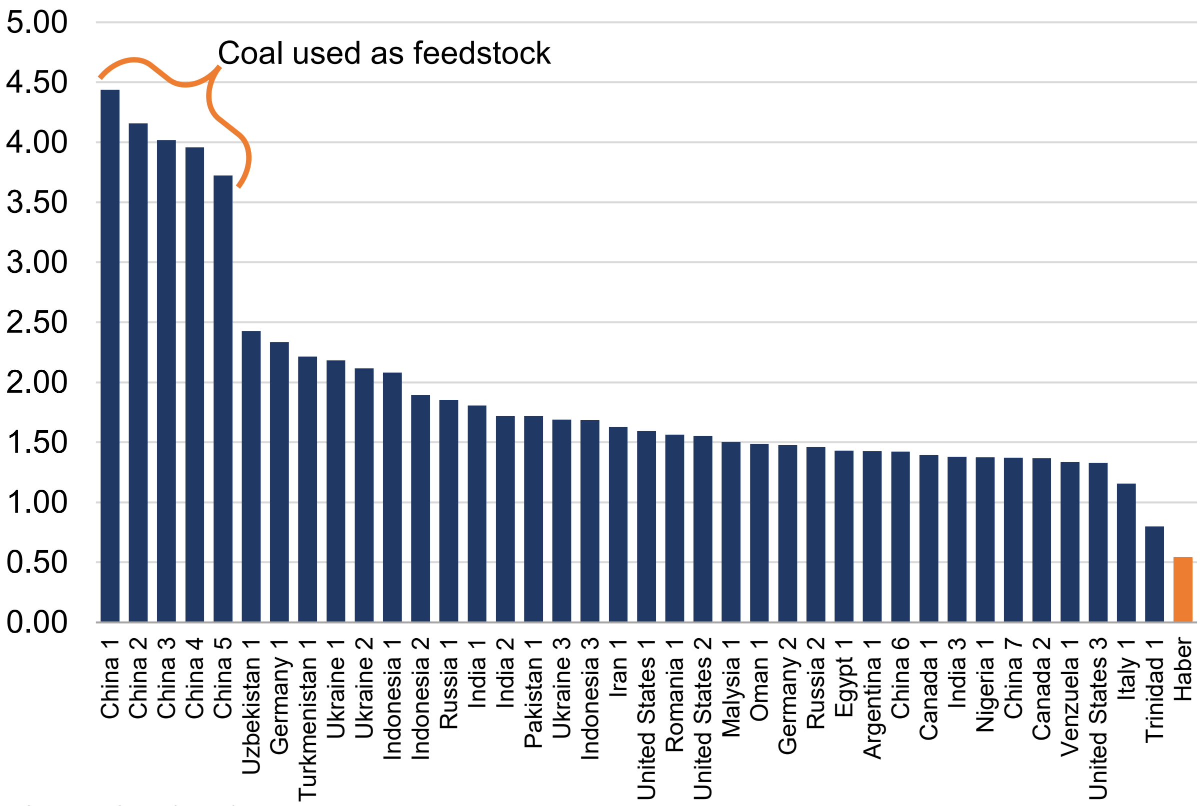


Figure 3.1 Project Haber to Commonwealth safeguard mechanism total emissions comparison

There are currently no other similar facilities synthesising urea from raw materials operating in Australia; therefore, a comparison to domestic facilities basis urea emissions was not possible

The yet to be implemented Perdaman urea project, which will use comparable technology, forecast an intensity of the 0.32 t CO_2-e/t urea. The basis for the lower intensity estimate is not well understood by Strike. The Perdaman urea project forecast production (2 Mtpa) is higher than the Proposal (1.4 Mtpa) and the CO_2 content of the processed natural gas feedstock is significantly lower than the unprocessed South Erregulla feedstock used in the Project Haber GHG calculations. The economy of scale and CO_2 content of the feedstock are unlikely to account for the entire difference in projected intensity.

Comparison of the Proposal against overseas facilities producing ammonia feedstock through to synthesis of urea at a similar production capacity, determined it to be at the lowest end of the emissions intensity range; the use of coal as a feed stock in some of the overseas plants results in a significantly higher emissions intensity as show in Figure 3.2.



Source: CRU (2021), Emissions Database.

Note: Net CO_2 emissions intensity for urea producing facilities producing ± 25% of Proposal's intended production

Figure 3.2 Emissions intensity by ammonia/urea facility

A comparison of the Proposal's energy efficiency, per unit of interim ammonia production, against operating ammonia facilities in Western Australian is presented in Table 3.5. The operating facilities only produce ammonia whereas the Proposal will produce urea therefore, the Proposal's GHG intensity per unit of ammonia is greatly reduced by the sequestration of CO_2 into the urea product.

Table 3.5: Proposal emissions intensity per unit of ammonia compared with operating Western Australian Facilities

Project	Product	Energy Efficiency	GHG Intensity	Source
Ammonia Plant, Yara Pilbara Fertilizers on the Burrup	Ammonia	29.7-29.9 GJ_{LHV}/t NH_3	1.76 tCO_2/t NH_3	EPA Bulletin #1036 (EPA 2001)
Kwinana Ammonia project, Wesfarmers, CSBP Fertilisers, Kwinana	Ammonia	33-35 GJ_{LHV}/t NH_3	1.8 tCO_2/t NH_3	EPA Bulletin #882 (EPA 1998)
Project Haber, Strike, Midwest Australia	Ammonia / Urea	36.1 GJ_{LHV}/t ammonia in urea	0.95 tCO_2/t NH_3 in urea	Strike
Project Haber, Strike, Midwest Australia	Ammonia[4]	28.4 GJ_{LHV}/t NH_3	0.46 tCO_2/t NH_3	Strike

[4] Strike has calculated energy efficiency and GHG intensity for ammonia in isolation using process feed gas and fired heater fuel, assuming CO_2-e is captured in urea. The numbers aligned with the 78% of energy demands of the Project being required for ammonia production in energy efficiency and GHG intensity calculations found in the Perdaman Urea Project Greenhouse Gas Assessment found on the EPA website.

4. Emissions Reduction Targets

Emission reduction targets are outlined in Table 4.1. Key abatement measures to meet the emissions reduction targets are detailed in Appendix A.

Table 4.1: Emission reduction targets

Period	Cumulative Scope 1 emissions (kt CO_2-e)	Annual average (kt CO_2-e)	Reduction from baseline (%)	Mitigation measures
1 July 2027 to 1 July 2030	2,283	761	-	Baseline
1 July 2030 to 1 July 2035	3,425	685	10	Introduction of renewable power generation to substitute for gas fired power generation.
1 July 2035 to 1 July 2040	2,530	506	34	Increased renewable power generation and storage to further reduce gas fired power generation. Use of hydrogen from green hydrogen electrolyser.
1 July 2040 to 1 July 2045	1,715	343	55	Sequestration of the Proposal's CO_2 process streams into local geo-sequestration facility. Further expansion of renewable power generation and storage to reduce gas fired power generation.
1 July 2045 to 1 July 2050	860	172	77	Sequestration of third party's CO_2 to generate offset credits.
2050 onwards	0	0	100	Increased sequestration for third parties to achieve net zero by 2050 and purchase offset credits to meet any shortfall.

Strike will focus on achieving emission reductions through avoidance (by substituting renewables for gas) or net reduction of emissions (by utilising carbon sequestration).

Strike notes that the emission reduction target commitment is made even though the Proposal is a new plant employing best practice technology, with considerable GHG abatement opportunities already factored into its design (as detailed in Section 5 and Appendix B).

Key initiatives to be developed and implemented in the future to meet the reduction targets include:

- Substitution of third party generated renewable electricity for gas generated electricity initially used to power the ASU unit;
- Further development of renewables generating capacity (wind and solar) to substitute for remaining gas fired power generation to the maximum extent practicable while maintaining continuous operation of the plant;
- Increase renewable capacity towards 100% of electricity generating requirement utilising storage (batteries and/or solar thermal) and demand management options;
- Sequestration of excess high purity CO_2 (initially vented) from the process into geological formations under the Precinct (further studies required to ascertain feasibility); and
- Sequestrating high purity CO_2 for third parties to obtain required offsets.

Alternatively, if carbon capture technology advances to the point it can efficiently capture the low level CO_2 flue gas emissions from the process heaters into a form suitable for sequestration, this technology would be preferrable to sequestering CO_2 from third parties.

Total emissions across a 25 year project life, assuming base case emissions from the Proposal with no abatement applied, would be 19,029 ktCO_2-e. Through application of mitigation measures to meet the reduction targets, as described above, the total emissions across a 25 year project life would be reduced to 10,753 ktCO_2-e which would all occur prior to the point when net zero is targeted (2050).

5. Emissions Abatement

5.1 Study Findings

During the project feasibility stage, several studies and investigations were undertaken to assess the feasibility and practicability of various design components and aspects of the Proposal that could result in GHG emission reductions. Table 5.1 provides a summary of these studies.

Table 5.1: Study findings

Study	Description of findings
Autothermal Reforming (ATR) Process Evaluation (T. EN, 2021a)	A comparison of SynCOR ATR with SMR (conventional technology) was conducted during a BAT review. The study concluded: • An ATR scheme is generally considered economically attractive for capacities higher than the Proposal (T.EN, 2021a). However, in view of Strike's commitment to reduce the CO_2 footprint per tonne of urea, through the initial design process, the ATR scheme offers a higher CO_2 footprint reduction; and • With the proposed plant configuration (two gas turbine generators and two heat recovery steam generators) the overall natural gas consumption of the Proposal is reduced by about 3% compared to the SMR base case. Importantly, the proposed plant configuration allows for the future integration of renewable energy (up to 70 megawatts).
SWIS and grid connection review	It is not possible at this stage to connect to the SWIS: • Suitable local transmission infrastructure necessary to meet the Proposal's overall requirements does not exist; and • It would be prohibitively expensive to construct a suitable high-capacity grid connection, which wouldn't necessarily reduce overall carbon emissions given the average carbon emissions associated with SWIS of 0.68 kg CO_2-e/kWh (for Scope 2) (DISER 2021c) and projected Proposal intensity of 0.67 kg CO_2-e/kWh.
CO_2 Management Screening Study Report (T. EN, 2021b) – commercial in confidence	Strike commissioned a study into the options for reducing CO_2 emissions. The study examined the options from an emission saving perspective as well as expenditure to determine the full cost of the option. The options were examined from the aspect of immediate adoption or factoring into the plant design so that the option could be adopted when appropriate. The following have been factored into the Proposal design: • Adoption of the electrification of rotating equipment; and • The ability to use hydrogen as a fuel source in the future when availability and economic cost of hydrogen permit.

5.2 Mitigation Measures

Strike has conducted an extensive review of reasonable and practicable GHG emission abatement opportunities. Mitigation measures, including those implemented in the planning and design phase, have been considered in context of the mitigation hierarchy (avoid, reduce and offset). As detailed in Appendix B, many of these opportunities have been either adopted into the design of the plant or factored in for future adoption. Where an abatement opportunity is not adopted, detail has been provided as to why, and whether there is future potential for its inclusion.

An internal review of reasonable and practicable GHG emission abatement opportunities, including those detailed in Appendix B as future considerations, will be conducted on a five-year basis.

Key efficiencies identified are:

- Use of a pre-reformer that uses steam raised from process heat recovery to partially reform the hydrocarbons in the feed gas prior to the primary reformer. The pre-reforming step converts hydrocarbons at reduced temperatures, reducing the energy consumption of the reforming stage;
- The SynCOR™ oxygen fired ATR technology operates at a lower steam to carbon ratio than traditional ammonia plants, combined with high reforming temperatures produces syngas that is characterized by very low methane content, low H_2/CO ratios and high CO/CO_2 ratios.

The reduced steam demand leads to a significant energy saving in the gas reforming consequently lowering operational Proposal Emissions;

- Co-location of urea plant with ammonia plant enables the high purity CO_2 stream from the ammonia ATR process to be captured and fed to the urea synthesis process resulting in 90% capture (1.03 Mtpa CO_2 incorporated into urea);
- Heat recovery from the exothermic ammonia synthesis; and
- Process power requirements met with high efficiency CCGT with HRSG and a steam turbine that also utilises excess process steam.

Further process efficiencies are realised by co-location of the ammonia process with the urea plant enabling efficiencies through sharing of resources.

5.3 Adaptive Management

Strike has adopted an adaptive management approach that will embed a continuous cycle of monitoring, evaluating, and implementing change (where appropriate). Ongoing periodic review of abatement opportunities will be conducted to ensure any relevant future improvement opportunities not yet identified are captured and actioned.

Adaptive management will occur through the five yearly review of the management approach detailed in the GHGMP. The management approach will be reviewed, evaluated and updated as required, considering:

- Changes to the uncertainties or assumptions, as noted in Section 2.6;
- New and relevant data/information gained through implementing this GHGMP or from external sources;
- Effectiveness of internal processes and procedures to reduce and manage GHG emissions;
- Changes in markets and technology;
- Changes in regional infrastructure and energy resources; and
- Monitoring and corrective actions.

The annual monitoring and reporting of GHG emissions in accordance with annual NGER reporting requirements (Section 6) will provide the data to measure ongoing performance.

5.4 Timeline for Adaptive Management

An overview of the various actions and review requirement that will feed into the adaptive management process is included as Table 5.2.

Table 5.2: Adaptive Management Timeline

Year	Strike Action
2022	GHGMP developed
2023-24	GHGMP updated, if required, to reflect Ministerial Conditions
2027	**Forecast implementation of Proposal**
October 2027 and then annually thereafter	Assessment of GHG emissions abatement opportunities
October 2027 and then annually thereafter	Undertake annual NGER reporting
October 2027 and then every fifth October thereafter	Complete a GHGMP Adaptive Management Review

6. Reporting

In 2019, the Commonwealth Government introduced the safeguard mechanism for new industry projects under the NGER Act 2007. The safeguard mechanism was set up to ensure that net emissions of GHG from the operation of a designated large facility do not exceed the baseline applicable to the facility.

At the time of preparation of this GHGMP, Strike is in the process of applying for a 'baseline' of GHG emissions for the Proposal, which it will report annually against.

Annual monitoring and reporting of GHG emissions will be conducted as required by the NGER Act. The NGER reporting period is currently 1 July to 30 June each year, with reporting due on 31 October of that period ending year.

6.1 Management Plan Review

If the Proposal is formally assessed, any comments received on the GHGMP will be considered and changes made, where relevant, to the GHGMP.

Strike intends this GHGMP to be dynamic and it may be revised to reflect changes in management practices, technologies, the natural environment and State and/or Commonwealth Government policy over time. This will also allow flexibility to adopt new technologies and mitigation measures.

At a minimum, Strike will review and evaluate the GHGMP every five years (adaptive management review) to ensure actions are adequately addressing the relevant key risks and meeting State and/or Commonwealth legislation and policy requirements.

This GHGMP may also be revised by Strike prior to the five-year interval on an as needs basis. This may be due to the management targets and actions not achieving the desired objectives, monitoring which identifies a variation to predicted emissions, changes to relevant legislation, or improvements to practices which may achieve improved environmental outcomes.

If the five-yearly review cycle triggers a revision of the GHGMP, or an as needs review and revision is undertaken, a revised GHGMP will be submitted, approved and published in accordance with anticipated EPA requirements. Administrative changes to the GHGMP will be managed internally and notified to the EPA.

The outcome of the annual internal review of reasonable and practicable GHG emission abatement opportunities may trigger an update of Appendix A to the GHGMP. It is anticipated that this will not trigger an external review of the whole plan.

7. Stakeholder Consultation

Consistent with the EPA's expectations for the GHGMP to align with the principles of Environmental Impact Assessment (EIA), Strike consulted with stakeholders during the development of the EPA referral. Strike will continue to maintain effective communication with local and regional stakeholders throughout the delivery of the Proposal.

This GHGMP is included as an appendix to the document supporting the referral of the Proposal to the EPA under Part IV of the EP Act. The Proposal has not yet been assessed by the EPA. However, regardless of the outcome of the Part IV assessment, this document is anticipated to be required as an appendix to an assessment under Part V of the EP Act. As such, the document will be subject to a public review period. Comments received on the GHGMP will be considered, and changes made where considered relevant.

8. Limitations

Scope of services

This report ("the report") has been prepared by Strategen-JBS&G in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen-JBS&G. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, Strategen-JBS&G has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, Strategen-JBS&G has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen-JBS&G has also not attempted to determine whether any material matter has been omitted from the data. Strategen-JBS&G will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Strategen-JBS&G. The making of any assumption does not imply that Strategen-JBS&G has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. Strategen-JBS&G disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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Appendix A Objective-Based Management Provisions

Objective-based				
Management targets	**Management actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
Management Target 1 Develop and implement reporting standards and processes, prior to the start of operations, to systematically review opportunities for abatement, sequestration and offsets, in order to accurately record and improve the net GHG impact of the Proposal on the environment.	**Management Action 1 (MA1)** Prior to the start of operations: • Implement process of annual review of GHG emissions • Develop and implement process to review abatement opportunities as part of compliance with this plan, with a view to optimise Management Actions 2 through 9 (below) and pathway to net zero. • Develop and publish a GHGMP Public Summary Report within 31 days of approval of this GHGMP and include on the Proposal website.	**Indicator** Abatement opportunities measured against feasibility criteria and extent of mitigation achievable. **Method for data collection and analysis** Review against environmental, safety, technical, implement-ability, timing, scale, and commercial criteria.	Establish processes prior to commencement of operations. •	Annual Report to the CEO (DWER), which includes: • Comparison of emissions against approved limits; • Emissions intensity achieved and compared against this plan and previous years; and • Summary of measures taken during the period to reduce and/or offset emissions. Annual reporting to the Clean Energy Regulator to satisfy NGER and safeguard mechanism requirements Five (5) yearly submission of updated GHGMP.
Management Target 2 Develop and implement preventative maintenance program for detecting and repairing leaks to minimise fugitive emissions during Project Haber operations prior to commencement of operations.	**Management Action 2 (MA2)** Develop and implement preventative maintenance program for detecting and repairing leaks	**Indicator** Emissions monitoring Pressure Safety Valve release information, leak detection records, event reports, work orders for preventative and corrective maintenance system. **Method for data collection and analysis** Review against environmental, safety, technical, implement-ability, timing, scale, and commercial criteria.	Develop program prior to commencement of operations to be implemented throughout the Project lifetime.	Monitoring informs emissions reporting as per MA1 reporting.
Management Target 3 Substitution of gas generated electricity with electricity from renewable energy sources to reduce greenhouse gas emissions associated with Project Haber by 10%, approximately, 76 CO_2-e ktpa below the forecast baseline emissions of 761ktpa CO_2-e in the 2030 reporting year.	**Management Action 3 (MA3)** Facilitate the introduction of renewable powered electrical generating capacity into the local area (anticipated to be within the Precinct) to enable substitution of gas generated electricity to reduce the associated GHG emissions by the amount necessary to meet Management Target 3. **Risk-based priority and timing** There are principally two issues: • Whether a third party will undertake and develop sufficient capacity in a time frame consistent with meeting the requirement to be operating by 2030– '**timing issue**'. • Whether, once constructed and operating, the proposed generating capacity is able to displace sufficient gas from the role of generating electricity to meet the target of reducing the associated greenhouse gas emissions by the 76ktpa required by Management Target 3 – '**performance issue**'.	**Indicator** Capacity of the renewable generation facility under consideration (being negotiated), the stage of development reached, and estimated implied greenhouse gas emission reduction. **Method for data collection and analysis** Once operating, the electricity generated by renewables will be measured on transmission (kWh) between generator and Project Haber.	**Identify the timing/frequency** Required implementation of renewable sourced electricity by 2030.	**Annual reporting** From achievement of Final Investment Decision (FID) - renewable generating capacity under consideration, stage of development and in particular reporting against progress in relation to 'timing issue' and 'performance issue'. Once renewable capacity operating annual reporting on the amount of renewable electricity utilised (kWh) and the consequent estimated annual reduction in CO_2-e emissions.
Management Target 4 Manufacture sufficient green hydrogen to be used as process feed (substituting for methane feedstock) into Project Haber to reduce greenhouse gas emissions associated with the Proposal by 8 ktpa CO_2-e by 2035.	**Management Action 4 (MA4)** Develop and operate a hydrolyser (expected capacity ~ 10MW) to manufacture hydrogen feedstock from demineralised water to substitute for hydrogen derived from natural gas and thereby reduce the carbon dioxide emissions associated with the equivalent amount of hydrogen extracted from natural gas. **Risk-based priority and timing** There are principally two issues: • The '**timing issue**' - the timing associated with the availability of suitable renewable generated electricity ('suitability' defined by consideration of the 'performance issue') to allocate to the hydrolyser which requires, at a minimum, MA3 to have successfully achieved Management Target 3. • The '**performance issue**' – the allocation of available renewable generated electricity to the hydrolyser depends upon the relative efficiency in terms of 'carbon reductions' between allocating renewable generated power to displace power derived from gas, versus allocating that same power to the hydrolyser to manufacture hydrogen.	**Indicator** Kilograms of hydrogen gas manufactured by hydrogen electrolyser. **Method for data collection and analysis** Hydrogen gas flow measured between hydrolyser and ammonia synthesis plant.	Green hydrogen production via hydrolysis to be implemented by 2035.	**Annual reporting** From achievement of FID - stage of development and in particular reporting against progress in relation to 'timing issue' and 'performance issue'. Once hydrolyser is operational annual reporting to include: • The amount of hydrogen produced by hydrogen electrolysis and fed into the production process to substitute for methane feedstock. • an assessment of the trade-off between allocating renewable power to substitute for gas and the electrolyser and a justification of the choice – i.e., the performance issue.

<table>
<tr><th colspan="5">Objective-based</th></tr>
<tr><th>Management targets</th><th>Management actions</th><th>Monitoring</th><th>Timing / frequency of actions</th><th>Reporting</th></tr>
<tr><td>Management Target 5
Substitution of gas generated electricity with electricity from renewable energy sources to reduce greenhouse gas emissions associated with the Project by an additional 171 ktpa CO_2-e by 2035.</td><td>Management Action 5 (MA5)
Facilitate the expansion of renewable powered electrical generating capacity into the local area (anticipated to be within the Precinct) to enable the substitution of gas generated electricity to reduce the associated GHG emissions by the amount necessary to meet Management Target 5.

Risk-based priority and timing
There are principally two issues:
• Whether a third party will undertake and develop sufficient capacity in a time frame consistent with meeting the requirement to be operating by 2035 – 'timing issue'.
• Whether, once constructed and operating, the proposed generating capacity is able to displace sufficient gas from the role of generating electricity to meet the target of reducing the associated greenhouse gas emissions by the 171 ktpa required by Management Target 5 – 'performance issue'.</td><td>Indicator
Capacity of renewable generation facilities (both solar and wind) under consideration (being negotiated), the stage of development reached, and estimated implied greenhouse gas emission reduction.

Method for data collection and analysis
Once renewable capacity operating the electricity generated will be measured on transmission (kWh) between generator and Project Haber.</td><td>Required implementation of increased renewable sourced electricity (beyond that required to achieve MA3) by 2035.</td><td>Annual reporting
From achievement of FID - renewable generating capacity under consideration, stage of development and in particular reporting against progress in relation to 'timing issue' and 'performance issue'.

Once renewable capacity operating annual reporting on the amount of renewable electricity utilised (kWh) and the consequent estimated annual reduction in CO_2-e emissions.</td></tr>
<tr><td>Management Target 6
Operate a carbon sequestration facility of sufficient capacity to sequestrate 109 ktpa CO_2-e by 2040.</td><td>Management Action 6 (MA6)
Develop and operate a carbon sequestration facility to sequestrate all suitable carbon dioxide streams (i.e., relatively pure CO_2 streams generated by ATR but not utilised as process feed into urea synthesis plant) into an appropriately developed local (i.e., within the Precinct) underground carbon sequestration facility.

Risk-based priority and timing
There are principally two issues:
• The 'timing issue' – whether a suitable carbon sequestration can be developed in time to meet the 2040 target date. The work required includes:
I. Identifying the optimal location for such a facility;
II. Drilling into the determined geological layer (expected to be at least 2 kilometres deep);
III. Testing its ability to take and absorb the volume of CO_2 at the required flow rate; and
IV. Determining the capacity of the system and hence the ultimate volume of CO_2 capable of being sequestered in it.
• The 'performance issue' – whether a developed sequestration facility will have the capacity (in terms of annual flow rate capable of being absorbed and also ultimate volume) to justify its development.</td><td>Indicator
Initially – progress towards establishing the viability of the carbon sequestration facility by reporting on (i) – (iv) {identified under MA6 'risk-based priority and timing'}.

Once FID is made to proceed with developing the carbon sequestration facility – progress on development, expressed in term of work undertaken and expected date of operations.

Once operating, amount of CO_2-e estimated to have been sequestered.

Method for data collection and analysis
Once carbon sequestration facility established – carbon dioxide flows from Project Haber to sequestration facility measured and reported in tonnes of CO_2-e.</td><td>Required implementation of carbon sequestration by 2040.</td><td>Annual reporting
Initially from achievement of FID – progress towards establishing the viability of a carbon sequestration facility, including those factors (i) – (iv) {identified under MA6 'risk-based priority and timing'} considered relevant.

Once sequestration facility operating includes the amount of CO_2-e estimated to have been sequestered.</td></tr>
</table>

Objective-based				
Management targets	**Management actions**	**Monitoring**	**Timing / frequency of actions**	**Reporting**
Management Target 7 Enable sufficient substitution of gas generated electricity with electricity from renewable energy sources used by Project Haber or otherwise achieve a reduction in power requirements (and hence gas use) by efficiency measures sufficient to reduce greenhouse gas emissions associated with the Proposal by an additional 54 ktpa CO_2-e by 2040.	**Management Action 7 (MA7)** Introduce measures to enable substitution of gas generated electricity with sufficient renewable generated electricity (including by utilising battery storage to shift the required timing of power generation) or otherwise reduce power demand and thereby gas demand to reduce the associated carbon dioxide emissions by the amount necessary to meet Management Target 7. **Risk-based priority and timing** There are principally two issues: • **'Timing issue'** - whether suitable further reductions in emissions can be engineered (including by the use of new technologies not currently available) or otherwise achieved without compromising process efficiency or unduly adding to costs in a timeframe consistent with achieving the required reduction by 2040. • **'Performance issue'** - MA7 is seeking to achieve a reduction in carbon dioxide emissions beyond what can currently be achieved with existing technology and associated efficiencies. There is a risk that by 2040 suitable technological breakthroughs will not have been achieved and engineering out the residual CO_2 emissions to the extent required will not be feasible.	**Indicator** Reduction in gas use achieved by introduction of renewables (above that achieved under MA3 and MA5) or efficiency measures that enable a reduction in power required such that gas use and hence associated CO_2 emissions are reduced. **Method for data collection and analysis** Measured gas flow as process flows into various sub-components (to distinguish between feedstock and fuel use) to ascertain where reductions in gas use occurring.	Required implementation of increased renewable sourced electricity (beyond that required to achieve MA3 and MA5) by 2040.	**Annual reporting** Initially from achievement of FID - renewable generating capacity under consideration and stage of development and in particular any efficiency measures applicable that improve baseline performance and are covered under 'timing issue' and 'performance issue' for MA7. Once renewable capacity operating, reporting to include increased efficiency in provision such as power, technical changes that enable additional substitution for gas sourced power and other engineered changes that reduce gas demand.
Management Target 8 Obtain sufficient carbon offsets by sequestrating carbon dioxide for third parties to reduce net CO_2-e emissions by a further 171 ktpa CO_2-e by 2045.	**Management Action 8 (MA8)** Once MA6 has established the effectiveness and efficiency of establishing a local carbon sequestration facility and conditional upon sufficient surplus capacity being available for use by others, MA8 will involve the marketing of a sufficient amount of the surplus capacity to third parties to meet Management Target 8. **Risk-based priority and timing** There are principally two issues: • The '**timing issue**' – whether the viability and capacity of a carbon sequestration facility can be established early enough to enable third parties with sufficient need for such a facility to decide to adopt the facility as a solution and then build the transmission network necessary to bring the CO_2 requiring disposal to the sequestration facility in time to meet Management Target 8. • The '**performance issue**' – whether a developed sequestration facility will have the capacity and be sufficiently competitive to be attractive to third parties requiring such a facility and be adopted by them under terms that generate sufficient offset credits for Strike to justify selling that capacity to those third parties.	**Indicator** Capacity of carbon sequestration facility available for use by third parties. Progress in marketing facility to third parties and contractual obligations to sequester for others once established. **Method for data collection and analysis** CO_2-e sequestered on behalf of third parties measured by inflows to sequestration facility.	Implementation of carbon offsets generation via sequestration for third parties required by 2045.	**Annual reporting** Once MA8 has established the effectiveness and efficiency of establishing a local carbon sequestration facility and that sufficient surplus capacity is available for use by others – reporting will cover progress towards establishing suitable contractual arrangement with third parties and then outline contractual terms once agreement reached. Once sequestration facility operating (and conditional upon sufficient capacity for third parties having been established) annual reporting will include CO*2*-e sequestered on behalf of third parties.
Management Target 9 Obtain sufficient carbon offsets by sequestrating carbon dioxide for third parties to reduce net CO_2-e emissions by the residual amount after Management Targets 1 to 8 (above) have been implemented to achieve net zero by 2050, which is estimated at a further 172 ktpa CO_2-e.	**Management Action 9 (MA9)** MA9 is a continuation of MA8 with the intention of reaching a level of sequestration necessary to offset any residual CO_2-e emissions not capable of being engineered out by the use of renewables or sequestered in their own right.	**Indicator** Reporting on residual CO_2-e sequestration obligation necessary to meet Management Target 9. **Method for data collection and analysis** CO_2-e sequestration measured as inflows at location of sequestration facility. Residual obligation calculated from data collected under Management Target 8.	Implementation of extended carbon offsets generation via sequestration for third parties required by 2050.	**Annual reporting** Once sequestration facility operating (and conditional upon sufficient capacity for third parties having been established) annual reporting will cover estimated additional CO_2-e requiring sequestration in order to meet net zero target.

Appendix B Greenhouse Gas Abatement Opportunities

Greenhouse Gas Abatement Opportunities Table

Greenhouse gas abatement opportunity	Description	Mitigation hierarchy	Adopted, adopted for future use or future consideration	CO_2-e mitigated (tonnes CO_2/year)	Justification
Plant Design					
Co-location of ammonia and urea plant	Direct utilisation of the CO_2 from reforming in the synthesis of urea. All of the ammonia produced is converted into urea resulting in utilisation of 90% of the CO_2 produced from reforming the gas feedstock during ammonia synthesis that would otherwise be emitted to atmosphere.	Avoid	Adopted	1,034,000	The CO_2 captured in the urea product (~1.03 Mtpa) is not emitted by the Project as a Scope 1 emissions. Note when the urea acts as a fertiliser the carbon a portion of the carbon may be incorporated into soil biomass with the remaining CO_2 released at this stage as a Scope 3 GHG emission.
Auto-Thermal Reforming (ATR).	The plant design is incorporating Haldor Topsoe SynCOR™ ATR technology.	Reduce	Adopted	~50,000	Adoption of ATR instead of SMR reduces initial emissions. Furthermore, it provides a plant prepared for the integration of hydrogen feedstock.
		Avoid	Future consideration	Not determined	Allows for displacement of gas fired power with renewable electricity and increased green hydrogen importation, when it becomes available. This is due to the transfer of the energy from the firing of the SMR to the electrical demand of the air separation unit.
10 MW Green hydrogen electrolyser	The plant design includes a 10 MW green hydrogen electrolyser to supply green hydrogen into the ammonia production process.	Reduce	Partially adopted – to be installed but implementation dependent on future renewable energy supply	<5,000	This contributes to an initial small reduction in emissions, however, will provide demonstration of the ability to import green hydrogen to displace process gas when once renewable energy is available (either locally or via grid connection).
		Reduce	Future consideration	Not determined	Will allow for future green hydrogen importation and use as process feed. Note this opportunity is limited to ~50% process gas substitution by the current requirements of the gas reforming process to supply CO_2 for urea production. An alternative high purity CO_2 source would be needed to maximise displacement of natural gas process gas with green hydrogen (may become more feasible as flue gas carbon capture technology matures).
Power generation/supply.	The plant design will include a modern combined cycle power plant with cogeneration mode.	Reduce	Adopted	Not determined	The plant design will include GTGs with HRSG considered BAT. GTGs with HRSG enables steam generation for supply to Steam Turbine Generators (STG) improving efficiency >50%. The GTG's with HRSG allow for power generation to be completely displaced by renewable power when available. Although STGs are cheaper to install they would require additional steam to be generated via gas fired boilers so renewable power could not completely displace gas usage.
	Hydrogen fuel for power generation	Reduce	Future consideration	Not determined	Green hydrogen could also be incorporated as fuel for the GTGs, and gas fired heaters; however, this is currently cost prohibitive and may also require additional NOx emission controls to remain within regulated limits. Furthermore, the practicable extent of natural gas replacement requires further investigation.
	Renewable power importation.	Reduce	Future consideration	Up to 167,000 when renewable power becomes available.	Once the Mid-west power grid infrastructure is upgraded or a behind the meter connection to a renewable power producer is available, the GTGs can be turned down during periods when renewable power is available.
Equipment and piping design.	A component of engineering design focused on process efficiency through equipment and piping design.	Reduce	Adopted	~2,000 estimated	Engineering design focussed on reducing pressure drop as far as reasonably practicable.
Energy losses to the surrounding environment.	A component of engineering design is focused on process efficiency through the consideration of energy loss to the surrounding environment.	Reduce	Adopted	~2,000 estimated	Reducing energy losses to the surrounding environment by designing out energy losses from process equipment and pipework and adopting the latest and most effective insulation and refractory technology.
LED lighting	The plant design will include the use of efficient lighting throughout the plant.	Reduce	Adopted	<1,000 estimated	Use of LED lights throughout plant instead of traditional compact fluorescent lamps or incandescent lighting results in increased energy efficiency.
Process cooling.	The plant design will include water cooling.	Reduce		~2,400 estimated	Water cooling instead of air cooling to achieve a better condensing approach temperature and greater stability during hot days. Air cooling, a common design inclusion, would result in higher CO_2 emissions.
Non-continuous flare.	Only use of pilot/safety flare.	Reduce	Adopted	Not determined	
High efficiency pump selection.	Use of modern high efficiency pumps suitably selected for the process design requirements and including variable speed drives where appropriate to increase efficiency.	Reduce	Adopted	Not determined	
Maximised waste heat steam recovery systems.		Reduce.	Adopted	Not determined	
Site selection					
Location selection to avoid clearing of native vegetation.	Selected site is already predominately (>99%) cleared of native vegetation.	Avoid	Adopted	10,000	Consideration was made to the selection of the site to avoid vegetation clearing, where possible.
Proximity to the local gas supply	Reduction of fugitive emissions associated with the transfer of gas in a pipeline and reduction of pipeline footprint.	Avoid	Adopted	Not determined	Minimisation of the length of the pipeline and transmission infrastructure reduces fugitive emissions and reduces the footprint of the pipeline (and loss of carbon sequestration associated with clearing that corridor).

Carbon sequestration	Sequestration of excess high purity CO_2 from the process into geological formations under the Precinct.	Minimise	Future consideration	Potentially 117,000	Further studies are required to determine the feasibility of this; however, initial investigation indicate there may be a suitable reservoir which could accept the vented high purity CO_2 emissions of 117 ktpa (15% of projected emissions at 761 ktpa urea). If the use of natural gas in the process were superseded by hydrogen, the feasibility of utilisation of sequestered CO_2 for urea production could be investigated. Should sequestration be possible, there may be capacity to offer sequestration to third party projects.
Operational					
Scheduled preventative maintenance	Scheduled maintenance to optimise process efficiency and minimise fugitive emissions.	Minimise	Adopted	-	Preventative maintenance of plant and equipment to ensure efficiency is maintained.

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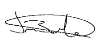
Rev No.	Author	Reviewer	Approved for Issue		
		Name	Name	Signature	Date
0	C. Ingram	J. Bailes	J. Bailes	On file	26/10/2022
0A	C. Ingram	J. Bailes	J. Bailes		07/11/2022

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