



**CLEANERGY
SOLUTIONS**
NAMIBIA

BASELINE REPORT **(YEARS 1 - 10)**



GREEN AMMONIA PIPELINE:

ARANDIS - WALVIS BAY

CLIMATE CHANGE IMPACT ASSESSMENT

Prepared by:



Advisory Services
Market Data & Studies
Due Diligence
Training





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This **Baseline Climate Change Impact Assessment Report** contains selected information and examples where applicable to support the understanding of the requirements in, and implementation of, the **Equator Principles** and transparency around the climate-related risks guided by the **Task Force on Climate-related Financial Disclosures (TCFD)** and **other leading reporting practices**.

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Environmental Compliance Consultancy
PO Box 91193, Klein Windhoek, Namibia
Tel: +264 81 669 7608
Email: info@eccenvironmental.com

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Project Summary

Project Name: Ammonia Pipeline: APP – 002567

The Ammonia Pipeline project covered by this **Baseline** Report is designed to connect two critical sites: Arandis, home of PV2FUEL (PV farm, Hydrogen + ammonia factory), where ammonia is to be produced, and the North Port (Ammonia terminal *Storage + loading*) in Walvis Bay, facilitating the storage, import, and export operations.

The ammonia pipeline from Arandis to Walvis Bay will transport approximately 1,440 metric tons of green ammonia per day (525,600 metric tons per annum) to the terminal at maximum capacity.

This initiative underscores a commitment to efficient and environmentally responsible industrial operations in the region.

Project Name	<i>Cleanergy Solutions Namibia Project (the “Project”)</i>
Location (s)	The Project is located in the Erongo Region of Namibia.
MAP	Overview ammonia pipeline Building upon Namibian strengths with respect for the environment Port Site: activities inherent o the port - Storage of ammonia needs to be close to the jetty. Pipeline needs to be limited (< 5 km) to avoid evaporation in the pipeline (ammonia is transferred at -33 °C and is heating up during transfer) - Loading and unloading vessels - Bunkering activities Arandis: harvesting best solar - Production of renewable energy hydrogen and ammonia. Further away from the ocean, as the solar park yield increases due absence of fog belt and higher solar irradiation. Legend: — NH₃ refrigerated pipeline (4km 18") — NH₃ pressurized pipeline (100km 6") ● Project location SCALE 0 10km © 2025 – CMB.TECH Public presentation - Do not replicate or distribute without the prior written permission of CMB.TECH
Project Owner / Developer	Cleanergy is a joint venture between: • CMB.TECH • H2 Infra
Project Contact	Mr. Paul Cuelenaere paul.cuelenaere@cmb.tech



Executive Summary

Introduction

The **Cleanergy Project** is a “clean” energy supporting activity that provides a pathway for society to have alternative fuels and ultimately transition away from fossil fuels. Thus, we have examined the operations activities for measurable emissions and calculated their impacts. A ten (10) year horizon is taken as a first step, noting the operations parameters are repetitive annually after Year 1. Furthermore, Year 1 will be assumed to be the period starting on the Commercial Operation Date.

This section of this **Baseline Report** provides a concise overview of the key findings, risks, and recommended actions, intended to summarize for those who may not have a need to read the entire report. It is a given that leading practice at all times is required to guide the process of emissions reporting and this report is no exception.

Importance of Emissions Calculation/Reporting

Reporting as explained by the Global Reporting Initiative (GRI)¹ sends a signal that an organization “*is dedicated to being open and honest with its stakeholders*”. The Task Force on Climate-related Financial Disclosures (TCFD) has a more directed approach and seeks “*to improve and increase reporting of climate-related financial information*”.

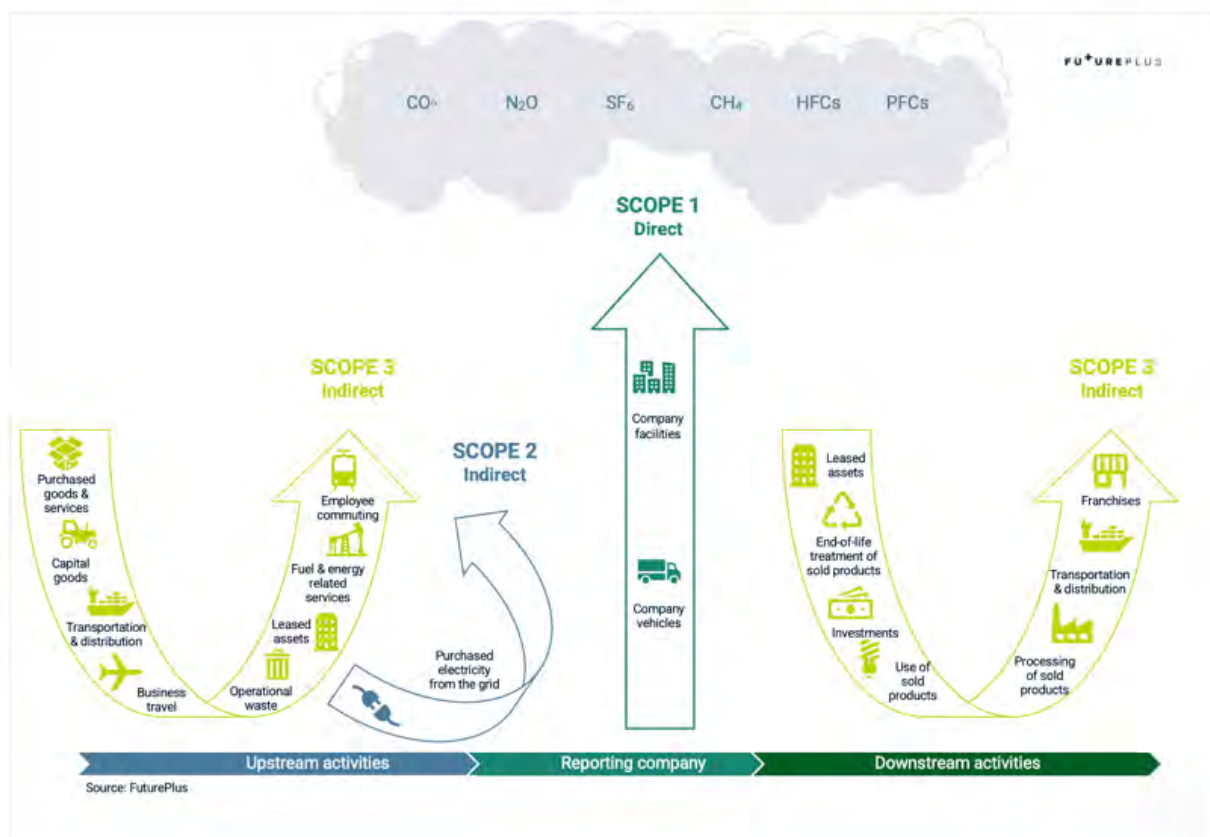


Figure 1 Scope Understanding

¹ <https://www.globalreporting.org/about-gri/>



As a result for compliance and adherence, the Report seeks to adhere to the (GHG Protocol) to provide **Relevance, Completeness, Transparency, Accuracy and Consistency**. As this is the “baseline” Report, it is further expected that experiential learning will lead to improvements and greater accuracy in the years to come.

Tracking Progress

By tracking emissions, organizations can identify opportunities for emission reductions, optimize energy use, and contribute to global efforts to mitigate climate change. The impact of various activities on greenhouse gas (GHG) emissions during operations is a critical consideration in today's business environment, as there is a growing emphasis on sustainability and reducing carbon footprints.

The emissions calculated in this Report are derived from data provided by the Client or assumed from best information available. Further, the modelling is focused on operational or maintenance parameters and **NOT construction**.

Emissions - Scope 1 (GHG Protocol)

Scope 1 in a reporting Year 1: 76.5 tonnes carbon dioxide equivalent (tCO₂e).

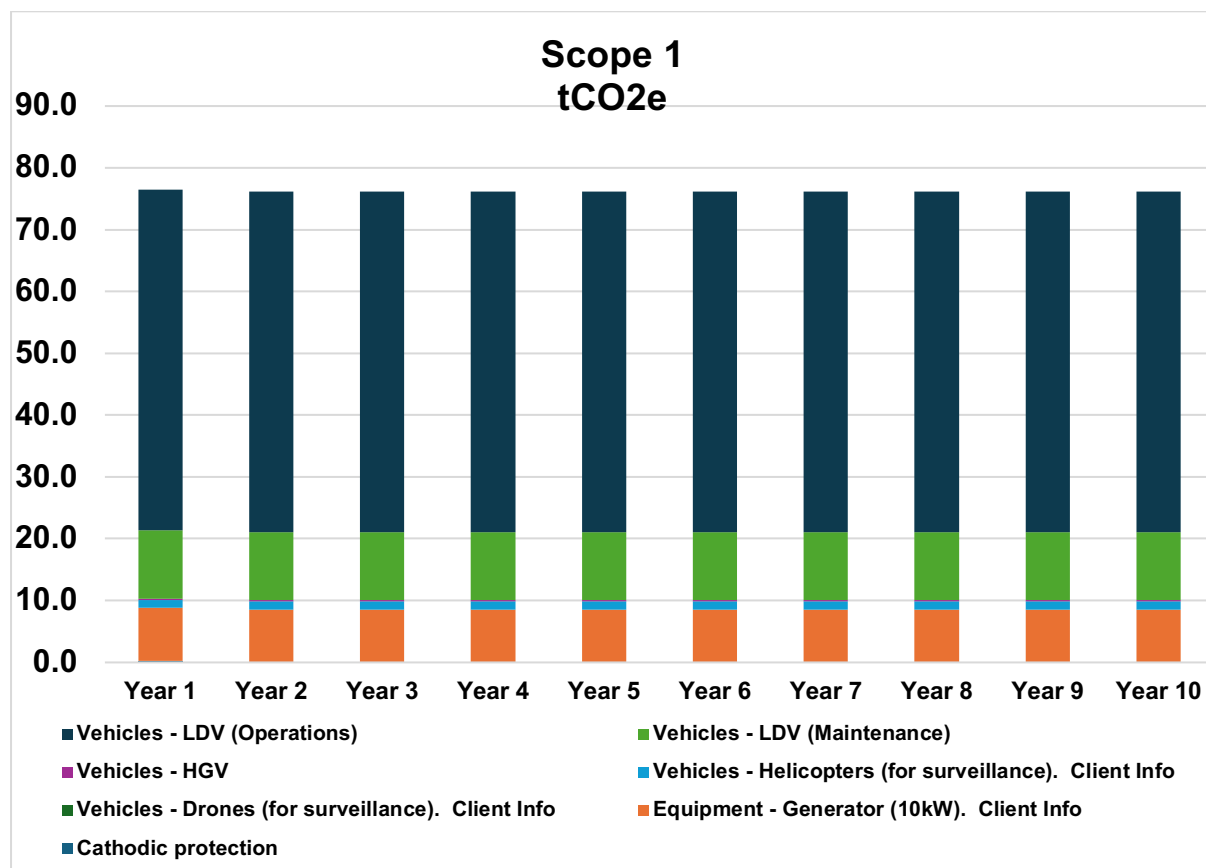


Figure 2 Scope 1 emissions (tCO₂e)

Scope 1 emissions in any reporting year as modelled, show that vehicle emissions account for some **87% of all emissions**, with operational vehicle use **accounting for 72% of all Scope 1 emissions**. This illustrates that the project has an opportunity to mitigate these emissions.



Proposed Reduction Strategies

1. The transition to battery, electric, hydrogen or hybrid vehicles.
2. The transition to hydrogen powered gensets
3. The use of drones powered by non-fossil fuels to replace frequency of helicopters use for aerial surveillance.

Emissions - Scope 2 (GHG Protocol)

Scope 2 in a reporting year: zero tonnes carbon dioxide equivalent (tCO₂e)

NO Scope 2 in a reporting year has been identified for the pipeline's operation.

The electricity that will be used to operate the various equipment including sectioning valves and optical fibre ammonia detection system along the pipeline will be sourced from the PV2FUEL solar plant in Arandis.

Cathodic protection is modelled as being "Galvanic" cathodic protection and uses a "sacrificial" metal (galvanic anode) to corrode instead of the steel pipe structure, making it the cathode of an electrochemical cell to prevent corrosion².

The project proponent has reported that electricity will be sourced for the pipeline operations from renewables.

Emissions - Scope 3 (GHG Protocol)

Scope 3 in a reporting year: 117.3 tonnes carbon dioxide equivalent (tCO₂e) in Year 1 and 20.6 tonnes carbon dioxide equivalent (tCO₂e) thereafter.

² <https://www.matcor.com/resources/cathodic-protection/>

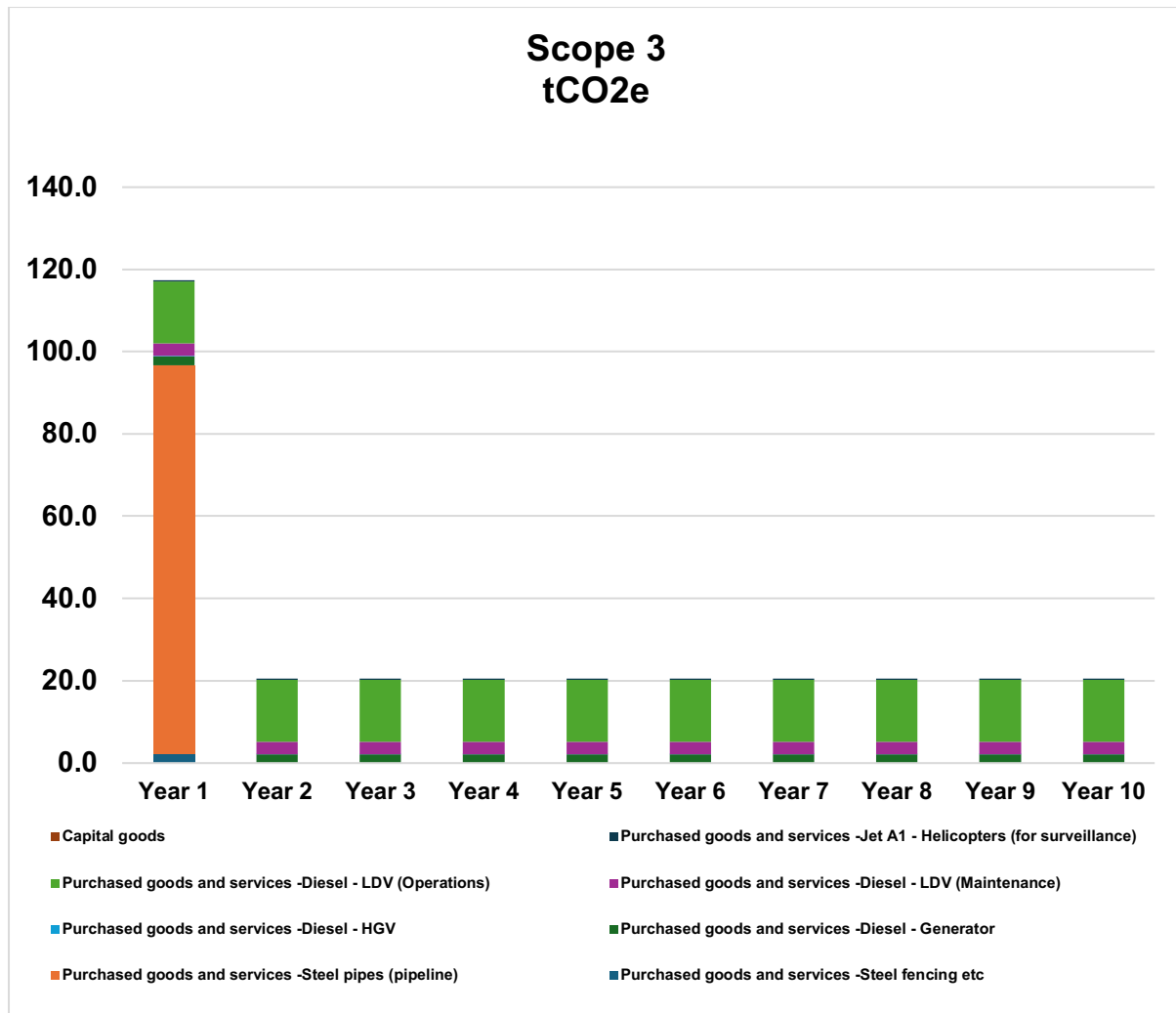


Figure 3 Scope 3 emissions (tCO₂e)

Scope 3 emissions even though hard to pin down, show as expected, the largest GHG impact on the project operations and maintenance annually.

Cleanergy has reported that key activities such as employee commuting and business travel will be served by the operations of other Cleanergy projects. To avoid double counting, no Scope 3 data other than those indicated above are carried in this report.

Climate Change Resilience

Some direct and tangible co-benefits of emission reduction measures provide climate change resilience and are derived from:

Alternative Options

- Hybrid Vehicles
- Plugin Hybrid Electric Vehicles (PHEVs)
- Battery Electric Vehicles (BEVs)
- Hydrogen powered vehicles
- Solar Power Plant (to provide energy for vehicle / equipment charging)



Constraints

While all steps will be taken to use leading practice for reporting, the same approach must be taken in understanding where limitations exist. Guidance from others note that “*When components contain material that has the potential to act as an air pollutant, emissions of this potential pollutant must be estimated³*”. Care and justification will be given when an emission is considered or not counted.

Conclusion

Effective management of Scope 1 emissions is a critical component of an organization's overall internal sustainability and climate change mitigation strategy, as it is internal and allows for the identification of emission reduction opportunities and the tracking of progress towards emission reduction goals.

Cleanergy has an opportunity to use the findings and guidance in this report to create a baseline and also to adopt deeper climate friendly options. As a result, RDJ Consulting Services CC propose the following recommendations:

I. Governance

Have a clear identification of the Board and the Management's role both in strategic direction, assessment, and reporting of climate related risks and opportunities including and beyond those mentioned in this report.

II. Strategy

Describe the resilience strategy with a clear climate scenario objective including and beyond those mentioned in this report. Setting targets is an essential component.

III. Risk management

Describe the process for managing climate related risks including and beyond those mentioned in this report.

IV. Operations

- Use of battery or hydrogen powered drones, replacing the need for fossil fueled helicopter patrols.
- Use of battery or at a minimum hybrid light delivery vehicle.

Recommendations for action

By addressing the risk factors through targeted mitigation strategies, the Project can enhance its resilience to climate-related risks and ensure sustainable and responsible operations. This proactive approach not only safeguards the Project's operations but also contributes to the broader efforts in combating climate change beyond that of the project itself.

³ Air Permit Technical Guidance for Chemical Sources Fugitive Guidance [APDG 6422]
<https://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/fugitive-guidance.pdf>



The following is suggested:

Short-term (Year 0-2)

- a) **Alternative Energy Sources:** Consider immediate adoption of Drones for all aerial inspection.
- b) **Vehicle Transition – Initial phase:** Transition vehicle fleets from any potential diesel-powered to hybrid or electric powered vehicles, which have lower carbon emissions.
- c) **Create data classification points:** This will involve classifying operational assets into groupings that allow for identification of emission “hotspots” and emission reduction opportunities.
- d) **Community Engagement:** Collaborate with local communities and stakeholders to develop long-term sustainable practices that align with environmental and social goals, thus minimizing the overall impact of the Project.

Medium-term (Year 2 - 5)

- a) **Vehicle Fleet Transition:** Continue to transition vehicle fleets from diesel-powered to electric vehicles, which have lower carbon emissions.

Long-term (Year 5 and beyond)

- a) **100% Transition:** It is anticipated that “learning” from the previous terms would now be better understood and possibly entrenched in the business culture.



1 Introduction

RDJ Consulting Services CC has been appointed by Environmental Compliance Consultancy (Namibia) to carry out a climate impact assessment (CIA) study on the proposed **Cleanergy Solutions Namibia (Pty) Ltd.**'s Ammonia Pipeline project.

Climate change is one of the most pressing global challenges of our time, with profound implications for the mining industry. Mining remains a central pillar of Namibia's economy, contributing roughly 13–14% of national GDP in recent years and generating about half of the country's export earnings. Its importance is expected to grow as global demand increases for transition-related minerals such as uranium, copper, and rare earth elements. Newer entrants such as Charcoal from invader species of biomass, Hydrogen and Ammonia stand to make its stability and long-term sustainability a key factor in Namibia's economic resilience.

Extreme weather events, changing precipitation patterns, and temperature fluctuations can significantly affect operations, including disruptions to supply chains, increased operational costs, and risks to worker safety.

1.1 Background

The primary objective of this report is to:

1. **Assess Climate Risks:** Identify the greenhouse gas emissions and evaluate the direct and indirect risks of climate change on project operations. Further, as this report is built upon studies and not historical data, it forms a baseline for reference.
2. **Propose Mitigation Strategies:** Outline the measures and strategies that can be implemented to reduce greenhouse gas emissions and enhance sustainability.
3. **Regulatory Compliance:** Ensure alignment with national and international climate regulations and standards.

Climate Change is understood by this Report to be the:

"Impact of human activity, creating the build-up of greenhouse gases in the atmosphere alters the radiative balance of the atmosphere. The net effect is to warm the Earth's surface and the lower atmosphere because greenhouse gases absorb some of the Earth's outgoing heat radiation and reradiate it back towards the surface".

(United Nations Framework Convention on Climate Change, 2011).

The Intergovernmental Panel on Climate Change (IPCC) demonstrates in its reports, that it is possible to limit global warming to 1.5 degrees Celsius with **rapid and deep emissions reductions** across all sectors of the global economy. It has given us many feasible, effective and low-cost mitigation and adaptation options to scale up across sectors and countries.

Simon Stiell, UN Climate Change Executive Secretary



In the various sections of the *Draft Scoping Reports*⁴, namely the

i) Ammonia Pipeline

Cleanergy Solutions Namibia Pty. Ltd. has identified Climate Change as a risk and thus needs to better understand the potential risk to its operations. This will allow **Cleanergy Solutions Namibia Pty. Ltd.** to determine reasonable strategies to mitigate or adapt to the pending climate-related risks.

Several leading practices and international standards set the tone for this work such but not limited to:

- Principle 2 of The Equator Principles
- International Finance Corporation (IFC) Principles
- the Task Force on Climate-related Financial Disclosure (TCFD)
- Paris Agreement, 2015

1.1.1 Just Energy Transition

With climate change being seen as a “*present*” danger and listed by many as a priority action, the Cleanergy projects are timely and basically essential for development and growthⁱ. The International Energy Agency (IEA) therefore identifies hydrogen, ammonia and other hydrogen-based fuels as important to the clean energy transitionⁱⁱ.

1.2 The Organization

The Client is identified as:

Cleanergy Solutions Namibia Project (the “Project”)

1.2.1 Roles of the Board

TCFD guidance suggests that the Board provide general oversight. This is because climate change governance matters need to be mainstreamed for effectiveness.

1.2.2 Roles of the Management

Day-to-day operations fall in the purview of the Management. They will carry out the Board decisions. Here, the actions needed can be effected to mainstream climate change understanding throughout the project.

1.3 Organizational Boundary

The “*organizational boundary*” in the context of a climate change impact report refers to the specific scope of activities, operations, and entities that are included in the assessment of climate change impacts.

1.3.1 Boundary

It is leading practice to set the boundary for the data to be collected. This requires an understanding of where a reporting company defines its upstream or downstream

⁴ ECC, Draft scoping report for the construction of a green hydrogen pipeline from Arandis to Farm 58, Erongo Region, Namibia, 2024



interactions for accuracy. The boundary used in this report is the **OPERATIONAL CONTROL AREA**.

The area of Operational Control spans along the ammonia pipeline from the town of Arandis to the town of Walvis Bay and concentrates only on the actual pipeline.

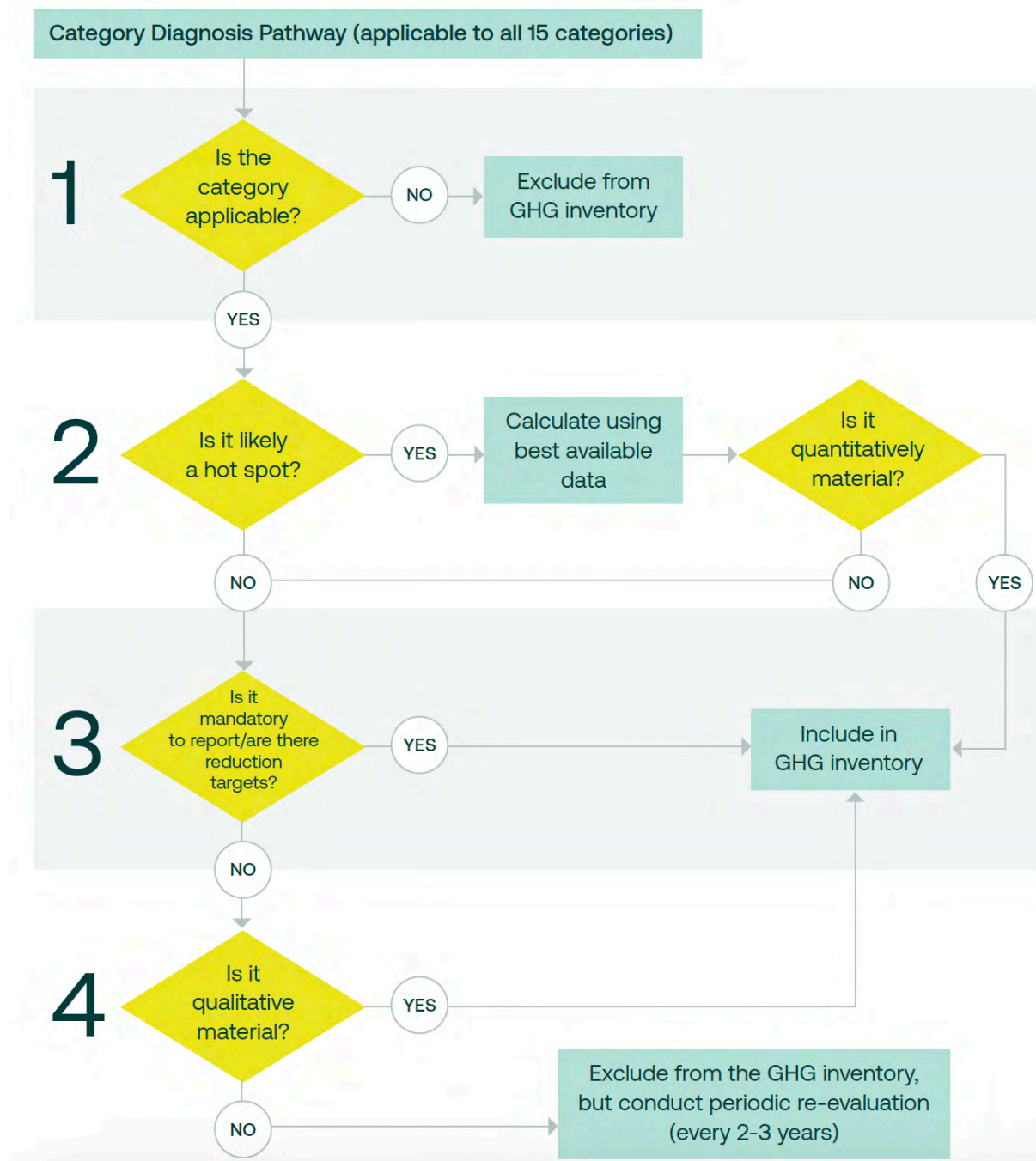


Figure 4 Category Diagnosis Pathways



1.4 Materiality

This is the determination of emissions suitability for report immediate needs. This means that **reliable information** should be available for the emissions accounting exercise or at best, good assumptions.

In relation to this Report, the following items were evaluated using the Category Diagnosis Pathways and so considered material in the GHG Inventory:

- a) Cathodic (Galvanic) protection – anodes
- b) Diesel generator
- c) Vehicles – LDV/HGV utilizing diesel
- d) Helicopter use
- e) Purchased goods - quantified

2 Reporting

Carbon accounting refers to the systematic process of measuring, calculating, analyzing, and reporting an organization's greenhouse gas (GHG) emissions in a way that ensures compliance with relevant environmental regulations, supports sustainability goals, and provides transparency to stakeholders.

To provide compliance with GHG Protocol, the following apply:

Relevance: Organizations must ensure that the GHG inventory accounting methodologies and report serves the decision-making needs of the intended users - both internal and external to the company. Furthermore, information in the report should be presented in a way that is readily understandable by the intended users.

Completeness: Businesses must account for and report on all GHG emission sources and activities within the specified boundaries. Furthermore, organizations must disclose and justify any significant GHG emissions and removals that have been excluded.

Consistency: To ensure compliance with the GHG Protocol, organizations must choose consistent methodologies, data, and assumptions that allow for meaningful comparisons of a GHG inventory over time. Furthermore, organisations should document any changes to the data, inventory boundary, methods, or any other relevant factors in the time series.

Transparency: Based on a clear audit trail, organizations should address all relevant issues in a factual and coherent manner. To ensure further transparency, organizations must disclose any relevant assumptions and make appropriate references to the data sources, and the accounting and calculation methodologies used.

Accuracy: To guarantee accuracy, organisations must take a systematic approach to ensure that the quantification of GHG emissions is neither under nor over actual emissions. Subsequently, they must take measures to ensure that uncertainties are reduced as much as possible. Finally, organizations



must warrant sufficient accuracy to enable stakeholders to make decisions with reasonable assurance as to the integrity of the reported information.

This practice is also known globally by several other terms, including *greenhouse gas accounting*, *carbon auditing*, *carbon inventory*, or *greenhouse gas inventory* (Kolk, 2008). Various entities ranging from businesses and municipalities to governmental organizations employ carbon accounting to track and manage their carbon footprints (Bebbington & Larrinaga, 2014).

The primary goal of carbon accounting is to quantify the GHG emissions produced by both private and public organizations. By doing so, it enables these entities to determine the volume of carbon emissions generated across their operations (Wiedmann & Minx, 2008). In addition to quantifying emissions, carbon accounting identifies specific operational areas responsible for generating those emissions, thus allowing for more targeted mitigation strategies (Simnett & Huggins, 2015).

In recent years, carbon reporting has become an essential component of Environmental, Social, and Governance (ESG) frameworks, aligning the measurement of GHG emissions with broader sustainability and corporate responsibility initiatives (Kolk, 2008). Through accurate carbon reporting, organizations contribute to the growing global focus on reducing carbon footprints and improving environmental performance (Eccles & Klimenko, 2019).

The Methodology of this report is based on GHG Protocol. Emission factors and calculation approaches come from various databases and national sources.

The **GHG Protocol**⁵ provides standards and guidance for companies to voluntarily calculate and report on their GHG emissions. Accounting and reporting coverage includes the following six greenhouse gases identified in the Kyoto Protocol:

- Carbon dioxide (CO₂)
- Methane (CH₄)
- Nitrous oxide (N₂O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF₆)

The GHG Protocol also includes reporting on Nitrogen trifluoride (NF₃) in GHG inventories, however it is our understanding that **Cleanergy** does not use processes that generate this gas and so it is not considered relevant.

2.1 Global Warming Potential

A specific Global Warming Potential (GWP) is applied to GHGs other than CO₂ to account for their higher warming effect, and the result is known as carbon dioxide equivalent (CO₂e). A GWP is a measure of how much energy the emissions of 1 tonne of a gas will absorb over a given period, relative to the emissions of 1 tonne of CO₂.

⁵ <https://ghgprotocol.org/>



This Report uses GWPs for different GHGs as defined by the Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report (AR6)⁶.

	Lifetime (years)		GWP ₂₀	GWP ₁₀₀	GTP ₂₀	GTP ₁₀₀
CH ₄ ^a	12.4 ^a	No cc fb	84	28	67	4
		With cc fb	86	34	70	11
HFC-134a	13.4	No cc fb	3710	1300	3050	201
		With cc fb	3790	1550	3170	530
CFC-11	45.0	No cc fb	6900	4660	6890	2340
		With cc fb	7020	5350	7080	3490
N ₂ O	121.0 ^a	No cc fb	264	265	277	234
		With cc fb	268	298	284	297
CF ₄	50,000.0	No cc fb	4880	6630	5270	8040
		With cc fb	4950	7350	5400	9560

Notes:

Uncertainties related to the climate-carbon feedback are large, comparable in magnitude to the strength of the feedback for a single gas.

^a Perturbation lifetime is used in the calculation of metrics.

^b These values do not include CO₂ from methane oxidation. Values for fossil methane are higher by 1 and 2 for the 20 and 100 year metrics, respectively (Table 8.A.1).

Environment, Social and Governance (ESG) is no longer a buzz-word or term but an active part of responsible corporate behaviorⁱⁱⁱ. To meet this challenge, emissions accounting needs to be credible especially in the push for acceptance of the needed global energy transition^{iv}.

In a recent report (Financial Education & Research Foundation, 2024) notes that reporting is now required by many corporations to meet the Securities and Exchange Commission (SEC) filing requirements or / and the European Union's Corporate Sustainability Reporting Directive (CSRD). In various jurisdictions, there are mandatory requirements. Under the US Environmental Protection Agency (EPA), emission per annum exceeding 25,000 tons of CO₂e at Ammonia or Hydrogen facilities *must report emission from all source categories*^v.

The Green Hydrogen Organisation^{vi} states that it;

"encourages project operators to calculate and report on the embodied emissions associated with green ammonia production, including embodied emissions associated with:

- (i) *purchased energy (grid) and energy produced on site (off grid);*
- (ii) *construction of green ammonia production facilities, and*
- (iii) *construction of storage, conversion and delivery infrastructure"*^{vii}.

2.1.1 Benchmarking

Benchmarking fosters a culture of continuous improvement within organizations. By regularly reviewing and updating benchmarks, companies can track their progress over time and adapt their strategies to meet new challenges and opportunities in sustainability. This iterative process is essential for fostering innovation and driving meaningful change in climate impact initiatives.

Benchmarking for climate impact reporting plays a pivotal role in enhancing organizational accountability and transparency regarding sustainability efforts. By

⁶ Chapter 7, p1017



establishing a framework to compare a company's climate-related performance against industry standards or peer organizations, benchmarking enables firms to identify their strengths and weaknesses in sustainability practices.

As businesses strive to minimize their carbon footprint and enhance their environmental stewardship, benchmarking serves as a crucial tool for assessing their progress. Setting realistic and ambitious climate targets is another significant benefit of benchmarking. By referencing established benchmarks, organizations can align their goals with best practices and scientific recommendations, such as those outlined in the Paris Agreement.

Ammonia pipelines exist globally with the United States has one operational ammonia pipeline, connecting seven states in the US Mid-West, and transporting 1.5 million tons per year over 2000 km⁷. Mexico also operates an ammonia pipeline, connecting the Gulf of Mexico and the Pacific Ocean.

Ammonia System Pipeline

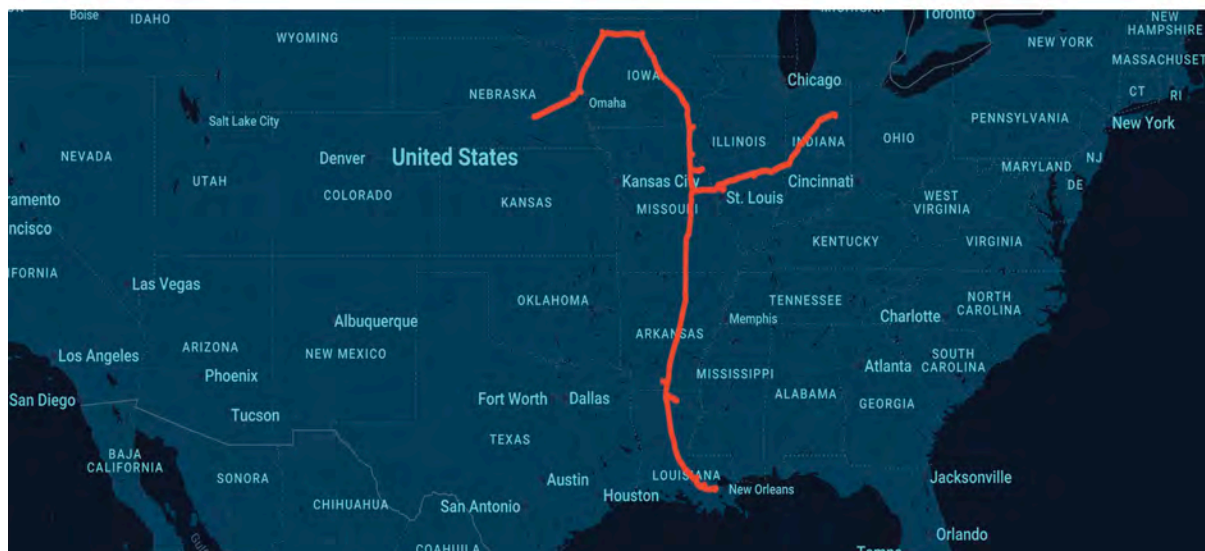


Figure 5 SUNOCO LP Ammonia Pipeline route

Europe also has ammonia pipelines under development. One such benchmark is the 550 km ammonia pipeline from the Port of Rotterdam to Venlo in the Netherlands, thereafter, crossing via Cologne to Karlsruhe in Germany⁸. The route covers rural areas, as well as densely populated areas. The pipeline in reference, is designed for an annual flow capacity of 7 million tons of ammonia. This benchmarked project utilizes 20" pipelines, while the Cleanergy project will use 8" pipes and accommodate a much lower flow of ammonia.

⁷ <https://www.sunocolp.com/segments/pipelines/view/ammonia-system>

⁸ <https://ammoniaenergy.org/articles/new-ispt-report-design-and-safety-for-large-scale-ammonia-pipelines/>



Figure 6 The route for the Netherlands-Germany ammonia pipeline⁹.

It has been shown generally by others show that life cycle assessments on different ammonia production methods show that "green" ammonia (produced using renewable energy) has significantly lower global warming potential compared to conventional methods. This project however focuses only on transport of ammonia from production to delivery over land.

3 Impacting Legislation

This section provides an overview of the projected climate change scenarios and regional legislative impacts relevant to the organization or project.

⁹ Fig 7 from [Design and Safety Aspects for large-scale Clean Ammonia Pipelines](#) (May 2025).



3.1 Local

Legislation	Impact
Constitution of the Republic of Namibia (1990)	<i>Maintenance of ecosystems, essential ecological processes and biological diversity of Namibia, and the utilization of living, natural resources on a sustainable basis for the benefit of all Namibians, both present, and future.</i>
Environmental Management Act, 2007 (Act No. 7 of 2007)	<i>Promotes sustainable management of the environment and the use of natural resources.</i> <i>The Act requires certain activities to obtain an environmental clearance certificate prior to Project development.</i>
Environmental Management Act Regulations, (Government Notice No. 28-30 of 2012)	<i>Brings the Environmental Act (2007) into force and lists activities for environmental clearance.</i>
Atmospheric Pollution Prevention Ordinance Ordinance No. 11 of 1976	<i>Promotes control of noxious or offensive gases. Also seeks to promote leading practice towards preventing or reducing the release of gases into the atmosphere.</i>
National Climate Change Policy (2011)	<i>The National Climate Change Policy provides the overarching framework for addressing climate change in Namibia. It outlines strategies for adaptation and mitigation and sets the groundwork for future legislation.</i>
Climate Change Bill (Draft)	<i>Namibia has been working on a Climate Change Bill, which was in draft. The bill aims to provide a comprehensive legal framework for climate change mitigation and adaptation in the country.</i>
Water Resources Management Act (2013)	<i>Namibia faces water scarcity challenges exacerbated by climate change. This act provides for the management and protection of water resources and plays a role in climate adaptation efforts.</i>

Table 1 Local Legislation

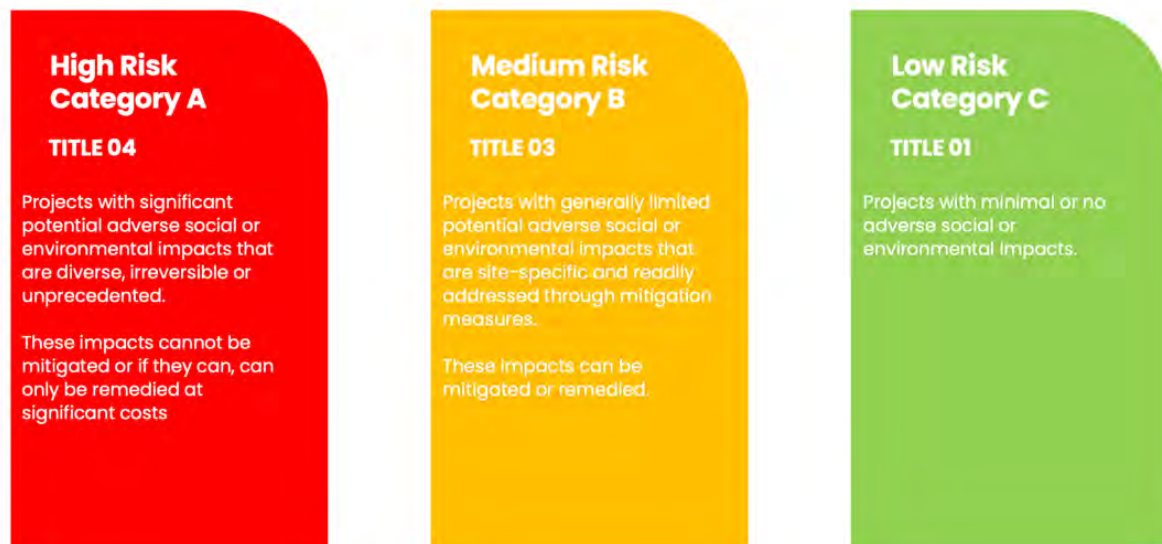


3.2 International Guidelines

3.2.1 Principle 2 of The Equator Principles

The Equator Principles require an alternatives analysis to be conducted when there is an “*expectation*” that CO₂e emissions will exceed 100,000 tonnes of CO₂e per annum during any stage of the Project (The Equator Principles Association, 2020). This will include both Scope 1 and Scope 2.

3.2.2 International Finance Corporation (IFC) Principle



<https://www.ifc.org/en/what-we-do/sector-expertise/sustainability/policies-and-standards/environmental-and-social-categorization>

Figure 7 IFC Project Risk Categorization

The IFC started their Performance Standards in 2006 and have since updated so that projects with “*significant emissions*” that are expected to or currently produce more than 100,000 tonnes of CO₂-equivalent annually,¹⁰ the client will quantify direct emissions from the facilities owned or controlled within the physical project boundary,¹¹ as well as indirect emissions associated with the off-site production of energy¹² used by the project.

IFC notes further that businesses pose varying risks dependent on operation type and location. This has resulted since 2012 in the following categories:

Quantification of GHG emissions will be conducted by the client annually in accordance with internationally recognized methodologies and good practice¹³. (International Finance Corporation, 2012).

¹⁰ The quantification of emissions should consider all significant sources of greenhouse gas emissions, including non-energy related sources such as methane and nitrous oxide, among others.

https://www.dfc.gov/sites/default/files/2019-08/world_resources_institute_1.pdf

¹¹ Project-induced changes in soil carbon content or above ground biomass, and project-induced decay of organic matter may contribute to direct emissions sources and shall be included in this emissions quantification where such emissions are expected to be significant.

¹² Refers to the off-site generation by others of electricity, and heating and cooling energy used in the project.

¹³ Estimation methodologies are provided by the Intergovernmental Panel on Climate Change, various international organizations, and relevant host country agencies.



3.2.3 The Task Force on Climate-related Financial Disclosure (TCFD)

The Task Force on Climate-related Financial Disclosure (TCFD) takes a different approach to understanding a company's long-term climate-related risks and the opportunities to adapt, mitigate or achieve positive cross-impact. With a “*forward-looking*” approach, TCFD focuses on awareness raising and transparency. Principles, therefore, surround *being clear, balanced, and understandable to reliable, verifiable, and objective* (Task Force on Climate-related Financial Disclosures, 2021).¹⁴

3.2.4 Paris Agreement

The Paris Agreement's main aim is to strengthen the global response to climate change threats by maintaining a global temperature rise well below 2 °C above pre-industrial levels¹⁵.

3.2.5 United Nations Framework Convention on Climate Change (UNFCCC)

The objective of the convention is to reduce and stabilize greenhouse gases at an atmosphere level to reduce impacts on climate systems, to allow ecosystems time to adapt to these changes, reduce food shortages and promote economies to develop in sustainable manners¹⁶.

3.3 Other External Compliance

Environmental, Social, and Governance (ESG) considerations have gained significant traction in the corporate landscape¹⁷, particularly within the burgeoning green hydrogen industry. Regulatory frameworks have placed ESG firmly on the board-level agenda, compelling organizations to integrate these principles into their core strategies. This shift has also influenced the corporate treasury function, as the demand for cash and debt products with an ESG focus continues to rise.

Treasurers now have access to a variety of innovative financial instruments designed to support sustainable initiatives, including green and sustainable bonds and loans specifically tailored for projects in the green hydrogen sector. Additionally, green deposits and ESG-focused money market funds (MMFs) are experiencing increased interest, alongside sustainable supply chain finance (SCF) programs and ESG-linked foreign exchange (FX) derivatives.

This growing emphasis on ESG not only enhances corporate reputation but also aligns financial practices with the urgent need for sustainable energy solutions, positioning organizations to contribute meaningfully to a low-carbon future.

¹⁵ ECC, Draft scoping report for the construction of a green hydrogen pipeline from Arandis to Farm 58, Erongo Region, Namibia, 2024

¹⁶ ECC, Draft scoping report for the construction of a green hydrogen pipeline from Arandis to Farm 58, Erongo Region, Namibia, 2024

¹⁷ <https://treasury-management.com/articles/a-new-framework-for-esg/>



3.3.1 Carbon Border Adjustment Mechanism¹⁸

The EU's Carbon Border Adjustment Mechanism (CBAM) is the EU's tool to put a fair price on the carbon emitted during the production of carbon intensive goods that are entering the EU, and to encourage cleaner industrial production in non-EU countries.

By confirming that a price has been paid for the embedded carbon emissions generated in the production of certain goods imported into the EU, the CBAM will ensure the carbon price of imports is equivalent to the carbon price of domestic production, and that the EU's climate objectives are not undermined. The CBAM is designed to be compatible with World Trade Organization (WTO) rules.

The Default Values for the transitional period related to this exercise are:

Aggregated goods category	CN code	Description	Default values (tonne CO ₂ e/tonne goods)		
			Direct emissions	Indirect emissions	Total emissions
Hydrogen	2804 10 00	Hydrogen	10,4	0,0	10,4

Source: JRC, 2023.⁴

Table 2 CBAM Default Values (FOR THE TRANSITIONAL PERIOD OF THE CBAM BETWEEN 1 OCTOBER 2023 AND 31 DECEMBER 2025)

CBAM will apply in its definitive regime from 2026, while the current transitional phase lasts between 2023 and 2025. This gradual introduction of the CBAM is aligned with the phase-out of the allocation of free allowances under the EU Emissions Trading System (ETS) to support the decarbonization of EU industry.

¹⁸ Taken verbatim https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en



4 Country Information

4.1 National Context

4.1.1 Overview of the national or regional policies and regulations

Namibia is a signatory to various UN conventions and protocols that allow for mainstreaming the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Convention on Biological Diversity (UNCBD), and United Nations Convention to Combat Desertification (UNCCD).

Namibia is a non-Annex 1 Party to the Paris Agreement. It was ratified on 21 September 2016, with the ratification of the Kyoto Protocol being 4th September 2003. As a result, Namibia is obligated to submit reports *including the National inventory of anthropogenic greenhouse gas emissions by sources and sinks* etc. (Ruppel & Ruppel-Schlichting, 2022).

Climate Change is a risk that will vary depending on the country, business location, and management outlook. Namibia is recognized as being vulnerable to the impacts of climate change (Ministry of Environment & Tourism, 2012).

The following national laws and policies were consulted to seek alignment and understanding to inform the analysis:

- Minerals (Prospecting and Mining) Act, No.33 of 1992
- Environmental Management Act, No. 7 of 2007
- Water Act, No.54 of 1956
- Water Resources Management Act 11 of 2013
- Water Supply and Sanitation Sector Policy, 2008
- Forest Act, No.12 of 2001
- Heritage Act, No.27 of 2004
- Labour Act, No.11 of 2007
- National Climate Change Policy (NCCP)
- National Climate Change Strategy and Action Plan (NCCSAP)
- Nationally Determined Contributions (NDCs)
- Biennial Update Report (BUR)
- National inventory report.
- Modified Single Buyer Policy (MSB)

4.1.2 Economic and demographic factors influencing emissions

This section of the report aims to assess the potential emissions impact on local communities along the pipeline route. The proposed ammonia pipeline, of approximately 112 kilometres (km) in length, will be constructed between Arandis and Walvis Bay in the Erongo Region of Namibia. The ammonia pipeline is to travel through mostly industrial or highly traffic areas. The anticipated fugitive emissions from the pipeline are not anticipated to directly affect any of the nearby residential communities.

Other sections of this report will highlight the activities along the route, but to avoid double counting the existing emissions will only examine emissions which occur as a



result of the Walvis Bay airports operations, road transport and railway activities which will be demonstrated under this ammonia pipeline project emissions report.

However, the proposed pipeline's route is designed to avoid disruptions to the communities within urban areas, inclusive of the Arandis, Swakopmund and Walvis Bay Municipalities and is still to be determined after further public consultations.

4.1.2.1 Demographic Factors

Often referred to as a “harbour town”¹⁹, Walvis Bay is a key infrastructural hotspot in Namibia and Western Africa. Walvis Bay hosts not only Namibia’s largest commercial shipping port but also an international airport^{viii}. Arandis commonly referred to as a “mining town” was originally established as a dormitory town for workers at the nearby Rössing Uranium Mine, was declared an official town in 1994. Now managed by the Arandis Town Council, the town serves as a residential hub for mine employees and local residents, aiming to provide cost-effective services, foster economic development, and improve the quality of life for its residents through principles of good governance²⁰.

The proposed ammonia pipeline, of approximately 112 kilometres (km) in length, will be constructed between Arandis and Walvis Bay in the Erongo Region of Namibia.²¹ This project, under the ownership of Cleanergy Solutions Namibia (Pty) Ltd., is intended to transport green ammonia to Walvis Bay from a green ammonia production plant to be located in Arandis.

The proposed ammonia pipeline corridor is bounded by the D1984 and the B1, B2 road between Walvis Bay and Arandis.²² The ammonia pipeline project is located from the town of Walvis Bay onwards to the town of Arandis. According to the 2023 Population and Housing Census report published by the Namibia Statistics Agency (NSA), Walvis Bay town population is estimated at 102 704 people. Walvis Bay has a higher male population, with approximately 51,817 men compared to 50,887 women²³. Moreover, according to the 2023 Population and Housing Census by the Namibia Statistics Agency (NSA), the town of Arandis has an estimated population of 5,726, and the project’s operational (*Scope 1 and 2*) emissions may impact local residents. Similar to Walvis Bay, census data indicates that Arandis has a higher male population, with approximately 3,102 men compared to 2,624 women²⁴. The estimated distance between the project site and the areas of Arandis for this report is approximated at 1.5 kilometres (km) at its nearest point of interaction.

¹⁹ <https://www.siyabona.com/towns-of-namibia.html#:~:text=Walvis%20Bay%20is%20a%20busy,least%20200%20000%20migratory%20species>

²⁰ <https://arandistc.com.na/mandate-of-arandis-town-council/>

²¹ Proposed Construction of a Hydrogen Pipeline From Arandis to Farm 58, Erongo Region, Namibia. Page 6

²² Draft scoping report for the construction of a green ammonia pipeline from Farm 58 to the Walvis Bay port area, Erongo Region, Namibia. Page 3

²³ <https://nsa.org.na/publications/> : 2023-Population-and-Housing-Census-Main-Report-28- Oct-2024.pdf page 88

²⁴ <https://nsa.org.na/publications/> : 2023-Population-and-Housing-Census-Main-Report-28- Oct-2024.pdf page 88



However, it is our understanding that the proposed pipeline's route is designed to avoid disruptions to the communities within urban areas, inclusive of the Arandis, Swakopmund and Walvis Bay Municipalities and is still to be determined after public consultations.

4.1.2.2 Economic Factors

The Cleanergy Solutions Namibia project aligns well with the green hydrogen and renewable energy generation pillar. This project is expected to provide additional economic benefits, creating employment for approximately 30 to 100 workers during the construction phase, with two security guards on night duty. The project envisions to source employees from local communities from the nearby towns like Arandis, Walvis Bay, or Swakopmund, thus there is no plan for on-site accommodation.

Through job creation, this project is anticipated to contribute positively to local livelihoods and income generation, fostering economic growth and supporting the communities in the region.²⁵

Arandis

Arandis, is also known as the “*Uranium Capital of the World*”²⁶, is home to some of the largest uranium mining operations globally, with the Rössing Uranium Mine located just 15 kilometres from the town²⁷. Uranium mining remains the dominant economic driver in the region. At the end of 2023, Rössing Uranium employed 860 Namibians, accounting for 98.74% of its workforce (CNNC Rössing Uranium, Sustainability and Performance Report 2024)²⁸. Additionally, the Swakop Uranium, one of the largest uranium mines in the world, is situated 22 kilometres of Arandis. According to Swakop Uranium’s 2022 Sustainability Report, the mine employed around 1,455 Namibians, representing 96% of its total workforce.²⁹

Beyond mining, Arandis has expanded its economic base to include other sectors, such as green charcoal production. The Green Charcoal Namibia facility, inaugurated in 2023, was expected create around 50 full-time jobs and 850 indirect jobs, contributing approximately N\$200 million to Namibia’s economy (Cleanergy Solutions Namibia (Pty) Ltd., 2024).³⁰

Arandis Town Council’s 2024-2029 Strategic Plan, aligned with Namibia’s Sixth National Development Plan (NDP 6), emphasizes **Joint Venture Participation, Green Hydrogen and Renewable Energy Generation, Industrialization, Support Services, and Logistics**. These pillars reflect the Town Council's commitment to

²⁵ Draft scoping report for the construction of a green hydrogen pipeline from Arandis to Farm 58, Erongo Region, Namibia. Page 47

²⁶ Cleanergy Solutions Namibia (Pty) Ltd (2024)

²⁷ Draft scoping report for the construction of a green hydrogen pipeline from Arandis to Farm 58, Erongo Region, Namibia. Page 60

²⁸ https://www.rossing.com/files/RUL_Sustainability_Report_2024.pdf page 29

²⁹ <http://www.swakopuranium.com/swakopuranium/c032012171/2023-09/29/4508d83fe1e14a9aa31375380d59bf90/files/aa6b59e6000d4931a83887f726bc19d2.pdf> page 14/15

³⁰ Draft scoping report for the construction of a green hydrogen pipeline from Arandis to Farm 58, Erongo Region, Namibia. Page 60



sustainable development, fostering an investor-friendly climate, and uplifting the local community's quality of life.³¹

Walvis Bay

The Namibian Ports Authority (also referred to as 'Namport' or the 'Authority') was established by the Namibian Ports Authority Act, No. 2 of 1994 (Namport, 2023). Namport manages Namibia's ports in Walvis Bay and Lüderitz. The Walvis Bay Port is Namibia's largest commercial port and receives approximately 3,000 vessel calls yearly and handles about 5 million tonnes of cargo. The Port of Walvis Bay handles container imports, exports and transshipments, as well as bulk and break-bulk of various commodities and serve a wide range of industries such as the petroleum, salt, mining and fishing industries (Namport, 2023). Both bulk and bagged salt are exported from the Port of Walvis Bay.

According to Namport's integrated annual report for the financial period from 1 April 2022 to 31 March 2023, Namport has recorded a revenue increase of N\$1.5 billion or 22% compared to the N\$1.2 billion increase recorded in 2022 (Endjala, 2024). The profit was set against a target of N\$1.2 billion while the ports authority announced an operating profit of N\$411 million compared to the 2022 financial year which recorded N\$375 million (Endjala, 2024).

The fishing industry is the third largest economic sector contributing ~3.5% of GDP since 2007. The value of fishing, onshore and offshore processing accounted for N\$3,410 million in 2008 (Erongo Regional Council, 2015). The industry at Walvis Bay, and Lüderitz in the ǀKaras Region, employs about 14,000 workers, of which about 43% work on vessels at sea while 57% are involved in onshore processing (Erongo Regional Council, 2015).

Tourism sector another important sector contributing to economic growth in Erongo region. There are variety of tourist attractions include Dune 7, Sandwich Harbour and Walvis Bay Lagoon (proclaimed Ramsar sites), Welwitschia Plains, Atlantic coastline and the Namib Desert, Cape Cross Seal Reserve, Dead Sea and the wider skeleton coastline (Nangolo, 2023). Furthermore, the Walvis Bay's Lagoon and the Sandwich Harbour are two of the five designated Ramsar sites in Namibia and provide pristine environments for various birdlife populations (Erongo Regional Council, 2022).³²

4.1.3 Historical context and previous efforts to reduce emissions

The approach used in this report focuses on identifying existing sources of emissions prior to this project under a philosophy of "*who and/or what produces emissions*" in the target locations, specifically the areas between Arandis, and Walvis Bay. The report will only assess emissions along these routes, including Walvis Bay's immediate urban vicinity (area).

In this area, apart from the route from Farm 58 to Walvis Bay, Walvis Bay itself is a full-fledged town comprised of industrial, commercial and residential activities.

³¹ <https://arandistc.com.na/documents/3476/> page 3

³² Draft scoping report for the construction of a green ammonia pipeline from Farm 58 to the Walvis Bay port area, Erongo Region, Namibia. page 56-57



According to a Census conducted by the Namibia Statistics Agency in 2023, Walvis Bay has a population of 102,704³³.

Emissions prior to this project is estimated at 56,222 tCO₂e making the project insignificant at 103 tCO₂e.

4.1.3.1 Energy Supply

Arandis is supplied with electricity from the ErongoRED electricity distribution company who acquires electricity in bulk from NamPower. Arandis is also home to a 3.5 MW solar photovoltaic plant that in principle helps offset electricity consumed in Arandis. *This is not accounted for in this report as it is outside the scope of our mandate.*

Walvis Bay is also supplied with electricity from the ErongoRED electricity distribution company who acquires electricity in bulk from NamPower. Walvis Bay is also home to the Anixas I and soon to be fully commissioned Anixas II heavy-fuelled oil power plant that is a heavy carbon emitter in Walvis Bay. This is not accounted for in this report as it is outside the scope of our mandate,

4.1.3.2 Road Transportation

To avoid issues of double accounting, this section focuses solely on vehicle produced emissions within the boundary proximity. On average, annually, vehicles emitting approximately 11,591 tCO₂e emissions.

4.1.3.3 Industrial Activities

Not accounted for due to insufficient data.

5 Climate Impact

Several reports on Namibia indicate the fact that the country is naturally arid and has several biodiversity hotspots and rainfall ranging between 250 mm – 600 mm per year, with mean temperatures between 16 deg Celcius – 22 deg Celcius (Ministry of Environment & Tourism, 2012)³⁴.

As an arid country, Namibia depends heavily on its groundwater resources. This brings with it challenges such as high rainfall variability that makes recharge into aquifers also variable, so groundwater reserves in many places are not reliable.

The general geographic area³⁵ is classified as a *Subtropical desert climate (Classification BWh)* as per the **Köppen climate classification system**. In these locations, stable descending air and high pressure aloft clear clouds and create hot, arid conditions with intense sunshine.

The Köppen-Geiger climate classification system provides a broad overview of climate types based on general patterns. Local variations, microclimates, and other factors may influence the specific characteristics of a region within a given climate

³³ <https://census.nsa.org.na/erongo/>

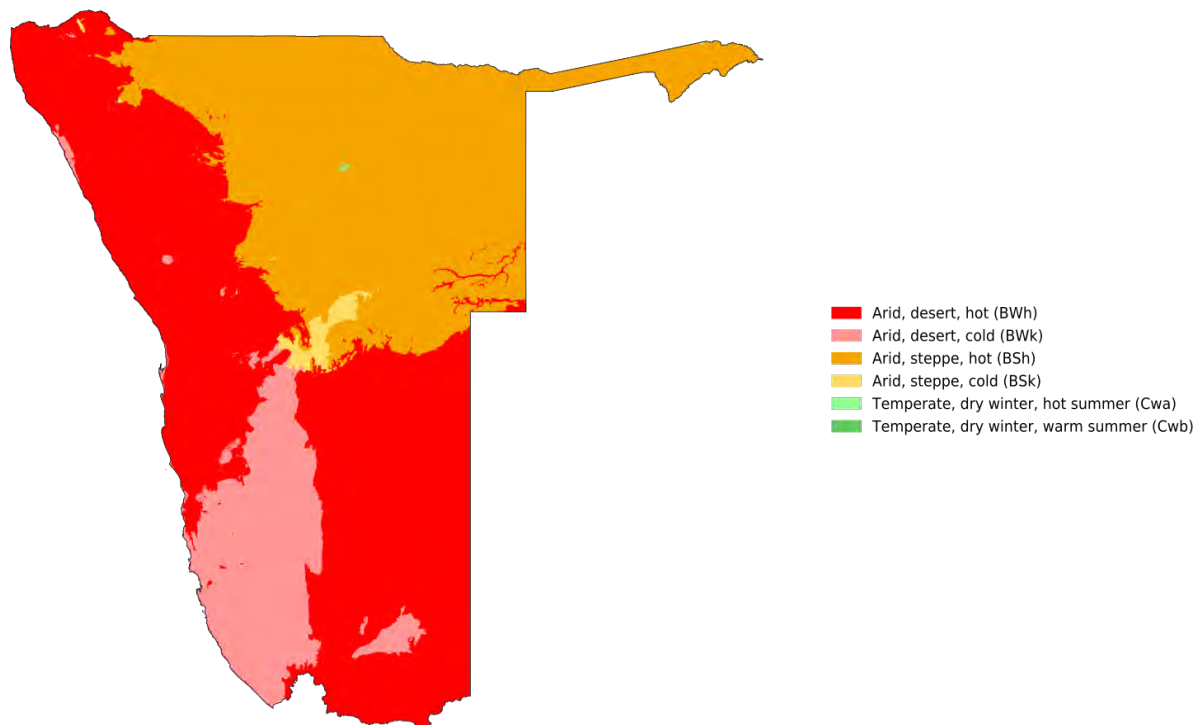
³⁴ Actual site data provided through others will be commented on under *Site Specific Climate*.

³⁵ <https://tckctck.org/namibia/erongo/karibib>



classification. Namibia is one of the regions with a *BWh* climate (that covers the Erongo region). "*BWh*" represents a hot desert climate.

Köppen-Geiger climate classification map for Namibia (1980-2016)



Source: Beck et al.: Present and future Köppen-Geiger climate classification maps at 1-km resolution, Scientific Data 5:180214, doi:10.1038/sdata.2018.214 (2018)



Figure 8 Köppen-Geiger Climate Classification, 1991-2020 (Courtesy: World Bank Knowledge portal)

The "*B*" stands for dry climates, while the "*Wh*" indicates a hot desert subtype. This climate classification is characterized by extremely high temperatures and very low annual precipitation.

5.1 Rainfall

Climate variability, marked by severe droughts and floods, poses significant risks to the country's socio-economic stability and development. Addressing these challenges requires comprehensive strategies that include improved water management, and infrastructure adaptation.

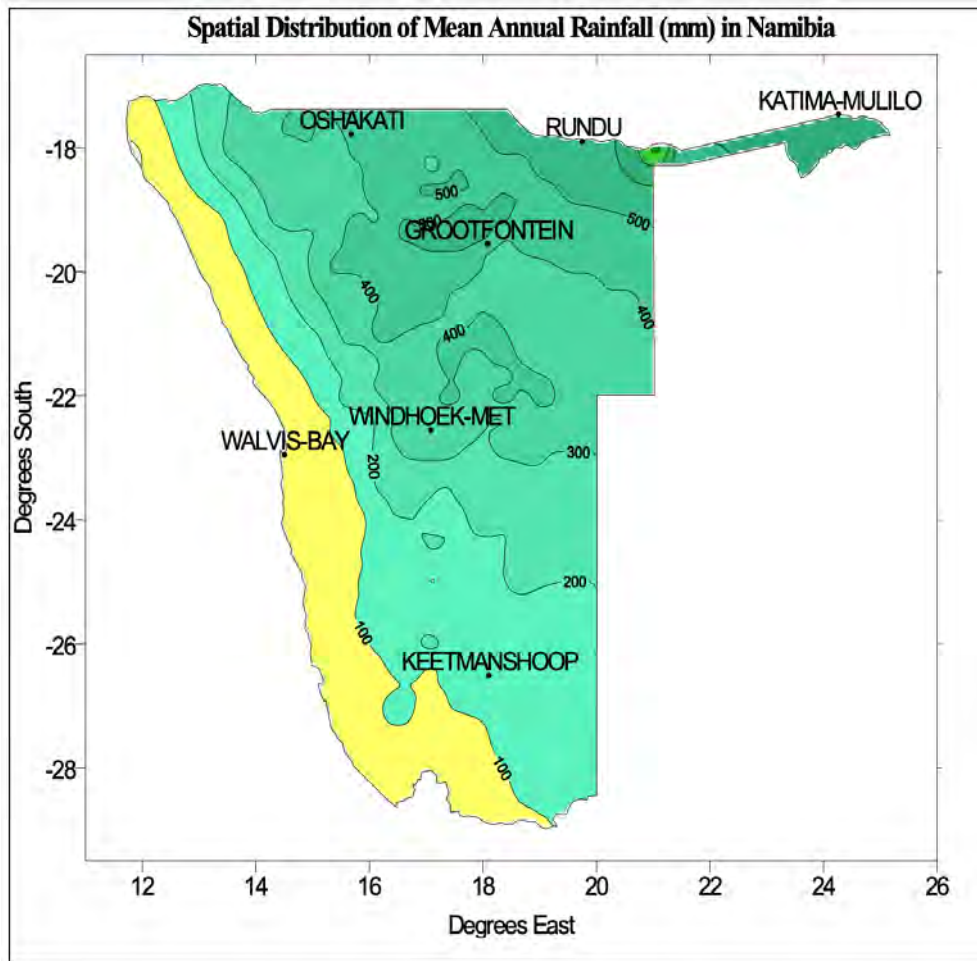


Figure 9 Namibia Mean Annual Rainfall Map. (Courtesy: Namibia Meteorological Service)

Namibia is particularly vulnerable to prolonged periods of drought, which can lead to severe water shortages. For the project, water is a crucial raw material for processes such as produced by desalination. Drought conditions can limit water availability, forcing projects to reduce production or halt operations, thereby impacting economic output and employment. This however should not occur due to the utilization of desalination of sea water to produce water for hydrogen/ammonia production.

On the opposite spectrum, floods pose a different set of challenges. Heavy rainfall can lead to flash floods, which can damage infrastructure, including roads, bridges, and processing facilities. Flooding can also cause soil erosion and sedimentation, affecting water quality and increasing operational costs for water management and infrastructure repairs. Additionally, floods can disrupt transportation and logistics, leading to delays in maintenance and affecting the overall performance of pipeline operations. Subsidence is therefore a real risk to this project if flooding occurs.

The increasing frequency and severity of climate-induced rainfall extremes present significant challenges for the project. It is imperative for stakeholders, including government authorities, and local communities, to collaborate on adaptive strategies. This includes investing in climate-resilient infrastructure and enhancing early warning systems for extreme weather events.

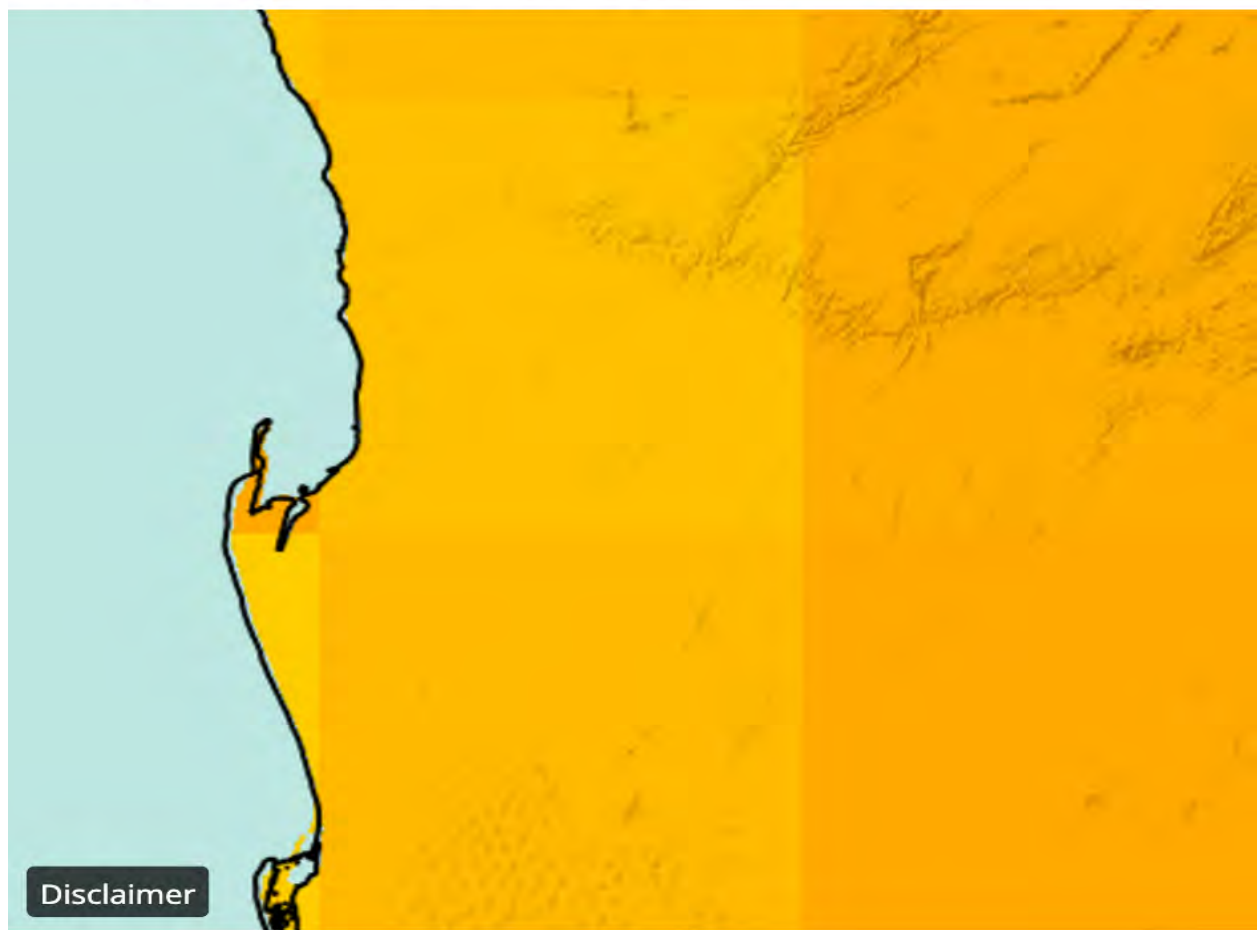


5.2 Temperature (Air)

High Temperatures: *BWh* climates are typically associated with scorching temperatures, particularly during the summer months. These regions experience long periods of intense heat, often with daily temperatures exceeding 38°C (100°F).

Low Precipitation: *BWh* climates are extremely arid, with very limited rainfall throughout the year. Annual precipitation is generally low, often falling below 250 millimeters (10 inches), and sometimes significantly less.

Observed Climatology of Average Mean Surface Air Temperature 1991-2020; Erongo, Namibia



TEMPERATURE (°C)



Average temperature in the Erongo region is 20.2 deg. C over the 1991 – 2020 period.

Mendelsohn et. al. points out however that Namibia's arid climate thus was a clear indication of its abundant sunlight resource. These extremes manifest primarily as



droughts and floods, which have profound impacts on the socio-economic fabric of the country.

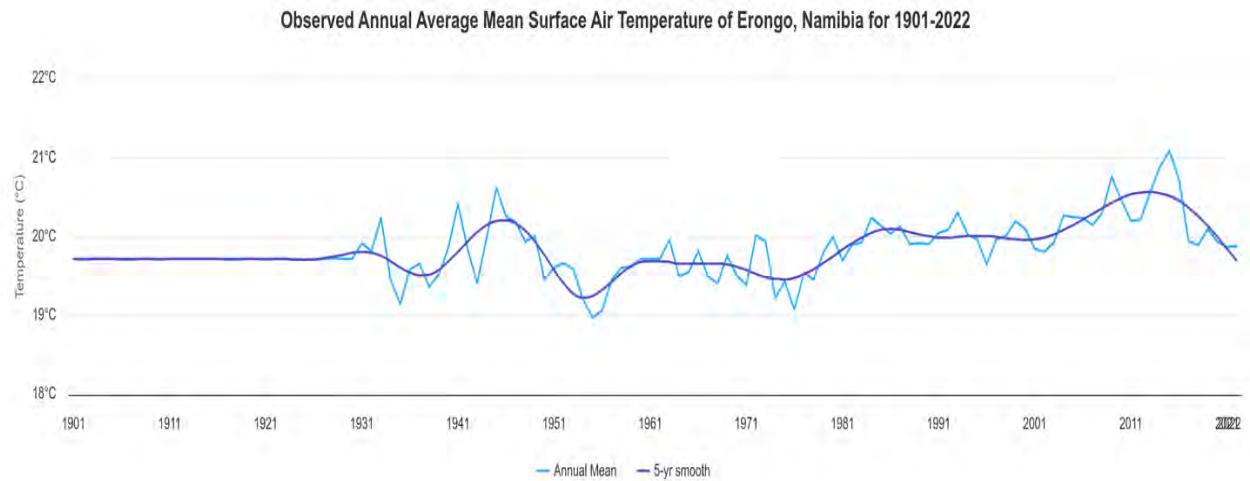


Figure 10 Air Temperature trend (1901 - 2022) - Erongo Region

6 Climate Impact - Site Specific

As the project is spread over several geographic climatic locations, they will be grouped by location and looked at separately for completeness and are analyzed as follows:

6.1.1 Walvis Bay

The mean yearly temperature trend shows that it is rising and so the impact of climate change in the area is increasing.

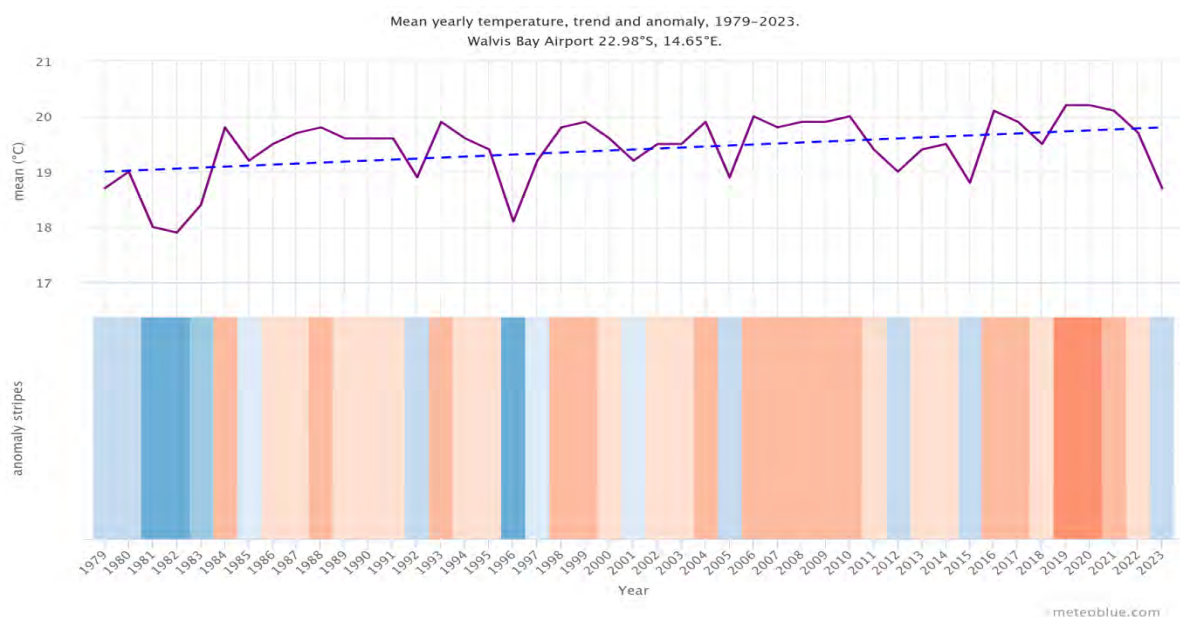


Figure 11 Walvis Bay area - mean yearly temperature



A similar trend also exists for precipitation showing extreme rainfall levels more frequently and indicating flooding events. These flooding events then are followed by long periods of droughts.

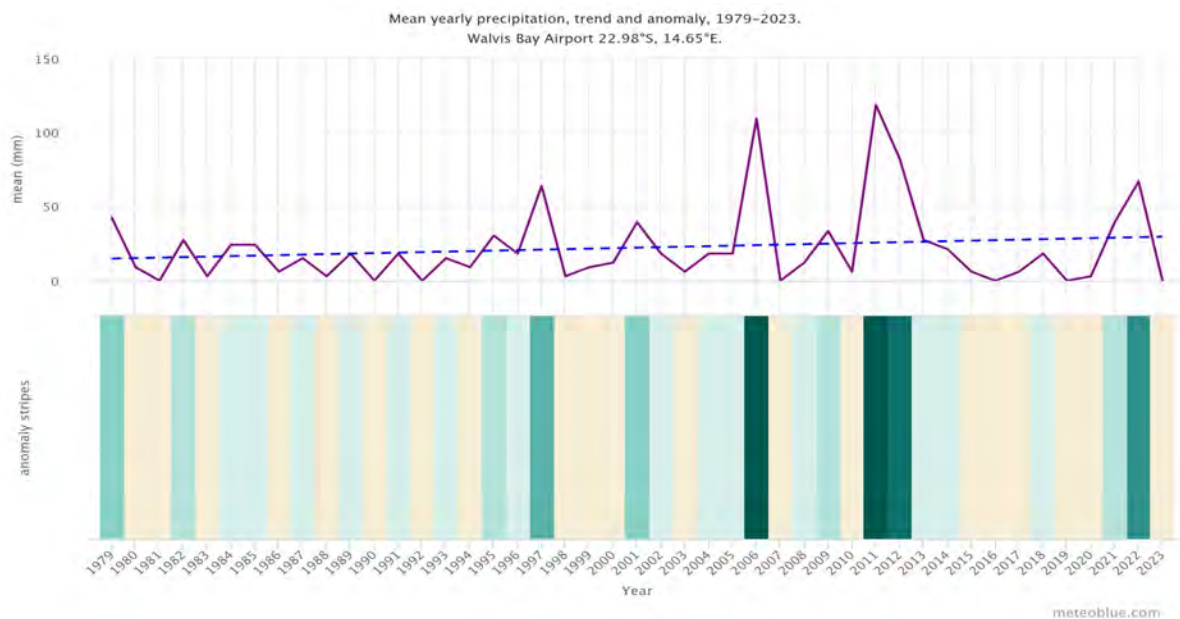


Figure 12 Walvis Bay area - mean yearly precipitation

6.1.2 Arandis

A similar temperature trend is seen in the Arandis area, as exists in the Walvis Bay area and is no surprise based on the fact that both lie in the hot arid desert areas of Namibia as defined by the Koppen-Geiger climate classification.

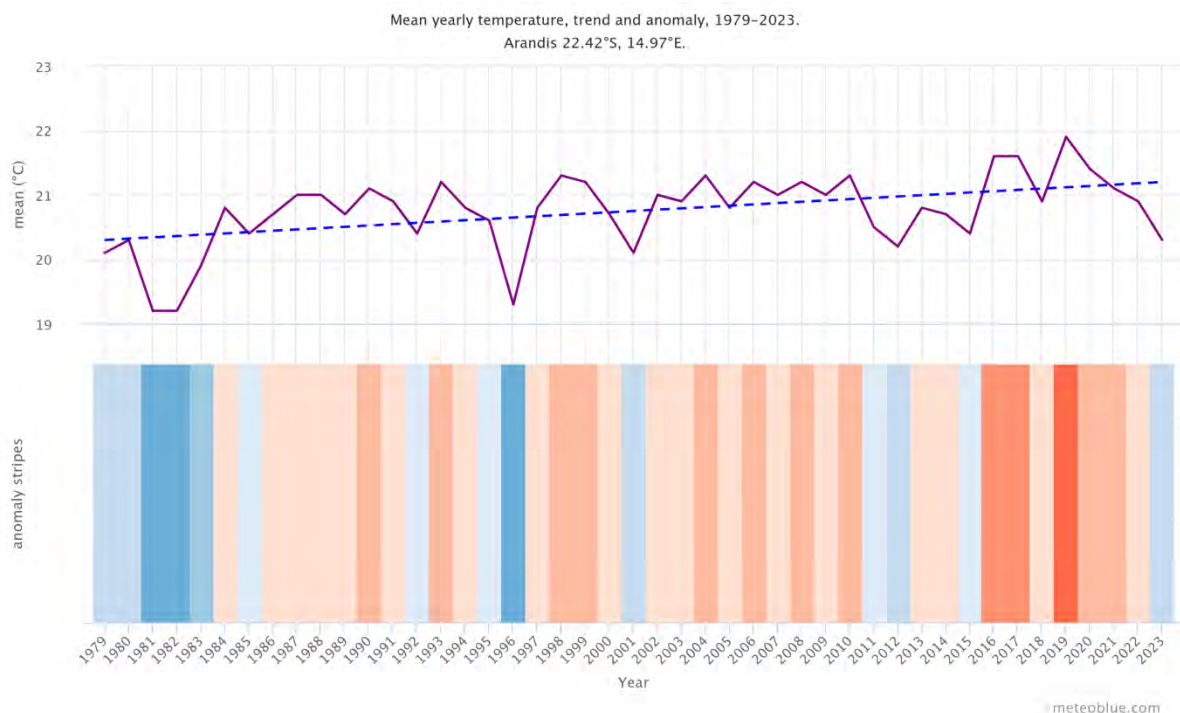


Figure 13 Arandis area - mean yearly temperature

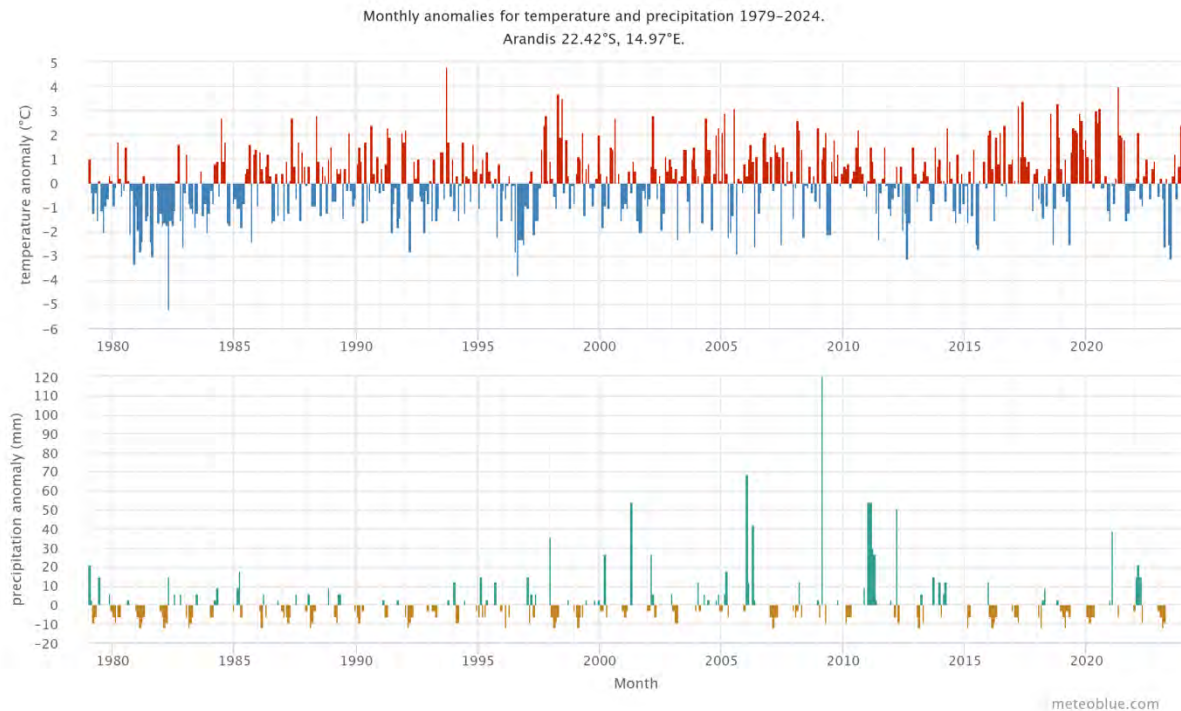


Figure 14 Monthly anomalies (1979 – 2024) - Arandis

The top graph of *Figure 14 Monthly anomalies (1979 – 2024) - Arandis* shows the temperature anomaly for every month since 1979 up to now. The anomaly tells you by how much it was warmer or colder than the 30-year climate mean of 1980-2010. Thus, red months were warmer and blue months were colder than normal. In most locations, you will find an increase of warmer months over the years, which reflects the global warming associated with climate change.

The lower graph of *Figure 14 Monthly anomalies (1979 – 2024) - Arandis* shows the precipitation anomaly for every month since 1979 up to now. The anomaly shows if a month had more or less precipitation than the 30-year climate mean of 1980-2010. Thus, green months were wetter and brown months were drier than normal³⁶.

6.2 Climate Change Resilience

The climate scenario analysis in this report is qualitative and the World Bank's Namibia Climate Risk report forms the basis (The World Bank Group, 2021), where the Representative Concentration Pathways (RCPs) scenarios is formed, as was the basis of the Intergovernmental Panel on Climate Change's (IPCC) analysis of the state of climate change globally.

³⁶ https://www.meteoblue.com/en/climate-change/arandis_namibia_3358670

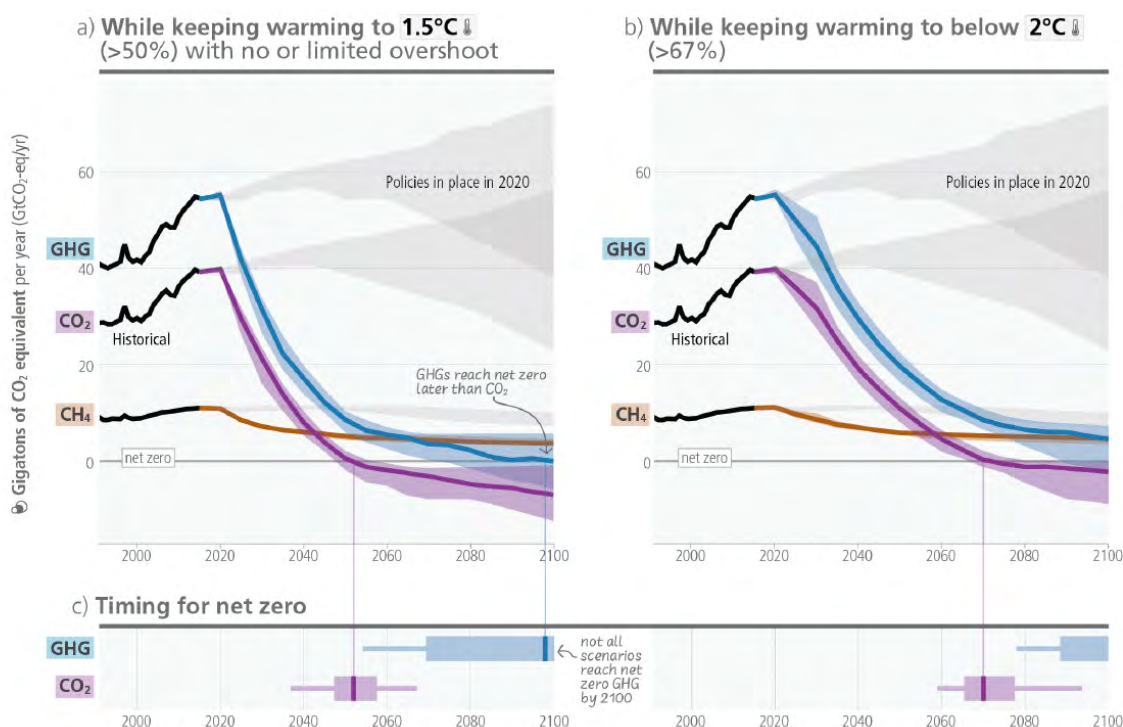


Figure 15 Global modelled pathways (limit warming to 1.5 deg. C)

6.3 Climate Outlook Approach

6.3.1 Representative Concentration Pathways (RCPs)

A common set of reference years and time periods are adopted for assessing climate change and its impacts and risks: the reference period 1850–1900 approximates pre-industrial global surface temperature, and three future reference periods cover the near-term (2021–2040), mid-term (2041–2060) and long-term (2081–2100).

RCP 2.6

The RCP 2.6 scenario envisions a low-emission future characterized by ambitious measures, including a reduction in the use of oil, enhanced energy efficiency leading to low energy intensity, global population stabilization at or below 9 billion by the year 2100, and the implementation of various interventions.

6.3.2 Climate Projections

Projections are taken utilizing information from the Coupled Model Inter-comparison Projects (CMIP)³⁷ that in earnest is the data used for IPCC Assessment Reports. The latest IPCC Assessment Reports utilize CMIP6 which this report relies on for direction and aligns with RCP 2.6 such as with the **SSP1-2.6** that supports increasing

³⁷ In CMIP6, future climate scenarios are presented through five SSPs: SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5, which present different societal development pathways. The total radiative forcing level by 2100 (the cumulative measure of GHG emissions from all sources) is presented at the end of each pathway (i.e., -1.9, -2.6, -4.5, 7.0, 8.5, etc.). <https://climateknowledgeportal.worldbank.org/country/namibia/climate-data-projections>



sustainability with global emissions cuts done severely but then only reach net-zero after 2050.

In line with this vision, it is imperative for the project to, at the very least, examine and prioritize the following key areas, although not a direct matter for this project, it is important in the overall approach for **Cleanenergy** that:

1. Increase Renewable Energy Electricity Generation: Incorporating the generation of electricity through solar photovoltaic (PV) or wind-based systems is an essential component of a sustainable energy strategy. By embracing renewable energies, the project can reduce its carbon footprint and contribute to the realization of a low-emission future.

2. Electric Vehicles (EVs): The adoption of electric vehicles, including Light-Duty Vehicles (LDVs), buses, and cars, is a crucial step toward reducing the dependence on fossil fuels and mitigating the carbon footprint associated with transportation. These are especially applicable for patrols, inspections and other operations and maintenance activities.

3. Hydrogen or Hydrogen Fuel Cell Vehicles: The adoption of hydrogen vehicles, particularly Heavy-Duty Goods Vehicles (HGVs) and buses is another crucial step toward reducing the dependence on fossil fuels and mitigating the carbon footprint associated with transportation. These are especially applicable for patrols, inspections and other operations and maintenance activities.

By considering alternative fuel vehicles as part of the project, it not only promotes sustainable mobility but also aligns with the RCP 2.6 vision of transitioning away from oil-based transportation systems.

Incorporating these elements into the project will contribute to its alignment with **the RCP 2.6 scenario** and support the pursuit of a low-emission future characterized by reduced oil usage, heightened energy efficiency, and a sustainable global population.

This strategic approach underscores the commitment to environmental responsibility and the mitigation of climate change.



7 Assessment Steps (Methodology)

This section of the Climate Impact Report outlines the methodology employed to evaluate the current and future effects of climate variability on ecosystems, economies, and communities. By integrating existing scientific research, stakeholder input, and local knowledge, we provide a framework for understanding the multifaceted challenges posed by climate change.

The assessment process commenced with a thorough review of existing climate data and projections, focusing on key indicators such as temperature fluctuations, precipitation patterns, and extreme weather events.

In addition to quantitative data, qualitative insights were gathered to illuminate the human dimensions of climate impact. Through this comprehensive assessment framework, we aim to equip policymakers, businesses, and civil society with the knowledge necessary to craft effective responses and build resilience against the ongoing challenges of climate change.

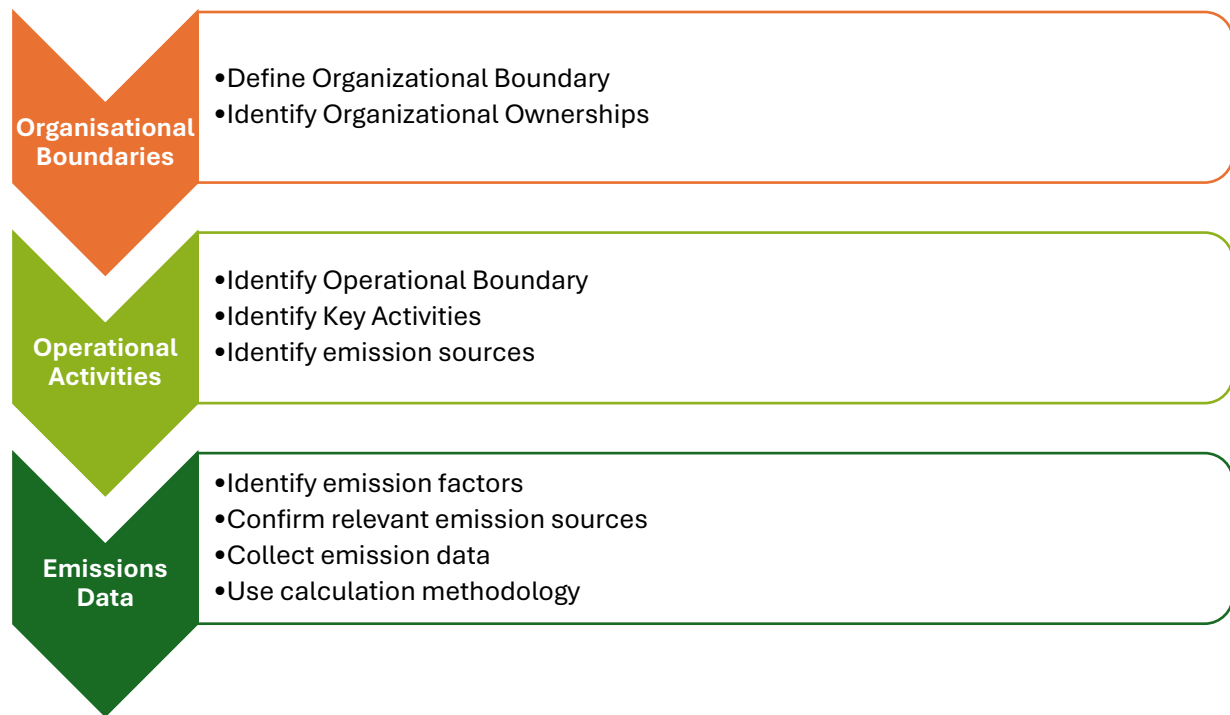


Figure 16 Assessment Steps

7.1 Measurement and Calculation

Activity data for each emission source is collected using a combination of direct measurement, calculation, estimation, and invoice information.

The calculation method is represented by the equation:

$$\text{Combustion Emissions} = \text{Activity Data (units used)} \times \text{Emission Factor/s (tonnes CO}_2\text{e/unit)}$$



8 Emission Sources

Scoped emissions are a systematic way to categorize greenhouse gas (GHG) emissions based on their sources and the level of control an organization has over them. This categorization helps organizations understand, measure, and manage their emissions more effectively.

The Greenhouse Gas Protocol, a widely recognized standard, divides emissions into three distinct scopes: **Scope 1, Scope 2, and Scope 3**. This framework provides a comprehensive approach to accounting for and reporting GHG emissions, facilitating better environmental management and climate strategy development.

8.1 Scope Understanding

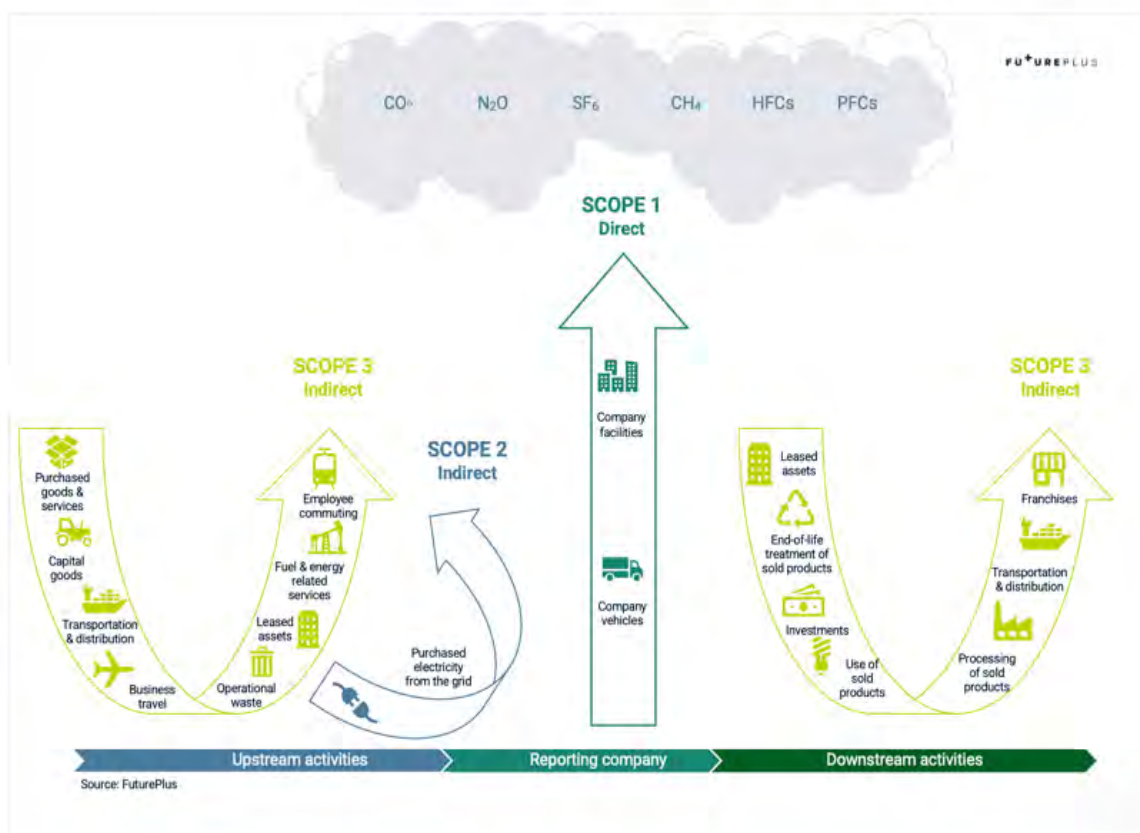


Figure 17 Scope Diagram: Scopes 1 - 3 (FuturePlus)

8.1.1 Scope 1 - Direct emissions from the company's operations

In the context of the **ammonia pipeline's operation**, these emissions arise directly from the operation and maintenance of the pipeline infrastructure, energy use, and not from possible fugitive leaks.

While ammonia pipelines themselves typically do not generate significant direct emissions, certain activities associated with their operation can still result in Scope 1 emissions.

These typically include:



- **Vehicle Operations:** Emissions from operations utilizing fossil fueled vehicles create greenhouse gas emissions.

Scope 1 in a reporting year: 76 tonnes carbon dioxide equivalent (tCO_2e)

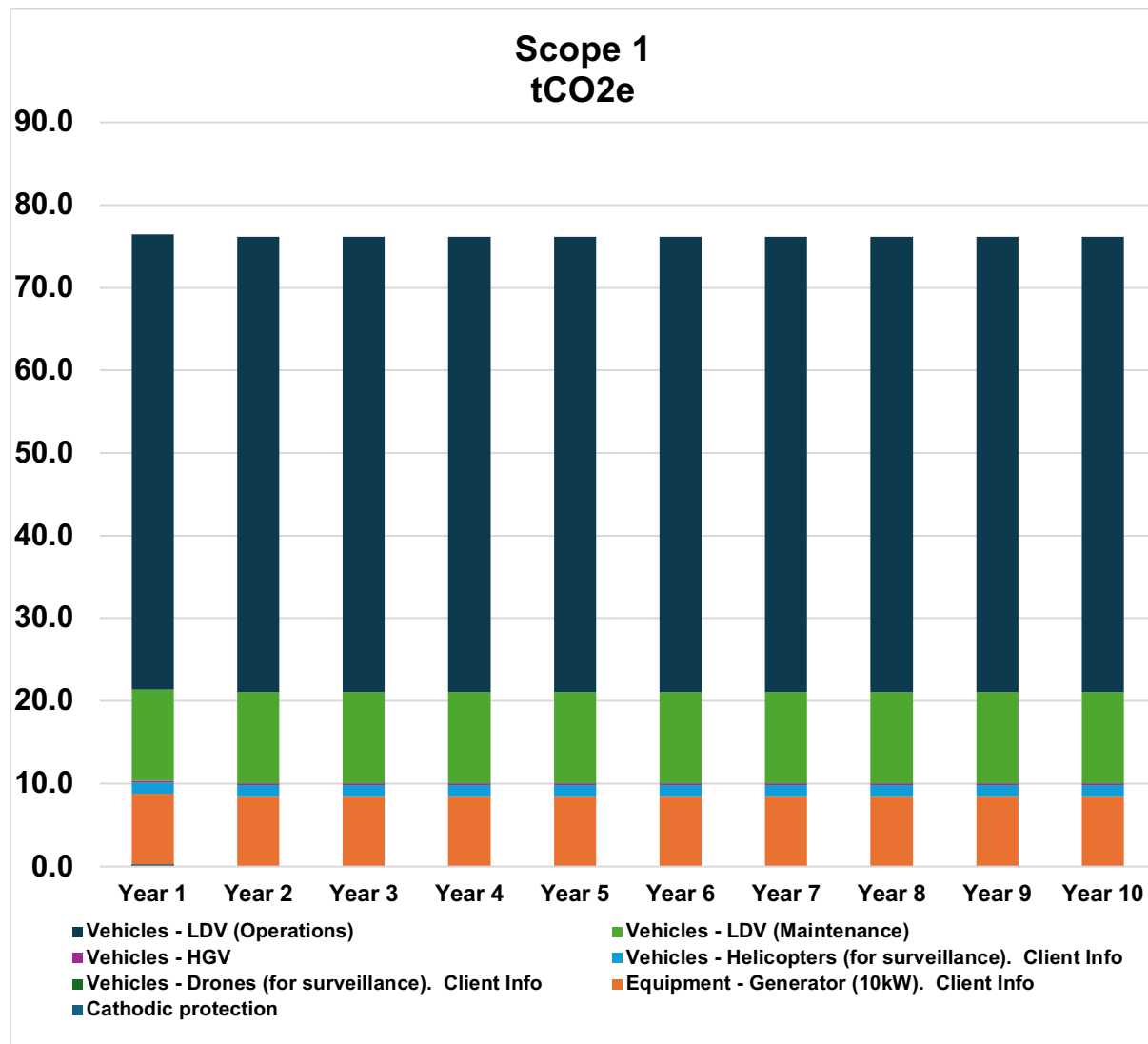


Figure 18 Scope 1 emissions (tCO_2e)

Scope 1 emissions in any reporting year as modelled, show that vehicle emissions account for some **87% of all emissions**, with operational vehicle use **accounting for 72% of all Scope 1 emissions**. This illustrates that the project has an opportunity to mitigate these emissions.

Effective management of Scope 1 emissions is a critical component of an organization's overall sustainability and climate change mitigation strategy, as it is internal and allows for the identification of emission reduction opportunities and the tracking of progress towards emission reduction goals.

Reduction Strategies

1. The transition to battery, electric, hydrogen or hybrid vehicles.



8.1.2 Scope 2 - Indirect energy emissions

Scope 2 emissions are indirect greenhouse gas emissions from the generation of purchased electricity, steam, heating, and cooling consumed by the organization. While the organization does not own the facilities where these emissions occur, it is responsible for the demand for the energy.

Organizations have a growing responsibility to account for their Scope 2 emissions as part of their broader sustainability and environmental management strategies. Accurate measurement and reporting of Scope 2 emissions are essential for demonstrating a commitment to environmental stewardship, transparency, and meeting regulatory and stakeholder expectations.

The electricity that will be used to operate the various equipment along the pipeline will be sourced from the PV2FUEL solar plant in Arandis.

Cathodic protection is modelled as being "Galvanic" cathodic protection and uses a "sacrificial" metal (galvanic anode) to corrode instead of the steel pipe structure, making it the cathode of an electrochemical cell to prevent corrosion³⁸.

The project proponent has reported that electricity will be sourced for the pipeline operations from renewables.

8.1.3 SCOPE 3

Scope 3 in a reporting year: 117 tonnes carbon dioxide equivalent (tCO_2e) in Year 1 and reduces to 20 tonnes carbon dioxide equivalent (tCO_2e) in the following years.

Scope 3 emissions even though hard to pin down, show as expected, the largest GHG impact on the project operations annually.

Scope 3 emissions are all other indirect greenhouse gas emissions that occur in the value chain of the reporting company, both upstream and downstream. These emissions are not directly owned or controlled by the organization but are a consequence of its activities.

Scope 3 emissions although still considered optional are increasingly recognized as a significant aspect of a company's overall carbon footprint and managing them is vital for a comprehensive approach to greenhouse gas emissions reduction.

Key to all scope understanding is the availability of accurate information and data. In regard to Scope 3, a full life cycle is not required³⁹. Focus will need to be placed on transparency and reliability of any data used.

³⁸ <https://www.matcor.com/resources/cathodic-protection/>

³⁹ GHG Protocol Guidance <https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf>

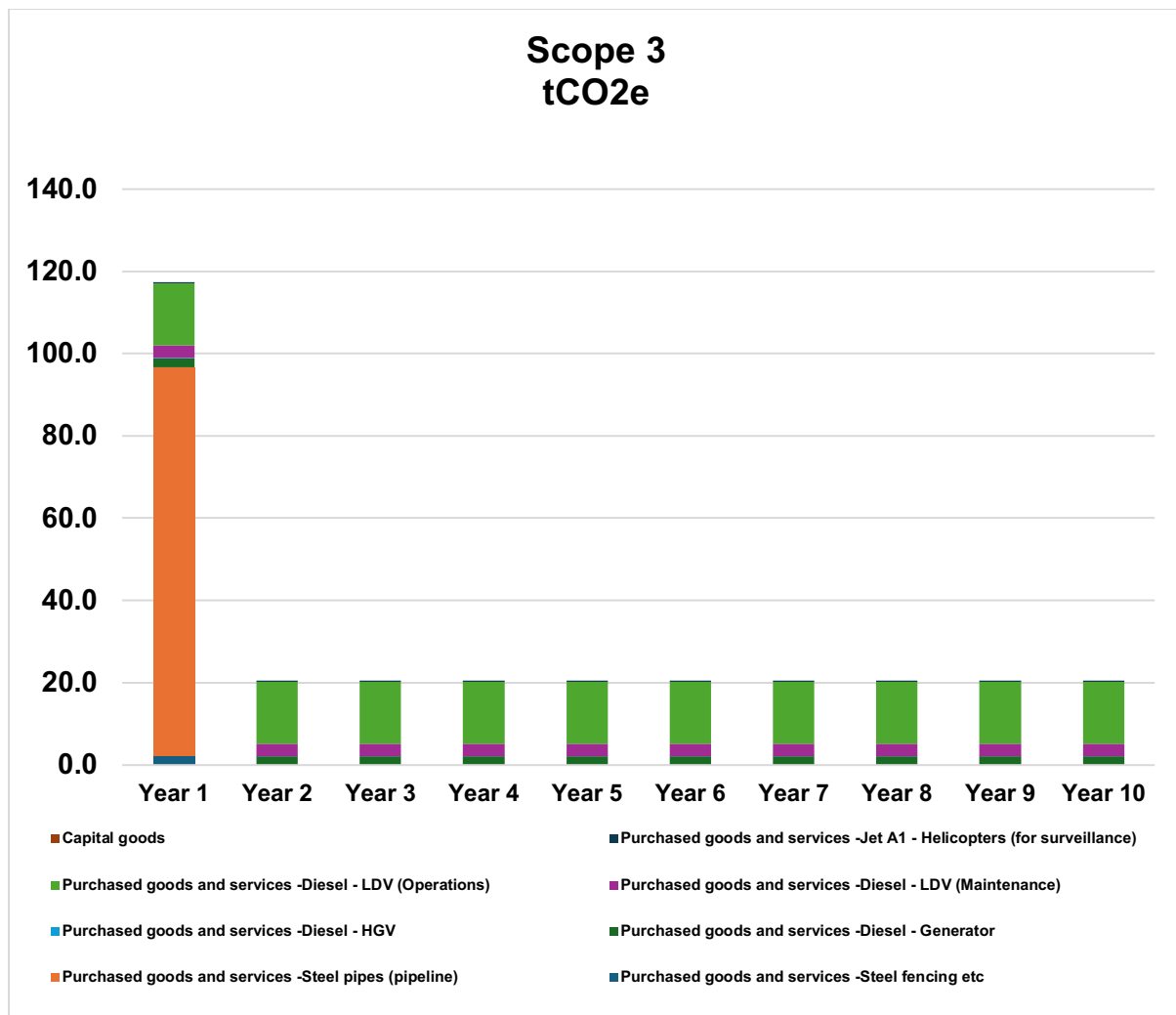


Figure 19 Scope 3 emissions (tCO₂e)

There are 15 categories of Scope 3 emissions, as defined by the Greenhouse Gas Protocol⁴⁰

8.1.3.1 Scope 3 limitations

While it is accepted that Scope 3 are those emissions not “*directly*” related to a company’s operations, the value chain however is a consequence of the business. As they (emissions) are not a result of direct control, then a difficulty in classification, records and measurement exist⁴¹.

Therefore, as noted by the International Council on Mining and Metals (ICMM)⁴², the “*Accounting and reporting the Scope 3 emissions of any company is inherently complex*” and so care has been taken not to create expectations of emissions that are literally “*guessed*”.

⁴⁰ <https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf>

⁴¹ <https://www.icmm.com/en-gb/guidance/environmental-stewardship/2023/scope-3-emissions-accounting-and-reporting>

⁴² <https://www.icmm.com/en-gb/guidance/environmental-stewardship/2023/scope-3-emissions-accounting-and-reporting>



In particular, there is no emissions data available for Namibian fuel suppliers and so following GRI guidelines, the Scope 1 and Scope 2 emissions are used as an Industry average to guide Scope 3 reporting.

Cleanergy has reported that key activities such as employee commuting and business travel will be served by the operations of other Cleanergy projects. To avoid double counting, no Scope 3 data other than those indicated above are carried in this report.

8.1.4 Electricity

No electricity from non-renewable sources will be used to operate the pipeline and is therefore not accounted for.

8.1.5 Water Supply

No water will be used to operate the pipeline and is therefore not accounted for.

9 Assumptions

The emission factors used in this Report are taken from various public and non-public sources. As pointed out by the IPCC⁴³ if no plant level information is available, a Tier 1 method emission factor (default factors).

Compiled fuel emission factors are based on well-to-tank (WTT) conversion factors that allow for the upstream Scope 3 emissions associated with extraction, refining, and transportation to an organizations site or asset to be included.

For all power (renewable and non-renewable), generation emissions factors are applied. The emission factor is based on a NamPower designated value.

The combustion of all fuels used, including by contractors are considered in Scope 1 and the associated upstream emissions in Scope 3.

9.1 Client Data

As the emissions in this report are based on a calculation of activity data. These are indicated below:

9.1.1 Fugitive Emissions

It is assumed that these will occur around areas such as valves, flanges, pump points etc. and is considered as zero emission value. The same value will be applied throughout⁴⁴.

However, it is also accepted that there are a “*wide range in estimates for emissions*”^{ix}. As a result, care has been taken to use the lowest default emission factors where more than one industry indicator^x.

9.1.2 Fugitive Emission Factor

The Fugitive Emission Factor (FEF) is an average leak factor determined from data collected during industry case studies. Emissions^{xi} from certain components are

⁴³ https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_3_Ch3_Chemical_Industry.pdf

⁴⁴ https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_3_Ch3_Chemical_Industry.pdf Table 3.1



expected to be so low that emissions from them do not need to be quantified. These include the following:

- Tubing size lines (flexible lines less than or equal to 125 mm in diameter⁴⁵) and equipment, unless the lines or equipment are subject to monitoring by any federal or state regulation. (*As of August 2017, no current state regulations require that tubing less than 125 mm be monitored*).
- Non-piping type fittings (swedge lock or ferrule fittings).
- Streams where the operating pressure is at least 0.7 psi below ambient pressure.

However, the information provided by Cleanergy have higher pressures and pipe sizes.

9.2 General Limitations

The following limitations associated with this assessment methodology occurs in part because assessment guidance has not been developed or regulated at this point in Namibia. However, using international leading practice, guidance and professional judgment give credence to the conclusions drawn.

There is always some level of uncertainty in estimating emissions factors, typically represented as a percentage margin (e.g., +/- 5%), and so contingencies are applied to create realistic upper limits. This arises because the activity data is often sourced from broad, averaged datasets, which may not accurately reflect the actual emissions. The extent of uncertainty can differ widely across different nations, particularly in cases where data collection practices are not as robust or precise.

9.3 Risk Factors

Identification of climate change-related risks and opportunities, which may include physical risks (e.g., extreme weather events, sea-level rise, temperature changes), transitional risks (e.g., policy and regulatory changes, market shifts), and reputational risks (e.g., public perception of the company's climate actions).

The IPCC (Intergovernmental Panel on Climate Change, 2022) notes that risk is key to their assessments. Risk is defined by the IPCC as

“The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from potential impacts of climate change as well as human responses to climate change.

Relevant adverse consequences include those on lives, livelihoods, health and well-being, economic, social and cultural assets and investments, infrastructure, services (including ecosystem services), ecosystems and species”.

⁴⁵ Assumed equal to 5 inches



Figure 20 TCFD Strategy Plan

Physical and transitional risks are important considerations in the context of climate change for several reasons:

- Business Continuity:
- Operational Efficiency:
- Regulatory Compliance:
- Investor and Stakeholder Confidence:
- Reputation and Social License:

In the context of climate change impacts, risks result from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system to the hazards. Hazards, exposure and vulnerability may each be subject to uncertainty in terms of magnitude and likelihood of occurrence, and each may change over time and space due to socio-economic changes and human decision-making.

As Namibia is dependent on its natural resources (Ministry of Environment & Tourism, 1995), Namibia has committed to combining an approach that incorporates both environmental awareness raising and promoting action thus creating “two fronts” to combat climate change.



10 Vulnerability

Vulnerability of a project to climate change is generally understood as a function of three main factors:

- I. **Exposure:** The degree to which the project is exposed to climate hazards (e.g., heatwaves, flooding, drought, sea level rise).
- II. **Sensitivity:** The degree to which the project is affected by climate impacts. For example, some sectors or regions are more sensitive to climate changes due to factors like reliance on specific resources (water, energy), infrastructure, or vulnerable populations.
- III. **Adaptive capacity:** The ability of the project to adapt to or cope with climate impacts. This depends on factors such as access to resources, governance, planning, and technological innovation.

The following sections encapsulate the potential vulnerability of the project stated over the short term (Years 1 – 3).

10.1 Risk Summary

RISK CATEGORY	RISK AND OPPORTUNITIES	Year 1	Year 2	Year 3
Physical	Water management	NO IMPACT	NO IMPACT	NO IMPACT
Physical	Ground stability	RL	RM	RH
Physical	Mobility, transportation and access to sites	RL	RL	RL
Physical	Disruption to energy infrastructure and supply	NO IMPACT	NO IMPACT	NO IMPACT
Physical	Worker health and safety	RL	RL	RL
Physical	Efficiency and performance of equipment	RL	RL	RL
Physical	Closure and post-closure of sites	RL	RL	RL
Physical	Biodiversity restoration and protection	RL	RL	RL
Transitional	Variable carbon pricing	OH	OH	OH
Transitional	Stricter environmental regulations	OH	OH	OH
Transitional	Compulsory emissions trading	OH	OH	OH



RISK CATEGORY	RISK AND OPPORTUNITIES	Year 1	Year 2	Year 3
Transitional	Higher than expected carbon taxes.	OH	OH	OH
Transitional	Shift in government policy	RL	RL	RL
Transitional	Poor performance of renewable energy technologies	RL	RL	RL
Transitional	Low or poor operational performance of alternative energy vehicles resulting in a return to fossil-fueled vehicles or expensive repairs/replacement.	RL	RL	RL
Transitional	Financial risks due to difficulty to attract investment.	RM	RM	RL
Transitional	Other policy changes not planned for.	RL	RM	RM

Table 3 Risk Summary

10.1.1 Risk Key

RISK	OPPORTUNITY	RISK CLASS
RH	OH	HIGH
RM	OM	MEDIUM
RL	OL	LOW
NO IMPACT	NO IMPACT	NO IMPACT

Table 4 Risk Key

10.2 Physical risks

Physical risks are impacts of extreme weather events (such as floods and cyclones) and long-term changes to weather and climate (such as precipitation patterns and rising sea levels).

Physical risks are generally associated with the direct impacts of climate change, such as extreme weather events (e.g., hurricanes, floods, wildfires), sea-level rise, and changing precipitation patterns. **Physical risks have direct financial consequences for organizations where those risks are realized, as well as up-front insurance**



and investment related costs and downstream effects for users of relevant goods and services.

These risks can disrupt operations, damage infrastructure, and lead to production interruptions, supply chain disruptions, and financial losses such as:

- Damage to pipeline infrastructure such as supports and footings due to subsidence created by excessive and irregular rainfall.
- Disruption of the power supply due to infrastructure damaged potentially from flooding created by excessive and irregular rainfall. (*This risk is placed at the Ammonia Plant*)
- Disruption or damage to transportation equipment or routes by heavy rains created by excessive and irregular rainfall.
- Drought-affected areas will probably increase, and extreme precipitation events, which are likely to increase in frequency and intensity, will augment flood risk. (United Nations Framework Convention on Climate Change, 2011)
- Flooding affecting employee safety and pipeline operations.

With climate change impacts, more frequent and intense flooding can result in damage to infrastructure, power plant, power lines and transport equipment or routes. Increased temperatures could lead to more “*bush/veld*” fires but this is expected to be low due to the arid nature of the pipeline route and absence of vegetation. Similarly, droughts will reduce water availability and add stress to water sources. This can lead to conflict with local communities (expected if occurring at the Ammonia Plant).

The challenges presented by climate change, such as extreme weather events (flooding, droughts, and storms), and temperature fluctuations, can impact the safety and efficiency the pipeline.

Stormwater Control: Design and implement robust stormwater drainage systems to prevent flooding and ensure that runoff water does not come into contact with the pipeline, which could cause subsidence, contamination or dangerous reactions.

The Integrated Water Resources Management (IWRM) (Ministry of Agriculture, Water and Forestry, 2010) states that due to the dry climate and unpredictable rainfall, water resources challenges in Namibia can only be addressed through a high degree of efficient water resources management.

The long-term objective of the IWRM Plan for Namibia is to enable the country to achieve a sustainable water resource management regime contributing to social equity, economic efficiency, and environmental sustainability in the country.

10.2.1 Ground Stability

The area along the pipeline, being run through an arid desert is sandy and so ground stability is a major issue although due to the generally arid nature of the area and this requires enhanced soil compaction or addition of soil stabilizers (e.g., cement or lime) to increase the ground's ability to withstand flooding and the additional weight of the pipeline infrastructure.



10.2.2 Closure and Post Closure

Due in part to the nascent nature of green hydrogen as a feed stock, there is a risk in the early years of this project that a minimal risk exists to the maintenance of activities to support any closure or post closure activities. There needs to be contingencies that bear this in mind.

10.3 Transition risks

Transition risks are generally classed as financial risks due to the structural shift to a low-carbon economy and are likely to result in the revaluation of a large range of assets, driven by changes in policy, technology and economics. Depending on the nature, speed, and focus of these changes, transition risks may pose varying levels of financial and reputational risk to organisations.

Transitional risks, if realized, can result in stranded assets, loss of markets, reduced returns on investment, and financial penalties, as well as adverse outcomes for governance and reputation.

A key issue is the stranding of assets that may not provide the expected financial returns and may end up as large financial liabilities.

Some key transition risks will be:

- Variable carbon pricing
- Stricter environmental regulations
- Compulsory emissions trading
- Higher than expected carbon taxes.
- Shift in government policy regarding the Modified Single Buyer⁴⁶ policy by reducing the portion of solar energy that a customer can produce or other conditions.
- Poor performance of renewable energy technologies especially due to erratic weather patterns brought about by climate change.
- Low or poor operational performance of alternative energy vehicles resulting in a return to fossil-fueled vehicles or expensive repairs/replacement.
- Financial risks due to difficulty to attract investment.
- Other policy changes not planned for.

11 Mitigation and Adaptation

Namibia is expected to see an 11.6% reduction in energy-related emissions versus a business-as-usual approach by 2030 (Ministry of Environment, Forestry and Tourism, 2021), resulting in some savings of national emissions of 2.8 MtCO₂e.

This reduction aligns with the country's efforts to mitigate climate change through improved energy efficiency, the adoption of renewable energy sources, and the implementation of sustainable practices across various sectors. The savings of 2.8 million tonnes of CO₂ equivalent (MtCO₂e) reflect the potential impact of these actions

⁴⁶ means the modified single buyer established under the Modified Single Buyer Market Structure, adopted by the Government of the Republic of Namibia, in April 2019.



on reducing Namibia's overall greenhouse gas emissions, contributing to global climate goals under the Paris Agreement.

11.1 Mitigation Measures

Mitigation seeks to reduce the release of harmful greenhouse gases (emissions) through sustainable energy utilization. **Emission reduction measures** not only help mitigate climate change but also bring about a range of **co-benefits** that contribute to broader societal and environmental goals.

Some direct and tangible co-benefits of emission reduction measures are derived from:

11.1.1 Alternative Options

- Hybrid Vehicles
- Plug-in Hybrid Electric Vehicles (PHEVs)
- Battery Electric Vehicles (BEVs)
- Hydrogen powered Vehicles
- Solar Power Plant

11.2 Adaptation Measures

The combination of rising temperatures, sensitivity of ammonia to heat, and the pipeline's partial above-ground exposure increases the probability and severity of operational and safety impacts.

11.2.1 Short-term (0–5 years)

- Enhance temperature monitoring and automated overpressure protection.
- Upgrade critical gaskets, sensors, and seal materials to high-temperature-rated alternatives.
- Implement predictive maintenance using thermal-stress modelling.
- Improve emergency response for heat-induced leaks.

11.2.2 Medium-term (5–15 years)

- Install passive cooling (shading, reflective coatings) in above-ground segments.
- Increase pipeline burial depth in identified hot-zone segments.
- Add redundancy to power systems at pumping nodes.
- Update design temperature thresholds to align with 2050 projections.

11.2.3 Long-term (15+ years)

- Redesign vulnerable sections using high-temperature-resistant alloys.
- Consider realignment of segments with highest projected heat stress.
- Integrate adaptation with broader decarbonized ammonia supply planning.



12 Recommendations

Cleanergy has an opportunity to use the findings and guidance in this report to create a baseline and also to adopt deeper climate friendly options. As a result, RDJ Consulting Services CC propose the following recommendations:

I. Governance

Have a clear identification of the Board and the Management's role both in strategic direction, assessment, and reporting of climate related risks and opportunities including and beyond those mentioned in this report.

II. Strategy

Describe the resilience strategy with a. clear climate scenario objective including and beyond those mentioned in this report. Setting targets is an essential component.

III. Risk management

Describe the process for managing climate related risks including and beyond those mentioned in this report.

IV. Operations

- Use of battery, hydrogen or at a minimum hybrid light delivery vehicles.
- Use of battery, hydrogen or at a minimum hybrid heavy delivery vehicles.

By addressing the above and tackling risk factors through targeted mitigation strategies, the Project can enhance its resilience to climate-related risks and ensure sustainable and responsible operations.

This proactive approach not only safeguards the Project's operations but also contributes to the broader efforts in combating climate change beyond that of the project itself.

The following is suggested:

Short-term (Year 0-2)

- a) **Vehicle Transition – Initial phase:** Transition vehicle fleets from any potential diesel-powered to hybrid or electric powered vehicles, which have lower carbon emissions.
- b) **Create data classification points:** This will involve classifying operational assets into groupings that allow for identification of emission “hotspots” and emission reduction opportunities.
- c) **Community Engagement:** Collaborate with local communities and stakeholders to develop long-term sustainable practices that align with environmental and social goals, thus minimizing the overall impact of the Project.

**Medium-term (Year 2 - 5)**

- a) **Vehicle Fleet Transition:** Continue to transition vehicle fleets from diesel-powered to electric vehicles, which have lower carbon emissions.

Long-term (Year 5 and beyond)

- a) **100% Transition:** It is anticipated that “*learning*” from the previous terms would now be better understood and possibly entrenched in the business culture.



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14 References

14.1 Project Name: Ammonia Pipeline: APP – 002567

The Ammonia Pipeline project is designed to connect two critical sites: Farm 58 (Portion 8

Project Name: Ammonia Pipeline: APP – 002567

The Ammonia Pipeline project covered by this **Baseline** Report is designed to connect two critical sites: Arandis, home of PV2FUEL (PV farm, Hydrogen + ammonia factory), where ammonia is to be produced, and the North Port (Ammonia terminal *Storage + loading*) in Walvis Bay, facilitating the storage, import, and export operations.

The ammonia pipeline from Arandis to Walvis Bay will transport approximately 1,440 metric tons of green ammonia per day (525,600 metric tons per annum) to the terminal at maximum capacity.

This initiative underscores a commitment to efficient and environmentally responsible industrial operations in the region.



14.2 Emission Tables

Unit	Scope 1 emissions by source	Assumed Qty	Assumed Unit	Year 1	Year 2
tCO ₂ e/kg	Cathodic protection	56 kg.		0.3	
tCO ₂ e/litre	Equipment - Generator (10kW). Client Info	3168 litres / annum		8.6	8.6
tCO ₂ e/	Vehicles - Drones (for surveillance). Client Info	3226 km/annum		0.0	0.0
tCO ₂ e/litre	Vehicles - Helicopters (for surveillance). Client Info	497 litres / annum		1.3	1.3
tCO ₂ e/km	Vehicles - HGV	395 km/annum		0.2	0.2
tCO ₂ e/km	Vehicles - LDV (Maintenance)	43428 km/annum		11.1	11.1
tCO ₂ e/km	Vehicles - LDV (Operations)	216153 km/annum		55.1	55.1
				76.5	76.2
Unit	Scope 2 emissions by source	Assumed Qty	Assumed Unit	Year 1	Year 2
tCO ₂ e/MWh	energy consumption (KWh) - purchased (utility based)		kWh	0	0
tCO ₂ e/MWh	energy consumption (KWh) - Renewable Energy supply (own plant)	9,203	kWh	0	0
				0	0
Unit	Scope 3 emissions by source	Assumed Qty	Assumed Unit	Year 1	Year 2
tCO ₂ e/kg	Purchased goods and services -Steel fencing etc	1200 kg (Year 1)		2.3	0.0
tCO ₂ e/kg	Purchased goods and services -Steel pipes (pipeline)	49728 kg (Year 1)		94.5	0.0
tCO ₂ e/litre	Purchased goods and services -Diesel - Generator	3168 litres / annum		2.1	2.1
tCO ₂ e/litre	Purchased goods and services -Diesel - HGV	99 litres / annum		0.1	0.1
tCO ₂ e/litre	Purchased goods and services -Diesel - LDV (Maintenance)	4560 litres / annum		3.0	3.0
tCO ₂ e/litre	Purchased goods and services -Diesel - LDV (Operations)	22696 litres / annum		15.1	15.1
tCO ₂ e/litre	Purchased goods and services -Jet A1 - Helicopters (for surveillance)	497 litres / annum		0.3	0.3
	Capital goods			0.0	0.0
	Waste generated in operations			0.0	0.0
	Business travel			0.0	0.0
	Employee commuting			0.0	0.0
	Investments			0.0	0.0
	Water use			0.0	0.0
				117.3	20.6



14.3 Assumed Data Tables

Calculations	Calculations	Calculations	Calculations	Calculations
Contingency	20%		365	Work Days - OPS
Pipeline length	112	km	220	Work Days - Mtce
Pipeline length	134.4	km	24	Day (Hr)
Generator	12	Litres/day	3	Shifts (24 hr)
Generator	3168	Litres/annum	8	hr (length - Shifts)
Drone (H2)	0	Zero Emissions	94	km
LDV - Drone Inspection	12	inspections - pipe		
LDV - Drone Inspection	3226	km/annum		
Helicopter - Inspections	2	inspections - pipe		
Helicopter Inspection	537.6	km/annum		
Helicopter Inspection	0.77	litres / km flight		
Helicopter Inspection	497	litres / annum		
Maintenance material (fence, etc)	1000	kg steel		
Maintenance material + contingency	1200	kg steel		
Pipeline steel - 6 inch	0.37	kg steel/metre		
Pipeline steel	49728	kg steel		
Paint	500	m2		
Paint (total 200 µm layer thickness)	0.3	l/m2		
Painting + contingency	180	liters		
Cathodic Anode	100	gram/annode		
Cathodic Anode - per 12m pipe	200	gram/annode		
Cathodic Anode - pipeline total	56000	gram/annode	33.6	km 25%
Contingency	5%			
Employee Commuting - OPS	197	km/day	Fuel (L/100km)	
Employee Commuting - OPS	216,153	km/annum	10.5/100	L/100km - LDV 10.5
Employee Commuting - Mtce	197	km/day	Fuel (L/100km)	
Employee Commuting - Mtce	43,428	km/annum	10.5/100	L/100km - LDV 10.5
HGV - Mtce	197	km/day	Fuel (L/100km)	
HGV - Mtce	395	km/annum	25/100	L/100km - HGV 2
				25
Electricity Use - DCS ops	0.5	kw		
Electricity Use - DCS ops	4,599	kWh/annum		
Electricity Use - Fibre Leak detection	0.5	kw		
Electricity Use - Fibre Leak detection	4,599	kWh/annum		
Electricity Use - DCS ops	5	kWh/annum		
TOTAL Electricity demand	9,203	kWh/annum		



14.4 Emission Factors

14.4.1 Emissions Factors

Scope	Source	Emission Factor	Unit
1	Diesel	0.00256	tCO ₂ e/litre
1	Petrol	0.00218	tCO ₂ e/litre
1	Lubricants	0.00300	tCO ₂ e/litre
1	Jet-A1	0.00260	tCO ₂ e/litre
1	Vehicles - HGV	0.00050	tCO ₂ e/km
1	Vehicles - LDV	0.00025	tCO ₂ e/km
2	Electricity - NamPower	0.00036	tCO ₂ e/kWh
3	Water - NamPower	0.00000	tCO ₂ e/litre
3	Stainless Fencing	0.00190	tCO ₂ e/kg
3	Stainless Steel Pipes	0.00190	tCO ₂ e/kg
3	Fuels - supply (Shell)	0.00066	tCO ₂ e/litre
3	Cathodic Protection	0.00518	tCO ₂ e/kg

Table 5 Emission Factors

14.4.2 Namibia Grid Emission Tables

In terms of this report, the *Harmonized IFI Default Grid Factors 2021 v3.2*⁴⁷ for Namibia and its Grid Network is taken as **0.3550 tCO₂/MWh** as advised by NamPower⁴⁸.

It is important to note the following guidance statement:

For the purpose of promoting greater harmonization, the IFI Technical Working Group (IFI TWG) on GHG accounting maintains a common dataset containing Default Emissions Factor (DEF) of the country's electricity grid including in-country interconnected grids.

The DEFs apply to electricity generation in a country and currently do not consider the impact of interconnections with neighbouring countries⁴⁹.

The common dataset containing DEFs is constructed using a Combined Margin (CM) for the grid that is comprised of an Operating Margin (OM) and a Build Margin (BM)⁵⁰.

⁴⁷ <https://unfccc.int/climate-action/sectoral-engagement/ifis-harmonization-of-standards-for-ghg-accounting/ifi-twg-list-of-methodologies>

⁴⁸ Via e-mail, January 2024

⁴⁹ IFI TWG is undertaking further work to develop harmonized approaches for interconnection with neighbouring countries.

⁵⁰ The methodologies and databases listed above are developed and solely owned by the Technical Working Group of the International Financial Institutions (IFI TWG). Any comments and queries related to these

14.5 Terms and Acronyms

Terms	Meaning
Accuracy	A relative measure of the exactness of an emission or removal estimate. Estimates should be accurate in the sense that they are systematically neither over nor under true emissions or removals, so far as can be judged.
Activity Data:	Activity data is a key input for the calculation of GHG emissions and refers to the data associated with an activity that generates GHG emissions, such as litres of gasoline consumed from company cars. This activity data is collected in physical units (gallons) or energy units (therms) and then combined with an emissions factor and the relevant greenhouse gas GWP value to calculate CO ₂ e
Business as Usual (BAU)	A practice or ensemble of practices that take place on a delineated area over a given period of time.
Carbon Dioxide Equivalent (CO₂e):	Carbon dioxide equivalent (CO ₂ e) is the standard unit used to compare and account for emissions from various GHGs based on their global warming potential. For example, CO ₂ has a GWP of 1 and CH ₄ (methane) has a GWP of approximately 28 (on a 100-year time horizon). Therefore, for every ton of CH ₄ emitted, an equivalent of 28 tons of CO ₂ would be emitted. Since one ton of a particular GHG is not the same GWP as one ton of another, this standard unit is a simple way to normalize and express GHGs as an equivalent of CO ₂ .
Carbon Footprint	The term 'carbon footprint' is used to mean the total mass of greenhouse gas emissions caused by an organisation, product or process over a given time period. A carbon footprint considers all seven of the Kyoto Protocol greenhouse gases: carbon dioxide (CO ₂), methane (CH ₄), nitrous oxide (N ₂ O), sodium hexafluoride (SF ₆), nitrogen trifluoride (NF ₃), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).
CO₂e	'CO ₂ e' or 'carbon dioxide equivalent' is a unit of measurement of greenhouse gases that allows the different gases to be compared on a like-for-like basis relative to one unit of CO ₂ .
Emissions	Metric tonnes (t)
Environmental, Social and Governance (ESG)	Environmental, Social and Governance framework.
Fugitive Emissions (oil and natural gas systems)	The intentional or unintentional release of greenhouse gases that occur during the exploration, processing, and delivery of fossil fuels to the point of final use. This excludes greenhouse gas emissions from fuel combustion for the production of useful heat or power. It encompasses venting, flaring, and leaks.
Gigajoule	Energy unit (GJ)
Good Practice	" <i>Good practice</i> " is a key concept for inventory compilers to follow in preparing national greenhouse gas inventories.

products should be addressed to the IFI TWG and sent to IFITWG-Coordinator IFITWG-Coordinator@unfccc.int



Terms	Meaning
	Certain terms in the definition have been updated based on feedback from the statistics community, such that this definition can be also understood as "a set of procedures intended to ensure that greenhouse gas inventories are accurate in the sense that they are systematically neither over- nor underestimates so far as can be judged, and that they are precise so far as practicable" in the context of refinement of Chapter 3 of Volume 1. <i>Good Practice</i> covers choice of estimation methods appropriate to national circumstances, quality assurance and quality control at the national level, quantification of uncertainties and data archiving and reporting to promote transparency.
Global Warming Potential:	GHGs released into the atmosphere have different radiative effects depending on the unique qualities of the gas. The factor describing the radiative forcing impact of one unit of a given GHG relative to one unit of CO₂ is known as the Global Warming Potential (GWP). Since the amount of warming a gas causes over a given period (normally 100 years) varies, GHG emission calculations must account for the GWP of each gas. GWP is an index with CO₂ having an index value of 1. The GWP for all other GHGs refers to the amount of warming they cause compared to CO₂
Greenhouse gas	Greenhouse gases are gases in Earth's atmosphere that trap heat. They let sunlight pass through the atmosphere, but they prevent the heat that the sunlight brings from leaving the atmosphere
Grid emission factor⁵¹ (GEF)	The List of Grid Emission Factors aims to provide information to be utilized for research and analysis regarding emissions from electricity generation. A "grid emission factor" refers to a CO₂ emission factor (tCO₂/MWh) which will be associated with each unit of electricity provided by an electricity system. It is a parameter to determine the baseline emissions for CDM projects in the renewable energy sector (hydro, wind, solar PV, and geothermal power, etc.) and waste heat/gas recovery sector.
Kilometre	Length (km)
kilowatt-hour	Energy unit used primarily with electricity (kWh)
Litre	Liquid measure of volume
Mass	Gravitational Weight (kg)
Metre	Length (m)
Methane	A greenhouse gas (CH ₄)
Nitrous Oxide	A greenhouse gas (NO ₂)
PPA	Power Purchase Agreement
Renewable Energy	In this report, refers to solar energy sources.
Scope 1 emissions	refer to a category of greenhouse gas emissions associated with direct sources of emissions that are owned or controlled by an organization. These emissions are a fundamental component of an organization's carbon footprint and typically originate from activities such as the combustion of fossil fuels, on-site industrial processes, and emissions from vehicles or equipment owned and operated by

⁵¹ <https://www.iges.or.jp/en/pub/list-grid-emission-factor/en>



Terms	Meaning
	the organization. In the context of the Greenhouse Gas Protocol, a widely recognized international standard for greenhouse gas accounting, <i>Scope 1 emissions are those for which an organization has operational control and are reported in the organization's carbon inventory.</i>
Scope 2 emissions	refer to greenhouse gas emissions associated with a company's activities. It specifically pertains to indirect emissions, which result from the generation of electricity, heating, and cooling consumed by the organization. <i>These emissions are not produced directly on-site but are a consequence of purchased energy sources.</i>
Scope 3 emissions	refer to indirect emissions that result from activities related to an organization but occur from sources not owned or controlled by the organization. These emissions encompass a wide range of sources, including the entire value chain of an organization, such as suppliers, customers, transportation, and the end-of-life treatment of products. The Greenhouse Gas Protocol's Scope 3 framework classifies these emissions into 15 different categories, such as purchased goods and services, transportation and distribution, and use of sold products, among others.
TCFD	Task Force on Climate-related Financial Disclosures https://www.fsb-tcfd.org/



14.6 Conversion Table

To:		TJ	Gcal	Mtoe	Mtce	MBtu	GWh
From:	Multiply by:						
Tera joule	TJ	1	2.39E+02	2.39E-05	3.41E-05	9.48E+02	2.78E-01
Giga calorie	Gcal	4.19E-03	1	1.0E-06	1.43E-07	3.97E+00	1.16E-03
Mega tonne oil equivalent	Mtoe	4.19E+04	1.0E+08	1	1.43E+00	3.97E+07	1.16E+04
Mega tonne coal equivalent	Mtce	2.93E+04	7.0E+06	7.00E-01	1	2.78E+07	8.14E+03
Million british thermal units	MBtu	1.06E-03	2.52E-01	2.52E-08	3.60E-08	1	2.93E-04
Giga watt hours	GWh	3.60E+00	8.60E+02	8.60E-05	1.23E-4	3.41E+03	1



14.7 Drones

14.7.1 Fixed Wing



Figure 21 The AiRanger™

Powered by fuel-injected gasoline engine, the AiRanger is designed for commercialized airborne applications in austere environments at large scale. Generating <5.5 lbs CO₂ per hour, the aircraft can carry multiple sensors simultaneously, including remote sensing, surveillance, particulate sensors and small cell sites for emergency communications^{xii}.

Length:	10 ft
Wing Span:	18.6 ft
Endurance:	15 + hours (configuration dependent)
Service Ceiling:	15,000 ft
Speed (dash/typ. cruise/min):	100kts / 50-75 kts / 50
Engine Power:	8.2 hp
Maximum Takeoff Weight:	220 lbs
Empty Weight:	145 lbs
Max. Payload Weight:	75 lbs (Payload + Fuel)
Payload Bays:	Fuselage and wing hard points
Launch/Recovery:	Lightweight catapult / belly skid landing
Onboard Power:	1,150 + watts (600 watts available for payloads)
Communications:	Line of sight (LOS), Beyond-line-of sight (BLOS), Global BVLOS (SATCOM + LTE)



14.8 Rotary Wing



Figure 22 Doosan DS30

The world's first mass manufactured hydrogen fuel cell drone, DS30W opens new scope for drone use by making 2 hours of flight a reality. This makes applications in industrial market possible. With 2 hours, DS30W can travel up to 80km, and has flown over 72km of seawater in 2019 at U.S. Virgin Island^{xiii}.

With this protective travel equipment, you can carry DS30W in your regular SUV, Van, or pickup truck. Because the internal structure was made to exactly fit the landing gear, the drone will remain stable in case of rough bumps or detour.

Product	DS30W	Dimensions (W x L x H) ¹⁾	1,850 x 1,850 x 815mm
Rated Power	2.7kW	Diagonal Wheelbase	1,990mm
System Weight	21.9kg (with 10.8L tank) 20.9kg (with 7L tank)	Max Take off Weight	24.9kg
		H2 Tank	10.8/7L
Payload(Max)	3kg	Operating Temperature	- 5 to 40°C
Flight Time	120min (without payload)	Wind resistance	12m/s



15 Endnotes / References

ⁱ <https://www.undp.org/africa/ticad/stories/just-energy-transitions-development-priority-africa>

ⁱⁱ <https://www.iea.org/reports/towards-hydrogen-definitions-based-on-their-emissions-intensity/executive-summary>

ⁱⁱⁱ <https://treasury-management.com/articles/a-new-framework-for-esg>

^{iv} <https://gh2.org/sites/default/files/2024-09/H2-Emissions-Accounting-White-Paper-Sept%202024-compressed.pdf>

^v <https://nepis.epa.gov/Exe/tiff2png.cgi/P1005ATT.PNG>

^{vi} The Green Hydrogen Organisation (GH2) is a not profit foundation under Swiss law. In addition to its office in Geneva it is present in London, Oslo, Perth, and Sydney. The mission of GH2 is to dramatically accelerate the production and utilisation of green hydrogen across a range of sectors globally. It will push to rapidly decarbonise industries like steel, cement, fertilisers, shipping and aviation that have so far made limited progress reducing their emissions. A global standard that defines green hydrogen is essential to promote confidence, raise and leverage investment, facilitate trade and unlock green hydrogen's vast potential. Additional information regarding GH2 is available via www.gh2.org.

^{vii} https://gh2.org/sites/default/files/2023-01/GH2_Standard_A5_JAN%202023_1.pdf Page 26.

^{viii} Walvis Bay is a harbour town. Home to Namibia's largest commercial port plays a vital role in the country's trade, receiving nearly a 1,000 vessels and handling approximately 8 million tonnes of cargo each year^{viii}. The Port Authority is committed to maintaining standards, fully complying with the International Ship and Port Facility Security Code (ISPS). Additionally, the port is certified for several ISO standards, underscoring its dedication to operational excellence and safety. This activity is generating emissions but to avoid double counting, emissions are included in the vehicle data and electricity consumption of the general Walvis Bay area.

Walvis Bay is home to a 5,000 hectare salt field^{viii} that processes approximately 100 million tonnes of sea water annually^{viii}, producing over 700,000 tons of high-quality salt.^{viii} This process is generating emissions but to avoid double counting, emissions are included in the vehicle data and electricity consumption of the general Walvis Bay area.

^{ix} <https://www.frontiersin.org/journals/energy-research/articles/10.3389/fenrg.2023.1207208/full>

^x Frazer-Nash Consultancy, (2022). *Fugitive hydrogen emissions in a future hydrogen economy*. United Kingdom: Frazer-Nash Consultancy.

^{xi} <https://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/fugitive-guidance.pdf>

^{xii} <https://americanaerospace.com/airanger-medium-altitude-long-enduranceunmanned-aircraft-system-uas/>

^{xiii} <https://www.doosanmobility.com/en/products/drone-ds30/>