METHODOLOGY

GS4GG PAA M400-11

SDG 13

GREEN AMMONIA PRODUCTION

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SUMMARY

This methodology is applicable to activities that reduce or avoid greenhouse gas (GHG) emissions from ammonia production by replacing fossil-fuel-intensive conventional processes with low-carbon alternatives. It applies to newly built (greenfield) or retrofitted (brownfield) industrial facilities that synthesize ammonia using green hydrogen (produced via water electrolysis) and nitrogen (separated from the air), powered exclusively or primarily by renewable electricity. The methodology quantifies emission reductions through the direct measurement (metering) of the electricity consumed and the exact volume of ammonia produced.

The methodology includes standardized approaches to:

- **Baseline Setting:** Utilizing Best Available Technology (BAT) benchmarks to ensure emission reductions are measured conservatively against modern, highly efficient conventional plants.
- **Additionality & Lock-in Risk:** Incorporating rigorous assessments to ensure activities demonstrate an ongoing financial need for carbon revenue and actively avoid creating long-term infrastructural dependencies on fossil fuels.
- **Grid & Leakage Accounting:** Applying marginal grid emission factors to accurately capture the climate impact of any non-renewable grid electricity used as a backup and comprehensively accounting for out-of-boundary leakage, including the cradle-to-gate embodied carbon of new infrastructure.
- **Encouraging Ambition over Time:** Applying a Downward Adjustment Factor (DAF) to progressively lower the crediting baseline, automatically aligning the activity's ambition with the host country’s evolving Net-Zero targets.

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1| KEY INFORMATION

1.1.1 | The following table describes the key information for the application of the methodology.

Table 1. Key information

Term	Description
Activity summary	The activity involves the production of low-carbon ammonia exclusively for eligible end-uses (currently limited to fertiliser manufacturing), replacing conventional, fossil-fuel-intensive ammonia production. The activity synthesises ammonia using green hydrogen (produced via water electrolysis) and nitrogen (separated from the air). The production process shall be powered entirely or predominantly by renewable electricity. Emission reductions shall be quantified through the direct measurement (metering) of the electricity consumed and the exact volume of ammonia produced, measured against a Best Available Technology (BAT) baseline and adjusted downwards over time.
Mitigation type	☒ **Emission reduction**
Applicable activity scale	☒ Micro scale (≤10,000 tCO_2e per year) ☒ Small scale (≤60,000 tCO_2e per year) ☒ Large scale (>60,000 tCO2e per year)
Sectoral Scope	**Sectoral Scope 1 (**Energy Industries) **Sectoral Scope 4:** Manufacturing Industries **Sectoral Scope 5:** Chemical Industries
Activity Requirement	The activity shall comply with the latest versions of the GS4GG Principles and Requirements and the GS4GG Safeguarding Principles and Requirements.
Activity start date	The start date shall be the earliest date on which the activity developer has committed to expenditures related to the physical implementation, equipment procurement, or construction of the proposed activity.
Crediting Period start date	The start date of the crediting period shall be the date of the start of commercial production of low-carbon ammonia, or a maximum of two years prior to the date of design certification, whichever occurs later.
Crediting period length	Five years, renewable twice (Total 15 years). If any legal mandate requiring the mitigation activity comes into force (and is enforced), the activity can be credited only until the date the legal requirements take effect.

Geographical applicability	Global
Limitations	The methodology strictly excludes ammonia produced using hydrogen derived from fossil fuels (e.g., Steam Methane Reforming or coal gasification) This includes "blue" ammonia equipped with Carbon Capture and Storage (CCS). Hydrogen derived from the gasification or pyrolysis of biomass or waste feedstocks is also excluded.

2| DEFINITIONS

2.1.1 | The definitions outlined in the Glossary of Gold Standard for the Global Goals and the Activity Requirements shall apply, in addition to those outlined below:

Table 2. Terms and definitions

TERM	DEFINITION
Air Separation Plants (ASU)	A facility or process unit that separates atmospheric air into its primary components—typically nitrogen and oxygen—using methods such as cryogenic distillation or Pressure Swing Adsorption (PSA).
Ammonia (NH_3)	A chemical compound consisting of nitrogen and hydrogen. Under this methodology, eligibility is restricted to ammonia used for fertilizer manufacturing (see Section 3.2, Applicability Conditions)[1].
Best Available Technology (BAT)	The most economically viable and environmentally sound technology currently operating at scale in the relevant geographical scope. in the relevant geographical scope. For the purposes of this methodology, BAT is determined using the five-criteria framework detailed in the Supplementary Information

[1] Between 75% and 90% of world’s industrial ammonia production is used for making fertilizer, and about half of the world’s food production relies on ammonia-based fertilizers. Global ammonia production currently reaches 183 million tonnes annually. The two main feedstocks are natural gas (72%) and coal (22%), complemented by smaller amounts of naphtha and heavy fuel oil. About 85% of this ammonia goes into producing nitrogen fertilizers, which help feed approximately half of the world's population. Carbon dioxide emissions vary by feedstock type: natural gas-based production generates 1.6 to 1.8 tonnes of CO_2 per tonne of ammonia (rising to about 2.2 tonnes when including upstream emissions), while coal-based production releases about 4.0 tonnes of CO_2 per tonne. Based on 2020 data, with production at 183 million tonnes and total emissions at 0.5 gigatonnes of CO2 (~1% of Global Greenhouse emissions), the global average emission intensity is 2.73 tonnes of CO_2 per tonne of ammonia. Source: IRENA and AEA (2022), Innovation Outlook: Renewable Ammonia, International Renewable Energy Agency, Abu Dhabi, Ammonia Energy Association, Brooklyn.

	and is operationalized as a specific emission factor (EF_{BAT}) representing the direct process and combustion emission intensity of top-decile conventional plants.
Commercial Operation Date (COD)	The date on which a renewable energy facility has completed commissioning tests, is connected to the grid (if applicable), and can continuously deliver electricity to the mitigation activity.
Conventional Ammonia production:	The highly carbon-intensive production of ammonia utilizing fossil fuels (such as natural gas or coal) as the primary feedstock for hydrogen generation and process heat.
Green Hydrogen	Hydrogen generated through a sustainable process where renewable electricity is used to power an electrolyser that splits water into hydrogen and oxygen.
Green or Low carbon Ammonia	Ammonia (NH_3) produced via a process pathway designed to result in near-zero greenhouse gas emissions. For the purposes of this methodology, this specifically refers to ammonia produced using hydrogen derived from water electrolysis and nitrogen separated from air using processes powered primarily by renewable energy.
Haber-Bosch-Process	The well-established industrial process where H_2 and N_2 react at high temperatures (e.g., 400-500°C) and pressures (e.g., 150-300 bar) over a catalyst to synthesize ammonia (NH_3).
Locally available drinking water	The volume of potable water (water safe for human consumption) that can be reliably accessed or supplied within a specific, defined geographic area. This geographic area, defined at the design certification stage, may refer to a water utility's service area or an administrative boundary (such as a city or county).
Placed In Service (PIS) Date	The date the low-carbon ammonia facility (or a functionally independent component thereof) is placed in a condition or state of readiness and availability for its specifically assigned commercial function. For phased construction, the activity may begin crediting only when the complete process chain (electrolysis, air separation, and ammonia synthesis) is operational and capable of producing ammonia eligible under this methodology. Individual components installed in earlier phases do not independently qualify as activities.
Renewable Energy / electricity	Electrical energy derived from zero-emission renewable sources (e.g., solar, wind, geothermal). To qualify for zero-emission accounting under this methodology, the electricity shall meet strict criteria regarding its origin, additionality to the grid, and hourly temporal matching with the activity's consumption unless exempted under the methodological tool applied for quantification of Grid emission factor. The purchase of generic, unbundled renewable electricity certificates of any form does not qualify as an eligible source of

	renewable electricity under this methodology, as they do not provide a direct, verifiable link to the activity's specific energy consumption. A scenario may involve the construction of a dedicated renewable energy facility built specifically to serve the load of the activity but located off-site. In such cases, the non-physical delivery of this dedicated renewable electricity to the activity via a grid connection may be considered acceptable under specific conditions. These conditions require robust contractual arrangements demonstrating that the electricity consumed by the activity originates from the dedicated renewable energy facility. Acceptable contractual mechanisms can include one or more Power Purchase Agreements (PPAs), including virtual PPAs, or other verifiable contractual instruments that ensure exclusivity and prevent double counting of the renewable attributes of the electricity generated.
Steam Methane Reforming (SMR):	The conventional, highly carbon-intensive industrial process for producing hydrogen by reacting methane (typically from natural gas) with steam at high temperatures and pressures.
Water Electrolysis	The process of using electricity to split water (H_2O) into hydrogen (H_2) and oxygen (O_2). Types include Alkaline Water Electrolysis (AWE), Proton Exchange Membrane (PEM) Water Electrolysis, and Solid Oxide Electrolysis (SOE).

3| SCOPE, APPLICABILITY, AND ENTRY INTO FORCE

3.1 | Scope

3.1.1 | This methodology is globally applicable to activities that produce low-carbon ammonia for the manufacturing of fertilisers. It facilitates the reduction of greenhouse gas (GHG) emissions by substituting fossil-fuel-intensive conventional ammonia production with a clean process pathway. This pathway shall utilize green hydrogen (produced via water electrolysis) and nitrogen (produced via air separation), powered entirely or predominantly by renewable electricity.

3.2 | Applicability

3.2.1 | This methodology applies to activities that satisfy the applicability conditions listed below. Failure to meet any of these conditions renders the methodology inapplicable.

3.2.2 | **Process Pathway:** The activity shall produce ammonia (NH_3) utilising a process sequence consisting of

a. Hydrogen (H_2) production exclusively via water electrolysis.

b. Nitrogen (N_2) production via air separation (e.g., using an Air Separation Unit based on cryogenic distillation or PSA technology).
c. Ammonia synthesis via the Haber-Bosch process using the hydrogen and nitrogen produced in the preceding steps.

3.2.3 | **Activity Type**

a. **Greenfield or Brownfield:** The activity may involve the construction of a newly built (greenfield) low-carbon ammonia facility, or the retrofitting (brownfield) of an existing facility by installing a new greenfield electrolyser to replace fossil-based hydrogen production.

b. **Service Levels:** For brownfield retrofits, the activity shall continue to produce the same type of output (ammonia) and shall not result in a reduction of overall service levels or production capacity.

c. **Modularity:** The eligible activity may involve small-scale, modular green ammonia production sites, close to where the outputs will be used, or larger centralised ammonia facilities.

d. **Clear Separation:** In cases where low-carbon ammonia production supplements an existing conventional facility, the activity shall ensure clear physical separation and robust smart-metering to precisely distinguish low-carbon ammonia from conventional output. The Validation and Verification Body (VVB) shall confirm the integrity of this tracking system.

3.2.4 | **Energy Source:** The electrical energy consumed for all significant process stages within the activity boundary – including, but not limited to, water electrolysis, air separation, hydrogen compression, nitrogen compression, the Haber-Bosch synthesis loop (reactor operation, syngas compression, product cooling/separation), and directly associated auxiliary systems – shall be demonstrated to originate solely from Renewable Energy sources as defined in this methodology.

a. **Grid electricity:** The grid electricity may be used as a backup or supplementary source only when renewable energy generation is insufficient. The annual consumption of grid electricity by the activity (including all subprocesses for ammonia production) shall not exceed 10% of the total annual electricity consumption of the activity. The VVB shall verify compliance with this requirement for each monitoring year. If the annual consumption of grid electricity by the activity exceeds 10% of the total annual electricity consumption[2] in a given monitoring year, the following consequences shall apply:

[2] If total annual electricity consumption is 100,000 MWh and grid electricity consumption is 12,000 MWh (12%), then: (i) all 12,000 MWh of grid electricity emissions are fully quantified as activity emissions; (ii) the ammonia production attributable to the excess 2,000 MWh (i.e.,

i. **Ineligibility for Crediting:** Ammonia production volume attributed to grid electricity consumed beyond the 10% annual threshold shall not qualify for carbon credit issuance. All GHG emissions associated with the total grid electricity consumed shall be fully quantified and accounted for as activity emissions.

ii. **Mandatory Corrective Action:** The VVB shall require the activity developer to develop and implement a detailed corrective action plan to address the root causes of excessive grid electricity consumption and ensure future compliance. Non-adherence may result in further sanctions or continued non-qualification.

iii. **Potential for Full Activity Disqualification:** Persistent or significant non-compliance, such as substantial exceedance or continued non-compliance without an approved corrective action plan, may result in the complete disqualification of the entire activity's output for the non-compliant monitoring year.

b. **Off-Site Renewable Energy (PPAs):** If dedicated off-site renewable energy facilities supply the activity, the electricity shall only qualify as zero-emission if all the following criteria are met:

i. **Origin & Contractual Timing:** The renewable energy facility’s Commercial Operation Date (COD) shall be within 36 months of the green ammonia facility's Placed In Service (PIS) date. A Power Purchase Agreement (PPA) or equivalent verifiable contractual instrument shall be mutually executed prior to the start of the crediting period for the activity. If the activity procures electricity from an existing (pre-commissioned) renewable energy facility via a PPA, the developer shall demonstrate that the host country grid's renewable generation capacity has not decreased as a result of the PPA arrangement. This may be demonstrated by showing that total grid-connected renewable capacity has been maintained or increased during the monitoring period. If this cannot be demonstrated, a conservative estimate of the displaced grid renewable energy shall be accounted for as leakage using the grid marginal emission factor.

[2,000/100,000] × total production) is excluded from baseline crediting; and (iii) a corrective action plan is mandatory.

ii. **Deliverability:** The renewable energy facility and any associated energy storage[3] shall be located in the same electricity grid region[4] as the ammonia activity.

iii. **Temporal Matching:** Renewable energy generation and the activity's electricity consumption shall be matched and tracked on an hourly basis.

iv. **Exclusive Claims:** The PPA shall legally prevent the double counting of the renewable attributes (e.g., the generator cannot sell Renewable Energy Certificates [RECs] for the power supplied to the activity).

3.2.5 | **Feedstock Constraints:** The sole feedstock for hydrogen production within the activity boundary shall be water. The use of any fossil fuels (e.g., natural gas, coal, oil) as a feedstock for hydrogen generation is strictly prohibited.

3.2.6 | **End-Use of Ammonia:** The low-carbon ammonia produced by the activity shall be used exclusively for fertiliser manufacturing. The activity developer shall implement and document a monitoring approach to verify this end-use. Additionally, the activity shall implement safeguards to ensure the low-carbon synthetic fertiliser does not actively displace the use of existing, sustainable organic fertilisers in the target region. The developer shall demonstrate, using regional agricultural surveys or FAO data, that the target market's organic fertiliser consumption has not declined by more than 10% since the activity start date. *While the current scope is limited to fertiliser manufacturing, other usages may be included in the future, and stakeholders may propose methodology revisions to expand this scope.*

3.2.7 | **Water Use limitation:** To ensure the water demand for industrial ammonia production does not exacerbate local water scarcity or displace essential human, ecological, or agricultural uses, the activity developer shall strictly comply with both a volumetric ceiling on potable water and a location-based water stress risk assessment.

a. **Absolute Volumetric Ceiling (5% Cap on Potable Water):** To protect human consumption, the activity's abstraction of municipal potable (drinking) water or water from dedicated community aquifers shall not exceed the lesser of the following two thresholds:
   i. 5% of the activity's total annual water demand; OR
   ii. 5% of the officially documented annual capacity of the local municipal water supply system, or the sustainable yield of the

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[3] The dedicated renewable energy facility shall be sized such that its annual energy yield, after accounting for round-trip battery storage losses, meets at least 90% of the activity's total electricity demand.

[4] The same national or sub-national electricity transmission system to which both the renewable energy facility and the ammonia production facility are connected, as delineated by the relevant grid operator or national electricity authority.

relevant community aquifer. *The activity developer shall provide official utility capacity declarations, government hydrological records, or an independent, peer-reviewed hydro-geological study to definitively quantify the denominator used for this calculation*.

b. **WRI Aqueduct Risk Assessment (Geographic Filter for All Freshwater):** In addition to the 5% ceiling on potable water, the activity's broader abstraction of any local raw freshwater (e.g., surface water from rivers or lakes, non-potable groundwater) shall be strictly governed by the Baseline Water Stress (BWS) classification of the exact activity location. At the time of validation, the activity developer shall determine this classification using the latest version of the World Resources Institute [(WRI) Aqueduct Water Risk Atlas] (currently Aqueduct 4.0) or its successor:

   i. **Low to Medium-High Stress Regions (BWS < 40%):** The activity is permitted to abstract local raw freshwater for its core electrolysis process, strictly provided it complies with all local water abstraction licences, the requirements of GS4GG Safeguarding Principle 8 (Water Resources), and the 5% cap on potable water defined above.

   ii. **High to Extremely High Stress Regions (BWS ≥ 40%):** If the activity is located in a highly stressed catchment, the burden of proof is elevated. The activity shall prioritise sourcing 100% of its process water from non-competing alternatives, such as renewable-powered seawater desalination or reclaimed municipal wastewater. The activity may only abstract local raw freshwater if the activity developer provides a bespoke, independent Environmental and Social Impact Assessment (ESIA) demonstrating that the specific abstraction will not lower the regional water table, disrupt ecological flows, or compromise community access to water resources. (The 5% cap on potable water for human staff sanitary needs remains permitted within this category.)

c. **Desalination Energy and Brine Safeguard:** If desalinated seawater is utilised as a process water source, the electrical energy consumed by the desalination plant and its associated pumping and treatment infrastructure shall be fully accounted for within the activity boundary and shall be powered entirely by renewable energy in accordance with Section 3.2.4 (Energy Source). Furthermore, safe brine disposal mechanisms that demonstrably cause no harm to marine ecosystems shall be implemented in accordance with applicable national environmental regulations and shall be verified by the VVB.

3.2.8 | Compliance with the 5% volumetric ceiling, the applicable WRI Aqueduct BWS classification, and (where applicable) the desalination energy and brine safeguards shall be verified by the VVB at initial validation and re-verified at each crediting period renewal using the most current official hydrological data and WRI Aqueduct dataset version available at the time.

3.2.9 | **Decommissioning of Existing Equipment (Brownfield):** If a greenfield electrolyser is installed within an existing ammonia facility that previously used fossil-based hydrogen production, the existing fossil-based hydrogen equipment (e.g., SMR units) shall be verifiably decommissioned, destroyed, or rendered permanently inoperable. If this equipment is transferred or continues to operate elsewhere, its continued emissions shall be fully accounted for as Leakage.

3.2.10 | **Exclusions:** This methodology is explicitly not applicable to activities involving:

a. Ammonia production using hydrogen derived from fossil fuels, including Steam Methane Reforming (SMR), Autothermal Reforming (ATR), or coal gasification. This exclusion applies *even if* Carbon Capture and Storage (CCS) or Utilisation (CCU) technologies are employed (i.e., all "grey," "brown," and "blue" ammonia pathways are strictly excluded).
b. Ammonia production using hydrogen derived from the gasification or pyrolysis of biomass or waste feedstocks.
c. Ammonia synthesis using alternative or novel technologies (e.g., direct electrochemical nitrogen reduction [NRR], plasma-assisted synthesis) lacking commercial-scale historical baseline data, unless this methodology is formally revised to include such pathways.

3.3 | Entry into force

3.3.1 | The date of entry into force is the publication date of this methodology.

3.4 | Mandatory Compliance and Safeguards

3.4.1 | The activity shall demonstrate conformance with the latest version of the GS4GG Principles and Requirements and the GS4GG Safeguarding Principles and Requirements. This involves an upfront assessment of potential risks and the implementation of a mitigation strategy.

3.4.2 | **Double counting:** The activity developer shall demonstrate conclusively that emission reductions generated by the activity will not be double counted. This includes but not limited to, establishing clear contractual agreements with all relevant stakeholders in the supply chain (e.g., producers, consumers, energy suppliers) to ensure unique ownership and claiming of emission reduction attributes, overlap with mandatory domestic mitigation schemes, overlap with other frameworks or environmental markets (e.g., renewable energy certificates, guarantees of origin, green hydrogen schemes, low-carbon fuel standards). The activity design document shall detail the specific measures implemented to prevent double counting.

3.4.3 | **Community Health and Safety (Safeguarding Principle 3):** The activity developer shall implement a comprehensive emergency preparedness and response plan. The developer shall proactively manage and mitigate risks associated with the high-pressure operation, storage, transport, and potential fugitive leakage of hazardous materials (specifically hydrogen gas and anhydrous ammonia).

3.4.4 | **Land Acquisition and Involuntary Resettlement** (**Safeguarding Principle 6):** Where the activity or its associated renewable energy infrastructure requires land acquisition, the activity developer shall comply with GS4GG Safeguarding Principle 6 regarding land acquisition and involuntary resettlement.

3.4.5 | **Water Resources (Safeguarding Principle 8):** In addition to the 5% drinking water limitation (Section 3.2.7), the activity shall comply with all host country environmental regulations concerning water abstraction, use, and safe discharge. The activity shall not negatively impact local water availability or quality for surrounding communities or ecosystems.

3.4.6 | **Hazardous and Non-Hazardous Waste (Safeguarding Principle 9):** The activity shall demonstrate the capability for the safe, environmentally sound handling, recycling, or disposal of any hazardous waste generated by the activity (e.g., spent catalysts, degraded electrolyser membranes).

3.4.7 | **Regulatory Compliance:** The activity shall comply with all applicable national, sub-national, and local laws, regulations, and environmental standards in the host Party.

4| NORMATIVE REFERENCES

4.1.1 | The following standards, methodologies, tools, and guidelines are normative references for the application of this methodology. Activity developers shall apply the latest valid version of these documents.

a. GS4GG Requirements and Procedures

i. GS4GG Principles and Requirements (V2.1)

ii. Safeguarding Principles and Requirements (V2.1)

iii. Community Services Activity Requirements (V1.2)

iv. Procedure for Development, Revision, and Clarification of Methodologies and Methodological Tools (V2.0)

b. GS4GG Methodologies, Standards, and Tools

i. Supplementary Information: Green Ammonia Production

ii. Methodology Standard: Requirements for Additionality Demonstration (V1.0)

iii. Methodology Standard: Requirements for Baseline Setting (V1.0)

Methodology Standard: Requirements for Methodology Development (V1.0)

iv. Methodology Standard: Requirements for Addressing Leakage in Methodologies (V1.0)

v. Tool 01: Emissions from Fossil Fuel Combustion (V1.0)

vi. Tool 02: Emissions from Freight Transportation (V1.0)

vii. Tool 05: Downward Adjustment Factor (DAF) Determination (V1.0)

viii. Tool 06: Common Practice Analysis (V1.0)

ix. Tool - Analysis of lock-in risk [Latest Approved Version]

x. Tool - Technical lifetime [Latest Approved Version]

c. **CDM/ PACM A6.4 Methodology/TOOL:**

References to CDM tools are valid until equivalent tools are published under Gold Standard (GS4GG) or the Article 6.4 Mechanism (A6.4)/Paris Agreement Crediting Mechanism (PACM).

i. Methodology: Hydrogen production from electrolysis of water, AM0124 / V 1.1

ii. Methodology: "Feed switch in integrated Ammonia-urea manufacturing industry". AM0050 V3.0

iii. Methodology: "Production of Ammonia through electrolysis of water, air separation and synthesis of hydrogen and nitrogen". A6.4-PNM001

iv. TOOL28: Calculation of baseline, project and leakage emissions from the use of refrigerants (V1.0)

v. A6.4 –AMT 007: Emissions from electricity generation and consumption (V1.0)

vi. A6.4-AMT-006: Determination of the technical lifetime of equipment (V1.0)

vii. A6.2 -AMT 002: Investment analysis (V1.0)

5| ACTIVITY BOUNDARY AND GHGS SOURCES/SINKS

5.1 | Activity boundary

5.1.1 | The activity boundary encompasses all anthropogenic sources of GHGs that are under the control of the activity developer, are related to the activity, or are significantly affected by the activity.

5.1.2 | The spatial extent of the activity boundary includes the physical infrastructure directly involved in the activity, as well as the upstream processes and market boundaries relevant for assessing the activity's baseline, activity, and leakage emissions

Table 3: Delineation of the Physical and Geographical Boundary

Component	Included?	Description/justification
Physical Infrastructure and sites		
Low-Carbon Ammonia Facility	Yes	The physical site containing the electrolysers, Air Separation Units (ASU), Haber-Bosch synthesis loop, compressors, and storage tanks. Activity emissions occur within this boundary.
Renewable Energy Plant (REP)	Yes	The physical site(s) of the dedicated renewable energy facility (on-site or off-site) supplying the activity.
Electricity Grid	Yes	The electricity transmission and distribution system. Relevant for quantifying emissions from any permitted backup grid electricity consumption (capped at 10%).
Water Supply and Treatment Infrastructure	Yes	Included if the activity operates dedicated water treatment or desalination facilities. Energy consumption from these facilities shall be accounted for within total facility electricity consumption and shall be powered by renewable energy in accordance with Sections 3.2.4 and 3.2.7. Brine disposal infrastructure (where applicable) is included for VVB safeguard verification per Section 3.2.7.
Processes and Activities		
Conventional Ammonia Production (Baseline)	Yes	The operation of conventional fossil-fuel-based ammonia production (e.g., SMR) that would have occurred in the absence of the activity.
Ammonia Transport	Yes	Downstream transportation of the final ammonia product to the fertiliser manufacturing facility.
Decommissioning of Existing Fossil Hydrogen Equipment, if applicable	Yes	Included if material

5.2 | GHGs Sources

5.2.1 | **Baseline Emissions:** The following table details the GHGs included in, or excluded from, the baseline scenario.

Table 4. Sources of Baseline Emissions

Source	Description	Gas	Included?	Justification
Hydrogen Production **(Fuel Combustion & Reforming)**	The thermal or chemical conversion of fossil fuels (e.g., SMR of natural gas, coal gasification) to produce hydrogen, including combustion for process heat.	CO_2	**Yes**	The primary source of baseline emissions resulting from fossil fuel combustion for process heat and chemical conversion.
Hydrogen Production (Upstream Fuel Supply)	Fugitive emissions associated with the extraction, processing, and transport of the baseline fossil fuels (e.g., natural gas, coal).	CH4	**No**	Explicitly excluded. Upstream methane (CH_4) emissions associated with the extraction, processing, and transport of baseline fossil fuels are strictly excluded to ensure the baseline crediting benchmark remains highly conservative (yielding a lower baseline emission benchmark).
		N2O	**No**	Insignificant; excluded for simplification and conservativeness.
Nitrogen Production & Ammonia Synthesis	The Haber-Bosch process powered by the baseline energy mix.	CO_2	**Yes**	Emissions associated with energy consumption for the ASU and Haber-Bosch loop in the baseline.

5.2.2 | **Activity Emissions:** The following table details the direct GHGs included in, or excluded from, the activity scenario.

Table 5. GHGs included in, or excluded from, the Activity Scenario

Source	Description	Gas	Included?	Justification
Grid Electricity Consumption	Electricity drawn from the grid (as backup/supplementary power) to run the	CO_2	Yes	Emissions from non-renewable grid electricity utilised as supplementary or backup power

	electrolysers, ASU, or Haber-Bosch loop.			(capped at ≤10% annually).
Fossil Fuel Combustion	Combustion of fossil fuels in on-site backup generators or auxiliary boilers (if any).	CO_2	Yes	Shall be accounted for if backup systems are utilised.
		CH_4 N_2O	No	Negligible for backup operations.
Fugitive Hydrogen Leaks	Physical leaks of hydrogen gas from electrolysers, compressors, pipelines, and storage.	H_2	Yes	Hydrogen acts as an indirect climate forcer. Physical leaks shall be directly quantified as CO_2e using an explicitly referenced 100-year Global Warming Potential (GWP100) of 14.4 (11.6 ± 2.8 Sand et al., 2023).
Fugitive Ammonia Leaks		N_2O	Yes	Included if volatilised NH_3 oxidises into N_2O in the atmosphere.
Product Transportation	Downstream transportation of the hydrogen product to the existing dedicated consumer(s).	CO_2	Yes	Incremental emissions from downstream transportation of the product to the fertiliser plant.

5.2.3 | **Leakage emissions:** The following table details the GHG emissions included in, or excluded from, the leakage emissions. In strict alignment with the GS4GG Requirements for Addressing Leakage in Methodologies, embodied emissions from the manufacturing of new infrastructure are classified as Leakage.

Table 6. Emissions included in, or excluded from, the leakage

Source	Description	Gas	Included?	Justification
Embodied Emissions (Infrastructure)	Cradle-to-gate emissions associated with the manufacturing, construction, and transport of the new activity	CO_2e	**Yes**	Mandatory inclusion. Cradle-to-gate emissions associated with manufacturing new electrolysers, renewable energy plants, and battery storage shall be fully accounted for as Leakage and amortised

	infrastructure (e.g., solar panels, wind turbines, electrolysers, storage batteries).			over the first crediting period.
Transfer of Baseline Equipment	For brownfield retrofits: Re-use of decommissioned baseline equipment (e.g., SMR units) outside the activity boundary, continuing to emit GHGs.	CO_2	**Conditional**	Applies to brownfield retrofits. Deemed zero if fossil-based equipment is verifiably destroyed. If transferred and reused outside the boundary, emissions shall be quantified and deducted.
Land Use Change (LUC)	Emissions resulting from the conversion of land (e.g., forest or grassland) to an industrial site for the ammonia plant or its dedicated renewable energy facility.	CO_2	**Conditional**	Changes in carbon stocks due to land clearing for the new industrial site or renewable energy plant. Included if material.

6| DEMONSTRATION OF ADDITIONALITY

6.1 | Requirements

6.1.1 | The activity developer shall demonstrate that the activity—comprising the production of low-carbon ammonia powered by renewable energy—would not have occurred in the absence of the incentives provided by carbon revenues.

6.1.2 | The demonstration of additionality shall be conducted in accordance with the latest version of the GS4GG *Methodology Standard: Requirements for Additionality Demonstration*.

6.1.3 | The additionality assessment shall follow the stepwise approach detailed below:

a. Step 1: Regulatory surplus analysis (Section 6.2 |)

b. Step 2: Lock-in risk analysis (Section 6.3 |)
c. Step 3: Financial viability analysis (Section 6.4 |)
d. Step 4: Common practice analysis (Section 6.5 |)
e. Step 5: Ongoing financial needs assessment (Section 6.6 |)

6.2 | Regulatory Surplus Analysis

6.2.1 | The activity developer shall demonstrate at the mitigation activity level that the emission reductions achieved are regulatory surplus[5] - meaning they are not mandated by any existing laws, regulations, or legal requirements within the host country's jurisdiction at the time of the activity start date. The analysis shall be updated at each verification of emission reductions, or at the latest, at each renewal of the crediting period.

6.2.2 | The activity developer shall provide verifiable evidence demonstrating that:

a. **Host Country Eligibility:** The low-carbon ammonia mitigation activity type is not excluded or declared ineligible for carbon crediting issuance by the host country (e.g., it is not on a national negative list).

b. **No Enforced Legal Mandate:** There is no legal obligation to produce ammonia exclusively via water electrolysis, nor any enforced mandate banning conventional fossil-fuel-based ammonia production without providing viable alternative pathways. The analysis shall verify that national, sub-national, or local laws do not:

   i. Directly mandate the implementation of water-electrolysis-based ammonia production.

   ii. Indirectly mandate the activity by preventing alternative scenarios (e.g., an outright ban on the use of natural gas for Steam Methane Reforming without providing viable alternative pathways).

   iii. Lead to the same amount of emission reductions without the mitigation activity due to laws requiring specific quantitative targets (e.g., an emissions trading system that caps the exact emission sources reduced by the activity, unless those allowances are verifiably cancelled).

   iv. Confirmation of No Exclusion (Default): In the absence of a published negative list, positive list, or specific regulatory

[5] For the purposes of this methodology, a legal mandate 'comes into force' when it is both enacted AND enforcement mechanisms are operational and funded. Legislation that has been passed but lacks funded enforcement mechanisms or contains implementation delays beyond the crediting period does not automatically terminate crediting but must be disclosed and assessed.

exclusion, the activity developer shall provide a formal declaration confirming that no official communication or regulation has been issued by the Host Country identifying the specific technology as ineligible for carbon crediting.

6.3 | Lock-In Risk Analysis

6.3.1 | The activity developer shall assess the risk that the activity may lead to a lock-in of GHG emissions, technologies, or carbon-intensive practices.

6.3.2 | This methodology explicitly mandates the use of water electrolysis and zero-emission renewable energy, inherently replacing a high-emission technology (fossil-based ammonia) with a zero-emission alternative. The activity developer shall confirm in the PDD that the activity meets all applicability conditions of Section 3 and therefore qualifies for the methodology-level lock-in risk classification of 'Low Risk' as documented in the Supplementary Information.

6.3.3 | A specific lock-in risk analysis is not required at the activity level, provided the activity strictly adheres to all applicability conditions defined in Section 3.

6.4 | Financial Viability Analysis (Default Approach):

6.4.1 | To demonstrate that the eligible mitigation activity would not be implemented without carbon credit revenue, the financial viability analysis shall be the default approach. It is mandatory for all large-scale activities.

6.4.2 | The activity developer shall conduct an Investment Analysis in strict accordance with the UNFCCC A6.4-AMT-002: Methodological tool: Investment analysis.

6.4.3 | **Selection of Financial Indicator:** The analysis shall use standard financial indicators (e.g., Net Present Value [NPV], Internal Rate of Return [IRR], or Levelized Cost of Ammonia [LCOA]). The chosen indicator and the benchmark (hurdle rate) shall be clearly documented and justified in the Project Design Document (PDD).

6.4.4 | The analysis shall account for all relevant cash flows, including capital expenditure (CAPEX) for electrolysers and renewable energy infrastructure, operational expenditure (OPEX) for electricity and water, and non-carbon revenues (e.g., ammonia sales, government subsidies).

6.4.5 | **Comparative Analysis:** The activity developer shall demonstrate that the activity without carbon revenues fails to meet the financial benchmark (e.g., Activity IRR < Hurdle Rate) or is financially less attractive than the continuation of conventional ammonia production. It shall then be demonstrated that the inclusion of carbon revenues enables the activity to meet the financial benchmark.

6.4.6 | **Step 4: Sensitivity Analysis:** A sensitivity analysis shall be included to demonstrate that the conclusion remains robust under reasonable variations to critical parameters (e.g., ±10% in CAPEX, OPEX, electricity costs, and ammonia sales revenues). Assumptions, data, and conclusions shall be transparently documented and supported by verifiable evidence.

6.5 | Common Practice Analysis

6.5.1 | The activity developer shall conduct a common practice analysis to demonstrate that the mitigation activity is not widely adopted in the relevant sector and geographical region.

6.5.2 | **Methodology-Level Exemption:** Based on global market assessments indicating that the current global market penetration of commercial low-carbon (electrolysis-based) ammonia capacity is approximately 0.036%, the technology is formally classified as nascent. In accordance with the GS4GG Additionality Standard, a methodology-level exemption is established.

6.5.3 | Any low-carbon ammonia activity submitted for validation under this methodology within three (3) years of the publication date of this methodology version shall automatically be deemed to satisfy the Common Practice Analysis requirement and is exempt from conducting an activity-level common practice calculation.

6.5.4 | For activities submitted after this 3-year validity period expires, the developer shall conduct an activity-level assessment demonstrating that the market penetration share of low-carbon ammonia in the applicable geographical area remains below the strict threshold (i.e., $F < 5\%$) defined by the prevailing GS4GG standard.

6.6 | Ongoing Financial Need (OFN) Assessment

6.6.1 | At the time of crediting period renewal, the activity developer shall conduct an Ongoing Financial Need (OFN) assessment to demonstrate that the activity still requires carbon credit revenue to remain financially viable and continues to be additional over time.

6.6.2 | The OFN assessment shall confirm compliance with Regulatory Surplus and reassess the Financial Viability Analysis utilised during the first crediting period.

6.6.3 | **Treatment of CAPEX:** Green ammonia production requires massive upfront capital expenditure. To ensure a fair and accurate OFN assessment at the time of renewal, the activity developer shall explicitly treat sunk CAPEX as follows:

a. The original, actually incurred CAPEX from the start of the activity shall be retained in the updated cash flow model at its original value (in Year 0).

b. Ex-ante estimates for OPEX and revenues for the elapsed crediting period shall be replaced with actual historical operational data.

c. Forward-looking projections for the renewed crediting period shall be updated using revised market forecasts.

d. The developer shall demonstrate that the recalculated activity financial indicator (e.g., IRR) across the entire operational lifespan, inclusive of the CAPEX, still fails to meet the original financial benchmark without the continued inclusion of carbon revenues.

7| BASELINE SCENARIO

7.1 | Baseline Determination (Stepwise Approach)

7.1.1 | The crediting baseline emissions (BE_y) shall be determined following the stepwise approach mandated by the *GS4GG Methodology Standard: Requirements for Baseline Determination in Methodologies*:

a. Step 1: Selection and Justification of the Baseline Approach. (Section 7.2 |)

b. Step 2: Application of the Selected Approach Prior to Downward Adjustment. (Section 7.3 |)

c. Step 3: Application of the Downward Adjustment for Uncertainty and Ambition. (Section 7.4 |)

d. Step 4: Identification and calculation of the Conservative Business-as-Usual (BAU) baseline. (Section 7.5 |)

e. Step 5: Comparison and selection of the final Crediting Baseline. (Section 7.6 |)

7.2 | Step 1: Selection and Justification of the Baseline Approach

7.2.1 | In accordance with Paragraph 36 of the Article 6.4 Rules, Modalities and Procedures (RMPs) and Section 8 of the GS4GG Baseline Standard, the activity developer shall select the baseline approach based on the activity type:

7.2.2 | **Scenario A: Greenfield Activities** (and Brownfield activities operating *beyond* the remaining lifetime of the replaced equipment).

a. **Selected Approach:** Approach 36(a) Best Available Technology (BAT) that represents an economically feasible and environmentally sound course of action.

b. **Justification:** Low-carbon ammonia production yields a highly homogeneous output (anhydrous ammonia) where emissions are primarily determined by the specific synthesis technology deployed. The BAT approach ensures that the baseline represents the most efficient, modern conventional plants available globally or regionally, driving high ambition and preventing the crediting of outdated, high-emission technologies. For greenfield activities in host countries without existing domestic ammonia production, the baseline scenario shall be deemed to be the importation of conventionally produced ammonia, and the global BAT benchmark shall apply.

7.2.3 | **Scenario B: Brownfield Activities** (operating *within* the remaining technical lifetime of the replaced fossil-based equipment).

a. **Selected Approach:** Approach 36(c) – An approach based on existing actual or historical emissions, adjusted downwards, and strictly capped by the BAT approach.

b. **Justification:** For existing facilities, emissions per unit of output are highly site-specific. Using historical emissions ensures that emission reductions represent actual improvements at the specific facility being retrofitted. However, to prevent rewarding historical inefficiency, this approach is strictly capped at the BAT benchmark. *(Note: Once the originally replaced equipment reaches the end of its remaining technical lifetime, the baseline shall automatically transition to Scenario A).*

7.3 | Step 2: Application of the Selected Approach (Prior to Downward Adjustment)

7.3.1 | The activity developer shall calculate the unadjusted baseline emissions ($BE_{unadj,y}$) prior to any downward adjustment. To ensure maximum conservativeness, upstream methane (CH_4) emissions associated with the extraction, processing, and transport of baseline fossil fuels shall be explicitly excluded from all baseline emission calculations.

7.3.2 | **Determination of the Applicable BAT Emission Factor (EF_{BAT}):** The activity developer shall identify both the Global BAT benchmark and the relevant National BAT benchmark (where available and applicable to the host country. The applicable BAT emission factor EF_{BAT}) shall strictly be the lowest (most conservative) value available.

$$EF_{BAT} = min(EF_{BAT,global}, EF_{BAT,national}) \qquad \text{(eq.1)}$$

Where

$EF_{BAT,global}$	The global conservative BAT default value representing top-tier natural gas SMR.in year y (1.6 tCO_2e/tNH_3)
$EF_{BAT,national}$	An officially established, peer-reviewed, or national BAT benchmark applicable to the host country.

7.3.3 | **Unadjusted baseline for Scenario A (Greenfield):** The baseline emissions are calculated based on the metered quantity of low-carbon ammonia produced, multiplied by the applicable BAT emission intensity.

$$BE_{unadj,y} = P_{NH3y} \times EF_{BAT} \qquad \text{(eq.2)}$$

Where

$BE_{unadj,y}$	Unadjusted baseline emissions in year y (tCO_2e/yr).
$P_{NH3,y}$	Monitored production of low-carbon ammonia by the activity used for fertiliser in year y (tNH_3/yr).

EF_{BAT}	Specific emissions intensity of the most conservative Best Available Technology (tCO_2e/tNH_3), representing direct process and combustion emissions exclusively.

7.3.4 | **Unadjusted baseline for Scenario B (Brownfield):** For existing facilities retrofitting fossil-based hydrogen units with electrolysers, the historical emissions intensity (EF_{hist}) of the displaced equipment shall be calculated based on verified direct CO_2 emissions over the most recent 3-year period of continuous commercial operation prior to the activity start date. Upstream CH_4 emissions shall be excluded.

To guarantee absolute conservativeness and prevent the rewarding of historical inefficiency, the unadjusted baseline shall be determined using the lowest value between the historical emissions intensity and the applicable BAT:

$$EF_{baseline} = min(EF_{hist}, EF_{BAT}) \qquad \text{(eq.3)}$$

$$BE_{unadj,y} = P_{NH3,y} \times EF_{baseline} \qquad \text{(eq.4)}$$

where

EF_{hist}	Historical specific emissions intensity of the replaced equipment (tCO_2e/tNH_3), explicitly excluding upstream CH_4 emissions.
$EF_{baseline}$	The final conservative baseline emission factor applied to the brownfield retrofit (tCO_2e/tNH_3).

7.4 | Step 3: Application of the Downward Adjustment & Uncertainty

7.4.1 | To ensure the baseline trajectory actively encourages climate ambition over time and aligns with national climate trajectories, a Downward Adjustment Factor (DAF) shall be applied to the unadjusted baseline.

a. **Uncertainty Adjustment ($BE_{adj,UNC,y}$):** GS4GG methodologies address statistical uncertainty primarily through parameter-level conservativeness. Because the methodology strictly mandates the lowest of Global/Regional BAT and explicitly excludes upstream methane, parameter-level conservativeness is robustly achieved. The cumulative conservativeness of the baseline methodology — comprising (a) the use of top-decile BAT rather than fleet average, (b) the exclusion of upstream methane, and (c) the DAF — collectively results in a crediting baseline substantially below what would be achieved by applying a standard aggregate uncertainty deduction. Therefore, an additional aggregate uncertainty discount is not required at this step.

b. **Ambition Adjustment (DAF):** The activity developer shall source the exact, country-specific DAF from the latest version of the GS4GG Tool: Downward Adjustment Factor (DAF) Determination (GS4GG PAA

MT400-05), based directly on the host country's officially declared Net-Zero target year or appropriate sectoral target.

7.4.2 | **Calculation of the Downward-Adjusted Baseline ($BE_{adj,,y}$):** The downward-adjusted baseline ($BE_{adj,y}$) shall be calculated as follows:

$$BE_{adj,y} = BE_{unadj,y} \times (1 - DAF_y) \qquad \text{(eq.5)}$$

Where,

$BE_{adj,y}$	Downward Adjusted Baseline Emissions in year y (tCO_2e/yr).
DAF_y	The annual Downward Adjustment Factor for the host country, applicable to year y (fraction), sourced from the GS4GG DAF Tool.

7.5 | Step 4: Identification and Calculation of the Conservative BAU Scenario

7.5.1 | The methodology shall identify the conservative Business-As-Usual (BAU) baseline to ensure the final crediting baseline remains demonstrably below BAU over time.

7.5.2 | **Define and Calculate the Unadjusted BAU (BAU_y):** The BAU scenario represents the emissions that would most likely occur in the host country in the absence of the activity. It shall explicitly incorporate any policies, legal requirements, and specific national targets that are active (e.g., legally enforced energy efficiency mandates)**.**

$$BAU_y = P_{NH3,y} \times EF_{BAU} \times (1 - RA_{mandate}) \qquad \text{(eq.6)}$$

Where,

BAU_y	Unadjusted, most likely net BAU emissions in year y (tCO_2e/yr).
EF_{BAU}	The prevailing average emission intensity of conventional ammonia capacity in the host country (tCO_2e/tNH_3).
$RA_{mandate}$	Regulatory Adjustment Factor (fraction) representing any legally enforced efficiency improvements taking effect in year y. It shall be calculated as the proportional reduction in BAU emission intensity attributable to legally enforced measures. For example, if a mandatory energy efficiency standard requires a 5% reduction in energy consumption per tonne of ammonia, $RA_{mandate}$ = 0.05. If no legally enforced measures are in effect during the crediting period, $RA_{mandate}$ = 0. The developer shall provide legislative references and calculate the factor based on the specific requirements of the applicable regulation.

7.5.3 | **Calculation of Conservative BAU Baseline:** The activity developer shall calculate the DAF-adjusted conservative BAU baseline as follows:

$$BE_{BAU,y} = BAU_y \times (1 - DAF_y) \qquad \text{(eq.7)}$$

Where,

$BE_{BAU,y}$	Conservative BAU baseline emissions in year y (tCO_2e/yr). (Note: As parameter-level conservativeness has been strictly applied, the separate aggregate uncertainty deduction is not required, and the Conservative BAU defaults to the DAF-adjusted BAU).)

7.6 | Step 5: Comparison and Selection of the Crediting Baseline

7.6.1 | The final Crediting Baseline (BE_y) used to calculate the activity's net emission reductions shall be strictly determined ex-post for each calendar year. The activity developer shall compare the downward-adjusted baseline (Step 3) against the conservative BAU baseline (Step 4) and select the lower (most conservative) value of the two.

$$BE_y = MIN(BE_{adj,y}, BE_{BAU,y}) \qquad \text{(eq.8)}$$

Where,

BE_y	Final crediting baseline emissions for year y (tCO_2e/yr).

7.6.2 | **Quantification of the Difference between BAU and Crediting Baseline:** To ensure transparency regarding the climate ambition embedded in the methodology, the activity developer shall quantify and explicitly report the precise volume of emissions excluded from crediting due to the application of the DAF and uncertainty mechanisms. This value shall be reported in each monitoring report.

$$\Delta y = BAU_y - BE_y \qquad \text{(eq.9)}$$

Where,

Δy	Difference between unadjusted BAU and the final crediting baseline emissions in year.

7.6.3 | This calculated difference (Δy) shall be reported solely as a transparency metric in each monitoring report to demonstrate the uncredited ambition automatically accruing to the host country; it is not used in the final calculation of issuable emission reductions.

8| ACTIVITY EMISSIONS

8.1 | Identification of Activity Scenario

8.1.1 | The activity scenario is defined by the production of low-carbon ammonia utilising green hydrogen (generated via water electrolysis) and nitrogen (separated from the air via an Air Separation Unit), synthesised via the Haber-Bosch process.

8.1.2 | Because the core chemical processes are powered exclusively or predominantly by zero-emission renewable energy, direct greenhouse gas

(GHG) emissions from the synthesis process itself are inherently near zero. Activity emissions (AE_y) shall solely encompass the anthropogenic emissions occurring within the activity boundary that are directly attributable to the operation of the facility.

8.1.3 | Activity emissions (AE_y) shall be limited to the following quantified sources:

a. Grid Electricity Consumption ($AE_{grid,y}$): Indirect emissions from the permitted consumption of grid electricity (capped at ≤ 10% annually) utilised as a supplementary or backup power source.

b. Fossil Fuel Consumption ($AE_{ff,y}$): Direct emissions from the permitted combustion of fossil fuels in on-site backup generators or auxiliary boilers.

c. Fugitive Emissions ($AE_{\text{fugitive},y}$): The climate impact of unintended physical leaks of hydrogen (H_2) gas and ammonia (NH_3) into the atmosphere.

d. Activity Transportation ($AE_{\text{trans},y}$): Incremental emissions associated with the downstream transportation of the final ammonia product to the fertiliser manufacturing facility.

8.2 | Calculation of Total Activity Emissions

8.2.1 | Total activity emissions in year y shall be calculated as the sum of the emissions from electricity consumption, fossil fuel combustion, and transportation:

$$AE_y = AE_{grid,y} + AE_{ff,y} + AE_{\text{fugitive},y} + AE_{\text{trans},y} \qquad \text{(eq.10)}$$

Where,

$\boldsymbol{AE_y}$	Total activity emissions in year y (tCO_2e/yr).
$\boldsymbol{AE_{grid,y}}$	Activity emissions from the consumption of non-renewable grid electricity in year y (tCO_2e/yr).
$\boldsymbol{AE_{ff,y}}$	Activity emissions from the consumption of fossil fuels for auxiliary/backup purposes in year y (tCO_2e/yr).
$\boldsymbol{AE_{\text{fugitive},y}}$	Activity emissions from physical fugitive leaks of hydrogen and ammonia in year y (tCO_2e/yr).
$\boldsymbol{AE_{\text{trans},y}}$	Activity emissions from the incremental transportation of the activity's ammonia product in year y (tCO_2e/yr).

8.3 | Emissions from Grid Electricity Consumption ($AE_{grid,y}$)

8.3.1 | The grid electricity consumption shall be calculated strictly in accordance with the latest version of the UNFCCC Article 6.4 mechanism tool: A6.4-AMT-007: Methodological tool: Emissions from electricity generation and consumption.

8.3.2 | The activity developer shall apply the tool to determine the applicable grid emission factor ($EF_{grid,y}$) and calculate the emissions as follows:

$$AE_{grid,y} = EC_{grid,y} \times EF_{grid,y} \times (1 + TDL_y) \quad \text{(eq.11)}$$

Where,

$EC_{grid,y}$	Total metered quantity of electricity drawn from the grid by the activity facility in year y (MWh/yr) (tCO_2e/yr).
$EF_{grid,y}$	Grid emission factor determined in accordance with A6.4-AMT-007 (tCO_2e/MWh).
TDL_y	Average technical transmission and distribution losses for the grid in year y (fraction). A conservative default of 0.10 (10%) shall be applied if official verifiable data is unavailable.

8.4 | Emissions from Fossil Fuel Combustion ($AE_{ff,y}$)

8.4.1 | The use of fossil fuels for the core hydrogen or ammonia synthesis process is strictly prohibited. Fossil fuel backup generators are strongly discouraged but may be utilised strictly for emergency safety shutdowns or critical auxiliary functions.

8.4.2 | If any fossil fuels are consumed during the monitoring period, the emissions shall be meticulously calculated based on actual metered fuel consumption using the latest version of GS4GG TOOL01: Emissions from Fossil Fuel Combustion (V1.0)

8.5 | Fugitive Emissions ($AE_{\text{fugitive},y}$)

8.5.1 | Fugitive emissions represent physical leaks of hydrogen (H_2) and ammonia (NH_3) into the atmosphere. Total fugitive emissions shall be calculated as:

$$AE_{\text{fugitive},y} = AE_{\text{fugitive},H2,y} + AE_{\text{fugitive},NH3y} \quad \text{(eq.12)}$$

8.5.2 | **Quantification of Fugitive Hydrogen (H_2) Leaks:** Hydrogen (H_2) is a potent indirect climate forcer. Physical leaks of hydrogen from electrolysers, compressors, pipelines, and storage shall be continuously monitored and directly quantified using the 100-year Global Warming Potential (GWP_{100}) established in recent peer-reviewed scientific literature.

$$AE_{\text{fugitive},H2,y} = Q_{leak,H2,y} \times GWP_{H2} \quad \text{(eq.13)}$$

Where,

$Q_{leak,H2,y}$	Total monitored mass of uncombusted hydrogen physically leaked to the atmosphere in year y (tonnes H_2). Monitored via mass balance reconciliation or integrated gas leak detection sensors. For the first monitoring period, if mass-balance reconciliation yields an uncertainty exceeding ±20% of the calculated hydrogen losses, the developer shall apply a conservative default leakage rate of 2% of total hydrogen produced, based on industry benchmarks for comparable electrolyser systems.

	This default[6] shall be used until sufficient operational data is available to validate the mass-balance approach.
GWP_{H2}	The 100-year Global Warming Potential (GWP_{100}) for hydrogen. The activity developer shall apply a value of 14.4 (sourced from Sand et al., 2023), unless a superseding value is officially adopted by the IPCC or GS4GG.

8.6 | Quantification of Fugitive Ammonia (NH_3) Leaks to Nitrous Oxide (N_2O):

8.6.1 | Fugitive ammonia leaks are a precursor to nitrous oxide (N_2O) formation in the atmosphere. The activity developer shall continuously monitor ambient NH_3 leakage.

8.6.2 | To calculate the resulting N_2O greenhouse gas emissions, the activity developer shall apply a conservative, higher-side default conversion factor derived from fertiliser-specific peer-reviewed literature. Alternatively, the activity developer may propose an activity-specific conversion factor, provided it is robustly justified by peer-reviewed, location-specific scientific literature and verified by the VVB.

$$AE_{\text{fugitive},NH3y} = Q_{leak,NH3,y} \times \frac{14}{17} \times EF_{NH3\rightarrow N20} \times \frac{44}{28} \times GWP_{N2O} \qquad \text{(eq.14)}$$

Where,

$Q_{leak,NH3,y}$	Total monitored mass of ammonia physically leaked or volatilised to the atmosphere in year y (tonnes NH_3).
$\frac{14}{17}$	Mass conversion factor from Ammonia (NH_3) to Nitrogen (N).
$EF_{NH3\rightarrow N20}$	The fraction of volatilised ammonia-nitrogen that converts to nitrous oxide-nitrogen (N_2O-N). The developer shall use a conservative, higher-side default factor derived from fertiliser-specific peer-reviewed literature, or a activity-specific value formally approved during validation (fraction). In the absence of project-specific empirical data formally approved during validation, the developer shall apply the IPCC

[6] Hydrogen leakage rates from electrolysis production vary substantially depending on system boundaries, operating pressure, and whether intermittent operational losses (start-up venting, purging) are included. Estimates range from 0.2% for steady-state membrane crossover and drying (Arrigoni & Bravo Diaz, 2022) to a literature-synthesis average of 1.72% when all operational losses are included (Trapani et al., 2025), with worst-case values reaching 9.2% for older technology. A conservative default of 2% is supported by the upper range of Colella et al. (2005) for pressurised systems and is consistent with the Trapani et al. (2025) central estimate when accounting for measurement uncertainty.

	Tier 1 default[7] of $EF_{NH3 \rightarrow N2O}$ = 0.01 (1%) as a minimum. To ensure conservativeness, the developer may apply the upper bound of the IPCC uncertainty range (0.05 or 5%) if the VVB determines that local atmospheric conditions may accelerate NH_3-to-N_2O conversion.
$\frac{44}{28}$	Stoichiometric mass conversion factor from N_2O-N to N_2O.
GWP_{N2O}	The 100-year Global Warming Potential for N_2O, unless a superseding value is officially adopted by the IPCC or GS4GG.

8.7 | Emissions from Activity Transportation ($AE_{\text{trans},y}$):

8.7.1 | If the low-carbon ammonia is not utilised on-site for fertiliser production but is instead transported to a separate off-take facility, the incremental downstream transportation emissions shall be accounted for.

8.7.2 | If the average two-way transportation distance from the activity site to the fertiliser manufacturing facility is less than 200 km, the transportation emissions may be deemed negligible and set to zero ($AE_{\text{trans},y} = 0$). For distances exceeding 200 km, emissions shall be calculated as follows:

$$AE_{\text{trans},y} = \sum_m \left(Q_{NH3,m,y} \times D_{proj,m} \times EF_{trans,m} \right) \qquad \text{(eq.15)}$$

Where,

$AE_{\text{trans},y}$	Incremental activity transportation emissions in year y (tCO_2e/yr).
$Q_{NH3,m,y}$	Quantity of low-carbon ammonia transported via transport mode m in year y (tonnes).
$D_{proj,m}$	Average two-way[8] distance from the activity site to the fertiliser manufacturing facility via mode m (km).
$EF_{trans,m}$	Emission factor for transport mode m (tCO_2e/tonne-km). Default values shall be sourced from recognised normative references (e.g., U.S. EPA Emission Factors Hub or national equivalents).

[7] The IPCC default factor (0.01) was originally derived for agricultural nitrogen volatilization. Its application to industrial fugitive NH_3 emissions is conservative and methodologically appropriate as a default in the absence of dedicated peer-reviewed conversion factors for industrial sources. Activity developers may propose alternative values supported by peer-reviewed atmospheric chemistry studies subject to VVB approval.

[8] The use of two-way distance multiplied by standard one-way emission factors deliberately introduces a conservative bias in activity emission accounting, equivalent to assuming all return trips are empty. This is an intentional conservativeness measure.

9| LEAKAGE EMISSIONS

9.1 | General Requirements

9.1.1 | In accordance with the GS4GG Methodology Standard: Requirements for Addressing Leakage in Methodologies, the activity developer shall apply a three-tiered approach to address leakage emissions:

a. Identify all potential sources of leakage;

b. Implement measures to avoid such leakage or, where avoidance is impracticable, to minimise any resultant negative leakage; and

c. Quantify and deduct any residual negative leakage in accordance with the specifications set forth below.

9.2 | Identification of Emission Sources

9.2.1 | The activity developer shall identify all potential sources of leakage associated with the low-carbon ammonia production activity. These sources shall include, inter alia, the following:

a. **Baseline equipment transfer:** For brownfield activities, leakage shall be accounted for where equipment that was operational within the activity boundary prior to the implementation of the activity (e.g., fossil-based hydrogen production equipment) is displaced, retains operational functionality and residual economic value for third parties, and may be used outside the activity boundary in a manner that could displace processes with lower GHG intensity.

b. **Resource competition:** Leakage attributable to competition for resource use shall be assessed if the activity induces an increased demand for limited resources (e.g., renewable electricity, local water supplies) that are also employed in competing applications, and the reallocation of these resources may give rise to higher GHG emissions outside the activity boundary.

c. **Diversion of existing production processes or outputs:** Leakage attributable to the diversion of existing production processes or outputs shall be considered where the types of outputs or levels of service delivered under the activity scenario deviate from those established in the baseline scenario.

d. **Increases in environmental greenhouse-gas releases:** Leakage shall be assessed for any release of GHG emissions from natural reservoirs directly attributable to the implementation of the mitigation activity (e.g., land-use change due to the construction of new facilities).

e. **Changes in upstream and downstream processes (Embodied emissions):** Indirect GHG emissions (cradle-to-gate) associated with the production, processing, transport, and delivery of major equipment and material inputs used by the mitigation activity (e.g., electrolysers, solar PV panels, wind turbines, and battery energy storage systems).

9.3 | Avoidance and Minimization of Leakage

9.3.1 | The methodology incorporates strict applicability conditions and provisions to avoid or prevent, or where avoidance is not feasible, to minimise all identified sources of negative leakage:

a. **Avoidance of baseline equipment transfer:** To fully avoid leakage from baseline equipment transfer, the activity developer shall ensure that all displaced baseline equipment is verifiably decommissioned, destroyed, or otherwise irreversibly disposed of. Verifiable evidence (e.g., destruction certificates, photographic evidence, and independent audits by the VVB) shall be provided. If verified, leakage from equipment transfer is successfully avoided and deemed zero.

b. **Minimisation of resource competition:** Leakage due to water resource competition is explicitly avoided via the applicability condition (Section 3) capping local drinking water consumption. Leakage due to renewable electricity competition is avoided by the applicability condition mandating that the activity procures its energy from dedicated, additional renewable energy generation. The VVB shall verify these safeguards, allowing resource competition leakage to be excluded from further calculation.

c. **Avoidance of diversion of existing production processes or outputs[9]:** The methodology restricts applicability to brownfield activities where the activity developer shall continue to produce the same type of output (ammonia) and shall not result in a reduction of overall service levels or production capacity compared to the baseline. Therefore, leakage from the diversion of existing production outputs is avoided and deemed negligible.

d. **Minimisation of environmental releases:** Activity developers are encouraged to site new infrastructure on degraded, abandoned, or existing industrial lands to avoid disturbing natural carbon sinks and to minimise environmental GHG releases.

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[9] This methodology credits emission reductions on a per-unit basis (t_{CO_2e} per tonne of green ammonia produced for eligible end-use). It does not explicitly account for market-level substitution effects, whereby displaced conventional ammonia production may continue serving other markets. This treatment is consistent with prevailing methodological practice for industrial decarbonization activities and is supported by the assumption that growing global ammonia demand will progressively absorb green ammonia as a substitute rather than purely as a displacement.

9.4 | Calculation and subtraction of leakage

9.4.1 | When negative leakage cannot be fully avoided through the measures outlined in Section 9.3, the methodology shall require the quantification of the remaining net leakage. If the calculation yields a net increase in emissions (negative leakage), the absolute amount of this leakage shall be deducted from the total quantified emission reductions.

9.4.2 | The total leakage emissions (LE_y) in year y shall be calculated as:

$$LE_y = LE_{equip,y} + LE_{LUC,y} + LE_{embodied,y} \qquad \text{(eq.16)}$$

Where,

$\boldsymbol{LE_y}$	Total leakage emissions in year y (tCO_2e/yr).
$\boldsymbol{LE_{equip,y}}$	Leakage from transferred baseline equipment in year y (tCO_2e/yr).
$\boldsymbol{LE_{LUC,y}}$	Leakage from indirect land-use change in year y (tCO_2e/yr).
$\boldsymbol{LE_{embodied,y}}$	Leakage from amortised embodied infrastructure emissions in year y (tCO_2e/yr).

9.4.3 | **Leakage from transferred baseline equipment ($LE_{equip,y}$):** If the transfer of baseline equipment cannot be avoided by its destruction, decommissioning, or disposal, the activity developer shall quantify the resulting negative leakage from its continued operation. The activity developer shall apply one of the following two approaches:

a. **Conservative default penalty:** The activity developer shall conservatively assume that the transferred equipment operates continuously at its historical maximum annual capacity.

$$LE_{equip,y} = Q_{\max\_Cap} \times EF_{hist} \qquad \text{(eq.17)}$$

Where,

$\boldsymbol{Q_{\max\_Cap}}$	The historical maximum annual nameplate capacity of the transferred equipment (tNH_3/yr).
$\boldsymbol{EF_{hist}}$	The historical specific emissions intensity of the transferred equipment prior to the activity (tCO_2e/tNH_3), as determined in Section 7.

b. **Explicit tracking and metering:** The developer shall explicitly track the relocated equipment and directly meter its actual operational output ($Q_{\text{actual},y}$) at its new location for the duration of its remaining technical lifetime. If access to the relocated equipment is denied or records are unverifiable, the developer shall default to the maximum capacity penalty.

9.4.4 | **Changes in upstream processes($LE_{embodied,y}$):** In compliance with the GS4GG Requirements for Addressing Leakage in Methodologies, the total cradle-to-gate lifecycle GHG emissions of major equipment and material inputs (e.g., the new renewable energy facility, electrolyser units, and energy storage infrastructure) shall be quantified using verified Environmental Product Declarations (EPDs compliant with ISO 14025/14040) or conservative IPCC/IEA median defaults. To ensure maximum conservativeness, the total upfront embodied emissions shall be amortised linearly across the exact duration of the first crediting period (e.g., 5 years).

$$LE_{embodied,y} = \frac{E_{RE,total}+E_{electrolyser,total}+E_{storage,total}}{CP1st} \quad \text{(eq.18)}$$

Where,

$LE_{embodied,y}$	Annual amortised embodied emissions attributed to the activity in year y (tCO_2e/yr).
$E_{RE,total} + E_{electrolyser,total} + E_{storage,total}$	Total cradle-to-gate lifecycle GHG emissions of the newly installed activity infrastructure (tCO_2e).
$CP1st$	The duration of the first crediting period in years (e.g., 5). After the first crediting period concludes, $LE_{embodied,y}$ shall be zero.

9.4.5 | **Land Use Change ($LE_{LUC,y}$):** If the greenfield construction of the ammonia plant or its dedicated renewable energy facility results in the conversion of land from a natural state (e.g., forest, wetland, or grassland) to an industrial site or solar/wind farm, the resulting GHG emissions from the loss of carbon stocks shall be quantified as leakage. LUC emissions shall be deemed immaterial and set to zero if:

a. the activity is located on existing industrial, commercial, or degraded land with no significant above-ground biomass; AND
b. the total estimated leakage for land use change is below 5% estimated annual emission reductions over the crediting period (i.e., 15 years). In all other cases, a full LUC assessment per Equation 19 is required.

9.4.6 | The $LE_{LUC,y}$ shall be calculated as the difference between the carbon stocks of the land before conversion and after conversion across all five IPCC pools (Above-Ground Biomass, Below-Ground Biomass, Dead Wood, Litter, and Soil Organic Carbon). This shall be calculated using Tier 1 default values from the 2006 IPCC Guidelines for National GHG Inventories, unless higher-tier local data is verifiable.

9.4.7 | In accordance with IPCC good practice guidance, the total carbon stock loss shall be amortized over a fixed 20-year period.

$$LE_{LUC,y} = \max\left[0, \sum_i \left(C_{BSL,i} - C_{pro,i} \times A_i \times \frac{44}{12}\right)/20\right] \quad \text{(eq.19)}$$

Where,

$C_{BSL,y}$	Total carbon stock per unit area for the land use type of parcel i before conversion (tonnes C/ha).
$C_{pro,i}$	Total carbon stock per unit area for the land use type of parcel *i* after conversion (tonnes C/ha).
A_i	Area of land parcel *i* undergoing conversion (ha).
$\frac{44}{12}$	Conversion factor from tonnes of carbon (C) to tonnes of carbon dioxide (CO_2).
20	Amortization period for LUC emissions, fixed at 20 years as per IPCC good practice guidance. The 20-year amortization period for LUC emissions is fixed in accordance with IPCC good practice guidance to ensure the total climate impact is accounted for in a standardized manner, even if this period extends beyond the activity's 15-year crediting period

10| NET GHG EMISSION REDUCTIONS

10.1 | Calculation of gross GHG emission reductions

10.1.1 | The gross GHG emission reductions achieved by the activity during a given monitoring period ($ER_{gross,y}$) represent the climate benefit prior to the application of the end-use safeguard. The activity developer shall calculate the gross emission reductions by subtracting the total activity emissions (Section 8) and total leakage emissions (Section 9) from the final crediting baseline emissions (Section 7).

$$ER_{gross,y} = BE_{credit,y} - AE_y - LE_y \qquad \text{(eq.20)}$$

Where,

$ER_{gross,y}$	Gross emission reductions during the monitoring period y (tCO_2e/yr)
$BE_{credit,y}$	Final crediting baseline emissions in the monitoring period y (tCO_2e/yr). This value inherently incorporates the Downward Adjustment Factor (DAF) and conservative BAU checks as determined in Section 7.
AE_y	Total activity emissions in the monitoring period y (tCO_2e/yr).
LE_y	Total leakage emissions in the monitoring period y (tCO_2e/yr).

10.1.2 | If the calculation of $ER_{gross,y}$ yields a negative value, the gross emission reductions for that monitoring period shall be deemed zero. Negative emission reductions cannot be banked or carried forward to subsequent monitoring periods).

10.2 | Safeguard for verified end-use

10.2.1 | In accordance with the applicability condition established in Section 3, emission reductions shall only be credited for low-carbon ammonia that is verifiably dispatched and utilised for eligible end-uses (currently restricted exclusively to fertiliser manufacturing). Any volume of ammonia sold, transferred, or utilised for non-eligible purposes shall be strictly excluded from the crediting calculations.

10.2.2 | To robustly operationalise this safeguard without limiting future methodology revisions, the activity developer shall apply the Eligible End-Use Fraction ($F_{eligible,y}$).

10.2.3 | The activity developer shall rigorously reconcile the total volume of low-carbon ammonia produced against audited sales receipts, dispatch logs, mass-balance tracking, or internal transfer records to the eligible manufacturing plant. *Note: If low-carbon ammonia is produced in year y but retained in storage inventory and sold for an eligible use in year $y+1$, the activity developer may defer the crediting of that specific volume until the monitoring period in which the eligible end-use is officially verified*

10.3 | Calculation of Final Net GHG Emission Reductions

10.3.1 | The final net emission reductions (ER_y) represent the actual, verifiable volume of GSVERs (Gold Standard Verified Emission Reductions) eligible for issuance. To determine ER_y, the activity developer shall apply one of the following two approaches:

a. **Option A: The Fractional Multiplier Approach (Default):** The final net emission reductions are calculated by multiplying the gross emission reductions by the verified Eligible End-Use Fraction.

$$F_{eligible,y} = \frac{Q_{eligible,y}}{P_{NH3,y}} \qquad \text{(eq.21)}$$

$$ER_y = ER_{gross,y} \times F_{eligible,y} \qquad \text{(eq.22)}$$

Where,

$\boldsymbol{ER_y}$	Final net emission reductions eligible for issuance during the monitoring period y (tCO_2e/yr).
$\boldsymbol{ER_{gross,y}}$	Gross emission reductions during the monitoring period y prior to end-use safeguard (tCO_2e/yr)
$\boldsymbol{F_{eligible,y}}$	The fraction of total low-carbon ammonia produced in year y that is verifiably utilised for eligible end-uses (fraction).
$\boldsymbol{Q_{eligible,y}}$	Quantity of low-carbon ammonia verifiably dispatched and sold for eligible end-uses in year y (tonnes).
$\boldsymbol{P_{NH3,y}}$	Total monitored production of low-carbon ammonia by the activity in year y (tonnes).

b. **Direct Baseline Allocation Approach (Alternative):** Alternatively, the activity developer may isolate the eligible production volume from the outset. In this approach, the baseline production parameter ($P_{NH3,y}$ defined in Section 7) shall strictly equal only the exact metered volume of ammonia verifiably delivered for eligible end-uses ($Q_{eligible,y}$). The remaining non-eligible volume is excluded from the baseline calculations entirely. To ensure absolute conservativeness under Option B, total activity emissions (AE_y) and total leakage emissions (LE_y) shall not be prorated downward; the full facility-level activity and leakage penalties shall be deducted from the eligible baseline:

$$ER_y = BE_{credit,y(eligible\ only)} - AE_{y(total)} - LE_{y(total)} \quad \text{(eq.23)}$$

c. Under either Option A or Option B, if the calculation of ER_y yields a negative value, the net emission reductions for that monitoring period shall be deemed zero. Negative emission reductions cannot be banked or carried forward.

11| MEETING METHODOLOGICAL PRINCIPLES

11.1 | Encouraging ambition over time

11.1.1 | This methodology ensures the continuous encouragement of climate ambition—moving beyond static emission reductions—through the following mandatory mechanisms:

a. **Downward Adjustment Factor (DAF):** The methodology operationalizes ambition by mandating the application of the DAF (Section 7.4.2).

b. **Best Available Technology (BAT) Baselines:** By setting the unadjusted baseline against the performance of highly efficient, modern conventional plants (Section 7.3.1), rather than a less ambitious fleet average or older coal plants, the methodology ensures only activities pushing the technological frontier generate carbon revenues.

11.2 | Equitable sharing of mitigation benefits

11.2.1 | The methodology promotes the equitable sharing of mitigation benefits between participating Parties (the host country and the activity developer) by operating under the GS4GG framework and aligning with national development goals.

a. **Long-Term Host Country Benefit:** Industrial ammonia facilities possess operational lifetimes (e.g., 25–50 years) that significantly exceed the maximum 15-year crediting period allowed under this methodology. Consequently, the host country will continue to derive massive, uncredited emission reductions (well beyond BAU) for decades after carbon financing ends, directly contributing to the host country's Nationally Determined Contributions (NDCs).

b. **Uncredited Ambition:** Because the crediting baseline is forced below the actual, most likely Business-As-Usual (BAU) scenario via the DAF and uncertainty discounts, a significant volume of emission reductions physically occurs but is explicitly excluded from carbon crediting. These "uncredited" emission reductions automatically accrue to the host country.

c. **Safeguards and Local Co-Benefits:** Adherence to the GS4GG Safeguarding Principles and Requirements ensures that the rights and interests of local stakeholders are protected. Specifically, the strict 5% cap on local drinking water consumption for electrolysis (Section 3.2.7) guarantees that the activity's massive resource needs do not compromise local community access to essential water resources or agricultural livelihoods.

11.3 | Avoidance of double counting:

11.3.1 | Given the complex, overlapping policy incentives emerging in the global hydrogen and ammonia sectors, the methodology includes strict safeguards to prevent double issuance, double use, and double claiming:

a. **Environmental Markets & Subsidies:** The activity developer shall demonstrate in each monitoring report that the emission reductions claimed under GS4GG are not simultaneously monetized or claimed under other environmental markets (e.g., Renewable Energy Certificates [RECs], Guarantees of Origin [GOs], or Low-Carbon Fuel Standards). As mandated in Section 3.2.3, any Power Purchase Agreement (PPA) utilized by the activity shall legally prevent the renewable energy generator from selling RECs to a third party for the power supplied to the ammonia plant.

b. **Domestic Mitigation Schemes:** The Regulatory Surplus Analysis (Section 6.3) requires the developer to prove the emission reductions do not overlap with mandatory domestic compliance markets (e.g., an Emissions Trading System [ETS] that caps the exact emission sources reduced by the activity). If an overlap exists, the developer must prove that allowances equal to the GSVERs requested for issuance were verifiably cancelled.

c. **End-User Notification:** The activity developer shall explicitly assert ownership rights over the emission reductions via contractual agreements with the fertilizer off-taker and legally notify the end-users that they cannot claim the emission reductions for their own Scope 3 decarbonization targets unless the GS4GG credits are formally retired on their behalf.

11.4 | Aligning with NDC and LT-LEDS:

11.4.1 | The methodology ensures strict alignment with the host country's NDCs and Long-Term Low-Emission Development Strategies (LT-LEDS), as well as the temperature goals of the Paris Agreement:

a. **Lock-In Risk Avoidance:** The mandatory Lock-In Risk Analysis (Section 6.3) prevents the issuance of carbon credits to transitional fossil-fuel technologies (e.g., "blue" ammonia equipped with CCS or SMR units). By strictly limiting eligibility to water electrolysis powered by zero-emission renewable energy, the methodology ensures the infrastructure built today is fully compatible with mid-century Net-Zero pathways.

b. **DAF Alignment:** The magnitude of the Downward Adjustment Factor (DAF) is explicitly derived from the host country's declared Net-Zero target year (Section 7.4.2), ensuring that the baseline trajectory mathematically mirrors the national long-term decarbonization pathway.

11.5 | Encouraging Broad Participation:

11.5.1 | The methodology encourages broad participation across diverse geographies through standardization and flexibility:

a. **Global Applicability and Defaults:** The methodology is globally applicable to micro, small, and large-scale facilities. To reduce transaction costs and encourage participation in data-poor regions, it provides standardized, conservative global default values for the BAT baseline).

b. **Programmatic Approach:** The methodology is highly suitable for aggregation under Programmes of Activities (PoA) (Section 16), allowing for the scaled deployment of modular, decentralized green ammonia production units (e.g., for local agricultural cooperatives) under a single, streamlined certification umbrella.

11.6 | Including Data Sources, Accounting for Uncertainty, and Monitoring:

11.6.1 | The methodology ensures extreme robustness in data utilization, uncertainty management, and monitoring integrity.

11.7 | Taking into Account Policies, Measures, and Relevant Circumstances:

11.7.1 | The methodology accounts for relevant national policies and local circumstances:

a. **Regulatory Surplus:** The mandatory Regulatory Surplus Analysis (Section 6.3) ensures the activity is not legally mandated by current or anticipated national laws.

b. **Conservative BAU Integration:** The calculation of the Conservative Business-As-Usual (BAU) baseline (Section 7.5) explicitly incorporates any legally enforced efficiency improvements or emission caps taking effect during the crediting period, ensuring the crediting baseline reflects the true regulatory reality of the host country.

12| REVERSALS

12.1 | Reversal risk assessment

12.1.1 | This methodology addresses the avoidance of greenhouse gas emissions through the displacement of conventional, fossil-fuel-intensive ammonia production with electrolysis-based ammonia synthesis powered by renewable energy.

12.1.2 | As an emission avoidance activity, there is no physical risk of captured or sequestered carbon re-entering the atmosphere, as the activity does not rely on carbon removal or storage technologies. Consequently, the concept of a "reversal" (the loss of stored carbon) is not applicable to this methodology.

12.1.3 | The only operational requirement for maintaining the integrity of emission reductions is demonstrating the continued, eligible operation of the zero-emission production facility. If the facility ceases operation or reverts to non-eligible production practices (e.g., using fossil-derived feedstocks), the activity shall immediately be disqualified from issuing further emission reductions.

13| UNCERTAINTY QUANTIFICATION

13.1 | Approach to Uncertainty Management

13.1.1 | This methodology establishes a structured framework to quantify and mitigate uncertainty, ensuring the calculated Net GHG Emission Reductions remain strictly conservative. This approach combines methodological standardisation for non-measured parameters with mandatory industrial metering accuracy and calibration for core empirical parameters.

[Note: The management of measurement and parameter uncertainty detailed in this section is structurally distinct from, and applied prior to, the DAF. Uncertainty adjustments correct for empirical and instrumental variance, whereas the DAF addresses macroeconomic policy ambition].

13.1.2 | **Standardisation and Defaults**: Uncertainty for non-measured parameters (e.g., Best Available Technology benchmark [EF_{BAT}], embodied infrastructure emissions [$LE_{embodied,y}$], Global Warming Potentials [GWP_{100}], and chemical conversion factors) is managed using strictly conservative, methodology-approved defaults, peer-reviewed scientific consensus (e.g., Sand et al., 2023 for hydrogen), or third-party verified Environmental Product Declarations (EPDs).

13.1.3 | **Measurement Conservativeness (Industrial Metering):** The industrial green ammonia production relies on continuous, direct measurement. Uncertainty for core empirical parameters (e.g., electricity consumption, ammonia production, physical gas leaks) is managed through mandatory adherence to international calibration standards (e.g., ISO, IEC) for all metering equipment. If any measurement equipment falls out of calibration or precision targets are compromised, a mandatory conservative adjustment shall be mathematically applied to the dataset using the maximum observed error margin.

13.2 | Sources of Uncertainty and Mitigation

13.2.1 | Key uncertainty sources and their mandated mitigation measures are summarised in the following table. This matrix shall serve as the normative reference for VVBs when auditing uncertainty.

Table 7. Key uncertainty sources and mitigation measures

Source of Uncertainty	Affected Parameter(s)	Mandatory Mitigation Measure(s)
Measurement Uncertainty (Metering & Sensors) Sensor drift, flow meter inaccuracies, and electricity meter errors during continuous industrial operations.	$P_{NH3,y}$ (Ammonia Production) $Q_{eligible,y}$ (Eligible Ammonia Sales) $EC_{grid,y}$ (Grid Electricity) $Q_{leak,H2,y}$ (Fugitive H_2) $Q_{leak,NH3,y}$ (Fugitive NH_3	1. **High-Precision Equipment:** Mandatory use of industrial-grade, continuous metering equipment complying with relevant national/international accuracy standards. 2. **Calibration:** Routine calibration of all meters against known reference standards (Section 14). 3. **Conservative Adjustment:** If a meter is discovered to be out of calibration during a post-test check, the maximum observed error margin shall be mathematically applied to the entire affected dataset in the most conservative direction (i.e., decreasing baseline production or increasing activity consumption/leaks).
Parameter Uncertainty (Defaults & LCA): Inherent uncertainty in lifecycle assessments, global warming potentials, and chemical conversion fractions.	GWP_{H2} (Hydrogen GWP) $EF_{NH3\ à\ N2O}$ (Ammonia to N_2O conversion) $LE_{embodied,y}$ (Embodied Emissions) $EF_{grid,y}$ (Grid Emission Factor)	1. **Standardisation:** Mandatory use of the specified, peer-reviewed GWP_{100} value for hydrogen 14.4 (11.6 ± 2.8) and conservative defaults for atmospheric oxidation of NH_3. 2. **Verified LCAs:** Mandatory use of third-party verified, ISO 14025/14040 compliant EPDs for embodied emissions of new infrastructure, or conservative IPCC/IEA median defaults. 3. **Approved Tools:** Adherence to A6.4-AMT-007 for grid emission factors.

Analytical Uncertainty (Baselines): Overestimating historical baseline emissions for brownfield retrofits or poorly selecting comparable regional BATs.	$EF_{baseline}$ (Final Crediting Baseline Emission Factor) EF_{hist} (Historical Emissions)	1. **Structural Conservativeness:** Mandatory application of the $min(EF_{hist}, EF_{BAT})$ logic for brownfield retrofits. 2. **BAT Selection:** Mandatory application of the $min(EF_{BAT,global}, EF_{BAT,regional/national}$ logic. 3. **Boundary Exclusions:** Explicit exclusion of upstream baseline methane (CH_4) emissions to structurally guarantee a lower, highly conservative crediting benchmark.
Market and End-Use Uncertainty Ammonia being diverted to non-eligible end-uses (e.g., maritime fuel, explosives) instead of the designated fertiliser manufacturing, leading to unverified downstream impacts.	$F_{eligible,y}$ (Eligible End-Use Fraction) ER_y (Final Net Emission Reductions)	1. **End-Use Reconciliation:** Mandatory reconciliation of the total low-carbon ammonia produced against audited sales receipts, dispatch logs, or internal mass-balance transfer records. 2. **Strict Exclusion:** Any volume of ammonia lacking definitive proof of eligible end-use shall be strictly excluded from the baseline ($Q_{eligible,y}$), while full activity and leakage penalties shall remain fully deducted from the final crediting volume.

14| MONITORING METHODOLOGY

14.1 | General Requirements

14.1.1 | **Monitoring Plan:** The activity developer shall develop and implement a Monitoring Plan in the Project Design Document (PDD) or VPA-DD. The plan shall delineate the continuous industrial procedures for collecting, recording, analysing, and archiving all data required for the quantification of emission reductions, the tracking of eligible fertiliser end-uses, and the verification of applicability and safeguard criteria.

14.1.2 | **Measurement Equipment and QA/QC Calibration:** All physical measurement equipment used for monitoring (e.g., electricity meters, mass flow meters for hydrogen and ammonia, gas leak detection sensors, and weighbridges) shall be industrial-grade and comply with relevant national or international accuracy standards (e.g., ISO, IEC):

a. To prevent data invalidation due to calibration drift, all primary custody-transfer meters (for grid electricity import and final ammonia product output) shall undergo strict third-party calibration annually or in accordance with the manufacturer's specified calibration intervals, whichever is more stringent. Calibration logs shall be maintained and made available to the VVB.

b. If a primary meter is discovered to be out of calibration beyond its permissible error margin during a post-test check or routine maintenance, the maximum observed error margin shall be applied to the dataset in the most conservative mathematical direction (e.g., decreasing eligible baseline production or increasing activity electricity consumption and leaks).

14.1.3 | **Digital Monitoring (SCADA) and Reconciliation:** The utilisation of digital, continuous monitoring technologies—specifically Distributed Control Systems (DCS) and Supervisory Control and Data Acquisition (SCADA) systems—is mandatory for this industrial activity to ensure high-fidelity data capture of electricity consumption, gas flow rates, and physical leak detection. For fugitive emissions, continuous SCADA integration is mandatory for real-time alerting; however, mass-balance reconciliation across the production loop may be utilised as a primary or fallback valid alternative to verify aggregate physical gas losses. Data shall be aggregated logically (e.g., hourly or daily) to facilitate robust VVB auditing.

14.1.4 | **Data Archiving:** All monitored data, including SCADA telemetry logs, mass-balance transfer records, dispatch/sales receipts for eligible end-use verification, and calibration certificates, shall be archived electronically. The data shall be securely backed up and retained for the duration of the crediting period plus an additional two (2) years after the final issuance of the corresponding vintage.

14.2 | Data and parameters not monitored

14.2.1 | The following parameters are determined ex-ante and remain fixed for the duration of the crediting period, unless otherwise noted.

Parameter ID	**GAM 1**
Data/parameter:	EF_{BAT}
Description	Best Available Technology (BAT) emission factor for conventional ammonia production.
Data unit:	tCO_2e/tNH_3
Purpose of data:	☒ Baseline emissions ☐ Activity emissions ☐ Applicability
Value(s) applied:	To be determined at the activity level.
Source of data:	☐ Measured ☒ Other source
Choice of data or measurement methods and procedures:	The applicable BAT emission factor shall strictly be the lowest (most conservative) value available: $min(EF_{BAT,global}, EF_{BAT,regional/national}$. Sourced from the methodology's normative annexes or officially established, peer-

	reviewed regional/national BAT benchmarks applicable to the host country.
Treatment of uncertainty	Conservatively addressed by explicitly excluding upstream methane emissions from the benchmark value and applying the minimum between global and regional/national BAT.
Comments:	Used to determine the unadjusted baseline emissions for Scenario A and as the strict cap for Scenario B.

Parameter ID	**GAM 2**
Data/parameter:	EF_{hist}
Description	Historical specific emissions intensity of the replaced fossil-based equipment.
Data unit:	tCO_2e / tNH_3
Purpose of data:	☒ Baseline emissions ☒ Leakage emissions
Value(s) applied:	To be determined at the activity level (applicable only to brownfield retrofits).
Source of data:	☒ Measured ☒ Other source
Choice of data or measurement methods and procedures:	Calculated based on verified direct CO_2 emissions from process heat and reforming over the most recent 3-year period of continuous commercial operation prior to the activity start date. Upstream CH_4 emissions shall be explicitly excluded.
Treatment of uncertainty	Conservatively managed by capping the historical baseline at the applicable BAT benchmark ($min(EF_{hist}, EF_{BAT})$) to prevent rewarding historical inefficiency.
Comments:	Also used to calculate Leakage if baseline equipment is transferred and reused ($LE_{equip,y}$).

Parameter ID	**GAM 3**
Data/parameter:	EF_{BAU}
Description	The prevailing average emission intensity of conventional ammonia capacity in the host country (Business-As-Usual).
Data unit:	tCO_2e / tNH_3
Purpose of data:	☒ Baseline emissions ☐ Activity emissions ☐ Applicability
Value(s) applied:	To be determined at the activity level based on host country statistics or industry benchmarks.
Source of data:	☐ Measured ☒ Other source
Choice of data or measurement	Sourced from official national statistics, IEA reports, or recognised industry associations representing the specific host country grid/feedstock mix.

methods and procedures:	
Treatment of uncertainty	N/A
Comments:	Used exclusively to calculate the unadjusted Conservative BAU Baseline (BAU_y) in Section 7.5.

Parameter ID	**GAM 4**
Data/parameter:	$RA_{mandate}$
Description	Regulatory Adjustment Factor representing legally enforced efficiency improvements.
Data unit:	Fraction (%)
Purpose of data:	☒ Baseline emissions ☐ Activity emissions ☐ Applicability
Value(s) applied:	To be determined at the activity level.
Source of data:	☐ Measured ☒ Other source
Choice of data or measurement methods and procedures:	Derived from existing policies, legal requirements, or specific national targets scheduled to take effect within the crediting period.
Treatment of uncertainty	N/A
Comments:	Used to adjust the BAU scenario to ensure it accurately reflects the de facto regulatory environment.

Parameter ID	**GAM 5**
Data/parameter:	GWP_{H2}
Description	100-year Global Warming Potential for hydrogen (H_2) to account for its indirect climate forcing effects.
Data unit:	tCO_2e / tNH_3
Purpose of data:	☐ Baseline emissions ☒ Activity emissions ☐ Applicability
Value(s) applied:	14.4.
Source of data:	☐ Measured ☒ Other source
Choice of data or measurement methods and procedures:	Sourced from peer-reviewed scientific literature assessing the indirect climate forcing of hydrogen (Sand et al., 2023).
Treatment of uncertainty	Managed via standardisation. This value remains fixed unless a superseding value is officially adopted by GS4GG.

Comments:	Used to calculate activity emissions from physical fugitive hydrogen leaks.

Parameter ID	**GAM 6**
Data/parameter:	GWP_{N2O}
Description	100-year Global Warming Potential for Nitrous Oxide (N_2O).
Data unit:	tCO_2e / t N_2O
Purpose of data:	☐ Baseline emissions ☒ Activity emissions ☐ Applicability
Value(s) applied:	265
Source of data:	☐ Measured ☒ Other source
Choice of data or measurement methods and procedures:	IPCC Sixth Assessment Report (AR5).
Treatment of uncertainty	N/A
Comments:	Used to calculate activity emissions from fugitive ammonia leaks that oxidise into N_2O.

Parameter ID	**GAM 7**
Data/parameter:	$EF_{NH3 \rightarrow N2O}$
Description	Fraction of volatilised ammonia-nitrogen that converts to nitrous oxide-nitrogen in the atmosphere.
Data unit:	Fraction (%)
Purpose of data:	☐ Baseline emissions ☒ Activity emissions ☐ Applicability
Value(s) applied:	To be determined at the activity level.
Source of data:	☐ Measured ☒ Other source
Choice of data or measurement methods and procedures:	A conservative, higher-side default factor derived from fertiliser-specific peer-reviewed literature, or a activity-specific value formally approved during validation.
Treatment of uncertainty	Conservatively addressed by mandating higher-side defaults if activity-specific empirical data is unavailable.
Comments:	Used to calculate activity emissions from fugitive ammonia leaks.

Parameter ID	**GAM 8**
Data/parameter:	$EF_{LCA,k}$

Description	Cradle-to-gate lifecycle GHG emission factor of newly installed activity infrastructure component k (e.g., electrolyser, renewable energy plant, battery storage).
Data unit:	tCO_2e/unit of capacity
Purpose of data:	☐ Baseline emissions ☐ Activity emissions ☒ Leakage emissions
Value(s) applied:	To be determined at the activity level.
Source of data:	☐ Measured ☒ Other source
Choice of data or measurement methods and procedures:	Shall be quantified using verified Environmental Product Declarations (EPDs compliant with ISO 14025/14040) specific to the manufactured equipment, or conservative IPCC/IEA median defaults.
Treatment of uncertainty	Managed by mandating ISO-compliant EPDs or conservative international defaults.
Comments:	Used to calculate embodied infrastructure leakage.

Parameter ID	**GAM 9**
Data/parameter:	$Q_{\max\_cap}$
Description	Historical maximum annual nameplate capacity of the transferred baseline equipment.
Data unit:	tNH_3/yr
Purpose of data:	☐ Baseline emissions ☐ Activity emissions ☒ Leakage emissions
Value(s) applied:	To be determined at the activity level.
Source of data:	☒ Measured ☒ Other source
Choice of data or measurement methods and procedures:	Sourced from original manufacturer specifications, plant commissioning documents, or historical operational records.
Treatment of uncertainty	Conservatively assumes the transferred equipment operates continuously at absolute maximum capacity if explicit metering at the new location is not conducted.
Comments:	Applicable only to brownfield retrofits where equipment is transferred rather than destroyed.

Parameter ID	**GAM 10**
Data/parameter:	$D_{proj,m}$
Description	Average two-way distance from the activity site to the fertiliser manufacturing facility via transport mode m.
Data unit:	km

Purpose of data:	☐ Baseline emissions ☒ Activity emissions ☐ Leakage emissions
Value(s) applied:	To be determined at the activity level.
Source of data:	☒ Measured ☒ Other source
Choice of data or measurement methods and procedures:	Engineering estimates based on confirmed off-taker agreements, logistics contracts, and mapped transport routes.
Treatment of uncertainty	N/A.
Comments:	Used to calculate activity transportation activity emissions. If distance is ≤ 200 km, emissions may be deemed negligible.

Parameter ID	**GAM 11**
Data/parameter:	$EF_{trans,m}$
Description	Emission factor for transport mode m.
Data unit:	tCO_2e/tonne-km
Purpose of data:	☐ Baseline emissions ☒ Activity emissions ☐ Leakage emissions
Value(s) applied:	To be determined at the activity level.
Source of data:	☒ Measured ☒ Other source
Choice of data or measurement methods and procedures:	Default values shall be sourced from recognised normative references (e.g., U.S. EPA Emission Factors Hub or national equivalents).
Treatment of uncertainty	N/A.
Comments:	Used in conjunction with $D_{proj,m}$ to calculate transportation emissions.

Parameter ID	**GAM 12**
Data/parameter:	TDL_y
Description	Average technical transmission and distribution losses for the grid.
Data unit:	Fraction (%)
Purpose of data:	☐ Baseline emissions ☒ Activity emissions ☐ Leakage emissions
Value(s) applied:	0.10(10%)
Source of data:	☐ Measured ☒ Other source
Choice of data or measurement	Conservative methodology default.

methods and procedures:	
Treatment of uncertainty	Applied as a static default to penalise grid electricity usage if verifiable official data is unavailable.
Comments:	Used to calculate activity emissions from backup grid consumption.

Parameter ID	**GAM 13**
Data/parameter:	ΔC_{LUC}
Description	Total loss of carbon stock due to land use conversion across the activity area.
Data unit:	tCO_2e
Purpose of data:	☐ Baseline emissions ☒ Activity emissions ☐ Leakage emissions
Value(s) applied:	To be determined at the activity level.
Source of data:	☐ Measured ☒ Other source
Choice of data or measurement methods and procedures:	Calculated across all five IPCC pools using Tier 1 default values from the 2006 IPCC Guidelines for National GHG Inventories, unless higher-tier local data is verifiable.
Treatment of uncertainty	Addressed by applying conservative IPCC Tier 1 defaults and amortising over a strict 20-year period.
Comments:	Used to calculate leakage for greenfield activities that alter natural carbon stocks.

14.3 | Data and parameters monitored

14.3.1 | The following data and parameters shall be monitored continuously or periodically during the crediting period and recorded in the monitoring report.

Parameter ID	**GAM 14**
Data/parameter:	$P_{NH3,y}$
Description:	Total monitored production of low-carbon ammonia by the activity in year y.
Data unit:	tonnes ($tNH3$)
Purpose of data:	☒ Baseline emissions ☒ Activity emissions
Measurement and updating frequency	Continuous, aggregated monthly and annually.
Measurement methods and procedures:	Direct continuous measurement using industrial mass flow meters or precision load cells on product dispatch pipelines or storage tanks. Data shall be logged continuously via the facility's

	Supervisory Control and Data Acquisition (SCADA) or Distributed Control System (DCS).	
Entity/person responsible for the measurement:	Activity developer / Plant Operator.	
Measuring instrument(s):	Type of instrument	Industrial mass flow meters (e.g., Coriolis) or load cells integrated with SCADA.
	Accuracy class	Industry standard for custody transfer (e.g., Class 0.5 or better)
	Calibration requirements	Strict annual third-party calibration against certified international/national standards, or per manufacturer specifications (whichever is more stringent).
	Location	Ammonia synthesis loop output or storage tank dispatch points.
QA/QC procedures:	Data shall be cross-checked against SCADA logs and external sales/dispatch records.	
Treatment of uncertainty	Managed through mandatory ISO/IEC calibration adherence. If meters are found out of calibration, the maximum observed error margin shall be applied mathematically to decrease the reported production volume for the uncalibrated period.	
Comments:	Forms the basis for the unadjusted baseline emission calculation.	

Parameter ID	**GAM 15**
Data/parameter:	$Q_{eligible,y}$
Description:	Quantity of low-carbon ammonia verifiably dispatched and sold for eligible end-uses (e.g., fertiliser manufacturing) in year y.
Data unit:	tonnes ($tNH3$)
Purpose of data:	☒ Baseline emissions
Measurement and updating frequency	Continuous tracking per dispatch, aggregated annually.
Measurement methods and procedures:	Audited supply chain reconciliation. Documented via formal sales receipts, commercial off-taker contracts, dispatch logs, or mass-balance transfer records explicitly proving delivery to eligible manufacturing facilities.
Entity/person responsible for the measurement:	Activity developer / Commercial Management Team.

Measuring instrument(s):	Type of instrument	N/A (Documentary evidence).
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	Commercial records / Dispatch logs.
QA/QC procedures:	VVB shall conduct rigorous audits of off-taker agreements, delivery receipts, and invoices to verify the exact volume delivered for eligible end-uses.	
Treatment of uncertainty	Zero tolerance for ambiguity. Any volume of ammonia lacking definitive, auditable proof of eligible end-use shall be strictly excluded from baseline crediting ($Q_{eligible,y}$), while full activity/leakage penalties remain.	
Comments:	Used to calculate the Eligible End-Use Fraction ($F_{eligible,y}$) or directly allocate baseline volume to enforce applicability safeguards.	

Parameter ID	**GAM 16**	
Data/parameter:	$EC_{grid,y}$	
Description:	Total metered quantity of non-renewable electricity drawn from the grid by the activity facility in year y.	
Data unit:	MWh	
Purpose of data:	☒ Activity emissions	
Measurement and updating frequency	Continuous, aggregated monthly and annually.	
Measurement methods and procedures:	Direct measurement of all grid power imported into the facility boundary via the main utility connection point, logged automatically by the facility SCADA system.	
Entity/person responsible for the measurement:	Activity developer / Plant Operator.	
Measuring instrument(s):	Type of instrument	Utility-grade bi-directional electricity meters.
	Accuracy class	Custody-transfer grade (e.g., Class 0.2s or 0.5s).
	Calibration requirements	Calibrated in accordance with national utility regulations or international standards (IEC).

	Location	Main grid interconnection point(s).
QA/QC procedures:	SCADA logs shall be cross-checked against official utility invoices and grid operator statements. VVB shall verify that total annual grid consumption remains ≤10% of total facility electricity consumption to maintain eligibility.	
Treatment of uncertainty	If the meter under-reports due to calibration drift, the maximum error margin shall be applied to mathematically increase the recorded grid consumption.	
Comments:	Crucial for calculating activity emissions from backup grid consumption ($AE_{grid,y}$) and verifying the 10% applicability cap.	

Parameter ID	**GAM 17**	
Data/parameter:	$EF_{grid,y}$	
Description:	Grid emission factor for the host country/region grid in year y.	
Data unit:	tCO_2e/MWh	
Purpose of data:	☒ Activity emissions	
Measurement and updating frequency	Updated annually or fixed ex-ante for the crediting period, contingent upon the selected calculation option in the relevant tool.	
Measurement methods and procedures:	Calculated strictly in accordance with the latest version of A6.4-AMT-007: Methodological tool: Emissions from electricity generation and consumption.	
Entity/person responsible for the measurement:	Activity developer.	
Measuring instrument(s):	Type of instrument	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures:	The calculation and data sources shall be validated by the VVB according to the requirements in A6.4-AMT-007.	
Treatment of uncertainty	Managed via adherence to the rigorous standardisation of the A6.4 tool.	
Comments:	Used to quantify emissions from permitted grid electricity consumption.	

Parameter ID	**GAM 18**	
Data/parameter:	$FC_{ff,y}$	
Description:	Quantity of fossil fuel (e.g., diesel) combusted for backup generators or auxiliary purposes in year y.	
Data unit:	Mass or volume units (e.g., tonnes, litres, m^3)	
Purpose of data:	☒ Activity emissions	
Measurement and updating frequency	Continuous (when operating) or per delivery, aggregated annually.	
Measurement methods and procedures:	Direct metering using fuel flow meters, or volumetric monitoring via calibrated tank dipsticks and purchase invoices.	
Entity/person responsible for the measurement:	Activity developer / Plant Operator.	
Measuring instrument(s):	Type of instrument	Fuel flow meters or calibrated storage tanks.
	Accuracy class	Industry standard.
	Calibration requirements	Annual calibration per manufacturer guidelines.
	Location	Backup generator inputs or auxiliary boilers.
QA/QC procedures:	Metered consumption shall be cross-checked against fuel purchase receipts and inventory logs. Strict monitoring to ensure fossil fuels are used exclusively for emergency/auxiliary backup, not core synthesis.	
Treatment of uncertainty	Uncertainty is managed by assuming all purchased fossil fuel not remaining in inventory was combusted. Maximum error margins shall be applied upwards if meters are out of calibration.	
Comments:	Used to calculate activity emissions from backup fossil fuel combustion ($AE_{ff,y}$) using TOOL03.	

Parameter ID	**GAM 19**
Data/parameter:	$Q_{leak,H2,y}$
Description:	Total monitored mass of uncombusted hydrogen (H_2) physically leaked or purged to the atmosphere in year y.
Data unit:	$tonnes\ (tH2)$
Purpose of data:	☒ Activity emissions

Measurement and updating frequency	Continuous monitoring via SCADA, aggregated annually.	
Measurement methods and procedures:	Quantified via real-time SCADA integration with ambient gas leak detection sensors AND overall system mass-balance reconciliation (comparing hydrogen generated at the electrolyser vs. hydrogen consumed in the Haber-Bosch loop). The higher (more conservative) value between sensor-detected discrete leaks and unaccounted mass-balance losses shall be used.	
Entity/person responsible for the measurement:	Activity developer / Safety Team.	
Measuring instrument(s):	Type of instrument	Hydrogen gas leak detectors and mass flow meters.
	Accuracy class	Industrial safety grade (ppm precision for sensors, Class 1.0 or better for flow meters).
	Calibration requirements	Strict adherence to manufacturer and national safety calibration schedules.
	Location	Electrolysers, compressors, pipelines, and storage.
QA/QC procedures:	Continuous SCADA alerting for leaks. Regular manual leak detection and repair (LDAR) safety audits and mass-balance cross-checks by engineering staff.	
Treatment of uncertainty	Applying the higher value between discrete sensor-detected leaks and aggregate mass-balance losses ensures conservativeness.	
Comments:	Used to calculate fugitive hydrogen emissions ($AE_{fugitive,H2,y}$) using the GWP_{100} of 14.4.	

Parameter ID	**GAM 20**
Data/parameter:	$Q_{leak,NH3,y}$
Description:	Total monitored mass of ammonia (NH_3) physically leaked or volatilised to the atmosphere in year y.
Data unit:	$tonnes\ (tNH3)$
Purpose of data:	☒ Activity emissions
Measurement and updating frequency	Continuous monitoring via SCADA, aggregated annually.
Measurement methods and procedures:	Quantified via SCADA integration with ambient ammonia leak detection sensors and overall system mass-balance reconciliation (comparing theoretical yield vs. actual dispatched volume).

Entity/person responsible for the measurement:	Activity developer / Safety Team.	
Measuring instrument(s):	Type of instrument	Ammonia gas detectors and mass flow meters.
	Accuracy class	Industrial safety grade.
	Calibration requirements	Strict adherence to manufacturer and national occupational health and safety (OHS) calibration schedules.
	Location	Synthesis loop output, storage tanks, and dispatch loading bays.
QA/QC procedures:	Continuous SCADA alerting. Inventory reconciliations shall be conducted at least monthly.	
Treatment of uncertainty	Any unaccounted mass imbalance across the synthesis and storage loop shall be conservatively assumed to be volatilised to the atmosphere.	
Comments:	Used to calculate fugitive ammonia emissions ($AE_{fugitive,NH3,y}$) representing subsequent atmospheric N_2O formation.	

Parameter ID	**GAM 21**	
Data/parameter:	$DAF_{NetZero,y}$	
Description:	Downward Adjustment Factor for Ambition for the host country, applicable to year y.	
Data unit:	Fraction (%)	
Purpose of data:	☒ Baseline emissions (Ambition Adjustment)	
Measurement and updating frequency	Annual (based on the calendar year of the monitoring period).	
Measurement methods and procedures:	Sourced exclusively from the latest version of the GS4GG Methodology Tool 05: Downward Adjustment Factor (DAF) Determination, corresponding exactly to the host country and the monitoring year.	
Entity/person responsible for the measurement:	Activity developer.	
Measuring instrument(s):	Type of instrument	N/A

	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures:	VVB verification that the precise DAF value has been applied based on the host country and the exact vintage of the emission reductions.	
Treatment of uncertainty	N/A	
Comments:	Mandatory adjustment to continuously lower the crediting baseline.	

Parameter ID	**GAM 22**	
Data/parameter:	$Q_{actual,y}$	
Description:	Actual operational output of transferred baseline equipment at its new location in year y.	
Data unit:	$Tonnes\ (tNH3/yr)$	
Purpose of data:	☒ Leakage emissions	
Measurement and updating frequency	Continuous, aggregated annually for the duration of the equipment's remaining technical lifetime.	
Measurement methods and procedures:	Explicit tracking and direct mass-metering of the relocated equipment's output at its new operational site.	
Entity/person responsible for the measurement:	Activity developer (via contractual data-sharing agreements with the new owner).	
Measuring instrument(s):	Type of instrument	Industrial mass flow meters.
	Accuracy class	Industry standard for custody transfer.
	Calibration requirements	Proof of regular calibration required.
	Location	New operational site of the transferred equipment.
QA/QC procedures:	Third-party audits of the relocated plant's production records. If access is denied or records are unverifiable, the developer shall default to the maximum capacity penalty (Q_{max_cap})	

Treatment of uncertainty	If actual metered data is unreliable or tracking fails, the conservative maximum capacity default (Q_{max_cap}) shall be applied as a penalty.
Comments:	Applicable exclusively to brownfield retrofits where equipment is transferred and actively metered.

Parameter ID	**GAM 23**	
Data/parameter:	$Q_{NH3,m,y}$	
Description:	Quantity of low-carbon ammonia transported from the activity site via transport mode m in year y.	
Data unit:	tonnes (tNH_3).	
Purpose of data:	☒ Activity emissions	
Measurement and updating frequency	Per shipment, aggregated annually.	
Measurement methods and procedures:	Monitored based on product dispatch records, weighbridge tickets, and transport logistics logs.	
Entity/person responsible for the measurement:	Activity developer.	
Measuring instrument(s):	Type of instrument	Dispatch logs and weighbridges.
	Accuracy class	Industry standard
	Calibration requirements	Annual calibration per national standards.
	Location	Activity dispatch bay
QA/QC procedures:	Dispatch records shall be reconciled against total ammonia sales and made available for VVB verification.	
Treatment of uncertainty	N/A	
Comments:	Sum of product transported across all modes should equal the total product dispatched off-site. Applicable if transport distance exceeds 200 km.	

Parameter ID	**GAM 24**
Data/parameter:	$D_{PJ,m}$

Description:	Average two-way distance from the activity site to the end-user for transport mode m.	
Data unit:	km.	
Purpose of data:	☒ Activity emissions	
Measurement and updating frequency	Once at activity validation, and/or at verification immediately following installation of additional activity infrastructure.	
Measurement methods and procedures:	Calculated as a weighted average of distances to all delivery points for a given transport mode, based on transport logs.	
Entity/person responsible for the measurement:	Activity developer.	
Measuring instrument(s):	Type of instrument	Engineering estimates based on maps and transport routes.
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures:	Transport logs and routes shall be verified by the VVB.	
Treatment of uncertainty	N/A	
Comments:	Used to calculate activity transportation activity emissions.	

14.4 | QA/QC and Data Management

14.4.1 | **Data Validation:** The activity developer shall establish procedures for the validation of monitored data. This shall include the systematic cross-checking of automated telemetry (SCADA/DCS logs) against physical commercial records, such as utility electricity bills, off-taker sales receipts, and transport dispatch logs. Furthermore, an overall mass-balance reconciliation (comparing hydrogen gas generated against final anhydrous ammonia produced) shall be conducted at least monthly to verify system integrity and identify any unaccounted fugitive emissions. Arbitrary exclusion of data points, or system warnings is strictly prohibited.

14.4.2 | **Staff Trainings:** All plant operators, commercial managers, and health and safety personnel responsible for data capture, mass-balance reconciliation, and meter maintenance shall undergo documented training on Standard Operating Procedures (SOPs), calibration protocols, and data security compliance. Training records shall be maintained for VVB review.

14.4.3 | **QA/QC**:

a. **Protocols:** All data collection and reconciliation processes shall adhere to standardised, internationally recognised industrial protocols.
b. **Calibration:** All measurement equipment (e.g., electricity meters, mass flow meters, load cells, and gas leak detection sensors) shall be calibrated according to the manufacturer's instructions or relevant national/international standards (e.g., ISO, IEC), whichever is more stringent. Primary custody-transfer meters (for grid electricity import and ammonia product export) shall be checked frequently and calibrated by accredited third-party laboratories at least annually. Calibration records shall be maintained and made available for verification.
    i. If the calibration check reveals an error within the meter's permissible accuracy class margin, the data is accepted as is.
    ii. If the calibration check reveals an error beyond the permissible accuracy class margin, the recorded data is not discarded; instead, the measured values shall be mathematically corrected for the entire period since the last successful calibration by applying the maximum observed error percentage in the most conservative direction (e.g., decreasing eligible baseline production or increasing activity electricity consumption and leak volumes).
    iii. If the error indicates meter failure, all data collected since the last successful check shall be strictly excluded from the analysis, and the data gap rules below shall apply.
c. **Data Cross-Checks:** Procedures for cross-checking data entry and identifying anomalies shall be implemented. Outliers may only be excluded if there is a clear, documented reason (e.g., system calibration error, documented unusual plant trip event). All excluded data shall be retained in the database with a formal explanation.

14.4.4 | **Corrective Actions for Data Gaps ("Missing Data" Rule):** In the event of SCADA system failure, equipment breakdown, or irretrievable data loss, missing data shall be substituted using the most conservative mathematical approach to ensure emission reductions are not artificially inflated:

a. **For parameters contributing to Baseline Emissions (e.g., $P_{NH3,y}$, $Q_{eligible,y}$):** A value of zero (0) shall be assumed for the entire duration of the missing data period.

b. **For parameters contributing to Activity or Leakage Emissions (e.g., $EC_{grid,y}$, $FC_{ff,y}$, $Q_{leak,H2,y}$)**: The maximum hourly or daily value historically recorded for that parameter during normal operations (or the absolute theoretical maximum capacity of the equipment) shall be applied continuously across the duration of the data gap, provided a verifiable valid justification is available for the data gap.

Linear interpolation is permitted only for brief, documented data gaps of less than 24 hours, provided the facility was operating in a verifiable steady-state condition.

15| MONITORING REQUIREMENTS FOR ACTIVITIES WITH REVERSAL RISKS

15.1 | Scope and Applicability

15.1.1 | As established in Section 12 of this methodology, low-carbon ammonia production generates mitigation outcomes strictly via the avoidance of greenhouse gas emissions (displacing the combustion and reforming of fossil fuels). The methodology does not generate credits for carbon removal or physical sequestration.

15.1.2 | Because there is no physical carbon reservoir to be depleted or reversed, the physical reversal of credited mitigation outcomes is structurally impossible. Consequently, the continuous monitoring requirements for activities with reversal risks, including the establishment of a reversal management plan and contributions to a Reversal Risk Buffer Pool, are not applicable to this methodology.

15.1.3 | The only ongoing operational safeguard required is the continuous metering of the facility's production and energy consumption (as detailed in Section 14) to prove the ongoing, eligible operation of the zero-emission infrastructure.

16| APPLICATION TO PROGRAMME OF ACTIVITIES

16.1 | General requirements

16.1.1 | This methodology is fully applicable to a Programme of Activities (PoA). A PoA framework is particularly suitable for grouping multiple modulars, decentralised green ammonia production facilities (or the retrofitting of multiple existing facilities) under a single administrative structure.

16.1.2 | The implementation of the PoA shall comply with the latest version of the GS4GG Standard on Programme of Activities. The Coordinating/Managing Entity (CME) shall define clear, objective eligibility criteria for the inclusion of Voluntary Project Activities (VPAs) in the PoA Design Document (PoA-DD). These criteria shall ensure that every individual VPA explicitly meets all Applicability Conditions defined in Section 3 of this methodology.

16.2 | Additionality and baselines at the VPA level

16.2.1 | **Additionality:** Additionality shall be demonstrated independently for each VPA in accordance with Section 6. If a VPA is submitted during the active 3-year validity window of the methodology-level Common Practice exemption outlined in Section 6.5, the VPA shall be exempt from the activity-level common practice assessment. However, the Investment Analysis and Regulatory Surplus Analysis shall reflect the specific capital costs (CAPEX), operational costs (OPEX), revenues, and regulatory conditions relevant to the specific VPA. If a legal mandate requiring the mitigation activity comes into force in the host country of a specific VPA, that VPA shall cease crediting from the effective date of the mandate. Other VPAs within the same PoA that are located in different jurisdictions shall not be affected.

16.2.2 | **Baseline Scenarios:** The crediting baseline scenario shall be determined and justified individually for each VPA in accordance with Section 7. The CME shall explicitly evaluate whether each VPA qualifies as a Greenfield (Scenario A) or Brownfield (Scenario B) activity. If VPAs are located in different host countries or grid regions, parameters such as the regional Best Available Technology benchmark, the Grid Emission Factor, and the Downward Adjustment Factor shall be rigorously assigned based on the geographical location of each VPA.

16.3 | Monitoring and cross-VPA sampling

16.3.1 | The CME shall establish a uniform, comprehensive central monitoring system detailing data collection, SCADA/DCS integration, calibration schedules, and GDPR-compliant archiving across all VPAs.

16.3.2 | **Prohibition of Cross-VPA Sampling:** Because this methodology governs an industrial chemical process requiring rigorous, continuous metering of mass flows and electricity for safety and commercial custody transfer, statistical cross-VPA sampling (e.g., measuring one unit to estimate the output of another) is strictly prohibited. The monitoring parameter and data inputs shall be metered and reconciled uniquely at each individual VPA site.

17| RENEWAL OF CREDITING PERIOD

17.1 | General Requirements

17.1.1 | The crediting period for activities applying this methodology is 5 years, renewable twice (up to a maximum total of 15 years). The renewal of the crediting period shall be conducted in accordance with the latest GS4GG requirements.

17.1.2 | At the time of renewal, the activity shall strictly comply with the latest approved version of this methodology available at the time of submission.

17.1.3 | To ensure the methodology actively encourages ambition over time, the activity developer shall conduct a comprehensive reassessment of the baseline scenario, additionality, and specific ex-ante parameters to ensure they reflect the prevailing technological, macroeconomic, and regulatory realities.

17.2 | Reassessment of the baseline scenario

17.2.1 | The baseline scenario shall be formally reassessed at each crediting period renewal to ensure that conventional, fossil-fuel-intensive ammonia production remains the most plausible Business-As-Usual (BAU) scenario in the host country.

17.2.2 | For brownfield activities (Scenario B), the activity developer shall explicitly verify whether the replaced fossil-based equipment has reached the end of its remaining technical lifetime (as determined by A6.4-AMT-006). If the technical lifetime has expired during the preceding crediting period, the baseline shall strictly transition to Scenario A (Greenfield BAT) for the renewed crediting period; the historical emission factor shall no longer be used.

17.3 | Update of fixed ex-ante parameters

17.3.1 | To ensure the crediting baseline continuously tracks technological advancements, the following key parameters shall be updated at the renewal of the crediting period:

a. **Best Available Technology Benchmark:** The EF_{BAT} shall be formally re-established. The activity developer shall identify the latest Global BAT benchmark and the latest Regional/National BAT benchmark prevailing at the time of renewal. The lowest (most conservative) of these updated values shall be applied for the renewed crediting period.

b. **Downward Adjustment Factor:** The applicable DAF value shall be updated based on the latest version of the GS4GG Tool 05: Downward Adjustment Factor (DAF) Determination corresponding to the host country and the new crediting period's vintage years.

c. **Grid Emission Factor:** If fixed ex-ante during the first crediting period, the grid emission factor shall be recalculated using the latest available data and the most recent version of A6.4-AMT-007. d.

d. **Embodied Emissions:** Because the cradle-to-gate embodied emissions of the newly installed infrastructure were fully amortised over the first 5-year crediting period (Section 9.4), this parameter shall be set to zero (0) for the second and third crediting periods. If significant[10] new capacity or infrastructure (e.g., additional electrolyser stacks) is installed during the renewal, the new embodied emissions shall be calculated and amortised over the remaining crediting lifespan.

e. Major component replacement, including but not limited to electrolyser stack replacement at end-of-life, shall be treated as new infrastructure for the purposes of embodied emissions accounting. The embodied emissions of replacement stacks shall be calculated and

[10] New infrastructure additions shall be considered 'significant' and require embodied emissions recalculation if they increase the facility's installed capacity by more than 5% or involve the replacement of a core process component (electrolyser stack, Haber-Bosch reactor, or ASU).

amortized over the remaining crediting period at the time of replacement.

17.3.2 | The parameters relating to the historical maximum capacity of retrofitted brownfield facilities (Q_{max_cap}) shall remain fixed for the duration of the equipment's remaining technical lifetime and do not require updating.

17.4 | Reassessment of additionality

17.4.1 | **Regulatory Surplus:** The Regulatory Surplus Analysis (Section 6.2) shall be updated. If new, fully enforced, and funded legal mandates have come into force that legally require the activity to produce ammonia exclusively via electrolysis (or explicitly ban the baseline alternative without carbon finance), the crediting period shall not be renewed.

17.4.2 | **Ongoing Financial Need (OFN):** The activity developer shall demonstrate OFN in accordance with Section 6.6. This requires re-running the original Investment Analysis to demonstrate the continued financial need for carbon revenues. The activity developer shall explicitly apply the Sunk CAPEX rules (retaining the historically incurred CAPEX at its Year 0 value, replacing historical ex-ante OPEX/revenue estimates with actual operational data, and updating forward-looking market projections) to prove that the activity's financial indicator still fails to meet the benchmark without carbon revenues.

17.4.3 | The crediting period shall only be renewed if the OFN assessment mathematically confirms the continued additionality of the activity.

ANNEX -1| METHODOLOGY-LEVEL DETERMINATIONS AND DEFAULT FACTORS

A 1.1| Objective and Scope

A 1.1.1| This normative annex establishes the binding default factors and methodology-level determinations for additionality and baseline setting. Activity developers shall apply these values to standardise quantification, ensure conservativeness, and reduce transaction costs, without requiring bespoke activity-level modelling for these specific parameters.

A 1.2| Methodology-Level Common Practice Determination

A 1.2.1| **Rationale and Empirical Basis:** In accordance with the GS4GG Methodology Standard: Requirements for Additionality Demonstration, a methodology-level common practice analysis has been conducted for low-carbon (electrolysis-based) ammonia production. Based on comprehensive global market assessments (utilising 2024–2025 data), the total operational capacity of commercial-scale green ammonia plants using renewable electrolysis is approximately 67.6 ktpa (0.068 Mtpa). When evaluated against the total global ammonia production capacity of approximately 188 to 192 Mtpa, the current global market penetration rate of commercial green ammonia is 0.036%.

A 1.2.2| **Deemed Status and Exemption:** Because the global market penetration (0.036%) is orders of magnitude below the standard GS4GG common practice thresholds (e.g., 5% or 20%), low-carbon ammonia production via water electrolysis is formally classified as a nascent, non-common practice technology. Consequently, any activity submitted for Design Certification under this methodology shall be automatically deemed to satisfy the Common Practice Analysis requirement. The activity developer is explicitly exempt from conducting a bespoke activity-level common practice calculation.

A 1.2.3| **Validity Period (Sunset Clause):** This methodology-level exemption shall have a strict validity period of three (3) years from the publication date of Version 1.0 of this methodology. Following this period, the global penetration rate shall be reviewed by the GS4GG Secretariat to ensure continued empirical relevance or activity developer shall conduct the activity specific assessment.

A 1.3| Global Best Available Technology (BAT) Benchmark

A 1.3.1| **Rationale and Empirical Basis:** To ensure that baseline emissions are strictly capped at an ambitious level (Scenario A and Scenario B), this methodology establishes a Global BAT benchmark. Based on an analysis of the top 10% most efficient conventional ammonia plants globally, modern, highly optimised Steam Methane Reforming (SMR) facilities operating on natural gas without Carbon Capture and Storage (CCS) achieve a direct process and combustion emission intensity of approximately 1.6 tCO_2e/tNH_3.

A 1.3.2| **Normative Default Value:** The conservative Global BAT default values shall be applied as follows:

Baseline Technology Pathway	Global Default EF_{BAT} (tCO_2e/tNH_3)	Justification / Source
Natural Gas - Steam Methane Reforming (SMR)	1.6	Represents the highest efficiency, top-decile SMR plants operating globally without CCS. This value covers direct process and combustion emissions exclusively. Upstream methane (CH_4) emissions are explicitly excluded to ensure maximum baseline conservativeness.

A 1.3.3| As mandated in Section 7.3.2, the activity developer shall use this 1.6 value unless an officially established regional/national BAT benchmark exists that is mathematically lower (stricter) than the global default.

A 1.3.4| The default shall be reviewed by GS4GG Secretariat at least every three years or at methodology update (if earlier) and updated if peer-reviewed evidence demonstrates that top-decile SMR has achieved a lower emission intensity. The most current value at the time of activity validation shall apply

ANNEX -2| REFERENCES

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