Emissions Accounting Approach

Attachment to the Scheme Design paper

20 September 2023

Contents

Executive summary

This paper is an attachment to the Guarantee of Origin (GO) Scheme Design consultation paper and provides a transparent insight into the proposed emissions accounting framework that underpins the GO Scheme. The framework is designed to meet the requirements of the International Partnership for Hydrogen and Fuel Cells in the Economy's (IPHE's) published Methodology for Determining the Greenhouse Gas Emissions Associated with the Production of Hydrogen. It also explains how existing frameworks and data sources will be able to be leveraged to meet the requirements of the IPHE methodology.

This attachment is supported by the Guarantee of Origin Emissions Calculator (GO calculator), which has been published alongside this attachment and demonstrates a practical implementation of the framework.

The proposed accounting framework builds on the domestic and international stakeholder feedback received on the consultation papers released by the Department of Climate Change, Energy, the Environment and Water (the Department) in December 2022, trials of the draft scheme on selected operational and well-advanced projects and continuing international engagement.

The GO Scheme will commence initially with hydrogen (and its energy carriers) and renewable electricity only. The emissions accounting framework proposed in this attachment therefore focuses on production, transport and storage of hydrogen. However, it is intended that the Scheme will be expanded to cover a wide range of clean energy products and the emissions accounting framework will remain flexible and evolve as more products are added to the scope of the Scheme. Prioritisation of the products to include in future is underway and the input on this is also sought from the stakeholders in this round of consultation, through the survey form available on the Department's website.

This attachment is divided into five parts:

- Part 1 defines the system boundary for the emissions accounting framework under the GO Scheme and the relevant activities and emissions.
- Part 2 provides the definitions of emissions intensities and how they are treated in the GO Scheme.
- Part 3 provides details of how the emissions are calculated, with examples and linkages to the Calculator.
- Part 4 lists the appropriate methods of measurements for input data and the sources of standard parameters such as emissions factors and fuel efficiencies used in the calculations of emissions intensities.
- Part 5 is the glossary of terms referred to in this attachment.

Feedback received on this attachment will help shape the emissions accounting approach of the GO Scheme and the development of legislative instruments underpinning the scheme. The Department is seeking stakeholder views on the emissions accounting approach outlined in this attachment, to understand how well the regulatory burden of the scheme is balanced with the need for scheme integrity and how practical it is to provide the required information. Responses can be provided directly through the Department's consultation hub.

Part 1. Emissions accounting scope

Feedback sought:

The Department is seeking feedback on the ability for registered participants to provide information across the proposed production and post-production boundaries for the GO scheme.

The first step in defining the emissions accounting methodology for the Guarantee of Origin scheme (GO scheme) is to define the scope of the system boundary. There are two key components of the system boundary: the production boundary and the post-production boundary. The approach to identifying emissions within these boundaries can then be used to produce an estimate of the emissions intensity per functional unit of production.

The **system boundary** for the GO scheme's emissions accounting methodology will be based on a well-to-delivery gate system boundary (Figure 1). This position is consistent with the proposed scope of the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) methodology.

This system boundary in effect means that following emissions will be covered by the GO scheme:

- Upstream emissions associated with the extraction, processing and transport of feedstocks,
- Direct emissions associated with the production of outputs from the product facility,
- Post-production emissions associated with transport and storage of the registered product to its delivery gate.

This boundary excludes emissions associated with capital expenditure, consumption of the registered product, end-of-life and waste processing. These emissions sources may be considered for inclusion in the future but are currently outside of scope for the initial GO scheme.

The system boundary can be broken down into two smaller sections consisting of the **production boundary**, which covers the well to the gate at the production site, and the **post-production boundary**, which covers the transport and storage of the product from the production gate to the delivery gate (Figure 1). The scope of these boundaries can vary between different production pathways and supply chains. The profile registration process will effectively set the scope of these boundaries and how emissions will be reported throughout them.

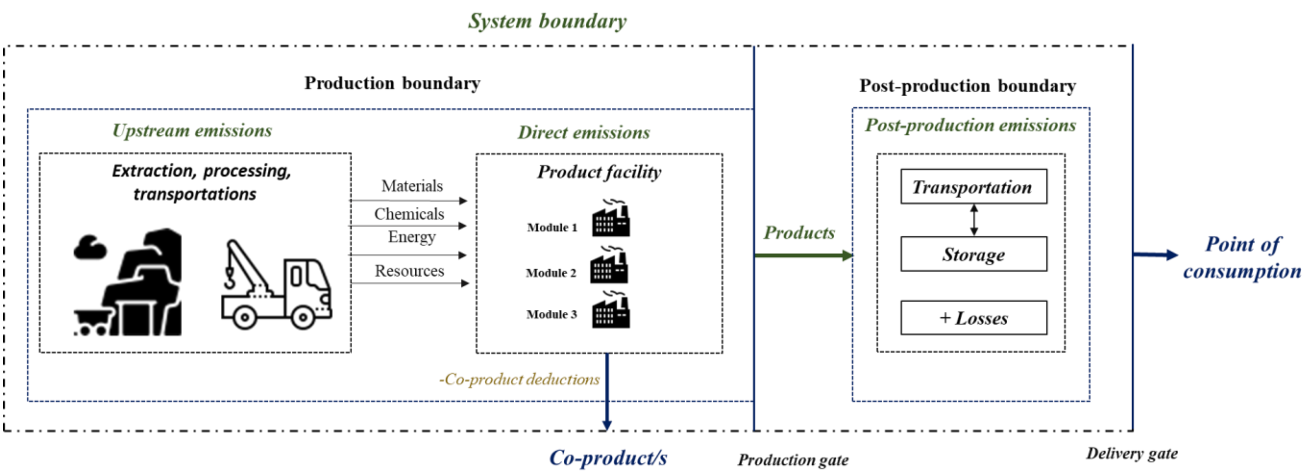

Figure 1 System boundary for the GO scheme's emissions accounting methodology.

Section 1.1 Production boundary

The production boundary includes upstream and direct emissions through to the production gate. It is set through the information provided during the product profile registration process. This boundary effectively sets the scope for the well-to-production gate portion of the system boundary discussed above.

The registered participant will need to define their production process through their product profiles, which will specify the production pathway and process steps (or modules) that are included as part of the product facility. Once these matters have been identified, the registered participant will then need to specify how they are intending to measure the emissions sources associated with each module.

Where the production boundary includes processing steps for different transport requirements, such as pressure and purity, the last common point where the conditions are homogenous (i.e. temperature, pressure and purity are the same) may be considered the end of the production boundary. Any processing steps to prepare the product that occur within the production boundary will instead be included as part of the post-production boundary. The alternative approach is to take the highest of the specifications, such as pressure, which is likely to over-estimate the emissions to the product.

GO Calculator user guide – "Facility Details" tab

The "Facility Details" tab requires users to input general product facility information to help identify the production boundary. This tab is applicable to all production pathways and must be completed to ensure the subsequent tabs of the calculator function appropriately.

Users need to provide inputs into all fields on this tab including the product facility and batch period details, as well as carbon capture and storage information where applicable. The measurement groupings are not included in the GO Calculator as they are not relevant to the calculations within.

Section 1.1.1 Product facility

The product facility definition will be based on the production pathway that is included in the product profile registration. Registering under a production pathway will require nominated persons to demonstrate that their product facility meets the eligibility requirements of that pathway. These eligibility requirements will be based on ensuring the types of technology or equipment installed at the site that are capable of producing the registered product in accord with the production pathway.

These requirements are articulated through the use of modules, which are emissions-generating process steps for a specified production pathway. The list of required modules for each production pathway defines minimum eligibility requirements. However, it is not all encompassing as there may be conditionally relevant modules which must be included where appropriate.

To ensure that the reported emissions between different facilities under the same production pathway are comparable, all product facilities under a production pathway must monitor and report emissions from the modules as specified in this section. The emissions arising from the specified modules for a given production pathway in effect define the system boundary for each product facility under that production pathway.

In the future as the GO scheme is expanded to cover new products and production pathways, product facilities and modules will be added to this list. This would include identifying the minimum required modules that set the eligibility for each production pathway and the emissions sources within these modules. There may also be a need to identify co-products and shared processes within these modules.

The three eligible hydrogen production pathways covered initially under the GO scheme are electrolysis, steam methane reformation, and coal gasification. The below tables outline the relevant modules.

Table 1.1 Minimum modules and sources required for product facilities.

Module	Emission sources
Electrolysis product facility	
Electrolysis specific water treatment	- Electricity, - Chemicals, - Fuel, - Water, - Water based fugitive emissions.
Electrolyser operation (Including electricity supply equipment)	- Electricity, - Water, - Fuel, - Steam.
Drying & purification	- Electricity, - Chemicals, - Fuel, - Steam, - Coolant leaks.
Compression	- Electricity, - Fuel, - Coolant leaks.
Steam methane reformation product facility	
Sulphur removal	- Electricity, - Fuel, - Steam, - Chemicals, - Water, - Fugitive emissions, - Treatment emissions.
Core steam methane reformer units: - **Gas heating,** - **Pressurization,** - **waste heat recovery,** - **HT shift reactor**	- Electricity, - Fuel, - Methane (as feedstock), - Steam, - Fugitive emissions, - Water.
Hydrogen purification	- Electricity, - Water, - Fuel, - Chemicals, - Steam, - Fugitive emissions, - Supplementary processing emissions.

Compression	- Electricity, - Coolant leaks, - Fugitive emissions, - Fuel.
Carbon Capture Transport and Storage	- Electricity, - Coolant leaks, - Fugitive emissions (during processing), - Fuel, - Transport (leakage, vehicle emissions, booster pumps in pipelines), - Electricity for pumps at injection site, - Leaks at injection well head.
Coal gasification product facility	
Coal processing (including washing and drying)	- Electricity, - Fuel, - Fugitive emissions, - Chemicals, - Water.
Air separation unit	- Electricity, - Fuel, - Fugitive emissions, - Chemicals, - Water, - Coolant leaks.
Core gasification units: - **Gasification unit,** - **Gas particulate filtration and cyclones,** - **Syngas cooling systems**	- Electricity, - Fuel (heat/power), - Coal (as feedstock), - Fugitive emissions, - Water, - Steam.
Syngas conditioning (including DeSOx and WGS)	- Electricity, - Fuel, - Fugitive emissions, - Steam, - Water, - Chemical/catalysts.
Syngas conditioning (carbon removal and hydrogen purification)	- Electricity, - Water, - Fuel, - Chemicals, - Steam, - Fugitive emissions, - Supplementary processing.
Compression	- Electricity, - Coolant leaks, - Fugitive emissions, - Fuel.

Carbon Capture Transport and Storage	- Electricity, - Coolant leaks, - Fugitive emissions (during processing), - Fuel, - Transport (leakage, vehicle emissions, booster pumps in pipelines) - Electricity for pumps at injection site, - Leaks at injection well head.

Table 1.2 Examples of optional modules that must be included where relevant

Module	Emission sources
Onsite electricity generation	- Fuel, - Water, - Fugitive emissions.
Onsite steam generation (not already part of the core units)	- Fuel, - Electricity, - Water, - Fugitive emissions.
Cooling systems	- Electricity, - Water, - Coolant leaks, - Fugitive emissions, - Chemicals, - Fuel.
Co-product conditioning	- Electricity, - Water, - Fuel, - Chemicals, - Fugitive emissions.
Wastewater pre-treatment	- Electricity, - Water, - Chemicals, - Steam, - Fuel.
Water treatment	- Electricity, - Chemicals, - Fuel, - Water, - Fugitive emissions.
Post removal sulphur processing	- Electricity, - Fuel, - Water, - Fugitive emissions.
Electricity supply control	- SF6 inventory

Section 1.1.2 Setting the production boundary

The product facility will set the scope for which emissions are required to be reported through the GO scheme. The registered participant will also need to identify in their product profiles how the various emissions sources included in product facility will be measured. Namely they will need to identify how inputs and outputs throughout the production process will be measured and define the **measurement groupings** for these emissions sources. They will also need to identify within these measurement groupings which processes are attributable, non-attributable and shared (defined in Table 1.3 below).

The final element of the production boundary is set when the registered participant initiates a Product GO Certificate creation claim. This claim will involve setting the batch period, an interval of time over which the production conditions are consistent and the registered product can be considered homogenous. The batch period sets the temporal boundary over which information on emissions will be collected and reported through the GO scheme.

The terms used to set the production boundary are based on the National Greenhouse and Energy Reporting scheme (NGER). However, there are some aspects where the needs of the GO scheme differ from that of NGER, summarised in the table below.

Table 1.3 Comparison of NGER and GO scheme terms

GO Term	GO scheme	NGER Term	NGER definition
Batch period	Reported between hourly and annually, captured in *batch period*.	**Reporting timeframe**	Reported annually
Product facility	A series of activities involving greenhouse gas emissions and production or consumption of energy that form part of a specific production pathway for a registered product covered by the GO scheme.	**Facility**	A series of activities that involve greenhouse gas emissions, production or consumption of energy that are part of a single undertaking.
Measurement grouping	A portion of the product facility that the scheme participant elects to report emissions on.	**N/A***	Measurements may be aggregated but must apply to entire facility.
Non-attributable processes	Any emissions that are within a *measurement grouping* but not attributable to the product.	**N/A***	All processes within facility definition must be included where they produce emissions.
Shared processes	*Product facility* emissions that are attributable to co-products.	**N/A***	All processes within facility definition must be included where they produce emissions.

* Where terms are listed as N/A the definition column provides a conceptual link to the NGER scheme.

Measurement groupings

The measurement groupings are intended to structure how registered participants will report information used to estimate emissions. These measurement groupings can include individual modules, multiple modules or all relevant modules for the product facility. The measurement groupings are intended to provide a high degree of flexibility for registered participants in how they wish to meter their inputs and emissions, as long as all relevant emissions sources are covered (Figure 2).

The Clean Energy Regulator (CER) will develop guidelines in the future to assist with defining reasonable measurement grouping options.

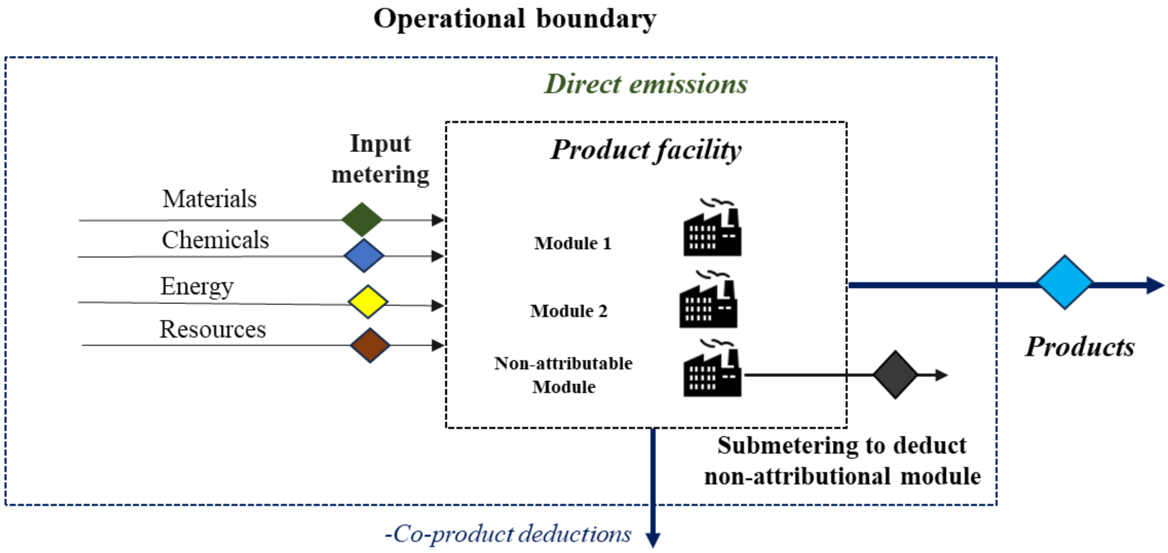

Figure 2 Measurement grouping for the operational boundary.

The scope of the GO scheme discussed above means that there may be attributable, non-attributable and shared processes within the product facility. The default assumption will be that all emissions sources within the product facility bounds are attributable to the product being certified. The registered participants will be able to identify where processes within the product facility are non-attributable or shared processes.

Non-attributable processes

The non-attributable processes are a component of the product facility that are not within scope for the emissions accounting methodology. As an example, a facility may have a measurement grouping that covers electricity used in the electrolysis module. This electricity may include attributable processes for electricity that is used to power the electrolysis unit. However, it may also include a non-attributable process for electricity used to provide lighting for crew quarters.

The quantity of an input used in a non-attributable process and its associated emissions can be removed from the emissions calculation of the measurement grouping. The product profile registration process will allow for nominated person's to either model or directly measure the split between attributable and non-attributable processes.

The Clean Energy Regulator will develop guidelines to specify how the split needs to be modelled to ensure it represents average operating conditions. If the nominated person elects to directly measure the split between these processes, they will need to report this information as part of the claim process.

Shared processes

The shared processes may be used to produce both the registered product and a recognised co-product, which is a product with independent value produced alongside hydrogen. These processes will also need to be identified as part of registering the product profile alongside any evidentiary requirements to prove the co-products were consumed. The approach to estimating and setting co-product allocations is detailed in Section 3.1.5.

Batch period

When submitting a creation claim, scheme participants will be able to set their own batch period for the registered product they are producing under the GO scheme. They will provide a batch start time and batch end time for the GOs they are seeking to create. This start and end time is then used to create the batch period. The minimum interval of time for a batch period is one hour and the maximum interval is 12 months. A claim period may include many batch periods but must not exceed 12 months in a single claim. A batch period start must be the same as the end of the preceding batch period, to make sure that no unreported periods exist.

Part 3 sets out how emissions are required to be measured within the batch period. The post-production emissions are required to be reported as they apply to the products produced within the batch.

Section 1.2 Post-production boundary

The post-production boundary encompasses the transport and storage steps that may occur to get a registered product from the point of production (production gate) to the point of consumption (delivery gate). Similar to the production boundary, the post-production boundary sits within the broader system boundary and defines the production gate-to-delivery gate portion of the emissions accounting methodology. Unlike the production boundary, the post-production boundary can have considerably greater variability as supply chains after the point of production may involve multiple storage and transport steps.

There are two points throughout the supply chain that help to define the scope of the post-production boundary. These are the point of production which is reported in the production profile, and the point of consumption which is reported in the consumption profile. The mass balance approach discussed in more detail in the scheme design paper sets out that there must be a 'reasonable physical link' between the point of production and point of consumption for Product GO certificates. Together these two locations and the requirement for a reasonable physical link between them set the post-production boundary.

The relevant emissions attributable to transport and storage steps, as well as associated product losses, that occur to get the product from its point of production to its point of consumption must be reported under the GO scheme. How this information is reported and the verification checks to ensure the reasonable physical link is maintained is covered in the scheme design paper.

GO Calculator user guide – Post-production boundary

Users will be able to input information about the transport and storage processes throughout the post-production boundary in the "Transport & Storage – Hydrogen" tab. The details are split out by storage and transport using vehicles and pipelines. More information on the transport and storage information and how it is input into the calculator is available in Part 3.

Section 1.3 Greenhouse gases considered

The greenhouse gases and the related global warming potentials (GWPs) considered in the GO scheme's emissions accounting approach are based on the GWPs used in NGER. The current approach is based on the Intergovernmental Panel on Climate Change's (IPCC's) Fifth assessment report. The GO scheme is proposed to require ongoing updates to ensure that the approach to measuring greenhouse gases is consistent with NGER.

GWPs allow for the direct comparison of the impact of different greenhouse gases in the atmosphere by comparing how much energy the emissions of one tonne of a gas will absorb compared to the emissions of one tonne of carbon dioxide. The greenhouse gases and their associated GWPs listed by the IPCC that are relevant to the GO scheme's accounting methodology are available in the table below.

Table 1.4 Greenhouse gases and GWPs

Greenhouse gas	Global Warming Potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	28
Nitrous Oxide (N_2O)	265
Hydrofluorocarbons (HFCs)	Dependent on HFC type defined in Appendix B of the National Greenhouse Accounts (NGA) factors[1].
Sulphur hexafluoride (SF_6)	23,500

GO Calculator user guide – Global warming potentials

These GWP values used in the Scheme are listed in the "Key Values" tab of the GO Calculator. Users will not need to input these values.

[1] Australian National Greenhouse Accounts Factors (dcceew.gov.au)

Section 1.4 Materiality threshold

The GO scheme will apply a materiality threshold to the production boundary, which is a limit below which an emissions source does not need to be measured and reported as it is considered immaterial. The emissions sources listed as part of the product facility above will need to be reported regardless of their materiality. However, in addition to these emissions sources, any other emissions sources will also need to be reported where they exceed the materiality threshold.

The materiality threshold will be set at 2.5% of the total emissions from each source within the production boundary. Where an emissions source is not listed in Table 1.1 or Table 1.2 and exceeds this threshold, they will need to be reported. Where an emissions source is below this threshold, they will need to be recorded but will not require detailed measurement or reporting. This approach was considered in the last consultation paper released in December 2022 and received majority support from the respondents.

If another emissions source is required to be estimated under the NGER scheme and it is within the GO scheme's scope it must be reported even if it is below the materiality threshold.

GO Calculator user guide – Including material emissions

Where there are other material emissions outside those listed above, they can be input in the *OTHER EMISSIONS* section of each production pathway tab.

Part 2. Emissions intensity values

Feedback sought:

The Department is seeking feedback on the approach to calculating the emissions intensity on GO Certificates, including which information should be reported upfront in profiles and which information should be provided as part of claiming GO Certificates.

The creation process for Product GO Certificates is described in Part 3 of the Scheme Design paper and involves collecting batch specific data then combining it with profile data. Throughout the process the emissions intensity of the registered production is estimated across the production and post-production boundary.

Emissions intensity values will be calculated by aggregating the emissions associated within each boundary and then dividing this by the total quantity of product represented in terms of its functional unit. This will result in a value that is the carbon dioxide equivalent per functional unit of product, for hydrogen this would be kilograms of carbon dioxide equivalent per kilogram of hydrogen (kg CO_2-e/kg H_2).

The certificate will display several emissions intensity values that contribute to the overall emissions intensity, which captures the emissions intensity across the system boundary per unit delivered. It is the sum of:

- The production boundary emissions intensity, which captures the well-to-production gate emissions per unit produced. This information is reported as part of initiating the Product GO Certificate Creation process.
- The post-production boundary emissions intensity, which captures the production gate-to-delivery gate emissions per unit delivered. This information is reported as part of completing the Product GO Certificate Creation process.
- A loss correction term to spread the production emissions attributable to lost product across the delivered quantity. This information is calculated as part of completing the Product GO Certificate Creation process.

This section covers how these emissions intensity values are proposed to be calculated. Part 3 of this paper provides guidance on how emissions from various sources should be estimated for use in the emissions intensity calculations.

GO Calculator user guide – "Certificate" tab

The "Certificate" tab displays the emissions intensity estimates and other relevant information which could be included on GO Certificates. This tab also provides graphical representation of emissions breakdowns from various emissions sources.

Section 2.1 Overall emissions intensity

The overall emissions intensity value summarises the emissions throughout the entire system boundary per kilogram of product delivered. The system boundary emission intensity is the sum of the production boundary emissions intensity, post-production emissions intensity and a loss correction term.

Overall emissions intensity in practice

Facility A produces 1,500 kilograms of hydrogen via coal gasification with CCS, with 1,480 kilograms being delivered to the delivery gate. The production boundary emissions intensity, post-production emissions intensity and loss correction terms are 5.33, 0.73 and 0.07 kg CO_2-e/kg H_2.

The gross emissions intensity per unit of product is proposed to be calculated using the below formula:

$$\boldsymbol{EI_{overall} = EI_{production} + EI_{post-production} + EI_{loss\ correction}}$$

Where:

$\boldsymbol{EI_{production}}$ is the emissions intensity across production boundary, $\boldsymbol{EI_{post-production}}$ is the emissions intensity across the post-production boundary, $\boldsymbol{EI_{loss\ correction}}$ is the emissions re-allocation factor from lost product. The approach to calculating these values is described in subsequent sections.

Substituting the values from the example into the equation above produces the below result:

$$\boldsymbol{6.13 = 5.33 + 0.73 + 0.07}$$

The resulting gross emissions intensity is 6.13 kg CO_2-e/kg H_2 delivered.

Section 2.2 Production boundary emissions intensity

The emissions from within the production boundary are calculated using product profile and batch specific data. The approach to calculating emissions intensity within the production boundary involves calculating the total emissions which include upstream emissions, direct emissions such as combustion emissions and accrued emissions (short term corrections for one-off emissions events) and electricity emissions, followed by deducting CCS and co-product allocations. The total emissions is then divided by the quantity of product produced to derive the emissions intensity value.

Guidance for calculating these various component emissions is provided in Section 3.1 of this paper.

Production boundary emissions intensity in practice

Facility A produces 1,500 kilograms of hydrogen via coal gasification with CCS. This facility estimates the emissions associated with this batch of hydrogen to be:

- Upstream emissions = 3,000 kg CO_2-e
- Electricity emissions = 3,000 kg CO_2-e
- Combustion emissions = 7,000 kg CO_2-e
- Accrued emissions = 2,808 kg CO_2-e
- Carbon Capture and Storage emissions = 692 kg CO_2-e
- Emissions allocations to co-products = 1,500 kg CO_2-e
- Carbon captured and stored = 7,000 kg CO_2-e

The total emissions from the production boundary is proposed to be calculated using the below formula:

$$\boldsymbol{E_{production} = E_{upstream} + E_{energy\ supply} + E_{combustion} + E_{accrued} + E_{Carbon\ capture\ and\ storage} - E_{co-products} - Q_{CCS}}$$

Substituting the example values in produces the result:

$$\mathbf{8,000 = 3,000 + 3,000 + 7,000 + 2,808 + 692 - 1500 - 7,000}$$

This results in a total emissions value of 8,000 kg CO_2-e.

Total emissions intensity in terms of kg CO_2-e/kg H_2 produced are calculated as follows:

$$\boldsymbol{EI_{production} = \frac{E_{production}}{Q_{produced}}}$$

Where $\boldsymbol{Q_{produced}}$ is the quantity of hydrogen produced within the production boundary.

Substituting the example values into the equation above results in:

$$\mathbf{5.33 = \frac{8,000}{1,500}}$$

The resulting emissions intensity is 5.33 kg CO_2-e/kg H_2 produced.

Section 2.3 Post-production boundary emissions intensity

Following the initial creation process, the Product GO Certificate may have additional information added to it that reflects any transport and storage steps throughout the supply chain. The approach to calculating the total emissions involves aggregating transport emissions and storage emissions and then deducting emissions attributed to other products. Total emissions are divided by the quantity delivered to derive the post-production emissions intensity value.

Guidance on how to calculate the various components for this boundary is available in Section 3.2.

Post-production boundary emissions intensity in practice

Facility A initially produced 1,500 kilograms of hydrogen at the production gate. Of this, 1,480 kilograms of hydrogen remains after transporting the batch to the delivery gate. They estimate that 1,000 kg CO_2-e is attributable to transport processes, of this 100 kg CO_2-e is attributable to other products. They also estimate 200 kg CO_2-e is attributable to storage processes.

The total emissions from the post-production boundary are proposed to be calculated using the below formula:

$$\boldsymbol{E_{post-production} = E_{transport} + E_{storage} - E_{other\ products}}$$

Substituting the example values into this equation produces the result:

$$\mathbf{1,100 = 1,000 + 200 - 100}$$

This results in a total emissions value of 1,100 kg CO_2-e.

Gross emissions intensity in terms of kg CO_2-e/kg H_2 produced are calculated as follows:

$$\boldsymbol{EI_{post-production} = \frac{E_{post-production}}{Q_{delivered}}}$$

Where $\boldsymbol{Q_{delivered}}$ is the quantity of hydrogen delivered to the end user at the delivery gate.

Substituting the values from the example above into this equation results in:

$$\mathbf{0.74 = \frac{1,100}{1,480}}$$

This results in a post-production total emissions intensity of 0.73 kg CO_2-e/kg H_2 delivered.

Section 2.4 Loss correction term

The final component of the emissions intensity reported on Product GO Certificates is a loss correction term to spread the production boundary emissions attributable to product losses across the remaining quantity. The loss correction is applied following the completion of transport and storage processes and once the final consumption quantity has been confirmed. The loss correction term is calculated by multiplying the production emissions intensity value by the ratio of the lost product quantity to the delivered product quantity.

Loss correction in practice

Facility A produces 1,500 kilograms of hydrogen initially. However, after transport and storage events occur, the recorded quantity of hydrogen at the point of consumption is 1,480 kilograms. The emissions intensity from the production boundary is 5.33 kg CO_2-e/kg H_2.

The proposed approach to calculating the loss correction term is as follows:

$$\boldsymbol{EI_{loss\ correction} = \frac{Q_{lost}}{Q_{delivered}} \times EI_{production}}$$

Where:

$\boldsymbol{Q_{lost}}$ is the quantity of hydrogen that was lost between the production and delivery gate. $\boldsymbol{Q_{delivered}}$ is the quantity of hydrogen that was recorded at the delivery gate. $\boldsymbol{EI_{production}}$ is the emissions intensity from the production boundary.

Substituting the example values into this equation produces the following result:

$$\boldsymbol{0.07 = \frac{20}{1480} \times 5.33}$$

The loss correction term is therefore 0.07 kg CO_2-e/kg H_2 delivered.

Part 3. Estimating emissions

Feedback sought:

The Department is seeking feedback on the proposed methods for estimating emissions and whether any additional methods should be considered.

The Department is also seeking feedback on how practical it will be to report each input and output for every creation claim, and whether some inputs or outputs should be estimated in reporting profiles up front.

The approach to estimating emissions for the GO scheme is conceptually based on the approaches that are currently used in the NGER Scheme. However, the scope of the GO scheme requires that these approaches be amended to reflect the system boundary of the GO scheme. There are two overarching components to the methodology for the GO scheme. These are the:

- Production boundary methodologies, covering:
  - Upstream emissions,
  - Direct emissions, including emissions from combustion and accrued emissions,
  - Electricity emissions,
  - Carbon capture and storage,
  - Co-product deductions.
- Post-production boundary methodologies, covering:
  - Transport emissions,
  - Storage emissions,
  - Loss corrections.

Following sections provide a transparent explanation of how emissions are proposed to be accounted in the GO scheme, which are practically demonstrated through the GO Calculator accompanying this attachment. The purpose of this Calculator is to demonstrate the methodology to interested stakeholders during the consultation period.

Scheme participants will be required to define the variables that are used in these calculations. Most of these variables will be static and set through the profile registration process, this includes but is not limited to emissions factors and modelled values. Some variables will be dynamic batch information that needs to be reported as part of the certificate claim process. This includes certain quantities of inputs.

GO Calculator user guide – “Production Summary” tab

The “Production Summary” tab displays the total estimated emissions and other relevant information which are calculated based on the inputs provided throughout the “Electricity Usage”, “Electrolysis”, “Natural Gas Reforming”, “Coal Gasification”, and “Transport & Storage - Hydrogen” tabs of the GO Calculator.

The summary values add up the various individual emissions estimates which are calculated in accordance with the following sections.

Section 3.1 Production boundary emissions

The production boundary is defined above and broadly covers emissions within the well-to-production gate portion of the system boundary. The guidance below proposes approaches for upstream emissions, direct emissions, electricity emissions, carbon capture and storage, and co-product deductions. These approaches are specific to the production boundary and not proposed for the emissions within the post-production boundary.

GO Calculator user guide – Production pathway tabs

The variables relevant to calculating production boundary emissions can be input in the "Electricity Usage", "Electrolysis", "Natural Gas Reforming" and "Coal Gasification" tabs in the GO Calculator.

The relevant production pathway will determine which of the tabs is relevant. Users can specify their production pathway in the "Facility Details" tab.

Section 3.1.1 Upstream emissions

Upstream emissions are associated with the acquisition, processing and transport of feedstocks. This includes water, fuels, chemicals and various other feedstocks that may have upstream emissions associated with them.

The initial approach proposed for the GO scheme is to multiply the relevant quantity of the feedstock by an appropriate default emissions factor to determine the total kilograms of carbon dioxide associated with that feedstock. Determining the relevant quantity will involve removing the quantity of a feedstock associated with a non-attributable process where necessary, see Section 1.1 for more detail. Measurement guidance and emissions factors proposed for these upstream factors is provided in Part 4 of this document.

The variables used to calculate upstream emissions will be provided by the registered participant who owns the production profile. The production profile will need to incorporate the feedstocks that are included in the production boundary, the upstream emissions factors they are electing to use and how they propose to measure the quantity of the feedstock used in production. When the nominated person submits a creation claim for Product GO Certificates, they may be required to submit measurement information in accordance with their product profile.

Upstream emissions in practice

Facility A, located in non-metro Victoria, imports and consumes 100 gigajoules of natural gas distributed in a pipeline. Of this amount, only 90 gigajoules are relevant to the production boundary with 10 gigajoules being associated with non-attributable processes.

The proposed approach to recognising upstream emissions in practice will follow the equation below:

$$E_{upstream,i} = Q_i \times EF_{upstream,i}$$

Where:

Q_i is the quantity of input i consumed within the production boundary.

$EF_{upstream,i}$ is the upstream emissions factor associated with input i. The emissions factor is reported in terms of kilograms of carbon dioxide equivalent per functional unit used in Q_i.

In the example mentioned above, the relevant quantity of natural gas is 90 gigajoules while the upstream emissions factor sourced in accordance with Part 4 of this paper is 4.0 kg CO_2-e/GJ natural gas. Substituting this into the above equation we get the following:

$$\mathbf{360 = 90 \times 4}$$

This would mean that the total upstream emissions attributable to the natural gas within the production boundary is 360 kg CO_2-e.

This proposed approach to upstream emissions is intended to provide a solid foundation to the emissions accounting approach. However, there is an option for further development in the future. There are already default upstream factors for most of the feedstocks. However, there may be some gaps where the Department may undertake further work.

There could also be the option to develop bespoke upstream emissions factors to reflect supplier specific emissions. The Government will explore options for how these factors could be derived. However, this would also require the Clean Energy Regulator to develop an assessment approach to ensure the integrity of these factors. This is outside of the scope for this paper, and these bespoke upstream factors could be developed at a later date.

Another future consideration is Product GO Certificates that provide specific information about the upstream emissions. This paper does not propose a specific approach. However, Product GO Certificates would be eligible substitutes to the above approach where Product GO Certificates exist. An approach will be developed when other products such as ammonia are integrated into the GO scheme.

Where specific and timely data does not exist for upstream emissions, data from historical emissions may be used to estimate factors annually based on NGER reporting.

GO Calculator user guide – Inputting upstream emissions variables

The production pathway tabs require inputs to calculate upstream emissions associated with inputs to the production process. Users will be able to provide information about the source for the input, including the quantity, and bespoke upstream emissions factors, or relevant information for identifying an eligible default factor.

The upstream emissions are calculated in the consumption sections related to water, steam, feedstocks, combustion fuels and other inputs.

Section 3.1.2 Direct emissions

Direct emissions are the scope 1 emissions associated with the consumption of feedstocks within the production boundary. The types of direct emissions that are proposed to be captured under the GO scheme include combustion emissions and accrued emissions events which include fugitive emissions and industrial process emission. The proposed approach to reporting these emissions is detailed below.

Section 3.1.2A Combustion emissions

The combustion emissions are produced from the combustion of solid, liquid, and/or gaseous fuels. The emissions associated with the relevant quantity of all fuels combusted within the production boundary must be included. This includes fuel combustion for all purposes, including stationary purposes, transport purposes, electricity generation and steam generation.

There are two proposed approaches to calculating the direct emissions associated with combustion. These are either through a default factor estimation method, similar to the upstream emissions approach discussed above, or through the direct measurement approach.

This categorisation is slightly different to that required by NGER, in the case of steam generation being called out separately here, while it is combined under stationary purposes in NGER. This is specifically called out to facilitate co-product allocation in the case where steam is exported.

GO Calculator user guide – Inputting combustion emissions

The GO Calculator provides two options for calculating combustion emissions in various sections.

Emissions factor method

The default factor method involves providing inputs to calculate combustion emissions such as quantity of fuel, bespoke emissions factors or information to identify appropriate default emissions factors.

Combustion emissions related to electricity generation can be calculated using the default factor method in *the ELECTRICITY GENERATION VIA FUEL COMBUSTION* and *ELECTRICITY GENERATION VIA COMBINED HEAT AND POWER (CHP)* sections of the "Electricity Usage" tab.

Combustion emissions other than those for electricity generation can be calculated using the default factor method in the *COMBUSTION FUEL CONSUMPTION* sections of the production pathway tabs.

Direct measurement method

The direct measurement method involves providing information about the quantity of emissions and units. The direct measurement of combustion emissions can be reported in the *OTHER EMISSIONS* section of the production pathway tabs.

Default factor method

The default factor method approach is to multiply the relevant quantity of the fuel by an appropriate default factor to determine the total kilograms of carbon dioxide associated with combustion. Similar to the upstream emissions approach, this method will involve determining the relevant quantity of the fuel after removing the quantity associated with non-attributable processes. The measurement guidance and default factors proposed for these direct emissions is provided in Part 4 of this document.

A potential future expansion to this approach would be to develop guidelines to enable scheme participants to calculate more specific emissions factors. These could be based on the NGER methods that already exist in the first instance, like the use of oxidation factors. However, this approach would require the Clean Energy Regulator to develop assessment methods to ensure that factors are appropriate.

This potential expansion is likely to be less material than upstream emissions factors because variations in direct emissions are likely to be low – they primarily relate to direct combustion or release of GHGs, which are not variable. The upstream emissions factors are more complex because they need to reflect embedded emissions, which can vary significantly depending on what sources are or are not included. As such, enabling source specific direct emissions factors would be considered less critical than methods for upstream emissions factors.

Default factor method for direct emissions in practice

Continuing on with the example for upstream emissions, Facility A is located in non-metro Victoria and consumed 100 gigajoules of natural gas. Of this amount only 90 gigajoules is relevant to the production boundary with 10 gigajoules being associated with non-attributable processes.

The proposed approach to recognising direct emissions in practice will follow the equation below:

$$\boldsymbol{E_{direct,i} = Q_i \times EF_{direct,i}}$$

Where:

$\boldsymbol{Q_i}$ is the quantity of input i consumed within the production boundary.

$\boldsymbol{EF_{direct,i}}$ is the direct emissions factor associated with input i. The emissions factor is reported in terms of kilograms of carbon dioxide equivalent per functional unit used in Q_i.

Using the example above, the relevant quantity is again 90 gigajoules while the direct emissions factor sourced in accordance with Part 4 of this paper is 51.53 kg CO_2-e/GJ natural gas. Substituting into the equation above produces the following:

$$\boldsymbol{4,637.7 = 90 \times 51.53}$$

This would mean that the total direct emissions attributable to the combustion of the natural gas within the production boundary is 4,637.7 kg CO_2-e.

Direct measurement method

The direct measurement method is applied where a scheme participant elects to meter the emissions from the combustion activity directly. The direct measurement of emissions can either be done using continuous or periodic emissions monitoring in accordance with Part 1.3 of the *National Greenhouse and Energy Reporting (Measurement) Determination 2008*[2]. The emissions measured using this direct measurement approach must be reported in kg CO_2-e. This approach would require metering to be specified in the production profile, and the measured values would be required to be reported in each claim.

Section 3.1.2B Accrued emissions

Accrued emissions events are direct emissions that are incurred within the production boundary. However, they are not ongoing and may occur on an inconsistent basis. These events include fugitive emissions, waste emissions and industrial process emissions. The emissions associated with these events are 'accrued' and reported over a period of production, which has been defined as the 'accrual period'.

The total emissions from an accrued emissions event are worked out depending on the relevant emissions source – a list of reportable accrued emissions events, and their corresponding emissions

---

[2] National Greenhouse and Energy Reporting (Measurement) Determination 2008 (legislation.gov.au)

sources and emissions estimation methods, is provided in Table 3.1. The accrued emissions are then added to total well-to-production gate batch emissions. The accrual period commences on the day the accrued emissions event is reported to the CER. Allocation occurs on a daily basis over the specified allocation period, discounting periods of non-production.

The following table sets out what is a reportable accrued emissions event, and the accrual period for each type of event. A no-double-counting principle applies – if emissions from an event have been previously accounted for under another emissions source, emissions from that event should not be reported as an accrued emissions event.

Table 3.1 Accrued emissions measurement

Accrued emissions event type	Emission sources	Emissions estimation method	Accrual period (AP_j)
Reportable venting event	- Fugitive emissions	Direct emissions	30 days
Reportable flaring event	- Fugitive emissions	Direct emissions	30 days
Reportable leakage event	- Fugitive emissions	Direct emissions	30 days
Reportable solid or liquid disposal event	- Waste	Measure and model	30 days
Refrigerant and SF_6 leakage/loss	- Industrial processes	Maintenance logs	No more than 365 days

The accrued emissions that are to be included is calculated by first dividing the emissions associated with the emissions event by the accrual period. This gives an emissions per day value that can be divided by the production quantity for each day to apportion the emissions over the quantity of output. Once the accrual period has lapsed, the associated emissions will have all been allocated and there will be no need to continue apportioning emissions.

The approach to estimating the emissions associated with the various emissions events is discussed in Part 4 of this paper.

GO Calculator user guide – Inputting accrued emissions

The GO Calculator has sections where accrued emissions information can be input in the relevant production pathway tabs.

Accrued emissions related to fugitive emissions or waste can be calculated in the GAS STREAM FUGITIVE EMISSIONS and REPORTABLE FUGITIVE EMISSIONS sections of the “Natural Gas Reforming” and “Coal Gasification” tabs.

Accrued emissions related to industrial processes can be calculated in the *INDUSTRIAL PROCESS EMISSIONS* section of the production pathway tabs. Once the process, gas, quantity and units have been provided the tab will automatically calculate the relevant emissions for the batch period.

Accrued emissions in practice

Facility A determines that their emissions associated with a reportable venting event over a 30 day period is 700 kg CO_2-e.

The proportion of these emissions on a daily basis can be calculated using the below equation:

$$E_{daily,i} = \frac{E_{accrued,i}}{Accrual_{period}}$$

Substituting the example values into the above equation gives the result:

$$23.33 = \frac{700}{30}$$

The emissions attributable to this reportable event for each day of operation is therefore 23.33 kg CO_2-e. This value is then able to be apportioned across the production output for each day over the next 30 days. Facility A then produces 3 kgs of hydrogen over the course of a single day.

The accrued emissions attributable to the reportable event i for each unit of hydrogen can then be calculated as:

$$E_{unit,i} = \frac{E_{daily,i}}{Q_{daily,i}}$$

Substituting the example values above, the accrued emissions per unit of hydrogen (kg CO_2-e/kg H_2) comes out to:

$$7.78 = \frac{23.33}{3}$$

This value is then apportioned across the various batches within the day based on the quantity produced in each batch.

Section 3.1.3 Electricity emissions

The GO scheme is proposed to use a market-based approach to accounting for emissions from electricity imported from the grid. The proposed method is based on the Climate Active and NGER approaches and modified to account for the production boundary of the GO scheme.

The GO scheme approach allows for the use of LGCs and REGO certificate surrenders to demonstrate renewable electricity consumption. There are two types of surrenders that may occur for the GO scheme, direct surrenders and indirect surrenders. Direct surrenders are recognised as renewable electricity use claimed against the grid consumption of electricity. Indirect surrenders are recognised as an Applicable Renewable Power Percentage (ARPP) applied to the grid consumption of electricity.

The ARPP is determined by several conditions where LGCs or REGO Certificates are expected to be surrendered on behalf of the product facility, detailed in the table below. The ARPP values in the table below can be added together where multiple conditions are met. For example, a non-EITE entity with a 30% GreenPower accredited level would have an ARPP of 48.96%.

The direct and indirect surrenders are removed from the total quantity of grid sourced electricity consumed in the production boundary. The residual amount of electricity is then multiplied by a residual mix factor representing the scope 2 and scope 3 emissions associated with the residual energy mix.

The RMF is proposed to be sourced from Table 1 of the NGA Factors workbook[2]. The GO scheme will initially utilise a national RMF rather than a state or territory, or source specific RMF. This position is consistent with the NGER approach to accounting for electricity emissions. This may be revised as the GO scheme expands to include optional time and location matching.

Table 3.2 Applicable Renewable Power Percentage

Category	Condition	ARPP value
EITE Entity	Product facility is an EITE entity	0%
Renewable Power Percentage (RPP)	Product facility included in RPP	18.96%
ACT Jurisdictional Target	Product facility in ACT	72.39%
GreenPower	Product facility participates in GreenPower program	Determinant*

*The ARPP depends on the GreenPower accredited level of electricity consumed by the Product Facility.

GO Calculator user guide – 'Electricity Usage' tab

The GO Calculator provides an 'Electricity Usage' tab for users to input the quantities and sources of electricity used in the production boundary.

Users need to provide relevant inputs in the *GRID ELECTRICITY INPUTS, RENEWABLE ELECTRICITY INPUTS, ELECTRICITY GENERATION VIA FUEL COMBUSTION*, and *ELECTRICITY GENERATION VIA COMBINED HEAT AND POWER (CHP) sections*. These inputs enable the emissions associated with electricity to be calculated, as well as the percentage of electricity that is renewable.

Once these inputs are provided emissions associated with electricity usage will be calculated using the grid electricity emissions and combustion emissions approaches.

Grid electricity emissions in practice

Facility A is not an EITE entity and has consumed 1000 MWh of electricity from the local distribution grid. They have also generated and consumed 100 MWh of renewable electricity from a behind the meter solar system, which also created LGCs. In addition, they have surrendered 500 REGO Certificates and signed up for 30% renewable electricity through GreenPower.

The proposed approach to calculating electricity emissions is:

$$E_{electricity} = \left(\left(Q_{grid} \times (1 - ARPP)\right) - Q_{RECs}\right) \times RMF$$

Where:

Q_{grid} is the quantity of electricity consumed from the grid,

$ARPP$ is the applicable renewable power percentage for the product facility,

Q_{RECs} is the quantity of REGO Certificates and LGCs surrendered by Facility A to demonstrate renewable electricity use for the Product GO certificate, and

RMF is the national residual mix factor that is applied to the quantity of electricity without a renewable claim.

From the example above the quantity of electricity consumed from the grid is 1,100 MWh. The behind the meter generation is treated as electricity from the grid as certificates were created for it. The ARPP for the product facility is 0.4896, after combining the RPP and GreenPower percentage. The quantity of REGO Certificates surrendered is 500, and the RMF is 0.73. Substituting into the above equation results in

$$\mathbf{44.85} = \left(\left(\mathbf{1,100} \times (\mathbf{1} - \mathbf{0.4896})\right) - \mathbf{500}\right) \times \mathbf{0.73}$$

The result is therefore that 44.85 kg CO_2-e is attributable to electricity emissions.

Section 3.1.4 Carbon capture and storage (CCS)

Carbon capture and storage will be recognised as an emissions reduction within the production boundary of the GO scheme. The only method for CCS that is initially proposed to be recognised in the GO scheme is for permanent geological storage. This is in alignment with the NGER (Measurement) Determination 2008 (NGER Determination)[2] which does not cover forms of storage such as mineral carbonation or forms of utilisation.

The fugitive, combustion, and electricity emissions related to the carbon capture and storage process must be accounted for in accordance with the relevant sections above. This includes all modules as listed in the product facility definition, including the transport and injection processes.

The allowable deduction from the CCS process is calculated by subtracting any losses that are incurred in the transport and injection process from the total quantity of greenhouse gases that are captured for permanent storage. The measurement approach required for the quantity of carbon captured for storage and losses is detailed in Part 4 of this paper.

The generation of Australian Carbon Credit Units (ACCUs) as part of a CCS activity may be used to assist in the accounting. However, these ACCUs must be surrendered for the emissions reduction to be claimed in the GO scheme. This prevents double counting of emissions reductions. CCS reversals, particularly in relation to potential future loss events, are considered outside of the scheme. A failure or major event at a CCS module/facility would have implications for claiming behaviour and require timely event reporting to ensure accuracy.

The GO scheme is not proposed to cover Carbon Capture and Utilization (CCU) at commencement. However, as international and domestic accounting approaches to CCU continue to develop they may eventually be recognized in the GO scheme. This could include processes such as mineral carbonation for building material production, or products which consume carbon dioxide in their production such as urea or resin.

The approach to CCU will involve setting measurement rules, minimum lifetime for products and require approaches to prevent double counting.

GO Calculator user guide – Inputting CCS emissions

Users need to input the emissions associated with capturing, transporting, storing and injecting carbon dioxide in the *CARBON CAPTURE AND STORAGE EMISSIONS* section in the “Natural Gas Reforming” and “Coal Gasification” tabs.

The quantity of carbon dioxide captured and stored is also input here.

Section 3.1.5 Co-product allocation

Hydrogen production results in a variety of waste, by-products and co-products. Co-products are products that have a financial value from being on-sold or reused. The eligible list of co-products is detailed in the table below. Co-products present a unique challenge for the GO scheme, as emissions within the *production boundary* can be allocated to these co-products instead of the registered product, in accordance with the IPHE, ISO 14044 and the GHG Protocol.

GO Calculator user guide – Co-product allocations

There are numerous sections for co-product allocations throughout the production pathway tabs. The approach for each co-product is based on the allocation approaches for each eligible co-product listed below. There are specific sections for products like electricity, steam, oxygen and air products, which require specific information be input to calculate emissions attributable to these co-products.

There are also sections for other co-product allocations where quantity produced and sold, and emissions attributable to the co-product can be reported. The GO calculator does not automatically calculate emissions from these other co-products, users will need estimate these outside the calculator.

Eligible co-products

The list of eligible co-products for each production pathway is defined in the table below. As the GO scheme expands to include additional *production pathways* and *registered products*, this table will be updated to include any co-products from these new *product facilities*. As an example, if the scheme expanded to include salt-water electrolysis and chlor-alkali production pathways for hydrogen, then caustic soda and chlorine could be added as co-products.

The table below defines the shared processes which can be apportioned between the registered product and co-products across the three production pathways. The table also puts forward the preferred allocation approach order for each eligible product per production pathway.

Table 3.3 List of co-products by production pathway

Production pathway	Eligible co-products	Shared processes	Allocation approach (in order)
Electrolysis	*Oxygen*	- Electrolysis specific water treatment - Electrolyser operation	System expansion using a cryogenic distillation system
Steam methane reformation	*Steam*	Core steam methane reformer units	Energy value allocation, or Process-property relationship
Steam methane reformation	*Electricity*	Core steam methane reformer units	Energy value allocation, or Process-property relationship
Coal gasification	*Steam*	Core gasification units	System expansion using a natural gas boiler.
Coal gasification	*Electricity*	Core gasification units	System expansion using a grid residual mix factor, or Energy value allocation, or Process-property relationship
Coal gasification	*Air products* - Nitrogen - Argon.	Air separation unit	Process-property relationship, using IPHE output ratios: - Oxygen 22.2%w/w

			- Nitrogen 76.9%w/w - Argon 0.9%w/w
Coal gasification	*Liquid hydrocarbon*	Core gasification units	System expansion using a to-be-defined alternative system.
Coal gasification	*Coke*	Core gasification units	System expansion using a to-be-defined alternative system.
Coal gasification	*Ash/Slag*	Core gasification units	System expansion using a to-be-defined alternative system.
Coal gasification	*Sulphur*	- Coal processing - Air separation unit - Core gasification units - Syngas conditioning (including DeSOx and WGS)	Energy value allocation, or process-property relationship

Proposed approach to co-product allocation

The proposed approach to co-product allocation is to set out a modelled proportion of the production boundary emissions that are attributable to the relevant co-products. This modelled proportion can be calculated and reported as part of the product profile registration process and will be used as a static variable that is applied during the creation claim process. There may be some ongoing validation checks to ensure the co-products are still being produced and have a legitimate financial value.

Through the creation claim process, the modelled co-product allocation proportion value can then be used to remove the relevant proportion of the other emissions within the production boundary from the overall production boundary emissions inventory.

An alternative approach would be for the co-product allocation to be calculated bespoke each time a creation claim is submitted. This alternative approach would provide more accurate data. However, it would substantially increase the reporting burden of the GO scheme.

Co-product allocation approach in practice

Facility A is an electrolysis plant that has determined that the proportion of emissions within their production boundary that is associated with the co-product oxygen is 0.20 (20%). They have also calculated the emissions throughout their production boundary are; 20 kg CO_2-e total upstream emissions, 15 kg CO_2-e total direct emissions, 30 kg CO_2-e total electricity emissions, 5 kg CO_2-e total CCS emissions deduction.

The proposed co-product allocation approach is:

$$\boldsymbol{E_{cp}} = \left(\boldsymbol{E_{Upstream}} + \boldsymbol{E_{Direct}} + \boldsymbol{E_{electricity}} - \boldsymbol{Q_{CCS}}\right) \times \boldsymbol{P_{cp}}$$

Where:

$\boldsymbol{E_{cp}}$ is the emissions allocated to co-product,

$\boldsymbol{E_{Upstream}}$ is the total upstream emissions,

$\boldsymbol{E_{Direct}}$ is the total direct emissions (including combustion and accrued emissions),

$E_{Electricity}$ is the total electricity emissions,

Q_{CCS} is the total CCS emissions deduction, and

P_{cp} is the proportion of emissions attributable to co-products.

Substituting the values from the above example into this equation results in:

$$12 = (20 + 15 + 30 - 5) \times 0.20$$

This would mean that 12 kg CO_2-e is able to be allocated to the co-product oxygen and deducted from the emissions total of the production boundary attributed to the registered product.

Allocation methods

In many cases, the emissions associated with the registered product and its co-products can not be independently measured. The GO scheme is proposed to use several methods to allocate emissions between co-products and registered products. These methods will inform how the modelled co-product proportion values are calculated.

The method selected to model the co-product proportion values should use the following order if feasible:

- Energy Content (Physical Allocation)
- System expansion
- Economic valuation

An example to this ordering is for oxygen as a co-product, which must be allocated using system expansion or economic valuation as it does not have an energy content. A concept referred to throughout this section is that of *shared processes* which are modules within the production boundary that are used to produce the registered product and co-product.

Energy Content (Physical Allocation)

The Energy Content (Physical Allocation) method uses the physical relationship between the product, co-product and emissions to determine the allocation. There are several physical relationships that could apply to apportioning emissions from hydrogen production to co-products, using the process property relationship, including energy values and other approaches such as mass or volumetric basis.

Process property relationship

This method can be applied when the quantity of the co-products can be independently varied and reduced entirely. Processes with fixed product ratios such as electrolysis of water are ineligible for this method. Then the proportion of emissions attributable to these co-products can be ascertained by deriving the ratio of emissions from the product facility if it weren't producing the co-product compared to if it were producing the co-product.

Co-product allocation based on process property relationship in practice

Facility A estimates the total emissions throughout its production boundary to be 3 kg CO_2-e/kg H_2 when producing hydrogen with co-products and 2.4 kg CO_2-e/kg H_2 when producing hydrogen without co-products.

The proposed process property calculation is:

$$P_{cp} = 1 - \frac{E_{total,nocp}}{E_{total,withcp}}$$

Where:

$E_{total,nocp}$ is the production boundary emissions per unit of registered product produced where no co-product is produced, and

$E_{total,withcp}$ is the production boundary emissions per unit of registered product produced where co-products are produced.

Substituting the values from the above example into this equation produces the result:

$$0.2 = 1 - \frac{2.4}{3}$$

The modelled proportion of emissions within the production boundary that is attributable to co-products is 0.2.

Energy value

The energy value allocation can be applied in many instances where the co-product and registered product are both energy products. This method allows for the emissions associated with shared processes to be allocated based on the ratio between the energy content of the co-product and registered product.

Co-product allocation based on energy value in practice

Facility A produces on average 1.5 kg of co-product per kilogram of hydrogen. The energy content of one kilogram of the co-product is 72 megajoules, while the energy content of one kilogram of hydrogen is 120 megajoules. Facility A also models that the total emissions attributable to shared processes per kilogram of hydrogen produced is 1 kg CO_2-e, while the total emissions from the production boundary per kilogram of hydrogen produced is 3.2 kg CO_2-e.

The proposed energy value allocation calculation is:

$$P_{cp} = Q_r \times \frac{EC_{cp}}{EC_{rp}} \times \frac{E_{total,sp}}{E_{total,ob}}$$

Where:

Q_r is the average quantity of the co-product produced per kilogram of registered product produced,

EC_{cp} is the energy content of a single functional unit of the co-product,

EC_{rp} is the energy content of a single kilogram of registered product,

$E_{total,sp}$ is the total emissions that is incurred in shared processes within the production boundary per kilogram of registered product, and

$E_{total,ob}$ is the total emissions that is incurred throughout the production boundary per kilogram of registered product.

Substituting the values from the above example into this equation produces the result:

$$0.28 = 1.5 \times \frac{72}{120} \times \frac{1}{3.2}$$

Under the energy value allocation approach, Facility A would be able to use a modelled allocation value of 0.28.

Other approaches

Other approaches to physical allocation such as on a mass, volumetric, molar or enthalpy basis may be able to be applied in the future as new products are able to be certified under the GO scheme. However, these other approaches are not proposed to be included at scheme commencement as the only product initially covered under the GO scheme will be hydrogen. Allocation using these approaches for hydrogen is problematic as it has a high energy to mass ratio compared to the potential co-products. This position is consistent with the allocation approaches utilised in the IPHE methodology.

System Expansion

The system expansion method is based on the *System Expansion with Displacement* approach discussed in the IPHE methodology. System expansion can be applied where the prior method is unavailable and where an alternative system producing just the co-product can be identified. The approach allows for emissions associated with this alternative system to be subtracted from the production boundary emissions.

The approach to estimating the emissions allocatable under this method is to divide the modelled total emissions associated with the alternative system by the emissions associated with the production boundary. These modelled values must reflect the average emissions per functional unit of the co-product produced.

Co-product allocation based on system expansion in practice

Facility A models the emissions incurred to produce a single unit of a co-product as 4.1 kg CO_2-e. An alternative system for producing a single unit of the same co-product is 1.1 kg CO_2-e.

The proposed system expansion allocation calculation is:

$$P_{cp} = \frac{E_{total,as}}{E_{total,ob}}$$

Where:

$E_{total,as}$ is the total emissions that is incurred in the alternative system to produce a single unit of the co-product. Guidance on alternative systems is outlined by the IPHE as the 'best practice' production method of that product, and

$E_{total,ob}$ is the total emissions that is incurred throughout the production boundary per unit of the co-product.

Substituting the values from the above example into this equation produces the result:

$$\mathbf{0.27} = \frac{\mathbf{1.1}}{\mathbf{4.1}}$$

Under the system expansion allocation approach, Facility A would be able to use a modelled allocation value of 0.27.

Economic valuation

Economic valuation is the final proposed method for allocating co-product emissions in the GO scheme. This method allows for proportion to be allocated based on the relative economic value of co-products relative to registered products. This approach can help ascertain the intention of operating the product facility and can help reflect differences between regions and markets for similar products.

The method can be applied where the other methods are not available, and where there are market prices for all co-products at the production point, or a reasonable price is defined if not a commodity traded product. However, economic valuation is the least preferred method because it generally does not reflect the physical causalities of producing or purchasing a specific product.

Co-product allocation based on economic value in practice

Facility A produces on average 1.5 kilograms of co-product per kilogram of hydrogen. The market value of one kilogram of the co-product is $10 and one kilogram of hydrogen is $20. Facility A also models that the total emissions attributable to shared processes per kilogram of hydrogen produced is 1 kg CO_2-e, while the total emissions attributable to the production boundary per kilogram of hydrogen produced is 3.2 kg CO_2-e.

The proposed energy value allocation calculation is:

$$\boldsymbol{P_{cp}} = \boldsymbol{Q_r} \times \frac{\$_{cp}}{\$_{rp}} \times \frac{\boldsymbol{E_{total,sp}}}{\boldsymbol{E_{total,ob}}}$$

Where:

Q_r is the average quantity of the co-product produced per kilogram of registered product,

$\$_{cp}$ is the dollar value of a single functional unit of the co-product,

$\$_{rp}$ is the dollar value of a single kilogram of registered product. Market prices may be sourced from commodity indexing services and the specific service should be referenced.

$E_{total,sp}$ is the total emissions that is incurred in shared processes within the production boundary per kilogram of registered product.

$\boldsymbol{E_{total,ob}}$ is the total emissions that is incurred throughout the production boundary per kilogram of registered product.

Substituting the values from the above example into this equation produces the result:

$$\mathbf{0.23 = 1.5 \times \frac{10}{20} \times \frac{1}{3.2}}$$

Under the economic value allocation approach, Facility A would be able to use a modelled allocation value of 0.23.

Section 3.2 Post-production boundary emissions

The post-production boundary is defined in Part 1 of this paper and broadly covers emissions within the production gate-to-delivery gate portion of the system boundary. The guidance below proposes approaches for calculating emissions associated with transport and storage, as well as the approach to correcting for losses. These approaches are specific to the post-production boundary and not proposed for the emissions within the production boundary.

Section 3.2.1 Transport emissions

Transport emissions are associated with transporting registered products from their point of production to their point of consumption, including any stops for storage or multi leg steps. There are a range of transport options that may be used throughout supply chains, such as trucks, trains, maritime shipping and through pipelines. These transport processes may also have varying information available to help quantify the emissions.

The GO scheme is also proposed to include a method for allocating emissions to other products where they are transported alongside the registered product. The emissions allocated to other products will be able to be deducted from the overall transport emissions.

GO Calculator user guide – Inputting transport emissions

The emissions associated with transport of the registered products from the product facility gate to the delivery gate are captured in the "Transport and Storage – Hydrogen" tab.

There are separate sections in this tab for vehicular transport and pipeline transport.

In the *TRANSPORT DETAILS – VEHICULAR TRANSPORT* section users can choose the emissions estimation method and input the mode of transport (vehicle type, coastal shipping or rail) for each leg of the transport route. Depending on the emissions estimation method chosen, further details are required in either the *VEHICULAR TRANSPORT - FUEL CONSUMPTION METHOD* section or *VEHICULAR TRANSPORT - LOAD DISTANCE METHOD* section to estimate vehicular transport emissions.

The emissions attributable to other products transported alongside the registered product can be estimated in the *VEHICULAR TRANSPORT - OTHER PRODUCT ALLOCATION* section.

For transport via pipeline, users can input the pipeline distance and the quantity of the product transported in the *TRANSPORT DETAILS – PIPELINE* section. Co-product allocations are estimated in the *PIPELINE – OTHER PRODUCT ALLOCATION* section for each pipeline route.

Calculating transport emissions attributable to the registered product in mixed cargo in practice

Transport company A estimates that the emissions associated with transporting a batch of hydrogen from the point of production to the point of consumption is 0.8 kg CO_2-e. The portion allocated to other products transported alongside the registered product is 0.25.

The proposed allocation calculation is:

$$\boldsymbol{E_{transport} = E_{transport,overall} \times (1 - P_{otherproducts})}$$

Where:

$E_{transport}$ is the emissions attributable to the transport process for the registered product,

$E_{transport,overall}$ is the total emissions attributable to the transport process overall for the registered product and other products transported together, and

$P_{otherproducts}$ is the proportion of emissions attributable to other products transported with the registered product.

Substituting the values from the above example into this equation produces the result:

$$0.6 = 0.8 \times (1 - 0.25)$$

The emissions attributable to the transport of this batch of hydrogen is 0.6 kg CO_2-e.

Section 3.2.1A Emissions approaches

The GO scheme is proposed to recognise two broad approaches to estimating the transport emissions; the fuel consumption approach and the load-distance approach.

The fuel consumption approach relies on the quantity of fuel consumed multiplied by emissions factors. The quantity of fuel can either be estimated using measured fuel consumption or an estimate of fuel consumption based on the fuel efficiency and distance of the journey.

The load-distance approach effectively uses an emissions factor per kilometre travelled. This reduces the need to know exactly the quantity of fuel that is combusted and instead enables emissions to be estimated based on distance.

The available methods and required information for each are listed in the table below. These are listed in the order of preference for these methods, but these will be defined on the availability of information for the transport method.

Table 3.4 Approaches for estimating the transport emissions

Approach	Method	Applicability
Fuel consumption	Receipts and allocations	Mobile transport
Fuel consumption	Fuel efficiency and distance	Mobile transport
Load-distance	Fleet or default factor	Mobile transport
Load-distance	Pipeline distance	Pipeline

The exact reporting rules and mechanisms for each of the above methods such as rules for reporting using fuel receipts and freight system log-books will be specified in scheme guidance documents.

Fuel consumption approach

There are several proposed methods to calculate transport emissions using the fuel consumption approach. These methods all multiply the quantity of fuel consumed by an emissions factor that covers direct and upstream emissions associated with the fuel. However, the approach to estimating how much fuel has been used by the transport process differs.

Receipts and allocations

The receipts and allocations method is the most direct method as it relies on direct measurement of the quantity of fuel. The quantity of fuel is estimated either using logbooks or fuel receipts from the transport service provider. Once the quantity of fuel has been measured, this is multiplied by the emissions factor associated with the fuel type. Blended and mixed fuels should be reported independently and added together where appropriate, in line with the rules for fuel use reporting in NGER. Fuels consumption may include electricity consumption for battery powered trucks and trains.

Calculating transport emissions - fuel consumption-based method in practice

Transport company A measures that it consumes 6.7 litres of petrol in the transport of the registered product. The emissions factor for the petrol consumed is 13.9 kg CO_2-e/GJ for direct emissions and 3.6 kg CO_2-e/GJ for upstream emissions. The conversion factor from litres to gigajoules for petrol is 0.0388 GJ/L.

The proposed transport emissions calculation is:

$$\boldsymbol{E_{transport,overall} = Q_f \times CF \times EF_i}$$

Where:

$\boldsymbol{Q_f}$ is the quantity of fuel consumed in the transport process.

$\boldsymbol{CF}$ is the conversion factor to ensure the functional unit for the fuel is consistent with the emissions factor. Where the functional unit is already appropriate, this value is 1.

$\boldsymbol{EF_i}$ is the combined scope 1 and scope 3 emissions factor associated with fuel type i. It must be sourced in accordance with Section 4.2.

Substituting the values from the above example into this equation produces the result:

$$\boldsymbol{4.55 = 6.7 \times 0.0388 \times (13.9 + 3.6)}$$

The overall transport emissions attributable to the transport process using this method is 4.55 kg CO_2-e.

Fuel efficiency and distance

The fuel efficiency and distance method is very similar to the previous method. However, the quantity of fuel consumed is estimated by multiplying the fuel efficiency of the vehicle by the round trip distance travelled (full and empty). Once the quantity of fuel has been estimated, it is then multiplied by the emissions factor for the type of fuel. Where specific vehicle information is not available, relevant fleet-wide estimates may be used to estimate the fuel consumption averages.

Guidance for measuring fuel efficiency of vehicles and distance travelled is provided in Part 4 of this paper.

Calculating transport emissions - fuel efficiency and transport distance-based method in practice

Transport company A uses a vehicle with a fuel efficiency of 0.268 litres of petrol per kilometre to transport a registered product 25 kilometres. The emissions factor for the petrol consumed is 13.9 kg CO_2-e/GJ for direct emissions and 3.6 kg CO_2-e/GJ for upstream emissions. The conversion factor from litres to gigajoules for petrol is 0.0388 GJ/L.

The proposed transport emissions calculation is:

$$\boldsymbol{E_{transport,overall} = FE_i \times D \times CF \times EF_i}$$

Where:

$\boldsymbol{FE_i}$ is the fuel efficiency of the vehicle used to transport the registered product, while $\boldsymbol{D}$ is the distance in kilometres that the registered product was transported. $(FE_i \times D)$ replaces the $\boldsymbol{Q_f}$ value from the previous receipts example.

$\boldsymbol{CF}$ is the conversion factor to ensure the functional unit for the fuel is consistent with the emissions factor. Where the functional unit is already appropriate, this value is 1.

$\boldsymbol{EF_i}$ is the combined scope 1 and scope 3 emissions factor associated with fuel type i. It must be sourced in accordance with Section 4.2.

Substituting the values from the above example into this equation produces the result:

$$\boldsymbol{4.55 = 0.268 \times 25 \times 0.0388 \times (13.9 + 3.6)}$$

The overall transport emissions attributable to the transport process using this method is 4.55 kg CO_2-e.

Load-distance approach

The load-distance approach uses an emissions factor that is measured in kilograms of carbon dioxide per tonne-kilometre. This reduces the need to know exactly the quantity of fuel that is combusted and instead enables emissions to be estimated based on distance directly. Instead, the mass of the product transported and the distance transported will be used to estimate the attributable emissions.

Fleet or default factor method

The fleet or default factor method relies on a default or fleet specific emissions factor that incorporates the direct and upstream emissions factors for each of the fuels (full-fuel cycle emissions). Where the emissions are reported as emissions per tonne-kilometre (kgCO_2-e/t.km), no conversion factor is required, in the case where average fuel efficiency of the fleet is known on a t.km basis, the basic fuel conversion factors may be used.

Calculating transport emissions - fleet average-based method in practice

Transport company A transports registered products and co-products weighing a total of 100 kilograms over a distance of 25 kilometres. The fleet-wide combined scope 1 and 3 emissions factor for eligible vehicles freighting these products over the previous 12 months was 0.8656 $kgCO_2$-e per tonne per kilometre.

The proposed transport emissions calculation is:

$$E_{transport,overall} = M \times D \times CF \times EF_i$$

Where:

$\boldsymbol{M}$ is the weight of the products transported.

$\boldsymbol{D}$ is the distance in kilometres that the registered product was transported.

$\boldsymbol{CF}$ is the conversion factor to ensure the functional unit for the fuel is consistent with the emissions factor. Where the functional unit is already appropriate, this value is 1.

$\boldsymbol{EF_i}$ is the combined scope 1 and scope 3 emissions factor associated with fuel type i. It is a default or fleet average value on a weight of the product transported over unit distance basis and must be sourced in accordance with Section 4.2.

Substituting the values from the above example into this equation produces the result:

$$\mathbf{2.164} = \frac{\mathbf{100}}{\mathbf{1000}} \times \mathbf{25} \times \mathbf{1} \times \mathbf{0.8656}$$

The overall transport emissions attributable to the transport process using this method is 2.164 kg CO_2-e.

Pipeline distance

The pipeline distance method would apply where transport occurs via a gas pipeline. The proposed approach is to multiply the distance the product is transported via the pipeline by an emissions factor. The emissions factor would need to reflect the upstream and direct emissions associated with each kilometre the product is transported.

The Department is exploring the availability of emissions factors for hydrogen transported via a pipeline.

Section 3.2.1B Allocation for multi-product legs

Where there are multi-product legs throughout a transport process, the transport emissions can be allocated between the product covered under the GO scheme and any other products that were transported alongside it. Where transport occurs with multiple products being shipped simultaneously or in a cyclic system, allocation to each product must be applied using a mass-based approach which also reflects the distance travelled by registered products and co-products.

The approach will apportion emissions associated with transport based on the tonne-kilometre of other products. This value is then able to be divided by the tonne-kilometre of the registered product to derive an allocation value. This allocation value can then be applied to the transport emissions calculated above to remove the component associated with other products.

Allocation in transport process in practice

Transport company A transports 25 kilograms of hydrogen over a distance of 100 kilometres. Transported alongside this was 10 kilograms of another product over a distance of 75 kilometres.

The proposed allocation calculation is:

$$P_{otherproduct} = \frac{D_{other} \times M_{other}}{D_{total} \times M_{total}}$$

Where:

D_{other} and M_{other} are the distance and weight respectively of the other product transported alongside the registered product**,**

D_{total} and M_{total} is the total distance travelled by the registered product and the total weight of all products transported together respectively.

Substituting the values from the above example into this equation produces the result:

$$0.21 = \frac{75 \times 10}{100 \times (25 + 10)}$$

The portion of the transport emissions allocatable to other products is 0.21.

Section 3.2.2 Storage emissions

Where storage and transport mode/leg transfers occur, the emissions relating to the activity may be material, and in which case, this will be required to be either measured or modelled and added to the certificate. The storage facility boundary will need to include compression, fuel use, and cooling for the storage facility related to storing the product. The approach to a more standardised storage system boundary will be developed over time as storage processes for hydrogen continue to develop.

Short duration storage and long duration storage are likely to require different treatments. Longer term storage is likely to include material emissions from actions such as the maintenance of conditions, leak prevention systems, monitoring equipment and reconditioning. These are less likely to be material for shorter duration storage systems. Where possible, a time-based factor may be used for the storage facility, where the emissions are allocated to the relevantly stored product.

The mechanisms of transfer between transport modes are proposed for inclusion of the system boundary. These emissions may be allocated based on an emissions per transfer rate. That is 0.01 kg CO_2-e per TEU (twenty-foot equivalent unit) as an average emission for a ports annual throughput.

GO Calculator user guide – Inputting storage emissions

The emissions associated with storage of the registered products are captured in the “Transport and Storage – Hydrogen” tab.

Users can input electricity usage and fuel combustion associated with product storage in the *STORAGE - ELECTRICITY CONSUMPTION* and *STORAGE - COMBUSTION FUEL CONSUMPTION* sections.

Input required are the quantity of total electricity consumption as well as the quantities allocated to renewable electricity, grid electricity and electricity generated on site via fuel combustion, as applicable. For emissions from combustion of fuels, fuel types and quantities and their emissions factors are required to be entered.

Section 3.2.3 Loss measurement

The post-production processes applied to hydrogen are likely to result in losses throughout the supply chain. These losses need to be measured in a similar manner to the overall production quantity to ensure that emissions associated with lost products can be applied over the remaining batch. If the IPCC and NGER develop GWP for hydrogen in the future, the losses would also be multiplied by this GWP to provide an estimate of emissions attributable to this lost hydrogen.

Product losses can be estimated from the difference in the quantities of stock received and delivered, measured using the relevant measurement method. It may also be estimated from the storage duration and the daily loss factor for the product and the relevant storage type. Those factors are still to be decided at this time.

The Department is also exploring the option to rely on estimated loss rates as a substitute to direct measurement at the delivery gate. These loss rates could specify an estimated quantity of the product lost per kilometre transported and would differ depending on the mode of transport. For comparison, the NGER Determination sets out estimated loss rates for natural gas transported via transmission and distribution pipelines.

GO Calculator user guide – Inputting product losses

The product losses needs to be input in the *VEHICULAR TRANSPORT – LOSSES* section, *PIPELINE – LOSSES* and *STORAGE - LOSSES* section in the “Transport & Storage – Hydrogen” tab as applicable.

In each of these sections, users can provide either directly measured losses or use an estimation approach. If users select the estimation approach, they will need to specify an applicable loss factor.

Part 4. Data sources

Feedback sought:

The Department is seeking feedback on the proposed data sources for the GO Scheme and whether any additional data sources should be considered.

The GO scheme is proposed to leverage numerous domestic and international schemes and providers of measurement standards, default factors and other variables used to estimate emissions. This approach is intended to reduce the regulatory burden of the GO scheme and ensure alignment with well-established practices in the emissions accounting environment. The measurement standards will primarily be based upon the approach used in the NGER scheme, with default factors drawn from numerous sources including NGER, NGA Factors, EcoInvent and AustLCI.

However, there may be additional data sources which could be appropriate for use in the GO scheme have not been identified in this paper. Feedback is sought on whether there are additional data sources that should be included in the GO scheme.

GO Calculator user guide – Key values

The default values and their sources for the emissions factors, energy contents, electricity constants fuel efficiencies, as well as steam properties, Global Warming Potentials and unit conversion factors used in the Calculator are listed in the "Key Values" tab.

Users may also have the option of providing bespoke values throughout the Calculator.

Activity Definitions

The table below provides the definition source for the various activities that form each emissions source that must be reported under the GO scheme. The emissions sources included in the product facility definition are based on the types of emissions sources and activities defined in the NGER Measurement Determination where appropriate. The table below provides the proposed emissions source definitions.

Table 4.1 Activity definitions

Emissions source	Activity
Fuel	Solid fuel combustion for; - stationary purposes - transport purposes - electricity generation - steam generation
Fuel	Gaseous fuel combustion for; - stationary purposes - transport purposes - electricity generation - steam generation

Fuel	Liquid fuel combustion for; - stationary purposes - transport purposes - electricity generation - steam generation
Fuel	Blended fuels combustion
Fuel	Estimation of energy for certain purposes
Fugitive emissions	Process vents and leaks of gas handling equipment
Chemicals	Process inputs used in certain production methods
Water	Water consumption in certain production methods
Steam	Energy consumption - non-electricity Scope 2
Cooling	Energy consumption - non-electricity Scope 2
Electricity	Scope 2 emissions from grid imported electricity

Section 4.1 Measurement guidance

The measurement standards for the GO scheme are based upon the approach currently used in the NGER scheme. This approach will allow businesses that are currently reporting under NGER to use similar measurement approaches in the GO scheme. For businesses that are not currently reporting under NGER, it will ensure consistency with the national best practice approach. The proposed measurement standards for the various inputs covered under the GO scheme are separated by emissions source type and summarised in the table below.

Table 4.2 Measurement of process inputs and outputs

Activity	Measurement guidance
Section A – Electricity measurement	
Electricity	The measurement of the quantity of electricity consumed must be completed in accordance with Section 6.5(2) of the *NGER Determination*. The amount of electricity must be either: - Evidenced by invoices, - Contractual arrangements, or - Industry metering records (Table 7.4.3 of National Electricity Rules)
Section B – Fuel measurement	
Solid fuels	Three criteria from Division 2.2.5 of the *NGER Determination*, namely: - the amount of the solid fuel delivered for the facility during the year as evidenced by invoices issued by the vendor of the fuel, - Indirect measurement at point of consumption, with sampling completed in accordance with Subdivision 2.2.3.3 of the *NGER Determination*. - Direct measurement at point of consumption.
Gaseous fuels	Three criteria from Division 2.3.6 of the *NGER Determination*, namely: - the amount of the gaseous fuel delivered for the facility during the year as evidenced by invoices issued by the vendor of the fuel, - Indirect measurement at point of consumption, with sampling completed in accordance with Subdivision 2.3.3.2 of the *NGER Determination*. - Direct measurement at point of consumption.
Liquid fuels	Three criteria from Division 2.4.6 of the *NGER Determination*, namely: - the amount of the liquid fuel delivered for the facility during the year as evidenced by invoices issued by the vendor of the fuel, - Indirect measurement at point of consumption, with sampling completed in accordance with Subdivision 2.4.3.2 of the *NGER Determination*. - Direct measurement at point of consumption.

Blended fuels	**Solid fuels** – In determining the amounts of each kind of fuel that is in a blended solid fuel, a person may adopt the outcome of the sampling and analysis done by the manufacturer of the fuel or themselves if: The sampling has been done in accordance with *NGER Determination* subsections 2.12(3) and (4); and the analysis has been done in accordance with one of the following standards or a standard that is equivalent to one of those standards: (i) CEN/TS15440:2006; (ii) ASTM D6866—20. **Liquid fuels** – The person may adopt the manufacturer's determination of each kind of fuel that is in a blended liquid fuel or adopt the analysis arrived at after doing both of the following: Sampling the fuel in accordance with a standard mentioned in *NGER Determination* subsections 2.47(3) and (4); Analysing the fuel in accordance with ASTM D6866—20 or a standard that is equivalent to that standard. **Gaseous fuels** – In determining the amounts of each kind of fuel that is in a blended gaseous fuel, a person may do either or both of the following: Adopt a determination of the amounts by the producer of the fuel or the operator of the pipeline that supplied the fuel; Adopt analysis arrived at after: (i) sampling in accordance with *NGER Determination* subsections 2.26(3) and (4); and (ii) the analysing the fuel in accordance with ASTM D6866—20 or a standard that is equivalent to that standard.
Section C – Chemical measurement	
Chemicals	Amount of chemicals used. If the acquisition of the inputs involves a commercial transaction, the quantity may be estimated based on the amounts delivered during the year (evidenced by invoices) as adjusted for the estimated change in the quantity of the stockpile of the inputs or the facility during the year. If the acquisition of the input does not involve a commercial transaction, the quantity may be estimated based on the quantities of inputs consumed from the operation of the activity; or derived from the amount of hydrogen or other by products produced from the operation of the activity. The measurement must be: • carried out using measuring equipment calibrated to a measurement requirement; or • carried out at the point of sale using measuring equipment calibrated to a measurement requirement.
Section D – Water measurement	
Imported water	Amount of water used. If the acquisition of the inputs involves a commercial transaction, the quantity may be estimated based on the amounts delivered during the year (evidenced by invoices) as adjusted for the estimated change in the quantity of the stockpile of the inputs or the facility during the year.

	If the acquisition of the input does not involve a commercial transaction, the quantity may be estimated based on the quantities of inputs consumed from the operation of the activity; or derived from the amount of hydrogen or other by products produced from the operation of the activity. The measurement must be: • carried out using measuring equipment calibrated to a measurement requirement; or • carried out at the point of sale using measuring equipment calibrated to a measurement requirement.
Section E – Steam measurement	
Imported steam	Amount of steam used. If the acquisition of the inputs involves a commercial transaction, the quantity may be estimated based on the amounts delivered during the year (evidenced by invoices) as adjusted for the estimated change in the quantity of the stockpile of the inputs or the facility during the year. If the acquisition of the input does not involve a commercial transaction, the quantity may be estimated based on the quantities of inputs consumed from the operation of the activity; or derived from the amount of hydrogen or other by products produced from the operation of the activity. The measurement must be: • carried out using measuring equipment calibrated to a measurement requirement; or • carried out at the point of sale using measuring equipment calibrated to a measurement requirement.
Section F – Cooling measurement	
Air cooling	Consistent with Section 4.102(2) of the *NGER Determination*. An estimation of the stock of synthetic gases contained in an equipment type must be based on one of the following sources: - The stated capacity of the equipment according to manufacturer's nameplate; - Estimates based on: o The opening stock of the gas equipment, o Transfers into the facility from additions of gas from purchases of new equipment and replenishments o Transfers out of the facility from disposal of equipment or gas.
Water cooling	Consistent with Section 4.102(2) of the *NGER Determination*. An estimation of the stock of synthetic gases contained in an equipment type must be based on one of the following sources: - The stated capacity of the equipment according to manufacturer's nameplate; - Estimates based on: o The opening stock of the gas equipment, o Transfers into the facility from additions of gas from purchases of new equipment and replenishments o Transfers out of the facility from disposal of equipment or gas.

Heat pumps	Consistent with Section 4.102(2) of the *NGER Determination*. An estimation of the stock of synthetic gases contained in an equipment type must be based on one of the following sources: - The stated capacity of the equipment according to manufacturer's nameplate; - Estimates based on: o The opening stock of the gas equipment, o Transfers into the facility from additions of gas from purchases of new equipment and replenishments o Transfers out of the facility from disposal of equipment or gas.
Section G – Carbon capture and storage measurements	
CCS	The quantity of greenhouse gases must be measured in accordance with Section 1.19E of the *NGER Determination*. The measurement guidance requires that the volume of greenhouse gas must be expressed in standard cubic metres. To convert from cubic meters to kilograms of carbon dioxide equivalent the conversion factor specified in Section 3.91 of the *NGER Determination*.
Losses	The fugitive emissions incurred during the transport, injection and geological storage of greenhouse gases must be measured in accordance with Part 3.4 of the *NGER Determination*.
Section H – Product and co-product measurement	
Exported Product	The amount of product produced should be measured to a reasonable standard. Where the product is considered a fuel, it should adhere to *NGER Determination* Part 6.1. In the case where the product is not a fuel or otherwise a greenhouse gas, industry standards and commercially accepted metering is required. For secondary properties are required such as pressure or temperature requirements on certificates, these will have to adhere to at least industry standard practice.
Section I – Direct emissions measurement	
Emissions metering	The direct measurement of emissions can be done using either continuous or periodic emissions monitoring in accordance with Part 1.3 of the *NGER Determination*. The emissions measured using this direct measurement approach must be reported as mass of carbon dioxide equivalent.

Section 4.1.1 Conversion factors

The measurement standards specified above may not be in the appropriate units for use in the GO scheme. There may be a need to convert from the measurement units specified in the NGER Determination into units that correspond to the emissions factors they are being combined with to estimate emissions. The *National Measurement Act 1960*, and any instrument made under that Act should be used for conversions, consistent with Section 1.15 of the NGER Determination.

Conversion factors may also be found in Appendix 1 of the NGA Factors[2] Workbook.

Section 4.2 Emissions factors

Emissions factors will be integral to the operation of the GO scheme as a part of the guidance for almost all emissions calculations. The sections below cover off on the proposed default emissions factors that will be used, as well as the potential for supplier specific factors to be developed in the future.

Section 4.2.1 Upstream emissions factors

Upstream emissions factors are intended to be used to estimate the upstream emissions (Section 3.1.1 of this paper). The GO scheme is proposed to rely on a list of identified default factors from existing sources listed in the table below. However, in addition guidelines will be developed for scheme participants wishing to calculate and utilise supplier specific upstream emissions factors.

Table 4.3 Upstream emissions factors sources

Activity	Source
Solid fuel combustion	Table 3 of the latest NGA factors document available on the Department of Climate Change, Energy, the Environment and Water's website.
Gaseous fuel combustion	Table 5 and Table 6 of the latest NGA factors document.
Liquid fuel combustion	Table 7 of the latest NGA factors document.
Blended fuels	Part 2.6 of the *NGER Determination* provides guidance for blended fuels.
Chemicals	Source specific upstream emissions factors.
Water treatment and wastewater treatment	AusLCI (V1.42) Carbon Emissions Factors[3] for - Electricity use –scope 2 electricity. - Major chemicals (substantial)
Fuel combustion to generate steam	Estimated on fuel consumption or default set by CER
Air cooling	Electricity use –scope 2 electricity.
Water cooling	Electricity use –scope 2 electricity.
Heat pumps	Electricity use –scope 2 electricity.

Source specific upstream emissions factors

The GO scheme is proposed to iterate over time to recognise the use of source specific upstream emissions factors. The CER will develop guidelines on how these source specific upstream emissions factors are to be calculated. There will also need to be a process for approving emissions factors for use formally in the GO scheme. There may be options to either integrate it as part of existing audits used for NGER or developing a new update and publication process through the CER's website.

There may also be existing information that could be incorporated, such as NGER reports, studies or schemes from other jurisdictions or industries that the CER could consider. The scope of upstream factors will need to cover any upstream emissions associated with extraction, production, processing, transporting, storage and fugitive of the input.

[3] https://www.auslci.com.au/Datasets/EmissionFactors/AusLCI_1.42_EF_Published.xlsx

Section 4.2.2 Direct emissions factors

Direct emissions are required to be calculated and reported based on the approaches proposed in Section 3.1.2. There are two types of direct emissions under the GO scheme; combustion emissions and accrued emissions. The approaches available are either using an emissions factor or through measurement of emissions.

The measurement of emissions is covered in the measurement guidance section above. The table below provides the proposed sources for the emissions factors and are separated by the activity types used in the NGER Determination.

Table 4.4 Direct emissions factors table for fuel sources.

Activity	Source
Section A – Fuel emissions source	
Solid fuel combustion	Schedule 1 Part 1 of the *NGER Determination*.
Gaseous fuel combustion	Schedule 1 Part 2 of the *NGER Determination*.
Liquid fuel combustion for stationary purposes	Schedule 1 Part 3 of the *NGER Determination*.
Liquid fuel combustion for transport purposes	Schedule 1 Part 4 of the *NGER Determination*.
Blended fuels	Part 2.6 of the *NGER Determination*.
Section B – Fugitives emissions source	
Fugitives	Leaks and vents from equipment. Chapter 3 of the *NGER Determination.*
Section C – Chemical emissions source	
Chemicals	The use of chemicals for production processes.
Section D – Water emissions source	
Onsite wastewater treatment emissions	Highly dependent on the source of the wastewater, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and treatment method. Parts 5.3 (domestic/commercial) and 5.4 (industrial) of the *NGER Determination.*
Section E – Steam emissions source	
Fuel or electricity consumption	Determined in other sections. Where steam is generated from non-combustion waste heat, this may be treated as 0.
Section F – Cooling emissions source	
Air cooling	Must be included in electricity
Water cooling	Must be included in electricity - Open cycle water cooling (evaporative) must also include importing/processing of water where applicable.
Heat pumps	Mainly includes electricity consumption and refrigerant inventory/leaks. - High GWP refrigerants per Part 4.5 of the *NGER Determination*

Section 4.2.3 Transport emissions factors

The two approaches accepted for calculating transport emissions are one based on the direct combustion of fuels used in transport and the other based on the distance transported.

Distance transported method

The sources of distance-based emissions factors are summarised in the table below, including the Bureau of Infrastructure and Transport Research Economics (BITRE) statistics yearbook.

Table 4.5 Distance based emissions factors

Type	Source
Section A – Transport via truck (bulk gas container)	
Articulated Truck (General)	BITRE 2021, Tables 6.6 and 11.5, -full fuel cycle (2017-2020 average)
Section B – Transport via truck (ISO fluid container on flat bed trailer)	
Articulated Truck (General)	BITRE 2021, Tables 6.6 and 11.5, -full fuel cycle (2017-2020 average)
Section C – Transport via truck (Gas cylinder trucks)	
Rigid Truck (General)	BITRE 2021, Tables 6.6 and 11.5, -full fuel cycle (2017-2020 average)
Light Commercial (General)	BITRE 2021, Tables 6.6 and 11.5, -full fuel cycle (2017-2020 average)
Section D – Transport via coastal shipping	
General ISO container vessels	BITRE 2021, Table 4.1c and table 11.9 (2017-2020 average)
Dedicated liquid hydrogen tanker	BITRE 2021, Table 4.1c and table 11.9 (2017-2020 average)
Section E – Transport via rail	
Dedicated rail car	BITRE 2021, Table 4.1c and table 11.9 (2017-2020 average)
ISO container flat-bed car	BITRE 2021, Table 4.1c and table 11.9 (2017-2020 average)

Direct combustion method

The direct combustion of fuels used in transport can use values sourced in accordance with the combustion emissions in Table 4.6, from BITRE and Australian Bureau of Statistics' Survey of Motor Vehicle Use, Australia (ABS SMVU).

For vehicular transport, the default fuel efficiency for each fuel type and vehicle type can be estimated using the data in the reference documents listed in the table below. The emissions intensity per distance is then calculated by multiplying this fuel efficiency factor and the fuel type factors.

Table 4.6 Fuel efficiency factors

Section A – Transport via truck (bulk gas container)	
Articulated Truck (Diesel)	BITRE 2011, Tables 6.6 and 11.9 and ABS SMVU
Section B – Transport via truck (ISO fluid container on flatbed trailer)	

Articulated Truck (Diesel)	BITRE 2011, Tables 6.6 and 11.9 and ABS SMVU
Section C – Transport via truck (Gas cylinder trucks)	
Rigid Truck (Diesel)	BITRE 2011, Tables 6.6 and 11.9 and ABS SMVU
Rigid Truck- Liquefied petroleum gas (LPG)	BITRE 2011, Tables 6.6 and 11.9 and ABS SMVU
Rigid Truck (Petrol)	BITRE 2011, Tables 6.6 and 11.9 and ABS SMVU
Light Commercial (Diesel)	BITRE 2011, Tables 6.6 and 11.9 and ABS SMVU
Light Commercial (LPG)	BITRE 2011, Tables 6.6 and 11.9 and ABS SMVU
Light Commercial (Petrol)	BITRE 2011, Tables 6.6 and 11.9 and ABS SMVU

Section 4.3 Co-product allocation values

The measurement of outputs and approach to conversion factors is outlined in the measurement guidance section above. The additional data that will need to be sourced to support co-product allocations are an energy content conversion factor and economic value. The approach to co-product allocations also requires evidence that the co-products have actually been sold to be utilised.

Section 4.3.1 Energy content

This method requires knowledge of the proportion of fuel/energy input into the process that is attributed to the co-product. For this it is required to know the underlying chemistry and process for each step, including upstream emissions factors for substantial chemical inputs.

Outside of the guidance outlined in NGER for allocation the case specific methods will be participant led to at least a minimal set of rules. Energy content allocation is generally completed on a lower heating value basis where applicable; the basis will be required to be stated (where not the lower heating value).

Section 4.3.2 System Expansion with Displacement

This method requires substantial knowledge of alternative methods to produce the co-product which is being excluded, such as how oxygen is produced at scale. Using the emissions intensity of an industry standard process may be used as a displaced emissions method. Some consideration around limitations and applicability are required to prevent double counting and over-allocation potential, noting that displacement hard to account as a continuous activity.

Questions remain around how this deduction may be applied multiple times (displacement at production, and displacement at consumption), and how to prevent double counting where not using certificates to track, or where the consumer is not regulated. There is also a potential risk that the displacement may result in an overallocation and, in some cases, the displacement is higher than the total emissions cost of production.

Section 4.3.3 Economic value

Economic allocation (based on either a cost or revenue basis) may be used where the energy and displacement methods are not possible. This method aligns closer with the default intention of operating the process but does not represent the physical causalities of producing or purchasing a specified product. Due to the potential fluctuation in pricing of traded commodities, it is likely that an upfront value setting is unlikely to be possible for this allocation method.

Section 4.4 List of potentially relevant chemicals

There are a large number of potentially relevant chemicals that may be an input into the production process beyond those already covered under both NGER and National Inventory as outlined above. This list of potentially relevant chemicals is listed in the table below, and while it looks expansive the majority of emissions related to the import of these goods are unlikely to meet the materiality threshold for the GO scheme. The chemical use and import will be required to be reported up-front, even if the emissions are not included in the emissions intensity calculations.

Table 4.7 Potentially relevant chemicals

Potentially relevant chemicals	Potential uses
Sodium hydroxide Potassium hydroxide Hydrochloric acid	pH control (salt making) - can also be used as a desulphurisation
Sodium carbonate Sulphuric acid	pH control
Hydrogen peroxide Chlorine gas Sodium hypochlorite potassium permanganate	Water treatment including disinfection Steam/condensate conditioning
Membrane Resins, ionic resins, Regenerative materials (Zeolites) Cyclic fluids (MEA/MDEA)	Purification and cleaning, water treatment
Oxygen	Wastewater treatment Sulphur removal Partial oxidation, autothermal gas reforming and coal gasification methods
Ammonia Hydrazine Ammonium chloride	Water and wastewater treatment
Thermal fluids	Heat transfer fluids (other than steam and refrigerants)
PSA consumable materials	Purification
Polyaluminium chloride (PAC), anti-scalant, $NaHSO_3$, biocides	Water and wastewater treatment
Hydrazine Sodium bisulphate	Degassing (steam generation)
Sodium Chlorate Sodium hypochlorite Chlorine gas Hydrogen peroxide	Water treatment Disinfection
Chitosan (and polyamides) Polytannate Iron sulphates (both II and III), ferric chloride and ferric chloride sulphate Aluminium sulphate, aluminium chloride, or sodium aluminate	Water treatment Coagulation and flocculation (ppm, lost to solid waste)

Part 5. List of terms and acronyms

Note on how these terms compare to other schemes

This section contains the terms that needed to be explained for operation of the GO scheme. Many of the terms may be closely aligned to concepts or terms used by other schemes. This section would be updated once the terms are finalised to align language with other schemes such as NGER, LRET and EITE where possible. Where the term relates to commonly used variables within any of the equations given in this document, these may be given as part of the definition.

Term or Acronym	Definition
ABS SMVU	Australian Bureau of Statistics - Survey of Motor Vehicle Use, Australia (latest version covering 12 Months ended 30 June 2020)
ACCU	Australian Carbon Credit Units – a unit representing one tonne of carbon dioxide equivalent (tCO_2-e) stored or avoided by eligible activities undertaken as part of the Australian Government's Emissions Reduction Fund.
Activity	An activity is a component of an emissions source for which scheme participants must report emissions information where applicable. This definition is intended to be closely aligned with the equivalent term in NGER.
Batch	A batch is a quantity of registered product produced at a product facility over the course of a batch period that is considered to have identical emissions intensity and production attributes.
Batch period	The batch period is a period of time that is determined by the scheme participant in accordance with Section 1.1.2. It is a core component of setting the system boundary for the emissions accounting methodology and represented throughout equations below by the variable b.
BITRE 2021	Australian Infrastructure and Transport Statistics - Yearbook 2021, published by the Bureau of Infrastructure and Transport Research Economics (bitre.gov.au), Department of Infrastructure, Transport, Regional Development and Communications
Claim	A claim is an application to the CER to create GO certificates for one or more batches of registered products. A claim may also refer to adding additional information to certificates created during an initial claim, including post-production emissions, consumption and certificate holder updates.
Climate Active	An ongoing partnership between the Australian Government and Australian businesses to drive voluntary climate action. Climate Active certifies business that have credibly reached a state of carbon neutrality by measuring, reducing and offsetting their carbon emissions. Certification is available for organisations

	(business operations), products and services, buildings, events and precincts.
Coal gasification	The process of reacting coal (also mixed with biomass) with oxygen under high pressure and temperature to form synthesis gas (syngas), a mixture consisting primarily of carbon monoxide and hydrogen.
Co-product	Coproducts are production outputs with economic value other than the registered product which are sold or reused. These may be eligible to be allocated a part of emissions from the production process.
Corporate Emissions Reduction Transparency (CERT)	The Corporate Emissions Reduction Transparency (CERT) report is a voluntary initiative for eligible companies to present a snapshot of their climate-related commitments, progress and net emissions position, published by the CER.
Delivered quantity	The remaining quantity from a batch of registered product after accounting for all losses from post-production modules and events.
Direct emissions	Direct emissions are the emissions that are directly attributable to the consumption of an input within a product facility or post-production process.
Ecoinvent	Ecoinvent is a not-for-profit association dedicated to promoting and supporting the availability of environmental data worldwide. The Ecoinvent database is a compilation of Life Cycle Inventory (LCI) data for materials and products
EITE	The Commonwealth Government's Emissions-Intensive and Trade-Exposed (EITE) scheme is designed to compensate industries affected by the incoming carbon price who are unable to pass costs downstream due to international competition.
Electrolysis	The process of using electricity to split water into hydrogen and oxygen. This reaction takes place in a unit called an electrolyser.
Emission factors	These are variables that are used in emissions calculations across all types of emissions sources. There are several types of emissions factors mentioned throughout this paper that may be used in the Guarantee of Origin scheme, these are discussed in more detail in Part 3. The various types are: - Direct factors, for use in emissions calculations related to direct emissions. - Upstream factors, for use in emissions calculations related to upstream emissions. - Residual energy mix factors, for use in emissions calculations related to indirect emissions (scope 2 emissions). - Default factors are a type of standardised emissions factor that is sourced from various inventories throughout Australia.

	- Bespoke factors, which are proposed as a future iteration for the GO scheme to allow participants to derive more specific emissions factors,
Emissions Intensity	The emissions intensity is the emissions per unit of product. This may be calculated per sub-category, measurement grouping and overall. The overall would be calculated from the summation of all measurement groupings divided by the quantity of product. The well-to-production gate emissions will be locked at the product facility boundary, production gate-to-delivery gate emissions will be adjusted as post-production emissions are added though transfer processes to the end consumer. It is represented throughout equations below by the variable EI. Reporting of emissions, specifically onsite and downstream emissions, will require separation of sources such as carbon dioxide, methane, nitrous oxide, and other greenhouse gas sources. Upstream emissions may be estimated as an aggregate if no reasonable burden of reporting exists.
Events	Events result in product losses and/or greenhouse gas emissions which occur within the well-to-delivery gate boundary which are not accounted for under the registered operating conditions. These include, but are not limited to: • Deliberate releases (venting), • Accidental releases (venting), • System upset releases, • System purges, • Non-routine venting or flaring, • And other uncontrolled losses.
Functional unit	The functional unit is the basis for which the overall emissions are converted to a standardised unit. This is outlined by the IPHE for hydrogen as 1 kg of product. Further guidance on conditions such as pressure and purity requirements are bound by the consumer requirements, ands this may be outlined as a definition of the product facility.
GO Certificate	A certificate created by the scheme participant under the Guarantee of Origin scheme calculated using this methodology, the Clean Energy Regulator is responsible for validating the claims made on the certificate including the emissions values.
GreenPower	GreenPower is a government accredited renewable energy product offered by most electricity retailers to households and businesses in Australia.
HUB	A facility designed as a transfer point between transport modes including storage facilities, docklands (wharfs), distribution centres, and road-rail freight hubs.
Indirect emissions	Indirect emissions are the scope 2 emissions that are related to the production output from a product facility or with a post-production event.

IPHE	International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) – an international government-to-government partnership whose goal is to promote the advancement of technical hydrogen industry standards and protocols that are expected to underpin future trade and investment in hydrogen.
Lost quantity	The quantity from a batch of registered product that was lost in post-production modules or events.
Measurement grouping	A measurement grouping is set by the *scheme participant* to structure how information about emissions sources throughout the product facility will be reported. 0 outlines how scheme participants can set this term. It is integral to determining the system boundary and represented throughout the emissions accounting methodology by the variable *i.*
Module	A sub-component of the relevant process that is required, or otherwise applicable, to be included as part of the product facility or post-production process as defined in Section 1.1.1. These modules generally relate to a process or sub-process which may be, but not required to be, treated in isolation within a product facility or post-product facility.
NGA Factors	The National Greenhouse Accounts (NGA) Factors provides emission factors and methods that help companies and individuals estimate greenhouse gas emissions. The Department of Climate Change, Energy, the Environment and Water publishes revised factors every year.
NGER Determination	The NGER (Measurement) Determination provides the methods and criteria for calculating greenhouse gas emissions and energy data under the NGER Act. The original instrument has been updated annually since 2009 to reflect updates to emissions factors, improvements to estimation methods and responses to consultation feedback. The range of emission sources covered in the Measurement Determination includes: • the combustion of fuels for energy • fugitive emissions from the extraction of coal, oil and gas • industrial processes (such as producing cement and steel) • waste management
NGER Measurement Determination	The *National Greenhouse and Energy Reporting (Measurement) Determination 2008* sets out estimation methods applicable under the NGER scheme.
NGER Regulations	The *National Greenhouse and Energy Reporting Regulations 2008* specify further detail of the NGER scheme as established under the *National Greenhouse and Energy Reporting Act 2007*.
NGERs	National Greenhouse and Energy Reporting scheme – A single national framework for reporting company information about greenhouse gas emissions, energy production and energy

	consumption. The NGER Scheme is administered by the Clean Energy Regulator.
Non-attributable processes	Non-attributable processes are determined by the scheme participant in accordance with Section 1.1.2. It is represented throughout equations below by the variable k.
Operational control	Operational control has the same definition as in NGER and refers to the core modules within the production boundary. Note that not all modules are required to be controlled.
Post-production	Refers to any events or activities that occur after the registered product has left the *product facility.* This may include some scope 1 and 2 emissions on a facility (not product facility) perspective as the boundaries may be different.
Post-production boundary	The post-production boundary encompasses the transport and storage steps that may occur to get a registered product from the point of production (production gate) to the point of consumption (delivery gate).
Process (and sub-process)	The components or set of relevant equipment which make up a module.
Produced quantity	The initial quantity from a batch of registered product prior to accounting for losses from downstream events.
Product Facility	Refers to the group of modules that make up the full production pathway for the registered product. This does not necessarily adhere to operational control of all sub-processes and may require visibility of sub-processes if not under operational control. The minimum components of the product facility for the hydrogen production pathways are set out in Section 1.1.1.
Production boundary	The production boundary refers to the operational stages of the hydrogen product facility for which emissions are to be measured and to which the GO scheme will apply.
Production emissions	The upstream, direct and indirect emissions associated with output from the product facility.
Production pathways	The methods of producing the registered product eligible for inclusion in the GO scheme. Initially three eligible hydrogen production pathways are covered under the GO scheme, namely, electrolysis, steam methane reformation and coal gasification.
Provenance principle	Applies to Product GO certification whereby Certificates would be traded alongside the product from production, to transport and storage, and then will note the end consumption.
Registered product	A product that the *scheme participant* has registered and been approved for by the CER. The registered product is the product, represented by certificates, which the participant is approved to interact with (generating, amending, or consuming) under the GO scheme.

Residual mix factor (RMF)	The Residual mix factor (RMF) is the national factor that is applied to the quantity of electricity without a renewable claim.
Scheme participant	Scheme participants are the legal entity that has registered to participate in the GO scheme. Scheme participants are the responsible party for compliance with scheme rules.
Scope 1 emissions	Has the same meaning as NGER Regulation 2.23, where facility relates to the *Product Facility*
Scope 2 emissions	Has the same meaning as NGER Regulation 2.24, where facility relates to the *Product Facility*.
Scope 3 emissions	These are relevant supply chain emissions relating to emissions which occur outside of the *Product Facility* other than those counted under the definition of scope 2 emissions. Scope 3 emissions may occur: - Upstream, such as the emissions generated in the sourcing of raw materials and products consumed in the *product facility*. - Downstream, such as emissions generated through the transportation of products and outsourced activities. This does not include the emissions from the consumption of the product.
Shared processes	Shared processes are any processes within the system boundary that are used to produce both registered products and co-products.
Source – (or *emissions source*)	is source, aligned with the definition in NGER, with additional sources specifically related to the expanded scope of the scheme over NGER (i.e., importing scope 3 emissions from a producer perspective).
Steam methane reformation	The process in which methane from natural gas is heated, with steam, usually with a catalyst, to produce a mixture of carbon monoxide and hydrogen used in organic synthesis and as a fuel.
System boundary	The system boundary for the GO scheme is based on the IPHE definition of cradle to user. This definition has been expanded on in this paper to provide a practical interpretation of the system boundary for the GO scheme's operation. The system boundary encompasses the operational and temporal boundaries.
Temporal boundary	The temporal boundary is the period of time over which the batch period has been set which sets out the temporal limits of the emissions accounting framework.
Twenty-foot equivalent unit (TEU)	A TEU or Twenty-foot Equivalent Unit is an exact unit of measurement used to determine cargo capacity for container ships and terminals. This measurement is derived from the dimensions of a 20ft standardized shipping container. Because standard containers can be 20 or 40ft in length the capacity of a container ship can depend on the ratio of the two sizes.

Upstream	Refers to events or activities that occur prior to the registered product being produced. This mostly covers emissions events related to extraction and transport for inputs consumed within the *product facility*.