



GREENHOUSE GAS INVENTORY GUIDE: BEST PRACTICES

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Executive Summary

This document provides guidance for air navigation service providers (ANSP) which are interested in assessing and managing their greenhouse gas (GHG) emissions. By producing this document, CANSO is encouraging ANSPs to consider how they can benefit from measuring their GHG inventory and how this is a crucial first step in identifying and delivering environmental improvement.

The purpose of this guide is to provide contextual material and best practices. While publicly available standards from the GHG Protocol describe the methodology to compile a GHG inventory, this guide also serves to clarify the GHG inventory methodology from an ANSP's perspective, including the treatment of aircraft emissions. In addition, an International Organization for Standardization (ISO) describes how businesses can approach a GHG inventory in terms of assurance and verification. This document does not seek to restate these approaches but describes specific considerations for ANSP organisations, whether it is considering its emissions for the first time or has already begun assessing its own GHG inventory.

The approach is neither prescriptive nor mandatory. Instead, it seeks to be flexible and fully respects the variability and differences in local regulations and priorities around the world. While individual needs and the level of implementation differ between organisations, measuring environmental impacts is a responsible and necessary first step in effectively managing them. GHG inventorying also allows comparison between the internal inventories of each ANSPs, albeit while remaining conscious of contextual differences.

Using the GHG Protocol as guidance, the rest of this document focuses on Scope 1, Scope 2 and Scope 3 and how they apply to ANSPs. This includes the management of 'estate' related carbon impacts, such as the emitted carbon because of powering ANSP buildings and infrastructure associated with delivering ANSP operations and services. The document also includes value chain emissions including aircraft operations, and touches on avoided emissions which is defined as Scope 4.

Introduction

The increase in global GHG concentration in the atmosphere contributes to climate change, which includes changes in global weather and temperature, the rise of the oceanic sea level and more frequent extreme weather events such as floods or tornadoes.

Measuring and reporting environmental performance is a key part of social responsibility for businesses as concerns about sustainability increase. As global warming and climate change have come to the forefront as a key sustainable development issue, and with governments taking steps to reduce GHG emissions, organisations have become compelled to measure and report on their activities and the associated environmental impact. In some countries, legislation requires businesses to do this, in others there is increasing societal pressure to do so on a voluntary basis. The aviation industry is increasingly in the spotlight as a contributor to climate change.

The aviation industry continues to grow as more people choose to fly. This enables economic growth and opportunities, but it also brings challenges to society and the environment. Environmental climate challenges in air transport are connected with emissions. On a local level, air quality can be affected around the airport and on a global level, an increase in GHG emissions is linked to climate change. ANSPs have a role to play both in terms of the influence they can have in reducing aircraft emissions through more efficient operations, but also directly in terms of the impact of operating their facilities. With vast communications and navigation infrastructure, and a need to operate safely and resiliently 365 days a year, 24 hours a day, ANSP energy requirements lead to carbon impacts. This document focuses on how ANSPs can take steps to quantify emissions as part of a GHG inventory and develop programs to reduce these emissions.

1. GHG Inventories and Environmental Management

1.1 Environmental Impact Management 1.2 GHG Inventory

Many organisations are responsibly managing their environmental impacts through implementing an environmental management system (EMS). An underlying principle of any EMS is the revision and understanding of the environmental impacts associated with business operations, and it is here where a GHG inventory can be useful.

The starting point in managing CO₂ emissions is to first complete an inventory of current emissions (GHG inventory). Measuring environmental impacts through a GHG inventory helps an organisation to identify which areas of the organisation are having the largest impact; to monitor performance; and to identify trends over time. Measurement helps to identify opportunities for improvement. Improvements target emissions that the ANSPs are responsible for as well as those from the full value chain. These operational inefficiencies include the inefficiencies in the service provided to airspace users, which contribute to total aircraft emissions.

A GHG inventory is a tool for organisations to understand their environmental impacts and focuses on estimating the impact of climate change from their business activities and emissions. A GHG inventory quantifies emissions from CO₂ and other greenhouse gases which together are often reported in terms of CO₂ equivalent (CO₂e). International standards and inventories are commonly used to facilitate calculation and outline the calculation methodology (GHG Protocol 2). This process captures contributions (for example CO₂ emissions) and helps enable comparability and transparency of GHG inventories across organisations and sectors of industry.

All industries, including ANSP's, categorise their emissions by Scope. This refers to the categorisation of greenhouse gas emissions between direct and indirect emissions from the value chain: these are distributed into Scope 1 (direct emissions), Scope 2 (indirect emissions from purchased energy), Scope 3 (all other indirect emissions in the value chain) and Scope 4 (avoided emissions). More information is available in Chapter 3.



1. GHG Inventories and Environmental Management

Scope 1 emissions refer to direct GHG emissions that occur from sources that are owned or controlled by an organisation. For ANSPs, Scope 1 emissions typically include Fuel Combustion, Stationary Sources and Fugitive Emissions.

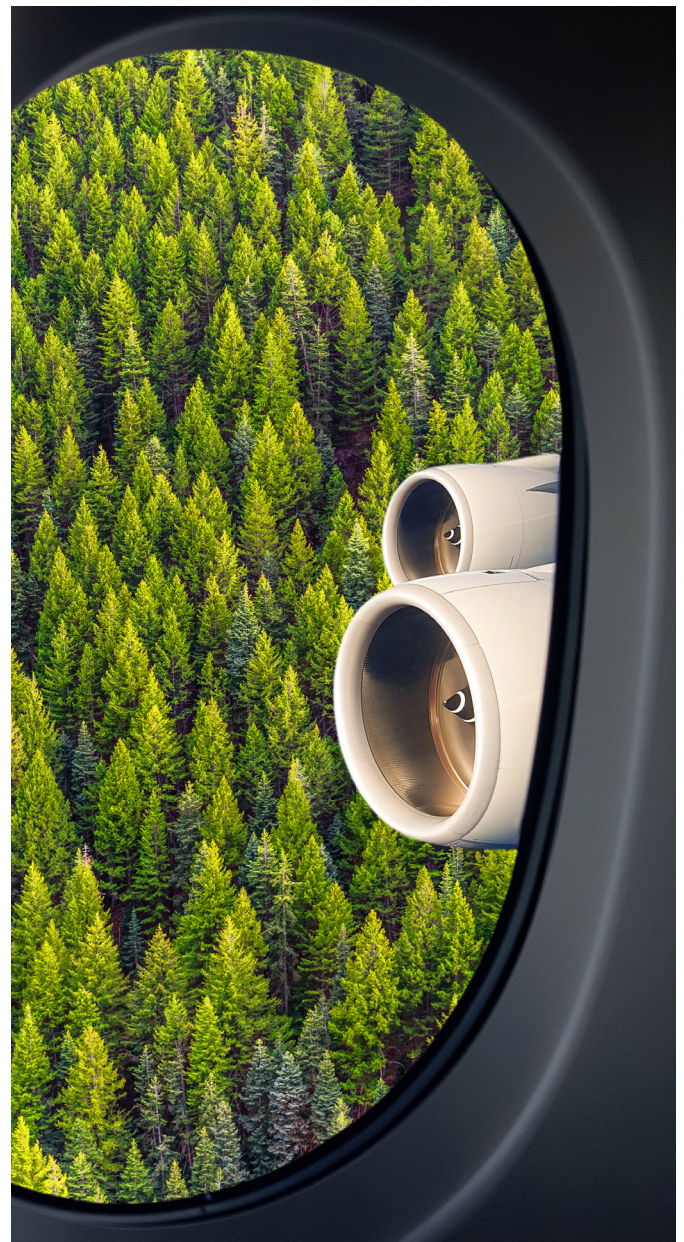
Scope 2 emissions refer to indirect GHG emissions that result from the generation of purchased electricity, steam, heating, and cooling consumed by an organisation. For ANSPs, Scope 2 emissions typically include electricity consumption, heating and cooling and data center energy usage. Overall, Scope 2 emissions reflect the impact of the energy consumption practices of ANSPs and highlight the importance of energy efficiency and the use of renewable energy sources to reduce their GHG footprint.

Scope 3 emissions refer to indirect GHG emissions that occur in the value chain of an organisation, including both upstream and downstream activities. For ANSPs, Scope 3 emissions can encompass a wide range of activities, including: employee travel and commuting, purchased goods and services, capital goods, fuel and energy related activities and waste disposal. Scope 3 emissions often represent the largest portion of an organisation's total GHG emissions, making it crucial for air traffic service providers to assess and manage these emissions. Addressing Scope 3 emissions can involve collaboration with suppliers, improving operational efficiencies, and promoting sustainable practices within the broader aviation ecosystem. It's important to note that while air traffic service providers are not directly responsible for aircraft emissions, they can influence operational practices and efficiencies that may indirectly affect overall emissions in the aviation sector.

Scope 4. The term Scope 4 is not officially recognised by the GHG Protocol, but it is sometimes used informally to refer to avoided emissions – i.e., emissions reductions resulting from the use of a company's products or services, compared to a baseline scenario. For example: a solar panel manufacturer might refer to Scope 4 when estimating the emissions their clients avoid by using renewable energy provided by the panels rather than conventional fossil-fuel based power sources.

For ANSP's, Scope 4 emissions typically involve operational improvements that reduce overall aviation emissions. While Scope 1-3 emissions focus on direct and indirect emissions, Scope 4 highlights how ANSPs can contribute to decarbonisation by enhancing efficiency and reducing emissions industry-wide.

Several standards and inventories have been developed to help businesses understand the entire end-to-end impact of their activities. The various standards and protocols are addressed in more detail in Section 3.



2. Why undertake a GHG Inventory?

There are many reasons why ANSPs make the decision to monitor their GHG emissions. Some of these are set out below.

2.1 Reducing environmental impact and cost reduction

For many ANSPs one of their biggest contributors to GHG emissions is the energy consumption required to heat, cool, and power air traffic management (ATM) systems, operations rooms, and information technology (IT) equipment. By conducting a greenhouse gas inventory, the most energy intensive areas of the business can be identified. For most ANSPs, essential operations IT must be left running 24 hours a day, seven days a week, resulting in large energy consumption. Even so, there are opportunities to implement newer, more efficient low carbon technologies, consolidate the equipment, and adjust building controls while being sensitive to the needs of current operations. Saving costs is a good motivating factor for each company. Improving the energy efficiency of buildings can reduce costs as well as decrease GHG emissions. There are also opportunities to save costs and reduce emissions by reviewing business travel, waste generation, and water consumption.

2.2 Legislation, regulation and national targets

The 1997 Kyoto Protocol and the 2015 Paris agreement are the main regulatory drivers for States to reduce their emissions.

Many States that ratified the Kyoto Protocol committed to reduce their GHG emissions by a certain level compared to the 1990 level. Since the Kyoto Protocol, the Paris Agreement was adopted in 2015 with the aim to limit global temperature rise to 1.5°C.

International climate agreements such as the Kyoto Protocol and Paris Agreement set overall climate goals, while underlying national policies determine how these goals are to be met at a state level. For example, many states are adopting the International Sustainability Standards Board (ISSB) standards to mandate sustainability disclosures, including ghg emissions reporting. Similarly, in the EU, the Corporate Sustainability Reporting Directive (CSRD) is driving these reporting requirements.

These national strategies or programmes on decreasing GHG emissions include emissions from facilities (especially energy consumption) and business traffic in general. In some cases, there are also limits for GHG emissions from aviation. For example, as a Swiss parastatal company, Skyguide is subject to Swiss law which requires it to become carbon neutral by 2040.

If ANSPs do not currently have national targets to reduce emissions, they may benefit from defining their own objectives rather than having them imposed.

EU Climate Law legally binds the EU to become climate-neutral by 2050. Member States and sectors are expected to contribute. The European aviation sector committed to net zero (destination2050.eu).

Whether it is mandated by a state or voluntary, preparing a GHG inventory helps provide transparency and monitoring for regulators and stakeholders, and shows the progress an ANSP is making towards their environmental goals/targets.

2.3 Net-zero ambition

Net zero refers to a state in which the greenhouse gases going into the atmosphere have been limited to the maximum amount possible and any emissions remaining are balanced by removal out of the atmosphere. The Paris Agreement underlines the need for net zero. In October 2022, 2500 delegates in Montréal from 184 States and 57 organisations at the 41st ICAO Assembly, ICAO Member States have adopted a collective long-term global aspirational goal (LTAG) of net-zero carbon emissions by 2050 for the aviation industry. All stakeholders of aviation, including ANSPs, have committed to this long-term goal.



2. Why undertake a GHG Inventory?

2.4 Managing Risk

GHG inventories include measuring and monitoring a variety of sources of GHG emissions, and natural resources such as oil, refrigerant gases and emissions associated with processing and distribution of water. As an example, there is a risk to the environment if there is an escape of refrigerant gases into the atmosphere. Monitoring can be a useful front-line control in determining whether there are any issues or system failures and thus reduce risk from environmental hazards.

From a financial risk perspective, measuring and monitoring emissions can also help to better inform financial decisions around potential rising energy costs. This insight can be useful to understand the full impact of policies such as carbon tax or cap-and-trade programs.

Measuring a GHG inventory now will also enable and prepare ANSPs for any future sustainability reporting that may become mandated by their state. It also aligns with stakeholder expectations, as many within the industry currently have regulations requiring them to report emissions. There is a reputational risk for ANSPs that appear to not be actively working towards reducing emissions, and measuring a GHG inventory is a critical step towards emissions reduction.

2.5 Sustainability Reporting

Sustainability reporting is a way of self-regulating which allows a company to set and manage its environmental goals and monitor how it performs within the interests of its local community and national goals. Reporting aids a company to work towards sustainability and often disregards any economic impacts, positive or negative. This business model allows the company to set objectives, and manage performance, and encourages a push towards sustainable development.

Airports and air traffic are often perceived negatively because of their environmental impacts. However, by undertaking a GHG inventory assessment alongside a sustainability report, ANSPs can promote their efforts to improve sustainable economic growth and demonstrate how cooperation with airports and airlines leads to benefits including emissions reduction.

2.6 Participate in GreenATM Carbon Environmental Accreditation

The CANSO GreenATM is an Environmental Accreditation programme that provides ANSPs with an independent, industry endorsed, accreditation of their environmental efforts. Through the programme, ANSPs are assessed with respect to their direct environmental impact, as well as their efforts to facilitate the reduction of emissions by airspace users. More information on the program is available on the [CANSO website](#).

Through the GreenATM Programme application, ANSPs answer a series of questions on a broad range of topics and provide evidence on how they are playing a part in aviation sustainability. The application covers topics related to governance and policy, ground, terminal and enroute operations, infrastructure, and procurement practices among others. The programme's topics and five accreditation levels can serve as a valuable guide for ANSPs looking to improve their environmental and sustainability performance and for dialogue with ATM stakeholders on critical sustainability issues.

The structure of the GreenATM programme has been built upon the levels recognised in maturity models. The programme aims to recognise the maturity of an ANSP's efforts to manage environmental impacts across a broad range of topics. These maturity models have five levels as shown to the right.

The GreenATM programme has established a number of categories to help identify areas to determine emissions for inventory standpoint and then to develop methods to reduce those emissions. The Improved ATM categories all fall under Scope 4 emissions.

Level 5 - Optimised

Level 4 - Assured

Level 3 - Managed

Level 2 - Defined

Level 1 - Informal arrangement



2. Why undertake a GHG Inventory?

The relationship between the GHG inventory elements and the GreenATM elements are shown in the two tables below. Table 1 shows the elements within GreenATM, while Table 2 shows the elements within the GHG inventory.

Governance	Improved ATM
<ul style="list-style-type: none"> • Policy and plan • Environmental Management System • Environmental culture • Environmental targets 	<ul style="list-style-type: none"> • Flexible Use of Airspace (FUA) • Meteorological information • Improved surveillance coverage • Airport - Collaborative Decision Making (A-CDM) • Surface management • Continuous Climb Operation (CCO) • Continuous Descent Operations (CDO) • Performance Based Navigation (PBN) • Wake turbulence optimisation • Trajectory Optimisation • Air Traffic Flow Management (ATFM) • Research and Development
Infrastructure and Utilities	
<ul style="list-style-type: none"> • Energy management • Power procurement and production • Communication, Navigation, Surveillance (CNS) Rationalisation • CNS Flight Inspection 	
Other	
<ul style="list-style-type: none"> • Sustainable procurement • Airport/Community relations • Airspace change management • Mobility management 	

Table 1 – Elements within GreenATM

Scopes 1 and 2	Scope 4
<ul style="list-style-type: none"> • Energy management • Power procurement and production • CNS Rationalisation • CNS Flight Inspection 	<ul style="list-style-type: none"> • Flexible Use of Airspace (FUA) • Meteorological information • Improved surveillance coverage • Airport - Collaborative Decision Making (A-CDM) • Surface management • Continuous Climb Operation (CCO) • Continuous Descent Operations (CDO) • Performance Based Navigation (PBN) • Wake turbulence optimisation • Trajectory Optimisation • Air Traffic Flow Management (ATFM)
Scope 3	
<ul style="list-style-type: none"> • Sustainable procurement • Mobility management 	

Table 2 – Related GHG Protocol Elements

3. GHG Inventory Standards

This chapter summarises the approach of the GHG Protocol to accounting GHG emissions. GHG Protocol comprises of multiple standards:

- [A Corporate Accounting and Reporting Standard](#)
- Corporate Value Chain (Scope 3) Standard

Following governmental and societal demands for increased transparency on greenhouse gas emissions, industry standards have been developed to help companies and organisations conduct the accounting and reporting of GHG emissions (often referred to as a GHG inventory).

Standards for GHG gas inventorying ensure consistency and transparency in accounting that allow for comparison and tracking of emissions reductions. Of the standards developed, the Greenhouse Gas Protocol (GHG Protocol), is the most commonly used methodology to report on an organisation's emissions (**Figure 1**). The GHG Protocol Initiative is a multi-stakeholder partnership of businesses, non-governmental organisations, governments and other stakeholders. It is the first systematic guide for quantifying and reporting GHG emissions, with the first edition published in 2001.

Another common standard is ISO 14064, but it is process standardisation document designed for third-party verification and certification. However, it overall has a similar approach to accounting as GHG Protocol. The two standards are very similar in content and intent. However, there is a clear difference in the nature of both documents. The GHG Protocol provides a more motivational drive while the lack of GHG targets in ISO 14064 highlights this difference.

In general, for an ANSP taking the first steps in completing a GHG inventory, and not yet familiar with this topic, the GHG Protocol can be a very useful tool. It is more descriptive and provides further guidance through real examples. The GHG Protocol also provides clear and practical information on setting organisational and operational boundaries, which is a fundamental step when calculating GHG emissions. If an ANSP then requires external assurance, it may be advisable to pursue ISO 14064 certification.

It should be noted that an organisation with a GHG inventory that meets ISO requirements would for the majority of cases also meet GHG Protocol requirements, and vice versa. It is also feasible to review both documents and create an internal process to accomplish an assessment that best meets needs.

As best practices, this document recommends the GHG Protocol, however either method is acceptable.

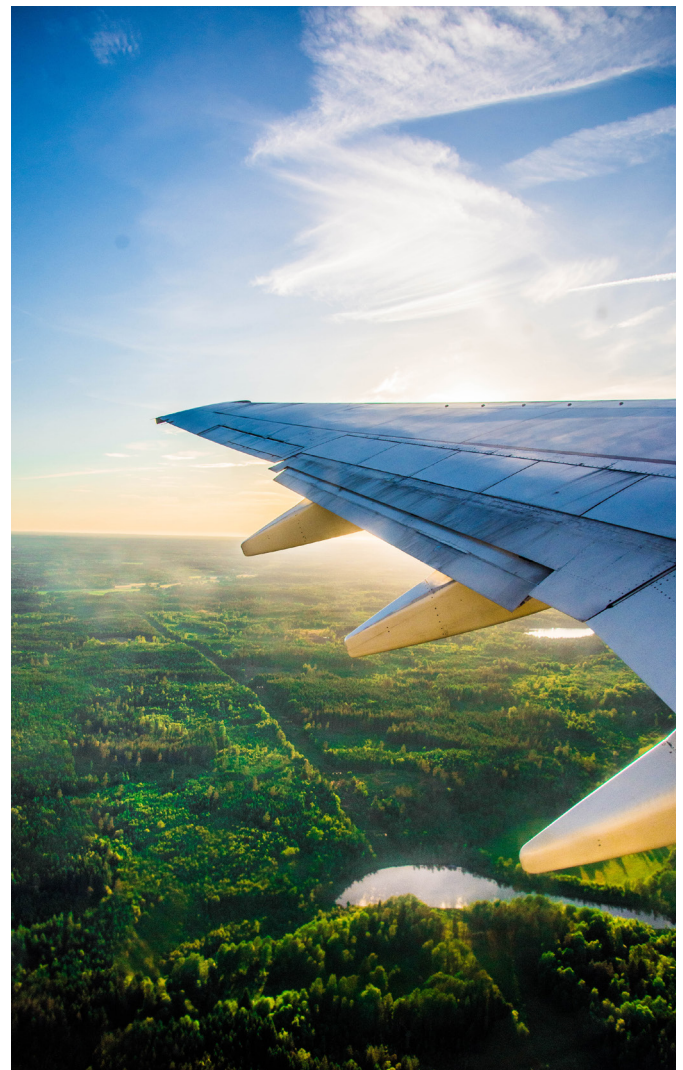
3.1 GHG Protocol

There are two main standards under the Greenhouse Gas Protocol that provide the methodology for an ANSP GHG inventory:

- the Corporate Net-Zero Standard and,
- the Corporate Value Chain (Scope 3) Standard.

The Corporate Net-Zero Standard and Corporate Value Chain (Scope 3) Standard define emissions-generating activities and organises these activities into three categories, referred to as Scopes (**Figure 1**).

- Scope 1 - direct emissions
- Scope 2 - indirect emissions
- Scope 3 - value chain emissions



3. GHG Inventory Standards

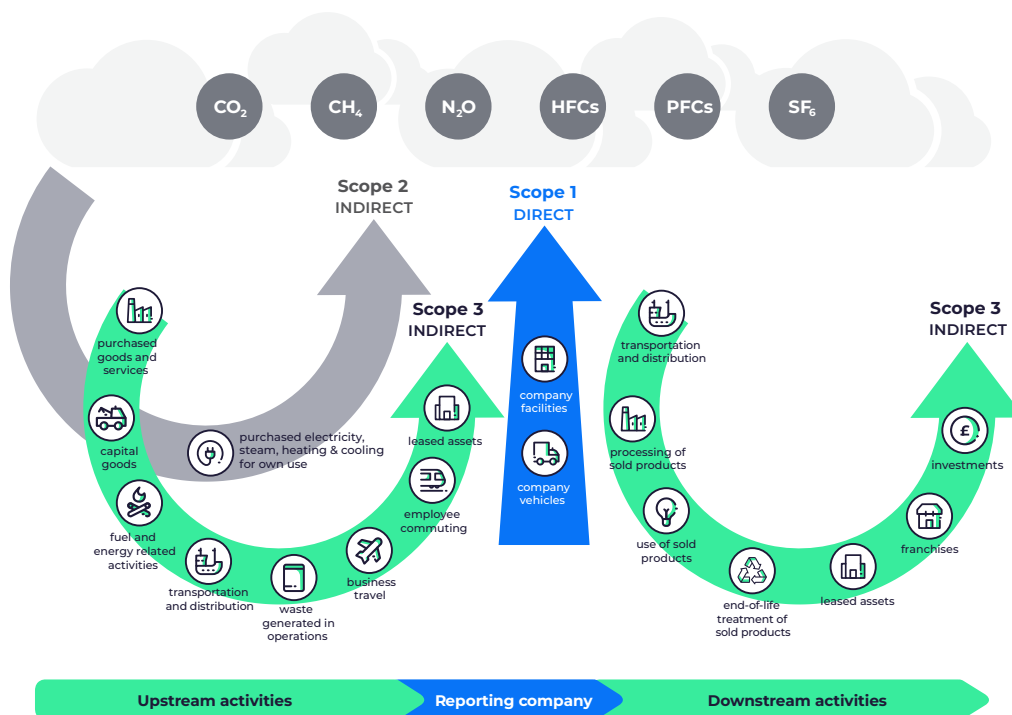


Figure 1 – Illustration of GHG Scope Emissions (reference the source GHG Protocol)

Scope 1 activities are direct emissions from owned or controlled sources – for example natural gas for heating and cooling, diesel for back-up generators, and fuel for fleet vehicles.

Scope 2 emissions are indirect emissions from the generation of purchased energy consumed by the reporting company – for example electricity for lighting or steam for heating. There are two approaches to measuring Scope 2 emissions:

- 1. Location-Based Approach:** Calculates emissions based on the emissions intensity of the grid where the electricity or other energy purchased is consumed. Therefore, reflecting the emissions consumed within a specific location.
- 2. Market-Based Approach:** Calculates emissions based on specific contracts (such as renewable energy certificates) that a company uses to procure electricity.

Organisations that choose to measure Scope 2 using the Market-Based Approach, should also measure and report their location-based Scope 2 emissions. This is a typical dual reporting requirement and provides more transparency into emissions reporting. Organisations should consult their local regulatory requirements for reporting to ensure compliance and refer to the GHG protocol for further guidance.

Scope 3 emissions represent all other indirect emissions from value chain activities and is expanded into fifteen categories:

- **Category 1:** Purchased goods and services
- **Category 2:** Capital goods
- **Category 3:** Fuel and energy-related emissions not included in Scope 1 and Scope 2
- **Category 4:** Upstream transportation and distribution
- **Category 5:** Waste generated in operations
- **Category 6:** Business travel
- **Category 7:** Employee commuting
- **Category 8:** Upstream leased assets
- **Category 9:** Downstream transportation and distribution
- **Category 10:** Processing of sold products
- **Category 11:** Use of sold products
- **Category 12:** End-of-life treatment of sold products
- **Category 13:** Downstream leased assets
- **Category 14:** Franchises
- **Category 15:** Investments

Scope 3 emissions can represent the largest source of emissions for organisations, however because of their tertiary nature it can be difficult to control reductions.

4. Starting a GHG Inventory

4.1 Initiation

This chapter guides the ANSP through the high-level steps required to complete the calculation of a GHG inventory. It is recommended to start with Scope 1 & 2 emissions, and eventually Scope 3 & 4 emissions can be included as an organisation's process matures.

The approach taken in this chapter reflects the methodology of the GHG Protocol standard, outlined in Chapter 3. However, the concepts could also be applicable to other standards, if selected by the ANSP. This chapter only intends to introduce the topic and the specificities of ANSPs' operations. For more detailed guidance and ensuring compliance, the ANSP is advised to refer directly to the documentation of its preferred standard.

The initiation of a GHG inventory should always consider the organisational capabilities, goals and objectives of the ANSP, and how the results will be used. We recommend following a seven-step approach:

1. Identification of main GHG sources
2. Definition of goals and objectives
3. Definition of methodology
4. Collection of activity data and emission factors
5. Calculation & reporting
6. Integration into managerial processes
7. Improvement of data collection and methodology.

Many of these steps are addressed in the GHG Protocol (or other inventory standards) and adherence will ensure a comprehensive inventory and capability for iterative improvements to the process.



4.2 Methodological considerations

Adhering to a consistent, accurate and transparent methodology from the outset is paramount to ensure that the GHG inventory reflects the ANSP's emissions and becomes a useful tool for decision making. Some main principles, presented below, should be followed. Especially long-term, issues can appear if methodology is not consistent year-on-year.

For comparison purposes, a base year of carbon emissions is usually determined. The exact Scope of this base year should be documented in sufficient detail so that it may be adjusted should the organisation or the methodology change significantly, affecting future calculations of an annual GHG inventory.

4.2.1 Operational Boundaries

Defining clear operational and geographical boundaries covered by the GHG inventory assessment enables the process to remain as concise or broad as an organisation needs. This allows for transparency, especially if the results are to be reported externally. Typical boundary considerations include:

- If an organisation has multiple sites, how many of these are included?
- If an organisation works internationally, are sites in different countries calculated differently using country specific emission factors or just one set of emission factors from the originating country?
- Are the activities and emissions from any contractors and subcontractors included?

Where an organisation is owned by multiple parties, the GHG Protocol describes two methods of consolidating GHG emissions to define the operational boundaries. This is relevant also for companies that might be owned by the ANSP such as subsidiaries, investments and daughter companies:

- **Equity share approach:** GHG emissions are split based on a company's share of equity in the operation, which is usually a company's percentage ownership.
- **Control approach:** GHG emissions are the responsibility of the company that has control over the operations from which they are emitted. It does not account for GHG emissions from operations that a company may own equity in but has no control over.

4. Starting a GHG Inventory

4.2.2 Data quality and estimates

Data quality is essential. The ANSP should document the data and methodology it is using. Standards such as the GHG Protocol recommend adhering to 5 key principles:

- 1. Relevance:** the emissions should reflect the operations of the company.
- 2. Completeness:** all (relevant) activities should be reported; exclusions should be disclosed and justified.
- 3. Consistency:** methodologies should be consistent between years to track performance over time. All changes need to be documented.
- 4. Transparency:** all issues need to be presented factually and coherently. Any assumptions and calculations need to be disclosed.
- 5. Accuracy:** as much as possible, emissions should not be systematically under- or over-estimated. The accuracy should be sufficient for management to take decisions.

When data is not available on specific areas of activity, standards allow the ANSPs to use estimates and calculations rather than disclosing the actual measure emissions.

- Starting with estimates: various methods are possible when primary data does not exist. These are temporary fixes while the ANSP builds up the capability to measure the activity itself.
- Using estimates and assumptions: if the ANSP is starting, it can make rough estimates or assumptions on certain categories. For instance, if it only has energy data on its main site, it can assume that its secondary sites have the same rate of consumption than per capita than HQ to obtain a first estimate of total energy consumption.
- Using calculation rather than direct measurements: if the ANSP does not have the measurement of CO₂, for instance from other actors in its value chain, it can use activity data and multiply it by emission factors (tons of CO₂ per unit). Databases are publicly available for such data. For instance, an ANSP can calculate the CO₂ of its commuting by using km driven by employees and using a government database on average CO₂ per km, or CO₂ of its procurement by using the amount spent on suppliers.
- Using secondary rather than primary data: the ANSP can use estimates from government statistics or databases to obtain a rough estimate of its footprint in certain activities. This is the least precise estimate and should only be used.

Data collection

A routine program of data collection should be defined and executed. This may be quarterly or monthly but needs to be regular enough to enable an understanding of the GHG inventory so that it can be measured against set targets.

The effects of carbon reduction initiatives may also be measured by regular assessments. It may make sense, for example, to measure the major contributors monthly and only quarterly for the minor contributors. Contractual agreements with suppliers may be written to require them to report regularly their carbon contribution, which will reduce the data collection burden on the ANSP.

The most appropriate area for data collection will vary among organisations, but will likely involve finance, facilities management and administration sections as these groups have access to all the information from energy and transport suppliers. Many utilities management tools exist which help collate the data and may already be in use in some organisations. Some commercial tools also provide a means of calculating the carbon impact of utilities' use. It is worth identifying what an organisation currently uses.

One way of ensuring data collection takes place is to implement an EMS; this would install a systematic method of monitoring and recording environmental data, as well as help verify data quality as an accredited EMS requires external audits.

4.2.3 Verifications and audits

If the detailed footprint is to be used for public reporting, or to fulfil reporting requirements for offset credits as part of a carbon neutral scheme, it will be necessary to have the footprint results independently audited by an external body.

This task is analogous to auditing company financial accounts and is typically performed by similar companies. The audit will consider the completeness of the assessment and consistency with previous calculations, including the definition of scope and boundaries, as well as the data collected for the reporting period.

Auditing should be performed by an organisation accredited for GHG emissions auditing.

4. Starting a GHG Inventory

4.2.4 Reporting

While it is not always mandatory that an organisation disclose its GHG inventory, it can contribute significantly to the corporate objective and the footprint can be communicated as part of the ANSP's corporate and social responsibility reporting. When reporting, it is useful to present the total GHG inventory in context rather than in isolation, where possible, showing the ANSP's contribution relative to the region and other businesses in the area as well as across time (yearly trend).

To highlight the result of carbon reduction initiatives, comparison with previous years and performance against any reduction targets will show how the organisation has performed.

To address any significant changes within the organisation's activities, it may be useful to present the carbon emissions normalised to key business indicators such as CO₂ emissions per employee or CO₂ emissions per facility.

4.3 Identification of GHG sources

4.3.1 Iterative approach

When establishing a GHG inventory, the ANSP should not expect a perfect and complete set of data from the start, unless there is already a very high level of environmental maturity. The ANSP will likely be faced with working with incomplete data, processes and capabilities required to measure and report on the entirety of its activities. This should not necessarily be a cause of concern but is part of the process of continual improvement. ANSPs are recommended to engage in an iterative approach where the quality and accuracy of the footprint will be improved over time.

The following principles should be adhered to:

Data collection should be prioritised for the main areas causing emissions. That is, the main sites, largest suppliers and clients, most polluting infrastructure or processes. Usually, a few contributors will cause most of the emissions. Precision can be built over time; the key is to begin with a rough idea of the order of magnitude of the footprint and its contributors.

Gaps in the data and processes should be identified and disclosed during the creation of the GHG inventory.

To address them, priority should be given to the areas which are either:

- High emitters
- Potential for large reduction
- Relevant for the business model

High quality data cannot necessarily be expected from the start. Rather, estimates and calculations can be used in the first footprints to obtain a big picture of the ANSPs' emissions. More information on the use of estimates and data quality is available in the previous section, "Methodological considerations".

4.3.2 Direct, indirect and Value Chain emissions

The organisation will have a different degree of control over every source of emissions. That is why direct (Scope 1), indirect (Scope 2), and value chain (Scope 3) emissions are reported separately.

Direct Emissions - Scope 1

As specified in the revised GHG Protocol, direct emissions are "emissions from sources that are owned or controlled by the company"¹. This includes all use of all primary energy sources, and these emissions originate in many areas of an ANSP's operations.

Indirect Emissions - Scope 2

Indirect emissions are caused by the firm's activities, but the primary source of the emissions occur in other companies. They are not controlled by the reporting organisation's activities but can be influenced or impacted by sourcing. For example, Scope 2 emissions from the use of electricity, which is purchased but where the emissions are created at the power generation site i.e., direct for the producer. While not directly controlled by the purchasing organisation, decisions can still be made to switch suppliers or implement energy efficiency measures to reduce associated emissions.

Value Chain Emissions - Scope 3

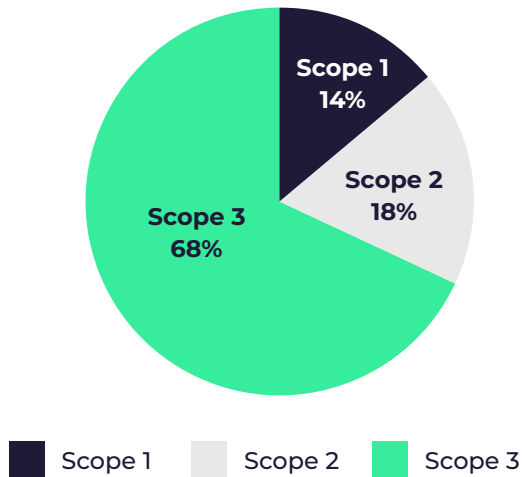
Value chain emissions, categorised together under Scope 3, contain all other indirect emissions. These are often the hardest to report, as they involve data from external partners. However, it is often the largest part of the GHG inventory for a service company. The reductions of value chain emissions is considered Scope 4.

¹ <https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf>

4. Starting a GHG Inventory

Scope 1, 2 and 3 Emissions Inventory Examples:

NAV CANADA Scope 1,2 and 3 GHG Emissions (tCO₂e) 2023



skeyes Scope 1, 2 and 3 Emissions:

Carbon footprint per GHG category - (ktCO₂e)

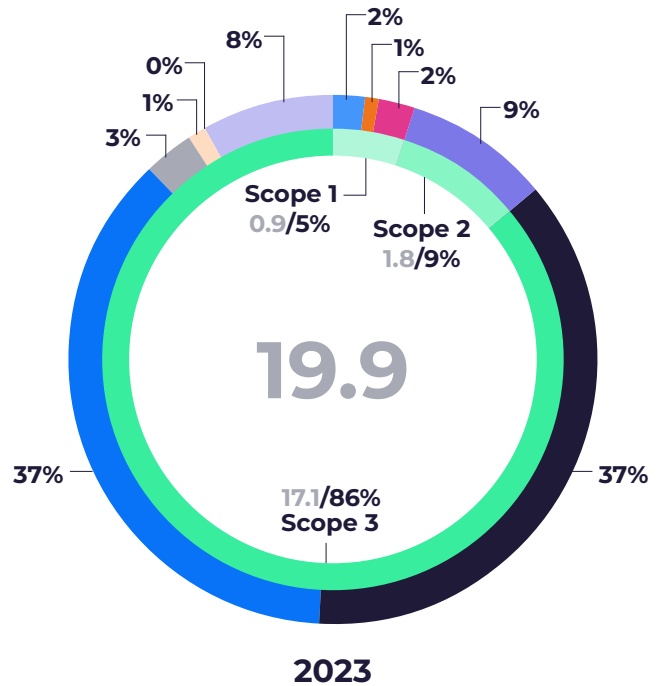


Figure 2 – Example inventory breakdown across Scope 1, 2 and 3: NAV CANADA

Included in NAV CANADA inventory:

Scope 1 and 2*:

- Staffed facilities
- CNS Equipment
- Inspection Aircraft
- Ground vehicle fleet

Scope 3**:

- Purchased goods and services (Category 1)
- Capital goods (Category 2)
- Fuel and energy-related activities (Category 3)
- Waste generated in operations (Category 5)
- Business Travel (Category 6)
- Investments (Category 15)

*Scope 1 and 2 are often reported on together due to the crossover in sources (e.g. fuels and electricity are used simultaneously to supply building needs).

**Some ANSPs include airline emissions as part of Scope 3 Category 11: Use of Sold Products. There is not yet consensus on whether airline emissions should be addressed in Scope 3 Category 11, as part of Scope 4 (Avoided Emissions), or both.

- Scope 1
 - Fuel consumption - buildings
 - Fuel consumption - company cars
 - Natural gas consumption
- Scope 2
 - Purchased electricity (location-based)
- Scope 3
 - Purchased goods and services (OPEX)
 - Capital goods (CAPEX)
 - Fuel- and energy-related activities
 - Waste
 - Business travel
 - Commuting

Figure 3 – skeyes tabulation of GHG emissions in 2023 - Source: [sustainability-report-2023.pdf](#)

4. Starting a GHG Inventory

Main areas of impact from ANSPs

ANSPs direct and indirect emissions are comparatively small with respect to airline emissions, but it is still valuable to quantify and reduce these emissions. In general, most ANSPs will have similar activities necessary for operations contributing to most of their GHG emissions. It is recommended to focus on measuring these areas when starting the process, as it will provide the best overview of the overall inventory. These areas are outlined in the following section, categorised per the GHG Protocol into emissions ‘Scopes.’

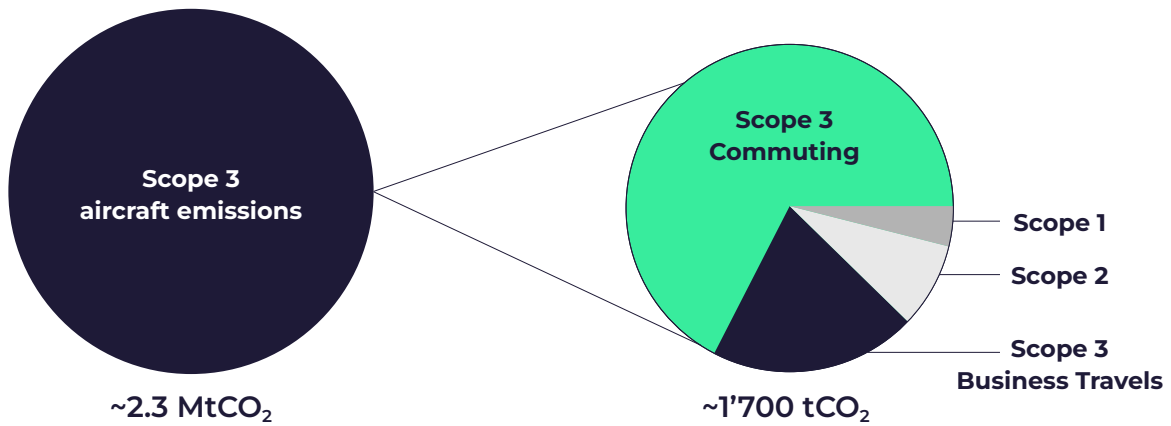


Figure 4 – Relative weight of the three main constituents of Scope 3 compared to Scopes 1 and 2: Skyguide

4.4 Scope 1

4.4.1 Energy

Due to the nature of activities conducted by ANSPs, infrastructure is needed and can range in size and type, from air traffic control towers to CNS equipment. In addition to infrastructure, vehicle assets like ground vehicles and inspection aircraft are often necessary for inspection and maintenance of equipment.

Across all types of infrastructure and assets, the main emissions source is energy use (e.g., fuel for generators, powering buildings and air traffic systems, and vehicle fuel).

As introduced in Section 1, Scope 1 emissions occur from sources that are owned or controlled by an organisation; for energy usage, this would be reflected in primary energy sources (i.e. fuels). Uses of primary fuels for infrastructure are outlined in the table below:

Asset Type	Direct energy activity resulting in Scope 1 emissions
Staffed facilities	<ul style="list-style-type: none"> Fuels used on-site for heating and cooling buildings Fuels used on-site for backup generators
Unstaffed facilities	<ul style="list-style-type: none"> Fuels used on-site for heating and cooling shelters for CNS equipment Fuels used on-site for backup generators of CNS equipment
Ground vehicle fleet	<ul style="list-style-type: none"> Fuel used for maintenance and inspection vehicles
Inspection aircraft	<ul style="list-style-type: none"> Jet fuel used for equipment inspection aircraft

Table 3 – Typical Scope 1 sources for ANSP’s

4. Starting a GHG Inventory

4.5 Scope 2

Scope 2 activities for ANSPs involve use of secondary energy sources, like purchased electricity or water that is heated/cooled off-site using emissions-emitting methods. Detailed examples can be found in the table below:

Asset Type	Indirect energy activity resulting in Scope 2 emissions
Staffed facilities	<ul style="list-style-type: none"> • Purchased electricity for lighting, or heating and cooling of buildings • Purchased chilled, heated water, or steam for heating and cooling of buildings
Unstaffed facilities (i.e. communications, navigation and surveillance equipment)	<ul style="list-style-type: none"> • Chilled, heated water, or steam for heating and cooling of buildings
Ground vehicle fleet	<ul style="list-style-type: none"> • If EVs are used, electricity for maintenance and inspection vehicles

Table 4 – Typical Scope 2 sources for ANSP's

Scope 1 and 2 Mitigation Options

Some activities that can help minimise impacts associated with energy consumption include:

- Raising the awareness of employees.
- Improving the management of heating ventilation air conditioning (HVAC) equipment operating hours.
- Free-cooling techniques (i.e., outside air is used when appropriate).
- Options for renewable energy production and use.
- Rationalisation and modernisation of CNS equipment. Energy consumption should be considered in the ANSP's CNS strategic roadmap, as new technologies offer great opportunities to reduce ground NAVAID equipment and lower the consumption of surveillance equipment. For example, the transition from primary to secondary and wide area multilateration (WAM) reduces each time consumption by a factor of about 100.

- GreenATM provides useful guidance on how to improve ANSP maturity in Energy Management, Power Procurement and Production, CNS Rationalisation and Environmental Culture topics.

4.6 Scope 3

4.6.1 Mobility

Mobility represents another key aspect of ANSP's GHG inventory, due to employees travelling for commuting and business purposes.

- The number of remote locations, with respective maintenance needs, and inter-site commuting can make this aspect quite important. The international nature of ATM, with transnational projects requiring business travel, can substantially increase the impact of mobility.
- Data can be hard to obtain for commuting, as it is a private activity from employees. It requires the development of measurement tools such as HR surveys.
- Disclosed in Scope 1 (own fleet) as well as Scope 3 (category 6: business travel; category 7: employee commuting).

Mitigation Activities

Activities that reduce business travel and commuting emissions include:

- Raising the awareness of employees (e.g. economical driving training for professional drivers).
- Preference for online meetings.
- Options to travel on transport with a lower emissions factor (public transport, biking, car-pooling, use of train rather than car or aircraft).
- Acquisition and use of electric cars or hybrids.
- Subsidies to employees for use of public or soft mobility.
- Promote remote work. Teleworking reduces emissions from transportation: However, emissions from remote working are accounted in Scope 3, category 7 -- employee commuting.
- GreenATM provides useful guidance on how to improve ANSP maturity in mobility management and Environmental Culture topics.

4. Starting a GHG Inventory

4.6.2 Supply Chain

ANSPs purchase substantial amounts of supplies, especially technical, IT and physical infrastructure, their procurement can become a large part of their GHG inventory. The main difficulty in this area consists of how to obtain accurate data from suppliers.

This is disclosed in Scope 3 category 1 (purchased goods and services), category 2 (capital goods) and category 4 (upstream transportation and distribution). Although not disclosed, the impact on biodiversity and land use from new construction or expansion projects should also be considered.

Mitigation Activities

To reduce its impact from the supply chain, the ANSP should develop policies, processes and green criteria for sustainable procurement, particularly for commonly purchased products and services or large orders. Specific examples are highlighted in table 3.

Purchased Goods or Service	Emissions associated with the purchased good or service
Software solutions and cloud storage	<ul style="list-style-type: none"> Emissions from data centre electricity usage
Purchased CNS equipment	<ul style="list-style-type: none"> Emissions associated with the manufacture and shipping of infrastructure and hardware
Landscaping services	<ul style="list-style-type: none"> Emissions associated with the operation of vehicles and machinery for landscaping and maintenance (e.g. snow clearing, mowing of grass, tree trimming)

Table 3 – Examples of value chain emissions from purchased goods and services

GreenATM provides useful guidance on how to improve ANSP maturity in Sustainable procurement and Environmental Culture topics.

4.6.3 Recycling and Waste Management

Impact from recycling and waste can be important for ANSPs. An important contributor to these emissions is the recycling of IT and physical infrastructure, such as the replacement of legacy systems and the decommissioning of CNS infrastructure.

These items will be disclosed in Scope 3 category 5 (waste generated in operations). Possible improvements include:

- Raising the awareness of employees (e.g. specific training for employees on the electromechanical systems).
- Depositing and selective collection of waste by type of waste, especially hazardous and non-hazardous.
- Rigorous monitoring of waste management service providers.

For example, Skyguide takes note of the compression of waste and arranges with other companies to reduce the number of waste pickup and disposal journeys for garbage trucks.

Reuse is also an important waste reduction strategy to consider and contributes to the circular economy. LVNL for example, donated 12 navigational beacons that had become obsolete in their operations to Zambia Airports corporation limited (ZACL), resulting in improved flight safety in Zambia, and the diversion of high-quality materials from landfill.

4.6.4 Water use

Water use is not directly recorded in GHG Protocol Scopes but should nonetheless be addressed as part of the ANSP environmental approach. The energy use associated with it is disclosed in Scopes 1 and 2.

Water consumption can be limited through the following initiatives:

- Raising the awareness of employees of water usage.
- Decoration with plants that require low water consumption.
- Replacing conventional water taps for taps with sensors or timers.
- Optimising irrigation in garden areas or using rainwater for irrigation.
- Using water-efficient toilets.

4. Starting a GHG Inventory

4.6.5 Recommendation on ANSPs accounting for aircraft emissions

Aircraft operators have the primary responsibility for GHG emissions created from the use of fuel while delivering their services (Scope 1). However, ANSPs can also report aircrafts emissions under Scope 3 category 11: use of sold products and services. Consequently, this category would then become – by far - the main contributor to the GHG footprint for most ANSPs.

It would be beneficial for the ATM industry if ANSPs systematically use common disclosure processes of aircraft emissions used across the world. Different approaches are possible to measure such emissions:

- Emissions from all flights through the controlled airspace. Within Eurocontrol airspace, the information is made available per Area Control Centre (ACC) through the Eurocontrol Flying Green or CO₂ MPASS tool using fuel consumption models.
- In the absence of solid data for emissions from flights, data from the ANSPs' Route Charge Office can be used as a rule of thumb, as it determines distances flown within the airspace for charging purposes. An average consumption per nautical mile can be applied (see, for instance, the Eurocontrol Standard Inputs for Cost Base Analysis documents advising a 49 kg consumption per nautical mile figure). The amount of CO₂ is then deducted by applying a ratio of 3.15 (i.e. one kg of Jet A1 fuel induces 3.15 kg of CO₂ emissions).
- In the case of a civil and military ANSP, CO₂ emissions from jet fighters under military control are more difficult to estimate, as data is not made public. A rule of thumb needs to be applied based on the available information, such as the typical consumption per minute of the relevant aircraft and the number of hours flown by the fleet. However, the share of emissions from military aircraft is low compared to civilian ones. In Switzerland, it is estimated to be less than 2%.
- Emissions can be extrapolated by the ANSP from the distance flown and type of aircraft using basic calculation (i.e.: average consumption per NM or minute of flight).

Difficulties might arise for ANSPs in collecting data from airspace users, especially if they also serve military and non-commercial traffic. Estimates might be used to obtain an approximation of the order of magnitude. Furthermore, reductions in emissions from SAF usage are still not clearly defined in the relevant global standards. Until it is clarified, a cautious approach would be to not report reductions from SAF usage.

Recognising that ANSPs can influence emissions from aircraft under their control, some ANSPs choose to additionally measure and report on avoided emissions from air traffic management improvements, unofficially designated as "Scope 4." For some ANSPs, the influence they can have on aircraft fuel burn can be more significant than the impact they can have managing their own direct emissions.

Some examples where an ANSP can influence emissions include proper implementation of:

- Flexible Use of Restricted Airspace (FUA)
- Airport Collaborative Decision Making (CDM)
- Continuous Descent and Climb Operations (CCO and CDO)
- Performance Based Navigation (PBN)
- Trajectory Optimisation
- Air Traffic Flow Management (ATFM)

The CANSO GreenATM accreditation program provides useful guidance on how to improve ANSP maturity in deployment of these functionalities.

4.6.6 Subsidiaries

The way in which CO₂ emissions from subsidiaries are accounted for, depends on the company doing the reporting, the level of financial and operational control exercised by the ANSP, and the reporting standard. If the ANSP controls the operations or finances of its subsidiary, the subsidiary's emissions are typically included in the ANSP's Scope 1 and 2 emissions.

For Scope 3, the relevant categories for subsidiaries are categories 15 (investments), 1 (purchased goods and services) and 2 (capital goods). Double counting of the services the ANSP buys from its subsidiary and its investments in it should be avoided.

4. Starting a GHG Inventory

4.7 Scope 4

Scope 4 emissions, as noted and defined above, is not a formal category per the GHG protocol but is generally used to refer to **avoided emissions**, meaning the reductions in greenhouse gas (GHG) emissions enabled by the use of a company's products or services, even though they do not directly reduce the company's own emissions. This is in contrast to Scope 3 category 11 (use of sold products) which defines the emissions generated (not avoided) related to use of a sold product or service. For **ANSP**, Scope 4 emissions typically involve operational improvements that reduce overall aviation emissions.

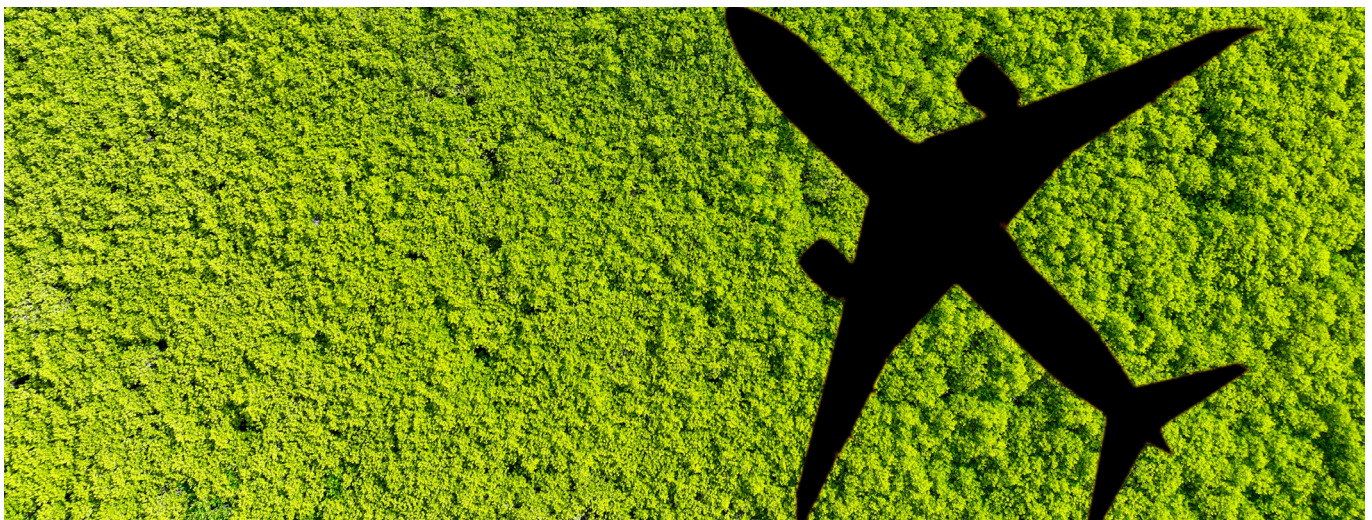
Analyses by ICAO and the Committee on Aviation Environmental Protection (CAEP) have identified environmental benefits that can be achieved through the advancement of Aviation System Block Upgrades (ASBUs) and other operational measures.

Through its GreenATM programme, CANSO has identified 12 ATM issues that provide environmental benefits that can be used as Scope 4 emissions. By measuring the savings achieved through the implementation of these ATM functionalities, ATS providers can quantify their contribution to the reduction of greenhouse gas emissions produced by airspace users.

Examples of ATM initiatives that would reduce Scope 4 emissions as identified in CANSO GreenATM programme:

- **Trajectory optimisation:** By implementing more efficient air traffic management (ATM) systems (e.g., Free Route Airspace, Flex Track Routes), ATS providers help airlines burn less fuel, reducing overall CO₂ emissions.
- **Performance Based Navigation (PBN):** PBN can broadly be defined as the concept of redefining an aircraft's required navigation capability from sensor-based to performance-based. The PBN concept primarily exists on the foundation of RNAV (Area Navigation), which is a concept whereby aircraft can fly on any flight path they wish if it is within coverage of station referenced navigation aids or within limits of self-contained aids.
- **Airport Collaborative Decision-Making (A-CDM):** Enabling better coordination between airlines, airports, and air traffic controllers reduces unnecessary fuel burn (e.g., by minimising ground holding or taxiing times).
- **Air Traffic Flow Management (ATFM):** Supports the effective use of airport and airspace capacity to ensure optimal traffic flow when demand is predicted to exceed actual available capacity. This enables the reduction of airborne and ground holding at airports and sectors operating above capacity and improves the system's ability to optimise flight paths.

While Scope 1-3 emissions focus on direct and indirect emissions, Scope 4 highlights how ATS providers can contribute to decarbonisation by enhancing efficiency and reducing emissions industry-wide.



5. Improvement and next steps

5.1 Improvement plans

The next step after an accounting of GHG emissions should be to define a reduction plan. These reductions are calculated by comparing changes in the company's actual emissions inventory over time compared to the base year, which can highlight important steps for developing a reduction plan:

- Setting GHG targets
- Identifying suitable areas for reduction
- Focusing resources on activities that result in the most cost-effective GHG reductions (4.2.2).

5.2 GHG Offsets, Capture and Storage

Some emissions are hard to abate – that is, they are technically, economically, or logistically difficult to eliminate to zero. This is the case when there is no easy substitute. For ANSPs, emissions in their Scope 3 or from remote infrastructure might represent a case of emissions which are difficult to reduce.

Thereafter, companies can partly neutralise their GHG footprint through alternative methods. These tools are not substitutes for the process of decarbonisation, but they are complementing an ANSP's emission reduction plan.

Carbon capture and storage (CCS) are emerging technologies which help to absorb CO₂ emissions from an organisation. With carbon capture, the CO₂ is physically removed from the air. Then the CO₂ is stored long-term, hence taking away its impact on the environment. However, these technologies are still relatively nascent: they remain small scale and expensive.

Offset projects are projects which indirectly compensate for the emissions by reducing them elsewhere. Most often, these are reforestation, replacement of fossil fuels by alternative energy sources, waste recovery, or the purchase of carbon credits. Offset projects must be carefully considered as they have been increasingly criticized. Their impact might be questionable depending on the project's quality. Selecting the most transparent and high-quality projects is paramount when choosing offsets.

6. Summary Findings

Many CANSO Member organisations have already seen the benefits of a GHG inventory in their own organisations. By measuring their GHG inventory, they have been able to identify areas of improvement, reduce environmental impacts and use of resources, while reducing risks and costs and supporting customers in their environmental goals.

Measurement of a GHG inventory has not only been the driver to implement short-term actions, but also for a permanent change in staff mind-set and the organisation's approach in general. A footprint can be a great foundation for exchanges with all of the ANSPs' stakeholders. Once the implementation of a GHG inventory has been embraced, the benefits quickly become obvious and GHG inventorying becomes an integral part of the organisation's philosophy.



7. Case Studies and Definitions

7.1 Skyguide example

Skyguide began measuring its carbon footprint in 2014 as part of the federal “Exemplary in Energy and Climate” initiative, launched after the 2011 Fukushima disaster to increase renewable energy and improve energy efficiency to replace nuclear energy. Initially, the focus was on energy savings and emissions from scopes 1 and 2. This enabled the implementation of several reduction measures and a better understanding of these emissions sources. Progressively, the initiative encompassed further areas and Skyguide expanded its footprint assessment to scope 3, such as those from business travel and employee commuting.

Following the Paris Agreement and the acceptance of the Swiss Law on Climate in 2023, Skyguide was mandated to achieve net-zero emissions by 2040. This ambitious goal will require a comprehensive understanding of all the ANSP’s emission sources. As a result, Skyguide prepared its first full carbon footprint covering scopes 1, 2, and 3 with all relevant categories identified and measured. This was done for reporting purposes, but also and foremost as a starting point for developing roadmaps to net zero.

Throughout the years, Skyguide has continuously improved the accuracy and coverage of its footprint. This enabled the effective monitoring of progress and helped to identify targeted opportunities for further reductions. It created a robust foundation to achieve long-term environmental goals.

7.2 NAV CANADA example

NAV CANADA began voluntarily measuring its GHG emissions in 2022, in support of its commitment to the UN Global compact and SDG 13: Climate Action. NAV CANADA is also a signatory to Canada’s Aviation Climate Action Plan, and is committed to enabling emissions reduction for customers and aviation stakeholders through improved ATM.

By measuring Scope 1,2 and 3 emissions, NAV CANADA is now able to monitor and understand the areas within its operation where environmental impacts are greatest. This led to the development and publication in 2025 of NAV CANADA’s Climate Action and Environment Strategy, outlining its approach to reducing GHG emissions across the company. Ongoing quantification and monitoring of emissions moving forward will help to measure reductions over time.

7.3 Environmental Aspects and Impacts

An environmental aspect is defined as an “element of an organisation’s activities or products or services that can interact with the environment”. An environmental impact is also defined within ISO 14001:2015 as “any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation’s environmental aspects”. These are often thought of as cause and effect.

One aspect (cause) can have multiple impacts (effects).

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