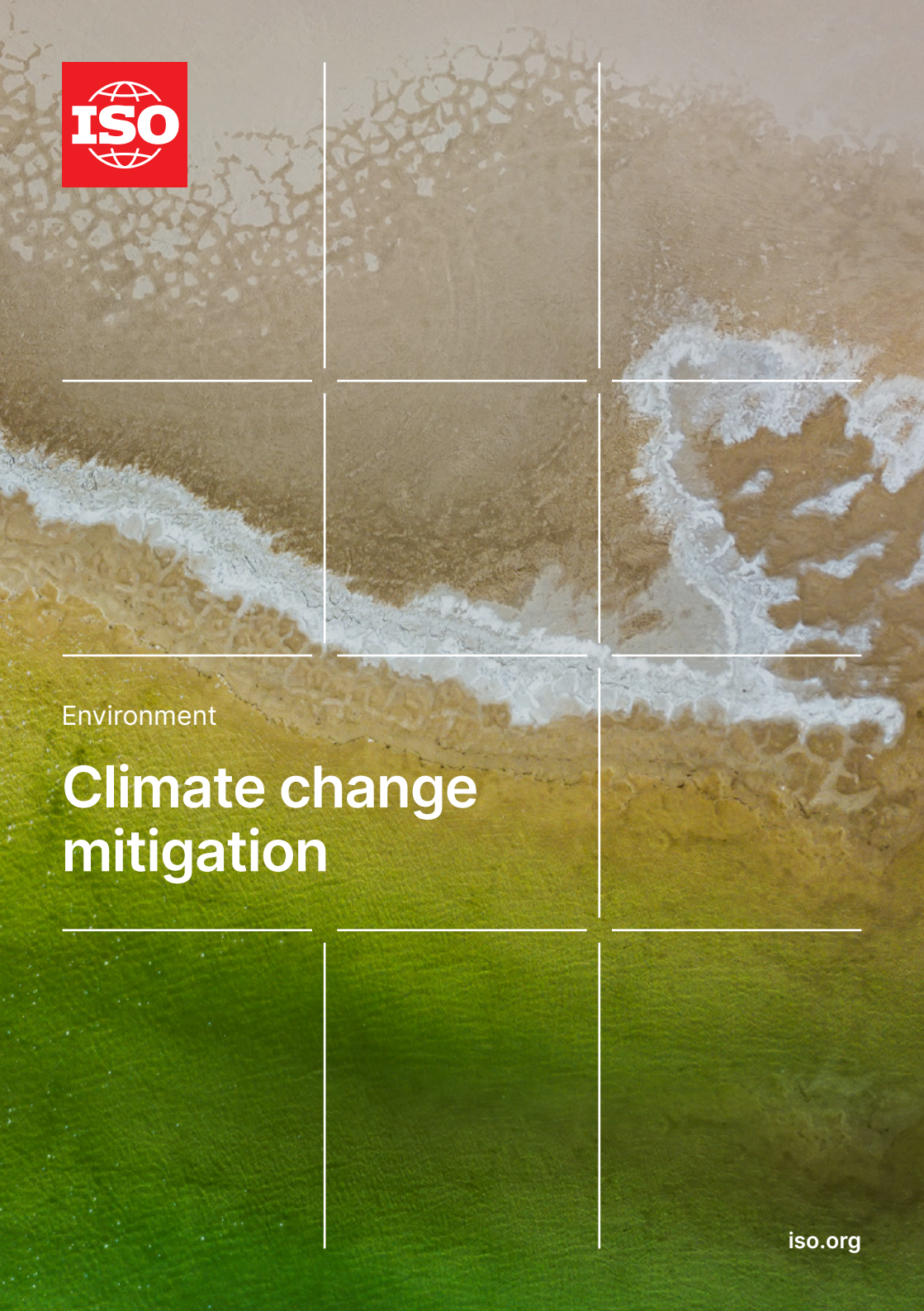
ISO
Environment
Climate change mitigation
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Emissions of greenhouse gases, especially carbon dioxide from burning fossil fuels for energy, are causing climate change. *ISO standards play a role in mitigating its effects.*

Climate change is a significant threat to life on Earth, so humankind needs to first reduce and then ultimately eliminate emissions of carbon dioxide (CO_2). Fortunately, this transformation to a zero-carbon economy is already taking place in many industrial, commercial and municipal sectors, with ISO standards playing a pivotal role in making this happen.

Based on the premise that monitoring, validating and verifying GHG emissions enables organizations to better target and control them, ISO technical committee ISO/TC 207 for environmental management has produced several standards in the ISO 1406x series to manage greenhouse gases (GHG) from organizations, projects and products. All three parts of ISO 14064, for example, have been so effective since ISO introduced them in 2006 that many governmental bodies regulating GHG emissions have adopted these standards and made them mandatory for assessing and verifying GHG emissions regulated within emissions trading schemes. Since then, ISO has published a related standard, ISO 14067, for determining the GHG emissions, or carbon footprint, of products. This document describes the standards in the ISO 1406x series and how these contribute to the transition to a zero-carbon economy.

Taking action

Climate change is the single largest threat facing humanity and biodiversity. There is strong evidence that increasing concentrations of greenhouse gases in the atmosphere – notably CO_2 from burning fossil fuels for energy and transportation – are changing the Earth's climate. The other key GHGs are methane (CH_4), which is typically generated when organic wastes such as sewage decompose, nitrous oxide (N_2O) and halogenated compounds.

Scientists have determined the Global Warming Potential (GWP) of all GHGs. This is the warming potential of a gas relative to CO_2. Halogenated gases, such as sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs), typically have the highest GWPs. This means that these GHGs can make a big contribution to climate change, even if their emissions are much lower than CO_2. (see table on p. 4)

Unless humankind takes firm and prompt action to reduce GHG emissions, the Earth will become much, much warmer, sea levels will rise and there will be greater extremes in weather. In simple terms, extreme weather means many more storms, droughts, major floods and heatwaves. This in turn leads to losses in biodiversity, crop failures and damage to infrastructure.

Principle greenhouse gases, their global warming potential (GWP) and main sources

GAS	ESTIMATED GWP* RELATIVE TO CO_2	MAIN SOURCES
Carbon dioxide (CO_2)	1×	Fossil-fuel combustion for power generation, transportation and domestic heating/cooking
Methane (CH_4)	28×	Fermentation, decomposition of wastes, oil & gas industry, coal mines
Nitrous oxide (N_2O)	265×	Agriculture, fossil-fuel combustion, industry
Sulphur hexafluoride (SF_6)	22 500×	Electrical insulation, medical applications, tracer gas
Perfluorocarbons (PFCs)	6 630× to 17 400×	Electronics manufacturing, refrigeration, fire suppressants, medical applications
Hydrofluorocarbons (HFCs)	4× to 8 060×	Refrigeration, air conditioning, insulation, fire suppressants, aerosols
Nitrogen trifluoride (NF_3)	17 200×	Used as a fluorine source in the electronics industry (plasma etching, silicon chips, semi-conductors, LCD panels) as well as in the photovoltaic and chemical laser industries

* Source: The Intergovernmental Panel on Climate Change (IPCC) www.ipcc.ch

The threats are so severe that many scientists believe that continued changes in climate will cause a mass extinction of biodiversity and make the Earth uninhabitable for most species, including us. According to the Intergovernmental Panel on Climate Change (IPCC), we need to contain the average global temperature rise to within 1.5 °C and do so by 2030.

This means we need to use energy more efficiently, replace fossil-fuelled sources of energy with zero-carbon, renewable energy sources to transform to a sustainable zero-carbon economy.

Many scientists believe that continued changes in climate will cause a mass extinction of biodiversity.

There have already been many successes in this transformation, with technologies and techniques available to reduce GHG emissions. In some industrial sectors, emissions of CO_2 have fallen and ISO standards have played a crucial role in making this happen.

This document describes the standards in the ISO 1406x series for assessing, validating and verifying GHG emissions.

These standards apply the principle that, in order to control an activity, we first need to measure it. They are founded on the principles that apply to all ISO standards, i.e. harmonization, consistency, comparability, traceability and, above all, validity. As such, they serve as a useful complement to ISO 14001, *Environmental management systems – Requirements with guidance for use*, and are designed to integrate easily within an organization's existing environmental management framework.

The role of ISO standards

ISO standards have many roles in tackling climate change, from strategic, governmental and organizational levels, through to tactical applications at the project and even product levels. ISO standards in the ISO 1406x series provide the tools for organizations to develop the starting point for all programmes to control and then eliminate GHG emissions, which is the baseline inventory. This can be at an organizational level, or at the detailed level of an individual process or product, also known as a carbon footprint. Having such data and information enables organizations, regulatory bodies and companies to make informed decisions and then track their progress in reducing GHG emissions.

The box on the right shows the main standards in the ISO 1406x series whilst the following sections explain how these standards work, how they fit together and how they play a big part in tackling climate change.

Standards in the ISO 1406x series for GHG assessment and verification

- **ISO 14064-1**, *Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*
- **ISO 14064-2**, *Greenhouse gases – Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements*
- **ISO 14064-3**, *Greenhouse gases – Part 3: Specification with guidance for the verification and validation of greenhouse gas statements*
- **ISO 14065**, *General principles and requirements for bodies validating and verifying environmental information*
- **ISO 14066**[1], *Greenhouse gases – Competence requirements for greenhouse gas validation teams and verification teams*
- **ISO 14067**, *Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification*

1 Under revision

Quantifying GHG emissions

ISO published all three standards in the ISO 14064 series in 2006, revising them in 2018 and 2019.

ISO 14064-1 for quantifying GHG emissions at the organizational level

The standard specifies how organizations develop auditable GHG inventories, where an inventory is defined as the "sum of an organization's GHG sources and sinks". ISO designed the standard for any organization requiring tools and guidance on evaluating and reporting GHG emissions. Specifically, ISO 14064-1 describes how an organization can create a list of sources and sinks by first considering its boundaries; if a GHG emission is within the company boundaries, then the company has complete control of these emissions.

Two types of boundaries apply here:

- The *organizational boundaries* refer to any facilities for which the organization has practical and financial responsibilities.
- The *operational boundaries* refer to the organization's activities, such as burning fossil fuels for heating and industrial processes.

Once the organization has established these boundaries, ISO 14064-1 provides guidance on developing a register of direct and indirect emissions; for example, employees travelling by air count as an indirect emission. The entity can then decide on appropriate methods set out by ISO 14064-1 for quantifying these emissions.

The standard also contains advice on verifying the organization's inventory; verification is defined as the process of evaluating the data and methods to determine accuracy.

The 2018 amendments to ISO 14064-1 reflect the increasing number of organizations reporting indirect emissions. Furthermore, it includes new guidance on the measurement and reporting of specific examples of GHG sources and sinks based on users' experience.

If a GHG emission is within the company boundaries, then the company has complete control of these emissions.

ISO 14064-2 for quantifying GHG emissions at the project level

ISO 14064-2 describes processes for quantifying, monitoring and reporting GHG emission reductions or removal enhancements at the project level. In this respect, a project is defined as a discrete activity or endeavour; some examples include:

- An anaerobic digestion facility at a sewage treatment plant designed to capture methane and then use the methane to generate power in a gas engine
- Reforestation for offsetting CO_2 emissions, in which trees are sinks or absorbers for CO_2
- A carbon-capture-and-storage facility, where an underground well would provide a reservoir for captured CO_2

ISO 14064-2 applies a life-cycle approach to assessing GHG emissions and removals from projects. The standard describes how users quantify the baseline emissions from sources and then explains the requirements for quantifying the GHGs that sinks, or reservoirs, remove from the atmosphere.

Case study
ISO 14064-2

In 2014, the Forest Carbon Alliance in Canada reforested 112 hectares of agricultural land with native species of tree. Known as the Ontario Biodiversity Afforestation Project, its aim was to convert agricultural lands used for fallow into forest in order to increase biodiversity and remove higher volumes of CO_2 from the atmosphere. The projected CO_2 removals were calculated according to ISO 14064-2 and the Alliance commissioned external verifiers to assess the results, according to ISO 14064-3. The verifiers then determined that the project would remove an additional 56 kilotonnes of CO_2 over the hundred-year project period.

ISO 14067 for the carbon footprints of products

ISO 14067 describes the processes of determining the indirect and direct CO_2 emissions of products. The scope applies to a single impact category – the climate change impacts of products, where the carbon footprint (CFP) is defined as the sum of GHG emissions and GHG removals in a product system, expressed as CO_2-equivalents. ISO 14067 applies the widely used and proven International Standards for life-cycle assessment (LCA), ISO 14040 and ISO 14044.

GHG removals are relevant because a product might reduce the impacts of climate change; for example, techniques to remove CO_2, such as carbon-capture-and-storage, or capturing and using methane from anaerobic digestion.

Applying the principles of LCA, ISO 14067 describes processes for determining GHG emissions and removals from acquiring raw materials through to the end of the product's life, i.e. a cradle-to-grave analysis. The standard also describes how users can determine a partial CFP, a cradle-to-factory-gate analysis, or the CFP during the life of the product in use.

ISO 14067 provides users with significant benefits; for example, the methods in the standard allow manufacturers and users of a product to track the performance of the product, assess how design changes affect the CFP of the product and provide information for consumers to make informed decisions about the product. Moreover, there are several different approaches to calculating CFPs, which can mean different results depending on how each method works.

GHG removals are relevant because a product might reduce the impacts of climate change.

For instance, ISO 14067 focuses on climate change impacts; it was developed by ISO/TC 207's subcommittee SC 7, *Greenhouse gas management and related activities*, to align with ISO 14064-1 and ISO 14064-2.

ISO originally published ISO 14067 as a technical specification (ISO/TS 14067) in 2013. When it was reviewed, revised and republished as a higher-status standard in 2018, the working group responsible for the revision aligned it with other GHG standards, especially ISO 14064-3 for the processes of validation and verification. And to ensure that verification bodies apply ISO 14064-3 in a sound and consistent manner, ISO developed ISO 14065 and ISO 14066.

Validation and verification

ISO 14064-3 for verifying and validating GHG statements

One of ISO's many strengths has been producing standardized tools for independent validation and verification. ISO 14064-3 fulfils this role. The standard specifies requirements and provides guidance on verifying and validating reports of GHG emissions, reductions and removals. The terms verification and validation are defined as follows:

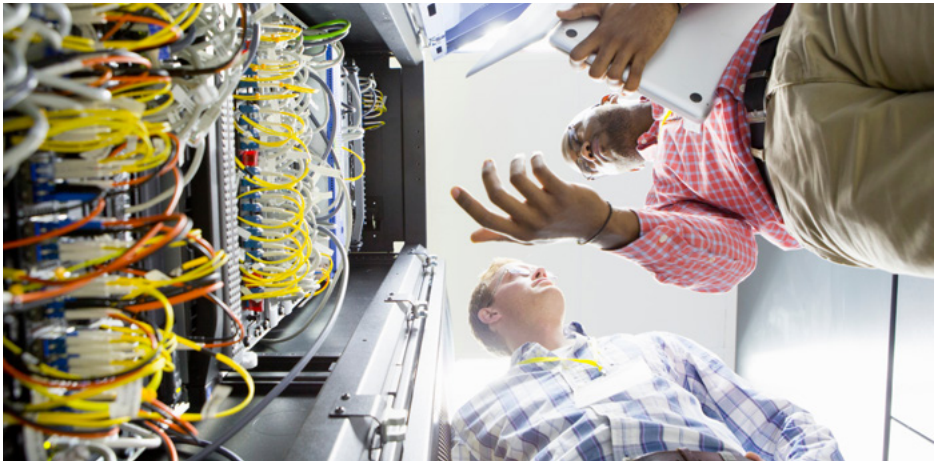
- **Verification:** a process for evaluating a statement of historical data and information to determine if the statement is materially correct and conforms to criteria
- **Validation:** a process for evaluating the reasonableness of the assumptions, limitations and methods that support a statement about the outcome of future activities

Users can apply the principles in the standard at organization, project and product levels. ISO developed the standard for external bodies – such as third-party verification bodies. It is therefore based on the four principles of independent assessment, which are impartiality, ethical conduct, fair presentation and due professional care. Many regulatory bodies worldwide have adopted ISO 14064-3 as a mandatory accreditation standard, such as within emissions trading schemes.

ISO 14064-3 provides many tools that are based on proven techniques in financial accounting. These tools allow users to assess the project or inventory in three main areas: the information system, the data itself and a comparison of the assertion with verification data. Using the concept of materiality from accounting, verifiers can assess how accurate the assertion is and define a *materiality* threshold that helps to identify the usefulness of the information and whether any misinformation has occurred and been transferred.

A verifier's statement according to ISO 14064-3 confirms whether an organization's reported GHG emissions, reductions and removals are consistent with the required criteria. This is critical for organizations, regulators and other stakeholders – such as investors – to make informed decisions.

The 2019 amendment to ISO 14064-3 brought harmony to the definitions of verification and validation across standards. It also encompassed additional annexes that provide guidance on the application of standards based on over a decade of user experience.

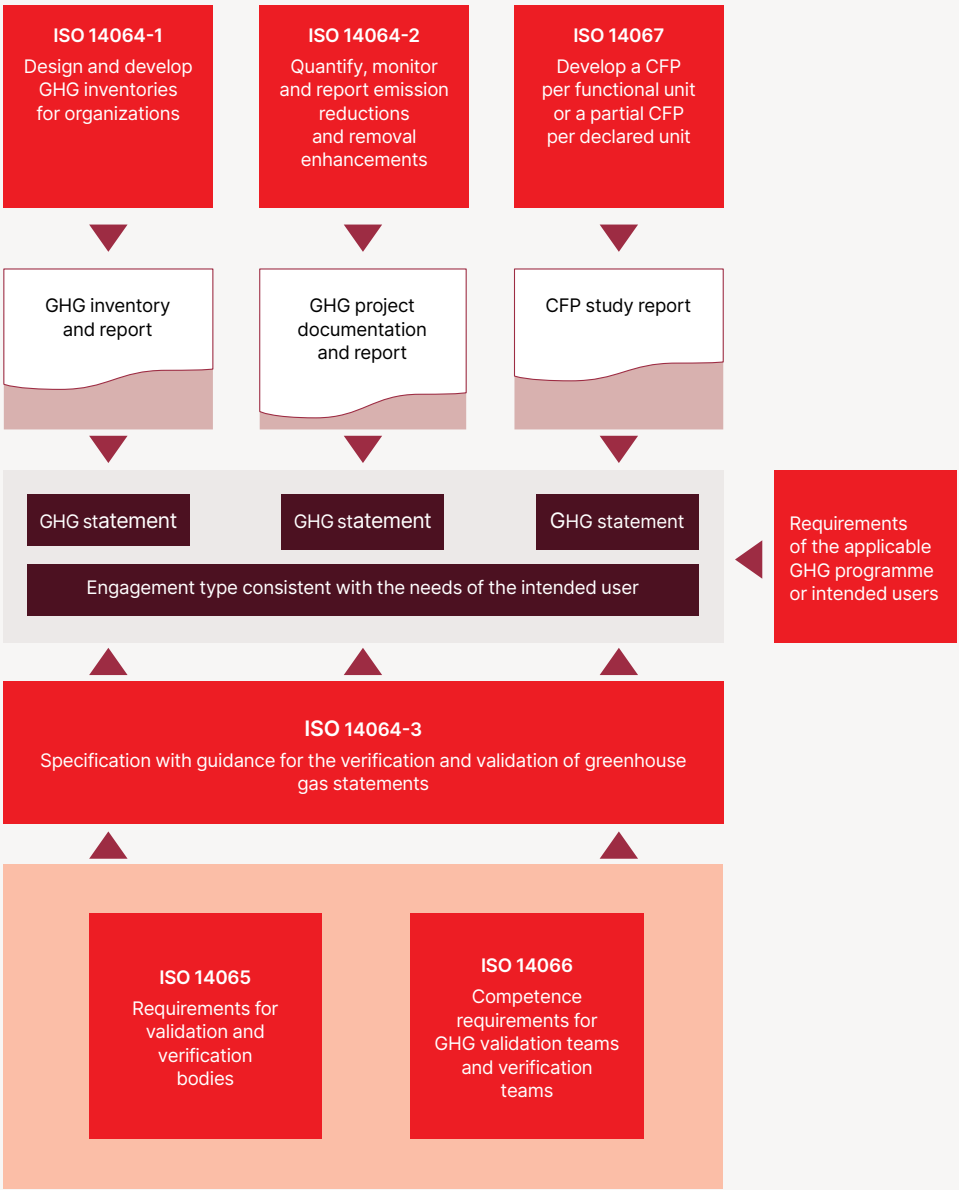


Working in harmony

The three ISO 14064 standards and ISO 14067 dovetail within a systematic framework of assessment, validation and verification. At the initial level, ISO 14064-1, ISO 14064-2 and ISO 14067 respectively describe processes and requirements for assessing the GHG emissions of organizations, projects and products. As each of these standards results in statements of GHG emissions, ISO 14064-3 then specifies how third parties validate and verify these statements.

Meanwhile, ISO 14065 provides a quality assurance framework for third-party validation and verification bodies. Since the skills, knowledge, experience and qualifications of personnel is a critical aspect of verification bodies, ISO 14066 in turn specifies the competency requirements for such staff. The following three sections describe ISO 14065 and ISO 14066 in more detail.

The ISO 1406x series at a glance



Validating and verifying GHG emissions

ISO has published two standards to ensure that validation and verification bodies assess GHG statements in a consistent, robust and comparable manner. The first standard, ISO 14065, *General principles and requirements for bodies validating and verifying environmental information*, applies to organizations, whilst the second, ISO 14066[1], *Greenhouse gases – Competence requirements for greenhouse gas validation teams and verification teams*, applies to the personnel who perform the assessments.

ISO 14065 is an organizational accreditation standard based on five principles. These are:

- Impartiality
- Competence of assessment personnel
- A factual approach to decision making
- Openness
- Confidentiality

The standard contains both general and specific requirements. The general requirements include: mechanisms of governance and management; legal and contractual matters; impartiality; liability and financing. Specific requirements include: specifications for the management system for GHG assessments; planning; risk assessment; managing personnel and their competencies; operations; communications; records; processes for validation or verification; appeals; and complaints.

ISO 14066 dovetails with ISO 14065 and describes the skills, knowledge and experience that GHG verifiers need. It is underpinned by the principles of independence, integrity, fair presentation, due professional care, professional judgment, and an evidence-based approach. ISO 14066 then details the knowledge that assessors require. This includes an understanding and experience of data processing, auditing, technical knowledge, and an understanding of GHG programmes and how these operate.

1 Under revision

The standard then describes the competencies that assessors must have to review statements of GHG emissions and those for processes of validation and verification. ISO 14066 also specifies requirements, and evidence needed, for assessors to demonstrate that they both possess and apply the required competencies, and that they are able to maintain their skills.

Overview of GHG standards and programmes

There are numerous programmes and schemes where GHG standards have either played a significant role, or where there is still scope for them to make a substantial contribution to monitoring, reporting and reducing GHG emissions. These include the United Nations Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change (IPCC) Methodology Reports, the GHG Protocol Corporate Standard of the World Business Council for Sustainable Development (WBCSD), and the European Union's Greenhouse Gas Emissions Trading System (EU ETS).

Case study
EU Emissions Trading System

The European Union's Emissions Trading System (EU ETS) is the world's first and currently largest trading scheme for allowance in GHG emissions. The scheme applies to over 11 000 energy-intensive industries and aviation in 27 EU countries, accounting for 45 % of the EU's GHG emissions. Since its inception over ten years ago, the EU ETS has set targets to reduce emissions by 20 % by 2020, using 1990s emissions of GHGs as a baseline, and by 40 % by 2040. The EU met the 2020 target by 2019.

As with other emissions trading schemes that countries outside the EU have developed, GHG standards including ISO 14064-1, ISO 14064-3 and ISO 14065 have played a crucial role in validating and verifying emissions – and hence made a significant contribution to these reductions in GHGs. Although the ISO 1406x series was developed as voluntary standards, many organizations such as the EU have made them mandatory, recognizing their value and importance in reducing GHG emissions. This means that the ISO 1406x standards still have an untapped potential to help contain and then reduce emissions elsewhere.

Other standards in the series

The ISO 1406x series has already demonstrated a clear role in climate change mitigation. Building on its success, user experience and other needs, ISO/TC 207 developed a number of other standards that contribute to the transition to a zero-carbon economy, as well as standards for climate change adaptation. This portfolio of standards provides management tools and techniques for climate change adaptation, carbon neutrality, environmental finance, carbon-risk disclosure and accreditation. It includes:

- ISO 14015, *Environmental management – Guidelines for environmental due diligence assessment*
- ISO 14016, *Environmental management – Guidelines on the assurance of environmental reports*
- ISO 14030-1, *Environmental performance evaluation – Green debt instruments – Part 1: Process for green bonds*
- ISO 14030-2, *Environmental performance evaluation – Green debt instruments – Part 2: Process for green loans*
- ISO 14030-3, *Environmental performance evaluation – Green debt instruments – Part 3: Taxonomy*
- ISO 14030-4, *Environmental performance evaluation – Green debt instruments – Part 4: Verification programme requirements*
- ISO 14080, *Greenhouse gas management and related activities – Framework and principles for methodologies on climate actions*
- ISO 14097, *Greenhouse gas management and related activities – Framework including principles and requirements for assessing and reporting investments and financing activities related to climate change*
- ISO/IEC 17029, *Conformity assessment – General principles and requirements for validation and verification bodies*

The last standard in this list, ISO/IEC 17029, developed jointly by ISO and the International Electrotechnical Commission (IEC), is the generic standard encompassing the application of ISO 14065 and ISO 14064-3. ISO/TC 207 continues to develop standards wherever there is a need and is currently working on a new standard for carbon neutrality (ISO 14068). It also supports climate neutrality strategies for energy-intensive industries with its future ISO 19694 series on stationary sources of emission.

About ISO

ISO (International Organization for Standardization) is an independent, non-governmental international organization with a membership of 166* national standards bodies. Through its members, it brings together experts to share knowledge and develop voluntary, consensus-based, market-relevant International Standards that support innovation and provide solutions to global challenges.

ISO has published more than 24 000* International Standards and related documents covering almost every industry, from technology to food safety, to agriculture and healthcare.

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