

NEW TASKS OF METROLOGY ON GLOBAL ENVIRONMENTAL PROBLEMS

Oleh Velychko¹ and Tetyana Gordiyenko²

¹State Enterprise “Ukrmetrteststandard”, Kyiv, Ukraine, Velychko@ukrcsm.kiev.ua

²State Enterprise “UkrSREC”, Kyiv, Ukraine, T_Gord@hotmail.com

Abstract: Significant attention is paid to general questions relative to new activity of international organizations for solution of new tasks of metrology on global environmental problems, monitoring of global climate change, and Web-bases e-learning for technical environmental experts, which are conducted by international environmental organizations.

Keywords: measurements, global environmental problems, greenhouse gases.

1. INTRODUCTION

The well-know definition of sustainable development was given by the World Commission on Environment and Development which is defined as “*development that meet the needs of the present without compromising the ability of future generation to meet their own needs*”.

Human activities have been shown to have major impacts on the global environment. Climate change (CC) is global warming that underway. CC is caused by increase of greenhouse gases (GHG) in the atmosphere. These gases reach the atmosphere as a result of activities of our everyday life: the use of energy from fossil fuels, in industrial processes, when flying or driving etc.

The governing bodies of the World Meteorological Organization (WMO) and of the United Nations Environment Programme (UNEP) created a body, the Intergovernmental Panel on Climate Change (IPCC), to marshal and assess scientific information on the subject.

The United Nations (UN) and its member states, aware of the seriousness of this global problem, as presented by the scientific community, have been engaged in action to deal with it at a global level.

The UN Framework Convention on Climate Change (UNFCCC) was adopted in 1992, and opened for signature a month later at the UN Conference on Environment and Development in Rio de Janeiro, Brazil. The 1992 UNFCCC was signed by 154 states (plus the EC) in Rio de Janeiro. Convention has 186 Parties now and it is approaching universal membership.

Further impetus came from the World Summit on Sustainable Development held in Johannesburg in 2002 (Rio+10) where many countries strengthened existing policies or initiated new ones. The Summit adopted the

Johannesburg Declaration whose Plan of Implementation included measures particularly relevant for CC.

Thus, as a result of the preparatory work for the 1992 Earth Summit and the creation of UNFCCC a number of countries established CC bodies. Brazil was one of the forerunners – founding a CC Advisory Unit within the Ministry of Science and Technology (MCT). MCT provides technical support to the CC Focal Point and coordinates the execution of national activities carried out under the Convention [1].

A Global Measurement System (GMS) is a kind of network in which metrological tasks are solved according to the same criteria worldwide. The International Bureau of Weights and Measures (BIPM) and National Metrology Institutes (NMI) are solving many new metrological tasks together, including in field of environmental monitoring. The International Organization of Legal Metrology (OIML) is developing new International Recommendation for legal metrology in wide range of application in environmental monitoring for improvement of the natural environment.

On Fig. 1 the potential CC impact (EPA data) is shown.

2. NEW ACTIVITY OF INTERNATIONAL ORGANIZATION

One of the effects of globalization of trade has been that traceable, comparable and mutually acceptable measurements across the world are now required not only in the trade of manufactured products and raw materials, but also in almost all aspects of international trade. This now includes the multitude of measurements that are the part of the process of protection of the environment.

The main way for this to be assured is for measurements in all areas of science to be made in terms of SI units, and that they are seen to be made within the context of the GMS whose reliability is assured by the BIPM and the NMI working together.

Measurements related to the monitoring of our environment with respect to CC require reliable, long-term stable and comparable measurements demanding corresponding measurement standards. Also in these matters various countries and economic communities are enacting legislation addressing the quality of measurements.

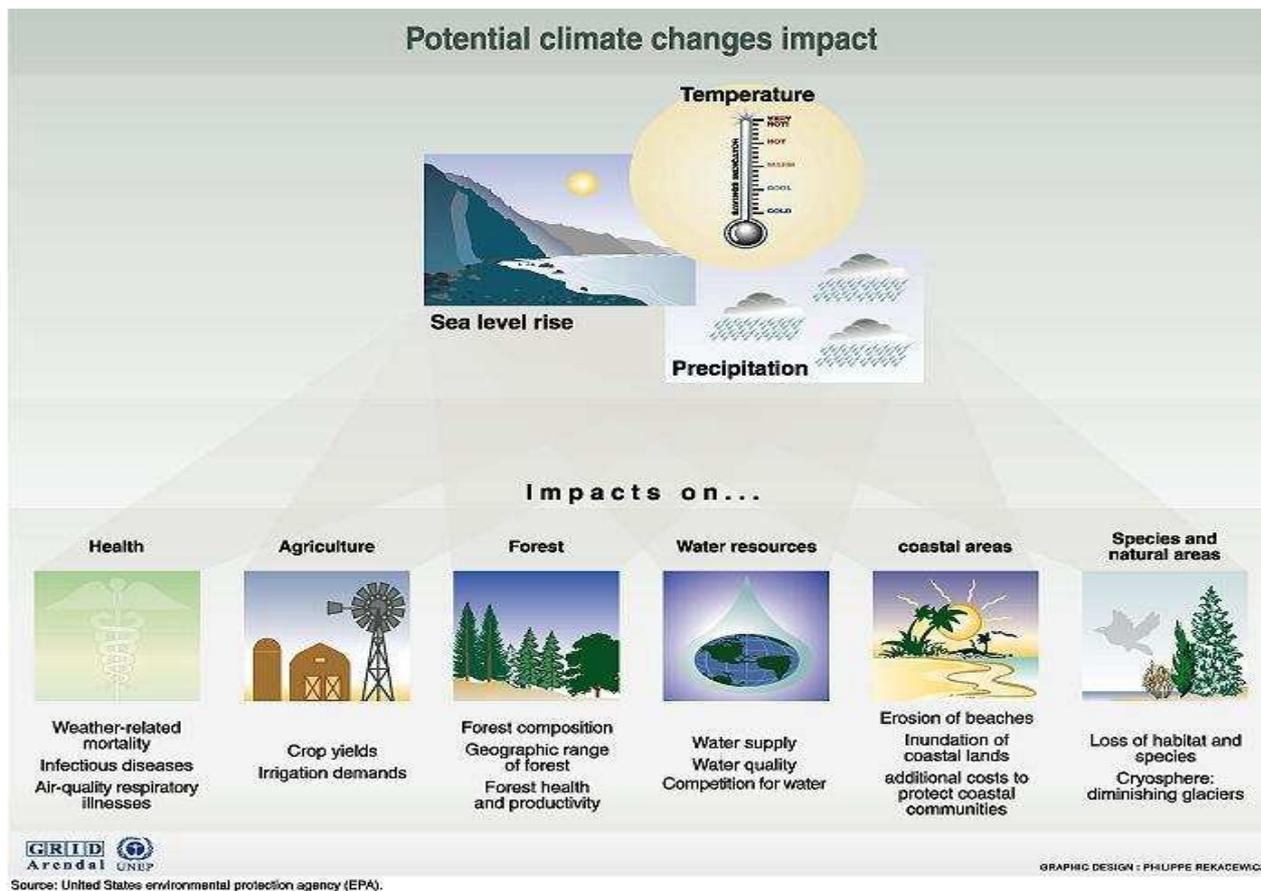


Fig. 1. Global potential climate change impact

These measurements are only meaningful if they are anchored well to very long-term, stable, internationally agreed and recognized, global measurement standards, i.e., standards that must themselves be linked to the unchanging fundamental constants of nature. It requires regular calibrations and international comparisons, not only in the field of physical measurements but also in the field of measurements in chemistry and close links to the world's NMI to provide SI standards [2].

OIML have developed a number of International Recommendations for instruments measuring organic and metal pollutants, pesticides and toxic substances and automobile emissions [3]. The work ISO Strategic Plan "Standards for a sustainable world" for 2005–2010 is comprehensive and ISO's International Standards and deliverables support for all mains field for a sustainable development: economical, *environmental* and social [4].

The first joint ISO International Standard/OIML International Recommendation will soon be published as ISO 3930/OIML R99, to replace the former and separate publications of both Organizations. The joint publication will contain metrological performance requirements applicable to instruments for measuring vehicle exhaust emissions as well as test procedures. It is not the first time that ISO and the OIML have produced common publications.

It is fostered and expected that cooperation will increase and will not be limited to the aforementioned fields, but will

be extended to cover all written standards in which traceability and measurement standards, are referenced, in particular also embracing measurements in environmental laboratory. It is highly desirable that the type of collaboration among the BIPM and the ISO, if appropriate, become additionally established at the regional level among the regional metrological organization and the regional standardization bodies and also at the national level among the NMI and the national standardization bodies.

In Table 1 new main tasks of international metrological, standardization and environmental organizations are shown.

On 1997 the Climate Technology Initiative (CTI) and the ISO issued a Joint Statement concerning the potential contribution of international standards to the ongoing international discussions concerning global CC. This statement is consistent with Kyoto Protocol (KP) to the UNFCCC. The ISO series 14000 do provide a framework for analyzing, managing, verifying and communicating a wide range of environmental aspects, including those relating to CC. ISO TC 207 established a Climate Technology Task Force (CTTF) to review the application of the ISO series 14000 [5] to the issue of global CC. ISO's goal in developing the standards is to provide a set of unambiguous and verifiable requirements or specifications to support organizations and proponents of GHG emission reduction projects.

ISO 14001 [6] calls for: the identification of the environmental aspects of the organization's business activities, the establishment of objectives and targets to

Table 1. New main tasks of International metrological (standardization) and environmental organization

International metrological (standardization) organization		International environmental organization	
Organization	New tasks	Organization	New tasks
BIPM	<ul style="list-style-type: none"> - the development GHG reference standards and reference methods for measurement of GHG; - the development and implementation of high-accuracy methods for the comparison of GHG standard provide by NMIs. 	IPCC	<ul style="list-style-type: none"> - to marshal and assess scientific information on the subject; - the development of internationally accepted new methods for conducting national GHG emission inventories.
OIML	<ul style="list-style-type: none"> - the development a number of International Recommendations for instruments measuring pollutants and automobile emissions; - the development joint publication will contain metrological performance requirements applicable to measuring instruments (ISO/OIML). 	UNFCCC	<ul style="list-style-type: none"> - the development e-learning training programme for environmental experts includes separate general and sector-specific modules; - organising and conducting the training programme for technical experts by on-line via the Internet.
ISO	<ul style="list-style-type: none"> - the development International Standards for support of mains field for a sustainable development (ISO 14000 series – <i>environmental</i>); - the development joint publication will contain metrological performance requirements applicable to measuring instruments (ISO/OIML). 	WMO	<ul style="list-style-type: none"> - the development monitoring CC in GAW Programme; - provide reliable data for climate modelling.

manage the aspects which are considered to be the most significant; and monitoring and measurement framework to determine the progress the organization made against according its objectives and targets. A management systems approach, as outlined in the ISO series 14000, can be used to set and monitor objectives and targets set out in the KP [7].

In Table 2 some of the potential applications of ISO series 14000 to the implementation of KP are shown.

ISO 14021 [9] will provide specific principles for such claims to ensure accuracy and transparency and prevent deception, which have interest for organizations in making self-declarations about CC-related aspects of products and services.

ISO 14041 [10], the Life Cycle Inventory standard, can assist organizations in measuring GHG emissions and other environmental impacts. It may be used to establish a

baseline of GHG emissions for a product system to benchmark environmental improvements or to evaluate alternatives. ISO 14041 can be used to: develop quantitative inventories of the GHG emissions associated with a product system, develop quantitative inventories of the GHG emissions of the unit processes that make up a product system (e.g. electricity production, transportation), provide data and information to identify which unit processes have the greatest use of energy and the greatest emissions, identify energy efficiency improvement opportunities and other options to reduce GHG emissions [11].

The ISO 14064 standards [5] for GHG accounting and verification published on 2006 by ISO provide government and industry with an integrated set of tools for programmes aimed at reducing GHG emissions, as well as for emissions trading. ISO launched the development of ISO 14064 as a solution to the problems posed by the fact that governments,

Table 2. ISO standards for implementation of KP

Article of KP of UNFCCC	ISO standards
Article 2	The ISO 14000 Environmental Management System (EMS) and auditing standards may be applied in a number of ways to this article. Where an organization identifies energy usage as a significant aspect of an industrial or commercial process that gives rise to an associated significant environmental impact, i.e. GHG, the use of the EMS approach allows for the setting of objectives and targets to reduce GHG emissions within the framework of an environmental management programme. Once targets have been set, performance against them may be tracked using the monitoring and measurement frameworks within the EMS.
Article 3	Parties of UNFCCC agreeing to the KP could apply the guidance in ISO 14031 [8] to the evaluation of their performance in achieving quantified emission limitation and reduction commitments.
Article 6	An ISO 14001 EMS may be applied to Joint Implementation projects between Parties of UNFCCC under this article by providing a framework within which the baseline level of GHG emissions can be determined at the commencement of a project and progress can be tracked during the lifetime of a project. The use of this framework could enhance the independent verification of GHG emission reductions by expert review teams as part of the compliance process. Implementing ISO 14064 is intended to achieve the following benefits: promote consistency, transparency and credibility in GHG quantification, monitoring, reporting and verification; enable organizations to identify and manage GHG-related liabilities, assets and risks; and facilitate the trade of GHG allowances or credits, and support the design, development and implementation of comparable and consistent GHG schemes or programmes.
Article 12	The ISO 14000 EMS and auditing standards may be of assistance in the development and operation of the Clean Development Mechanism in a similar manner to the application of the standards for use within the framework of projects between Parties of UNFCCC under the KP.
Article 17	The ISO 14000 EMS and auditing standards may be of assistance in the development and operation of national, regional and international GHG Emissions Trading (in particular, in the verification, reporting and accountability).
Article 18	The ISO 14000 auditing standards can provide a basis for the development of compliance auditing processes and reporting structures under the KP.

business corporations and voluntary initiatives were using a number of approaches to account for organization- and project-level GHG emissions and removals with no generally accepted validation or verification protocols [11].

3. MONITORING OF GLOBAL CLIMATE CHANGE

If governments and the international community are to take the most appropriate action on CC they will need to base their decisions on data that are accurate, consistent and internationally comparable.

Since 1994 governments have therefore invested significant time and resources into the preparation, collection and validation of data on GHG emissions, and the Conference of the Parties of UNFCCC has made determined efforts to improve the quality and consistency of the data and has prepared guidelines for reporting.

In order to monitor global CC and provide reliable data for climate modeling, a Global Atmospheric Watch (GAW) programme has been put in place by the WMO. These are measurement points spread all over the world that monitor the different parameters (wave heights, temperature, GHG, ozone etc) over very long periods.

The World Data Centre for GHG (WDCGG) is established in Japan under GAW programme to collect, archive and provide data for GHG in the atmosphere and ocean, measured under GAW and other programmes. Data also include information on site environment, measurement procedures, and calibration techniques. Global and integrated analyses used to monitor global changes in concentrations of GHG have become tasks of the WDCGG.

295 stations in 65 countries (Europe – 117 stations in 31 countries; North/Central America – 62/6 etc) and 29 mobile stations have contributed observational data for GHG to the WDCGG (March 2005 data). 139 stations have contributed observational data for CO₂, 123 – CH₄, 40 – N₂O, 80 – CO, 45 – NO₂, 48 – S₂O. The measurement systems are fully automated. In some cases multiple measurements in a single location are used [12, 13].

Under GAW programme, World Calibration Centers (WCC) are responsible for maintaining calibration standards for certain species, establishing instrument calibrations and providing training to the stations. A Reference Standards designated for each species to be used for all GAW measurements of that species.

Japan Center for Global Environmental Research of the National Institute for Environmental Studies (CGER/NIES) has been establishing series of NIES standards for GHG. In Table 3 using measurement methods of GHG and NIES scales are shown.

4. E-LEARNING FOR ENVIRONMENTAL TECHNICAL EXPERTS

The Secretariat of the UNFCCC coordinates the technical reviews of GHG inventories from Parties included

in Annex I to the Convention. The reviews are conducted with help of international expert review teams (ERT).

To manage and integrate the increasingly large and regular flows of data, Secretariat of the UNFCCC has developed a GHG Information System that serves as the basis for the provision of information to the Conference of the Parties and for various types of data analysis. This system, which now contains detailed inventory information for more than 140 Parties of UNFCCC at different levels of aggregation, is updated twice a year and is continuously supported and enhanced to ensure that it offers reliable data suitable for a wide range of analyses.

The Secretariat of the UNFCCC with co-operation Earth Council Learning Center (ECLC) has organized and conducts the GHG Inventory Review Training Program for experts by on-line via the Internet during some period, followed by a seminar (including a final examination). ECLC offers e-learning courses and programs on global importance such as CC, global trade, biodiversity, and sustainability (UNFCCC etc). Web-based e-learning CC course include possibility of interacting online with inventory review expert and other trainees participating in the study. At the end of the training programme successful trainees receive a certificate from the UNFCCC Secretariat.

The training programme includes separate general and sector-specific modules, which cover specific aspects of the review process and IPCC Guidance [14, 15]. The aim of modules is to introduce experts to the general procedures and requirements for reviewing GHG inventories under the UNFCCC and to cross-cutting aspects of IPCC guidance related to the review process.

The section of the training “Review Checks” focuses on ten kinds of review checks for the overall inventory and for the IPCC Good Practice [15] cross-cutting elements. These checks especially useful for the Generalists on review team and besides included: recalculation; methodological and data choice; quality assurance/quality control; uncertainty; verification [16].

On Fig. 2 the main steps of Web-based e-learning training for technical experts of UNFCCC are shown.

Training CC Program ECLC and UNFCCC have next main steps: on-line learning via the Internet; participation in a training seminar; final examination; receive a Certificate; participation in expert review teams; developing drafts of international documents.

Table 3. Measurement methods of GHG and NIES scales

Measurement methods	GHG	NIES Scale	Range
Non-depressive infrared analyser	CO ₂	NIES-95 NIES-00	320–390 ppm
Gas chromatograph equipped	CH ₄ N ₂ O CO	NIES-94 NIES-96 96Wk, NIES-95	1.2–2.5 ppm 250–400 ppm 70–350 ppm
Mo conversion/ Chemiluminescence	NO, NO ₂	-	-
Ultraviolet pulsed fluorescence	SO ₂	-	-

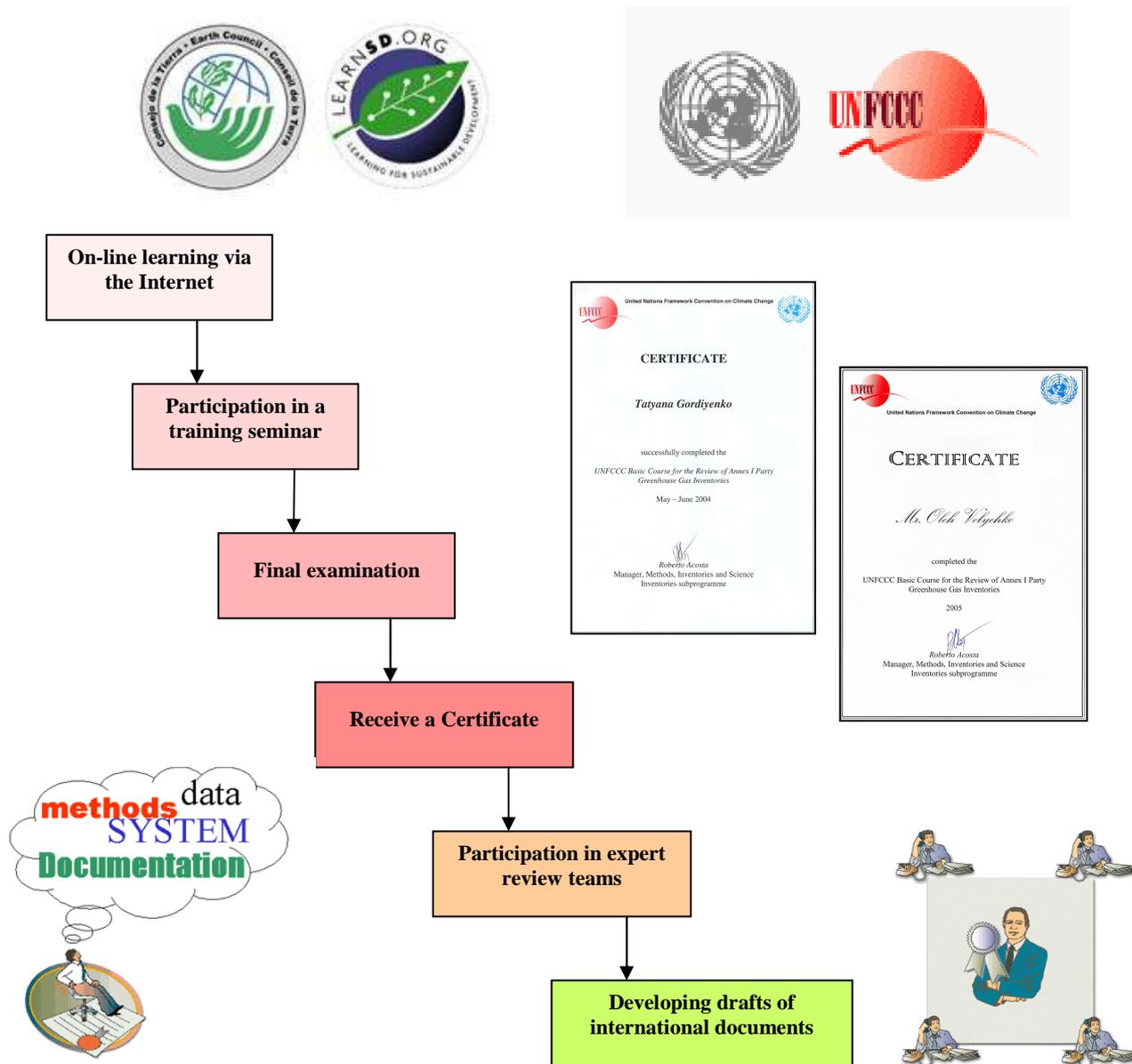


Fig. 2. The main steps of e-learning training for experts of UNFCCC

The following points are fundamentals for GHG inventory: methods; data; national inventory process (system); transparency (documentation). On Fig. 3 main points of e-learning training for technical experts of UNFCCC are shown.

5. CONCLUSION

1. International environmental organizations (IPCC, UNFCCC, WMO) need support of international metrological organizations for solving global environmental problems.

2. International metrological and standardization organizations (BIPM, OIML, ISO) have many new tasks now, including metrological support of environmental monitoring, which are solved with NMI together.

3. International Standards ISO series 14000 can be used to set and to monitor objectives and targets set out in the Kyoto Protocol to the UNFCCC.

4. The strategy combined Web-bases e-learning courses with attendance-bases workshops or seminars to a powerful approach, which must used by international organizations in different fields of knowledge.

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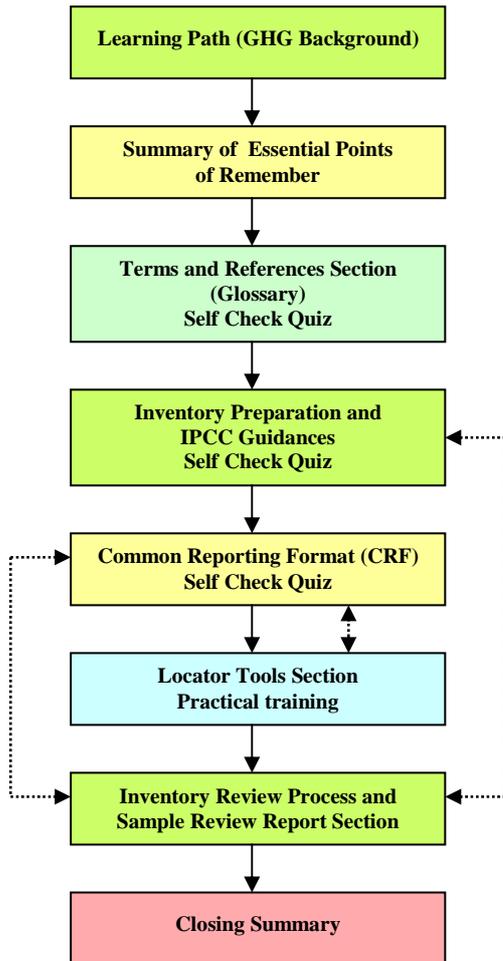


Fig. 3. The main points of e-learning training for technical experts of UNFCCC

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