



**Environmental Engineering (EE);
Guidelines for Assessing the Environmental Impact of
Artificial Intelligence systems**

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Reference

DES/EE-EEPS77

Keywords

artificial intelligence, green-house gas emission,
LCA

ETSI

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Sample Document

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Foreword

This final draft ETSI Standard (ES) has been produced by ETSI Technical Committee Environmental Engineering (EE), and is now submitted for the ETSI Vote phase of the ETSI Membership Approval Procedure (MAP).

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

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Executive summary

The present document provides methodology for assessing environmental impact of AI systems. The methodology is based on Life Cycle Assessment (LCA) methodology standardized in Recommendation ITU-T L.1410 / ETSI ES 203 199 [1] and method for enabling effects for other sectors standardized in Recommendation ITU-T L.1480 [2]. The guidance in the present document focuses on AI system specific aspects which need to be taken into account in the assessment. Aggregation of AI impact on international, national or regional level is not part of the present document.

Introduction

The present document was developed jointly by ETSI TC EE and ITU-T Study Group 5. It was published respectively by ITU as Recommendation ITU-T L.1801 [i.14] and ETSI as ETSI ES 204 135 (the present document), which are equivalent in technical content.

As the demand for Artificial Intelligence (AI) technology increases, so does the environmental pressure it imposes. The environmental impact associated with AI, driven by significant energy costs, has become a critical issue that needs to be addressed for the future development of AI.

The present document provides a holistic framework for evaluating the environmental impact of AI systems, covering direct and indirect impacts, assessment, and mitigation strategies. The methods in Recommendation ITU-T L.1410 / ETSI ES 203 199 [1] and Recommendation ITU-T L.1480 [2] provide the baseline for this framework. This standard is built on those methods and provides additional guidance to the practitioner on how to apply the methods for AI systems.

For minimizing and mitigating the environmental impact of AI systems, it is important to take a life cycle approach understanding the whole life cycle of AI systems. For this, Life Cycle Assessment (LCA) is the most widely used and best available methodology for assessing the environmental impact, including GHG emissions. Therefore, Recommendation ITU-T L.1410 / ETSI ES 203 199 [1] has been taken as the baseline for this framework.

The present document can further help relevant parties ensure that current actions are effective in addressing the evolving climate change over the long term. The present document provides a focused framework for evaluating whether it is environmentally beneficial, from an environmental impact perspective, to use AI technology compared to not using AI or comparing the environmental impact of two AI systems. This assessment takes into account the full life cycle of AI systems, including the use of the AI system. It can help AI users choose a system or solution that will have less impact on the environment. The methodology followed in the present document does not presume a result of the assessment of the use of AI, which may either contribute to or undermine global sustainability.

AI and the Environment report from ITU [i.12] describes the earlier work in this area and contains references to ITU documentation and the outcome from FG AI4EE group. This report also includes possible mitigation actions for reducing the environmental impact of AI.

Annex A of the present document describes other initiatives on this topic.

1 Scope

The present document provides guidelines for assessing the environmental impact of Artificial Intelligence (AI) systems objectively and transparently. The scope includes:

- Overview of the impacts of AI systems on the environment.
- Framework for evaluating the environmental impact of AI.

The guidelines in the present document are based on the Life Cycle Assessment (LCA) methodology standardized in Recommendation ITU-T L.1410 / ETSI ES 203 199 [1] and method for enabling effects for other sectors standardized in Recommendation ITU-T L.1480 [2].

The present document does not cover the assessment of the environmental impact of AI systems aggregated at worldwide or national level, which may be covered in the future in another standard.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found in the [ETSI docbox](#).

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long-term validity.

The following referenced documents are necessary for the application of the present document.

- [1] [Recommendation ITU-T L.1410 \(2024\)](#) / [ETSI ES 203 199](#): "Methodology for environmental life cycle assessments of information and communication technology goods, networks and services".
- [2] [Recommendation ITU-T L.1480](#): "Enabling the Net Zero transition - Assessing how the use of information and communication technology solutions impacts greenhouse gas emissions of other sectors".

NOTE: At the time of drafting the present document, the equivalent ETSI ES 204 087 is under development and is expected to be submitted for Member Vote shortly.

2.2 Informative references

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The following referenced documents may be useful in implementing an ETSI deliverable or add to the reader's understanding, but are not required for conformance to the present document.

- [i.1] [Regulation \(EU\) 2024/1689](#) of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence and amending Regulations (EC) No 300/2008, (EU) No 167/2013, (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797 and (EU) 2020/1828 (Artificial Intelligence Act).

- [i.2] [ISO 14040:2006](#): "Environmental management — Life cycle assessment — Principles and framework".
- [i.3] [ISO/IEC 22989:2022](#): "Information technology — Artificial intelligence — Artificial intelligence concepts and terminology".
- [i.4] [ISO/IEC 5338: 2023](#): "Information technology — Artificial intelligence — AI system life cycle processes".
- [i.5] ETSI EN 303 800-2 / Recommendation ITU-T L.1025: "Environmental Engineering (EE); Assessment of material efficiency of ICT network infrastructure goods (circular economy); Part 2: Server and data storage product secure data deletion functionality".
- [i.6] Farzan, M.; Kallio, S.: "[A transparent and standards-based way to assess the environmental impact of AI systems](#)", 2024.
- [i.7] [Recommendation ITU-T L.1420 \(2012\)](#): "Methodology for energy consumption and greenhouse gas emissions impact assessment of information and communication technologies in organizations".
- [i.8] GHG Protocol: "[A Corporate Accounting and Reporting Standard](#)".
- [i.9] ILCD Handbook: "[General guide for Life Cycle Assessment - Detailed guidance](#)", 2010.
- [i.10] ISO/IEC 22989:2022/DAmD 1: "Information technology — Artificial intelligence — Artificial intelligence concepts and terminology", draft Amendment 1.
- [i.11] ISO/IEC 5230:2020: "Information technology — OpenChain Specification".
- [i.12] ITU: "[AI and the Environment - 2024 Report](#)".
- [i.13] IEA: "[Energy and AI](#)", April 2025.
- [i.14] [Recommendation ITU-T L.1801 \(2026\)](#): "Guidelines for assessing the environmental impact of artificial intelligence systems".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

Artificial Intelligence (AI): <discipline> research and development of mechanisms and applications of AI systems

NOTE 1: Research and development can take place across any number of fields such as computer science, data science, humanities, mathematics and natural sciences.

NOTE 2: Source: ISO/IEC 22989:2022 [i.3].

AI agent: automated entity that senses and responds to its environment and takes actions to achieve its goals

NOTE: Source: ISO/IEC 22989:2022 [i.3].

AI system: engineered system that generates outputs such as content, forecasts, recommendations or decisions for a given set of human-defined objectives

NOTE 1: The engineered system can use various techniques and approaches related to artificial intelligence to develop a model to represent data, knowledge, processes, etc. which can be used to conduct tasks.

NOTE 2: AI systems are designed to operate with varying levels of automation.

NOTE 3: Source: ISO/IEC 22989:2022 [i.3].

automation: process or system that, under specified conditions, functions without human intervention

NOTE: Modified from Source: ISO/IEC 22989:2022 [i.3].

continual learning: incremental training of an AI system that takes place on an ongoing basis during the operation phase of the AI system life cycle

NOTE: Source: ISO/IEC 22989:2022 [i.3].

data sanitization: process of deliberately and irreversibly deleting or destroying any data stored in memory on a device to render it unrecoverable

NOTE: Source: ETSI EN 303 800-2 [i.5].

deep learning, deep neural network learning: <artificial intelligence> approach to creating rich hierarchical representations through the training of neural networks with many hidden layers

NOTE 1: Deep learning is a subset of ML.

NOTE 2: Source: ISO/IEC 22989:2022 [i.3].

embodied emissions: lifecycle(s) Greenhouse Gas (GHG) emissions from the following life cycle stages: raw material acquisition, production and end-of-life treatment

NOTE 1: Each life cycle includes transportation as generic process.

NOTE 2: The Greenhouse Gas (GHG) emissions include all life cycle stages other than the use stage.

NOTE 3: Source: ETSI ES 203 199 [1].

environmental impact: impact including positive and negative aspects on the environment

NOTE: Source: ETSI ES 203 199 [1].

expert system: AI system that accumulates, combines and encapsulates knowledge provided by a human expert or experts in a specific domain to infer solutions to problems

NOTE: Source: ISO/IEC 22989:2022 [i.3].

foundation model: AI model that can be used for or readily adapted to a wide range of tasks in one or more domains

NOTE 1: A typical way to build a foundation model is to apply supervised machine learning or self-supervised machine learning on a large amount of data.

NOTE 2: A foundation model can be used as part of various applications, tasks and use cases, which do not necessarily involve generative AI.

NOTE 3: Source: ISO/IEC 22989:2022/DAmD 1 [i.10].

functional unit: quantified performance of a product system for use as a reference unit

NOTE: Source: ISO 14040:2006 [i.2].

general AI, AGI, artificial general intelligence: type of AI system that addresses a broad range of tasks with a satisfactory level of performance

NOTE 1: Compared to narrow AI.

NOTE 2: AGI is often used in a stronger sense, meaning systems that not only can perform a wide variety of tasks, but all tasks that a human can perform.

NOTE 3: Source: ISO/IEC 22989:2022 [i.3].

generative artificial intelligence system, generative AI system, GenAI system: AI system based on techniques and models that aim to generate new content

NOTE 1: Examples of generated content can include text, audio, code, video and image.