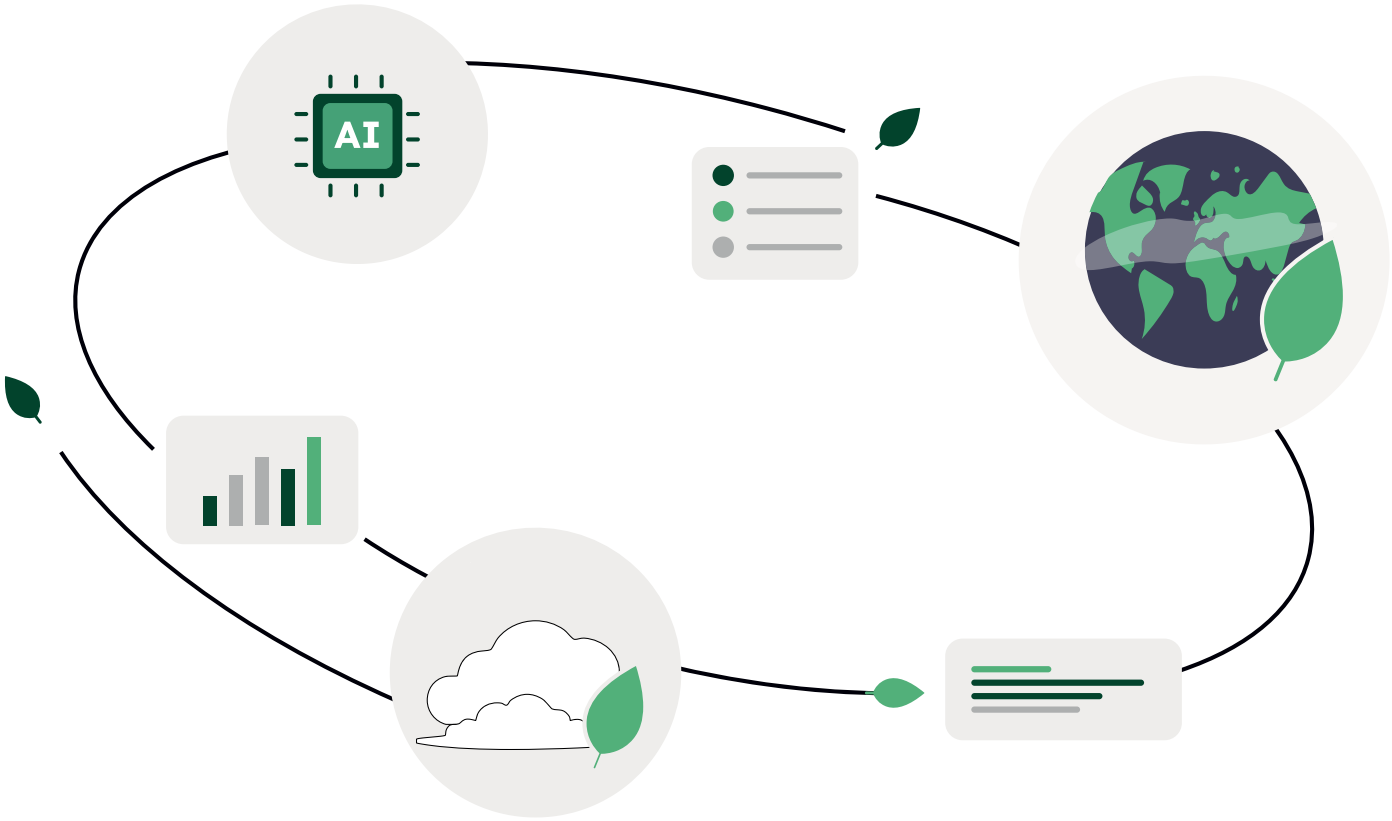
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WHITE PAPER

Evaluating the environmental impact of artificial intelligence

A state of the art of impact assessment methods and a comparison of existing tools

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Introduction

Artificial intelligence (AI), particularly generative AI (GenAI), is being integrated into a growing range of applications. This development is accompanied by increasing demand for computing infrastructure and electricity. The International Energy Agency estimates that global electricity consumption by data centers could reach around 945 TWh by 2030, against 485 TWh in 2025. AI is expected to be an important driver of this growth.
Understanding the environmental impacts associated with AI systems has therefore become increasingly important.

The **Life Cycle Assessment (LCA)** is a methodology that evaluates the environmental impacts of **all stages of a product's life cycle**:

- Raw material extraction
- Production
- Use
- Disposal

It is a comprehensive approach that considers **various environmental indicators** such as energy consumption, global warming potential, water

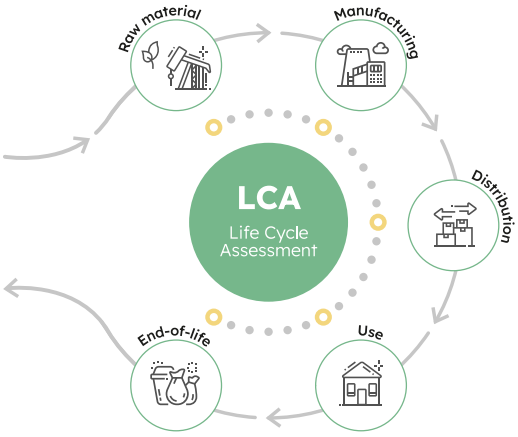


Figure 1 – Diagram of a product typical life cycle stages

This whitepaper gives an overview of the **methods and tools** used to assess the environmental impacts of large language models (LLMs) that are behind it. It aims to give a better understanding of the differences between them and identify the challenges that need to be addressed.

1. Presentation of LLM assessment from Resilio Database
2. Comparison with other assessment tools
3. AI project with Resilio & Partners to fill the knowledge gap



1. ResilioDB parametric modeling

ResilioDB is an environmental impact database focusing on digital equipment developed by Resilio. It contains, among others, a model for LLM impacts.

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ResilioDB accounts for both:

- **Training**, which develops the model, corresponding to **production** life cycle step
- **Inference**, which generates outputs in response to user requests, corresponding to **use** life cycle step.

On the associated compute, storage, network, and data-center infrastructure.

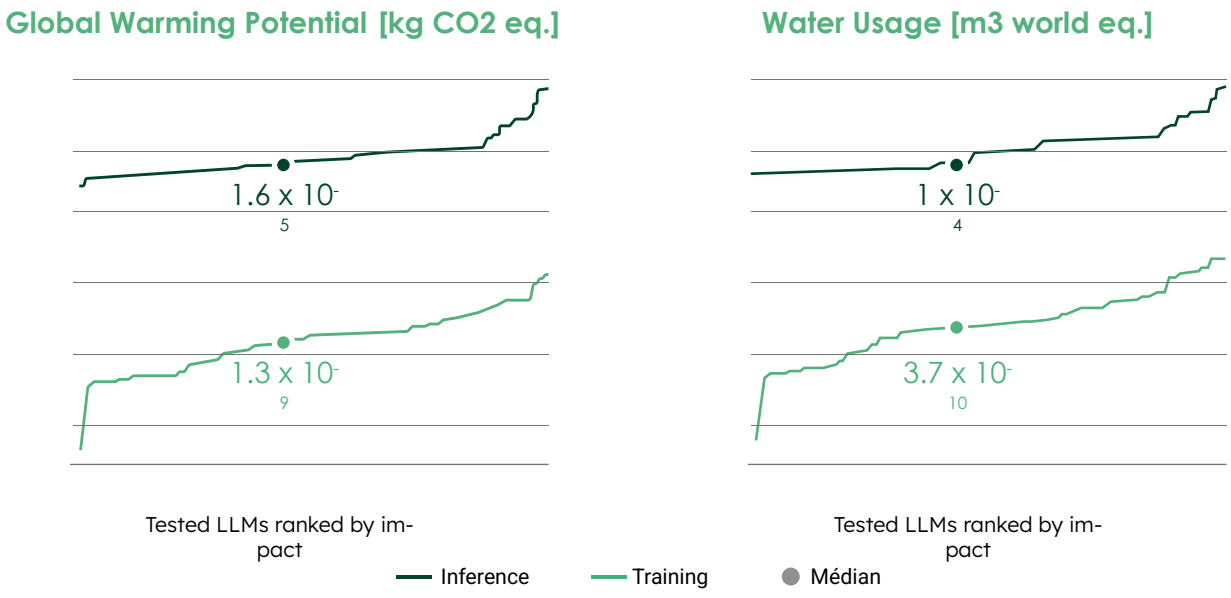
- And **considers** 16 environmental indicators, such as **Global Warming Potential** (GWP) and **Water Usage** (WU).

ResilioDB LLM assessment model



Resilio produced a first version of a parametric model based on 172 large language models (LLMs) from 5 service providers (Anthropic, Cohere, Google, Mistral AI, OpenAI). It considers a **base scenario** of **400 input** and **400 output tokens** per request.

For one request, the impact associated to training ranges from 10^{-12} to 10^{-7} kg CO_2 eq. with a median at 10^{-9} kg CO_2 eq. For inference, the median goes to 10^{-5} kg CO_2 eq. under the reference scenario. Regarding water usage, impact represents an order of magnitude equal to 10^{-10} m^3 for training and 10^{-4} m^3 for inference.



According to this first parametric LCA model, the **absolute impacts associated to the inference phase are greater relatively to those of the training phase across all LLMs**. This is due to the fact that the training is amortized by the very large number of tokens generated during the lifes-

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Impact increases with LLM size according to the ResilioDB mo-

- Among the LLMs we assessed, training impact grows **faster** than model size (i.e. the number of parameters in the LLM), while inference grows more slowly than size but still grows. The following table illustrates the trend with arbitrary values.

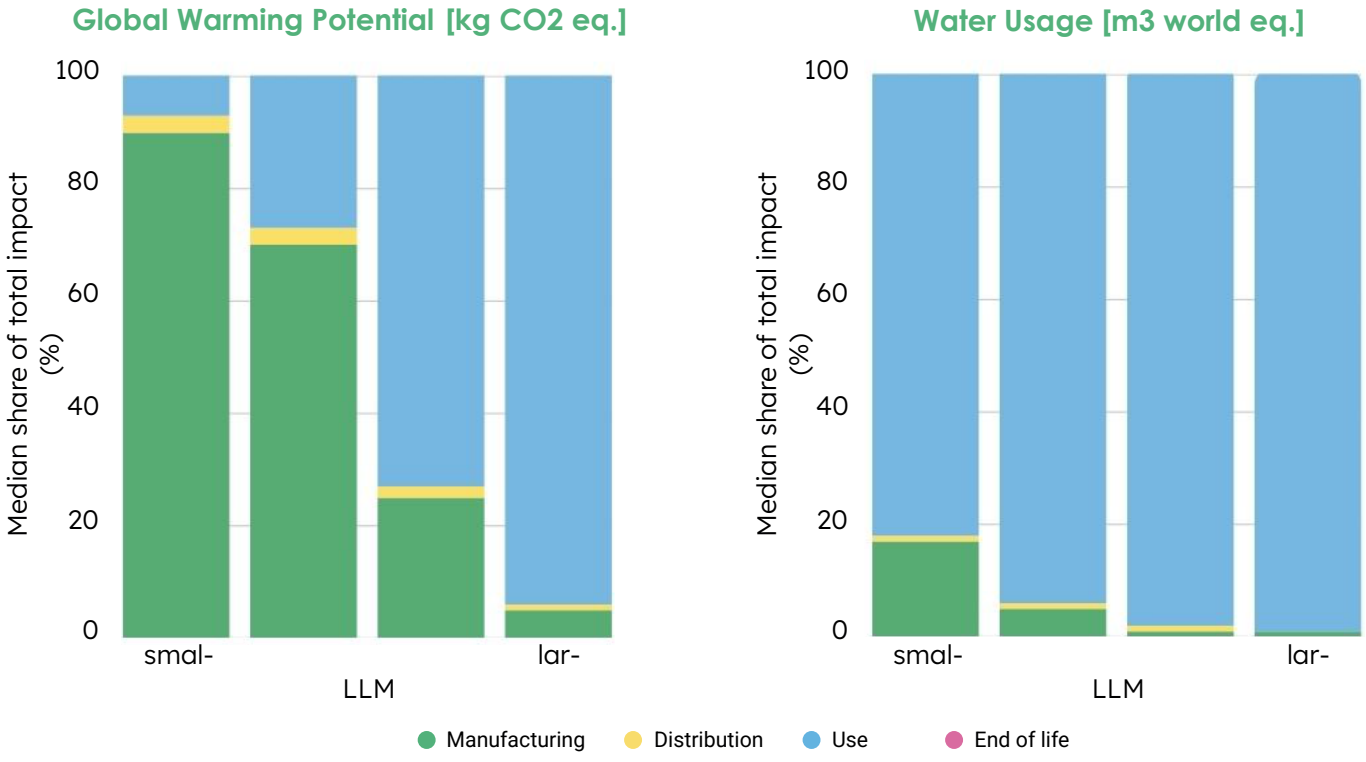
Impact GWP	Models size	Training	Inference
Trend	+1%	+1,22%	+0,66%
Example (artificial baseline)	10B parameters	100	100
	20B parameters	233	158
	100B parameters	1663	453

×2 ×10

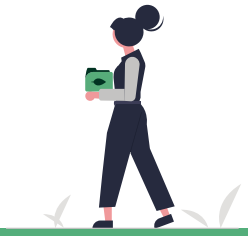
Water use follows the same logic: training impacts grow faster than model size, and inference impacts grow almost in direct proportion to it.

Contribution to life cycle phase according to model size:

- GWP impact shifts from manufacturing to use with model size increase
- WU impact occurs mostly during use phase, with a low influence of model size.



- **Therefore, model size is a relevant lever to reduce LLMs environmental impact.**



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Sensitivity to reference workload

To test how the base scenario is representative of different use cases, the **influence of changes in the reference workload** on the estimated impacts was also explored.
The key parameters of the model required to estimate environmental impacts are input and output tokens. Their respective influence on the impacts was assessed by estimating the impacts of **input intensive** and **output intensive** scenarios, with the following workloads:

Scenario	Input tokens	Output tokens
S1 : Input intensive	5.000	50
S2 : Reference workload	400	400
S3 : Output intensive	50	5.000

Overall, the absolute impacts are highly sensitive and positively linked to output tokens:

- The input intensive scenario with more input token and less output token shows reduced impacts compared to the reference workload.
- The output intensive scenario with less input token and more output token shows 12.5-fold increased impacts compared to the reference workload.

Difference in the impact compared with ResilioDB LLM model baseline scenario:

	GWP	WU
Input intensive	x0.15	x0.13
Output intensive	**x12.5**	**x12.5**

2. Comparison of existing impact assessment calculators

Only few assessment tools are based on LCA methodology. To our knowledge, so far one can find:

1. Mistral AI — **Mistral study** — By Carbone4 & ADEME
2. Sustainable AI Group — **CLEER** — By Sustainable AI Group (SAIG)
3. EcoLogits — **Ecologits open-source tool** — By CodeCarbon
4. database. — **ResilioDB LLM model** — By Resilio

These tools cover **different scopes, methodologies and indicators,** which are gathered in the following table. These differences explain part of the large range of impact values.

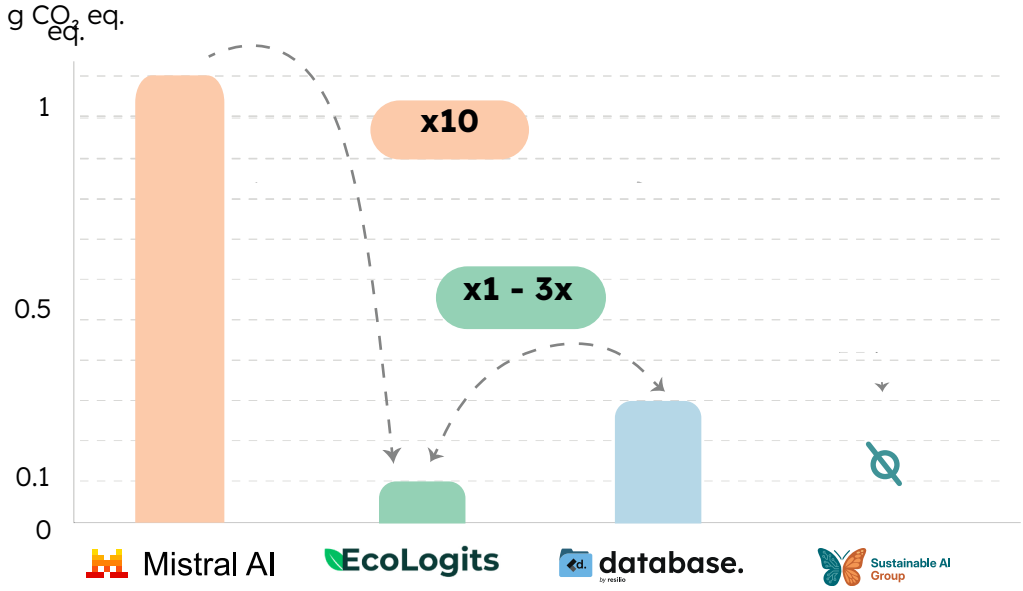
	Mistral AI	Sustainable AI Group	EcoLogits	database. by resilio
Model coverage	• Mistral Large3 • Medium3 • Ministral3B	• Multiple models • specifically closed models	Multiple LLM providers and models	Multiple LLM providers and models
Assessment scope	• Training • Inference	Inference only	Inference only	• Training • inference
Life cycle scope	• Hardware embodied impacts • Operational impacts	• Hardware embodied impacts • Operational impacts	• Hardware embodied impacts • Operational impacts	• Manufacturing • Distribution • Use • End-of-life
Indicators	• Energy • GWP • WCF • ADP	• Energy • GWP • WCF	• Energy • GWP • ADPe • PE • WCF	16 EF 3.1 impact categories
Methodology	LCA using provider data	• Empirical benchmarking • proxy-based estimation	Bottom-up LCA model	Parametric LCA model
Main inputs	• Actual model • Operational data	Number and type of tokens	• Model output token usage • provider information	• Model characteristics • Input/output token usage • Infrastructure • Operational settings
Output level	• Model-level cumulative impacts • per inference request	Per token	Per inference request	Per inference workload, with training/inference breakdown
Result example: Mistral Large (or Large 2)	• Mistral Large 2 • **1.1 g CO2e** • **50 mL water**	**Mistral model not available**	• Mistral Large • **0.121 g CO2e** • **6.66 mL water**	• Mistral Large-2411 • **0.276 g CO2e** • **73.92 mL water**

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3. A 10x gap between lab and real-data results

For similar AI model - Mistral Large - and a comparable use case, existing calculators yield widely varying results due to differences in data sources, scopes, and methodologies.

Environmental impact on GWP of Mistral LLM according to different assessment tools



ResilioDB gives **1x to 3x** Ecologits impact depending on indicator

There is a **10-fold difference** between EcoLogits and Mistral

Resilio is now working with **tech providers** (Scaleway, Infomaniak, Exoscale, Meta, etc.) to explain these disparities in environmental impacts.

4. Our proposal: a platform to assess AI environmental impact

Our goal: **provide a parametric model on the impacts of AI using real data.**

Research | **Stakeholder engagement**

Paris Ambassy
Novembre 2026

GenevaAI Summit
June 2027

World Economic Forum
January 2027

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