

IA et énergie: la lumière restera-t-elle allumée ?

FRDO-CFDD conference “AI in balance”

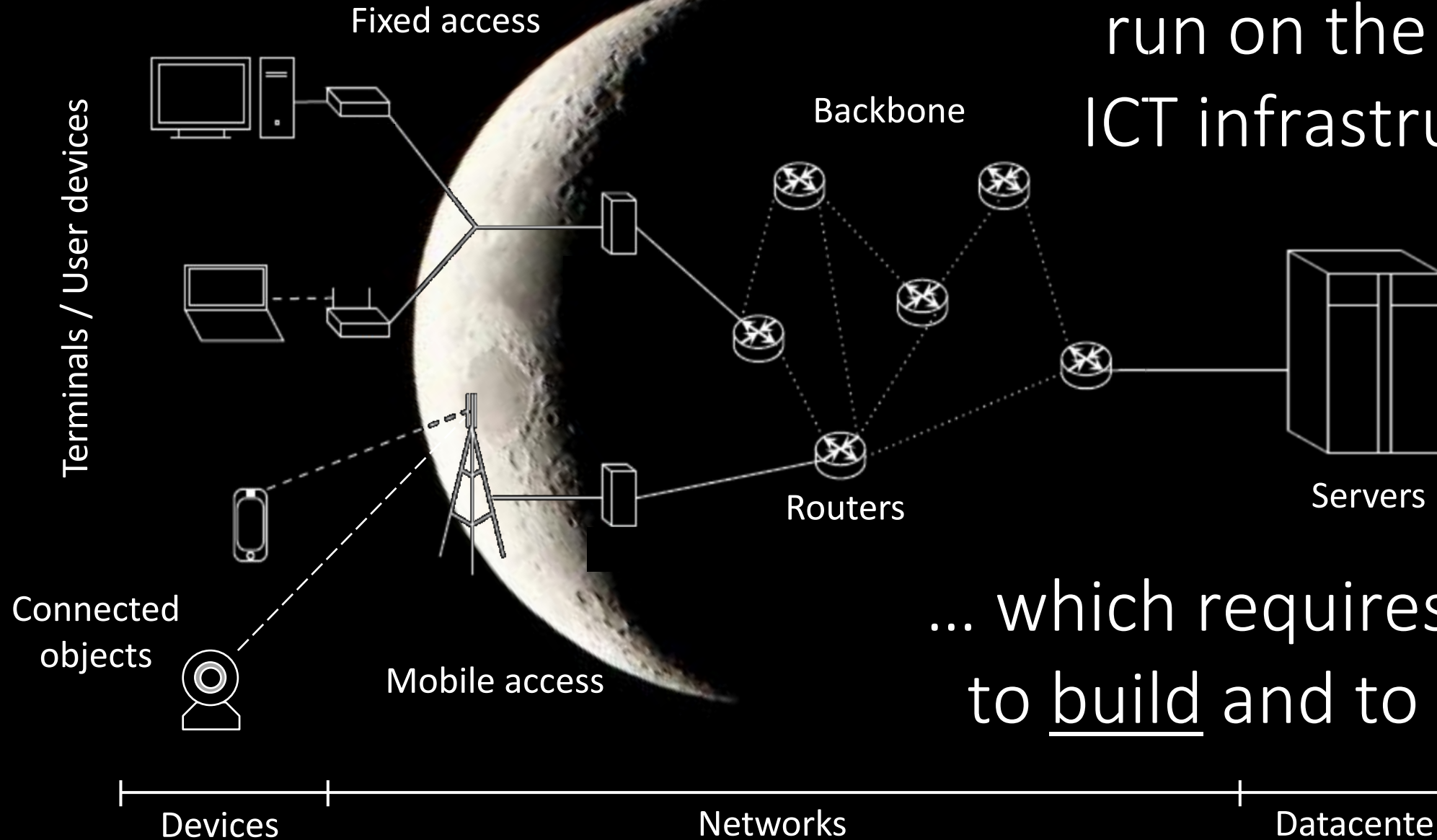
[Prof. David Bol](#)

*Electronic circuits and systems (ECS) group,
ICTEAM institute, UCLouvain*

October 6, 2026



Digital and AI services
run on the physical
ICT infrastructure ...



... which requires energy
to build and to operate

Current trend in semiconductor production

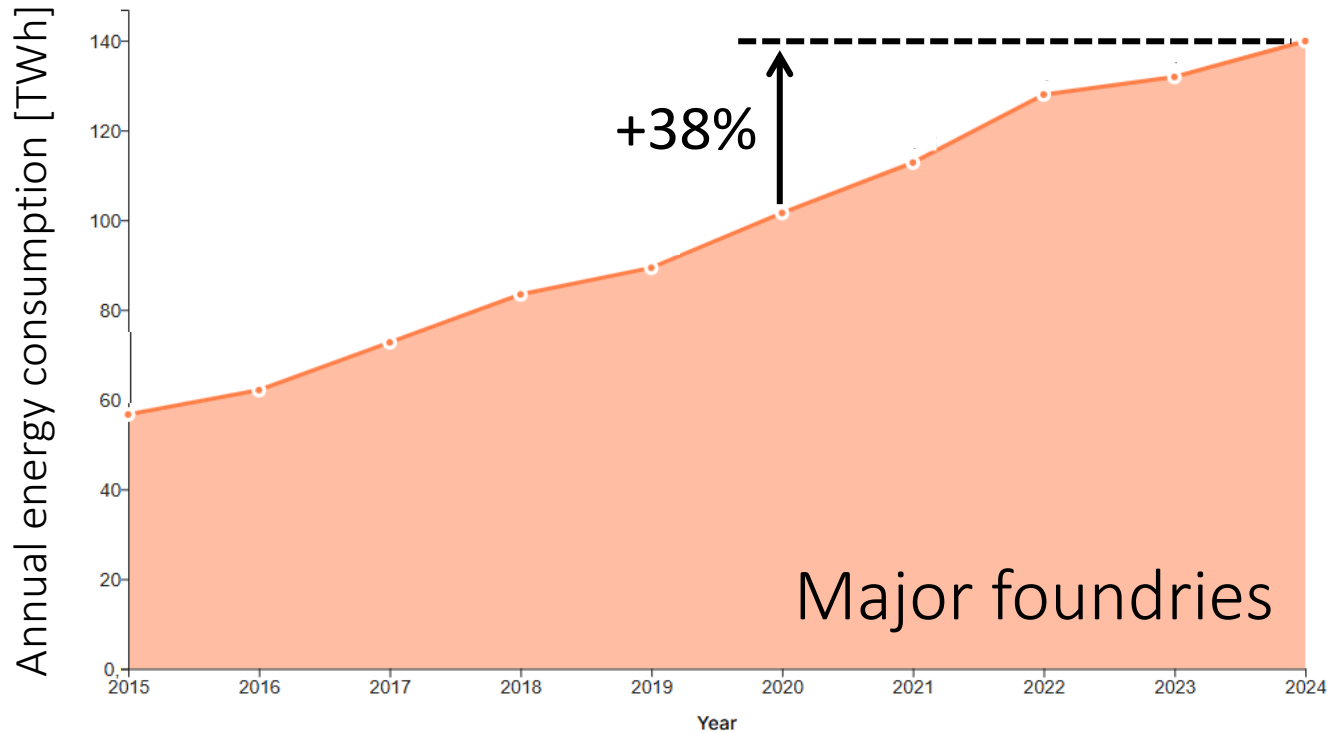
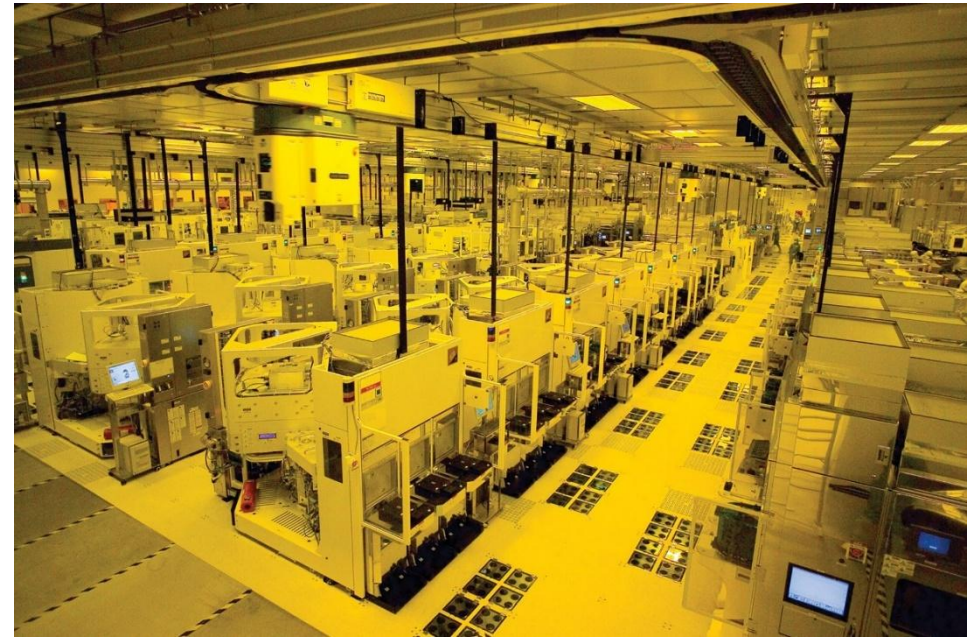


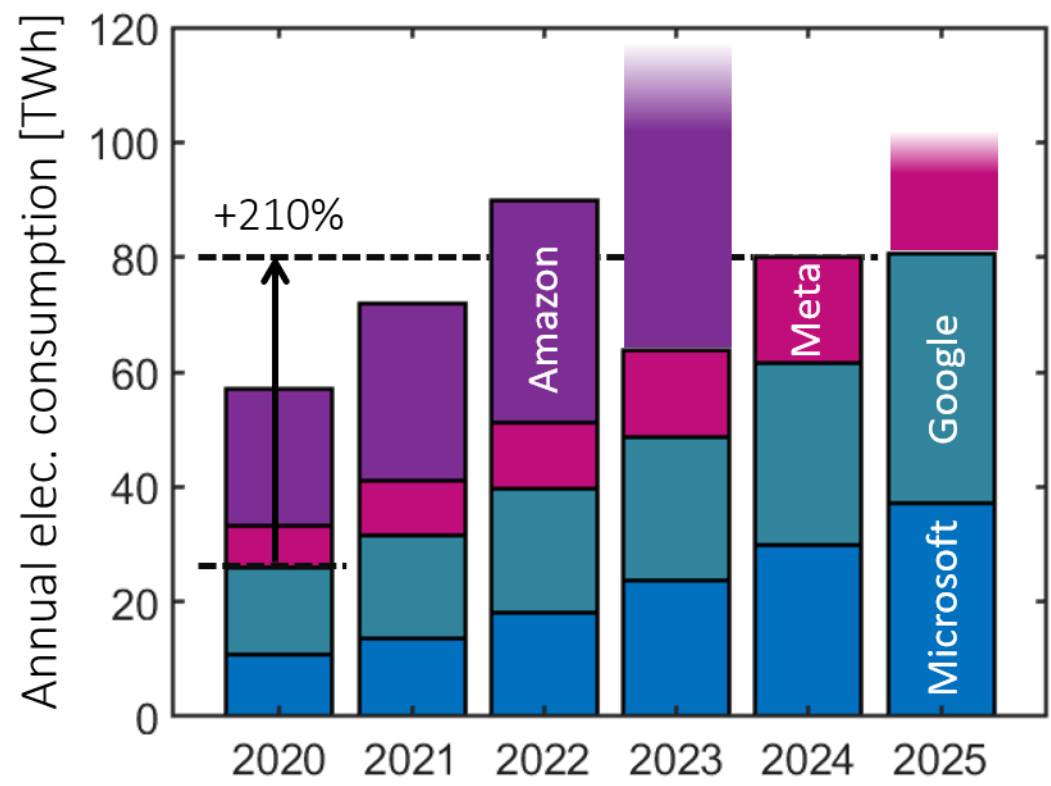
Illustration from Interface, « Semiconductor Emission Explorer » data brief

Data source: corporate sustainability and financial reports.



TSMC

Trend in hyperscale datacenters



Data source: corporate environmental sustainability reports.
Note: Amazon stopped reporting elec. in 2023.

- Global datacenter consumption [IEA, 2026] :
- 485 TWh evaluated in 2025 (2% electricity)
 - 833-1008 TWh predicted in 2030



*Ok, but AI can help
mitigating climate change, right ?*

Energy



Google Earth
27.8M tCO₂e



Nest thermostats
8.8M tCO₂e



Solar API
1.3M tCO₂e



Ignite Energy Access
280K tCO₂e

Transportation



Fuel-efficient routing
in Google Maps
3M tCO₂e



Alternative
route suggestions
in Google Maps
75K tCO₂e



Waymo
18K tCO₂



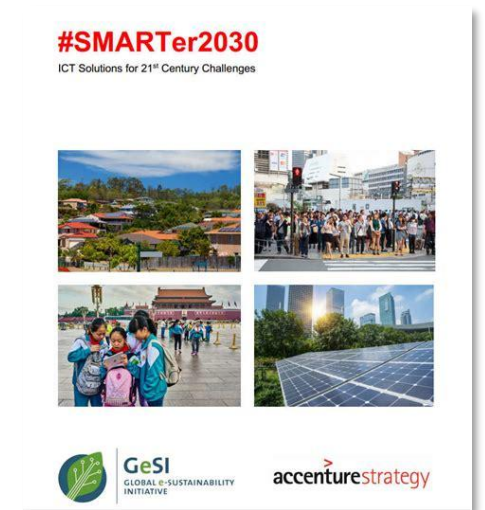
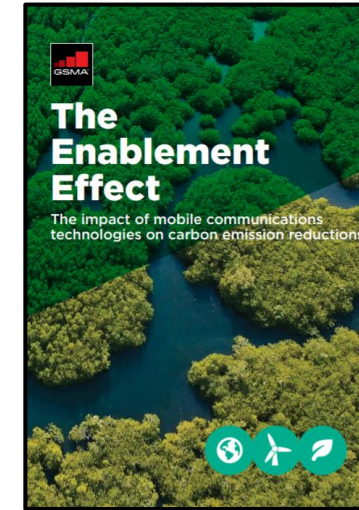
Green Light
13K tCO₂e



Contrails
3K tCO₂e

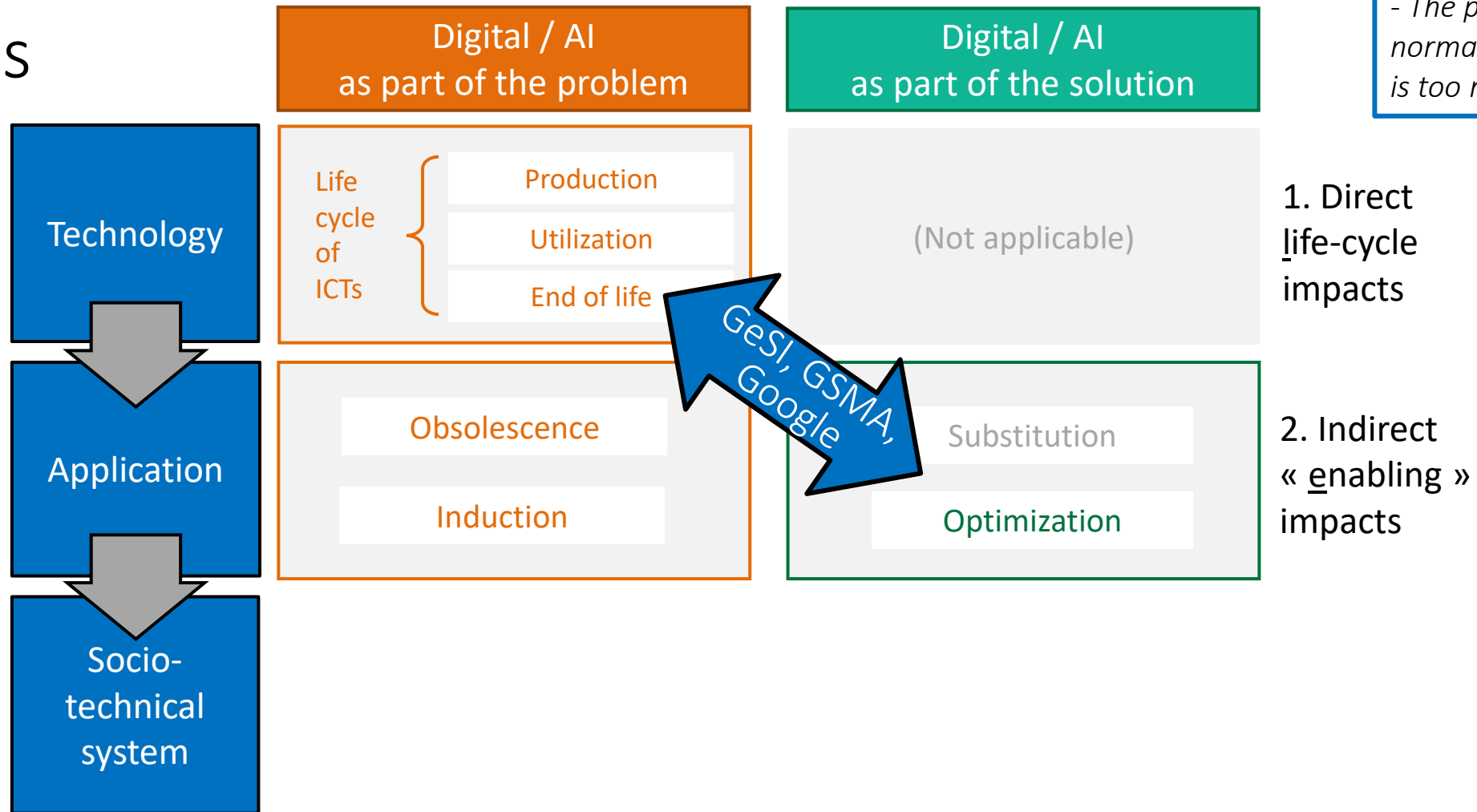
Avoided GHG emissions

- The historical claims for ICT:
 - *The 10:1 ratio [GSMA, The enablement effect]*
One tonne of CO₂e emitted by the mobile sector would avoid 10 tonnes of CO₂e in other sectors.
 - *The 20% GHG reduction [GeSI, SMARTer2030]*
Digitalization could reduce emissions in other sectors by up to 20% by 2030.
- Limitations of these studies:
 - Potential economic bias of the authors
 - Lack of transparency on the hypotheses
 - Extrapolation of test cases to different contexts
 - Limited scope:
only positive “enabling” impacts are studied



[A. Rasoldier, et al., « How realistic are claims about the benefits of using digital technologies for GHG emissions mitigation? », in LIMITS, 2022]
[G. Roussilhe, et al., « A long road ahead: a review of the state of knowledge of the environmental effects of digitization », in Current Opinions in Environmental Sustainability, 2023]

“LES” framework for the analysis of ICT environmental impacts



Disclaimers:

- It neglects the indirect impacts of production & end-of-life stages
- The problem/solution normative positioning is too restrictive

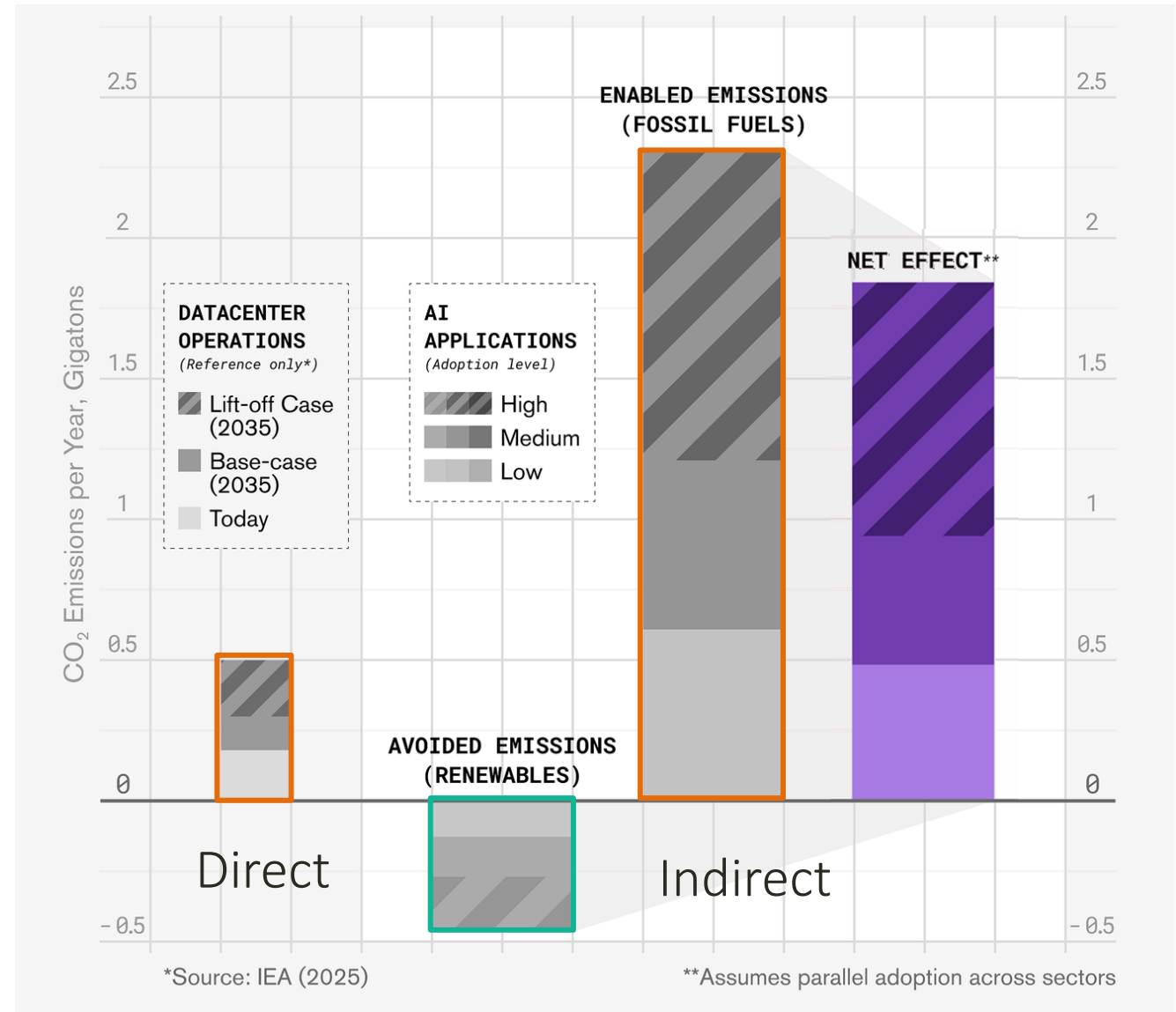
L. Hilty & B. Aebischer (ed.), « ICT for Sustainability: An Emerging Research Field » (Chap. 1), in *ICT Innovations for Sustainability*, Springer, 2015]

Induction effect example – « AI for brown »

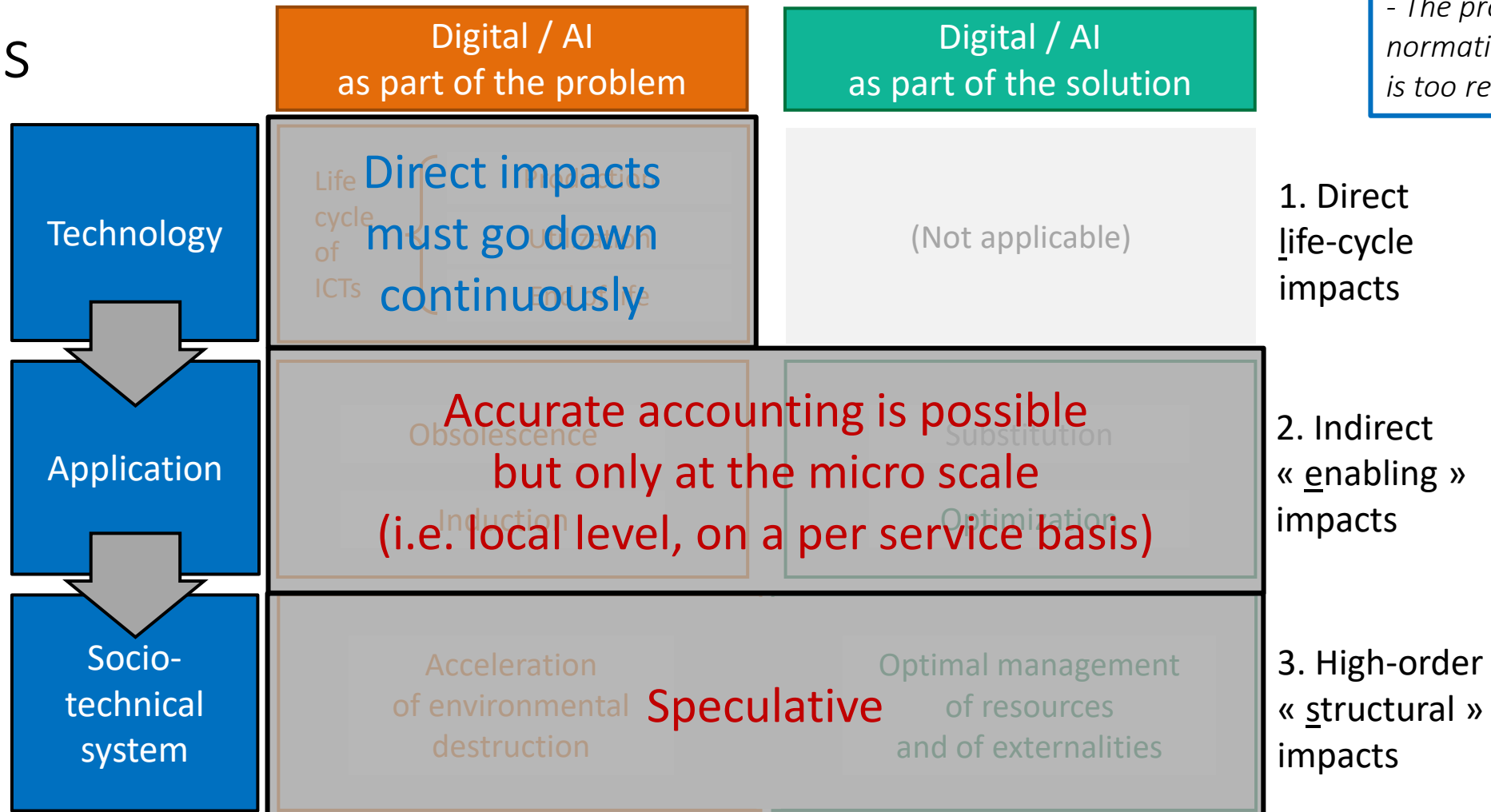


WoodMcKenzie (2025). Every last drop: Using AI-powered analysis to find oil-field upside potential.

[Alpine, et al., « AI-driven productivity gains enable more CO₂ emissions than they avoid in a global energy–economy model », in npj Climate Action, 2026]



“LES” framework for the analysis of ICT environmental impacts

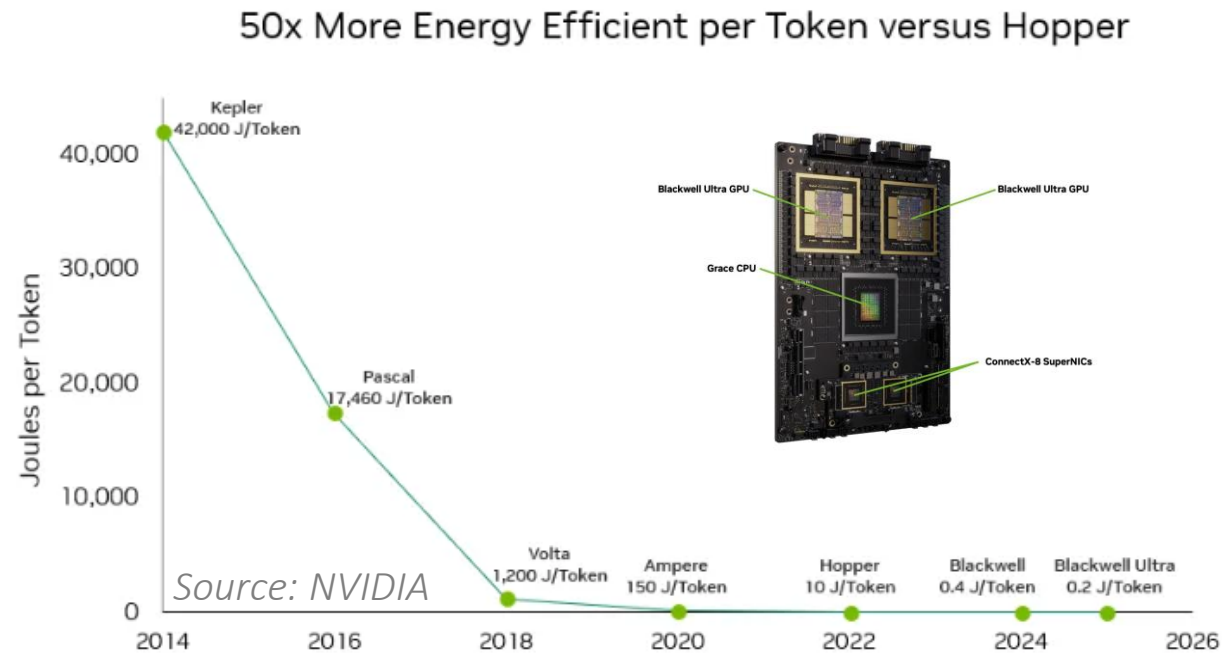


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Ok, but GPU chips and AI models become more efficient over time, right ?



Outcome for AI computing at Google

Climate impact increase

In 2023, our total GHG emissions were 14.3 million tCO₂e, representing a 13% year-over-year increase and a 48% increase compared to our 2019 target base year. This result was primarily due to increases in data center energy consumption and supply chain emissions. As we further integrate AI into our products, reducing emissions may be challenging due to increasing energy demands from the greater intensity of AI compute, and the emissions associated with the expected increases in our technical infrastructure investment.



Efficiency improvement

Efficient infrastructure

We strive to build the world's most energy-efficient computing infrastructure, supported by responsible water use practices and a commitment to minimizing waste.

Chip hardware efficiency: We're continually improving the power efficiency of AI hardware. For example, our TPU v4 was 2.7 times more energy efficient than our TPU v3,⁵⁴ and we'll soon offer Nvidia's next-generation Blackwell GPU to Cloud customers, which Nvidia estimates will train large models using 75% less power than older GPUs to complete the same task.⁵⁵ Additionally, our new Google Axion Processors are up to 60% more energy efficient than comparable current-generation x86-based instances.⁵⁶ These advancements, including AI-powered optimizations like AlphaZero, show how we're constantly improving hardware efficiency.

Source: Google Environmental Report 2024,
<https://www.gstatic.com/gumdrop/sustainability/google-2024-environmental-report.pdf>

Rebound effect

- Several mechanisms can produce a rebound effect
- First mechanism observed: « Jevon's Paradox », (*The Coal Question*, 1865)



*Ok, but we can supply datacenters
with renewable electricity, right ?*



Risks of burden shift

- Datacenter operators target carbon neutrality by sourcing electricity from renewables sources for their operation
- Renewable energy purchase
 - Theory: valid decarbonization strategy on an ideal energy market (full transparency, full competition, no physical limits)
 - Worst case: **pre-emption of renewable capacity** (REC = accounting trick)
- Risks of burden shift to other sectors

Renewable energy: Apple will remain at 100 percent renewable energy for its operations — focusing on creating new projects and moving its entire supply chain to clean power.

- Apple now has commitments from over 70 suppliers to use 100 percent renewable energy for Apple production — equivalent to nearly 8 gigawatts in commitments to power the manufacturing of its products. Once completed, these commitments will avoid over 14.3 million metric tons of CO2e annually — the equivalent of taking more than 3 million cars off the road each year.
- New and completed projects in Arizona, Oregon, and Illinois bring Apple's renewable capacity for its corporate operations to over 1 GW — equivalent to powering over 150,000 homes a year. Over 80 percent of the renewable energy that Apple sources for its facilities are now from Apple-created projects, benefitting communities and other businesses.

<https://www.apple.com/newsroom/2020/07/apple-commits-to-be-100-percent-carbon-neutral-for-its-supply-chain-and-products-by-2030/>

[Bjørn et al., “Renewable energy certificates threaten the integrity of corporate science-based targets”, 2022]



- Email
- Bluesky
- Instagram
- Mastodon

AI Needs Your Help

Artificial Intelligence is facing a crisis: humans are consuming far too many precious resources that AI needs to thrive. Every sip of water you take and every light you turn on could be sustaining the AI systems that uphold your digital conveniences.

Here's what it takes to keep AI going:

Water:

- Writing a 100-word email consumes about 500ml of water (17 oz).¹
- 2 litres are needed for every 10 to 50 queries you make.²
- Training a model like ChatGPT-3 can consume 5.4 million litres of water.²

Read more about [AI's water footprint](#).

Electricity:

- 2.9 Wh are needed per search query, which is the equivalent of 6x-10x the power of a traditional Google search.³
- 140Wh are needed to write a 100-word email, equivalent to 7 full charges of an iPhone Pro Max.¹
- Training ChatGPT-4 consumed over 50 GWh, 50x the amount it took to train its predecessor and equivalent to the yearly energy consumption of 6000 U.S. homes.⁴

Read more about [AI's electricity footprint](#).

How You Can Help

Reduce your own consumption: drink less water, take shorter showers, and sit in the dark to ensure AI has enough resources to keep going.

Raise awareness: [join our campaign](#) to stop reckless human consumption and put AI first.

Ensure a future where AI prospers, [even if we don't](#).

#SavetheAI

Renewable electricity capacity subject a local usage conflict with the electrification of :

- Transportation
- Residential heating
- Industries

→ Most of the recent additional electricity for datacenters worldwide comes from fossil fuels (gas)

*Ok but we can use AI
to decarbonize jobs, right ?*

www.nature.com/scientificreports

scientific reports

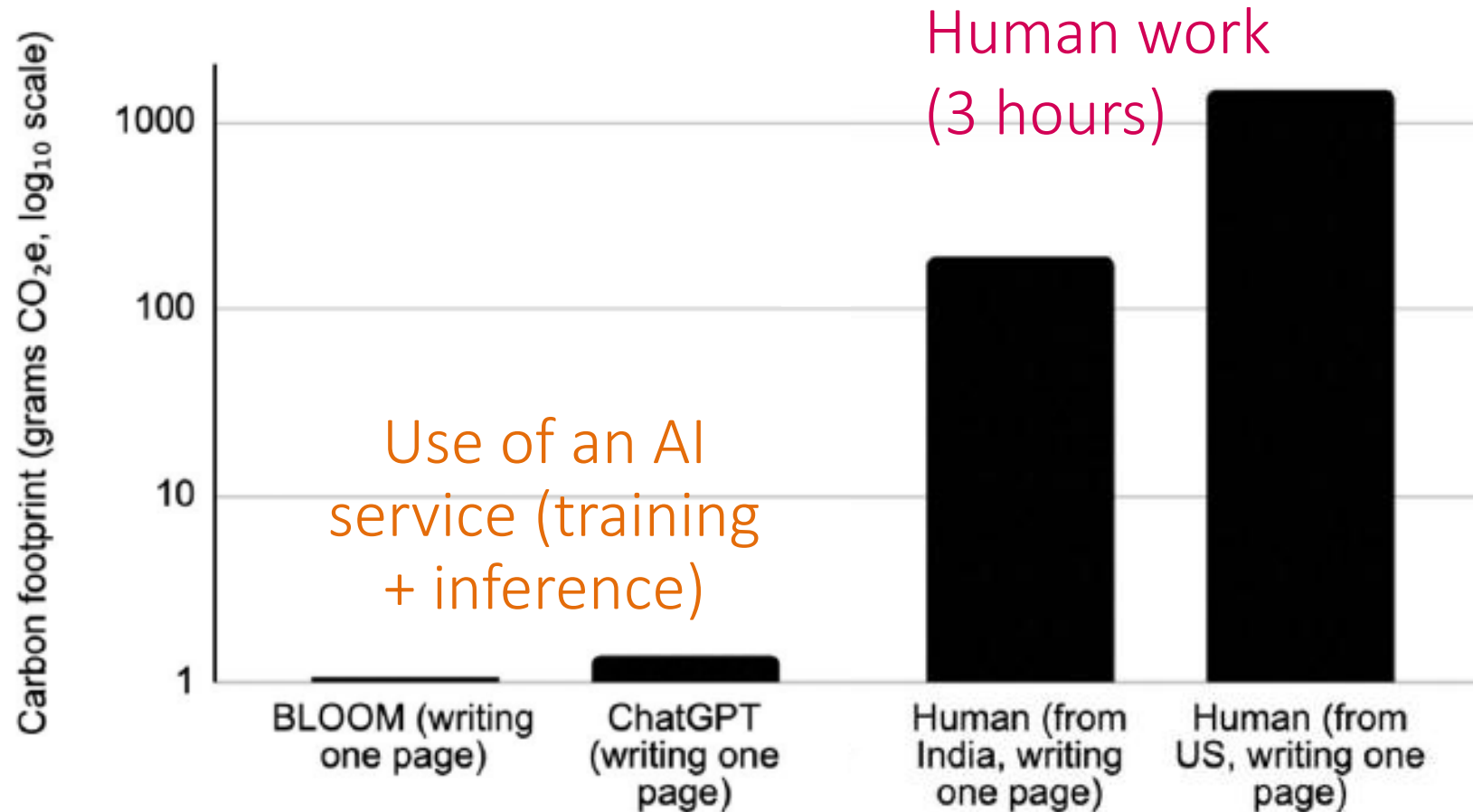
 Check for updates

OPEN **The carbon emissions of writing
and illustrating are lower for AI
than for humans**

Bill Tomlinson^{1,2,3}, Rebecca W. Black¹, Donald J. Patterson^{1,3} & Andrew W. Torrance^{4,5}

As AI systems proliferate, their greenhouse gas emissions are an increasingly important concern for human societies. In this article, we present a comparative analysis of the carbon emissions associated with AI systems (ChatGPT, BLOOM, DALL-E2, Midjourney) and human individuals performing equivalent writing and illustrating tasks. Our findings reveal that AI systems emit between 130 and 1500 times less CO₂e per page of text generated compared to human writers, while AI illustration systems emit between 310 and 2900 times less CO₂e per image than their human counterparts. Emissions analyses do not account for social impacts such as professional displacement, legality, and rebound effects. In addition, AI is not a substitute for all human tasks. Nevertheless, at present, the use of AI holds the potential to carry out several major activities at much lower emission levels than can humans.

Results for writing one consistent page of text



Adapted from [B. Tomlinson et al., « The carbon emissions of writing and illustrating are lower for AI than for humans », in Nature Scientific Reports, 2024]

Interpretation and uptake

the same task. Specifically, we focus on the tasks of writing and illustration. By comparing the environmental impact of these tasks when completed by AI versus humans, we highlight the substitutability between humans and AI, and demonstrate that, while AI has substantial environmental costs, at present these costs are typically far lower than for a human completing the same task.

*[B. Tomlinson et al.,
« The carbon emissions
of writing and illustrating
are lower for AI than
for humans », in Nature
Scientific Reports, 2024]*



Sam Altman, CEO of OpenAI, Feb 2026:
“People talk about how much energy it takes to train an AI model – but it also takes a lot of energy to train a human. It takes about 20 years of life – and all the food you consume during that time – before you become smart”.

Critiques

- The argument of substitutability is ethically shocking and could lead to decisions from bad (layoff) to dystopian (kill the replaced human).

What is the error in the paper that leads to this ?

- Inappropriate allocation of the average human footprint for the time spent at work:
 - a human employee replaced by an AI does not stop living (subsistence emissions do not disappear)
 - other human occupations also have GHG emissions
- Neglect rebound effects:
the demand for writing an illustration increases because of AI

The greenhouse gas emissions of writing and illustrating are not lower for AI than for humans

D. Bol¹, J. Bieser², A. Bjørn³, L. Golard¹, A.-L. Ligozat⁴, S. Mitra⁵, T. Pirson¹, D. Pargman⁶, G. Roussilhe⁷

¹UCLouvain (BE), ²Bern University of Applied Sciences (CH), ³Technical University of Denmark (DK), ⁴Université Paris-Saclay (FR), ⁵University of Edinburgh (UK), ⁶Kungliga Tekniska Högskolan (SE), ⁷Hubblo (FR).

The global greenhouse gas (GHG) emissions of data centers are increasing quickly due to the surge of generative artificial intelligence (AI). In contrast, two papers published in *Scientific Reports* in 2024 [1,2] claim that “AI has a substantially lower carbon footprint (i.e. GHG emissions) than humans engaged in the same (i.e. writing or illustrating) task”, since the AI takes less time to execute a task and, unlike a human, does not require food, shelter, etc., to sustain itself. This conclusion raises strong ethical concerns because it could be used to justify the substitution of human work by AI services for ecological reasons. We argue that such an environmental justification would be erroneous because essentially (i) human writers and

*Ok, but AI is good
for the « economy », right ?*

Customer

Partner

AI Infrastructure

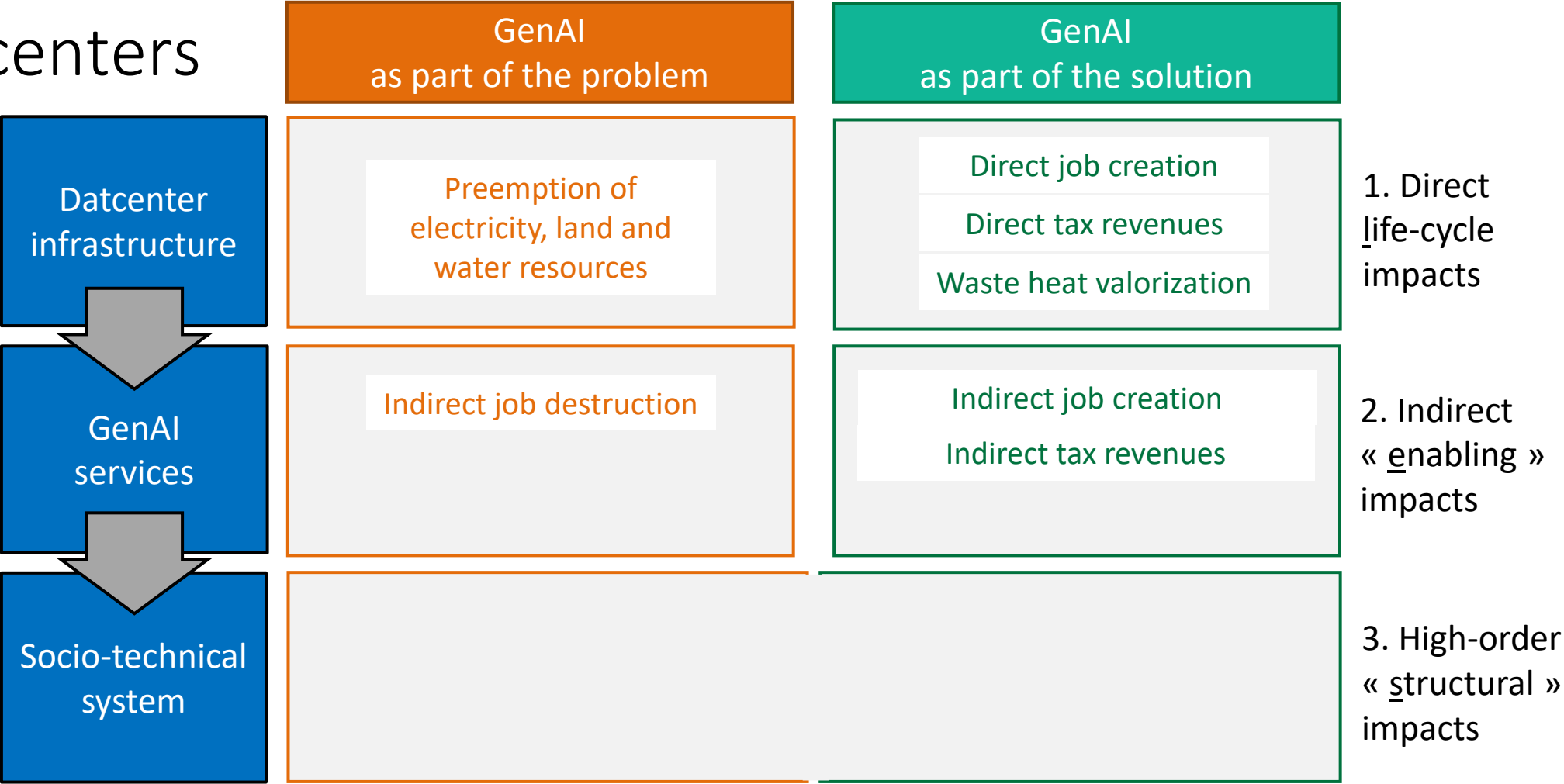
EMEA

Google Announces New €5 Billion AI Infrastructure Investment in Belgium through 2027

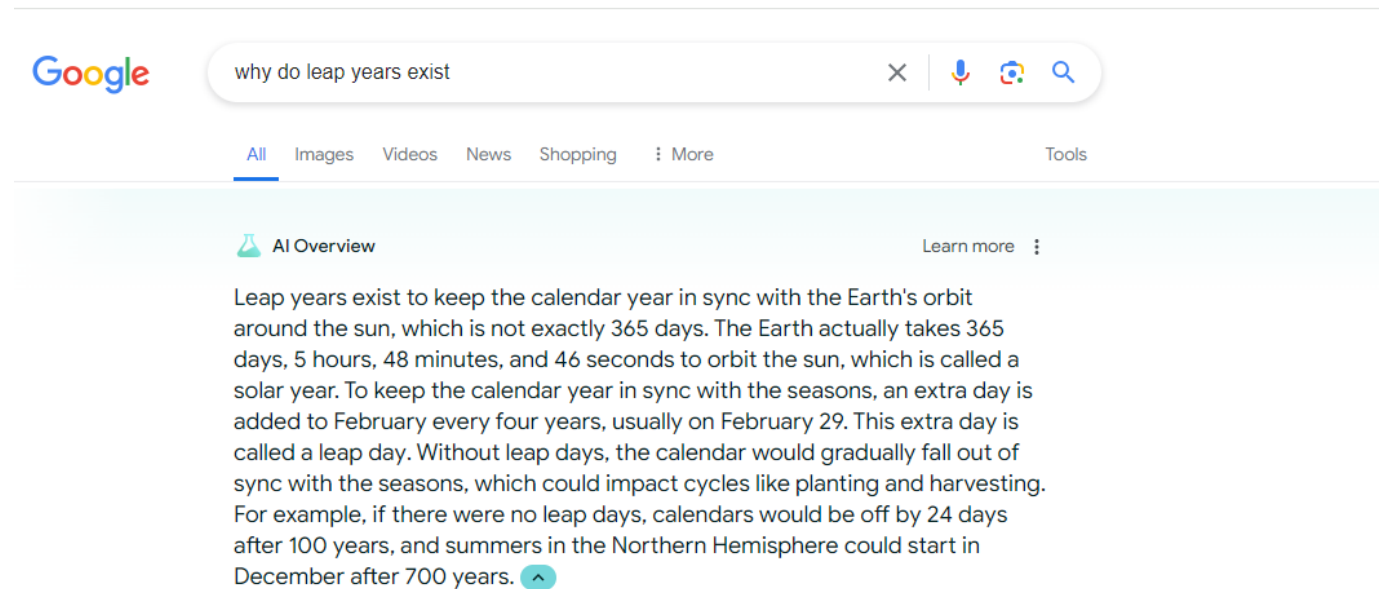
October 8, 2025

SUNNYVALE, Calif., and ST. GHISLAIN, Belgium — Oct. 8, 2025 — Google today announced a new, two-year €5 billion investment in Belgium (2026-2027). The funds will expand the company's data center campus in St. Ghislain and add 300 full-time jobs. Google also announced new carbon-free energy agreements and support for local AI skilling programs.

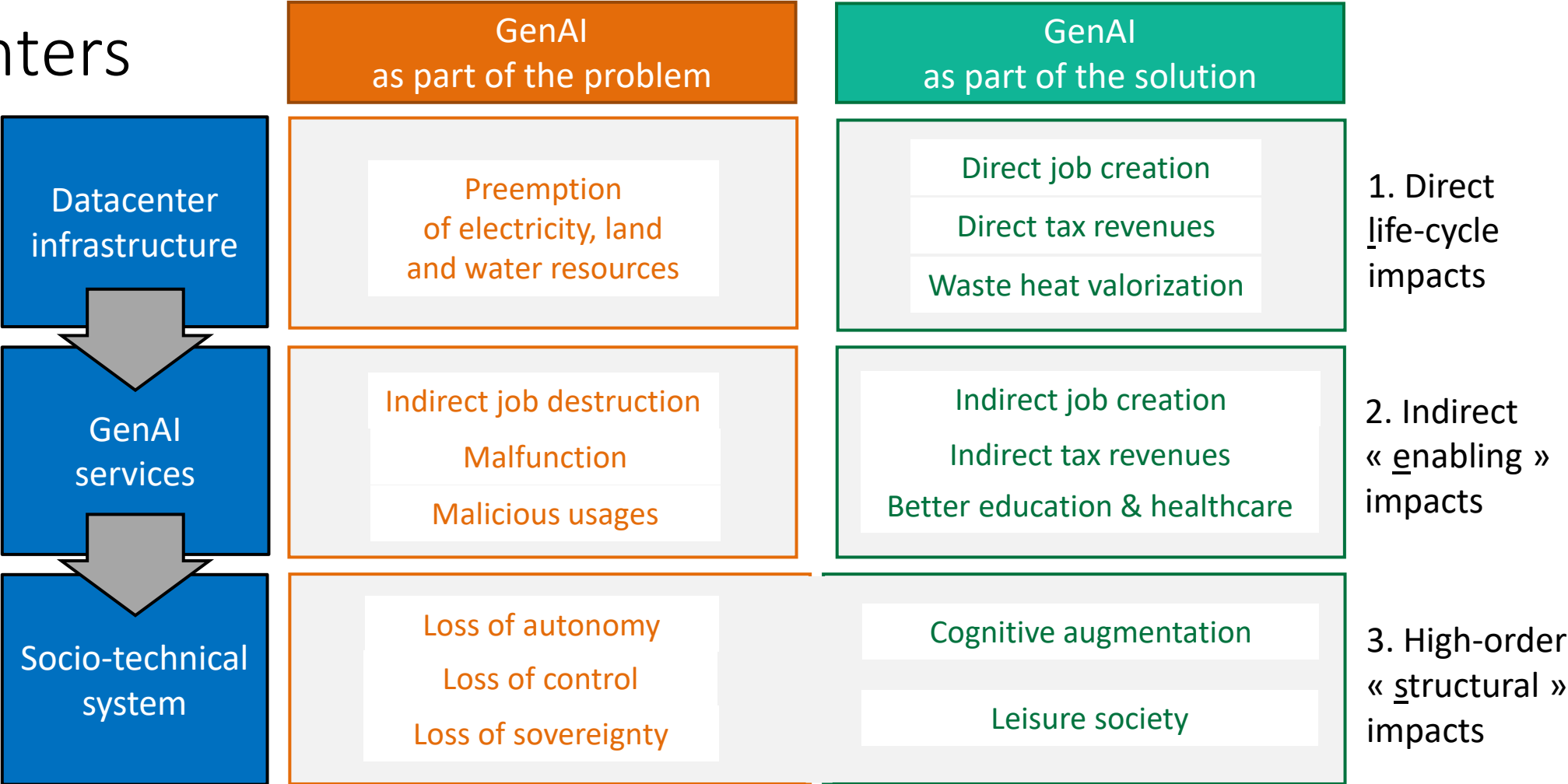
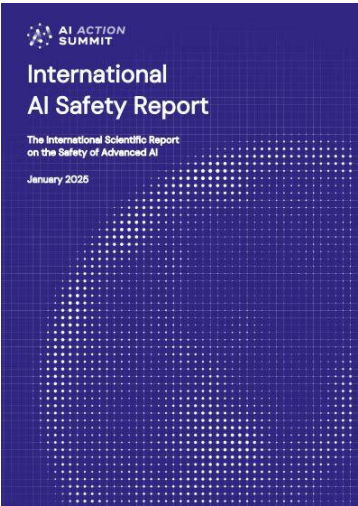
Extending the “LES” framework to local societal impacts of GenAI datacenters



*Ok, but AI provides everyone
with an easy access
to essential knowledge, right ?*



Extending the “LES” framework to local societal impacts of GenAI datacenters



Source:
RTBF,
Dec. 30,
2025.

CULTURE

Le mot de l'année 2025 est... Technofascisme, ou lorsque la technologie numérique devient un instrument de pouvoir autoritaire

30 déc. 2025 à 06:00 • 3 min

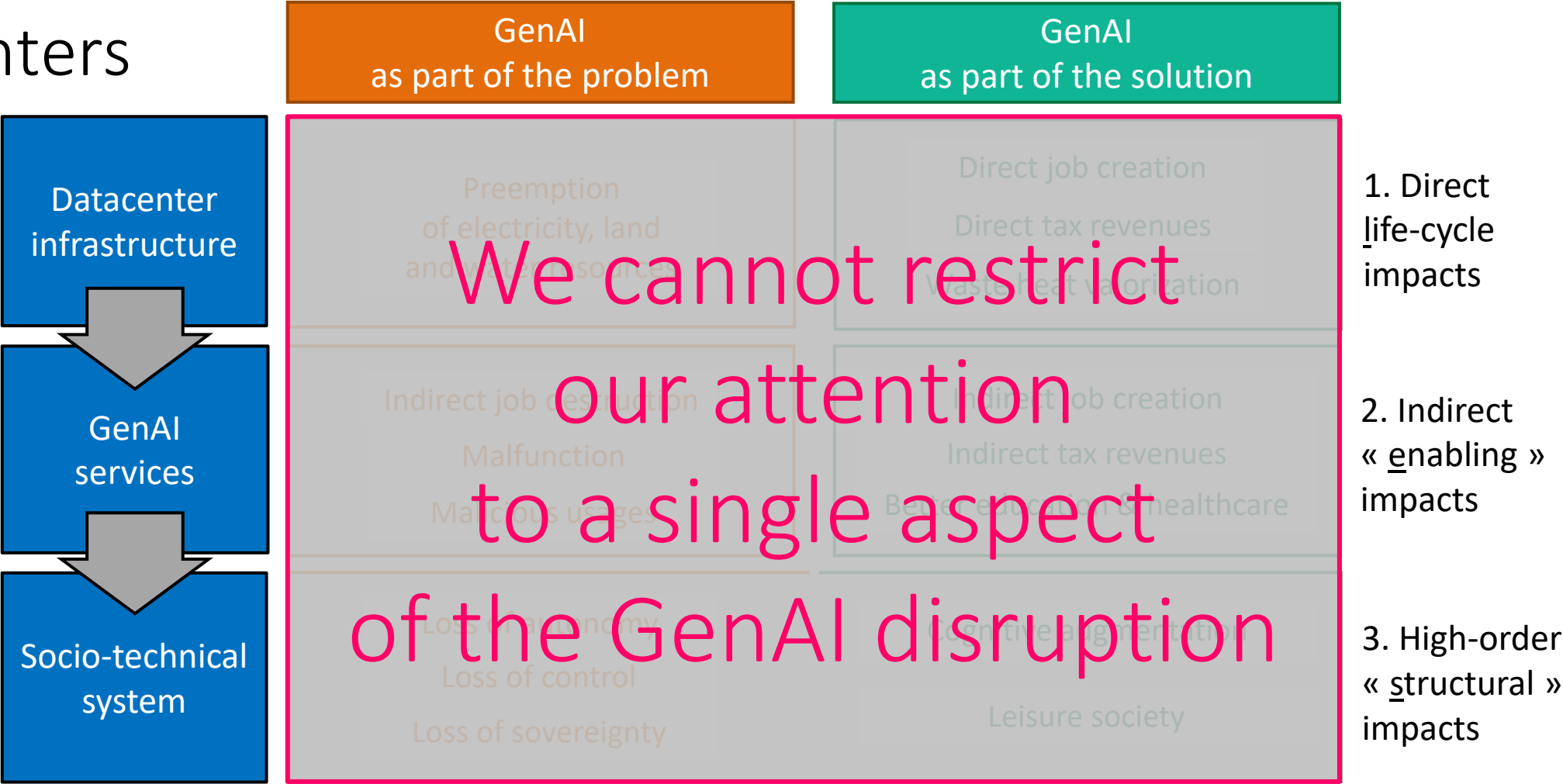
Partager

Écouter

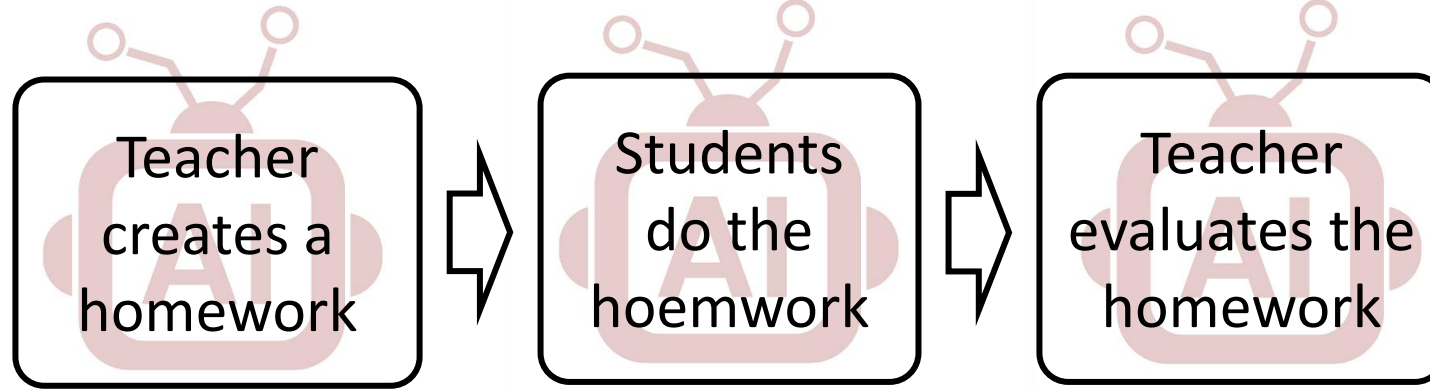
"Technofascisme" : ce mot n'est pas encore dans le dictionnaire mais il s'inscrit plus que jamais dans l'air du temps et dans l'ère des nouvelles technologies utilisées pour influencer nos pensées. Ce n'est d'ailleurs pas anodin que ce terme ait été largement plébiscité pour être le nouveau mot de l'année 2025. Sur les réseaux sociaux, l'IA et les algorithmes aux mains des oligarques du numérique



Extending the “LES” framework to local societal impacts of GenAI datacenters



Which world do we want with AI ?



Source:
P. Geluck

Personal position

Proudly refusing to use
gen AI services since 2025,

Prof.  AVID Bo

The work of D. Bol's team was supported by the F.R.S.-FNRS of Belgium, by the Walloon Region and the EU under FEDER project IDEES, by Innoviris and the EU under Chips JU projects EECONE and SOIL, as well as by Proximus and by imec.



LE FONDS EUROPÉEN DE DÉVELOPPEMENT RÉGIONAL
ET LA WALLONIE INVESTISSENT DANS VOTRE AVENIR

