

Sustainable AI, Sustainable ICT, Sustainable Societies: When does Green Tech Enable Systemic Change?

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Smart Monday, ULB, 2024-12-02

Short Bio

Professor at Université libre de Bruxelles,
Embedded Systems Design and Security

Topics, Research, Teaching:

- Hardware & Software Co-Design for Security
- Embedded Systems Security, Safety-Critical Systems
- Security and Privacy for Vulnerable People:
Children, migrant workers, sex workers
- Sustainability Aspects in ICT
 - Computing Within Limits
<https://computingwithinlimits.org/>
 - SICT Summer School on Sustainable ICT
<https://www.sictdoctoralschool.com/>
- **I don't actually do AI!**



Privacy Protections for Children

“Given that children merit specific protection, any **information and communication**, where processing is addressed to a child, **should be in such a clear and plain language that the child can easily understand.**”

– Recital 58, EU GDPR

Source: “Informing Children about Privacy: A Review and Assessment of Age-Appropriate Information Designs in Kids-Oriented F2P Video Games”, [SDM23]
Jan Tobias Mühlberg

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Informing Children about Privacy: A Review and Assessment of Age-Appropriate Information Designs in Kids-Oriented F2P Video Games

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With the rise of free-to-play (F2P) games, the profitability of video-gaming apps critically depends on the ability of developers to acquire, retain, and monetize large numbers of players. In this context, most game designers have no viable alternative than massively collecting players' personal data and monitoring their behavior to target them with personalized advertising and in-game purchases. Given the risks associated with such data practices, players, particular children, need to be aware that a video game might compromise their privacy. Game designers should therefore ensure that players receive appropriate information about the data practices associated with their games. This might, however, be challenging, especially when the game is directed at children, given the complexity of privacy information and the limited literacy capacities of children and their parents. To answer game designers' need for comprehensive guidance regarding the communication of privacy information to children, we provide a survey of the age-appropriate information design strategies which been recommended by data protection authorities, children protection organizations and the relevant scientific literature. On this occasion, we also refer to illustrative examples of designs which can be considered good practices. Finally, by using an “evaluation matrix,” we reviewed and assessed the implementation of those design strategies in nine F2P mobile games committed to following Google Play's Families Policies. Our findings show that, despite being child-oriented, the reviewed games largely fail at communicating privacy information in an age-appropriate way.

CCS Concepts: • Security and privacy → Social aspects of security and privacy; Usability in security and privacy; • Human-centered computing → HCI design and evaluation methods; • Social and professional topics → Privacy policies; Children.

Additional Key Words and Phrases: Privacy Notice, Transparency, Video Games, Gaming, Children's Privacy Literacy, Age-Appropriate Design, Children's Rights, Data Protection, GDPR, Dark Patterns

ACM Reference Format:

Martin Sas, Maarten Denoo, and Jan Tobias Mühlberg. 2023. Informing Children about Privacy: A Review and Assessment of Age-Appropriate Information Designs in Kids-Oriented F2P Video Games. *Proc. ACM Hum.-Comput. Interact.* 7, CHI PLAY, Article 390 (November 2023), 39 pages. <https://doi.org/10.1145/3611036>

1 INTRODUCTION

Free-to-play (F2P) and hybrid monetization models have become a mainstay of the gaming industry. The mobile market, recognized for its fierce competition, often experiences reluctance from players to buy paid games. As a result, most game designers have often no viable alternative other than

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<https://doi.org/10.1145/3611036>

Trustworthy Age Assurance?

- **Age checks when using online services:** games, social media, porn, gambling, etc.
- Different approaches:
“I’m over 18!” vs. eID vs. **biometrics**
- **Implications:** privacy, data protection, inclusivity, rights of the child
- **Technical solutions to a non-technical problem,** promoted by tech advocates against the expertise of experts in child protection.

Source: “Trustworthy Age Assurance? A risk-based evaluation of available and upcoming age assurance technologies from a fundamental rights perspective”, [SM24]

TRUSTWORTHY AGE ASSURANCE?

A risk-based evaluation of available and upcoming age assurance technologies from a fundamental rights perspective.



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Brussels, Belgium

February 2024



Trustworthy Age Assurance?

Studie: Altersverifikation im Netz ist nötig, in Demokratien aber nicht machbar

Von vielen Seiten werden die Rufe nach Online-Alterskontrollen lauter. Forscher beäugen das Instrument im Auftrag der Grünen im EU-Parlament aber skeptisch.



(Bild: REC Stock Footage/Shutterstock.com)

28.03.2024, 19:15 Uhr Lesezeit: 6 Min.

Von [Stefan Krempf](#)

INHALTSVERZEICHNIS

1. Studie: Altersverifikation im Netz ist nötig, in Demokratien aber nicht machbar
Erhebliche Sicherheits- und Ausschlussrisiken
Kinder müssen für problematische Inhalte "geimpft" werden
Alterskontrolle in der Politik en vogue

Source: <https://www.heise.de/news/Studie-Altersverifikation-im-Netz-ist-noetig-in-Demokratien-aber-nicht-machbar-9670768.html>

Does one of you have a good definition for sustainability at hands?

“The original semantic meaning of ‘sustainability’ (a noun) and ‘to sustain’ (a transitive verb) refers to the ability to continue over a long period of time.”

– <https://en.wikipedia.org/wiki/Sustainability>

“[...] development that **meets the needs of the present without compromising the ability of future generations to meet their own needs.”**

– Brundtland Report, <https://en.unesco.org/>, [Bru87]

“Security is a fundamental extra-functional requirement that systems should provide. As such, it should be implemented in a sustainable way, namely achieving at least a very limited energy consumption, and being at least capable of supporting crypto-agility (so to allow updates of security primitives rather than replacement of whole devices).”

– <http://sussec22.alari.ch/>

"[Sustainable AI] is about how to develop AI that is compatible with sustaining environmental resources for current and future generations; economic models for societies; and societal values that are fundamental to a given society. I have articulated that the phrase Sustainable AI be understood as having two branches; AI for sustainability and sustainability of AI."

– Aimee van Wynsberghe, [VW21]

EMERGING TECHNOLOGIES

4 ways AI can super-charge sustainable development

Nov 13, 2023



AI can help provide analytics for biodiversity projects on coral reefs.

Image: Francesco Ungaro/Pexels

Source: <https://www.weforum.org/agenda/2023/11/ai-sustainable-development/>

Claudia Ukonu

Growth Lead, Uplink, World Economic Forum

- 1 Monitoring & prediction:** climate, biodiversity, disasters, agriculture
- 2 Sustainable finance:** navigating climate risks with AI
- 3 Impact Management & Measurement:** ensuring accountability and transparency, specifically regarding sustainable development goals
- 4 Shifting perceptions:** AI's transformative role "as a powerful catalyst for reshaping how society views sustainability"

EMERGING TECHNOLOGIES

4 ways AI can super-charge sustainable development

Nov 13, 2023



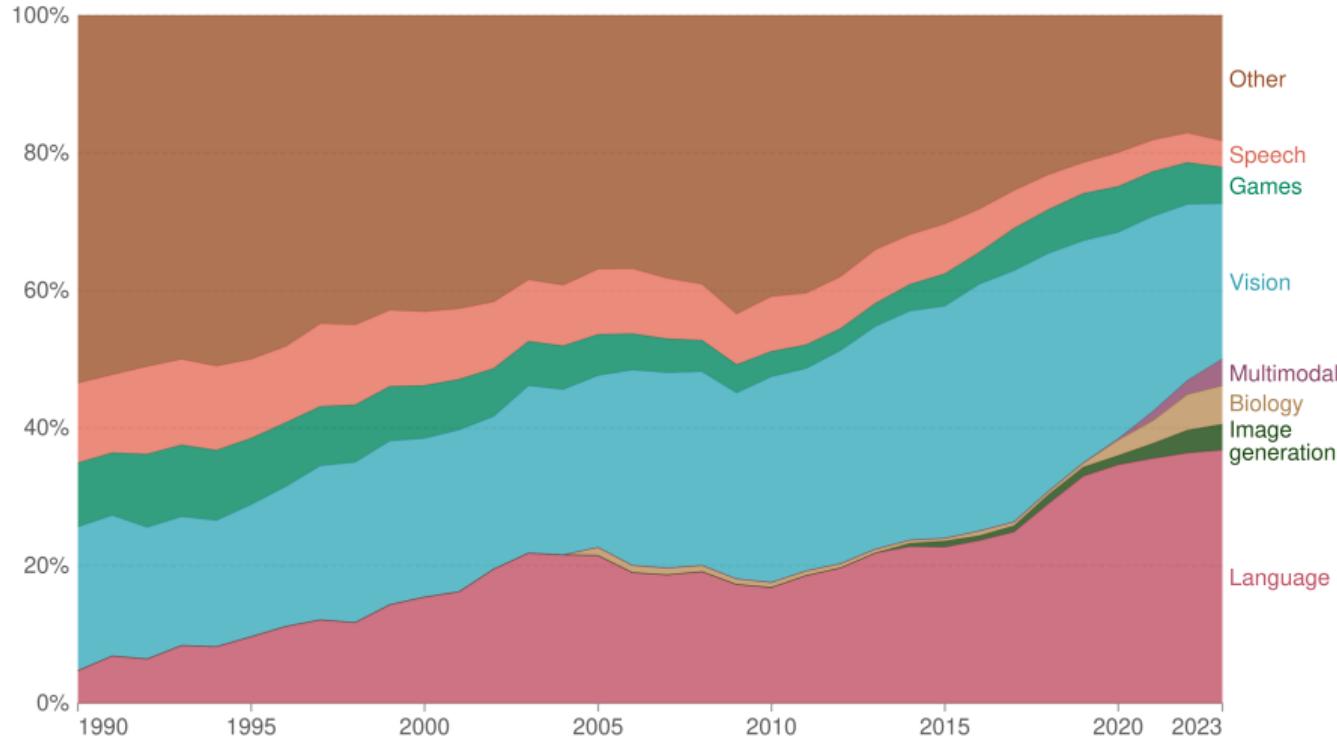
AI can help provide analytics for biodiversity projects on coral reefs.

Image: Francesco Ungaro/Pexels

Source: <https://www.weforum.org/agenda/2023/11/ai-sustainable-development/>

Share of notable AI systems by domain

Specific field, area, or category in which an AI system is designed to operate or solve problems.



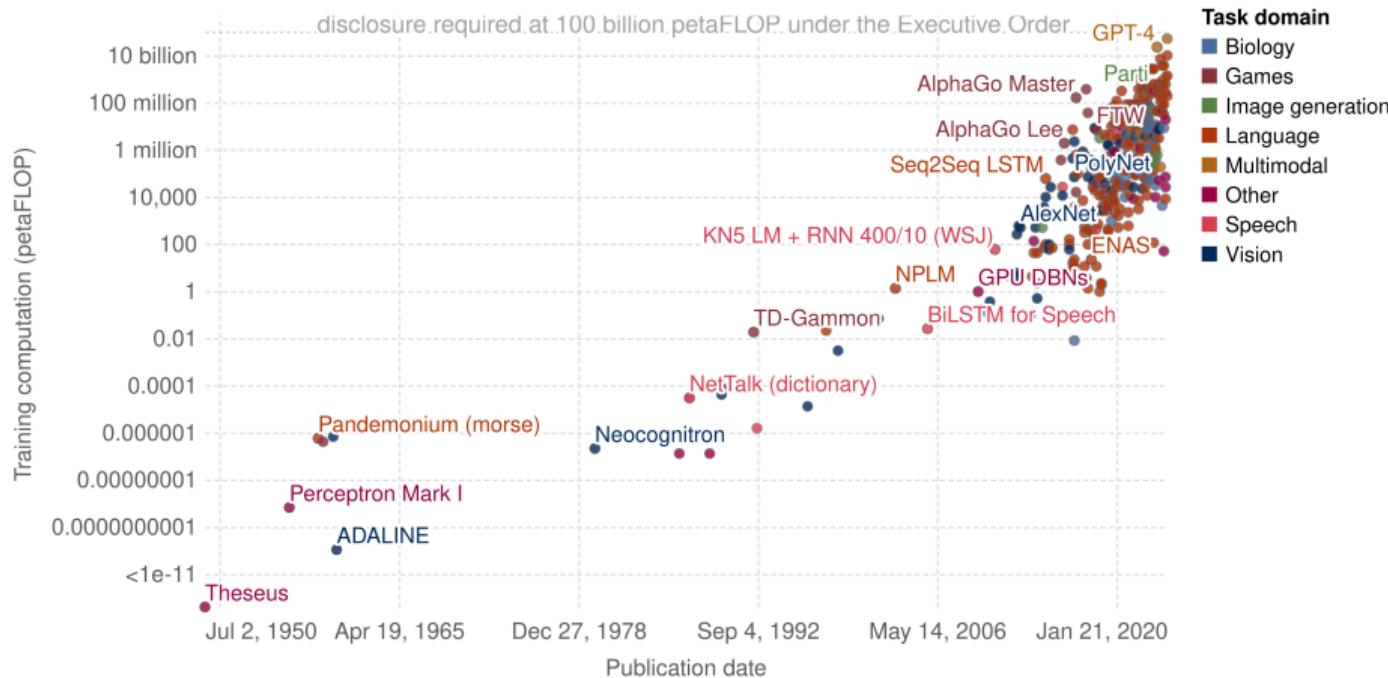
Data source: Epoch (2024)

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Note: Systems are defined as "notable" by the authors based on several criteria, such as advancing the state of the art or being of historical importance.

Computation used to train notable artificial intelligence systems

Computation is measured in total petaFLOP, which is 10^{15} floating-point operations¹ estimated from AI literature, albeit with some uncertainty. Estimates are expected to be accurate within a factor of 2, or a factor of 5 for recent undisclosed models like GPT-4.



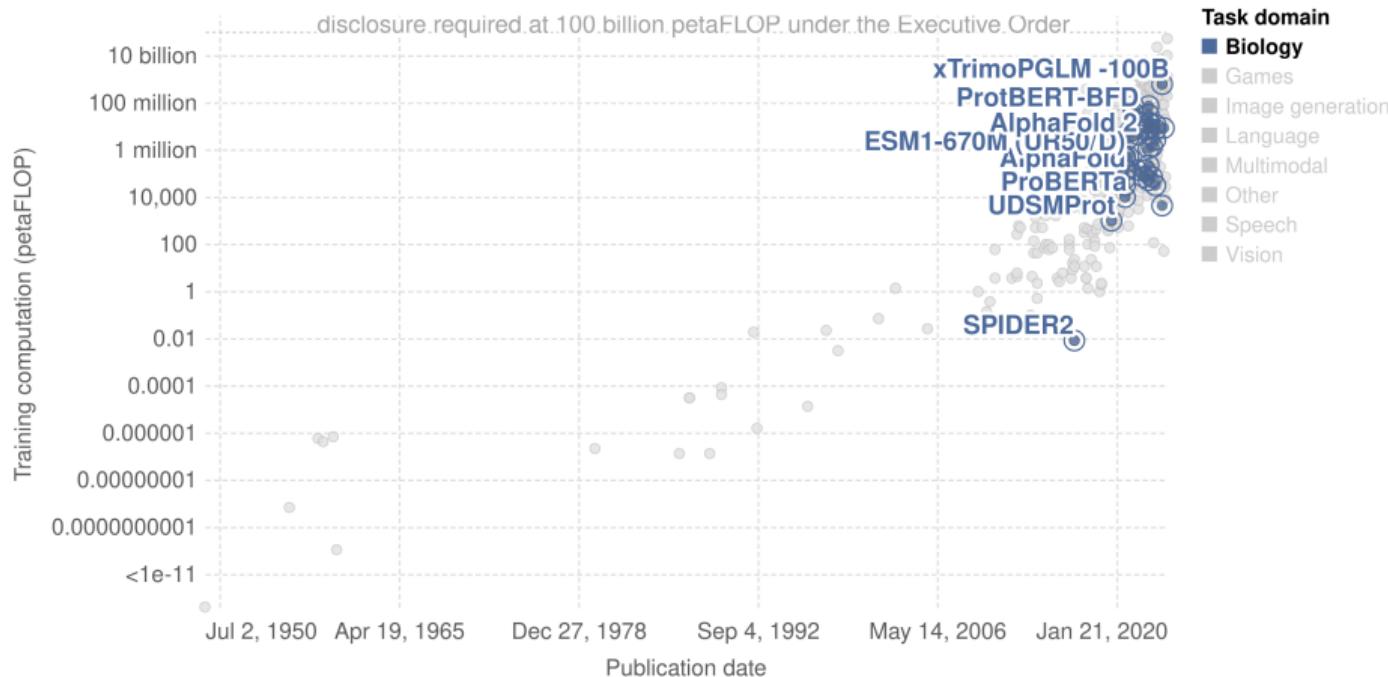
Data source: Epoch (2024)

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Note: The Executive Order on AI refers to a directive issued by President Biden on October 30, 2023, aimed at establishing guidelines and standards for the responsible development and use of artificial intelligence within the United States.

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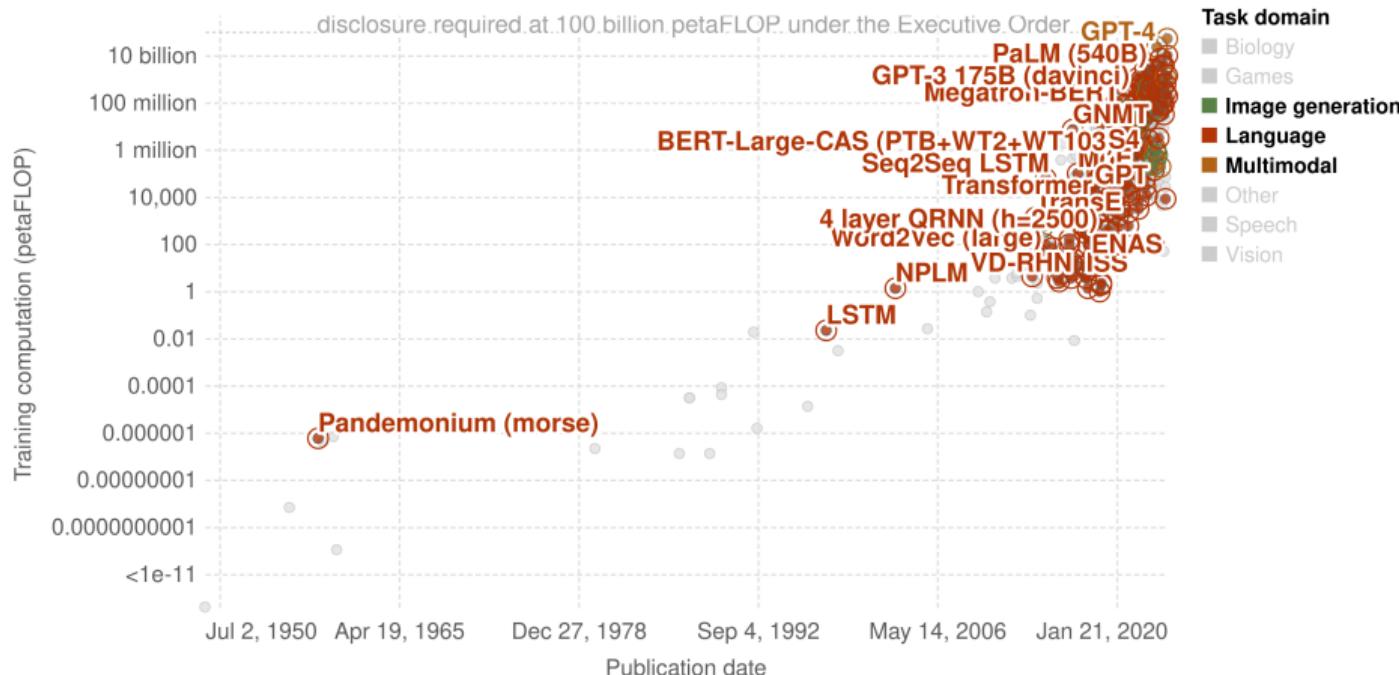
Data source: Epoch (2024)

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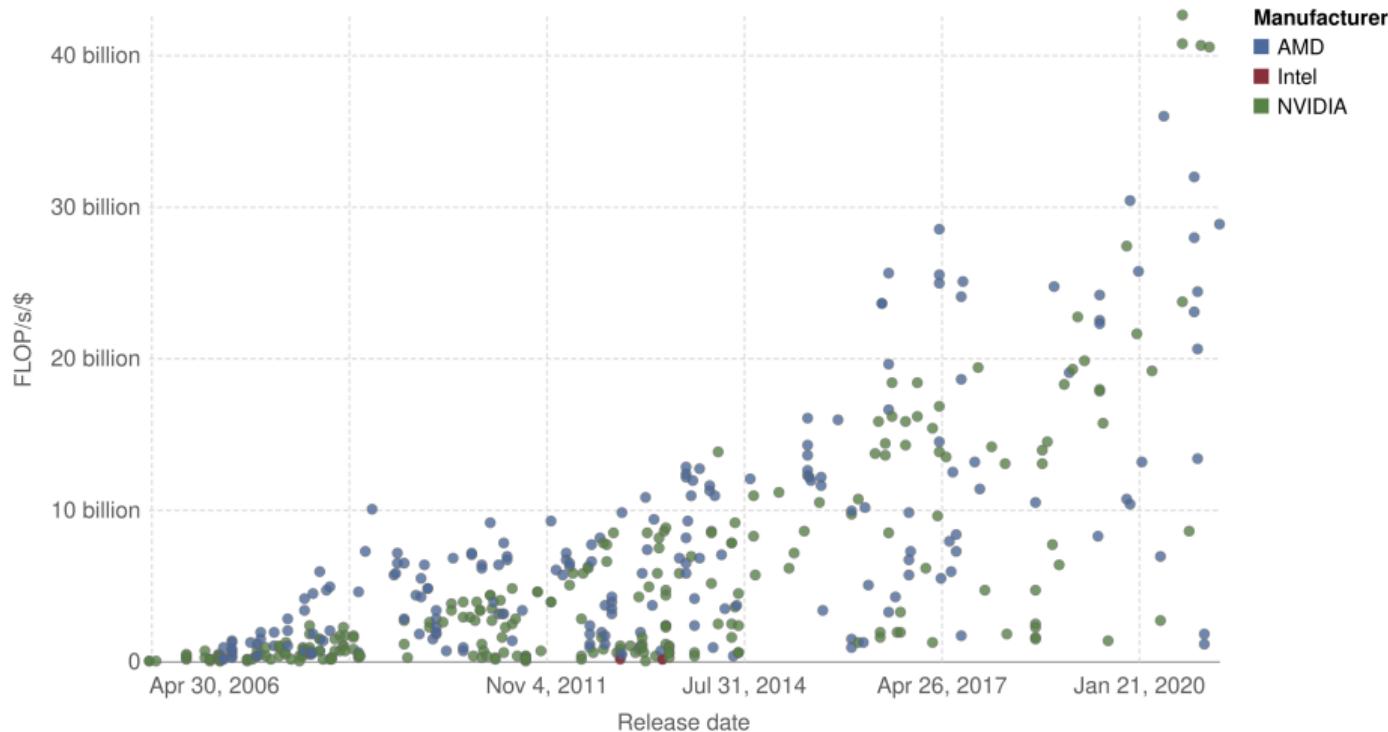
Data source: Epoch (2024)

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GPU computational performance per dollar

Graphics processing units (GPUs) are the dominant computing hardware for artificial intelligence systems. GPU performance is shown in floating-point operations¹/second (FLOP/s) per US dollar, adjusted for inflation.



Data source: Sun et al., Median Group via Epoch (2022)

Note: FLOP/s values refer to 32-bit (full) precision.

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FLOPS?!

FLOP = Floating Point OPeration

C64: 1000 FLOPs; my laptop: 1500 Giga FLOPS

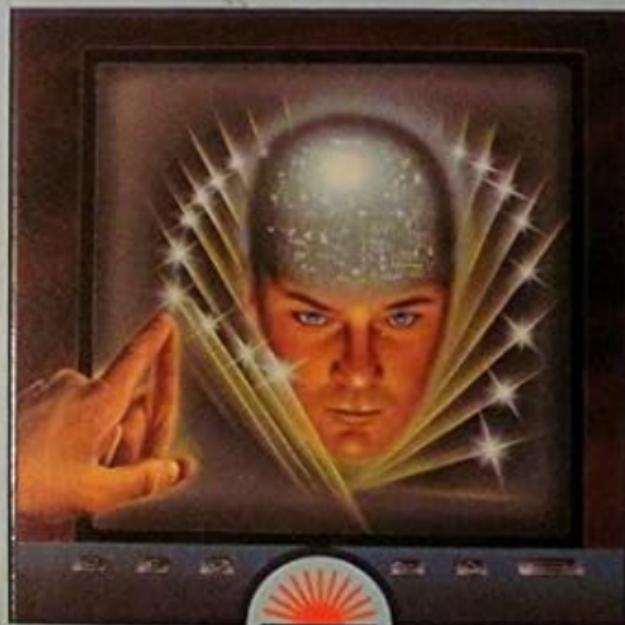
1 billion FLOPs = 1 Giga FLOP

1,000,000 billion FLOPS = 1 Peta FLOP

**artificial intelligence
on the commodore 64**

make your micro think

keith & steven brain



FLOPS?!

FLOP = Floating Point OPeration

C64: 1000 FLOPs; my laptop: 1500 Giga FLOPS

1 billion FLOPs = 1 Giga FLOP

1,000,000 billion FLOPS = 1 Peta FLOP

10 billion Peta Flops cost about

USD 50,000,000

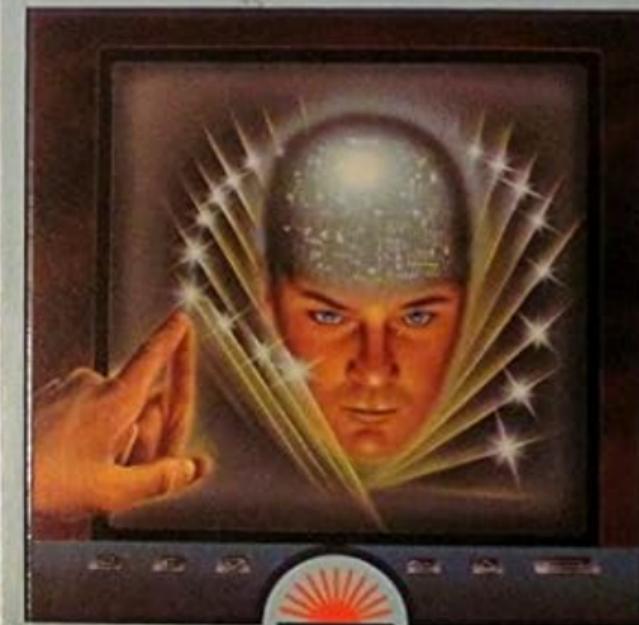
100 million Peta Flops cost about

USD 5000

artificial intelligence on the commodore 64

make your micro think

keith & steven brain



Who Owns the FLOPS?

AI businesses aspire tremendous growth

- Statista:
 - USD 184.00 billion in 2024
 - USD 826.70 billion by 2030
- OpenAI seeks USD 7 trillion
≈ 10% of global economy

Source: <https://www.wsj.com/tech/ai/sam-altman-seeks-trillions-of-dollars-to-reshape-business-of-chips-and-ai-89ab3db0>

TECHNOLOGY | ARTIFICIAL INTELLIGENCE

Sam Altman Seeks Trillions of Dollars to Reshape Business of Chips and AI

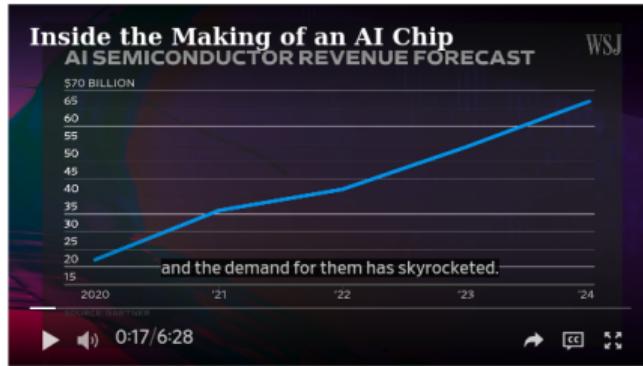
OpenAI chief pursues investors including the U.A.E. for a project possibly requiring up to \$7 trillion

By [Keach Hagey](#) [Follow](#) and [Asa Fitch](#) [Follow](#)

Feb. 8, 2024 9:00 pm ET

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Who Owns the FLOPS?

“This week’s earnings reports from Microsoft and Alphabet have soothed market anxiety about the huge jumps in spending on the infrastructure needed to power AI chatbots such as OpenAI’s ChatGPT and Google’s Gemini, as well as several other companies experimenting new AI models.”

Big Tech [+ Add to myFT](#)

Microsoft and Alphabet enjoy AI-powered gains from cloud divisions

Combined market value of the two tech giants rose by more than \$250bn after revenue growth beat expectations



Microsoft and Alphabet each reported double-digit revenue growth in their first-quarter results © FT montage/Getty Images

Stephen Morris, Richard Waters and Camilla Hodgson in San Francisco and Tim Bradshaw
In London APRIL 26 2024

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Source: <https://www.ft.com/content/f01c6852-8aa6-4cc0-991d-38f15077ba92>

Who Owns the FLOPS?

There is real physical infrastructure behind AI

- **Environmental impacts** during production and end-of-life, power consumption, water consumption
- **Social impacts**, we see protests against data centres and against extraction everywhere
- Whoever **controls** the means of computation and the training data, also controls development and use of AI.

Data center emissions probably 662% higher than big tech claims. Can it keep up the ruse?

Emissions from in-house data centers of Google, Microsoft, Meta and Apple may be 7.62 times higher than official tally



© An Amazon Web Services data center in Ashburn, Virginia, on 28 July 2024. Photograph: Nathan Howard/Bloomberg via Getty Images

Big tech has made some big claims about **greenhouse gas emissions** in recent years. But as the rise of **artificial intelligence** creates ever bigger energy demands, it's getting hard for the industry to hide the true costs of the data centers powering the tech revolution.

Source: <https://www.theguardian.com/technology/2024/sep/15/data-center-gas-emissions-tech>

Sustainable, Ethical, Fair, Eco, ...



**Fair PCs and
Phones**

No conflict minerals,
fair wages, recyclable.
fixed!

FREE REPAIRS

Lifelong guarantee
to get your devices

Ethical Storage

Big, blue, cool.
100% recycled.

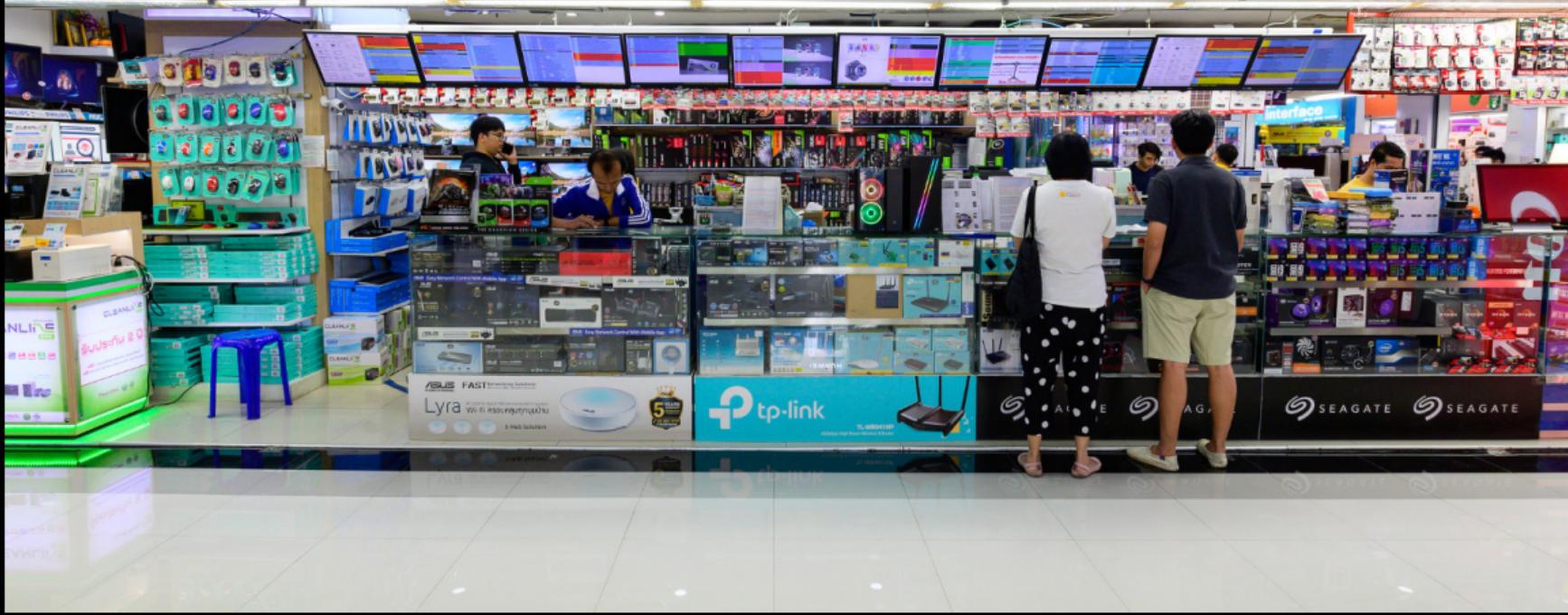
FUELED_BY DARKNESS

StoreGreen

**Sustainable Cloud
Services**

**REPUBLIC OF
GAMERS**

**GREEN
BLOCK CHAIN**
For Big Data,
with privacy.



Sustainability in ICT?

**Compromising the ability of
future generations?**



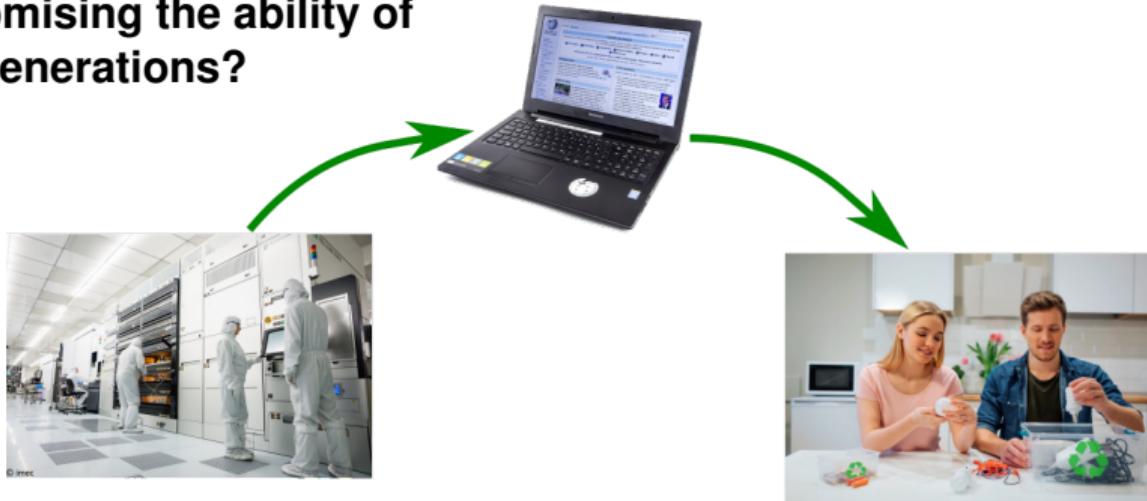
Sustainability in ICT?

**Compromising the ability of
future generations?**



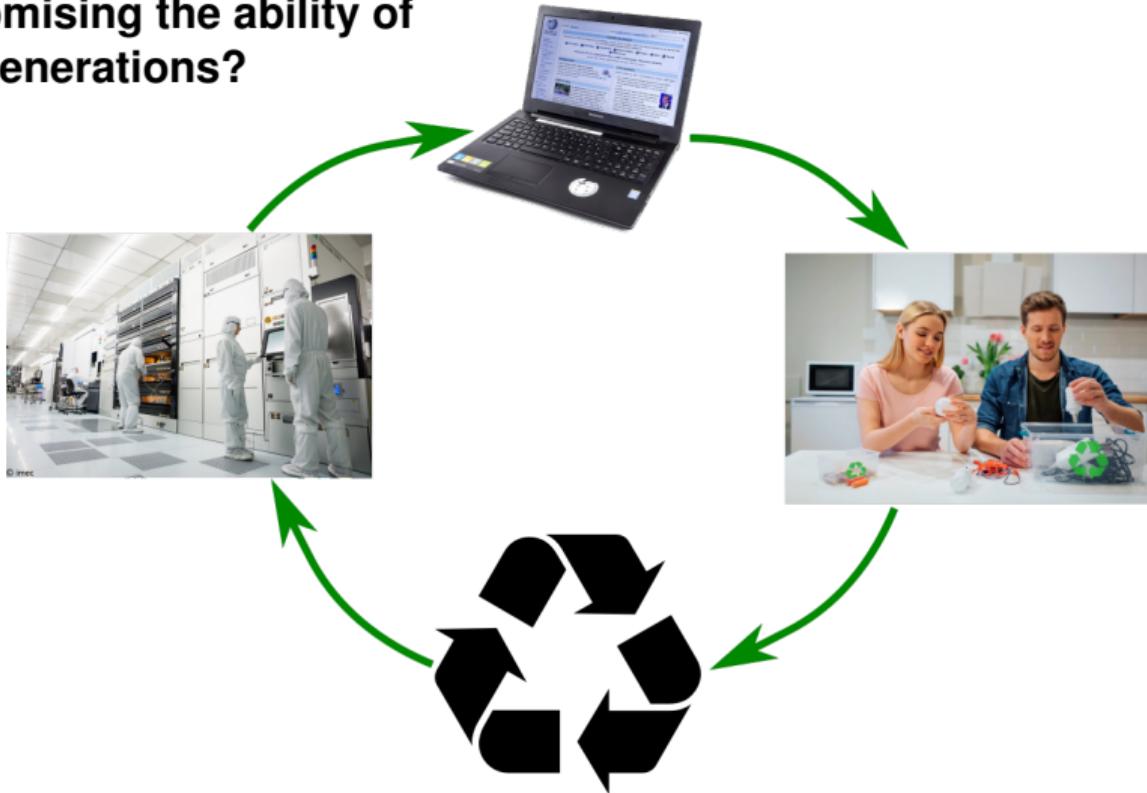
Sustainability in ICT?

Compromising the ability of
future generations?



Sustainability in ICT?

Compromising the ability of
future generations?

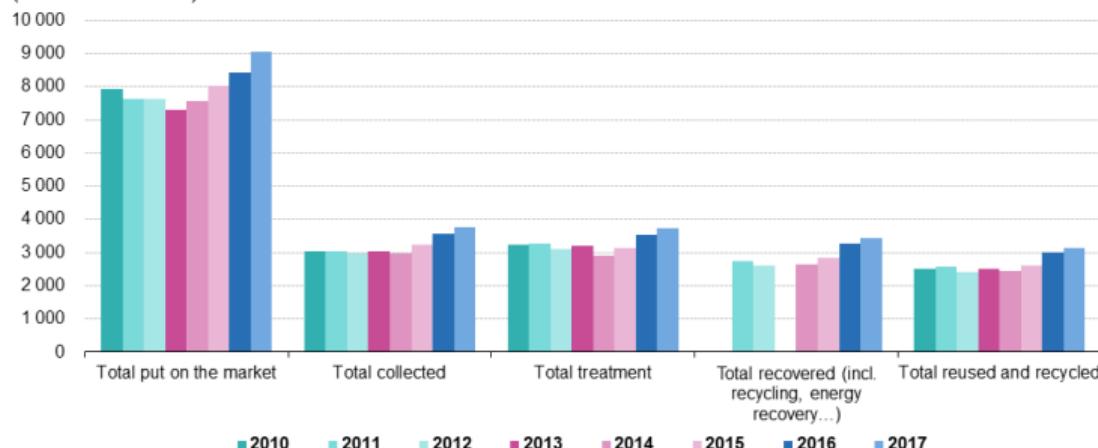


Waste Electric and Electronic Equipment in the EU

- 9 Mt WEEE in the EU (18 kg/person, 2017)
- 8.4 kg collected per person/year
- Collection rate estimated at 47%
- Only 40% treated or recycled in EU (20% globally, 2020)

Electrical and electronic equipment (EEE) put on the market and waste EEE collected and treated, EU-27, 2010–2017

(thousand tonnes)



Note: 2010, 2016 and 2017 data, as well as 2011 data for reused and recycled EEE waste: Eurostat estimates

Source: Eurostat (online data code: env_waselee)

eurostat

Source: Eurostat, <https://ec.europa.eu/eurostat/statistics-explained/>

Japan recycled nearly 80,000 tons of cell phones and other electronics to make the medals for the 2020 Tokyo Olympics and Paralympics

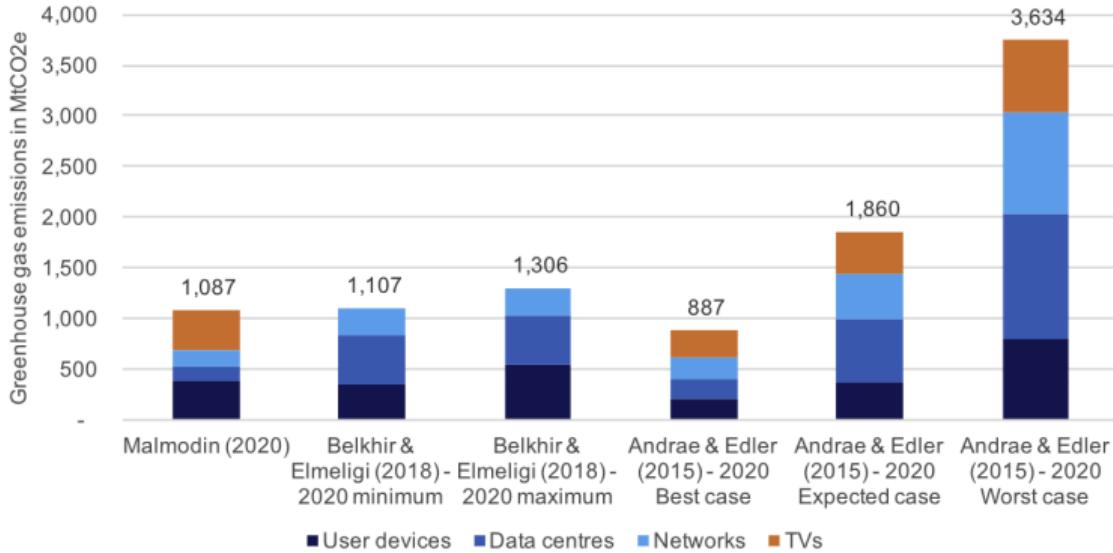
Antonio Villas-Boas Jul 24, 2019 6:42 PM



The silver, gold, and bronze medals for Tokyo 2020. Courtesy of Tokyo 2020.

Source: Business Insider 2019-10-28, <https://www.businessinsider.com/>

Energy & Emissions



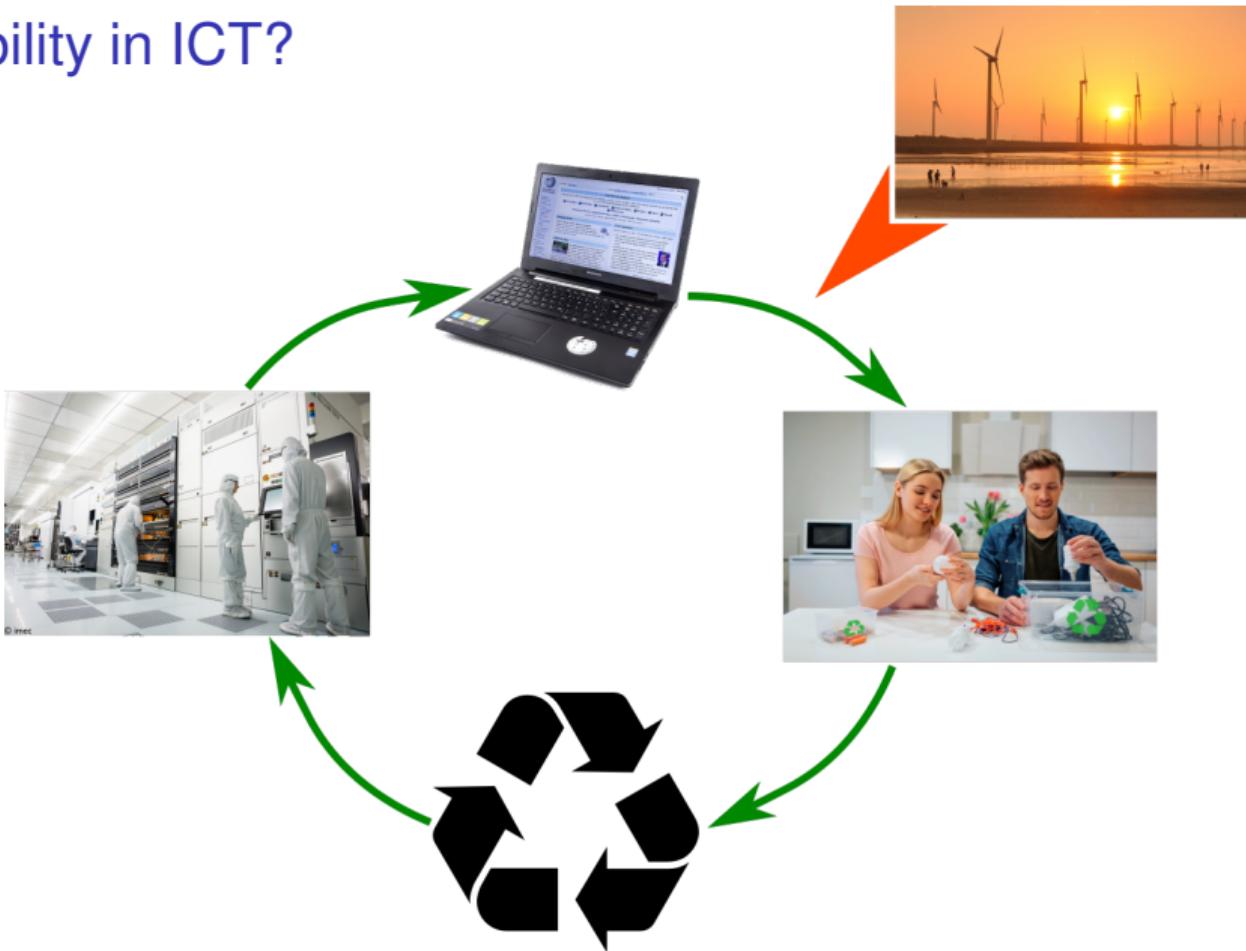
ICT produces about about
≈1.2–2.2 Gt CO₂-e
emissions, 2.1%–3.9% of
global total, spread across
many sectors (for 2020,
[FBLW⁺²¹]).

See also

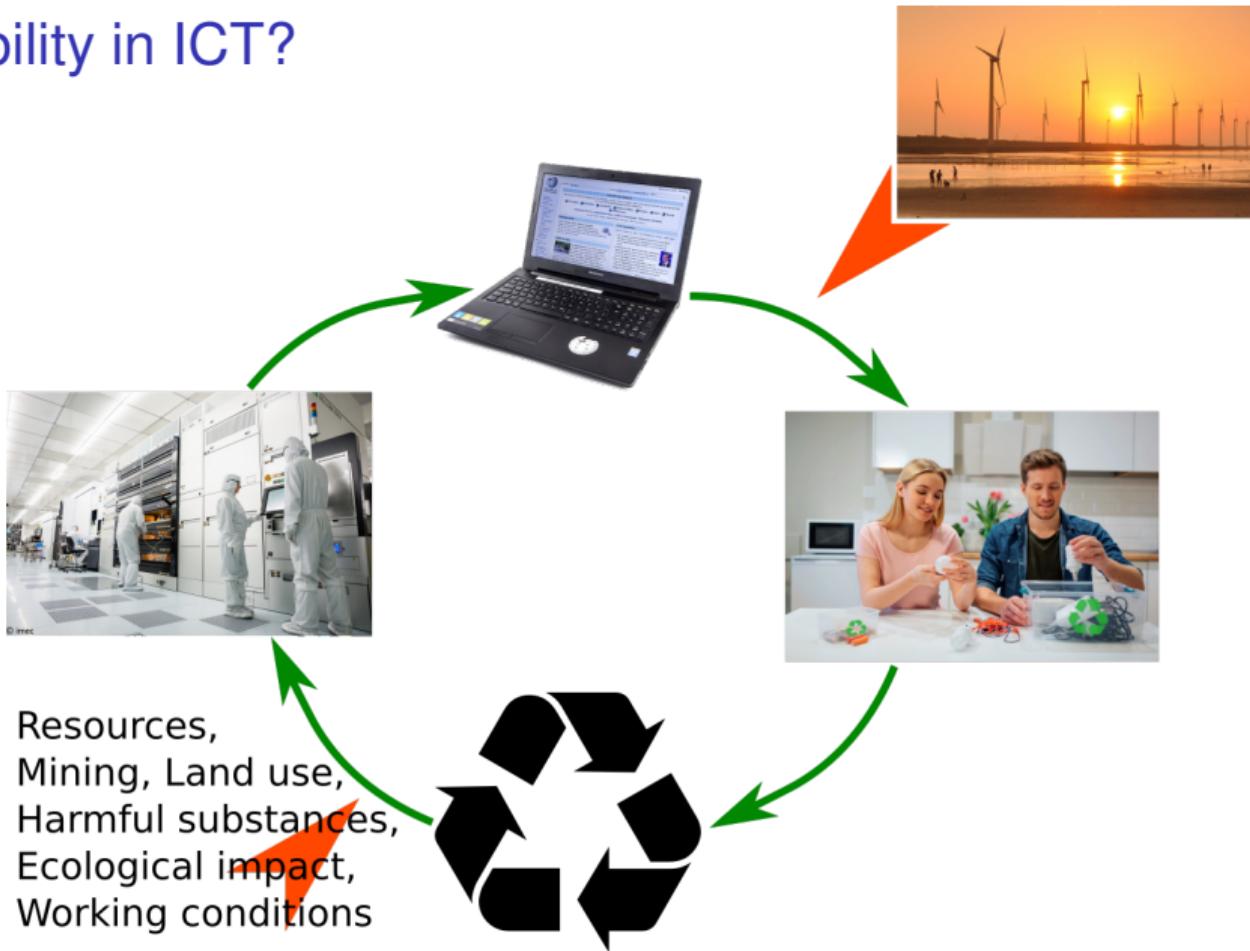
[AE15, And17, ML18].

Focus is on energy
consumption and partly
materials, while land use is
much harder to assess.

Sustainability in ICT?



Sustainability in ICT?



Sustainability in ICT?

Ergonomics,
Accessibility,
Algorithmic
fairness



Resources,
Mining, Land use,
Harmful substances,
Ecological impact,
Working conditions

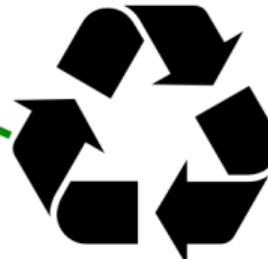


Sustainability in ICT?

Ergonomics,
Accessibility,
Algorithmic
fairness



Resources,
Mining, Land use,
Harmful substances,
Ecological impact,
Working conditions



Lifetime,
Retrieval,
Recyclability,
Recycling,
Harmful substances,
Working conditions

Sustainable AI, Sustainable ICT, Sustainable Societies...

The link to climate and ecosystems:

- A few % of the global economy is a lot of money!
- Infrastructure investments translate to emissions or biosphere impacts.
- Europe's legislation and industrial policy: competitiveness and growth
- Action on climate change: deterrence of migration, armed conflict, resource colonialism
- ICT and AI facilitate these actions!

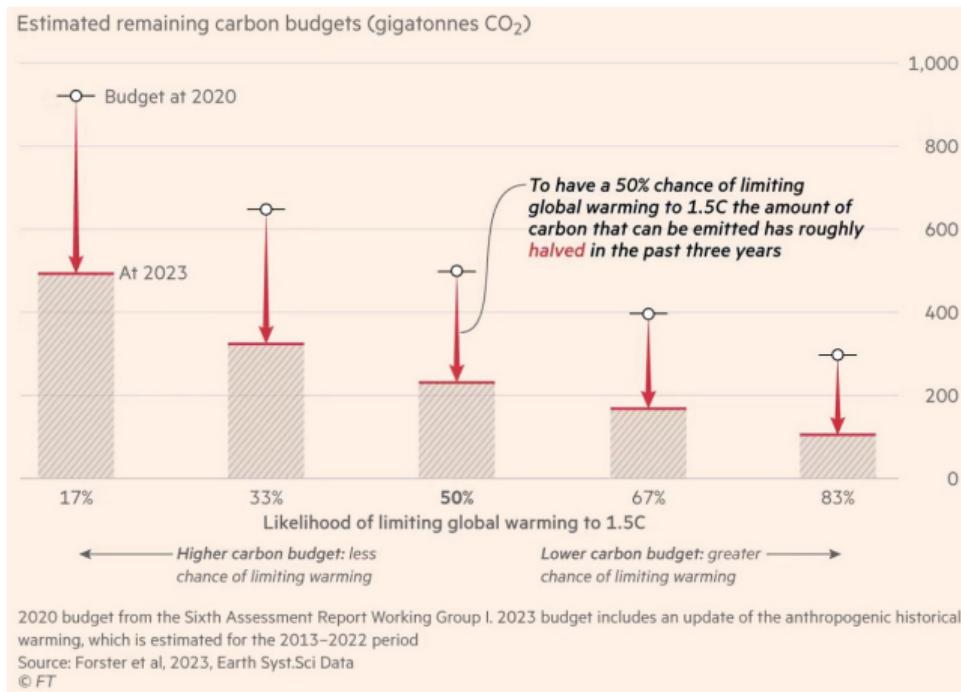


Image source: Financial Times 2023-06-08; Data source: [FSW⁺23]; Policy study: [JGK⁺23]

When does Green Tech Enable Systemic Change?

Sustainability is a Systems Property!

- “The environmental impact of the consumption of an average EU citizen is outside the safe operating space for humanity” [SBB⁺19]

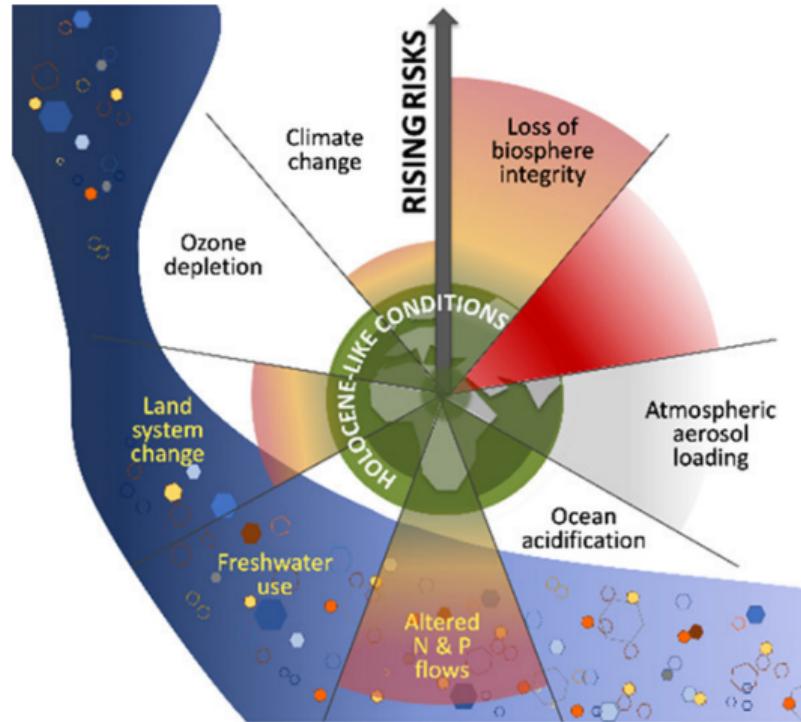


Image source: Persson et al., [PCAC⁺22]

When does Green Tech Enable Systemic Change?

Sustainability is a Systems Property!

- “The environmental impact of the consumption of an average EU citizen is outside the safe operating space for humanity” [SBB⁺19]
- **AI infrastructure has tremendous impacts and needs a democratic process and transparency for development and use!**

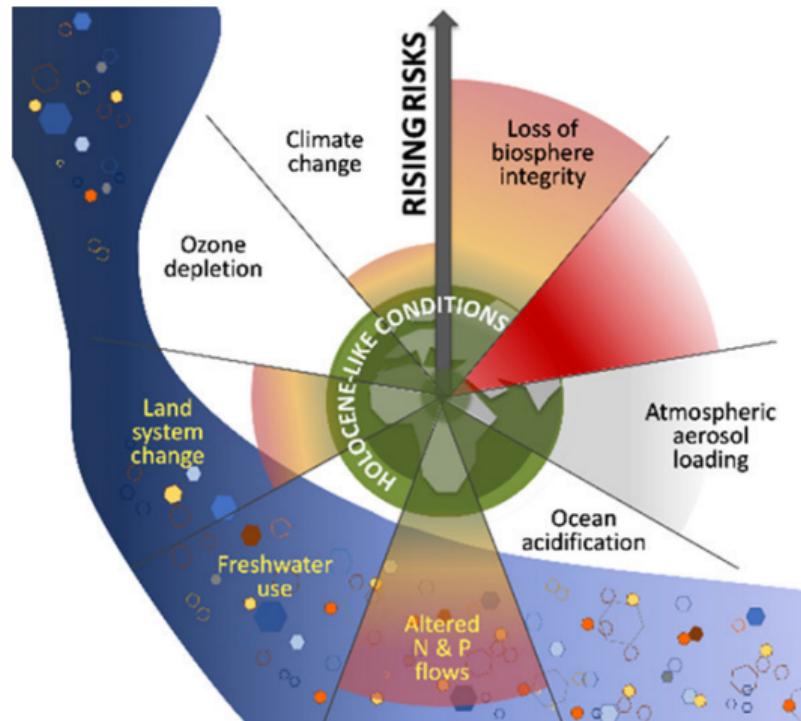


Image source: Persson et al., [PCAC⁺22]

When does Green Tech Enable Systemic Change?

Sustainability is a Systems Property!

- “The environmental impact of the consumption of an average EU citizen is outside the safe operating space for humanity” [SBB⁺19]
- **AI infrastructure has tremendous impacts and needs a democratic process and transparency for development and use!**
- I mostly talked about direct monetary impacts. There’s also **secondary impacts on economy and democracy, biases, copyright, privacy and data protection, equity of access, ...**

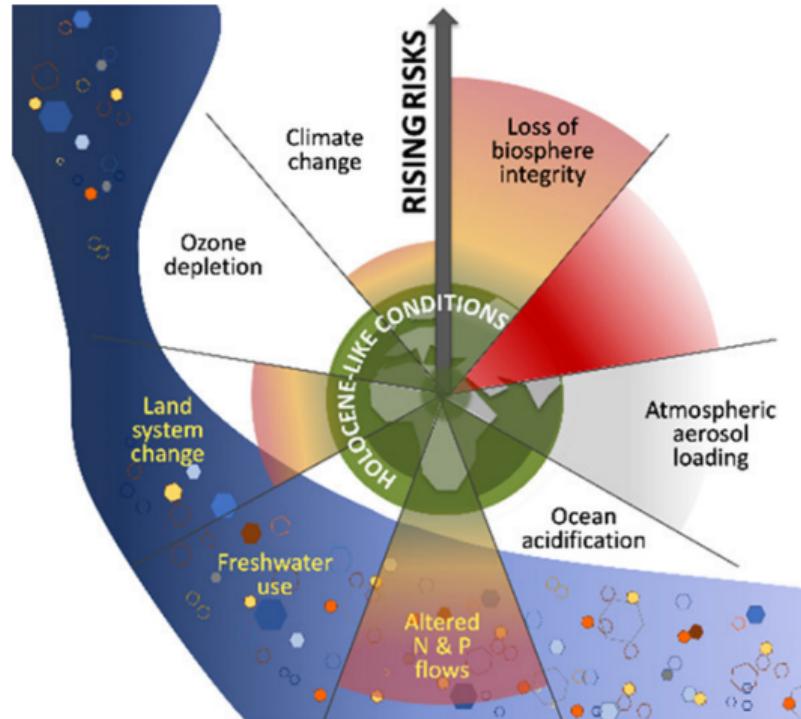


Image source: Persson et al., [PCAC⁺22]

Thank you!

Thank you! Questions?

<https://cybersecurity.ulb.ac.be/>

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