Climate Change AI

Hertie School

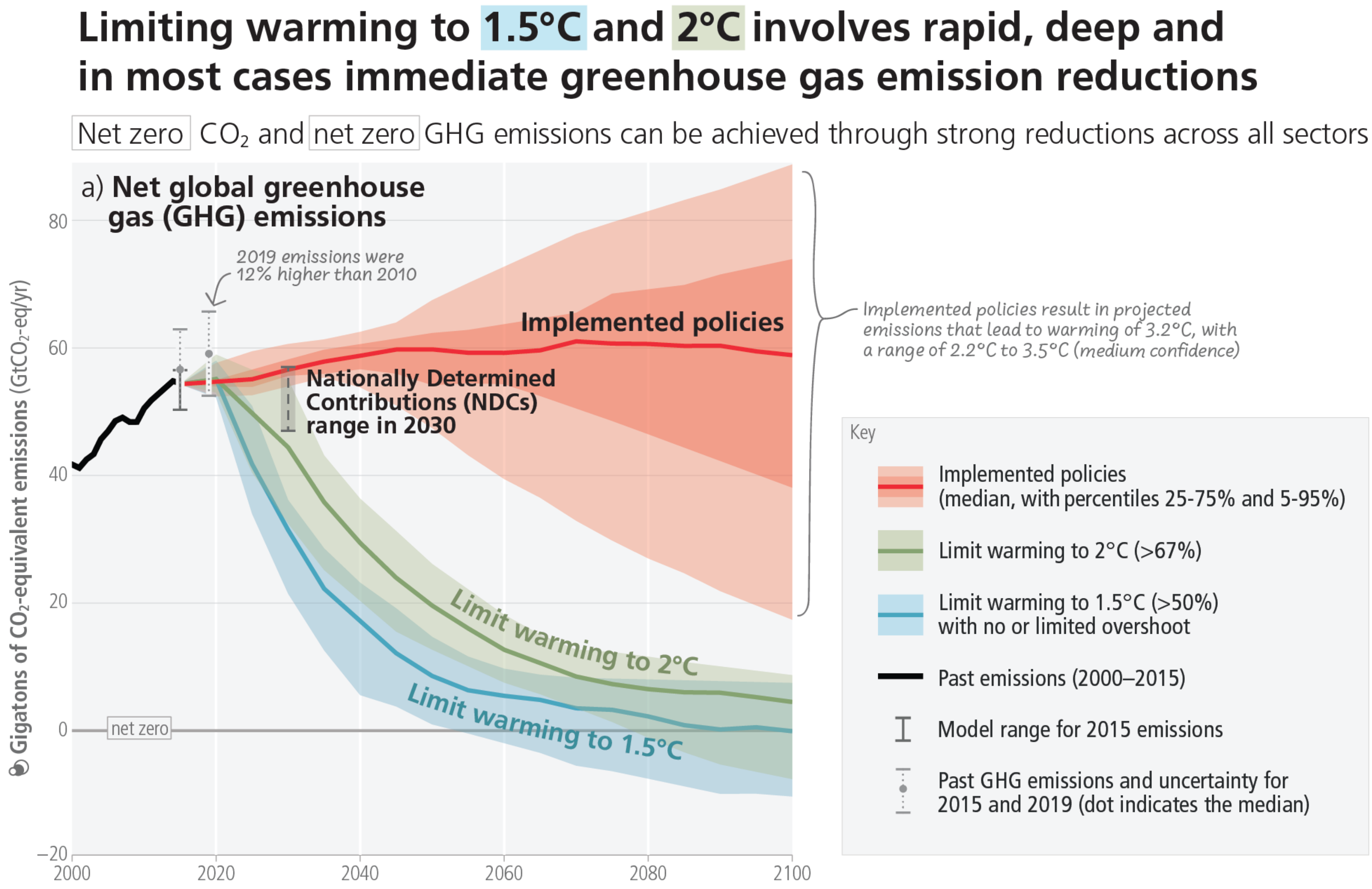
The energy footprint of AI

Lynn Kaack, Hertie School & Climate Change AI

BEREC External Workshop on digital services ecodesign for greener networks and ICTs

April 30, 2025

Limiting global warming



Source: IPCC AR6 Summary for Policymakers

Will AI help to fight climate change?

MIT Technology Review Featured Topics Newsletters Events Podcasts Sign in Subscribe

ARTIFICIAL INTELLIGENCE

Here are 10 ways AI could help fight climate change

Machine learning has the potential to make some real inroads against our biggest threat.

By Karen Hao June 20, 2019

MIT MANAGEMENT SLOAN SCHOOL IDEAS MADE TO MATTER DIVERSITY EVENTS ALUMNI FACULTY

MIT Sloan is the leader in research and teaching in AI. Dive in to discover why.

IDEAS MADE TO MATTER | ARTIFICIAL INTELLIGENCE

Sam Altman believes AI will change the world (and everything else)

by Brian Eastwood | May 8, 2024

"If we have to spend even 1% of the world's electricity training powerful AI, and that AI helps us figure out how to get to non-carbon-based energy or to do carbon capture better, that would be a massive win," – Sam Altman.

United Nations | UN News Global perspective Human stories

3 November 2023 | Climate and Environment

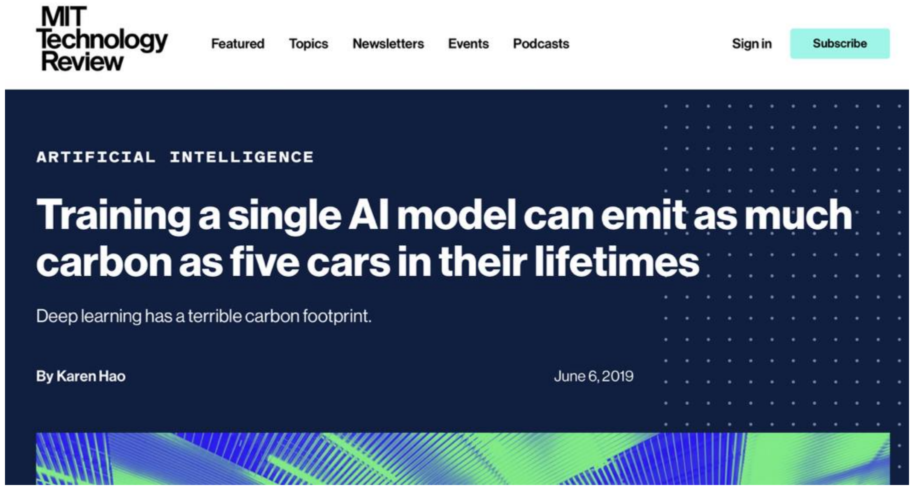
Artificial intelligence (AI) is already making inroads worldwide in health, education and industry, but how can this cutting-edge technology help the world combat and mitigate the effects of climate change?

The recent launch of the UN-led AI Advisory Body advanced a growing global trend to harness machine learning to find solutions to common challenges. AI is upping the data crunching game and a growing number of governments, businesses and civil society partners are working together to reap its many benefits.

That includes speeding up and scaling efforts to realize such global ambitions as the 2030 Agenda and its 17 Sustainable Development Goals (SDGs), which serve as the world's blueprint to make the planet greener, cleaner and fairer.

Ahead of the latest UN Climate Change Conference (COP 28), which begins at the end of November in Dubai, *UN News* looks at how AI helps the world, from communities to corporations to law makers, tackle climate change:

Will AI hurt the climate?

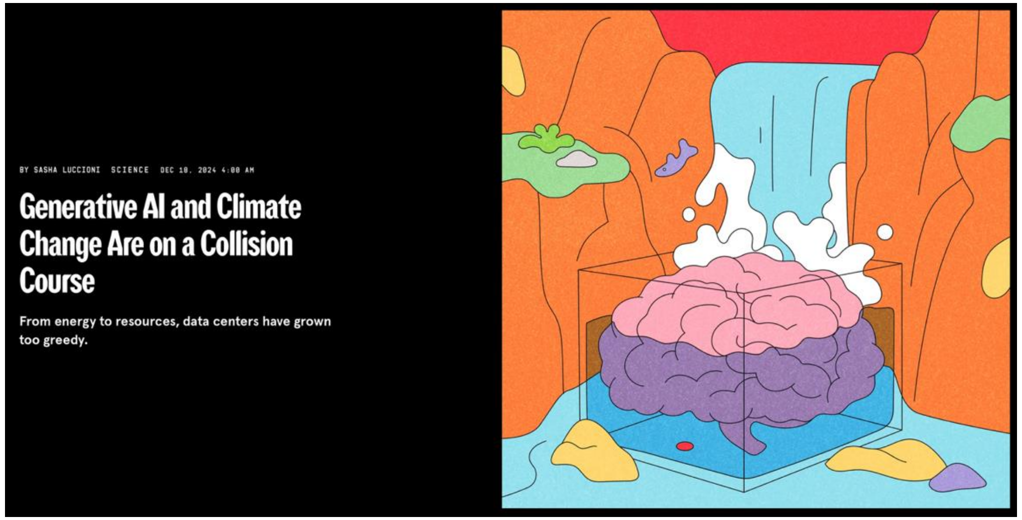

MIT Technology Review
Featured Topics Newsletters Events Podcasts Sign in Subscribe

ARTIFICIAL INTELLIGENCE

Training a single AI model can emit as much carbon as five cars in their lifetimes

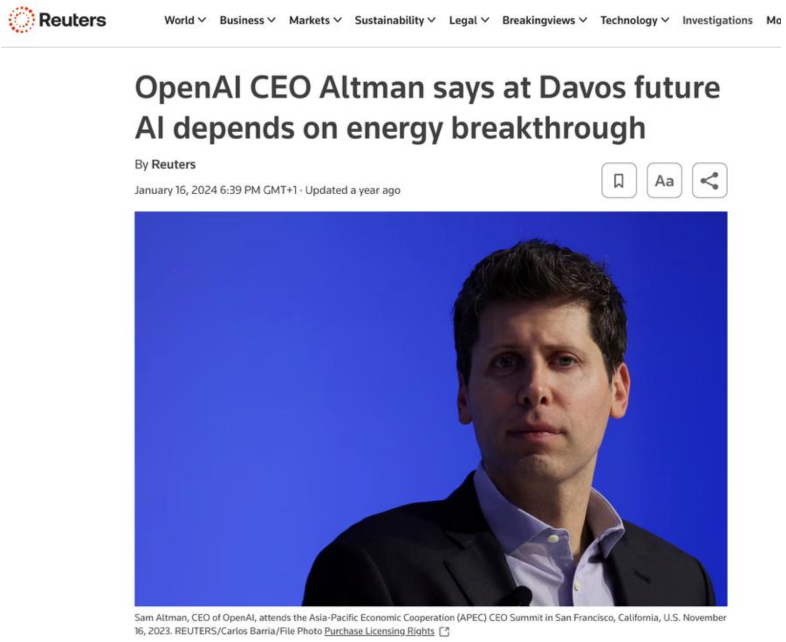
Deep learning has a terrible carbon footprint.

By Karen Hao June 6, 2019


BY SASHA LUCCIONI SCIENCE DEC 18, 2024 4:00 AM

Generative AI and Climate Change Are on a Collision Course

From energy to resources, data centers have grown too greedy.


Reuters
World Business Markets Sustainability Legal Breakingviews Technology Investigations Mo

OpenAI CEO Altman says at Davos future AI depends on energy breakthrough

By Reuters

January 16, 2024 6:39 PM GMT+1 · Updated a year ago

Aa

Sam Altman, CEO of OpenAI, attends the Asia-Pacific Economic Cooperation (APEC) CEO Summit in San Francisco, California, U.S. November 16, 2023. REUTERS/Carlos Barria/File Photo Purchase Licensing Rights


Popular Latest Newsletters The Atlantic Sign In

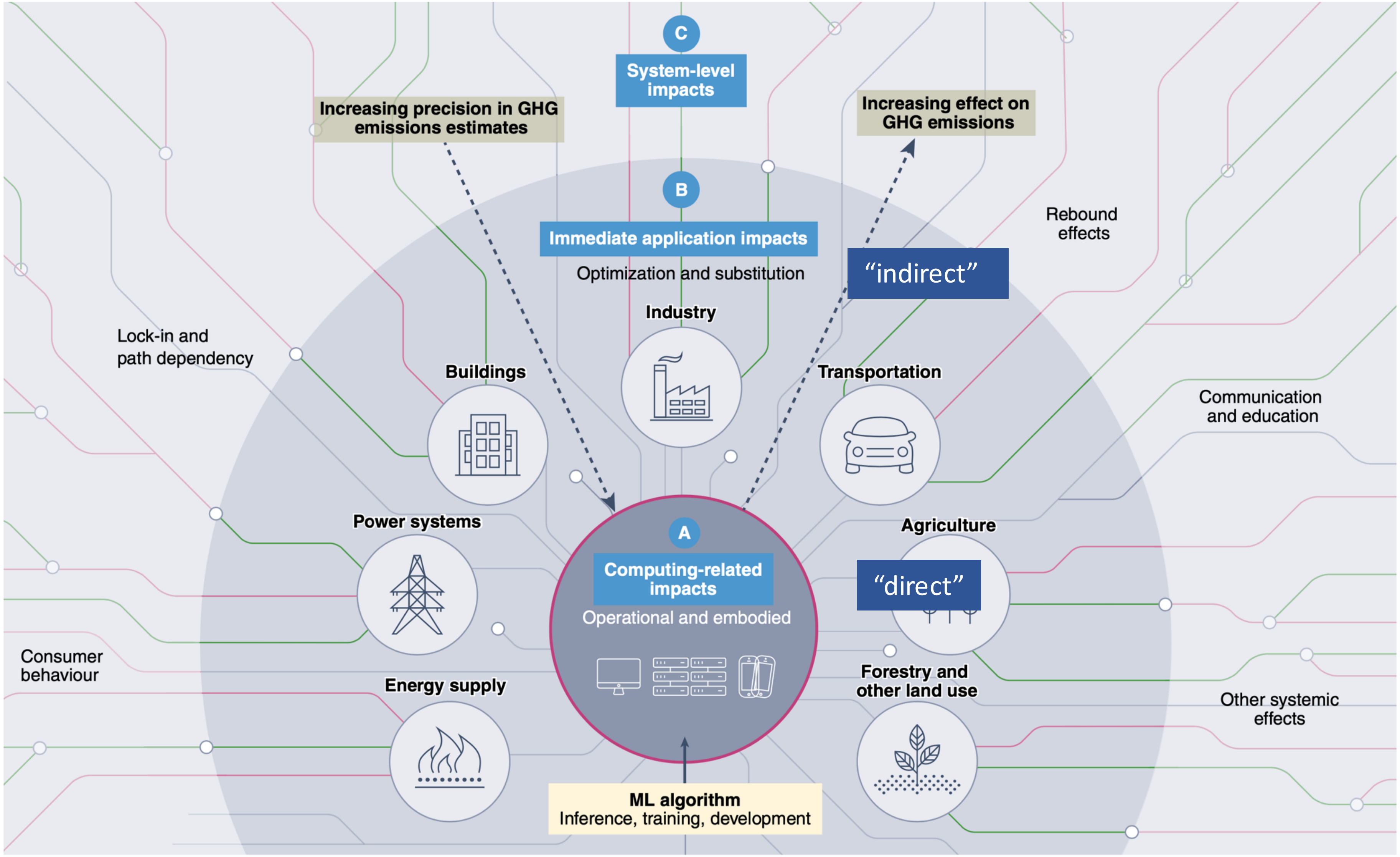
TECHNOLOGY

Microsoft's Hypocrisy on AI

Can artificial intelligence really enrich fossil-fuel companies and fight climate change at the same time? The tech giant says yes.

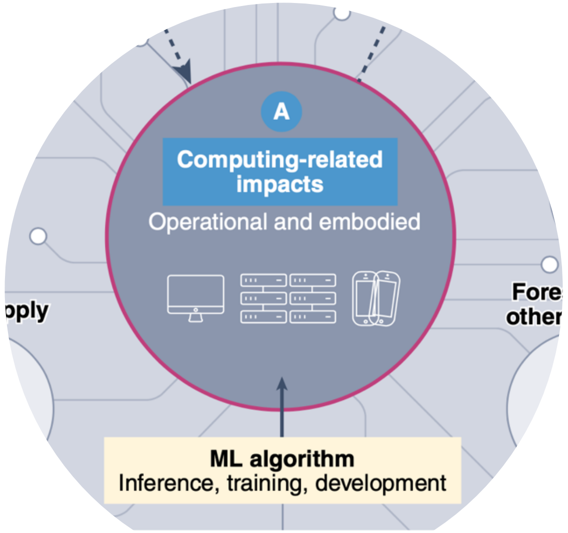
By Karen Hao

How AI affects greenhouse gas emissions



Kaack, L. H., Donti, P. L., Strubell, E., Kamiya, G., Creutzig, F., & Rolnick, D. (2022). *Nature Climate Change*, 1-10.

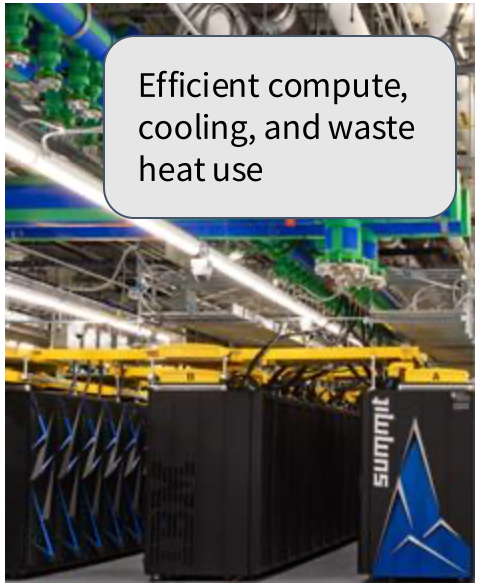
How AI affects greenhouse gas emissions



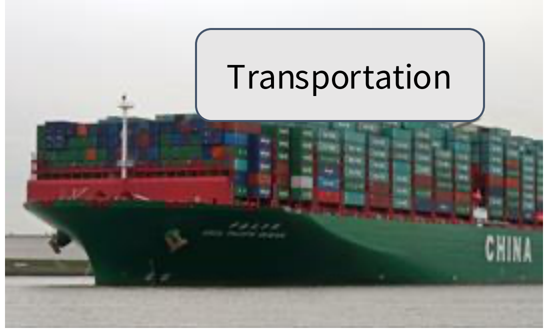
Kaack, L. H., Donti, P. L., Strubell, E., Kamiya, G., Creutzig, F., & Rolnick, D. (2022). *Nature Climate Change*, 1-10.

Impacts from AI computation & hardware

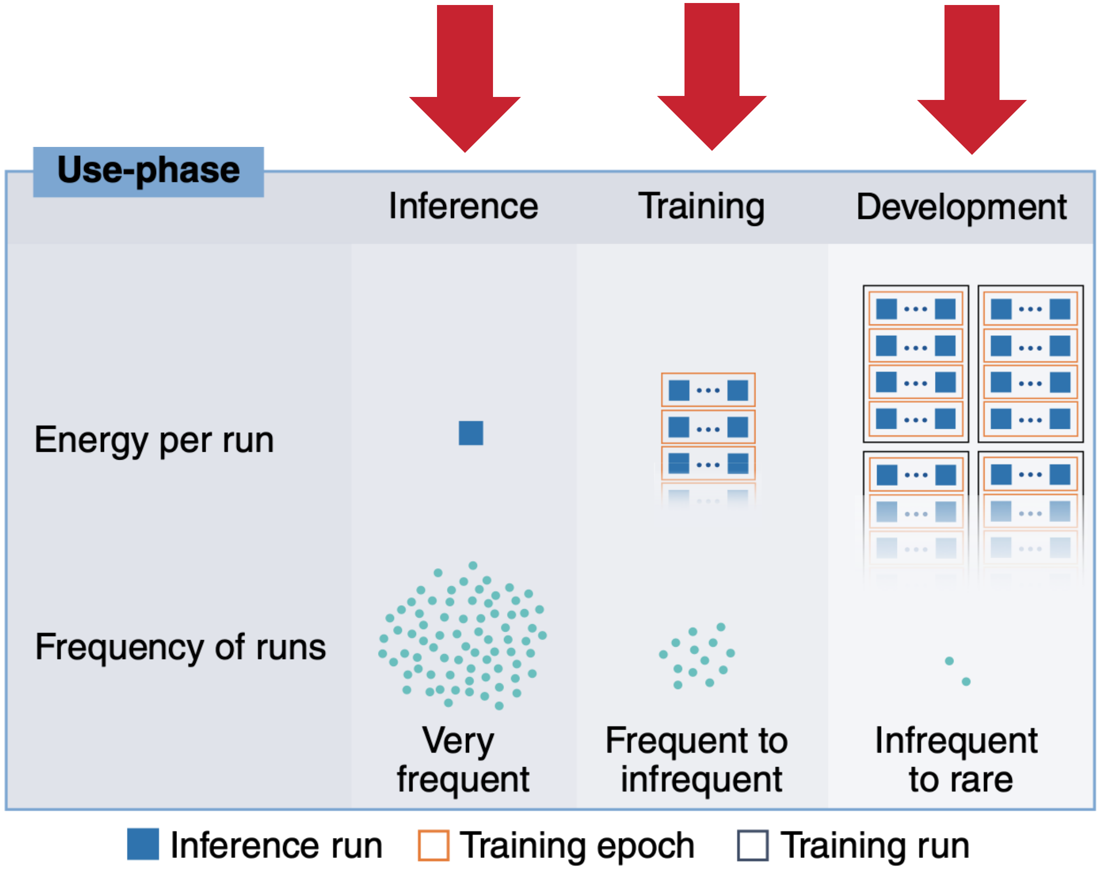
Operational emissions from energy consumed during computation



Embodied emissions from production and end-of-life of hardware



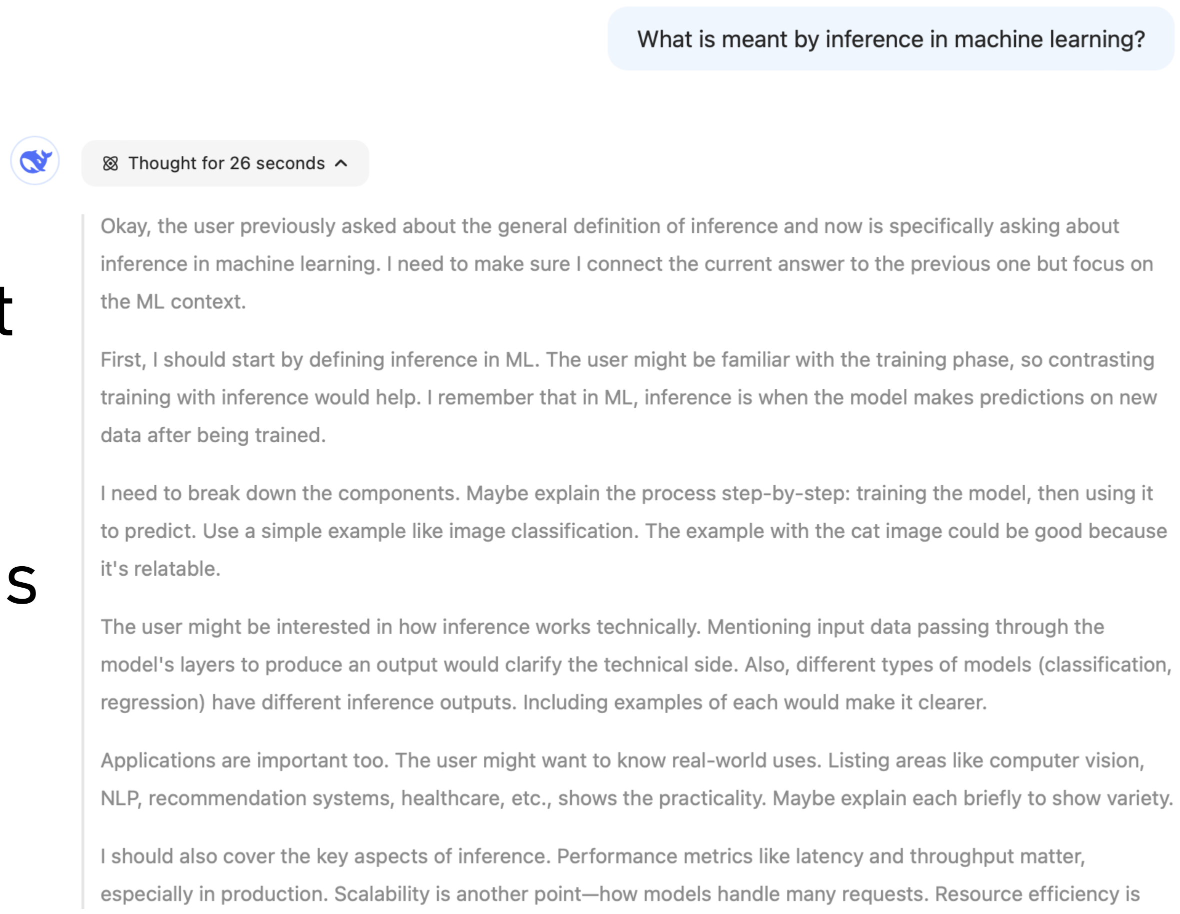
Computing-related emissions from AI



Kaack, L. H., Donti, P. L., Strubell, E., Kamiya, G., Creutzig, F., & Rolnick, D. (2022). *Nature Climate Change*, 1-10.

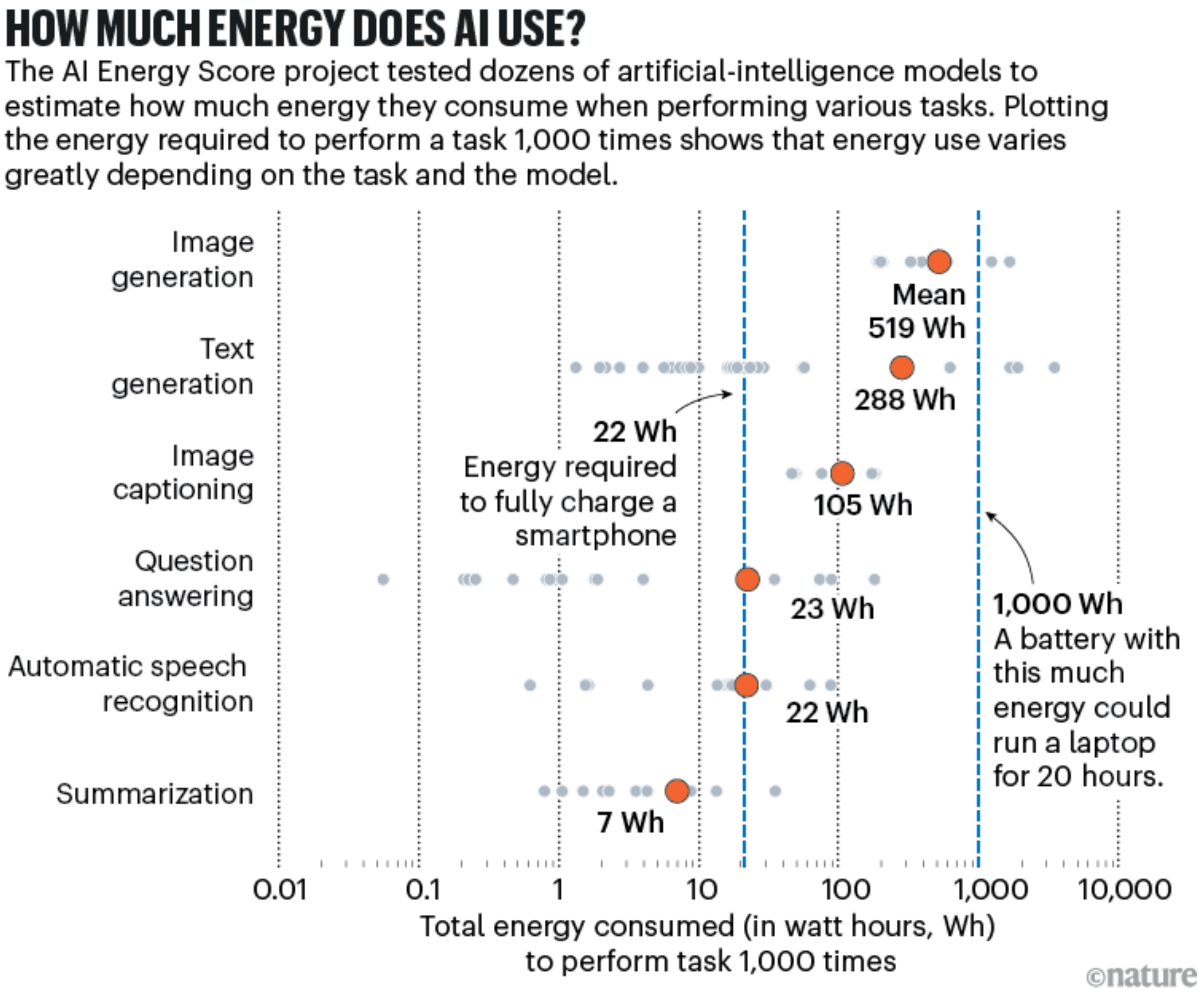
Inference is important

- Inference energy costs may outweigh training over time
- DeepSeek may be more efficient in training than other large language models (LLMs)
- Unclear how inference compares to other LLMs because of "chain of thought" approach in reasoning models
- More and longer outputs before final answer



Computing-related emissions from inference

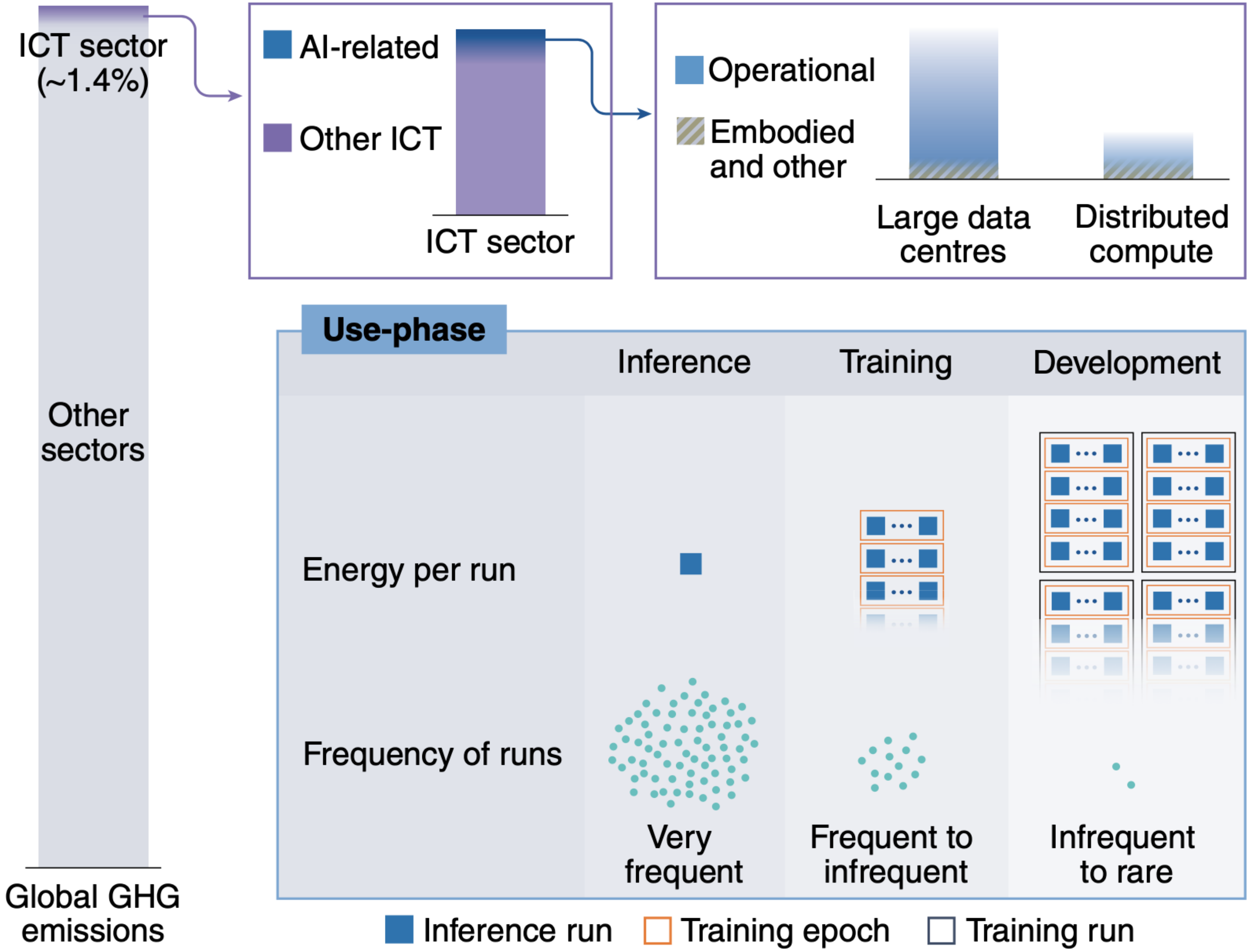
- Numbers on the right are from smaller open-source models and lower bound.
- AI Act: Inference energy reporting for proprietary GPAI models in Code of Practice
- Generative tasks are more energy-intensive compared to discriminative tasks.
- Tasks involving images are more energy-intensive compared to those involving text.
- Using general-purpose AI (GPAI) for discriminative tasks is more energy-intensive compared to task-specific models.



Source: https://www.nature.com/articles/d41586-025-00616-z

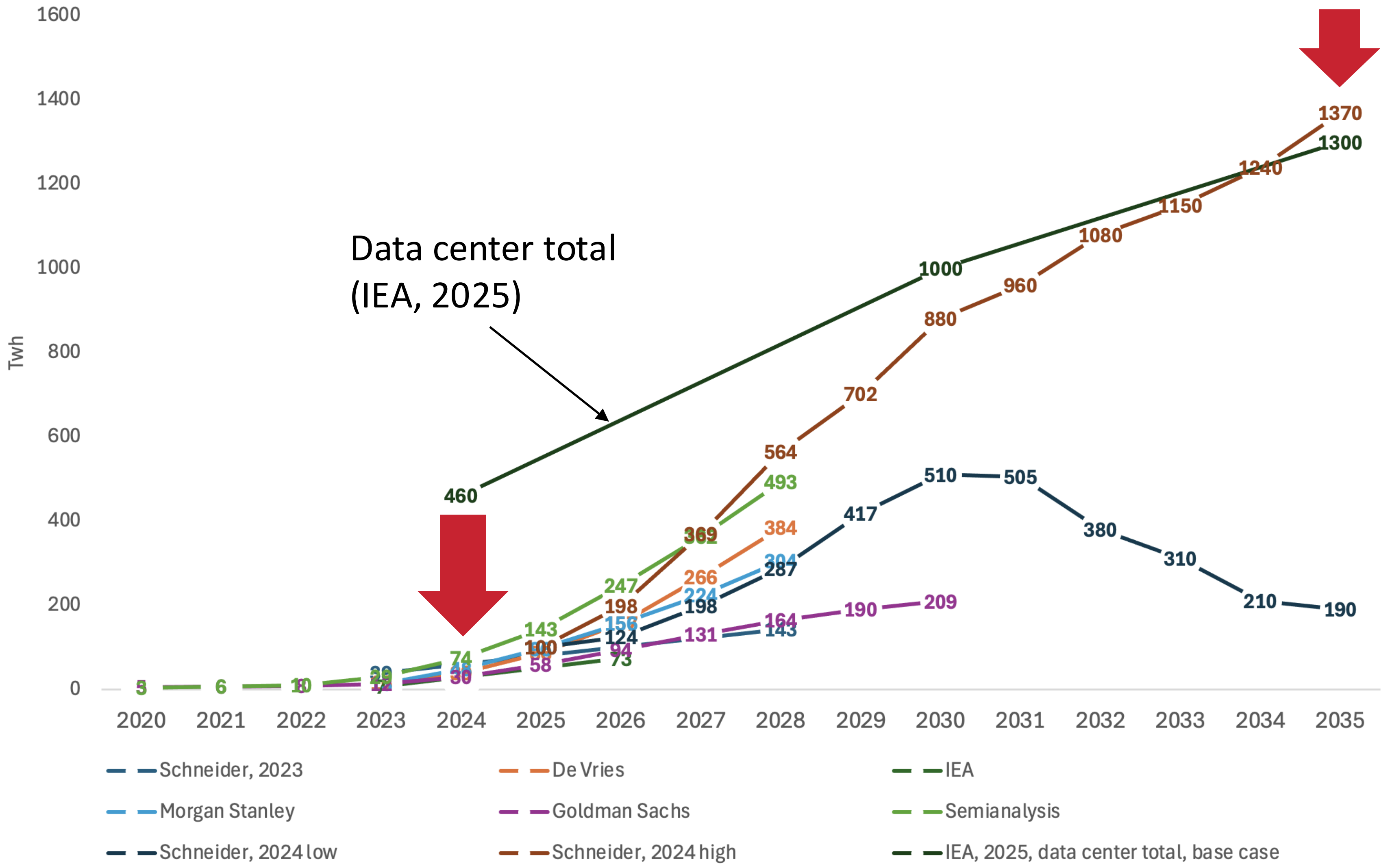
Computing-related emissions from AI

uncertain and now larger



Kaack, L. H., Donti, P. L., Strubell, E., Kamiya, G., Creutzig, F., & Rolnick, D. (2022). *Nature Climate Change*, 1-10.

Total annual computing-related energy consumption from AI



Comparison

Global electricity consumption 2023: 29,479.05 TWh

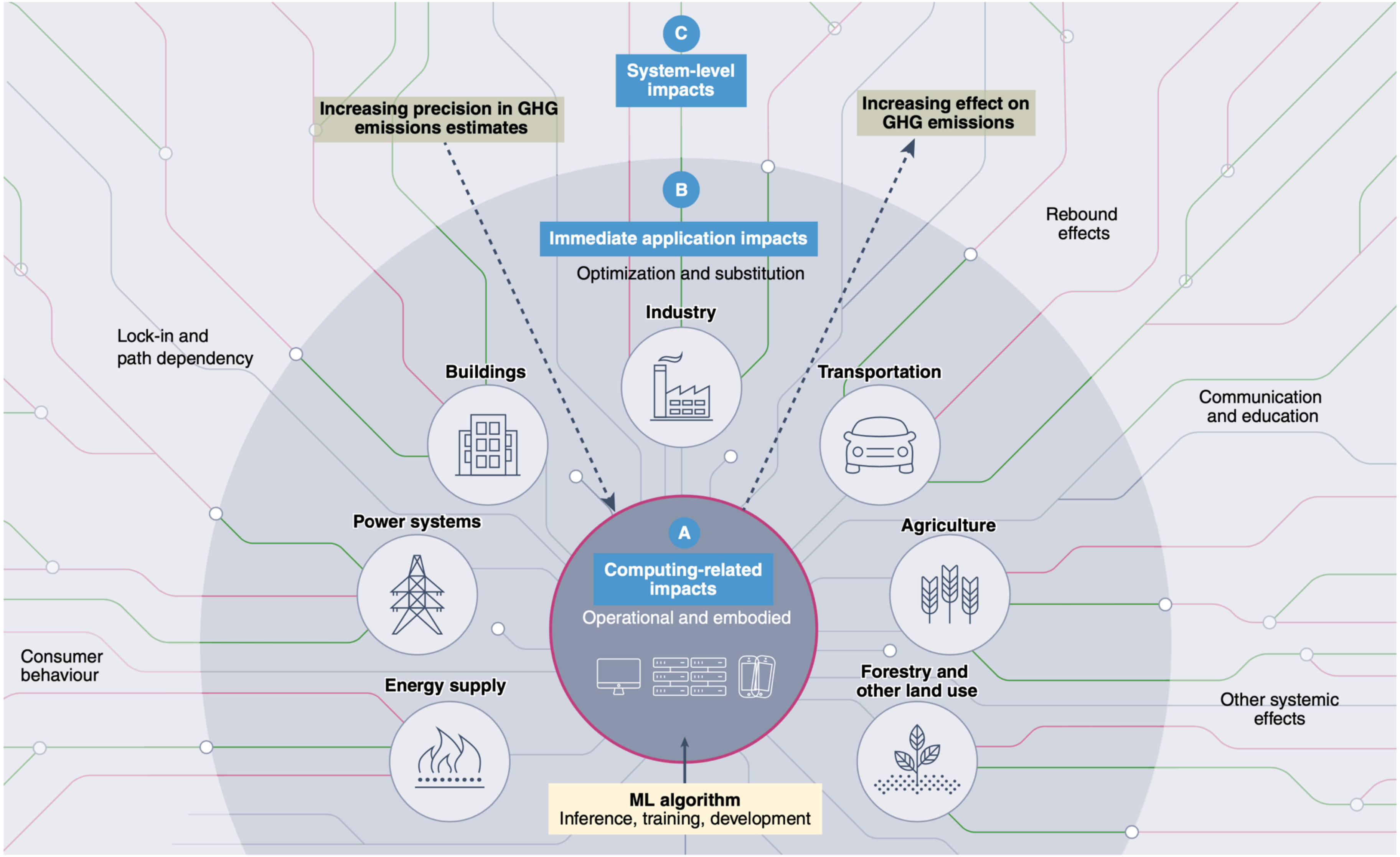
Total electricity consumption in 2023:

- low-income countries 2023: 126.35 TWh
- United States: 4,249.05 TWh

Source: Our World in Data

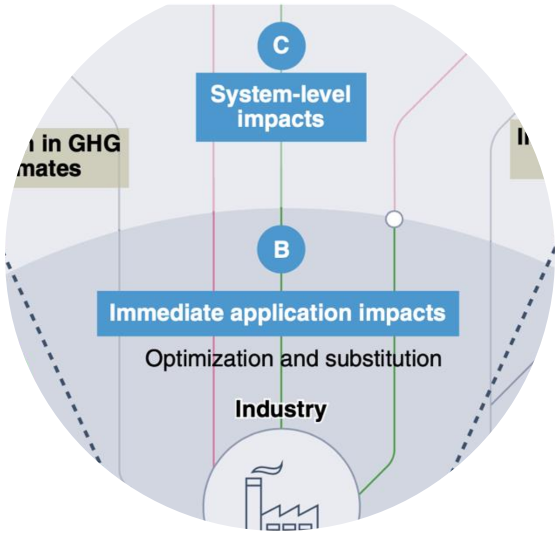
Source: adapted from Roegen Centre for Sustainability and INFRAS with data from Schneider Electric, 2023; Schneider Electric, 2024; De Vries, 2023; IEA, 2024; Morgan Stanley, 2024; Goldman Sachs, 2024; Semianalysis, 2024

How AI affects greenhouse gas emissions



Kaack, L. H., Donti, P. L., Strubell, E., Kamiya, G., Creutzig, F., & Rolnick, D. (2022). *Nature Climate Change*, 1-10.

How AI affects greenhouse gas emissions



Kaack, L. H., Donti, P. L., Strubell, E., Kamiya, G., Creutzig, F., & Rolnick, D. (2022). *Nature Climate Change*, 1-10.

Resources

SURVEY OPEN ACCESS

Tackling Climate Change with Machine Learning

Authors: David Rolnick, Priya L. Donti, Lynn H. Kris Sankaran, Andrew Slavin Ross, Nikola Miloj Alexandra Sasha Luccioni, Tegan Maharaj, Evan Carla P. Gomes, Andrew Y. Ng, Demis Hassabis, Yoshua Bengio (Less) Authors Info & Claims

ACM Computing Surveys, Volume 55, Issue 2 • March 2023

Online: 07 February 2022 Publication History

Article

A systematic map of machine learning in urban climate change mitigation

Marie Josefine Hintz[1] ORCID Email
Nikola Milojevic-Dupont[2] ORCID
Felix Creutzig[2] ORCID
Lynn Kaack[3]

[1] *Technical University Berlin,*
[2] *Mercator Research Institute on Global Commons and Climate Change,*
[3] *Hertie School*

This is a preprint; it has not been peer reviewed by a journal.

https://doi.org/10.21203/rs.3.rs-4242075/v1

Annual Review of Environment and Resources

Machine Learning for ... nergy Systems

...Zico Kolter[1,3]
...e Mellon University, Pittsburgh, Pennsylvania 15213,
...olicy, Carnegie Mellon University, Pittsburgh,
...ittsburgh, Pennsylvania 15222, USA

nature > perspectives > article

Perspective | Published: 13 February 2019

Deep learning and process understanding for data-driven Earth system science

Markus Reichstein, Gustau Camps-Valls, Bjorn Stevens, Martin Jung, Joachim Denzler, Nuno Carvalhais & Prabhat

Nature **566**, 195–204 (2019) | Cite this article

...orecasting and Social Change
...olume 180, July 2022, 121662

...al intelligence for climate change adaptation

Walter Leal Filho [a b], Tony Wall [c], Serafino Afonso Rui Mucova [d], Gustavo J. Nagy [e], Abdul-Lateef Balogun [f g], Johannes M. Luetz [h i j], Artie W. Ng [k], Marina Kovaleva [l], Fardous Mohammad Safiul Azam [m], Fátima Alves [n], Zeus Guevara [o p], Newton R Matandirotya [q r], Antonis Skouloudis [s], Asaf Tzachor [t], Krishna Malakar [u], Odhiambo Gandhi [v]

Show more

Add to Mendeley Share Cite

https://doi.org/10.1016/j.techfore.2022.121662 Get rights and content

ML for district energy

Motivation: District heating systems for use of waste heat

Application: Forecasting heat demand for better scheduling of efficient production units

ML: Sequence prediction based on heat generation and metering and environmental data

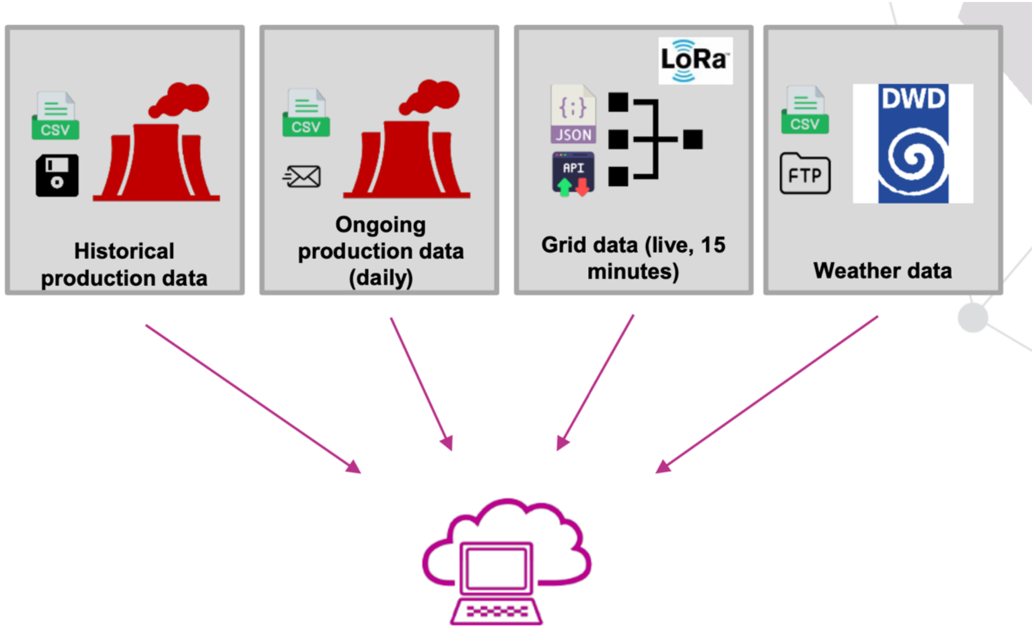
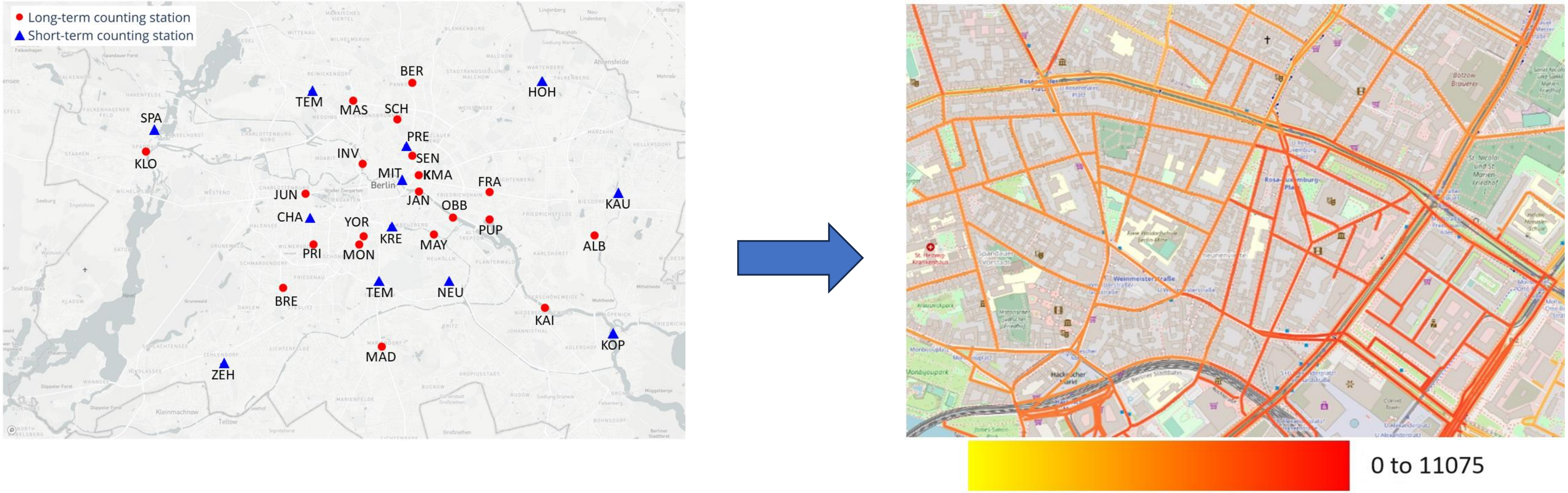


Image: dena

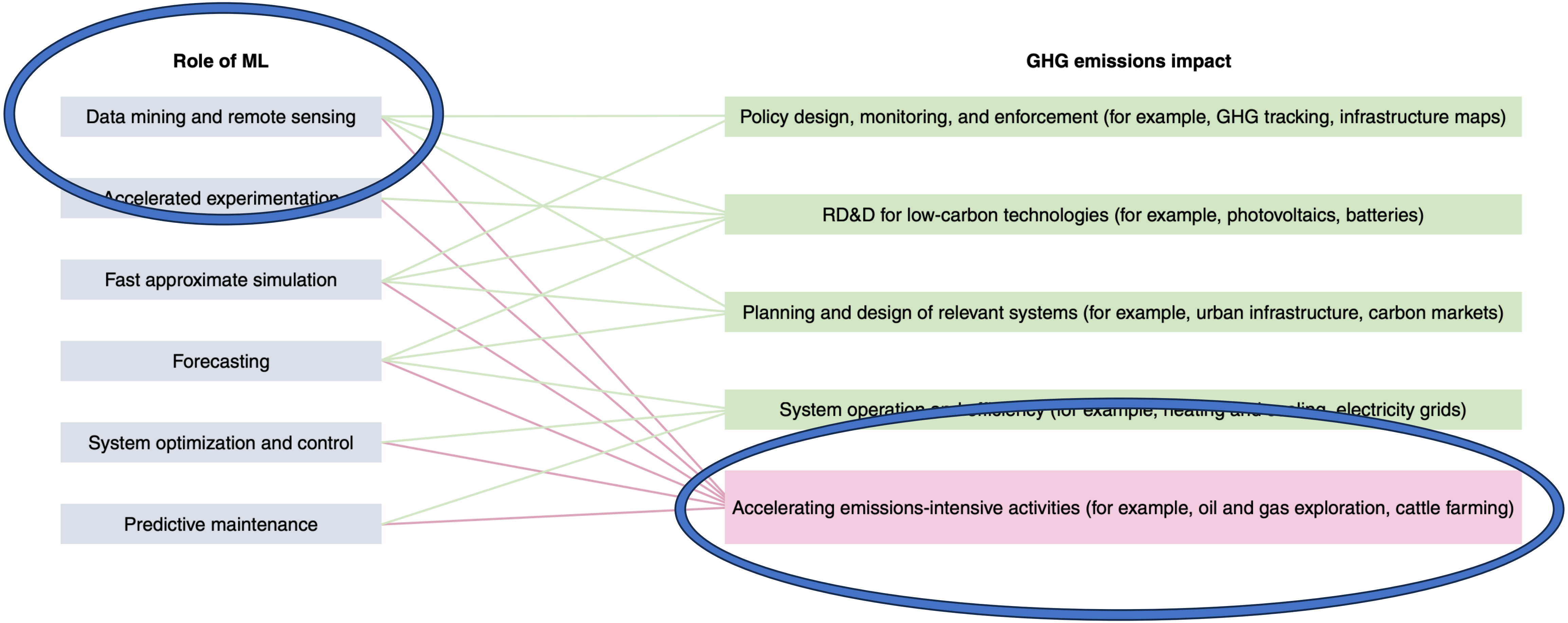
Data-Driven Bicycle Volume Extrapolation

Predicting daily and average annual daily street-level bicycle volumes using machine learning and various public data sources



Kaiser SK, Klein N, Kaack LH. From counting stations to city-wide estimates: data-driven bicycle volume extrapolation. *Environmental Data Science*. 2025;4:e13. doi:10.1017/eds.2025.5

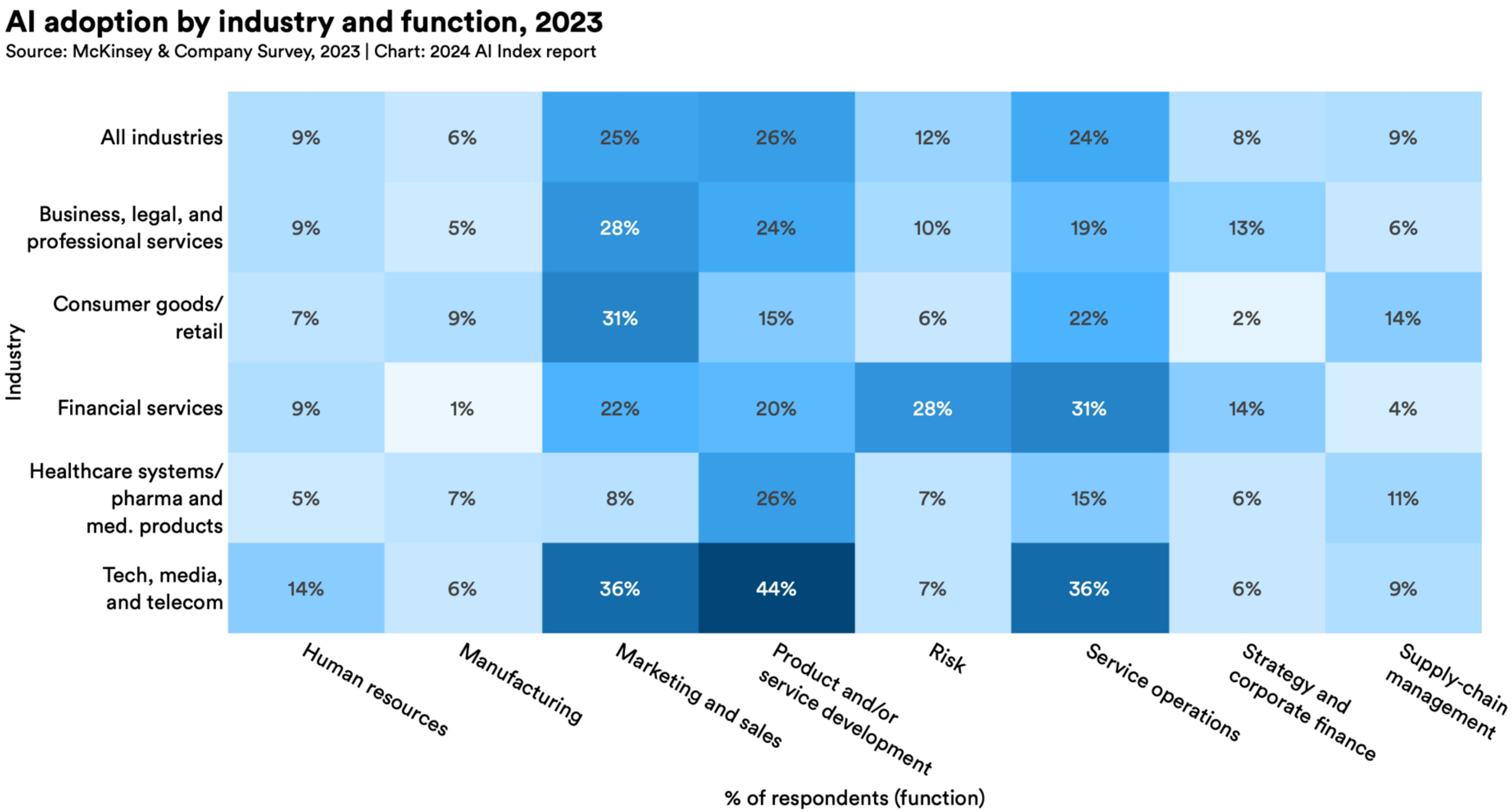
Role of AI for reducing emissions



Kaack, L. H., Donti, P. L., Strubell, E., Kamiya, G., Creutzig, F., & Rolnick, D. (2022). Aligning artificial intelligence with climate change mitigation. *Nature Climate Change*, 1–10.

The system perspective

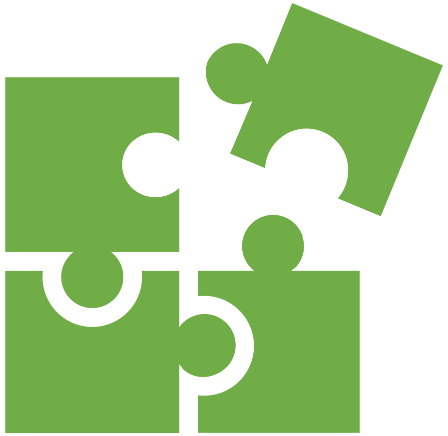
- Where is most AI applied?
  - Service development and operations in the tech sector
  - Marketing
  - Financial service operations
- Indirectly affect emissions
- Recent boom of Large Language Models (LLMs)
- Very few applications of LLMs to help climate action



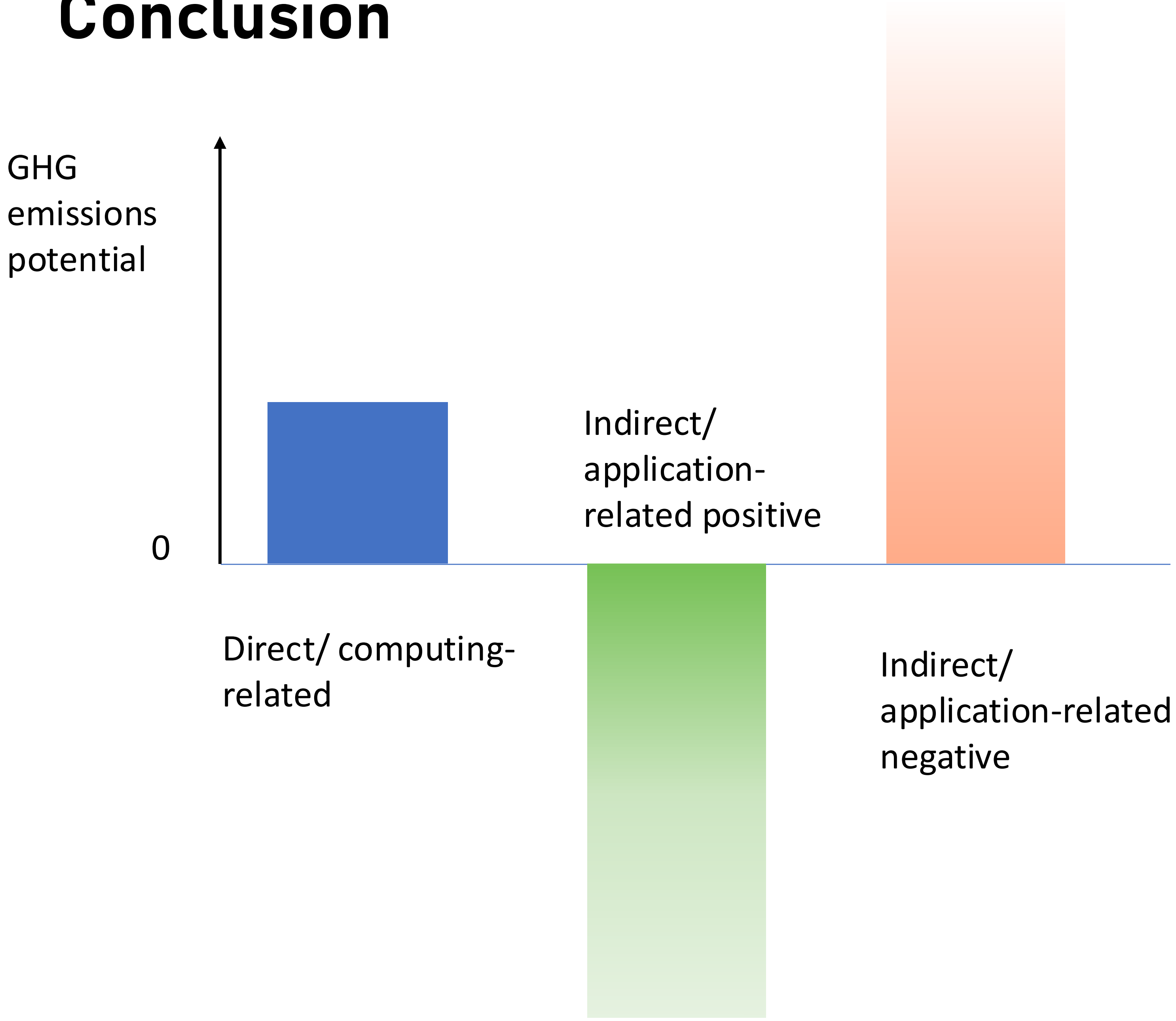
Source: AI Index Report, 2024

AI for sustainability applications need to scale

- Without deployment at scale in sectors like energy, transportation or agriculture, AI will not reduce emissions (barriers to deployment)
- Where AI is applicable, it is only one piece of the puzzle that needs to integrate with existing technologies and processes
- Many AI applications are not market-ready (yet)
- Benefits and costs are poorly understood – need for more pilot projects
- Different collaboration and implementation models - need for best practices



Conclusion

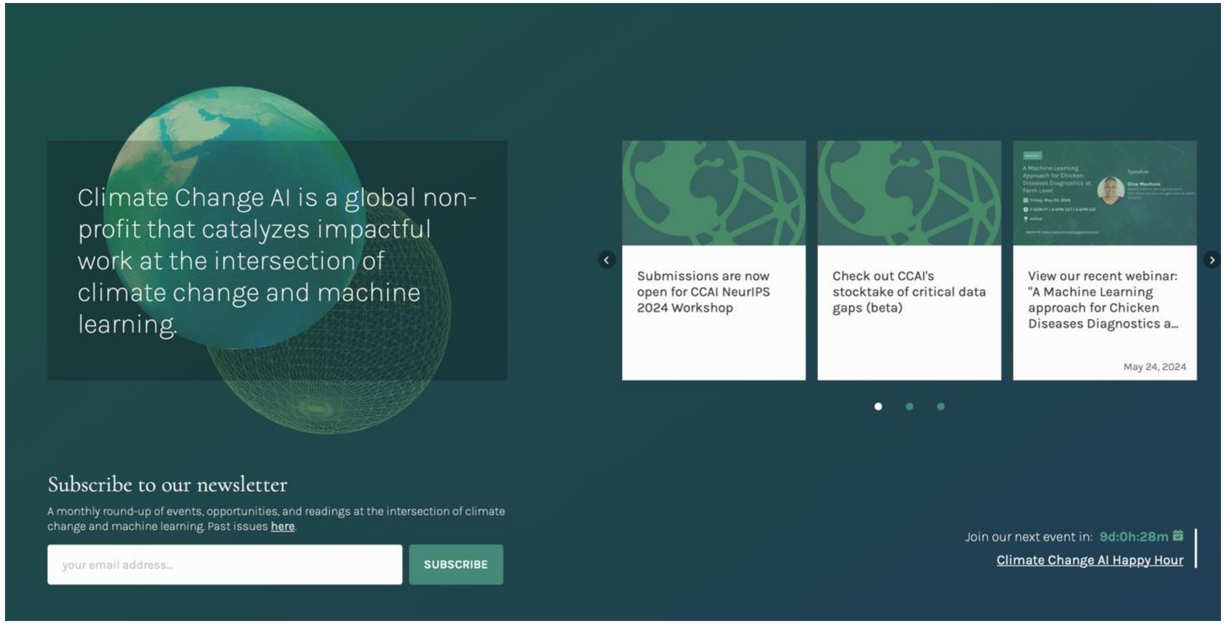


- Large uncertainty about current and future emissions effects
- LLMs have an energy problem – and contribute little so far to climate action

Climate Change AI

Catalyzing impactful work at the intersection of climate change and AI

- Workshops at main AI conferences
- $4MM Innovation Grants Program (3rd round)
- Summer schools 2022-24
- Policy advice and events at UNFCCC climate conferences
- Monthly newsletter
- Community platform



www.climatechange.ai

Hertie School

Thank you!

Contact

AI and Climate Technology Policy Group

Lynn Kaack

Assistant Professor at **Hertie School of Governance**

Co-founder and Chair of **Climate Change AI**

Homepage: https://lynnkaack.com

E-mail: kaack@hertie-school.org

www.climatechange.ai