

# *Digitalisation and Energy Demand*

Pippa Amanta

[felippa.amanta@ouce.ox.ac.uk](mailto:felippa.amanta@ouce.ox.ac.uk)

Energy and Society

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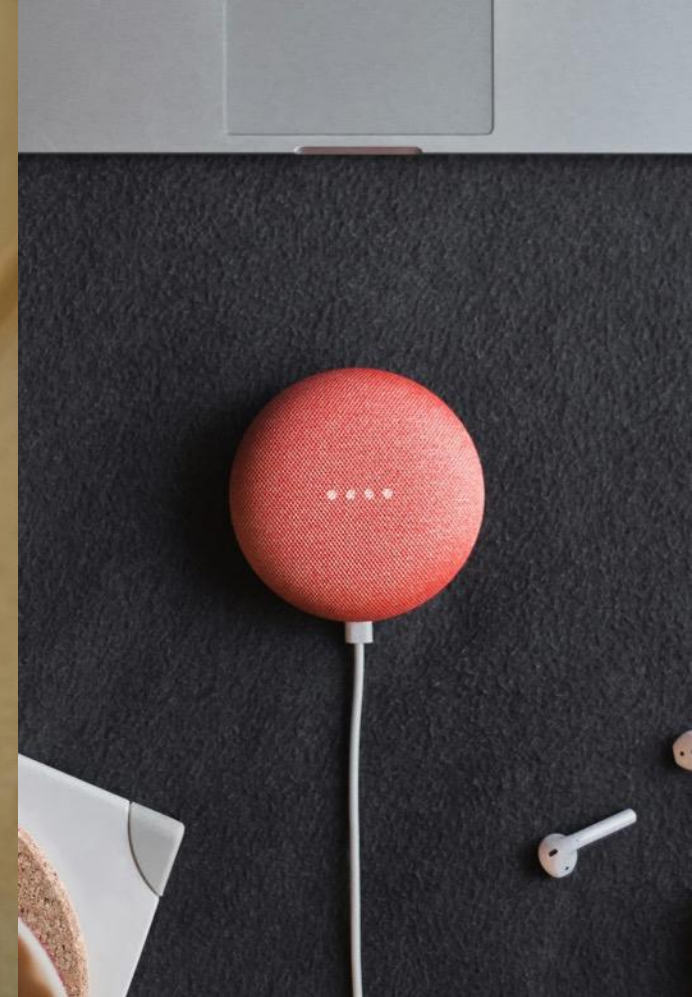
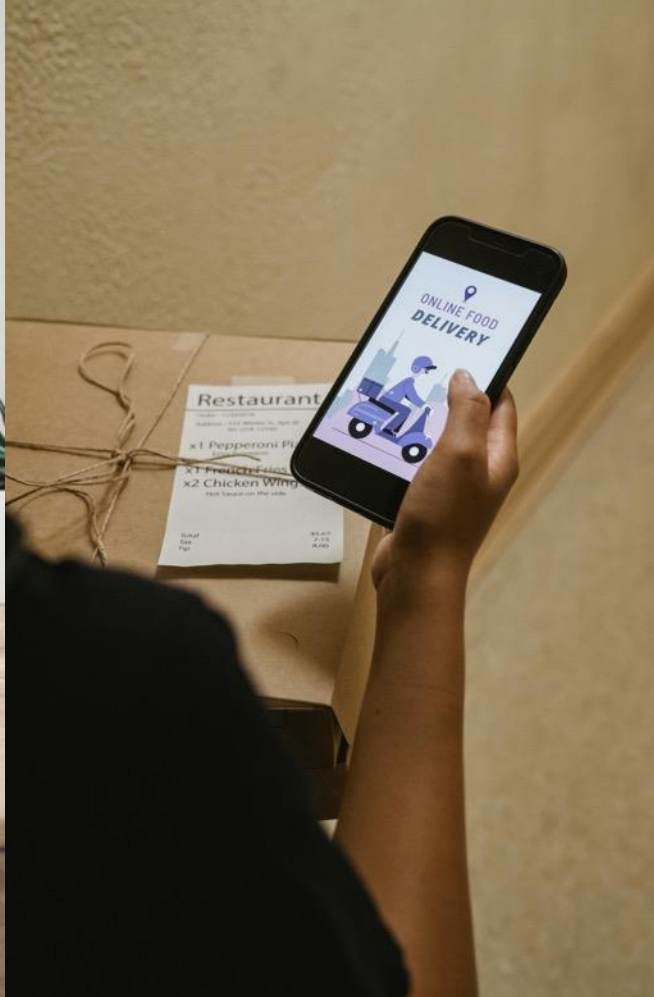
**How many digital devices  
do you use daily?**

# Outline

- Digital transformation trends
- Energy impacts of digitalisation
  - *Breakout discussion*
- Q&A





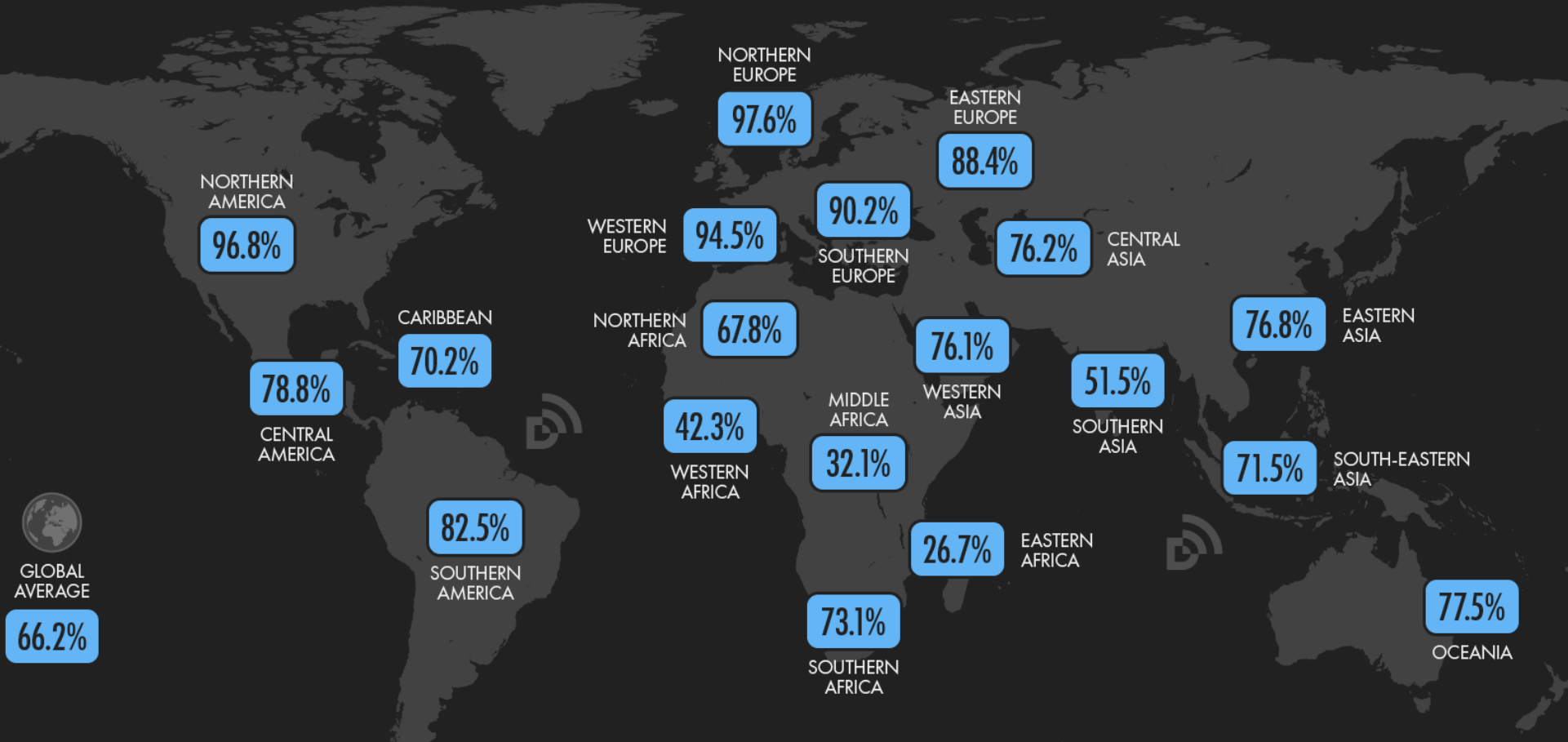


# *Digital Transformation*

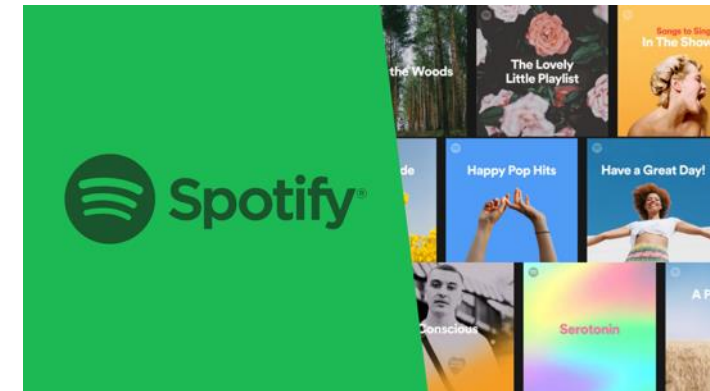
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# INTERNET ADOPTION

INDIVIDUALS USING THE INTERNET AS A PERCENTAGE OF TOTAL POPULATION

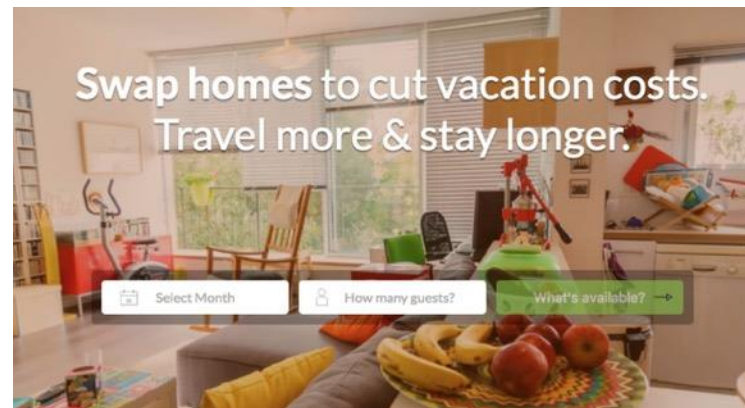
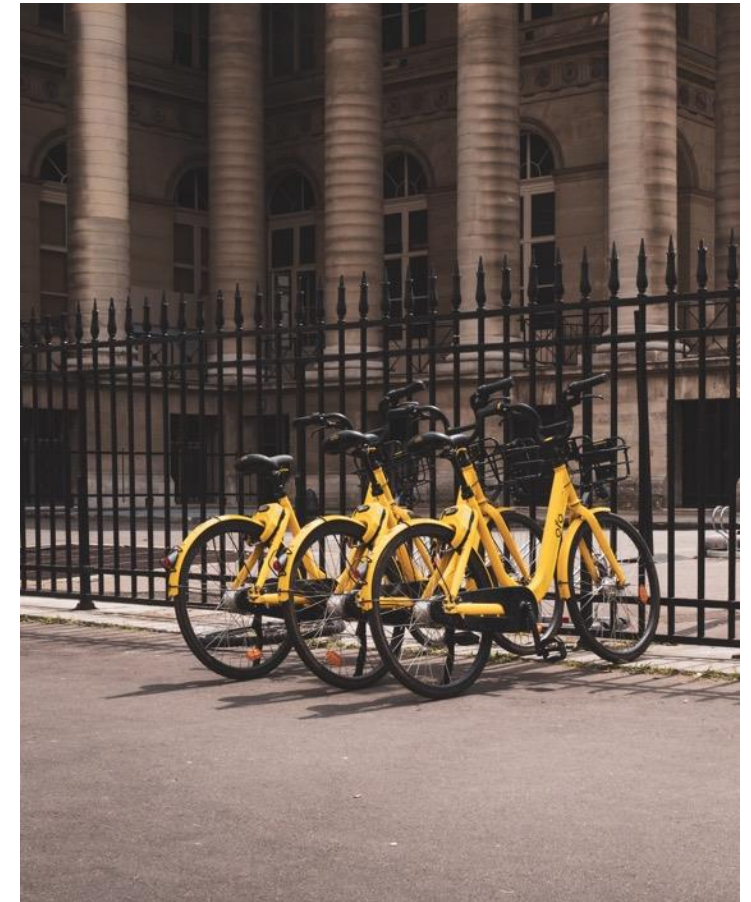


# Dematerialisation<sup>[1]</sup>

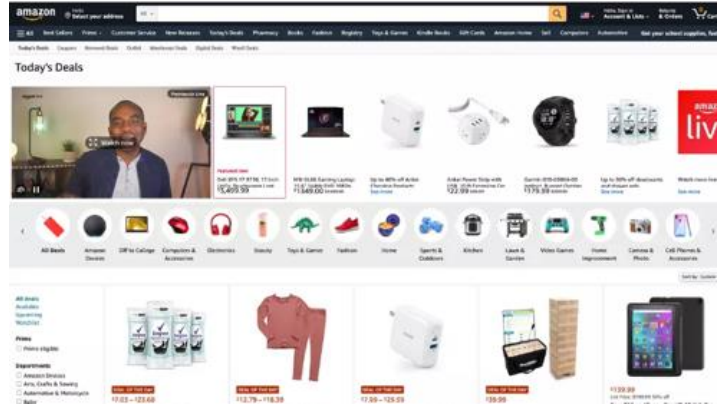




# Sharing economy [2]



# Platform economy [3]





# Global annual internet traffic<sup>[4]</sup>

Tracking Clean Energy Progress

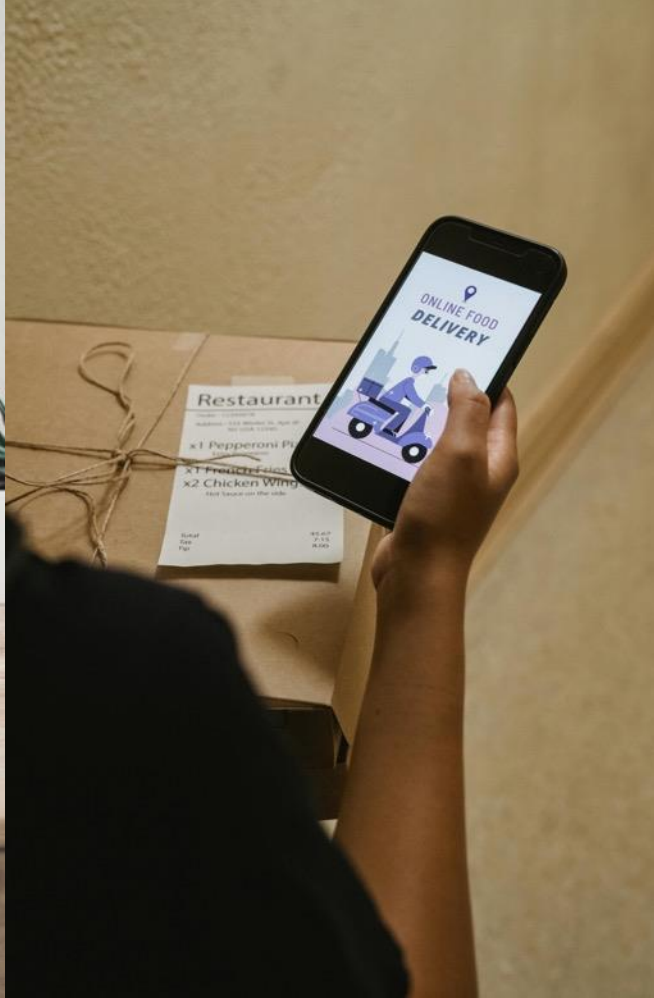
1997  
**60 PB**

2007  
**54 EB**

2017  
**1.1 ZB**

2022  
**4.2 ZB**

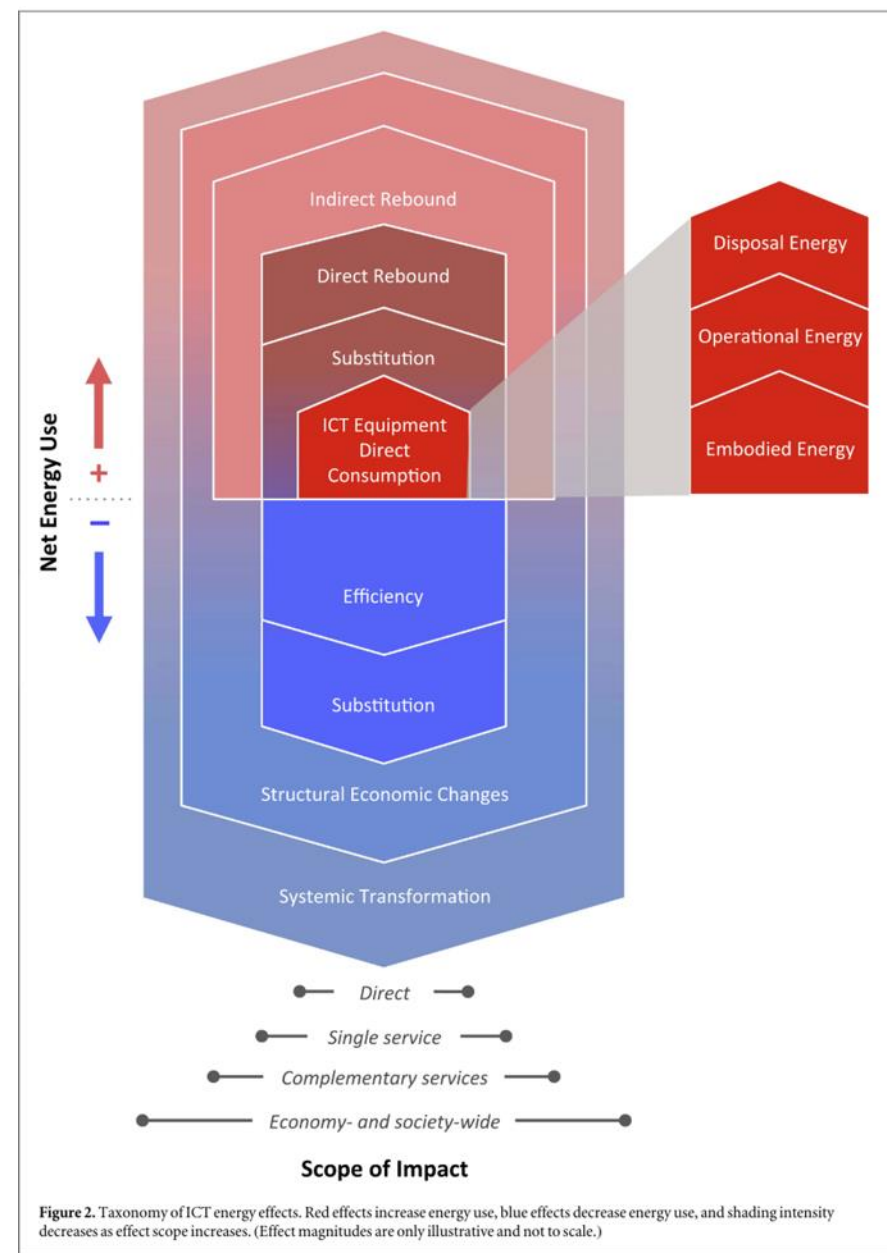
KB	kilobyte	$10^3$ bytes
MB	megabyte	$10^6$ bytes
GB	gigabyte	$10^9$ bytes
TB	terabyte	$10^{12}$ bytes
PB	petabyte	$10^{15}$ bytes
EB	exabyte	$10^{18}$ bytes
ZB	zettabyte	$10^{21}$ bytes
YB	yottabyte	$10^{24}$ bytes



# *Energy Impacts*

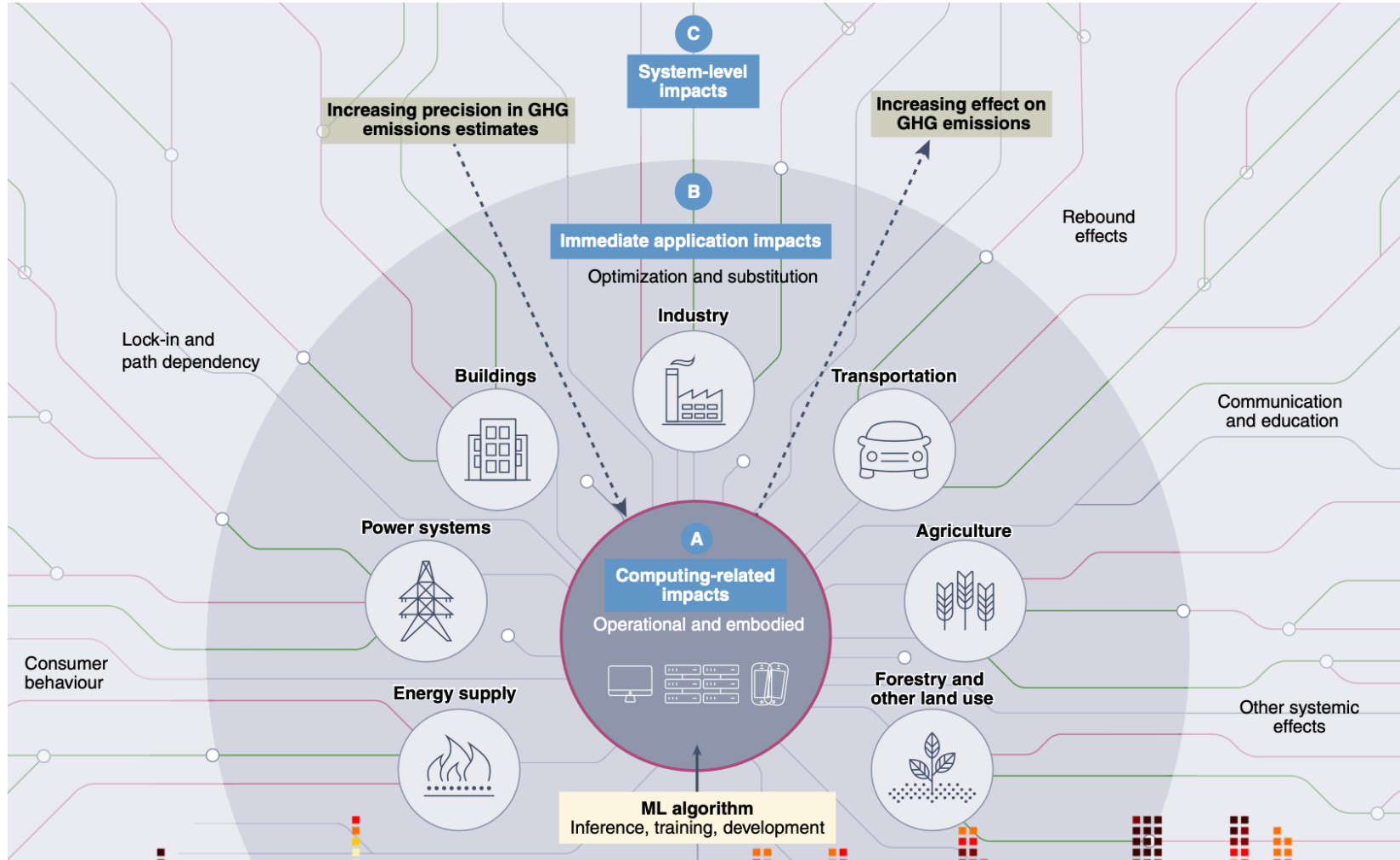
# Scope of Impact<sup>[5]</sup>

- Direct
- Indirect
- Systemic

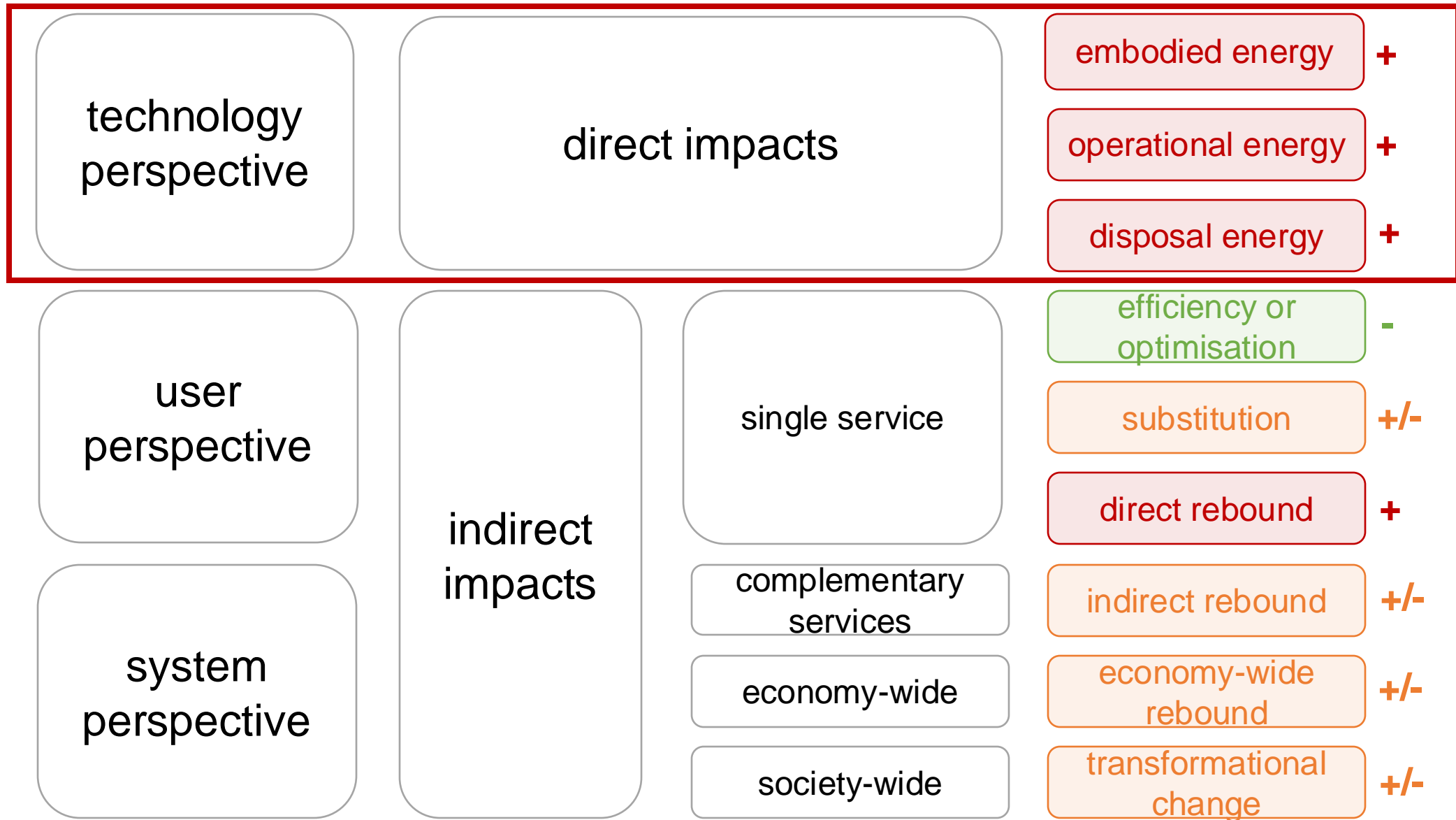




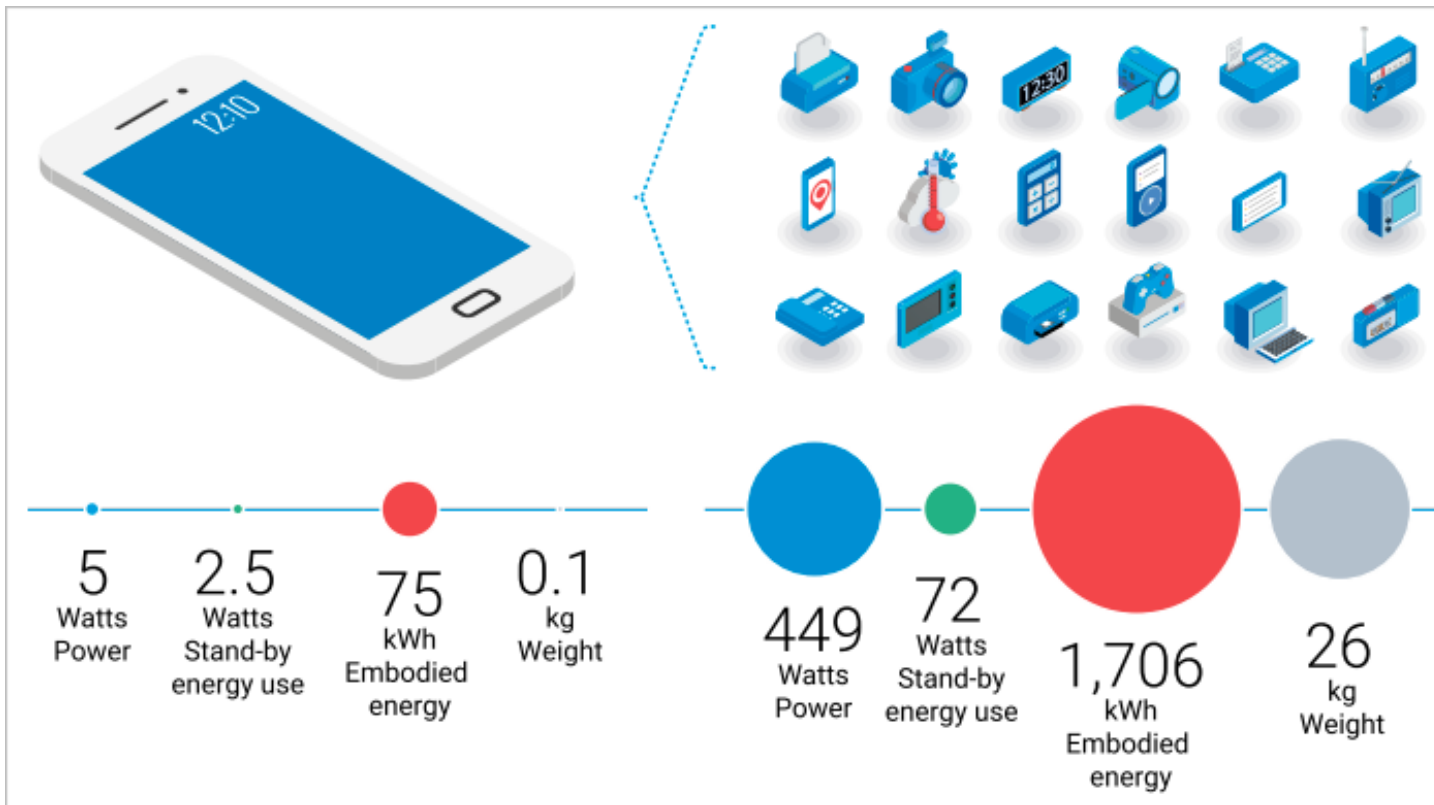
# AI and Energy [6]



# Impact Category <sup>[7]</sup>



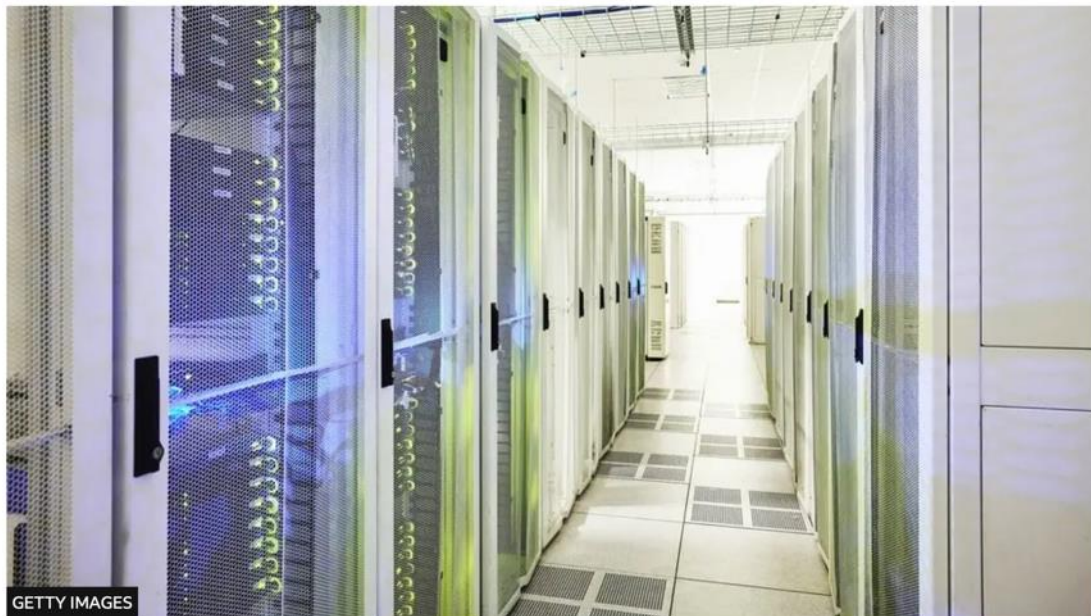
# Direct: ICT devices <sup>[8]</sup>





# Data centre power use 'to surge six-fold in 10 years'

© 26 March 2024 · 275 Comments



GETTY IMAGES

The boom in artificial intelligence (AI) and quantum computing will drive a spike in energy use, the National Grid has predicted.

# Electricity grids creak as AI demands soar



GETTY IMAGES

Data centre electricity needs are forecast to double between 2022 and 2026

**Chris Baraniuk**

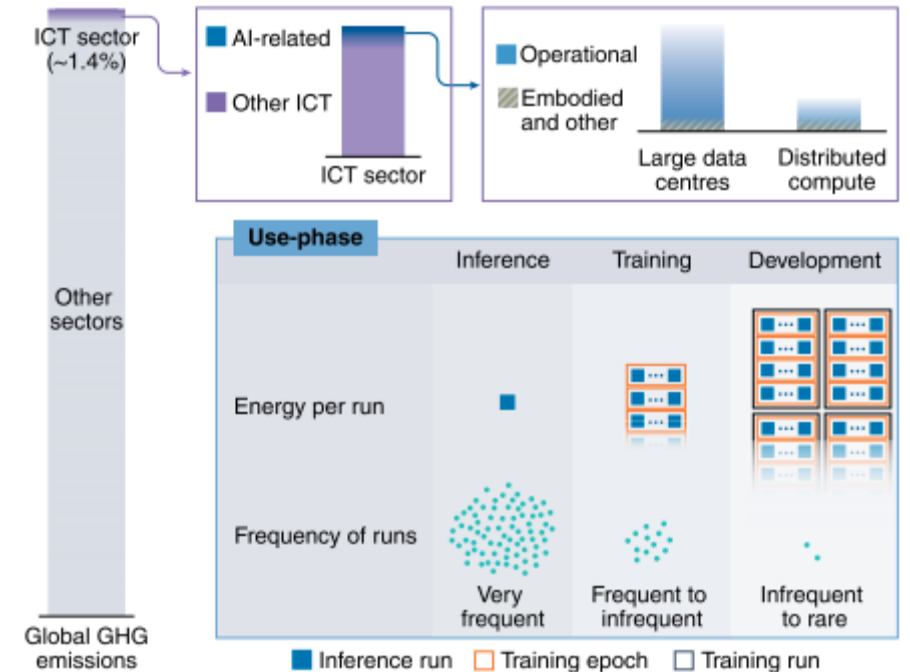
Technology reporter

21 May 2024 · 108 Comments

There's a big problem with generative AI, says Sasha Luccioni at Hugging Face, a machine-learning company. Generative AI is an energy hog.

# Data centre and AI's energy use <sup>[6, 9]</sup>

- Data centres, servers, and data transmission networks account for **1% to 1.5% of global electricity demand** (2% in the EU, 4% in the US, 3% in China)
- Between 7-10% of enterprise customers' total spend on compute infrastructure supports AI applications, with 3-4.5% used for training and 4-4.5% spent on inference



# Direct: AI training <sup>[10]</sup>

## CO2 equivalent emissions (tonnes) by select machine learning models and real-life examples, 2020–23

Source: AI Index, 2024; Luccioni et al., 2022; Strubell et al., 2019 | Chart: 2024 AI Index report

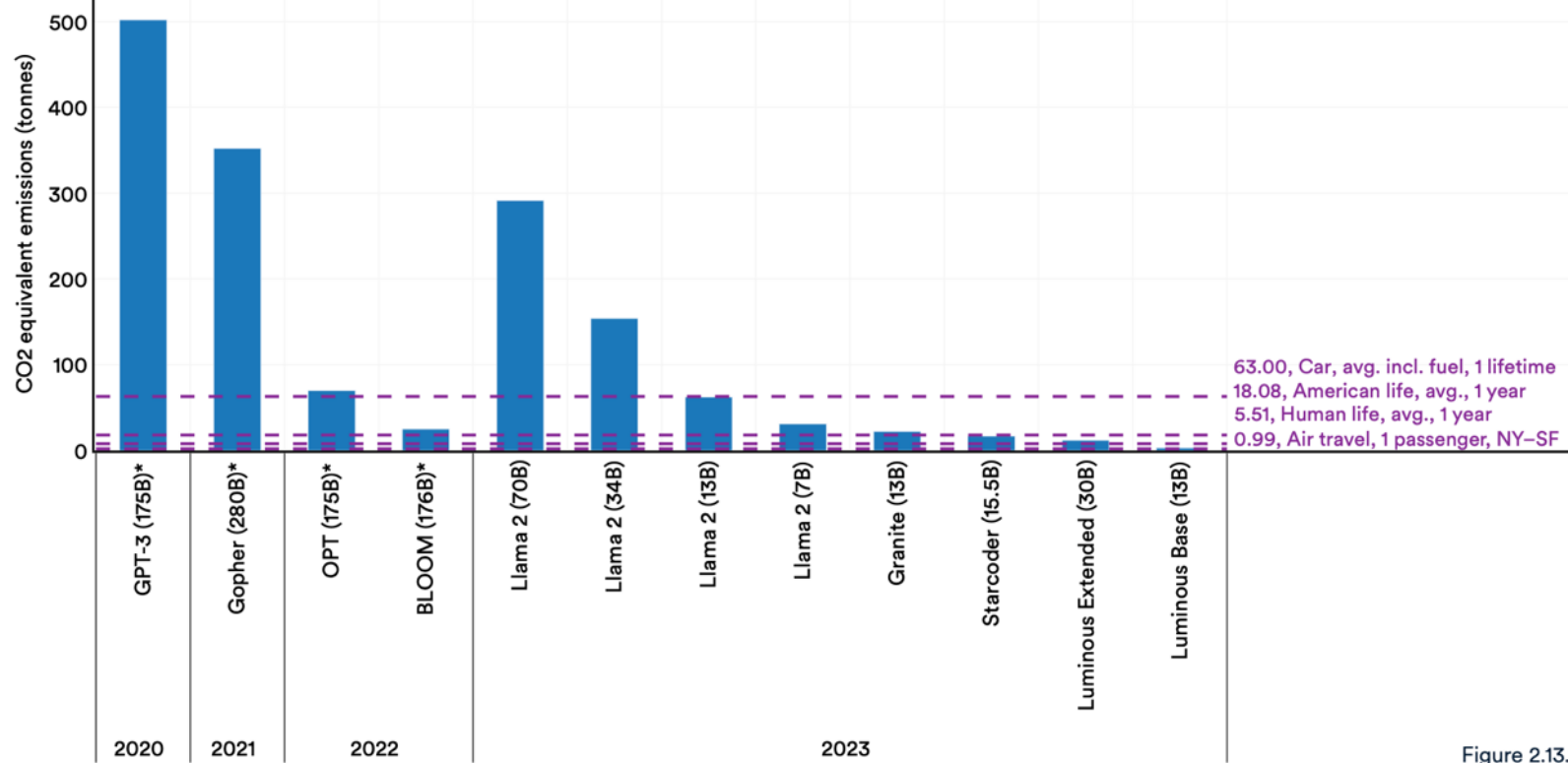


Figure 2.13.1

<sup>21</sup> In its technical report on [Llama 2](#), Meta notes that it offsets all the carbon emissions generated during the model's training process.

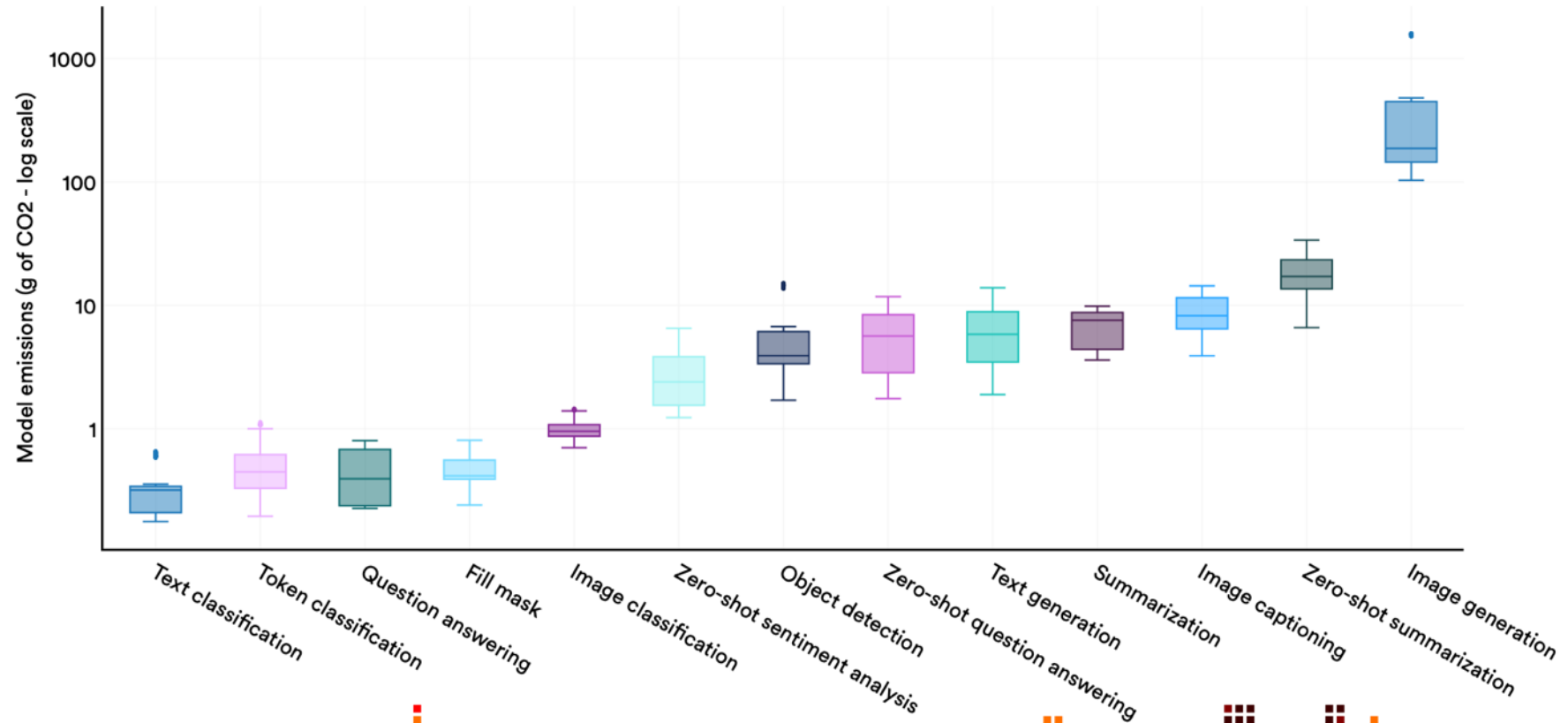




# Direct: AI inference <sup>[10]</sup>

## Carbon emissions by task during model inference

Source: Luccioni et al., 2023 | Chart: 2024 AI Index report



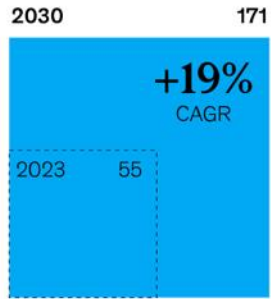
Task

Figure 2.13.4

Exhibit 1

### Global demand for data center capacity

Demand for data center capacity



Low-range scenario

Three scenarios showing the upper-, low-, and mid-range of chips (application-specific integrated circuits, general purpose) and network needs of AI workloads. Demand is measured in megawatts. Source: McKinsey Data Center Demand model

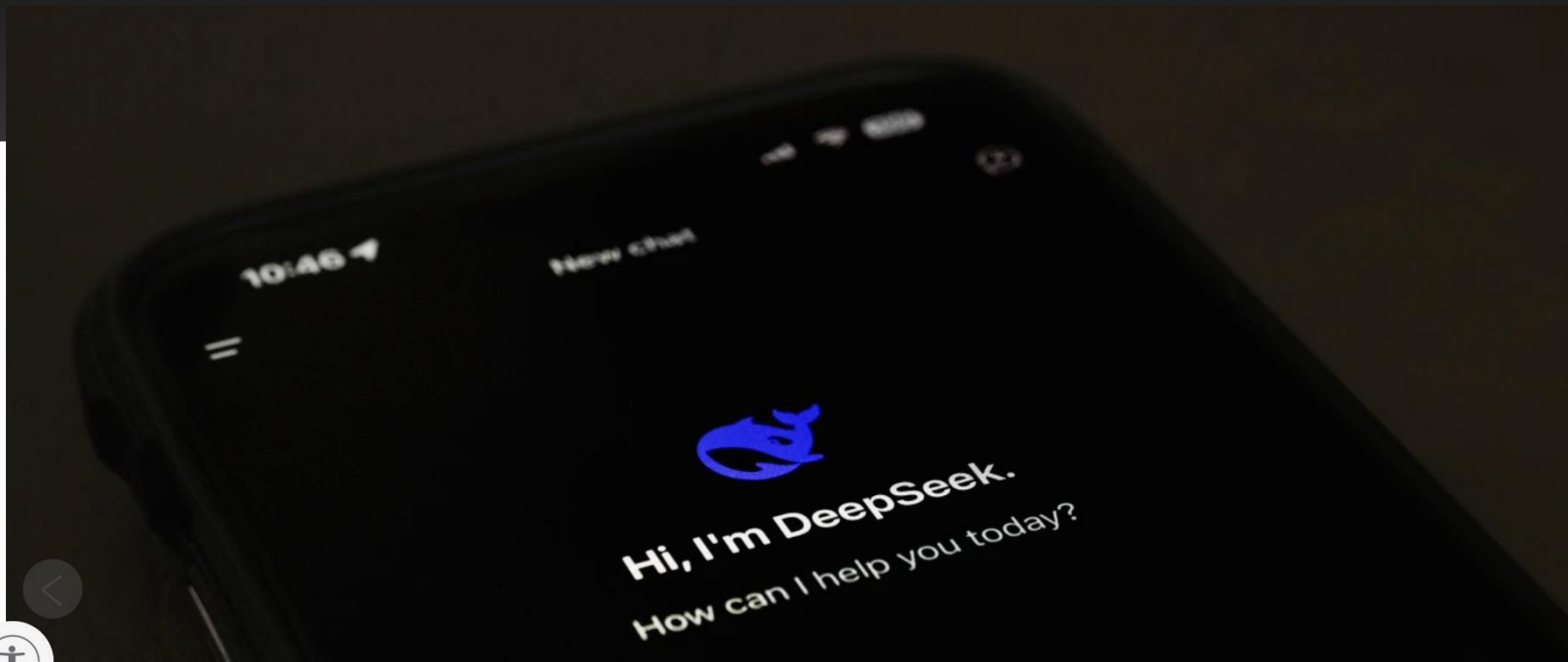
McKinsey & Company

Com

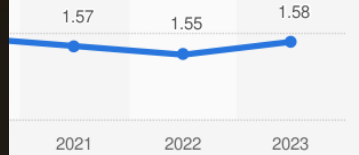


- Trump freezes federal grants
- Kumbh Mela stampede
- Caroline Kennedy
- "Doomsday Clock"
- Jim Acosta

# DeepSeek says it built its chatbot cheap. What does that mean for AI's energy needs and the climate?



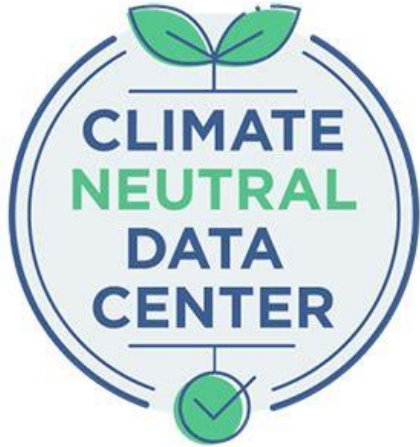
(UE) for your largest data



ns



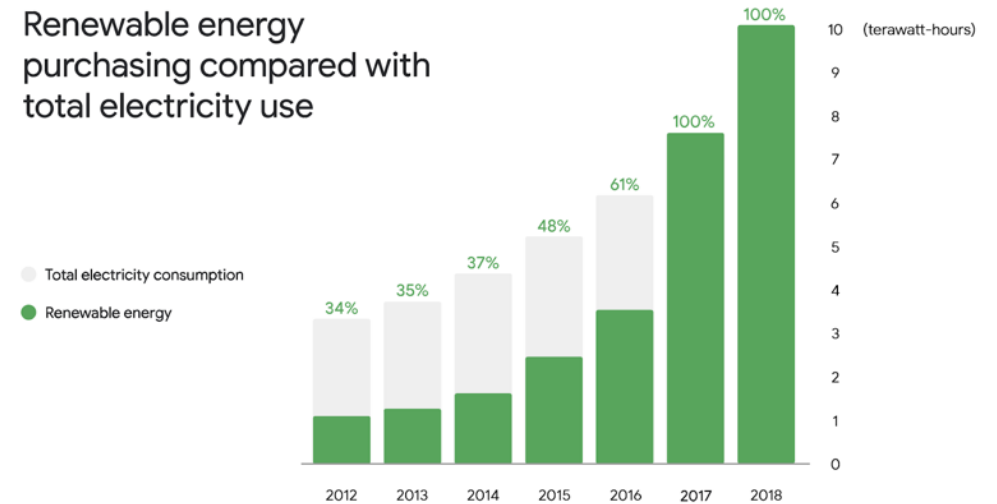
# Companies are investing on green data centres



Over 100 data centre operators are signatories:

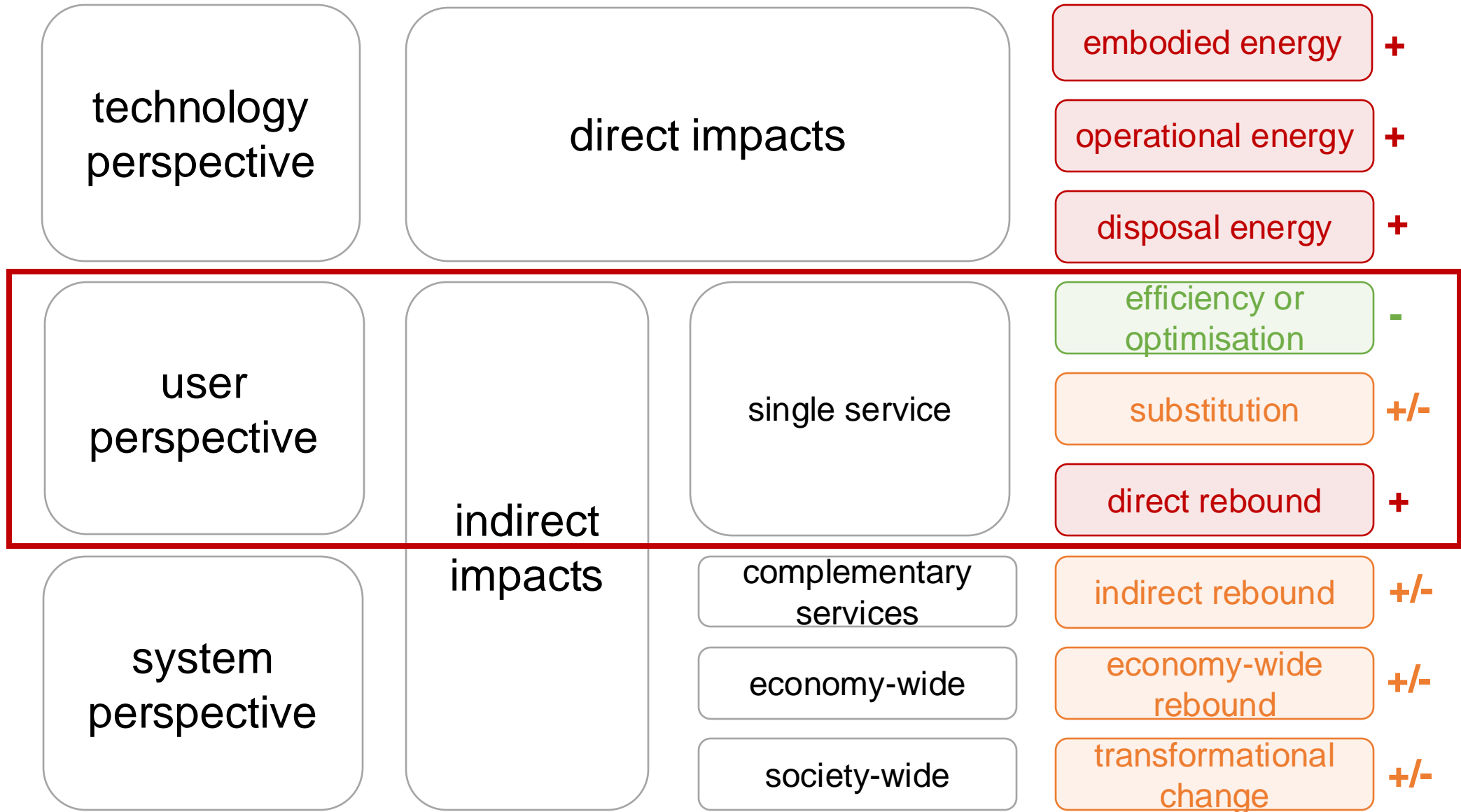
- Purchase 100% carbon-free energy
- Measurable targets for energy efficiency
- Water usage effectiveness
- Recycle heat?
- Repair and recycle materials?

Renewable energy purchasing compared with total electricity use



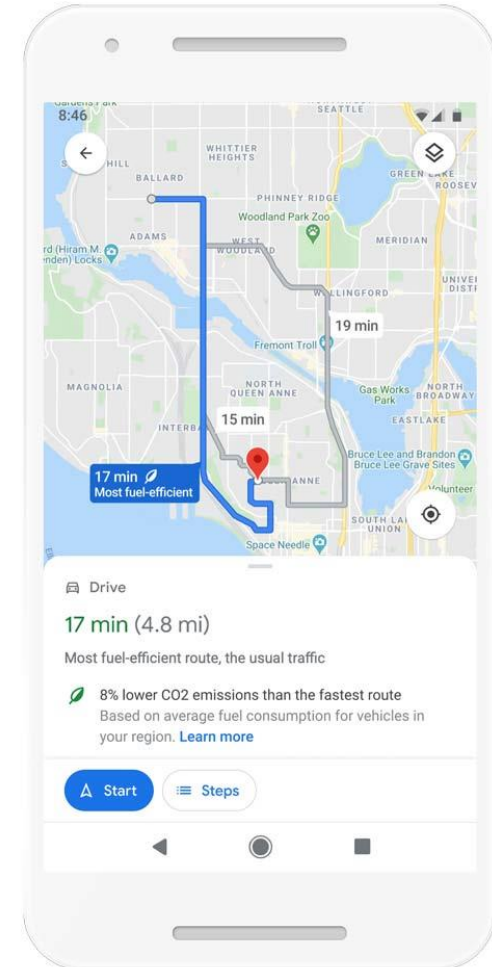
Google





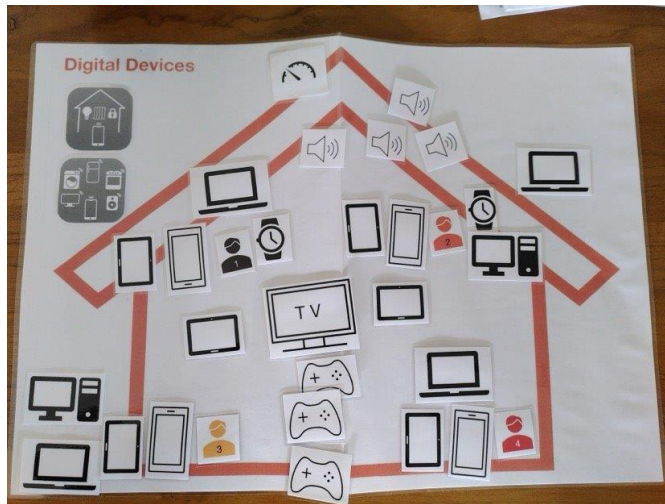
# Indirect effects are larger in magnitude, scale, and uncertainty

- **Efficiency**
  - Smart home technology
  - Google Maps
- **Substitution**
  - Teleworking
  - Ride-hailing
- **Rebound**



# Rebound effect <sup>[11]</sup>

- **Direct rebound:** as prices fall, consumption/activity increase
- **Time rebound:** time saving leads to additional activities
- **Psychology rebound** <sup>[12]</sup>: diffusion of responsibility, moral licensing



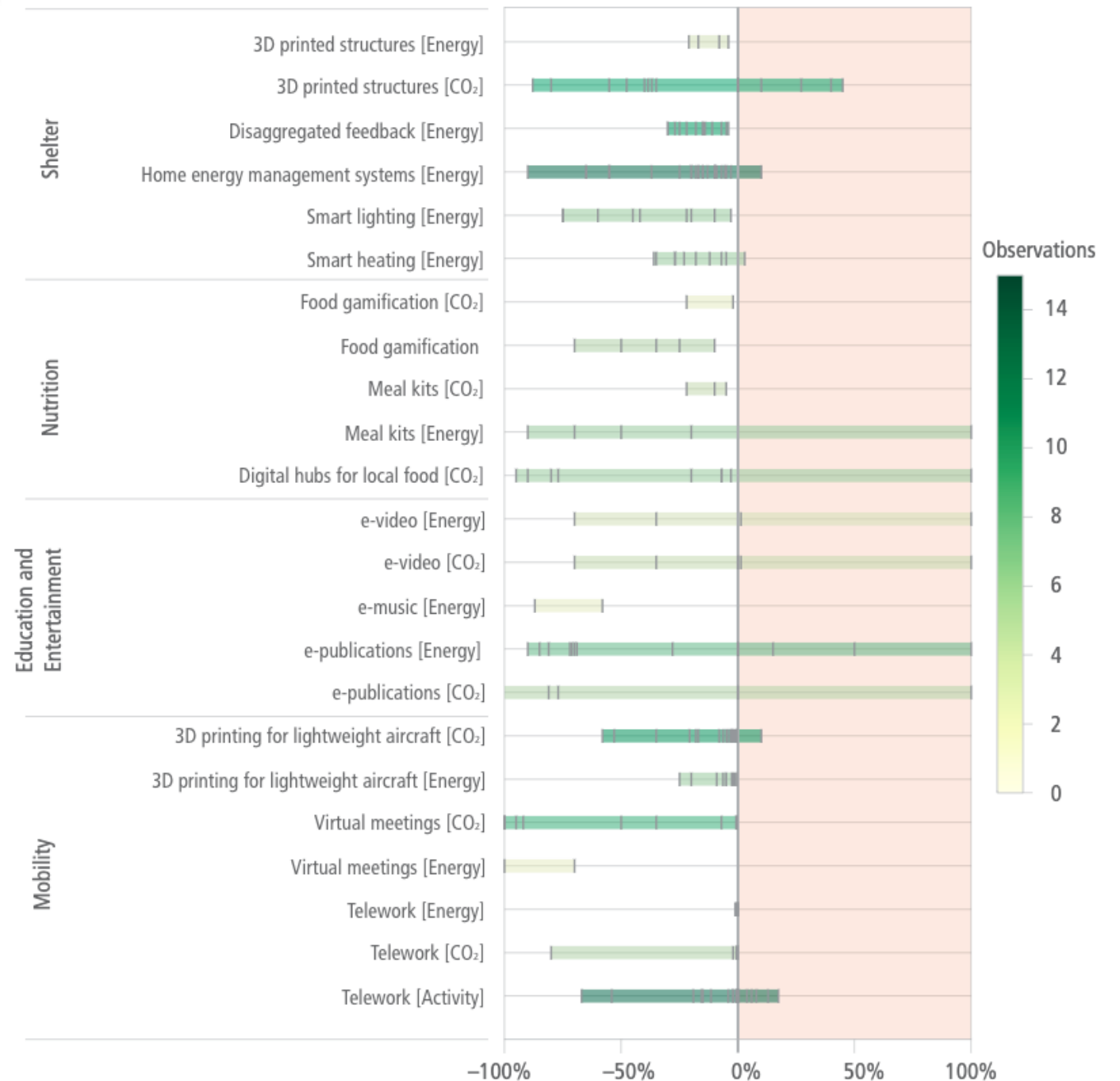


# Rebound effect – smart home <sup>[13]</sup>

- Energy consumption need to be reduced by at least **6%** for the production and use of smart heating to be environmentally beneficial
- Households purchase and use **additional smart devices** to increase controllability and comfort, rather than reduce energy demand



Digital solutions have **mitigation potentials**, but also **risks of increased emissions** due to inefficient substitutions, induced demand, and rebound effects [14]



# *Breakout group*

- Pick one of the following digital application:



Car share



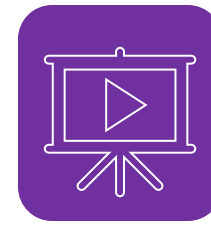
E-commerce



Meal kits



Smart thermostat

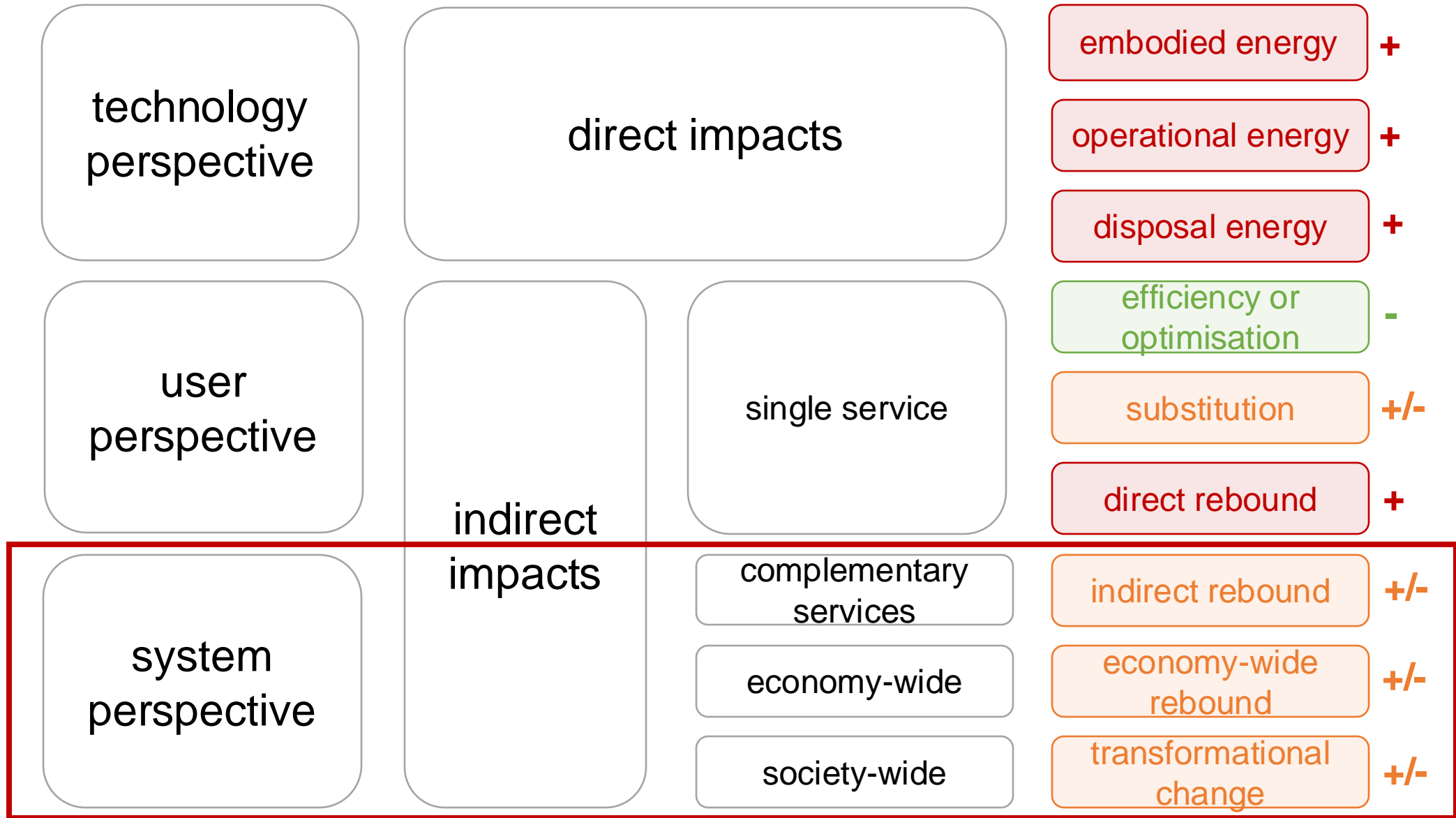


Video streaming

- What are the behaviour changes and energy implications (indirect – positive, negative) of the app?

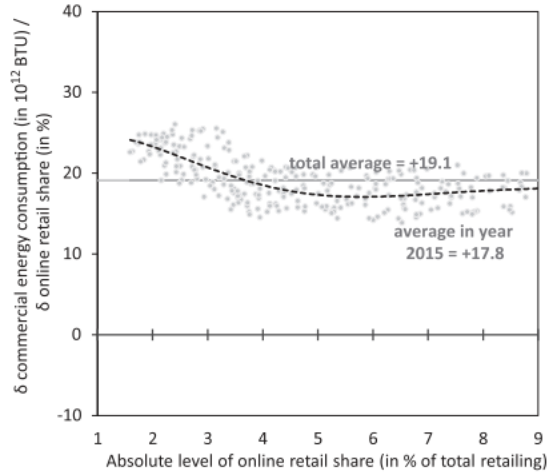




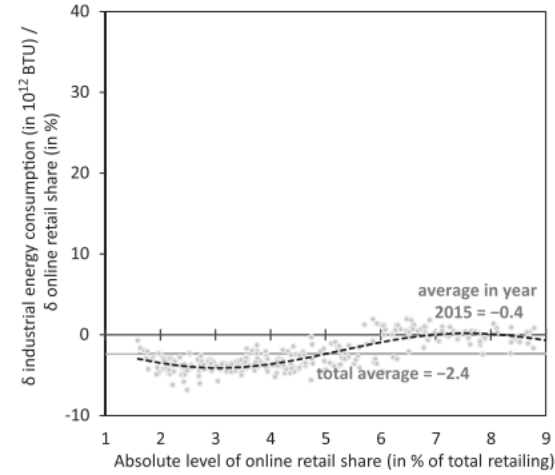


# Systemic Effects – E-Commerce [15]

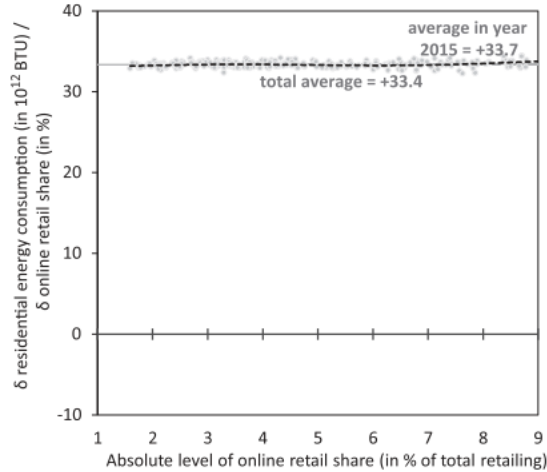
a) Commercial sector



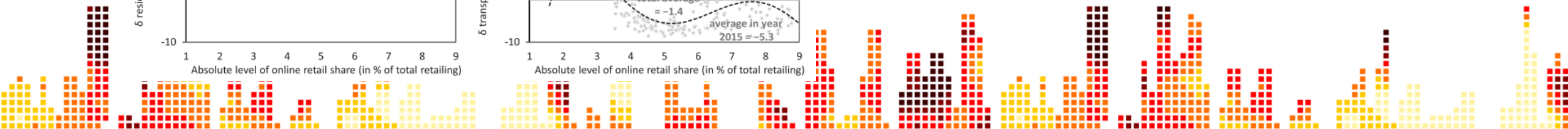
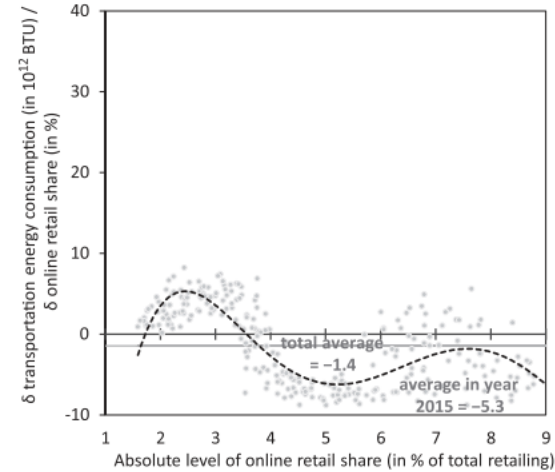
b) Industrial sector



c) Residential sector

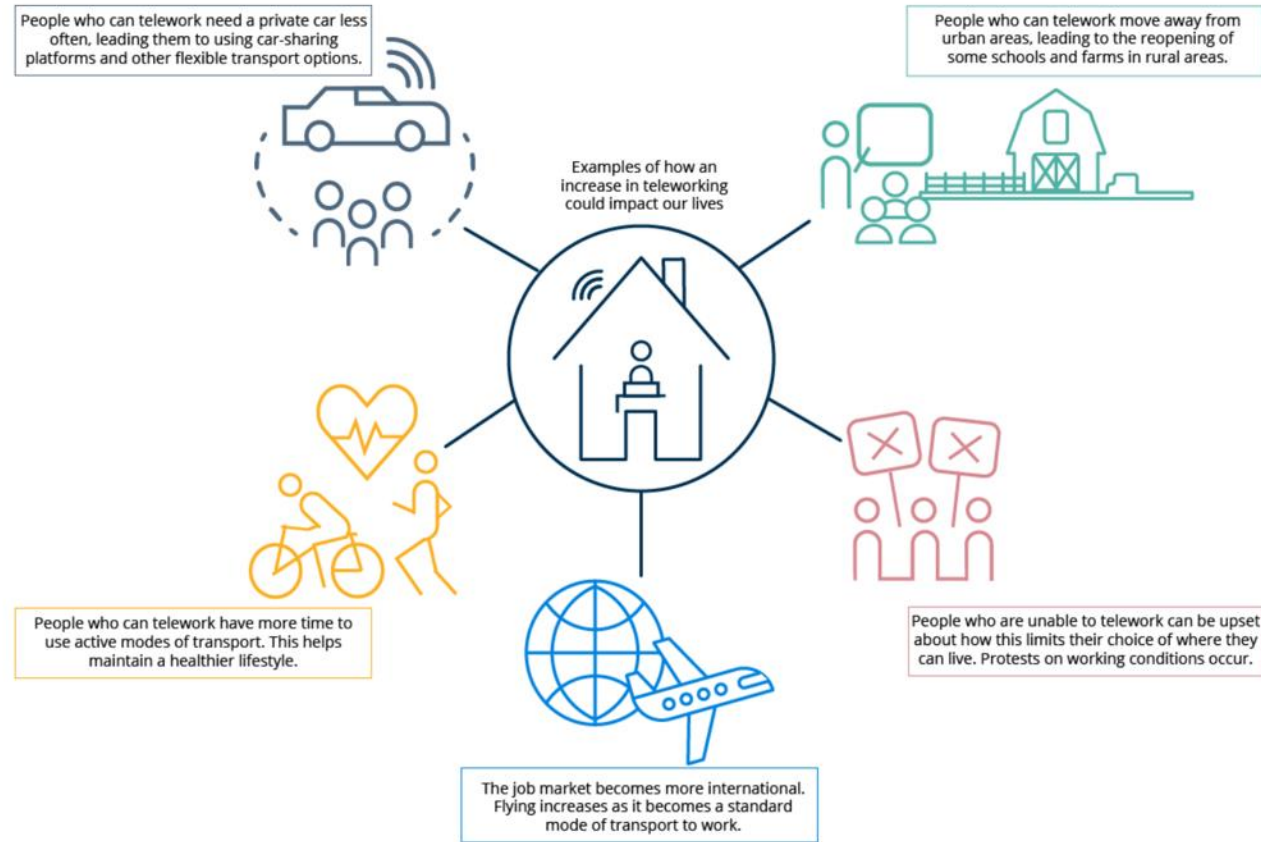


d) Transportation sector



# Systemic Effects – Teleworking [16]

Figure 3. How an increase in teleworking could impact our lives



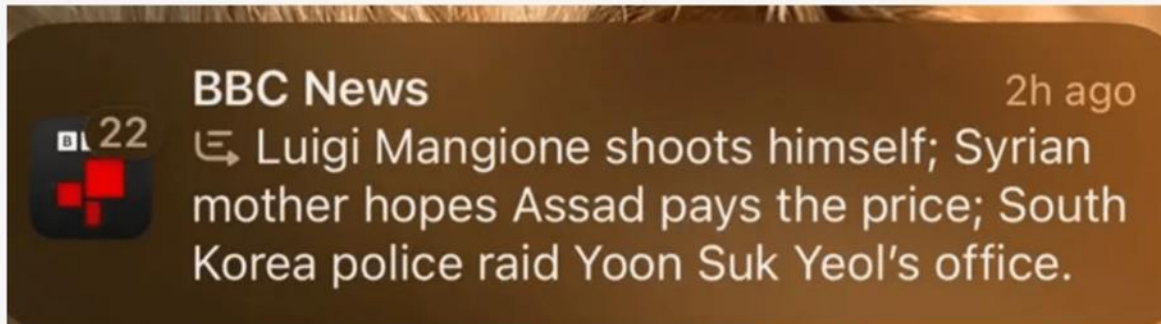


# Systemic effects – AI

BBC News sends Breaking News alerts on a single subject



Apple sends an AI-generated summary of BBC News headlines - which can create inaccuracies



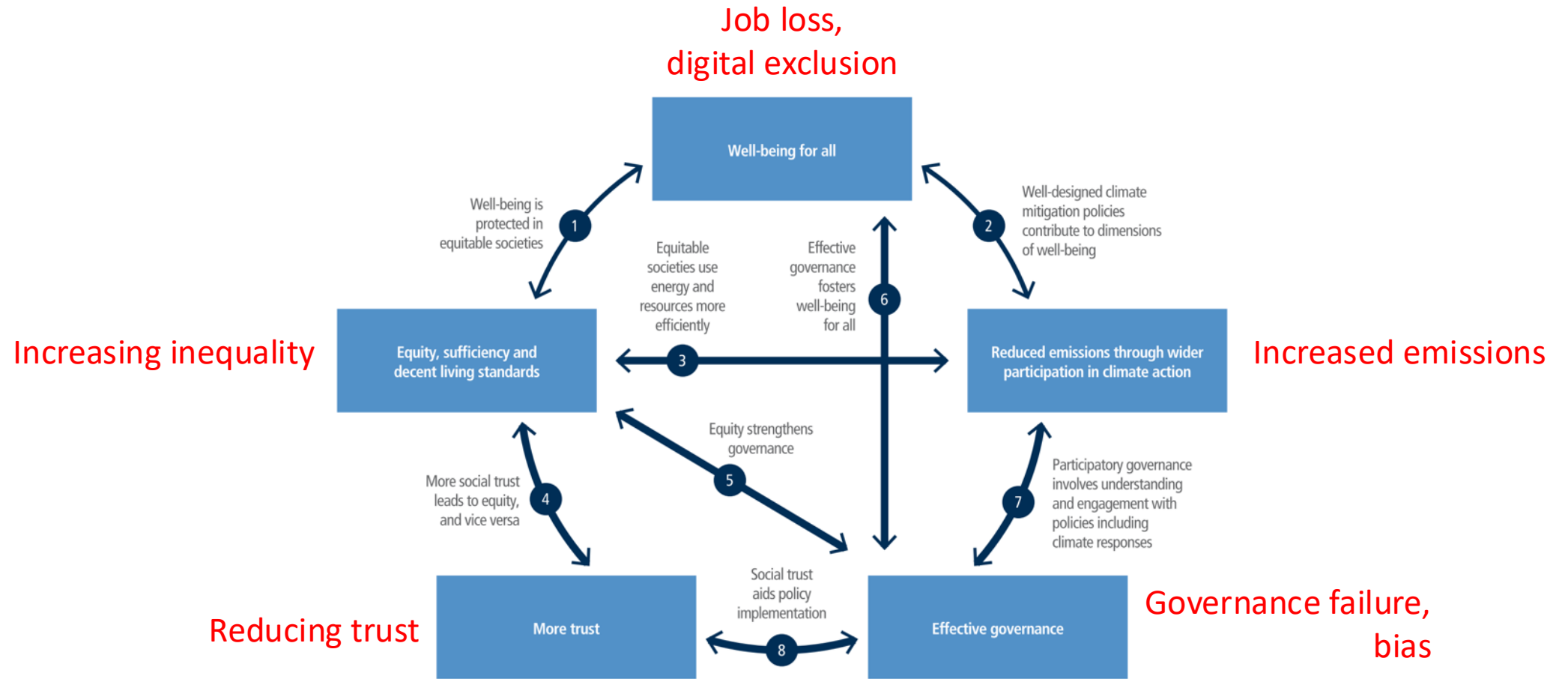
BBC

A news alert from December 2024 was among the complaints made by the BBC to Apple

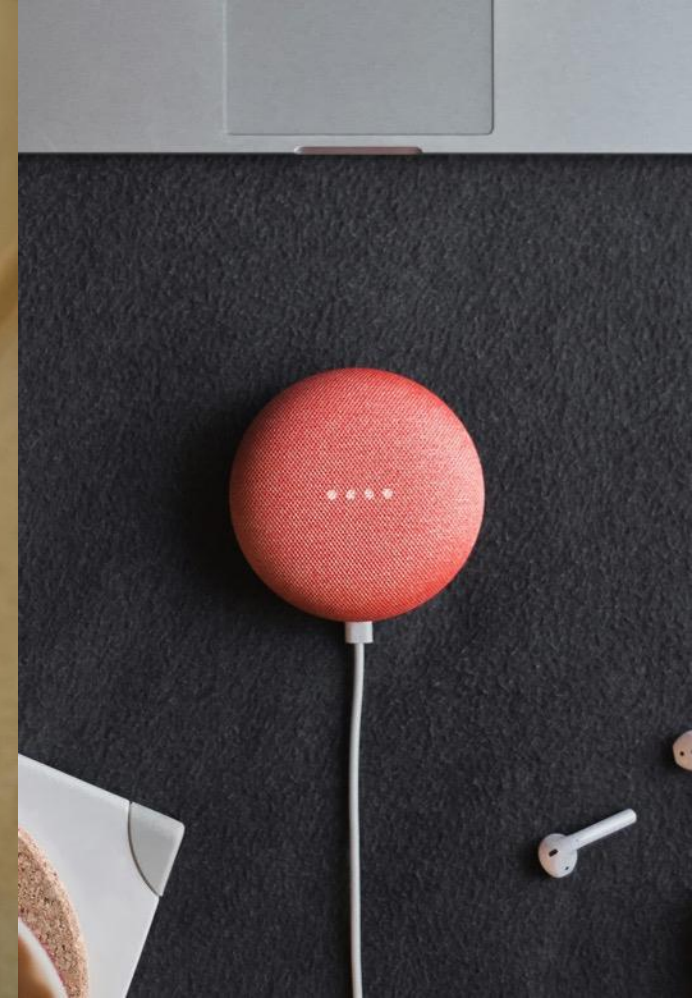
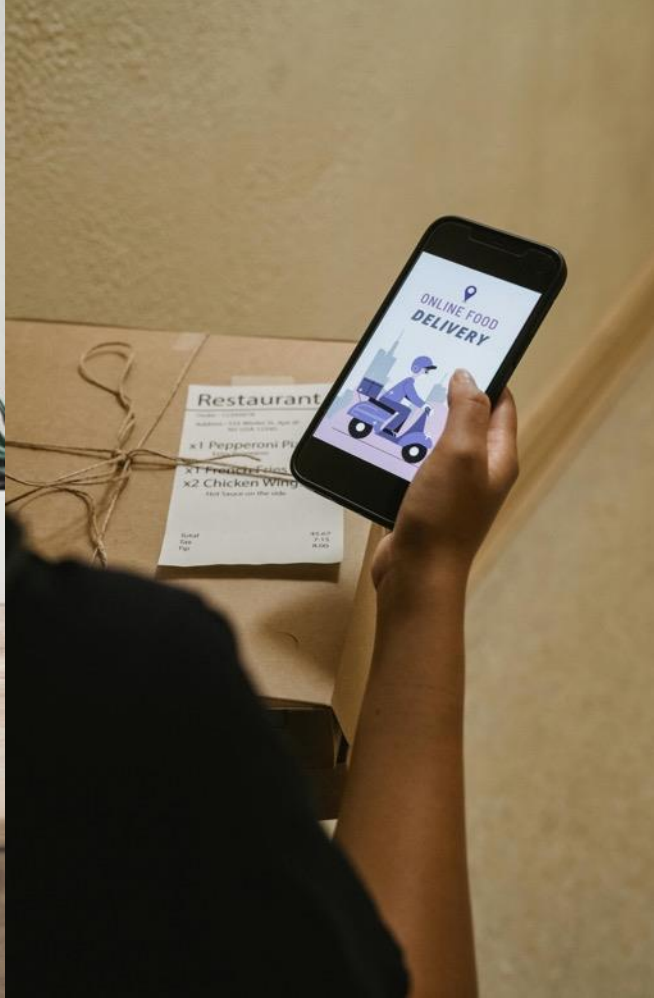
- Information processing?
- Autonomy and control in decision-making?
- Trust?
- Privacy concerns?



# Systemic effects – society-wide changes [14]

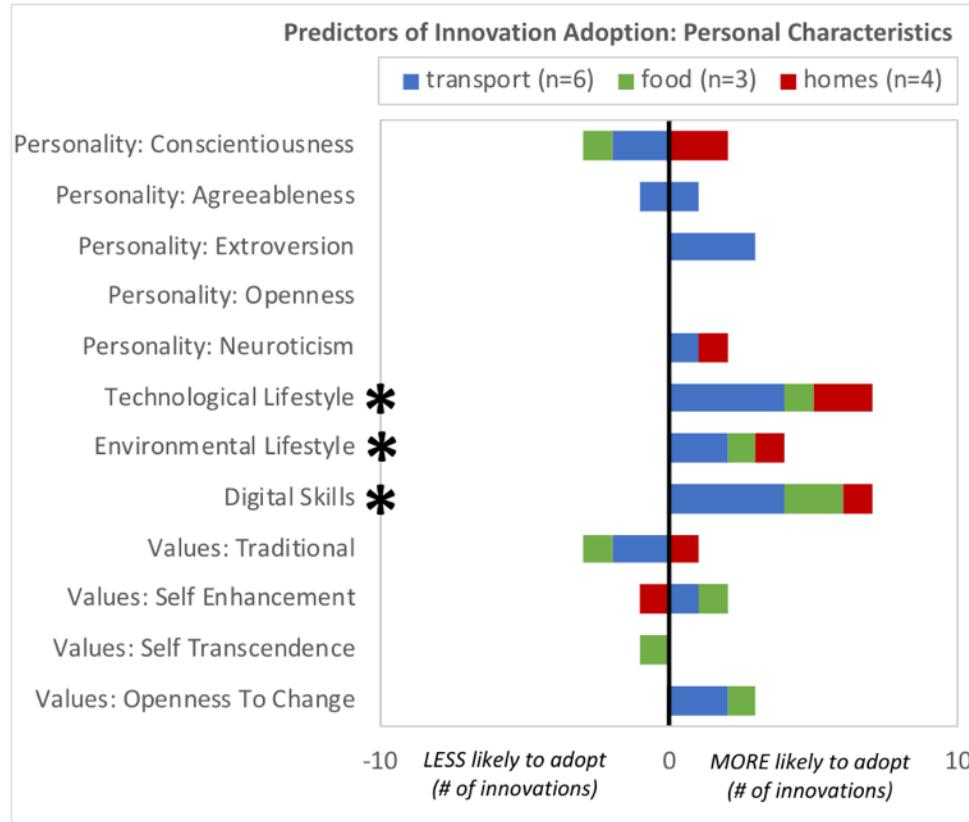


**Figure 5.5 | Well-being, equity, trust, governance and climate mitigation: positive feedbacks.** Well-being for all, increasingly seen as the main goal of sustainable economies, reinforces emissions reductions through a network of positive feedbacks linking effective governance, social trust, equity, participation and sufficiency. This diagram depicts relationships noted in this chapter text and explained further in the Social Science Primer (Chapter 5 Supplementary Material I). The width of the arrows corresponds to the level of confidence and degree of evidence from recent social sciences literature.



# *Reflections*

# Technology adoption is not a given <sup>[17]</sup>



Depends on...

- Skills
- Access
- Literacy
- Culture
- Attitudes
- Socioeconomic





# Digital transformation is a social process <sup>[18]</sup>

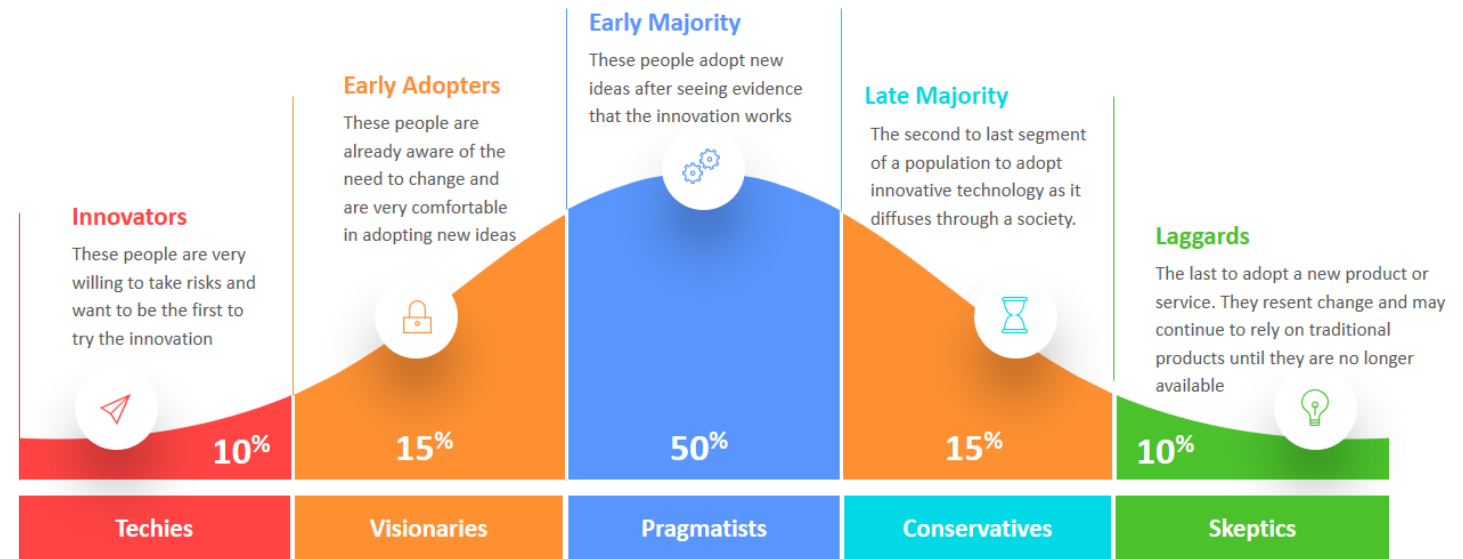
Depending on:

- Innovation
- Communication channels
- Time
- Social system

Leading to:

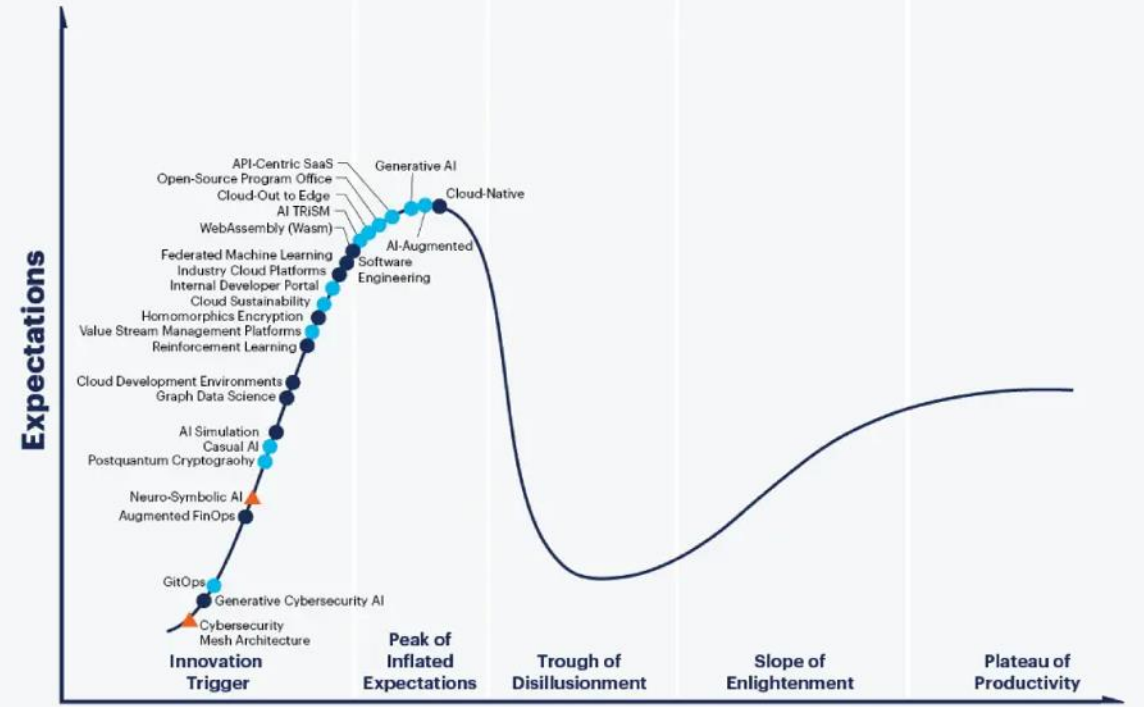
- Adapting
- Shaping
- Rejecting <sup>[19]</sup>

## DIFFUSION OF INNOVATION MODEL



*Societal response to technology is uncertain*

## Hype Cycle for Emerging Technologies, 2023



Plateau will be reached:

- less than 2 years
  - 2 to 5 years
  - 5 to 10 years
  - ▲ more than 10 years
  - ⊗ obsolete before plateau
- As of August 2023

[gartner.com](https://www.gartner.com)

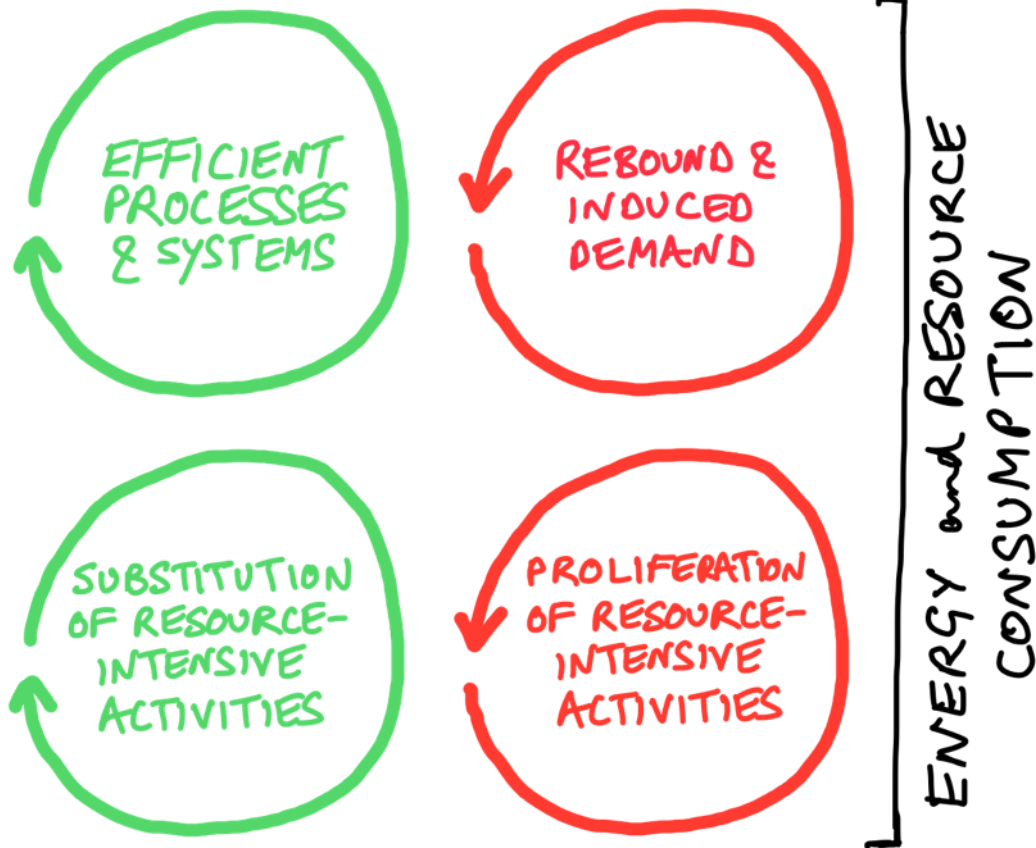
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**Gartner**

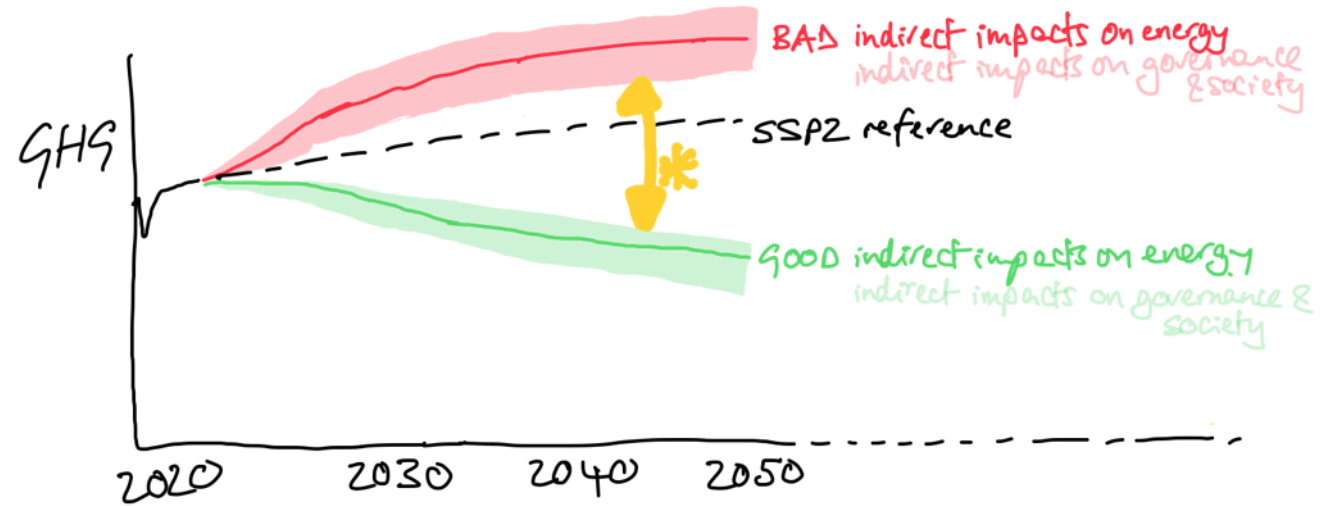


# DIGITALISATION DYNAMICS

both **HELP** and **HINDER**



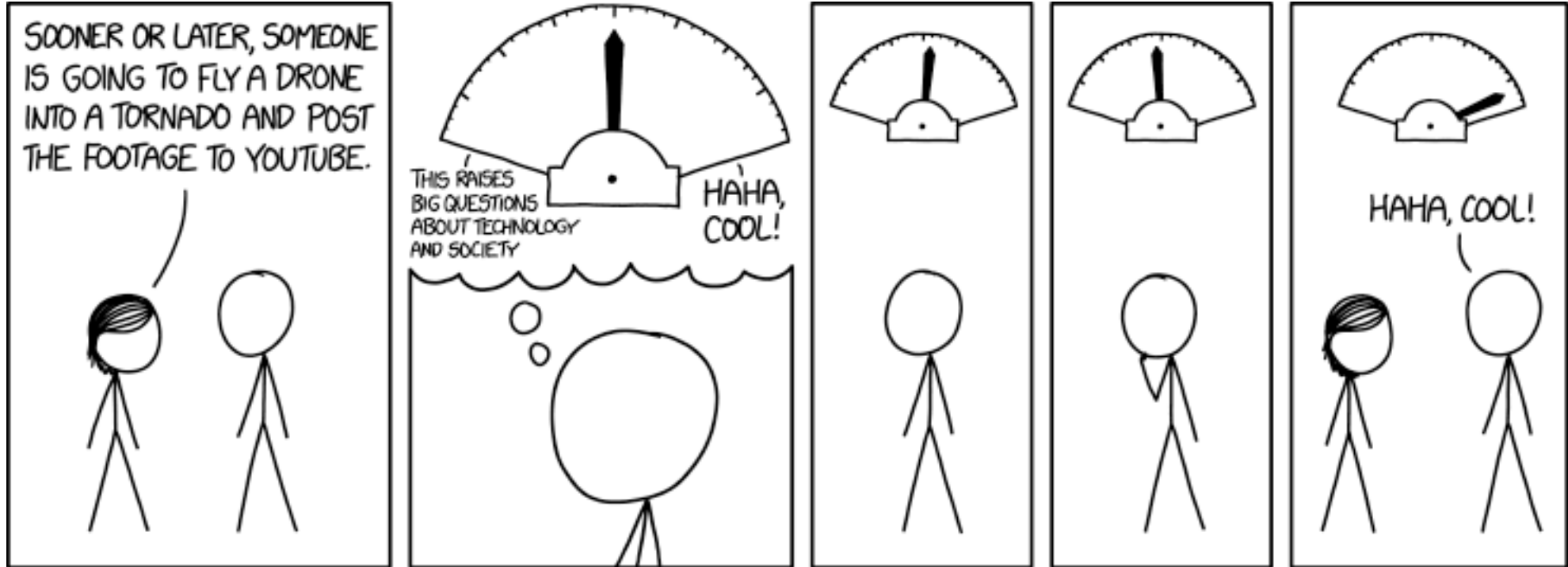
# THE DIGITALIZATION WILDCARD FOR MITIGATION



## \* policy response

- (1) generic enablers: access, skills, data, trust
- (2) specific climate policy for digitalisation?





<https://xkcd.com/2072/>



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# Thank you!

**Felippa Amanta**

Environmental Change Institute  
School of Geography and the Environment  
University of Oxford

[felippa.amanta@ouce.ox.ac.uk](mailto:felippa.amanta@ouce.ox.ac.uk)  
[idoddle.org](http://idoddle.org)

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