

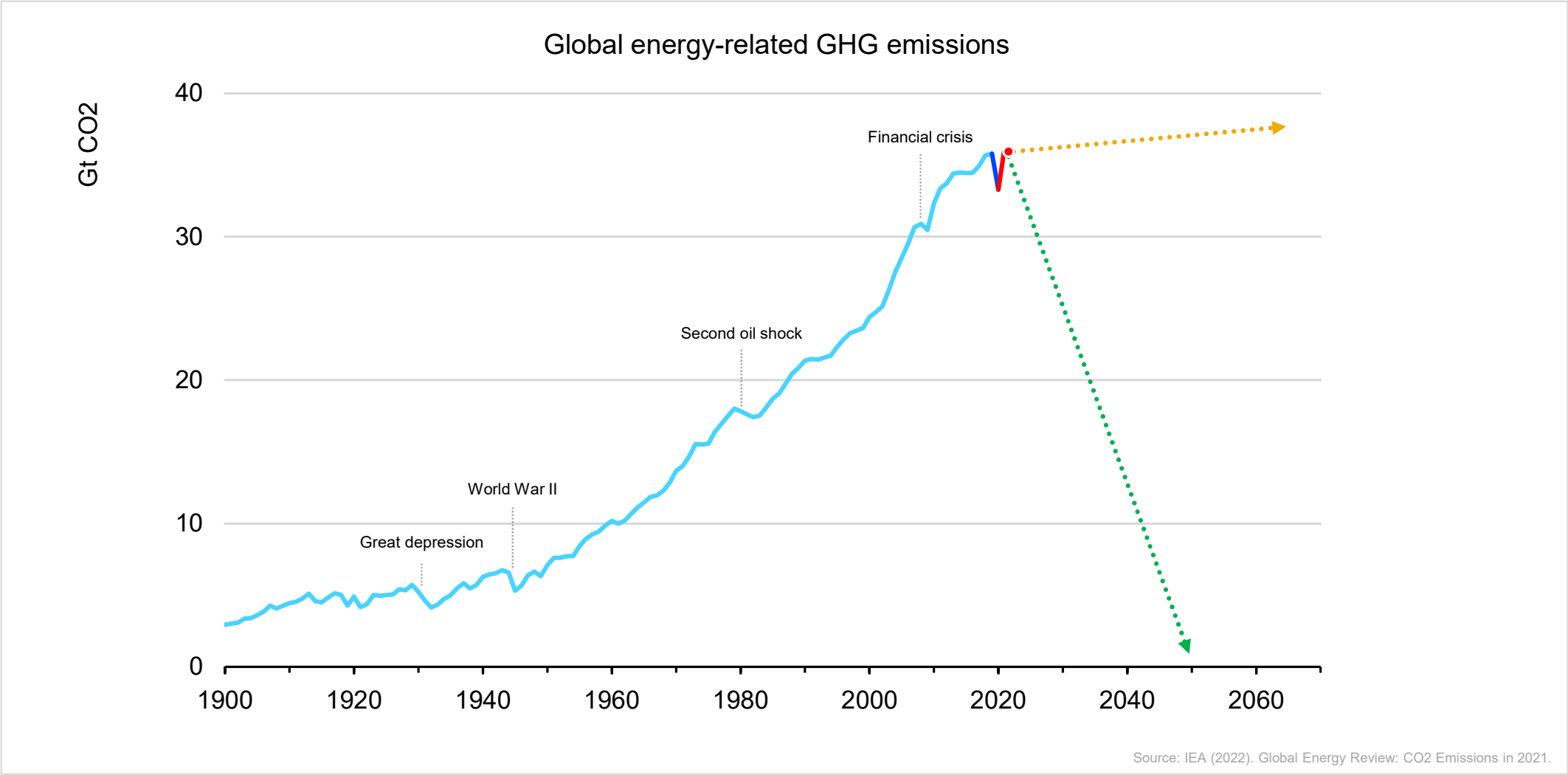


# Digitalisation, energy efficiency, and clean energy transitions

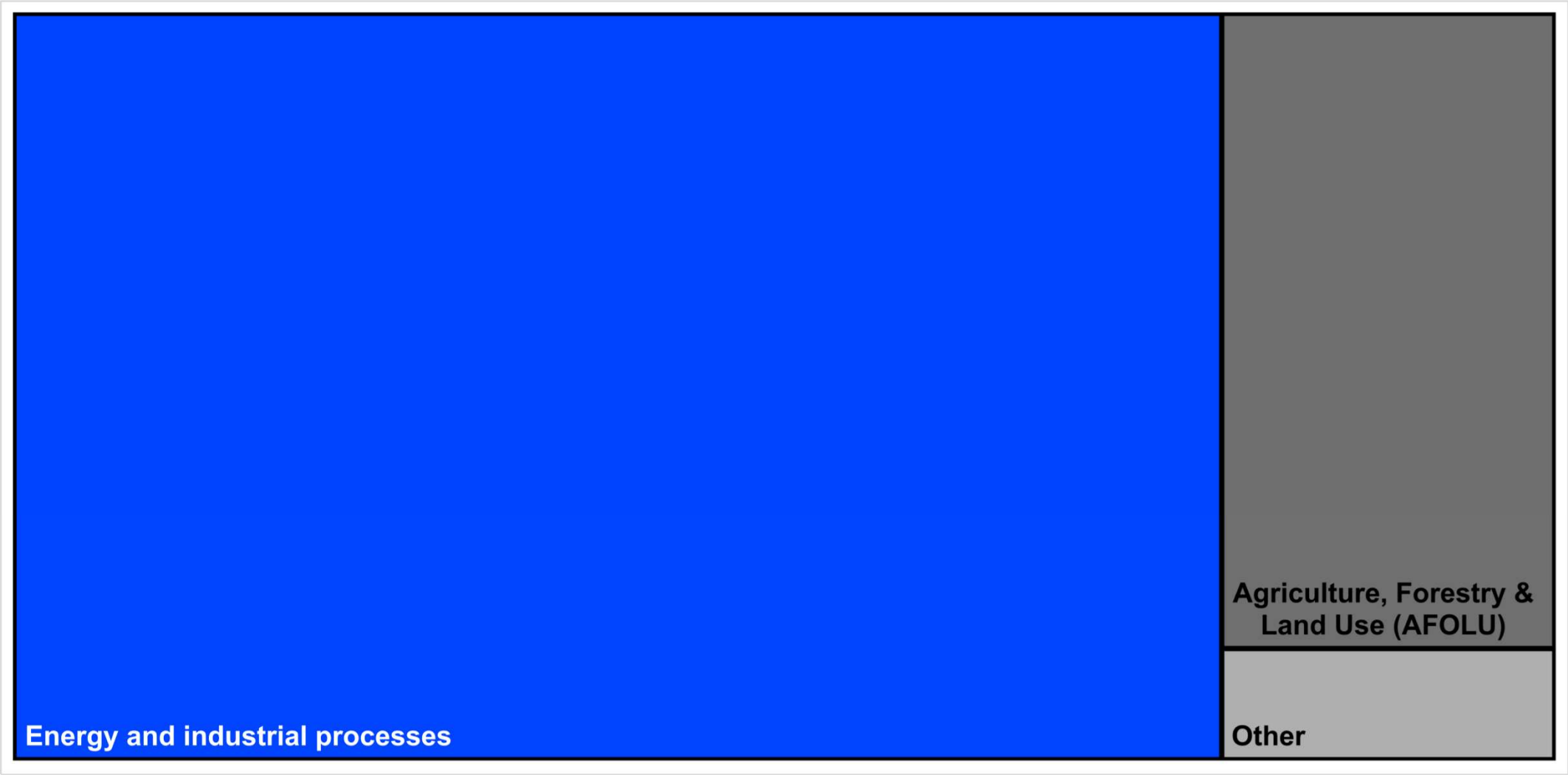
George Kamiya • Energy Policy Analyst

30 June 2022 • Climate Energy Summit Seoul 2022

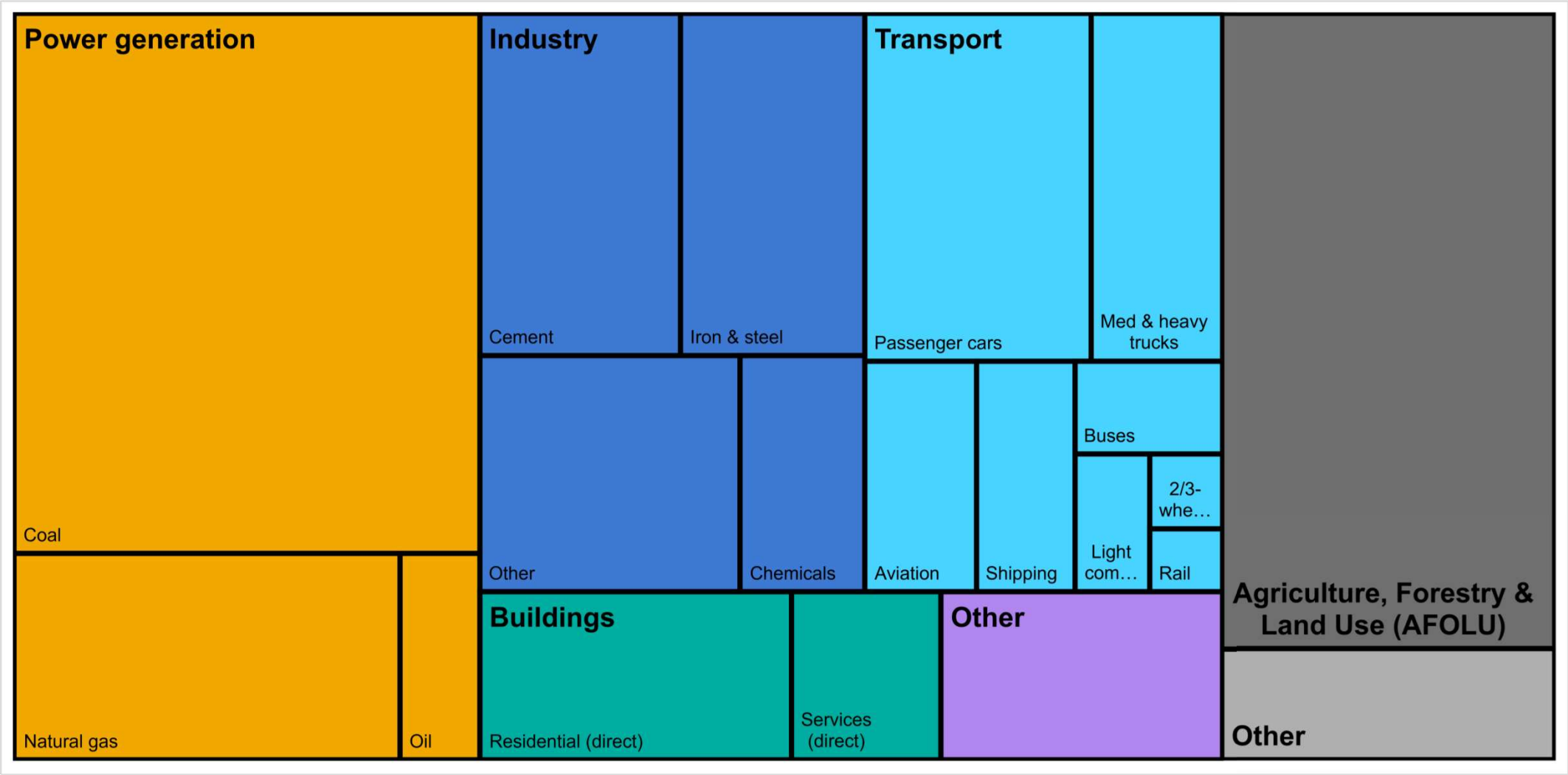
# Emissions rebounded in 2021 to a record high



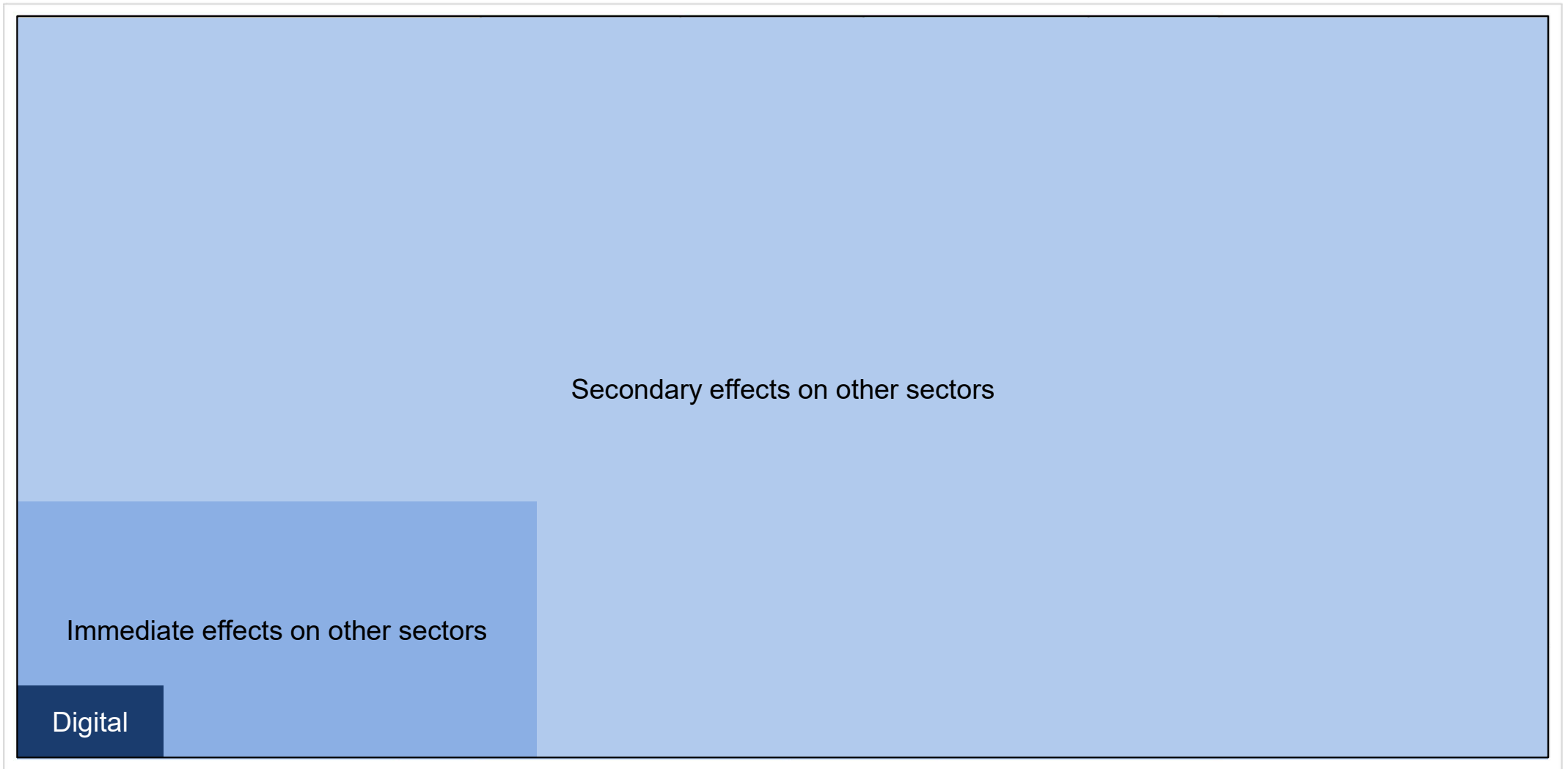
# Greenhouse gas emissions come from many sectors and sources



# Greenhouse gas emissions come from many sectors and sources



# Direct and indirect effects of digital technologies



# Energy and carbon emissions from digital technologies



Secondary effects on other sectors

Immediate effects on other sectors

Digital

**2000**

**2019**

6.1 billion



**Population**



7.7 billion

68 trillion



**GDP**



130 trillion

14 PWh



**Electricity use**

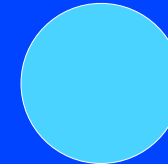


23 PWh

0.4 billion



**Internet users**



4.1 billion

0.9 EB



**Internet traffic**

2000 EB

Sources: UN (2019), World Population Prospects 2019; World Bank (2020), Data Bank: GDP, PPP (Constant 2017 International \$); IEA (2020), Data and statistics; ITU (2020), Statistics; Cisco (2015), The History and Future of Internet Traffic; Cisco (2018), Cisco Visual Networking Index: Forecast and Trends, 2017–2022

May 30, 1999

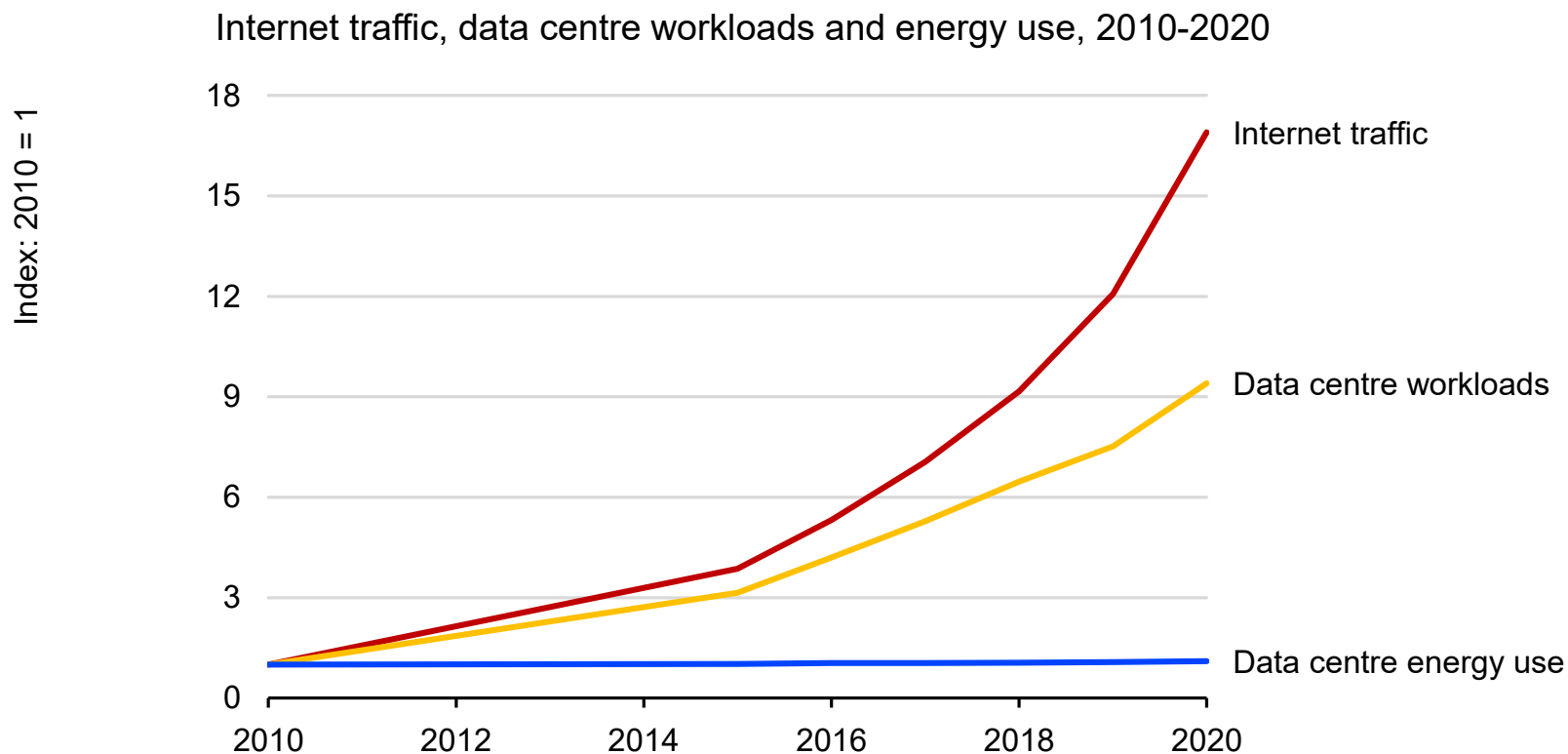
# Dig more coal -- the PCs are coming

🕒 This article is more than 10 years old.

“It’s now reasonable to project that half of the electric grid will be powering the digital-Internet economy within the next decade.”



# Global data centre energy use trends



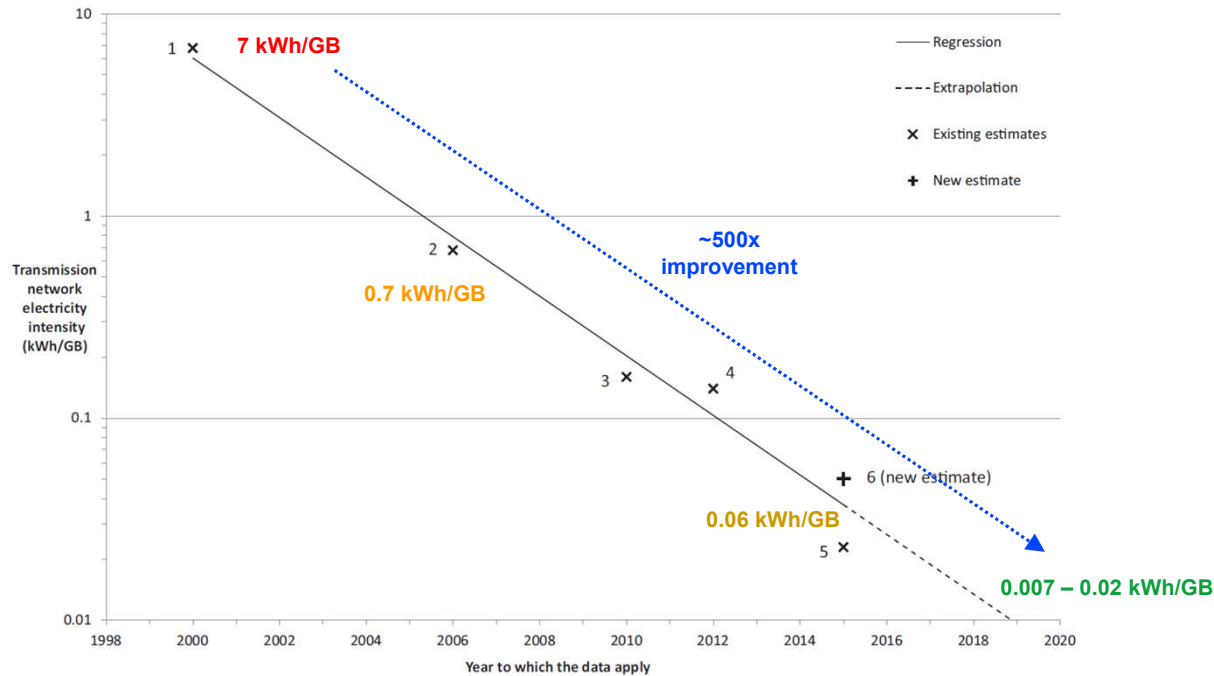
Sources: Masanet et al. (2020). Recalibrating global data center energy-use estimates. IEA (2021). Data centres and data transmission networks; Cisco (2018). Global Cloud Index: Forecast and Methodology, 2016-2021; Cisco (2019). Visual Networking Index: Forecast and Trends, 2017-2022.

Note: Figures exclude cryptocurrency mining

**Globally, data centres used an estimated 200-250 TWh in 2020, or around 1% of global electricity use**

# Energy efficiency trends

## Data transmission



Aslan et al. (2018). Electricity intensity of Internet data transmission: Untangling the estimates.

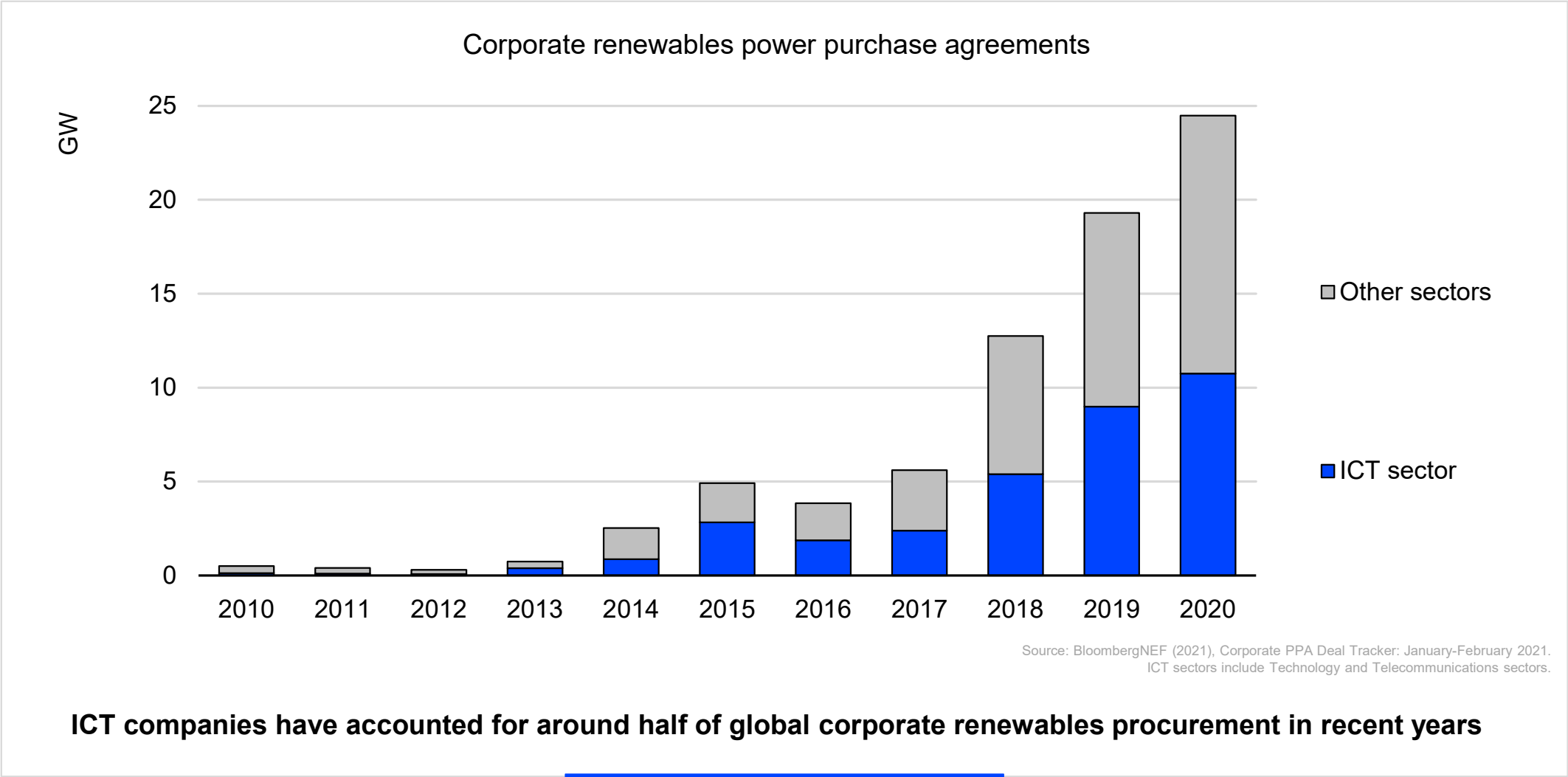
## Telefónica's decarbonisation



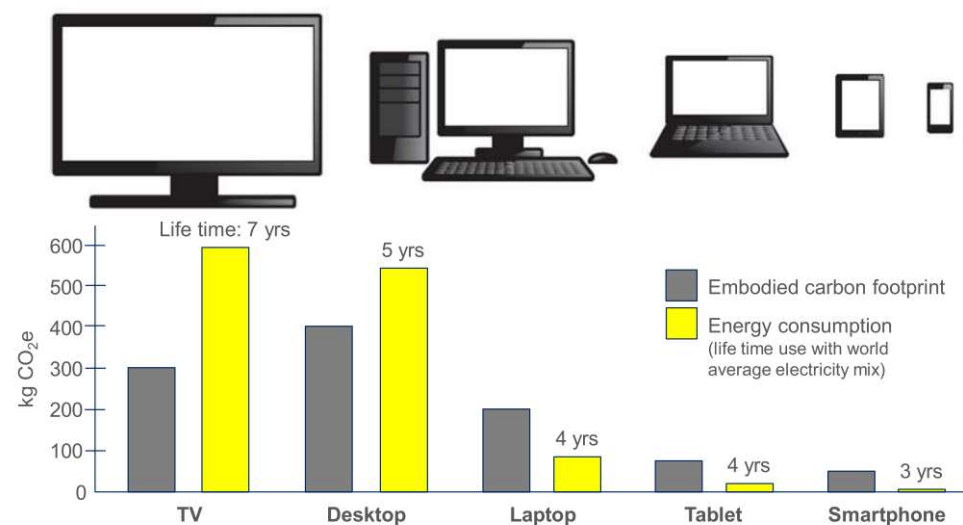
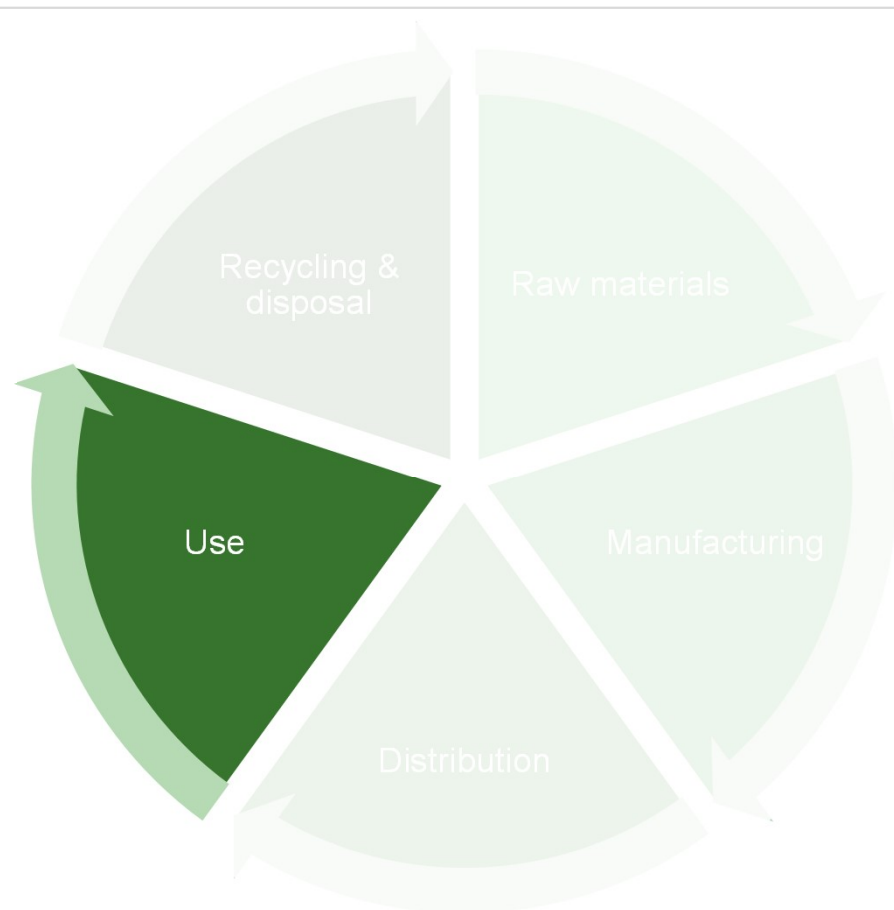
**Telefonica: traffic up 45% in 2020, but energy use down 1.4%**

**The energy efficiency of computing and data transmission has doubled every 2-3 years**

# Renewable energy procurement



# Impacts throughout the hardware lifecycle



Malmudin & Lunden (2018), The Energy and Carbon Footprint of the Global ICT and E&M Sectors 2010–2015

**There are environmental impacts beyond energy use and GHG emissions throughout the product lifecycle, including impacts on soil, air, water, biodiversity, and electronic waste.**

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## 'Tsunami of data' could consume one fifth of global electricity by 2025

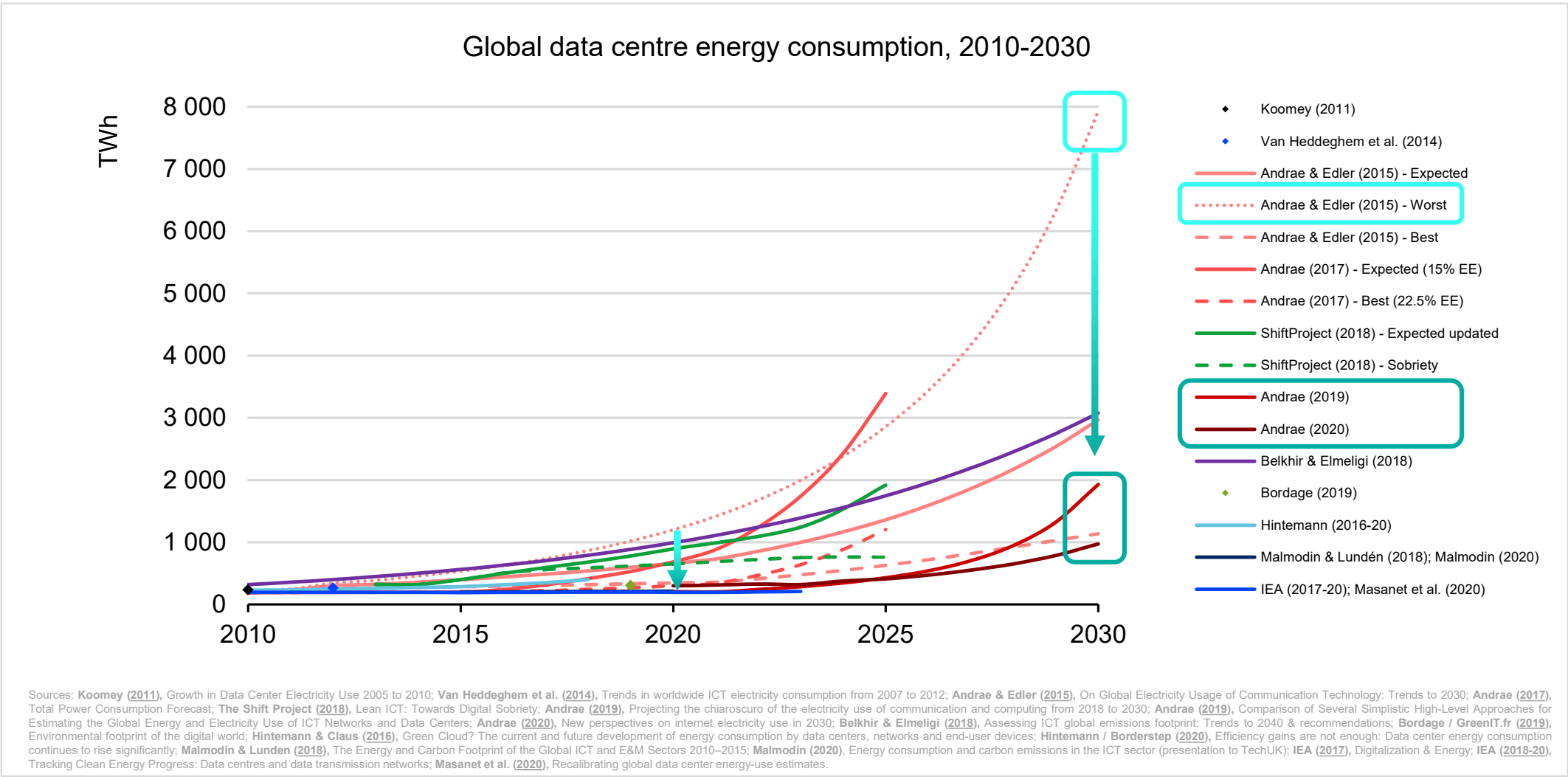
**Billions of internet-connected devices could produce 3.5% of global emissions within 10 years and 14% by 2040, according to new research, reports [Climate Home News](#)**

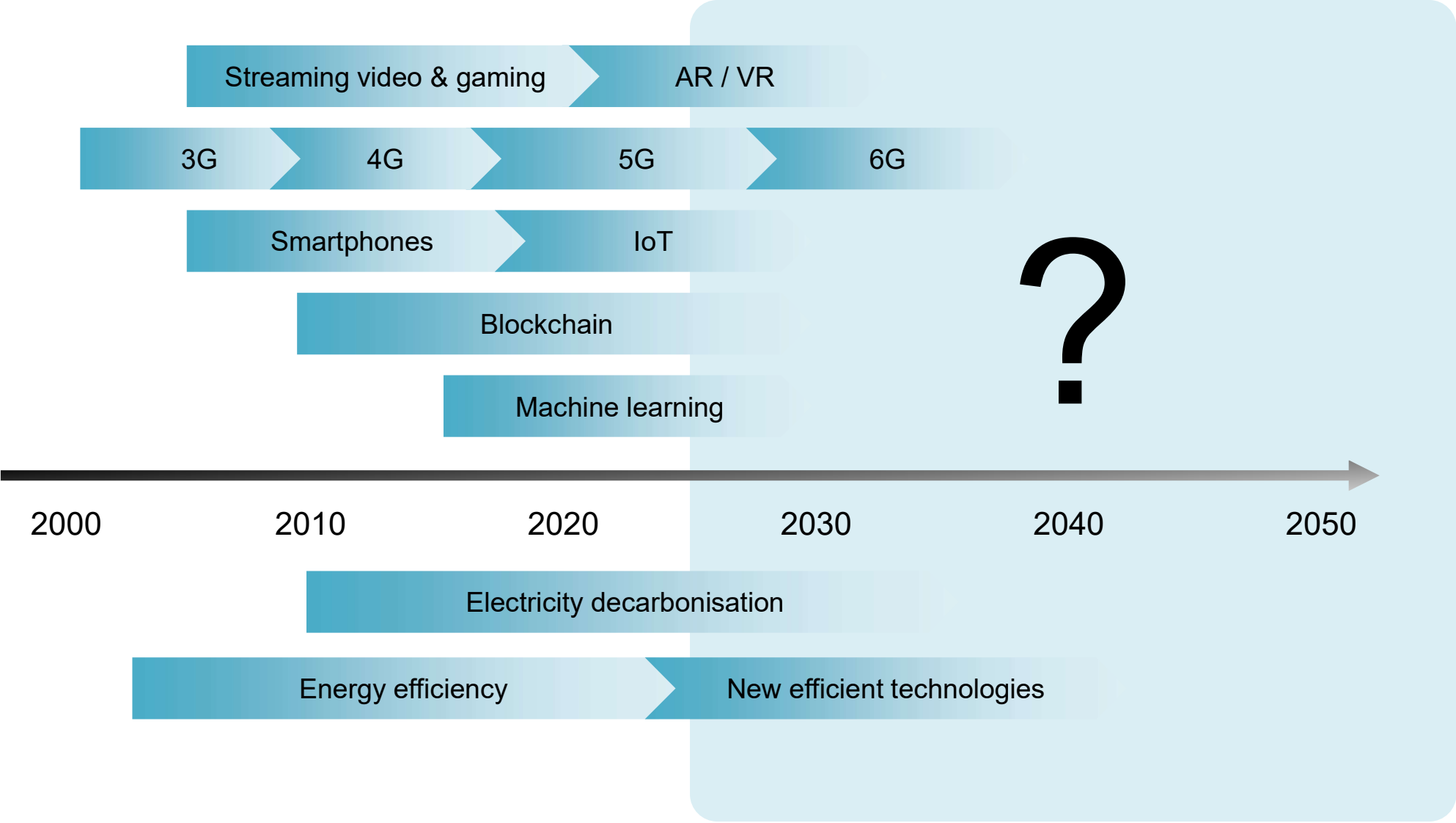
Mon 11 Dec 2017 13.27 GMT



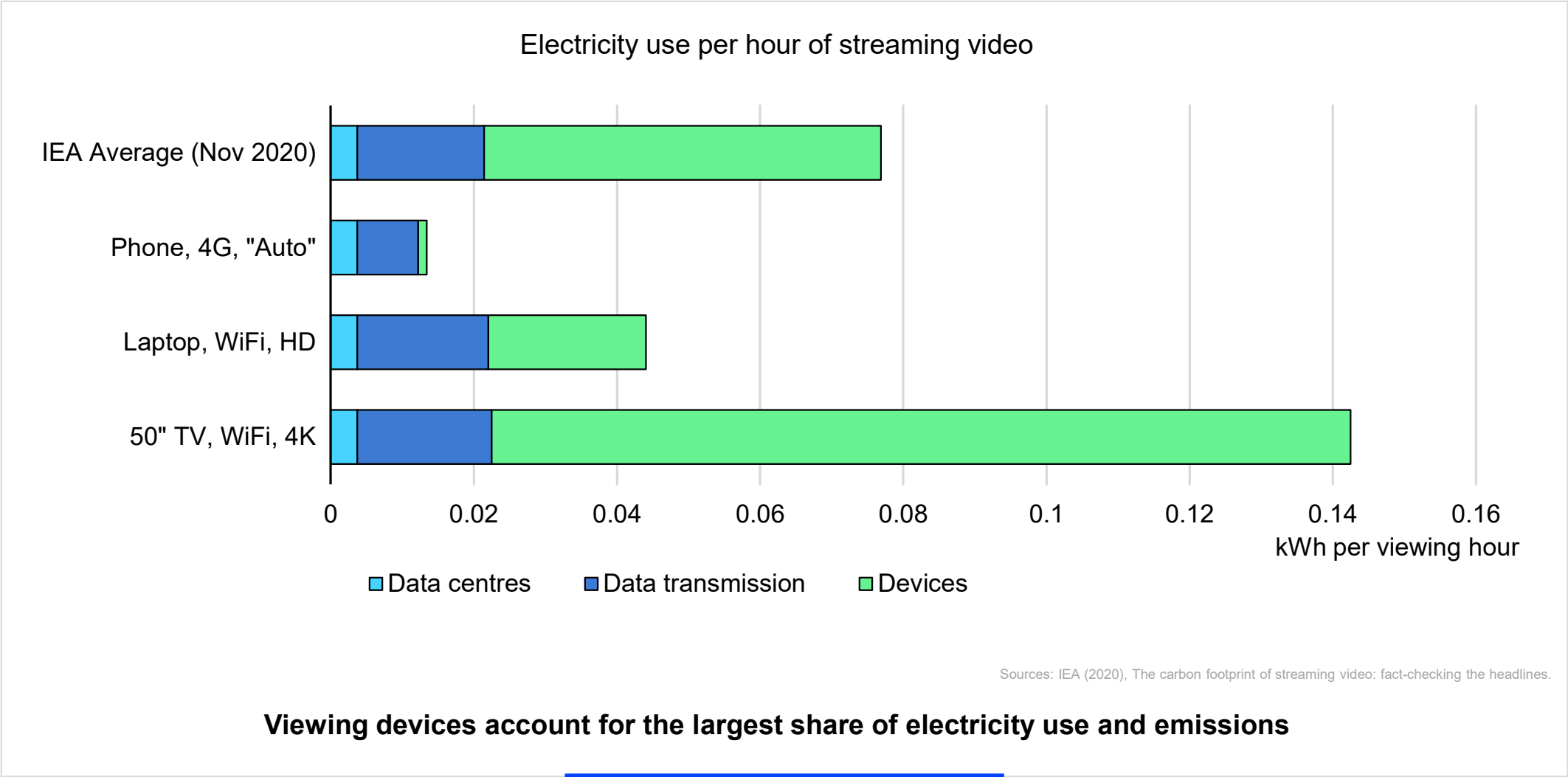
   
1,454 73

# Data centres: comparing global energy use estimates





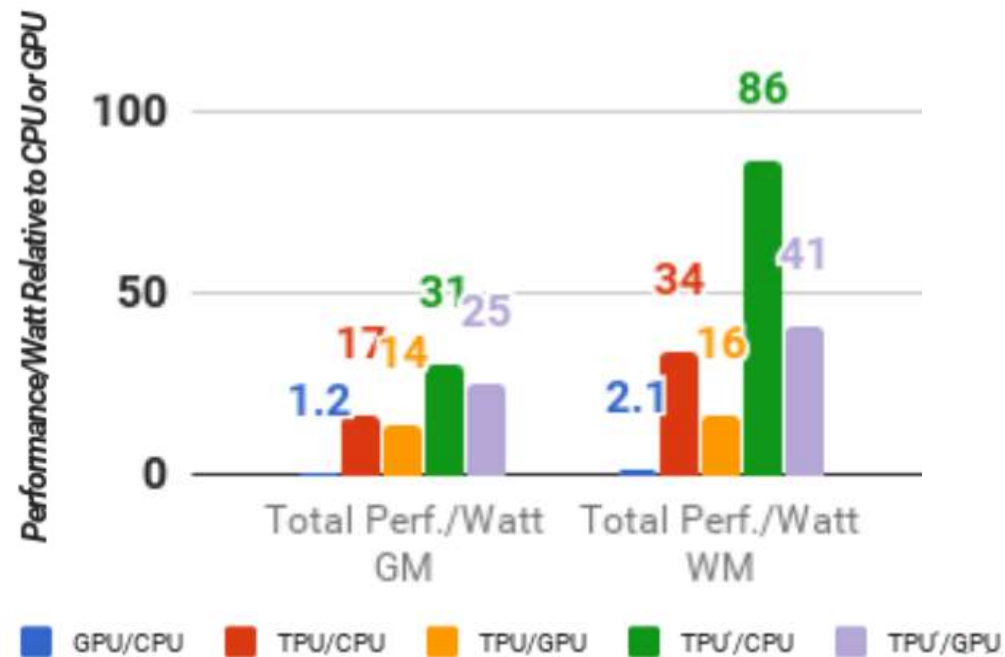
# Electricity use from streaming video





# Energy efficiency gains from specialised hardware

Relative performance/Watt of TPU, GPU and CPU servers

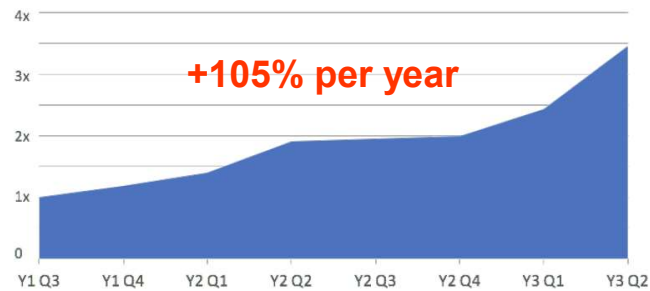


Jouppi et al. (2017). In-Datcenter Performance Analysis of a Tensor Processing Unit. <https://dl.acm.org/doi/pdf/10.1145/3140659.3080246>

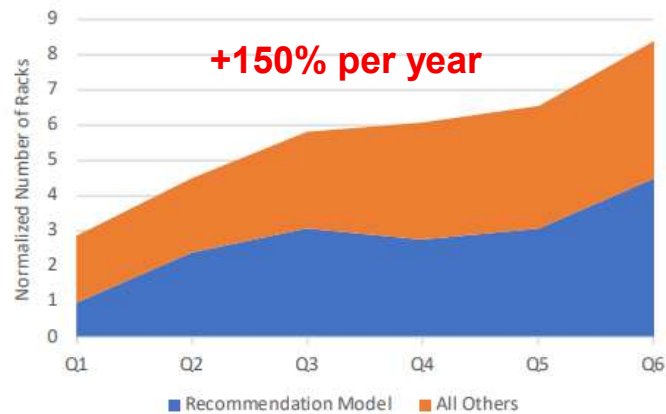
**Application-specific integrated circuits (ASICs) for machine learning are 15-30x faster and 30-80x more energy efficient compared to a contemporary CPU or GPU**

# Increasing demand for ML workloads

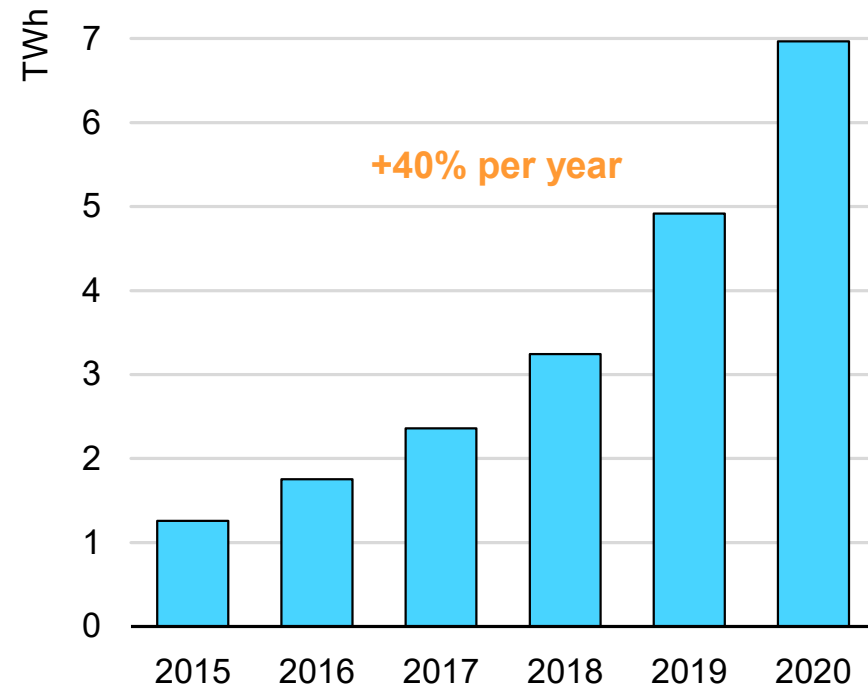
## Server demand for DL inference



## Server compute demand for training

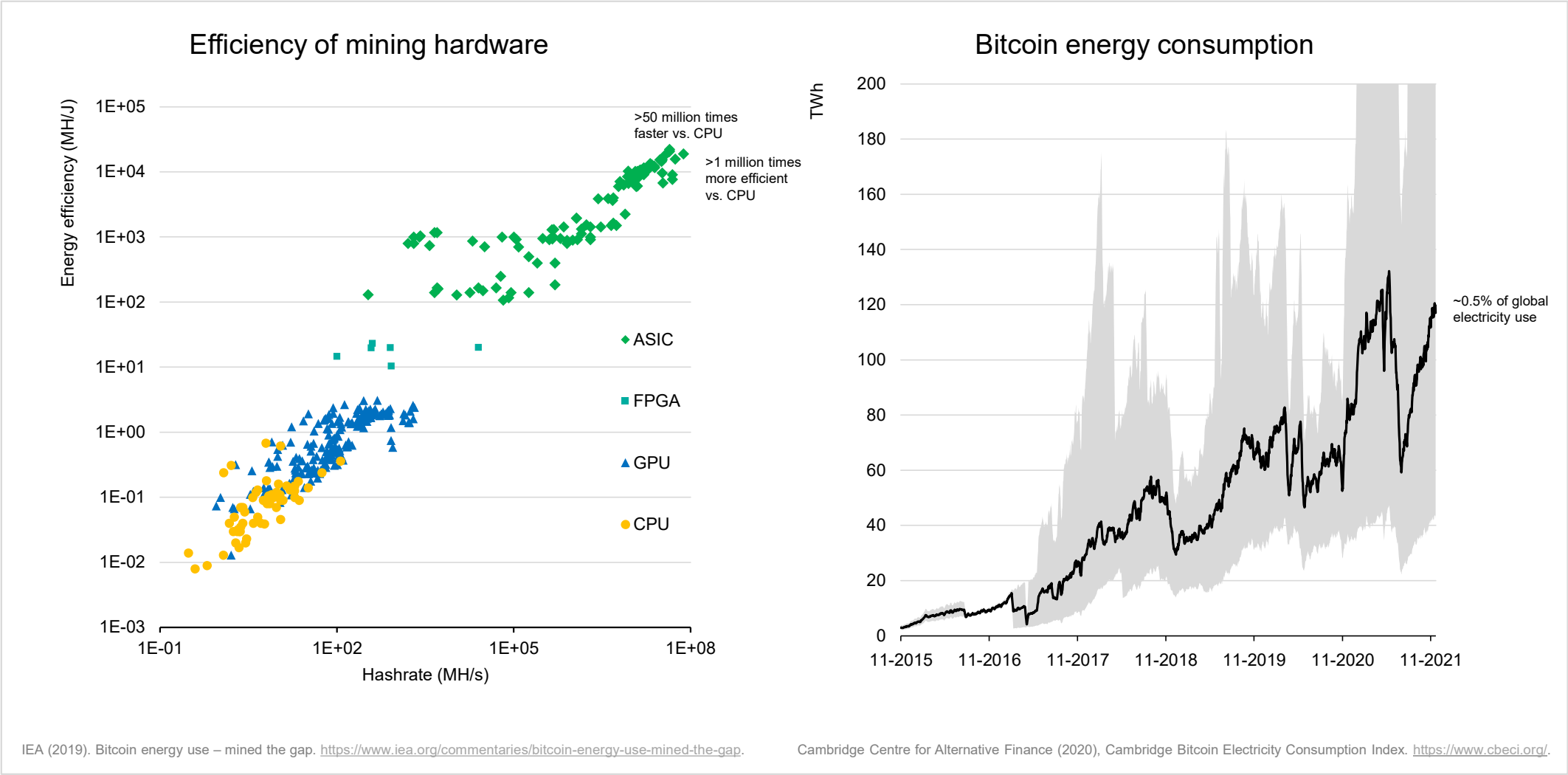


## Facebook data centre energy use, 2015-2020

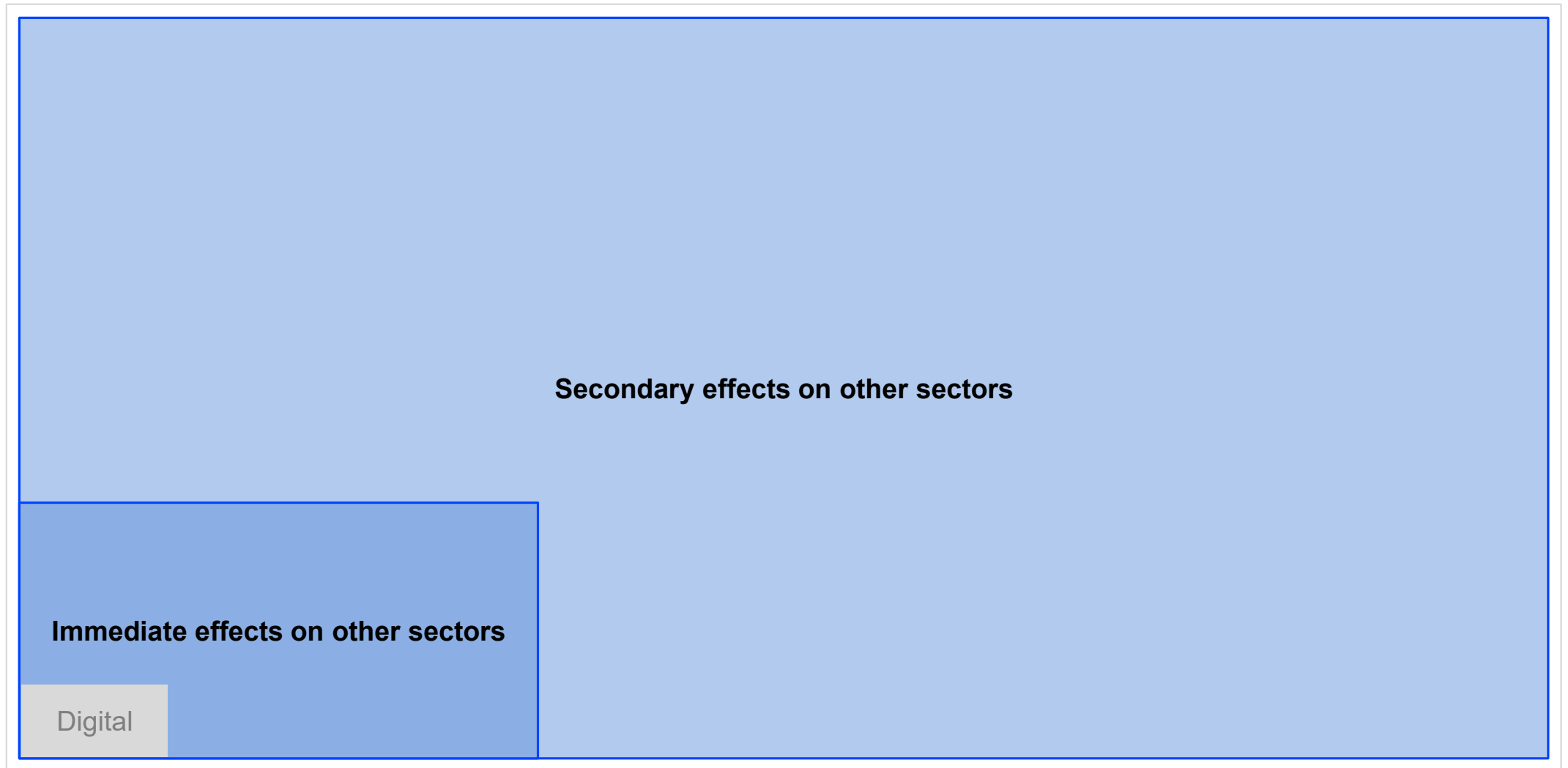


Sources: Park et al. (2018), Deep Learning Inference in Facebook Data Centers: Characterization, Performance Optimizations and Hardware Implications. <https://arxiv.org/abs/1811.09886>; Naumov et al. (2020), Deep Learning Training in Facebook Data Centers: Design of Scale-up and Scale-out Systems. <https://arxiv.org/abs/2003.09518>; Facebook (2021), Sustainability Report 2020, [https://sustainability.fb.com/wp-content/uploads/2021/06/2020\\_FB\\_Sustainability-Data.pdf](https://sustainability.fb.com/wp-content/uploads/2021/06/2020_FB_Sustainability-Data.pdf).

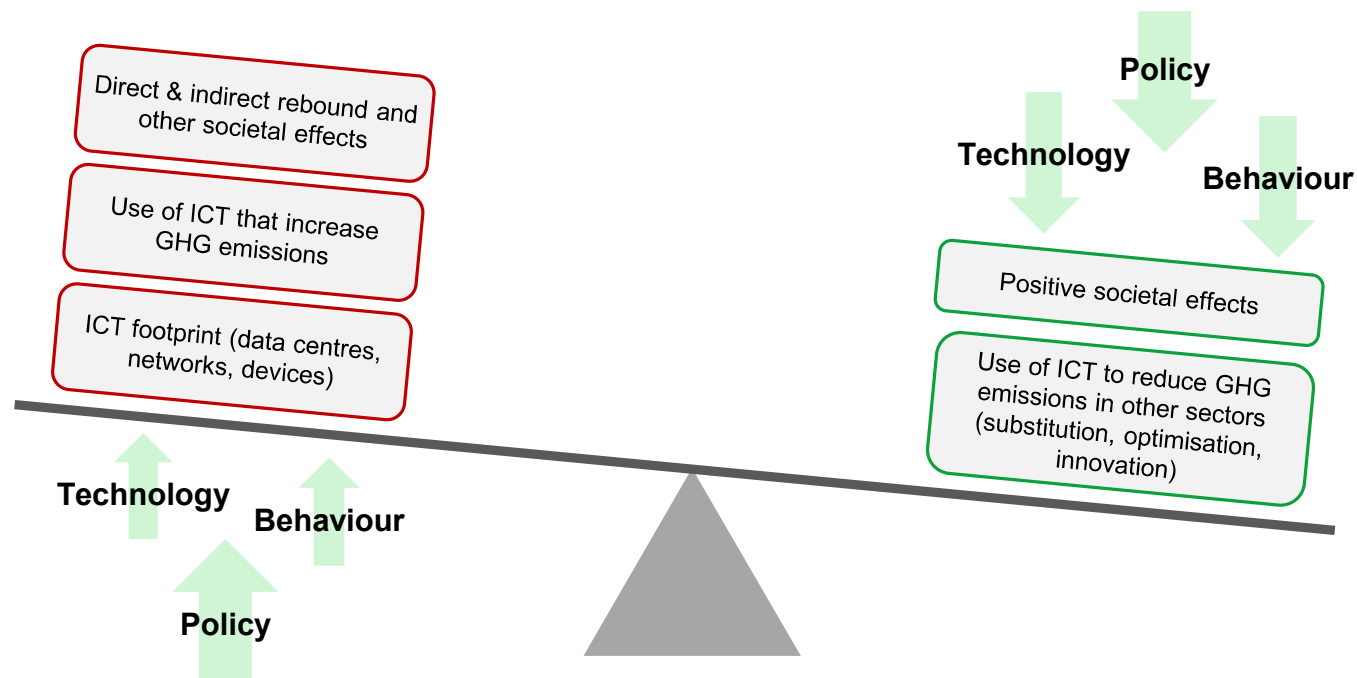
# Blockchain and cryptocurrencies



# Effects on other sectors



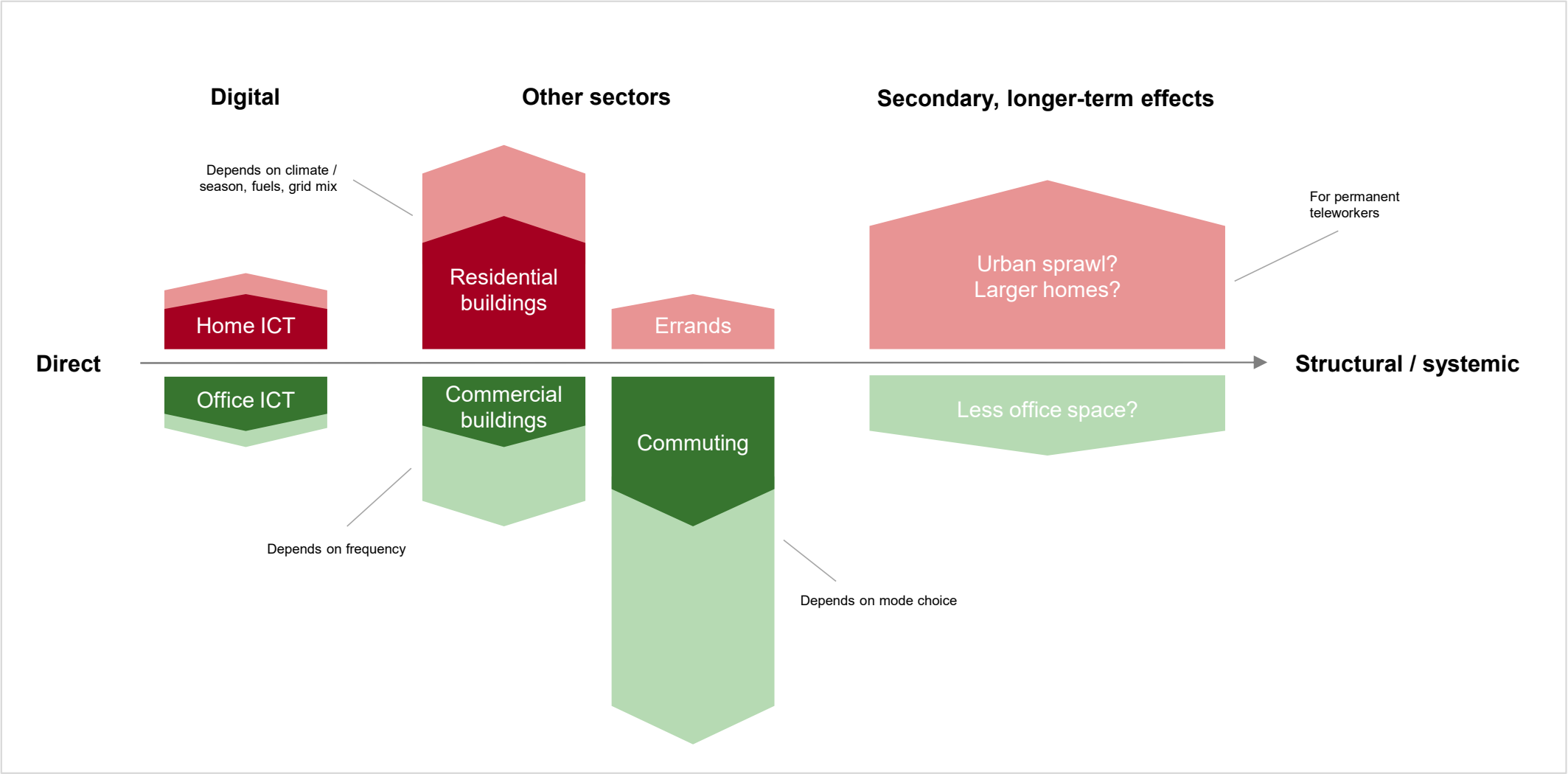
# Influencing the net climate impacts of digitalisation



Adapted from Bergmark (2021), Assessing the net climate impact of digitalisation.

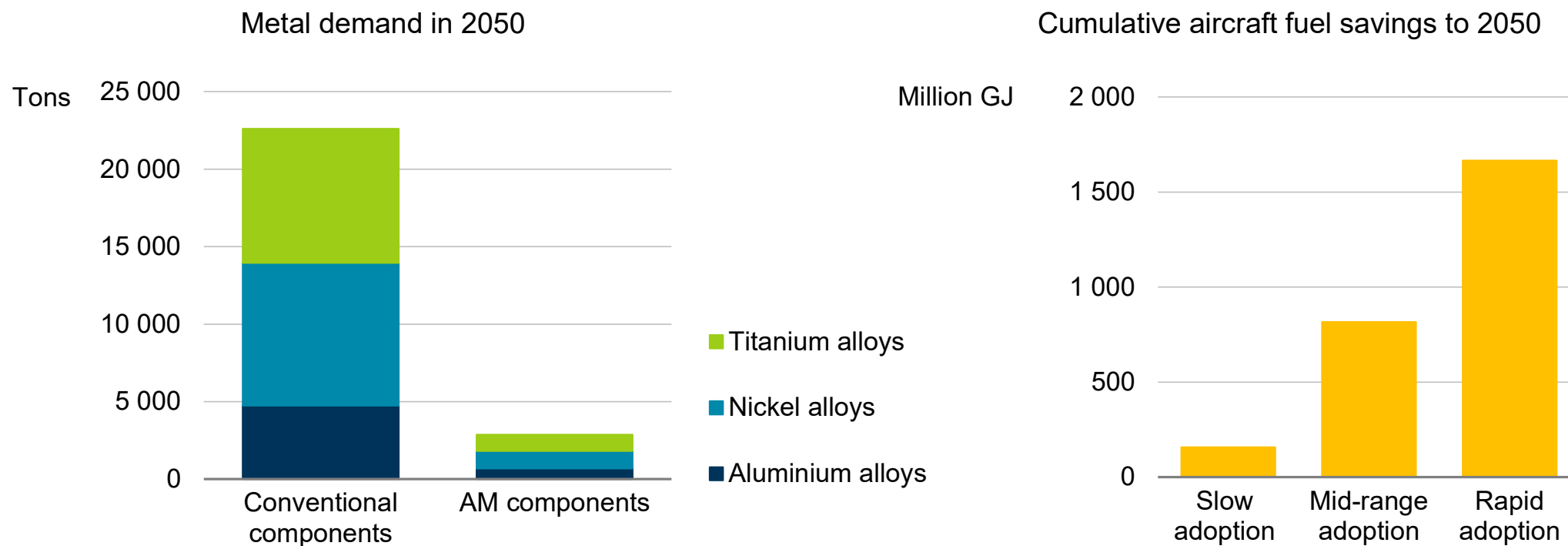
**Policy choices will play a central role in shaping the net energy and emission impacts of digitalisation**

# Changes in energy use and emissions from teleworking



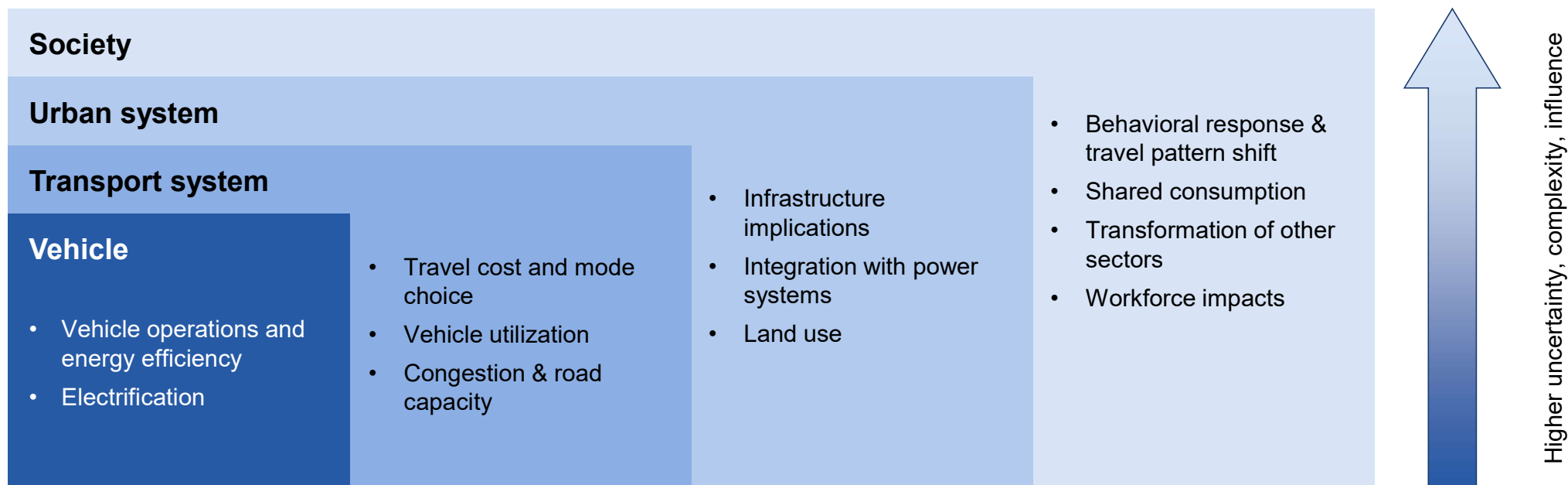
# Applying digital technologies in the energy sector

- **Buildings:** smart building controls & thermostats; connected appliances & lighting
- **Industry:** robotics; digital twins; 3D printing; machine learning



# Applying digital technologies in the energy sector

- **Buildings:** smart building controls & thermostats; connected appliances & lighting
- **Industry:** robotics; digital twins; 3D printing; machine learning
- **Transport:** shared mobility services; automated & connected vehicles; freight optimisation; extreme fast charging protocols; discovery of new battery materials



Taiebat et al. (2018), A Review on Energy, Environmental, and Sustainability Implications of Connected and Automated Vehicles.



# Applying digital technologies in the energy sector

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- **Buildings:** smart building controls & thermostats; connected appliances & lighting
- **Industry:** robotics; digital twins; 3D printing; machine learning
- **Transport:** shared mobility services; automated & connected vehicles; freight optimisation
- **Electricity:** IoT and automation to improve efficiency and reduce maintenance costs; machine learning to improve solar and wind forecasts, and better match supply and demand from increasingly decentralised sources
- **Oil & gas:** machine learning to reduce costs of detecting methane leaks
- **Energy access:** mobile services and infrastructure to facilitate electricity access
- **Policy:** data collection; modelling; assessing policy options and effectiveness

**Net impacts on energy use and emissions will be shaped by climate policy**

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# Key takeaways

- Understanding the effects of digitalisation on climate change requires a comprehensive, systems-level perspective.
- Given the growth in demand for digital technologies, policies and actions are needed to mitigate energy and emissions growth from the sector in three areas:
  1. energy efficiency, incl. RD&D into next-generation tech;
  2. zero-carbon electricity;
  3. decarbonising supply chains.
- The direct energy and GHG “footprint” is relatively small compared to the effects of digitalisation on other sectors and activities (“handprint”).
- Digital technologies can have both positive and negative effects on climate change. They are NOT a silver bullet to tackle climate change, but can be an important tool.
- Strong climate policies are critical to ensure that digital technologies are applied in areas that help reduce emissions.



### Questions?

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