The Climate Impact of ICT

Low Carbon and Sustainable Computing Seminar

University of Glasgow, April 2022

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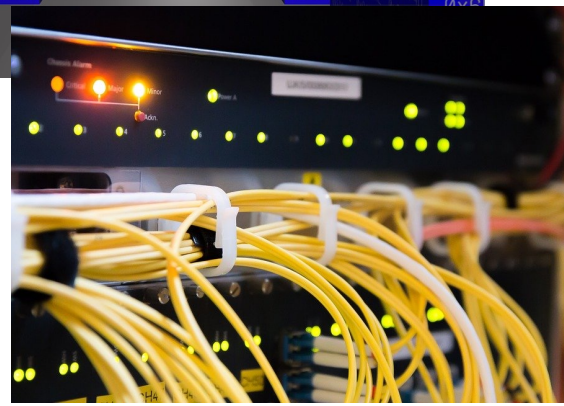
What is ICT?

ICT underpins society



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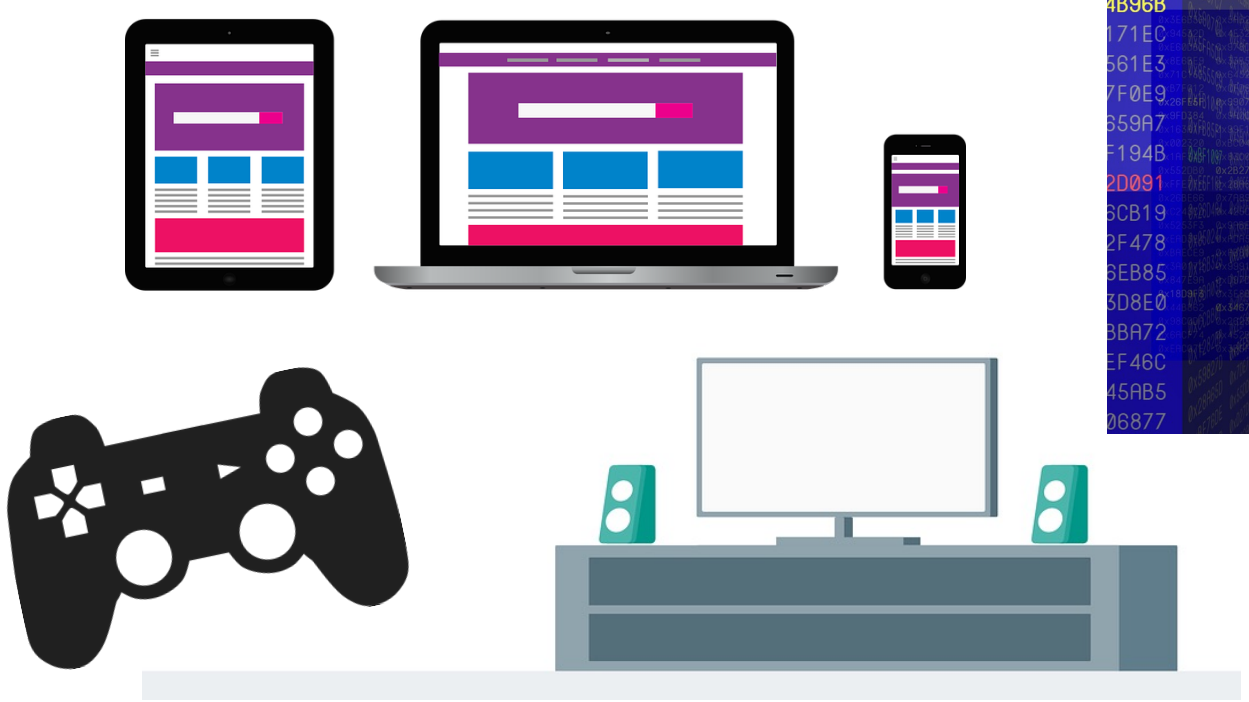
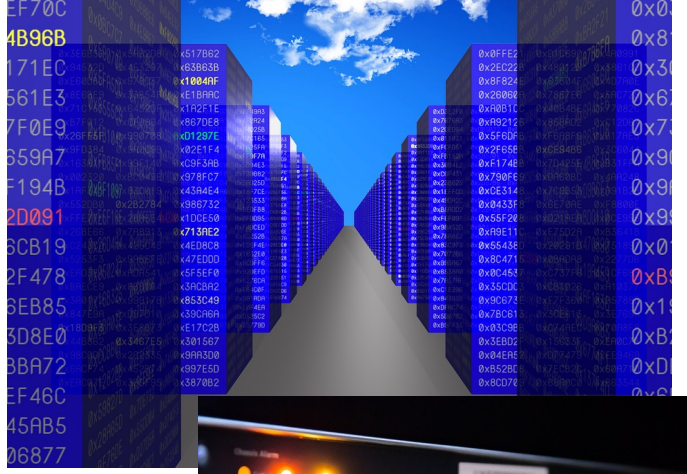
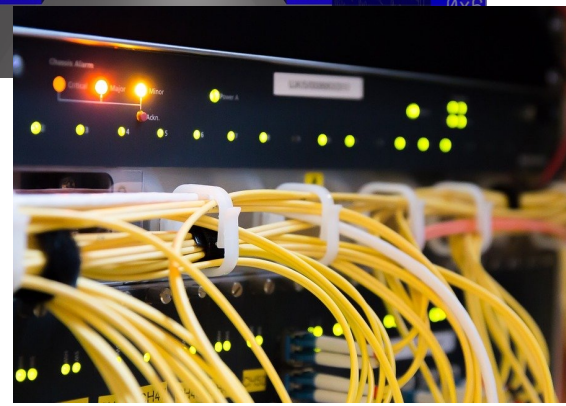






What are ICT's environmental impacts?

EMBODIED EMISSIONS:

WHEN WE BUILD THE TECHNOLOGY

USE PHASE EMISSIONS:

WHEN WE USE AND MAINTAIN TECHNOLOGY

END-OF-LIFE EMISSIONS:

WHEN WE DISPOSE OF A TECHNOLOGY

Methodology

1. Literature searches for peer-reviewed studies on ICT's carbon footprint

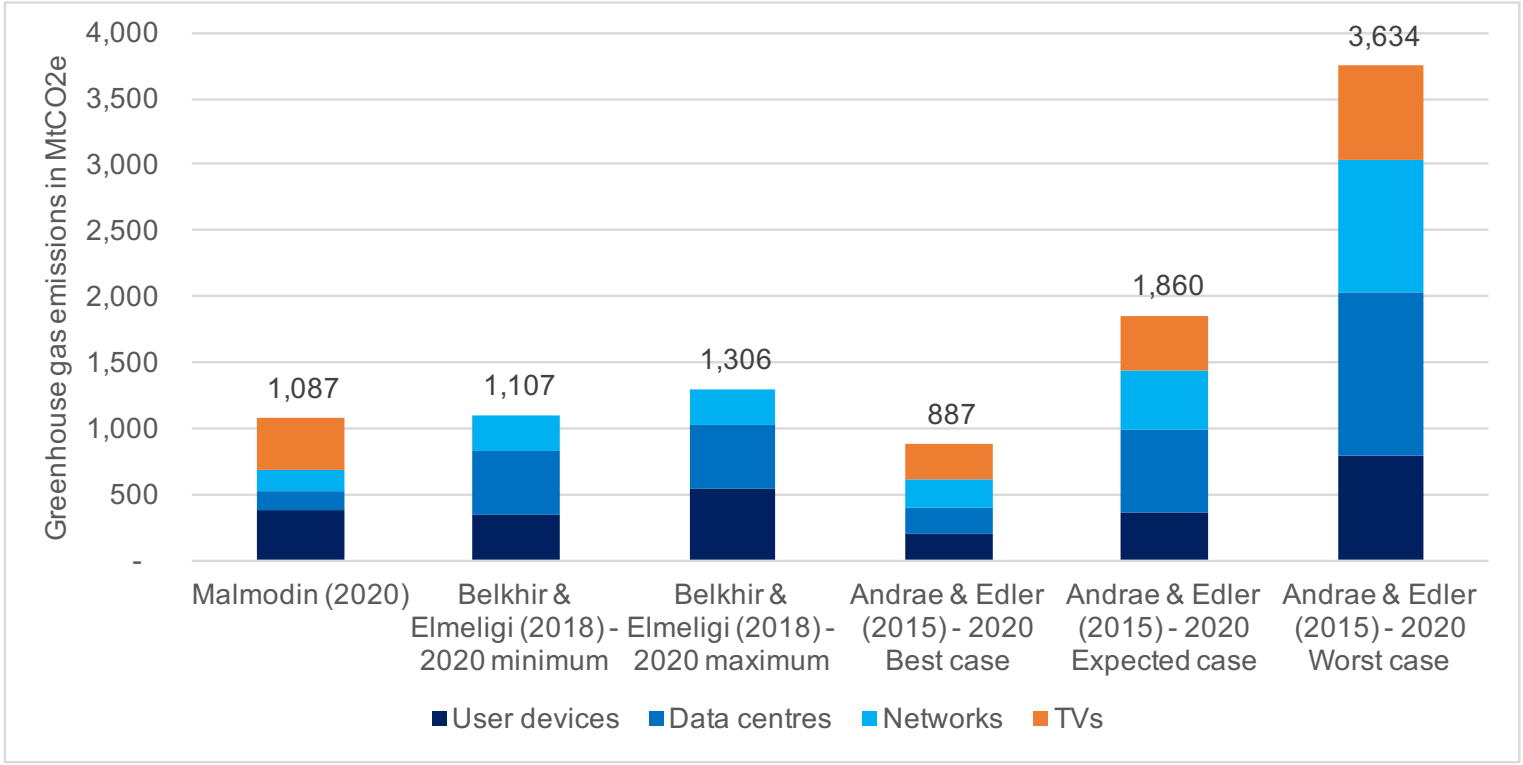
2. Supplemented by interviews with key analysts, i.e.

- Anders Andrae (Huawei Technologies)
- Jens Malmodin (Ericsson)
- Lotfi Belkhir (McMaster University)

3. Small World Consulting ongoing research with UK & global ICT companies

Where are we?

1.8-2.8%
of global
greenhouse
gas emissions



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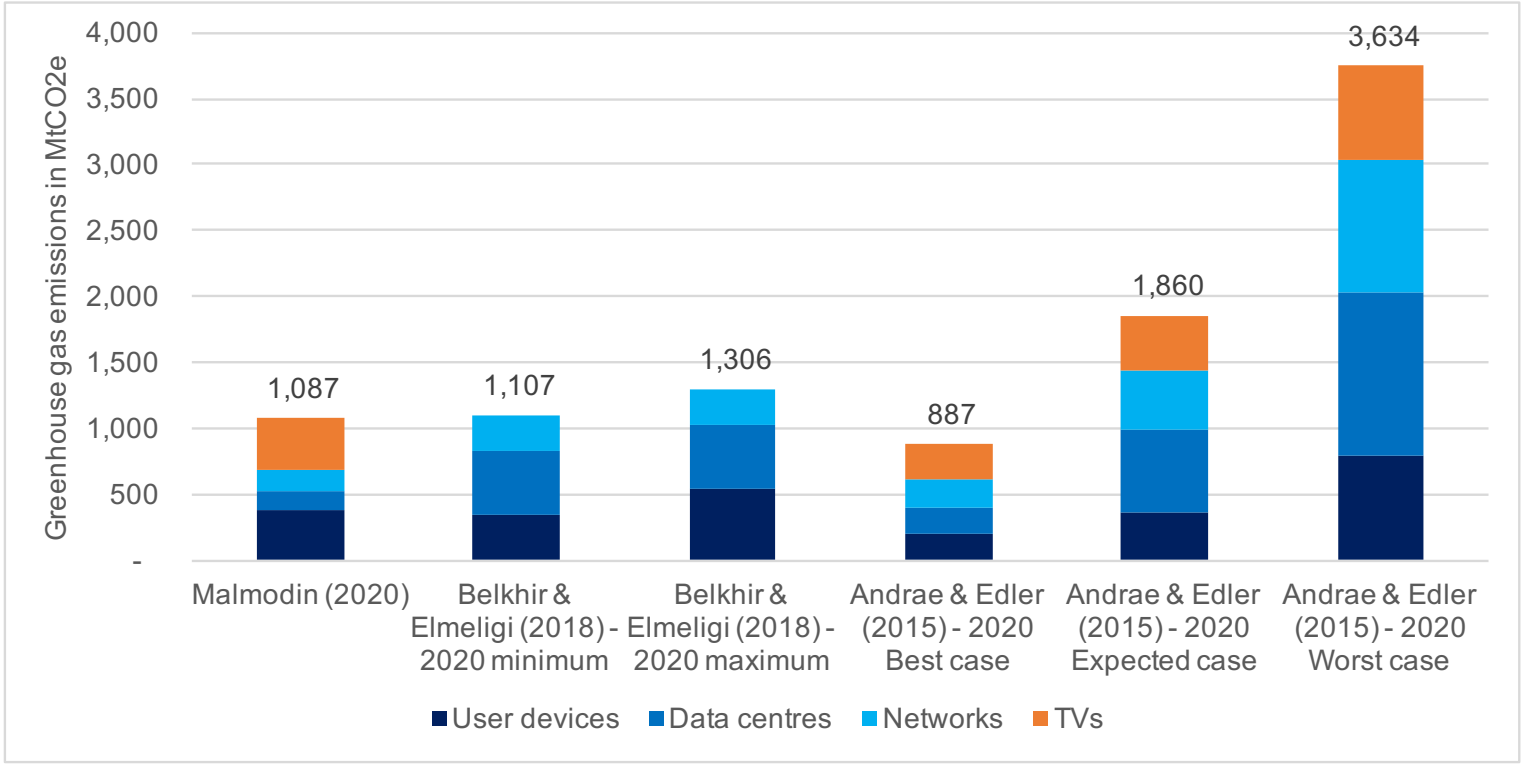


Estimates vary due to experts' data sources and decisions

Why is ICT's environmental impact underestimated?

- Data sources and decisions
- Truncation error
- Assumed future activities and behaviours in society

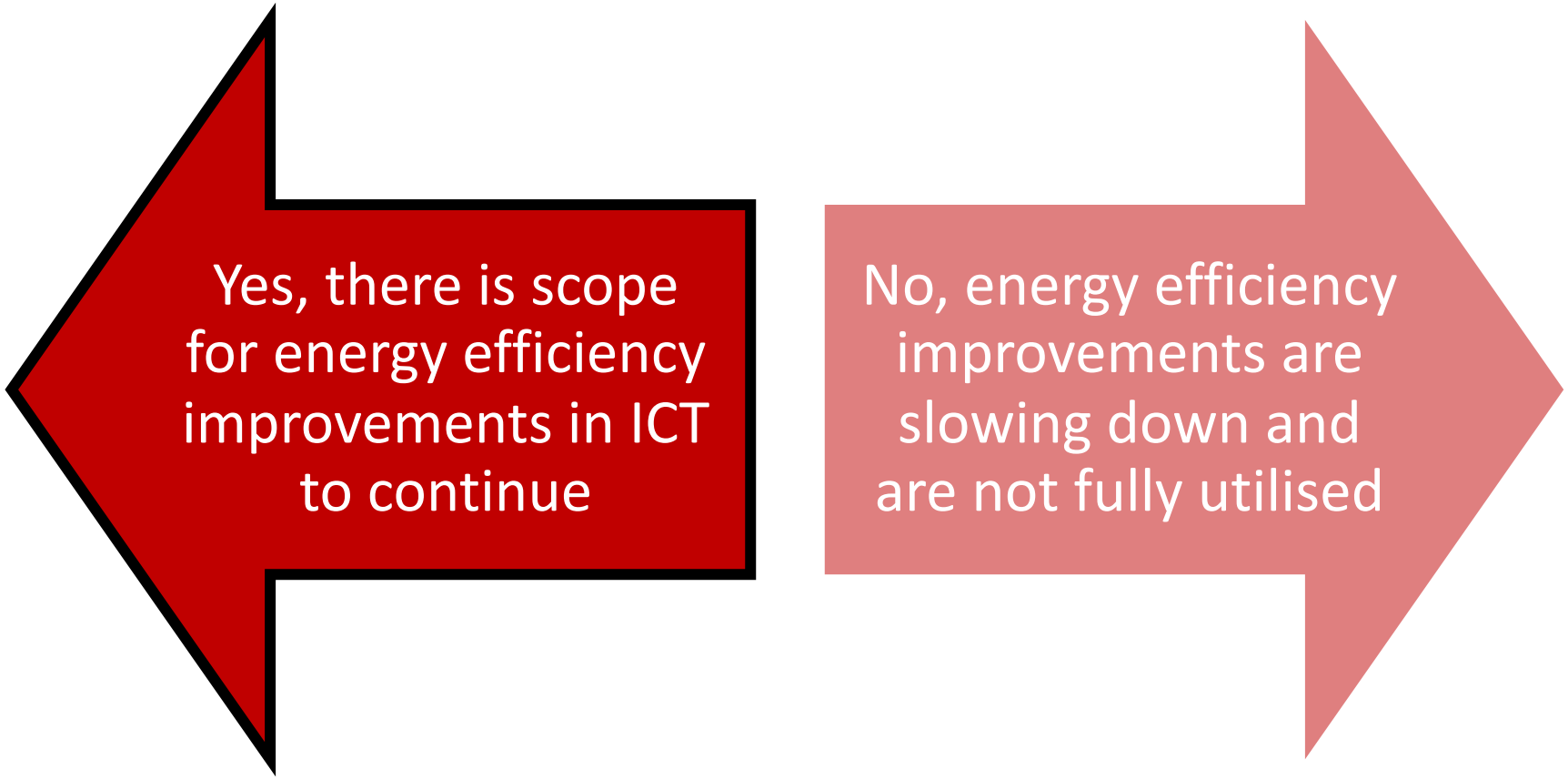
We ask:

- Will energy efficiency improvements in ICT continue?
- Will efficiency gains reduce ICT’s overall carbon footprint?
- Will ICT’s emissions stabilise due to saturation in demand?
- Is data traffic now independent of ICT emissions?
- Is ICT enabling carbon savings in other industries?
- Will renewable energy decarbonise ICT?

unsplash/ science-in-hd-joGs6hU_EKE

1. Will energy efficiency improvements in ICT continue?

- Moore's law
- PoE in data centres
- Shift to mobile devices



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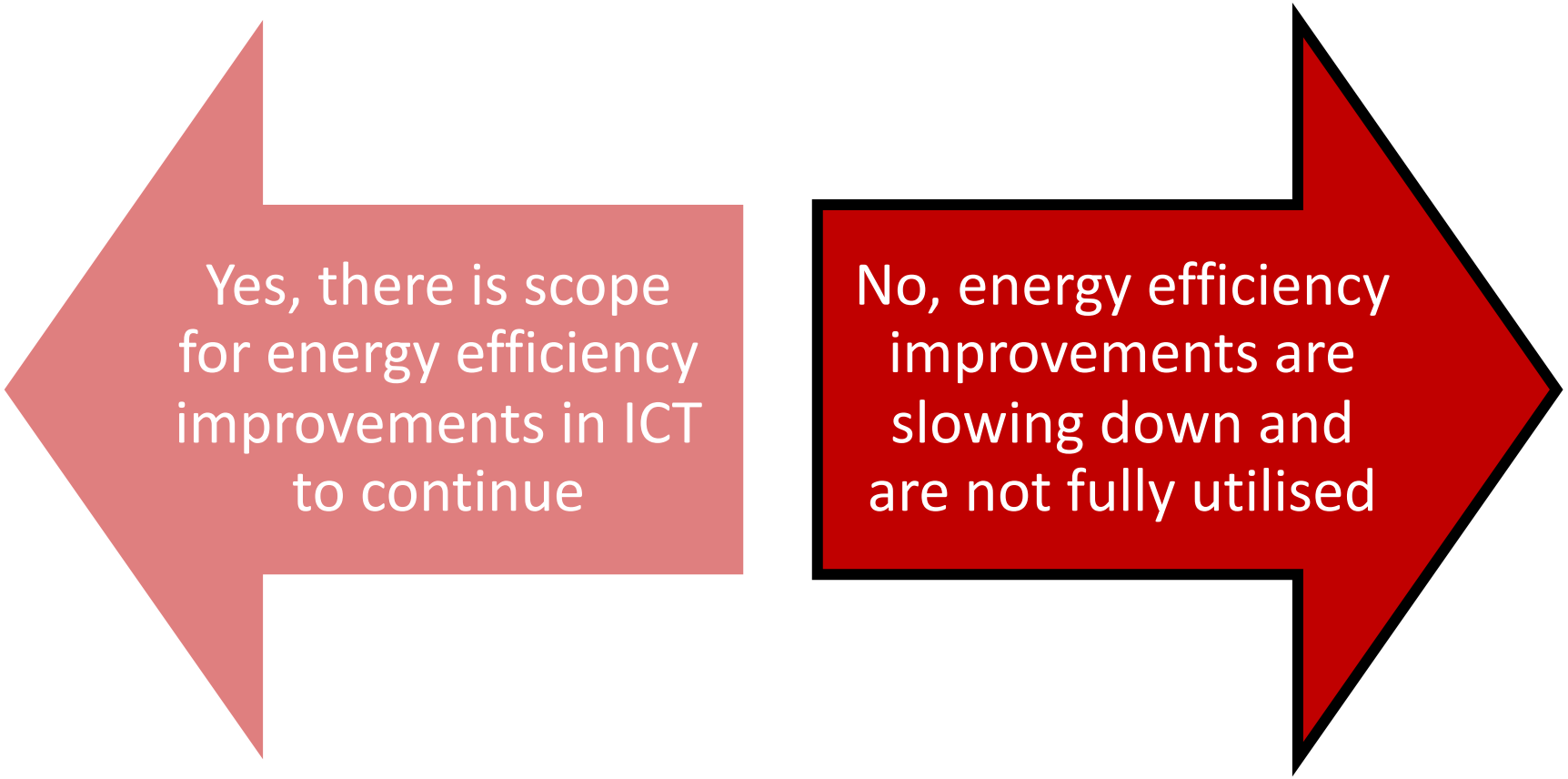
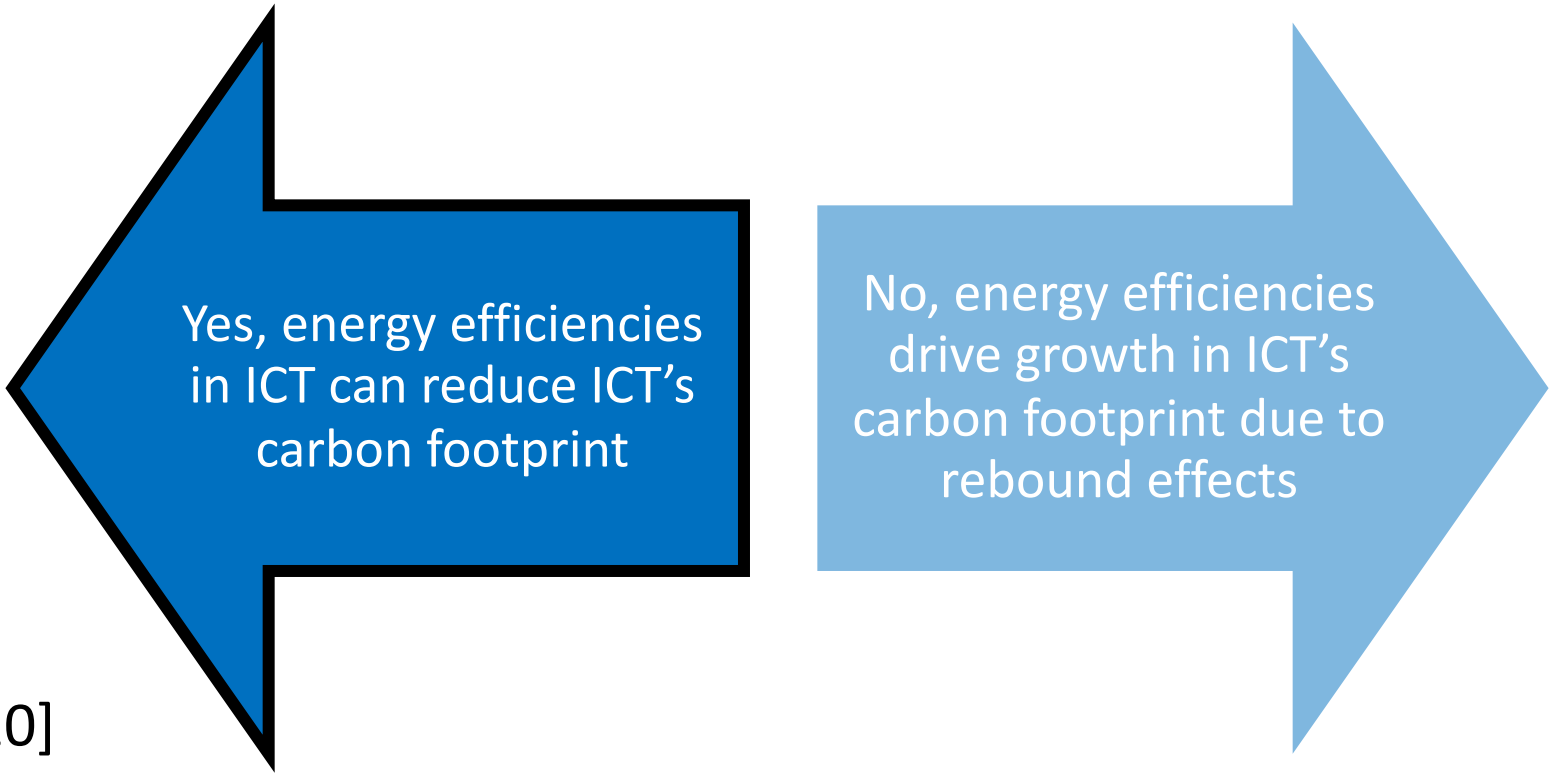


- Quantum limits
- Hotter CPUs = more cooling
- Does new replace old?

2. Will efficiency gains reduce ICT's overall carbon footprint?

- Efficiency has improved
- Data centres grown yet remained at ~1% global demand [Masanet, 2020]



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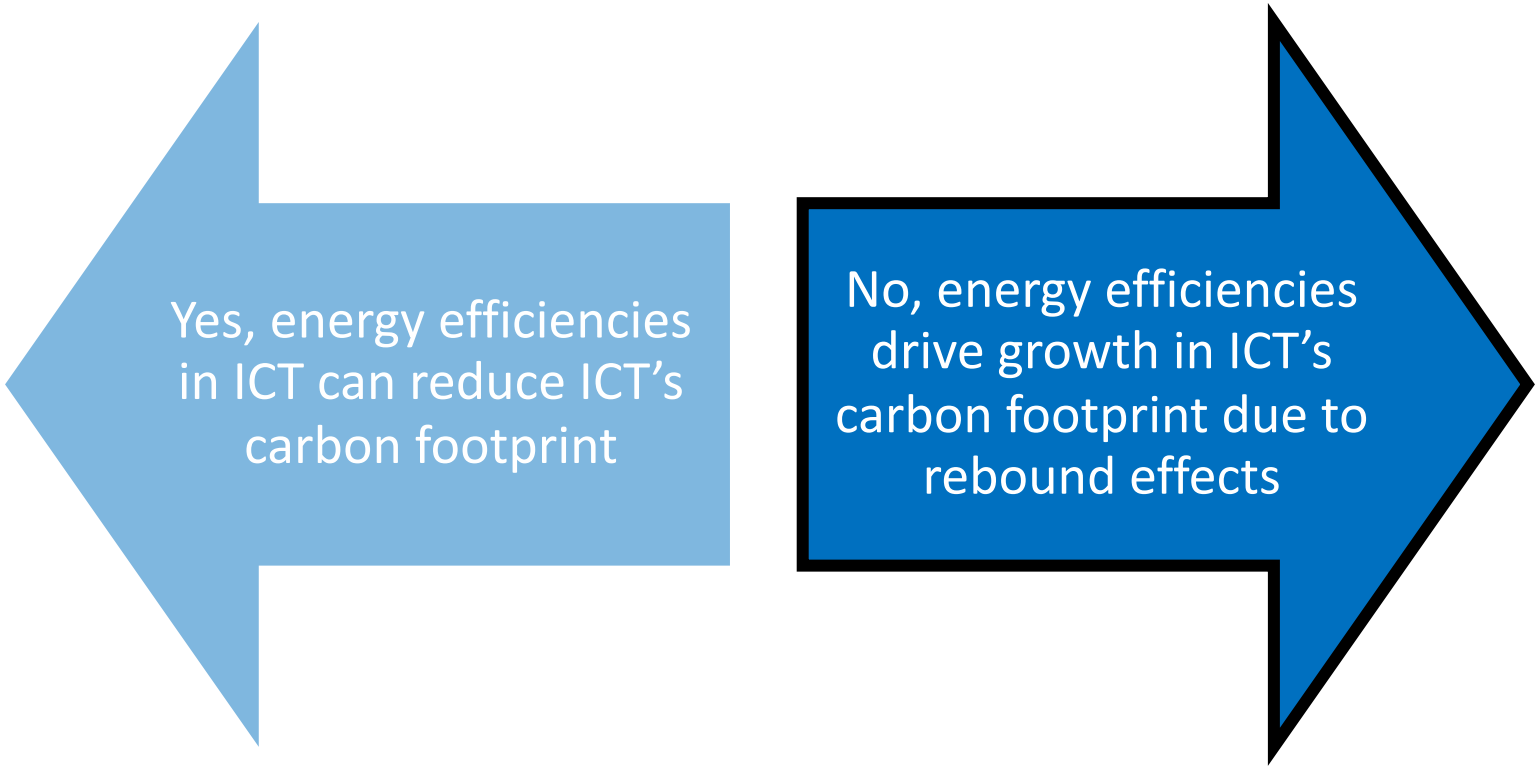

- Demand for more devices
- Carbon footprint undeniably growing
- Rebound effects

3. Will ICT's emissions stabilise due to saturation in demand?

- 5.7bn mobile subscribers by 2023 [Cisco, 2020]
- Limited available attention [Malmodin]

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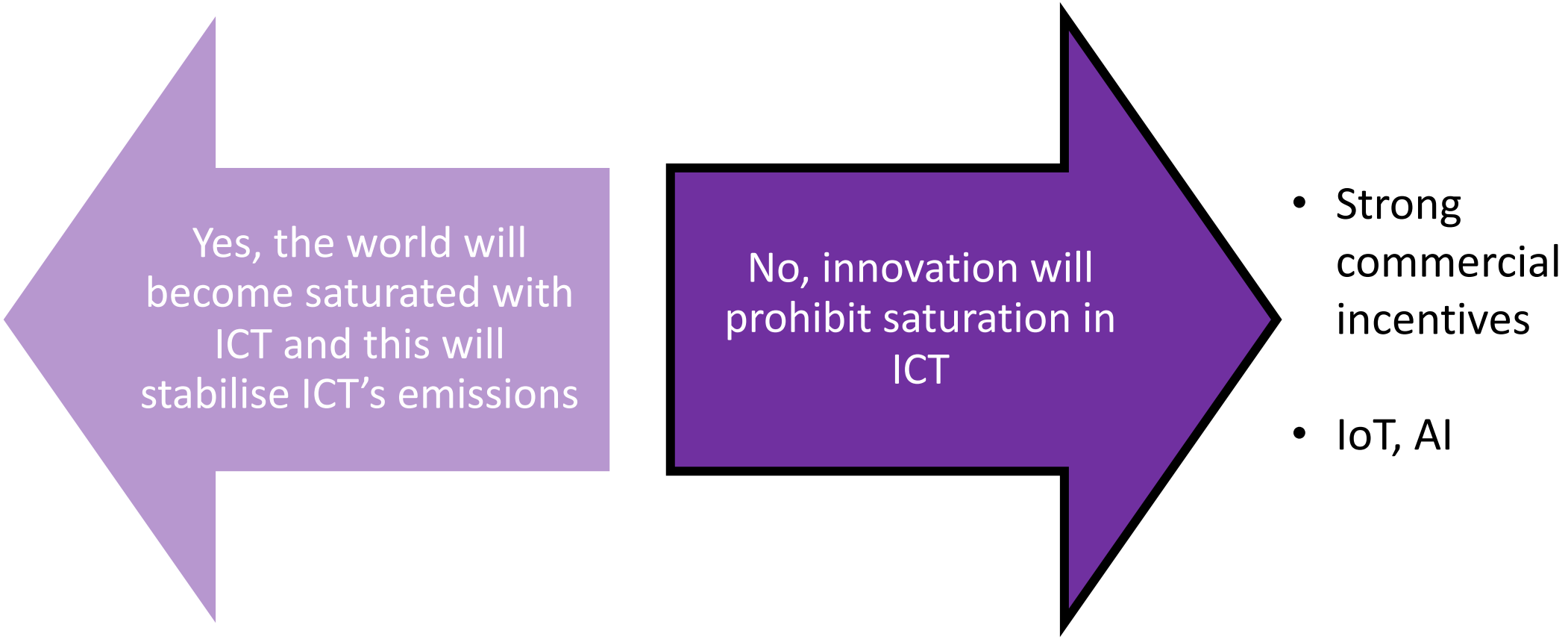
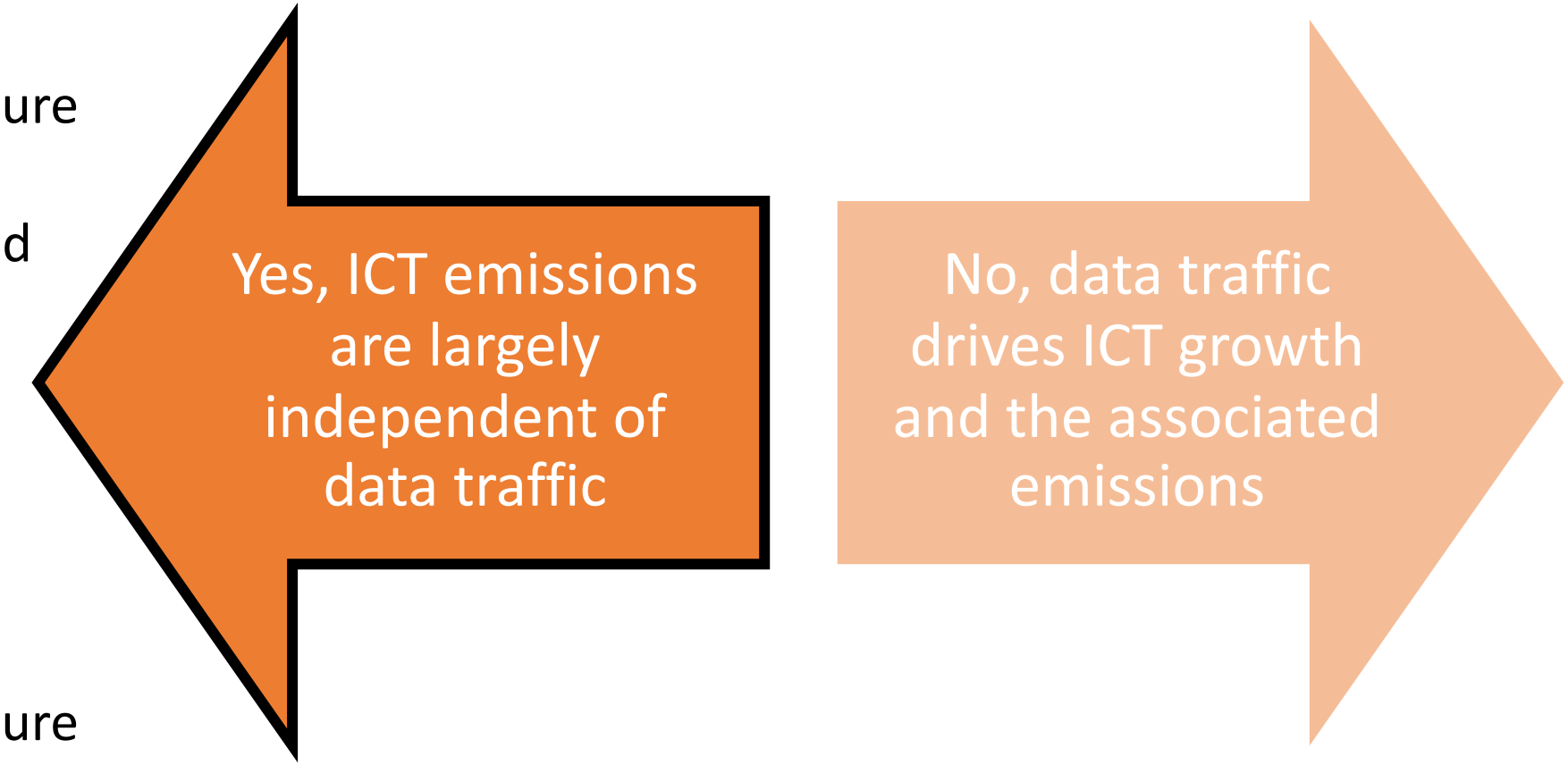


4. Is data traffic now independent of ICT emissions?

- Always on infrastructure
- Provisioned for peak demand
- More demand = more infrastructure



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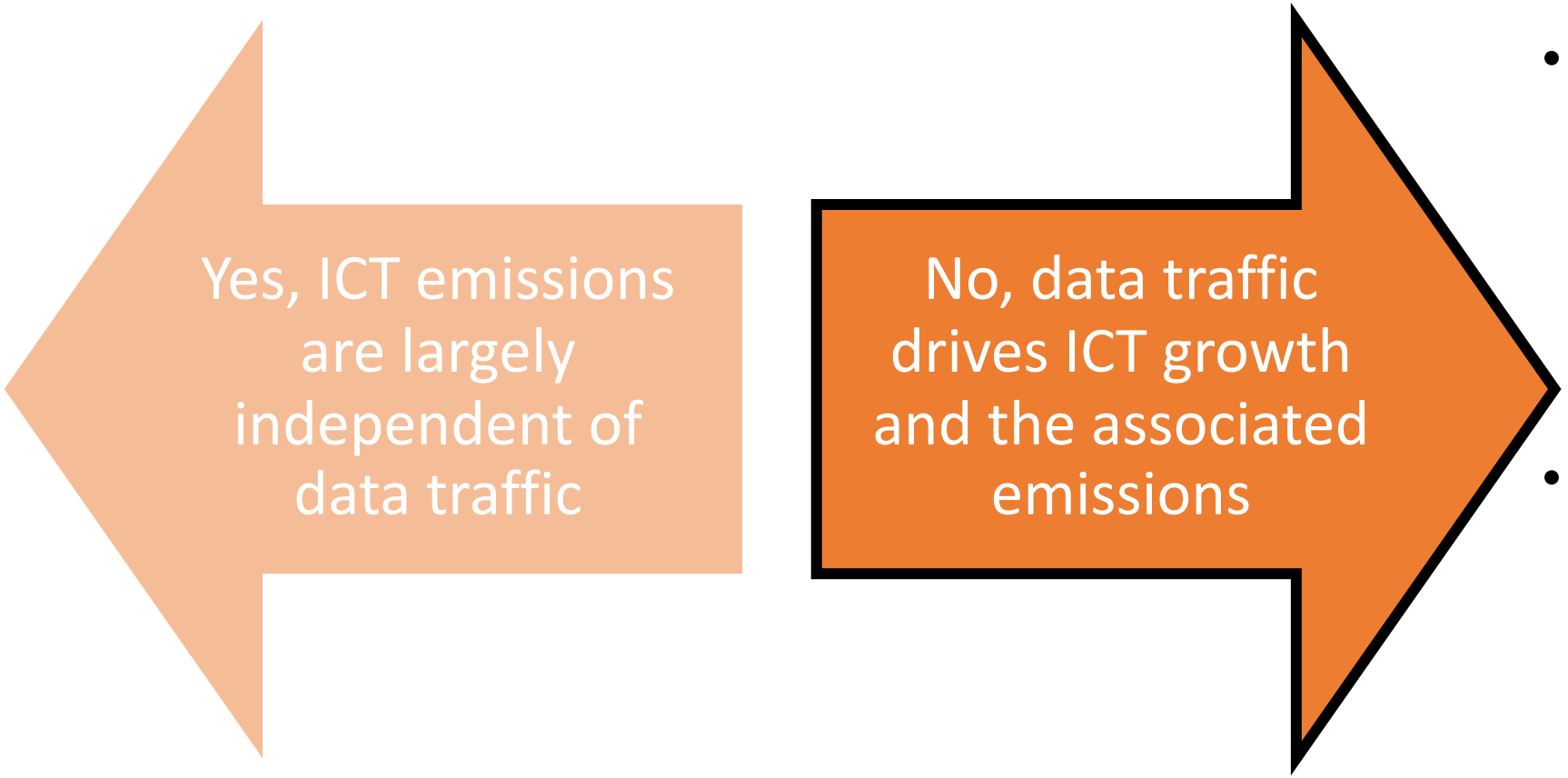
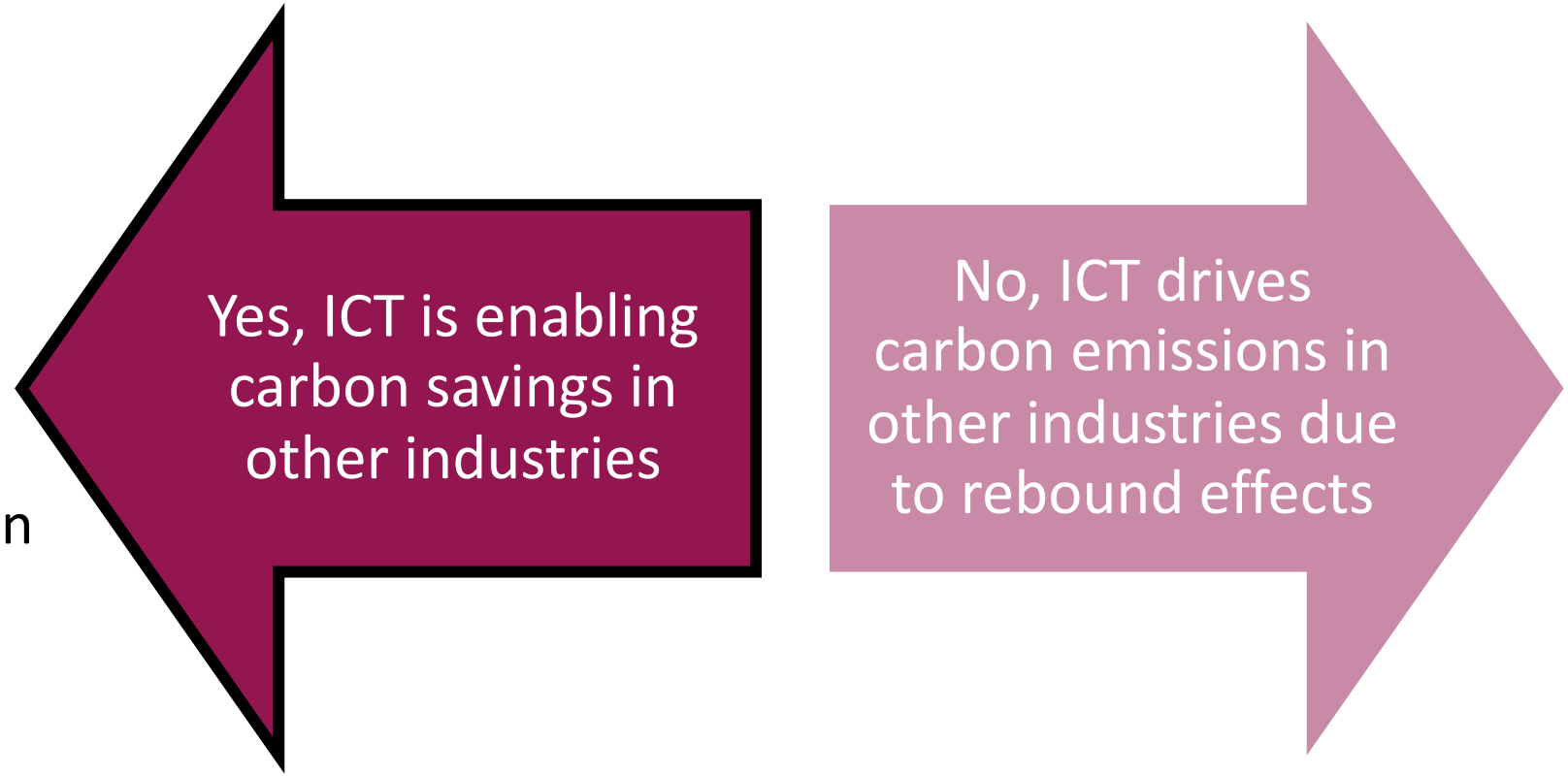


- Andrae and Belkhir agree data drives ICT growth
- Innovative services drive growth (e.g., video)

5. Is ICT enabling carbon savings in other industries?

- ICT could save 9.1 GtCO2e in 2020 through efficiency
- ICT enabling decarbonization of energy



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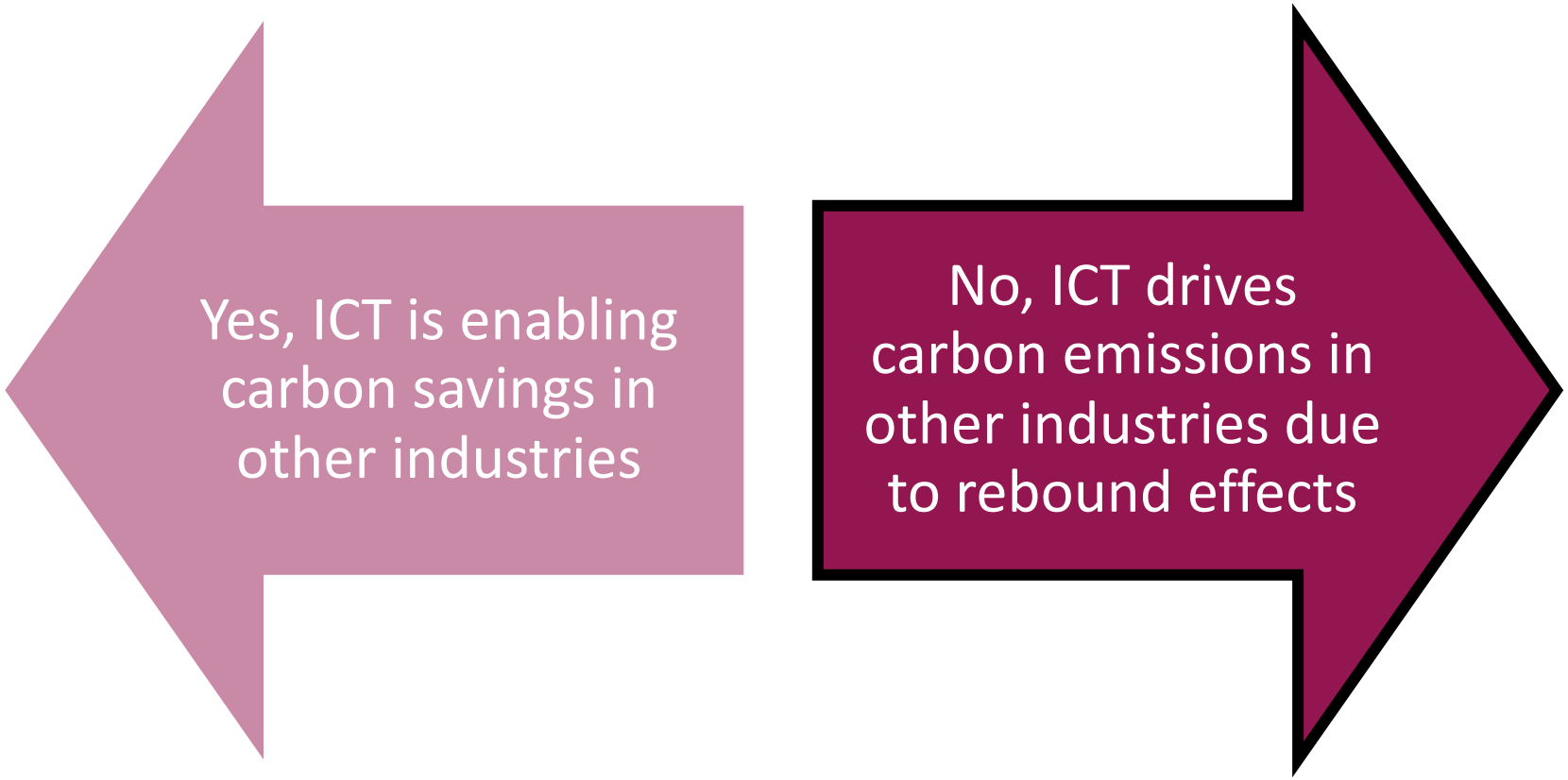
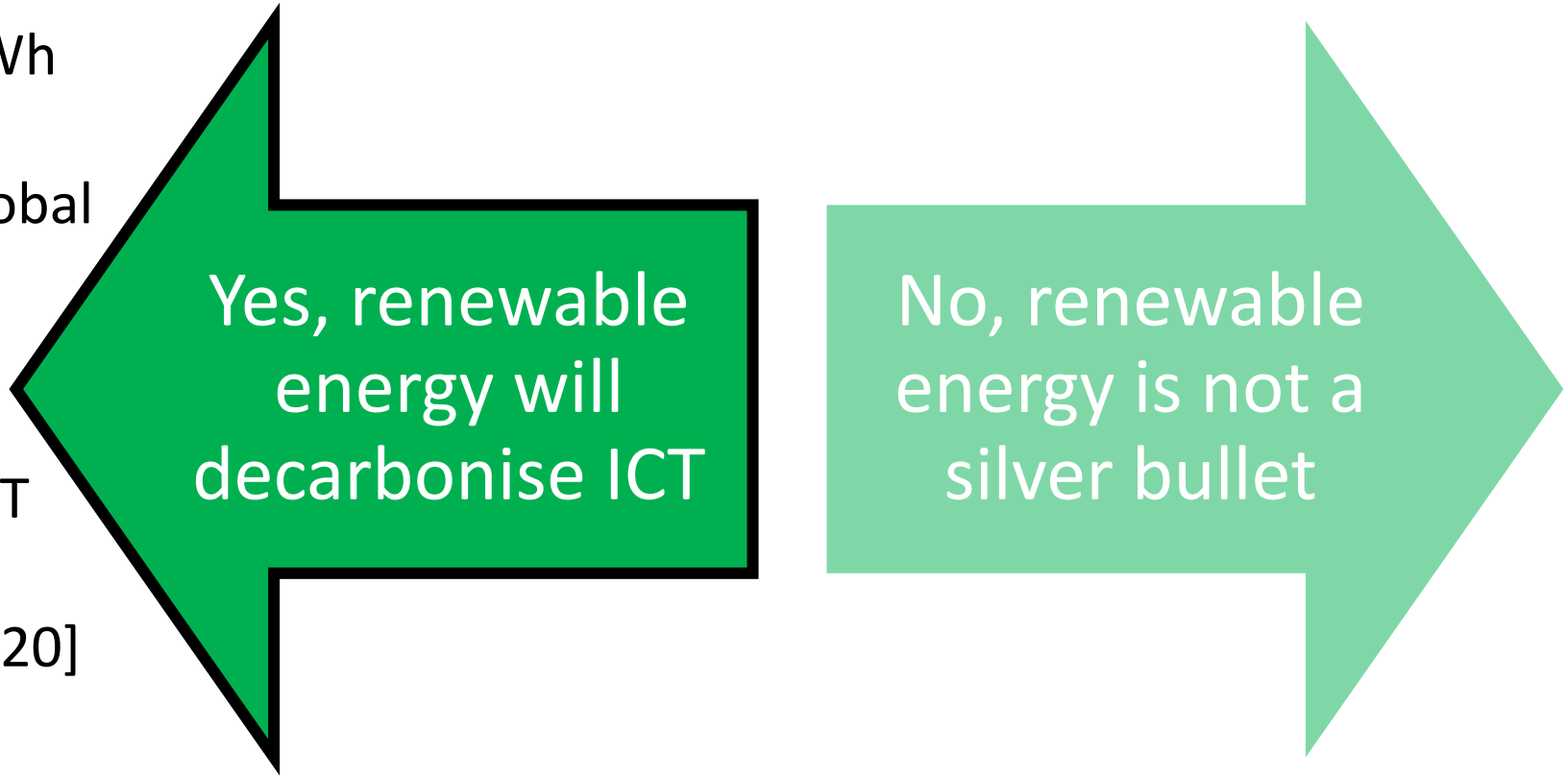


- Global emissions still climbing
- ICT-enabled rebound effects

6. Will renewable energy decarbonise ICT?

- 0.1 kgCO2e/kWh vs. 0.63kg CO2e/kWh (global energy mix)
- Up to 80% reduction in ICT emissions [Lövehagen 2020]



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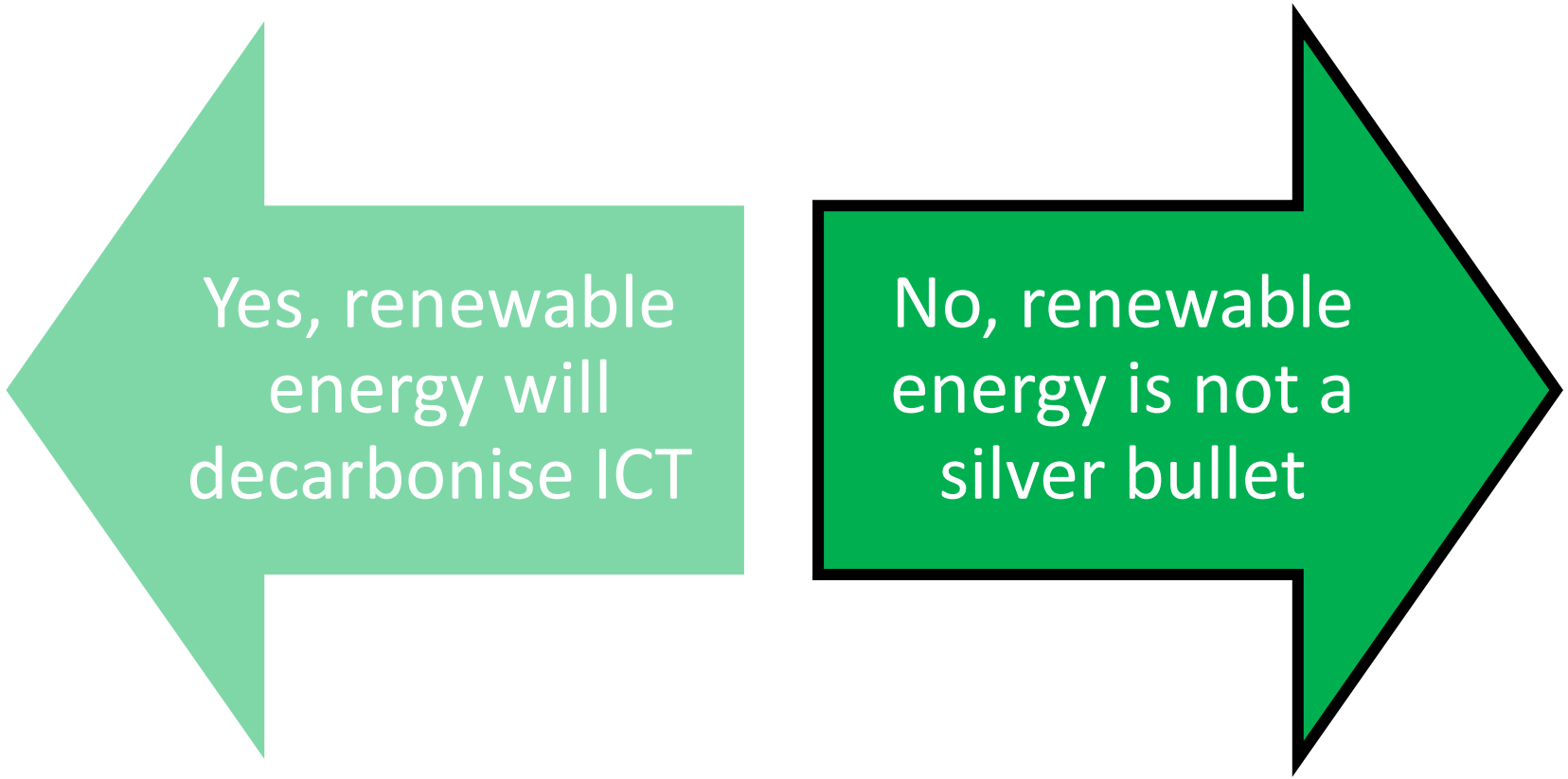
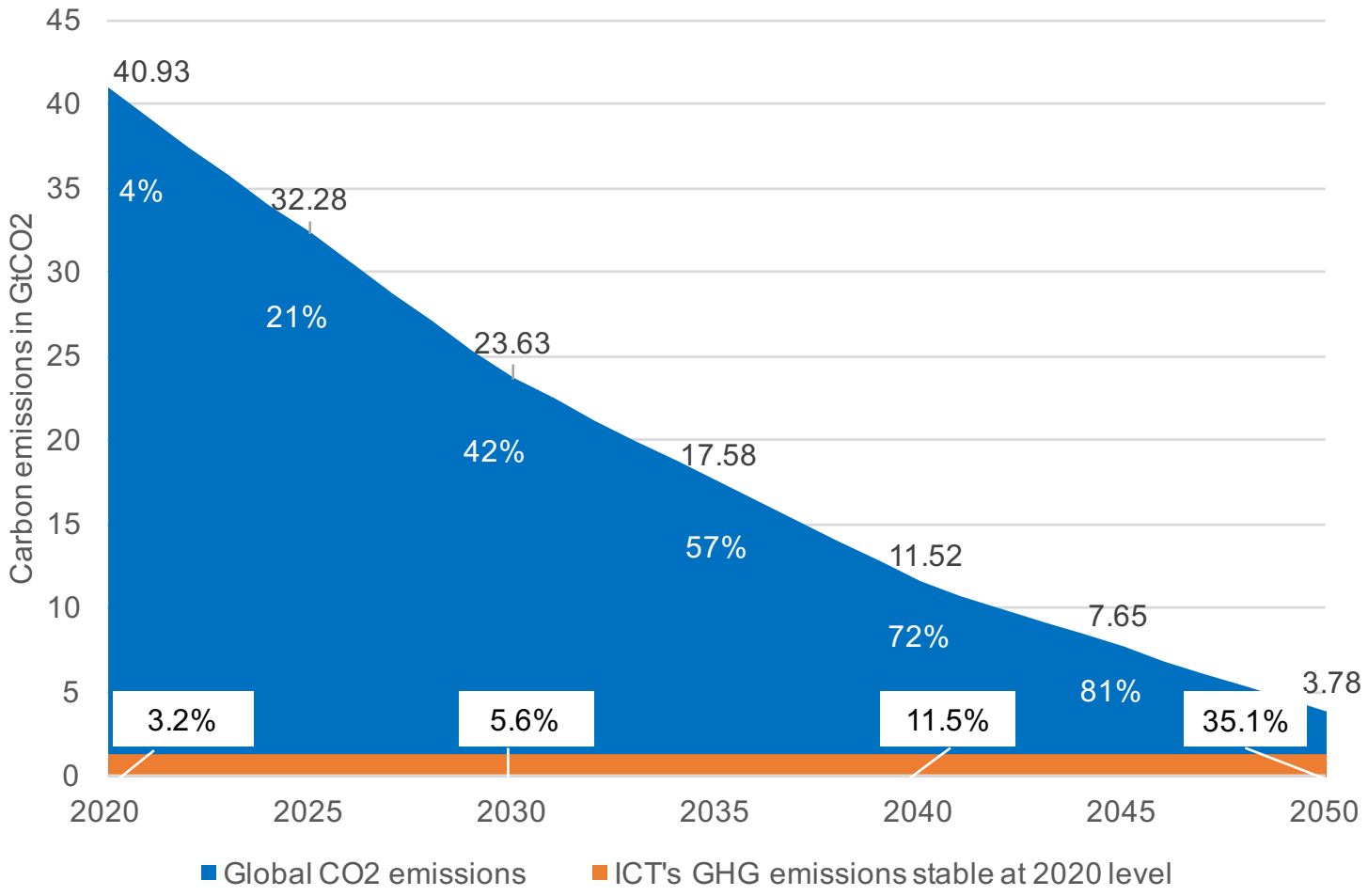


- Embodied footprints
- Resources (e.g. silver)
- Availability and share of renewables

ICT’s future share of emissions?



ICT emissions, assuming the 2020 level (adjusted for truncation error) remains stable until 2050, and global CO2 emissions reduced in line with 1.5°C under scenario SSP2-19.

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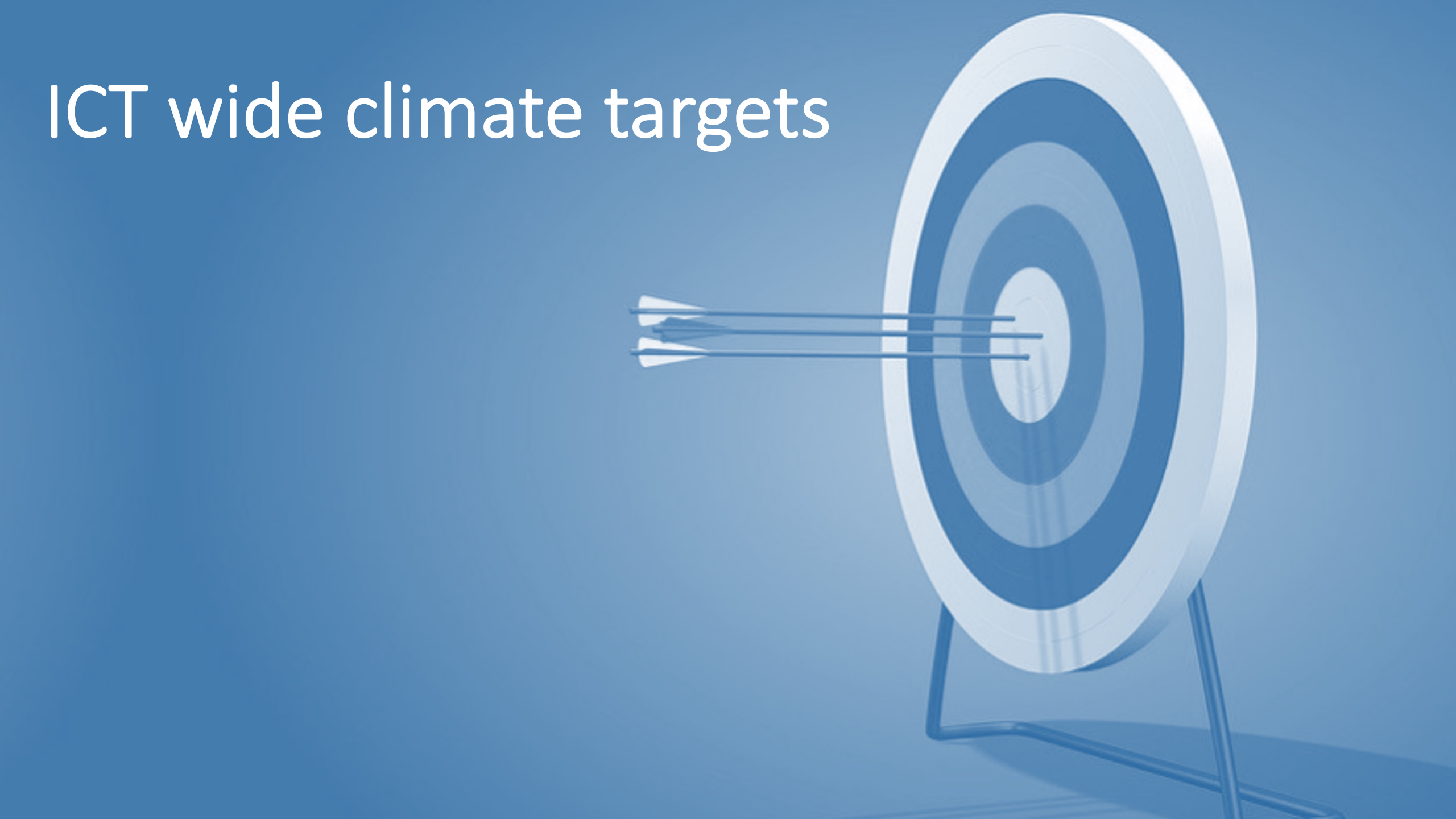
1. Historically, ICT efficiency gains have coincided with emissions growth
2. Omissions of growth trends in ICT climate impact estimates: Artificial Intelligence, Internet of Things, Blockchain
3. Significant investment and uptake in these growth trends (global rebounds)

ICT wide climate targets



ICT wide climate targets

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- Voluntary net zero target by International Telecommunication Union, approved by Science Based Target Initiative (SBTi)

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Transparent evidence is required to fully understand and mitigate ICT's environmental impacts

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Transparent evidence is required to fully understand and mitigate ICT's environmental impacts

Urgent action is needed across the ICT sector to align ICT's emissions with the Paris Agreement

PARIS-DE:

Design Principles and Responsible Innovation for a Sustainable Digital Economy

https://paris-de.org/

https://www.lancaster.ac.uk/scc/about-us/news/ensuring-new-technology-is-designed-to-help-meet-global-climate-targets

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Ensuring new technology is designed to help meet global climate targets

15 June 2021 12:18

Professor Gordon Blair

> *We are all aware of the increasingly urgent need to address carbon footprints and improve sustainability in order to keep planetary warming to manageable levels. The digital economy must take responsibility for its contribution to this.*
>
> Professor Gordon Blair

Share this story

Designers of new ICT technologies will be able to ensure new computing products and infrastructure are compatible with international efforts to stop global warming by accessing a suite of digital tools as part of a new virtual 'design lab'.

Core design principles, as well as the lab's tools, will guide designers and show the likely carbon cost of their designs. These will help inform more rounded decision making about the impacts of digital technologies.

Led by a team of Lancaster University researchers, and in partnership with researchers from the Universities of Oxford, Sussex and Kings College London, the PARIS-DE (Design Principles and Responsible Innovation for a Sustainable Digital Economy) project will create the virtual design lab with digital tools that assess the carbon emissions, and social impacts of ICT designs.

With the goal of ensuring alignment with **Paris climate targets** that seek to limit global temperature increases to 1.5 degrees Celsius, PARIS-DE will focus on three key challenges:

More detail in the full paper:

Freitag, C., Berners-Lee, M., Widdicks, K., Knowles, B., Blair, G.S., and Friday, A. 2021. **The real climate and transformative impact of ICT: A critique of estimates, trends and regulations.** *Patterns.* https://doi.org/10.1016/j.patter.2021.100340

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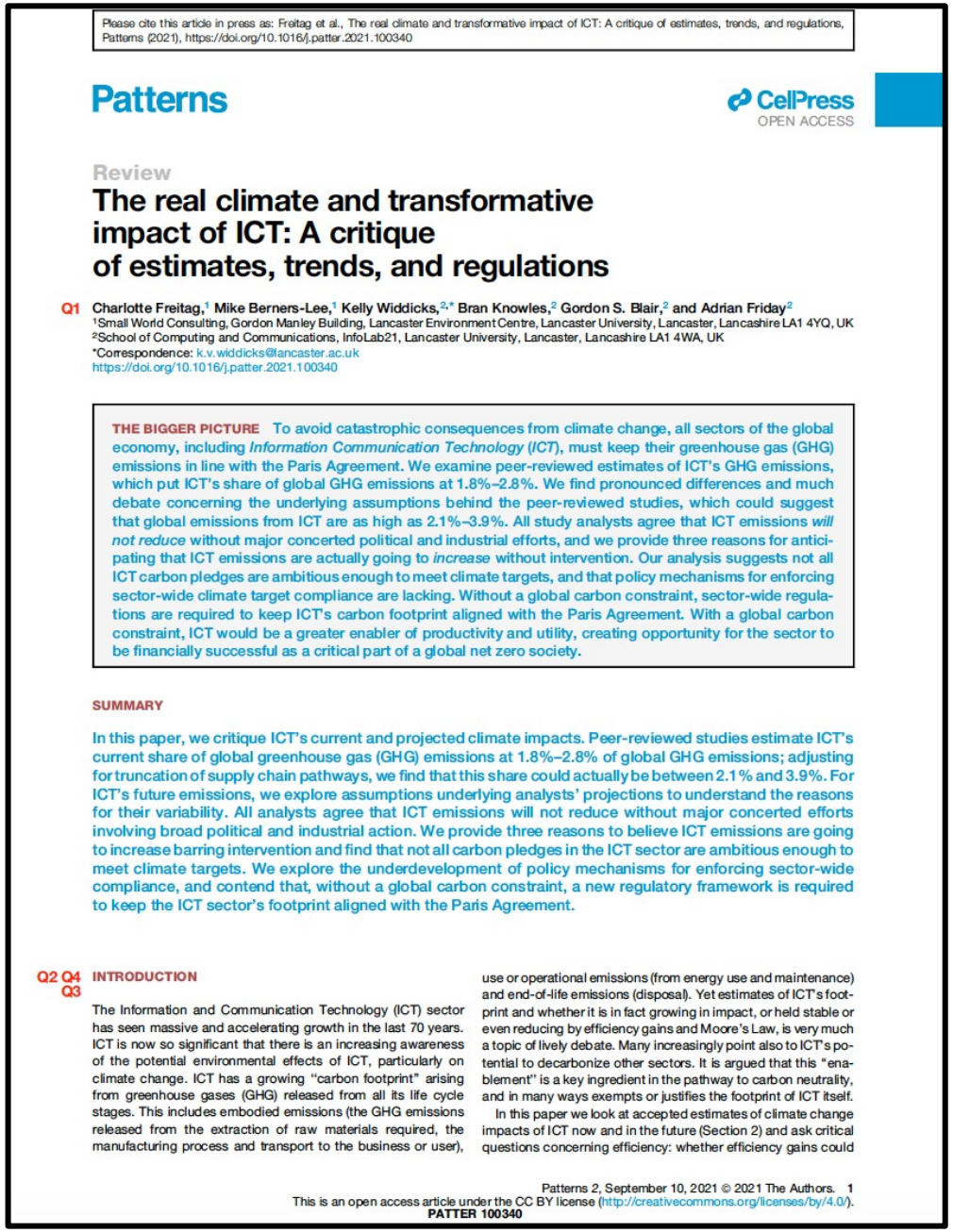

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Patterns

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Review

The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations

Q1 Charlotte Freitag,[1] Mike Berners-Lee,[1] Kelly Widdicks,[2,*] Bran Knowles,[2] Gordon S. Blair,[2] and Adrian Friday[2]
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https://doi.org/10.1016/j.patter.2021.100340

THE BIGGER PICTURE To avoid catastrophic consequences from climate change, all sectors of the global economy, including *Information Communication Technology (ICT)*, must keep their greenhouse gas (GHG) emissions in line with the Paris Agreement. We examine peer-reviewed estimates of ICT's GHG emissions, which put ICT's share of global GHG emissions at 1.8%–2.8%. We find pronounced differences and much debate concerning the underlying assumptions behind the peer-reviewed studies, which could suggest that global emissions from ICT are as high as 2.1%–3.9%. All study analysts agree that ICT emissions *will not reduce* without major concerted political and industrial efforts, and we provide three reasons for anticipating that ICT emissions are actually going to *increase* without intervention. Our analysis suggests not all ICT carbon pledges are ambitious enough to meet climate targets, and that policy mechanisms for enforcing sector-wide climate target compliance are lacking. Without a global carbon constraint, sector-wide regulations are required to keep ICT's carbon footprint aligned with the Paris Agreement. With a global carbon constraint, ICT would be a greater enabler of productivity and utility, creating opportunity for the sector to be financially successful as a critical part of a global net zero society.

SUMMARY

In this paper, we critique ICT's current and projected climate impacts. Peer-reviewed studies estimate ICT's current share of global greenhouse gas (GHG) emissions at 1.8%–2.8% of global GHG emissions; adjusting for truncation of supply chain pathways, we find that this share could actually be between 2.1% and 3.9%. For ICT's future emissions, we explore assumptions underlying analysts' projections to understand the reasons for their variability. All analysts agree that ICT emissions will not reduce without major concerted efforts involving broad political and industrial action. We provide three reasons to believe ICT emissions are going to increase barring intervention and find that not all carbon pledges in the ICT sector are ambitious enough to meet climate targets. We explore the underdevelopment of policy mechanisms for enforcing sector-wide compliance, and contend that, without a global carbon constraint, a new regulatory framework is required to keep the ICT sector's footprint aligned with the Paris Agreement.

Q2 Q4 Q3 **INTRODUCTION**

The Information and Communication Technology (ICT) sector has seen massive and accelerating growth in the last 70 years. ICT is now so significant that there is an increasing awareness of the potential environmental effects of ICT, particularly on climate change. ICT has a growing "carbon footprint" arising from greenhouse gases (GHG) released from all its life cycle stages. This includes embodied emissions (the GHG emissions released from the extraction of raw materials required, the manufacturing process and transport to the business or user), use or operational emissions (from energy use and maintenance) and end-of-life emissions (disposal). Yet estimates of ICT's footprint and whether it is in fact growing in impact, or held stable or even reducing by efficiency gains and Moore's Law, is very much a topic of lively debate. Many increasingly point also to ICT's potential to decarbonize other sectors. It is argued that this "enablement" is a key ingredient in the pathway to carbon neutrality, and in many ways exempts or justifies the footprint of ICT itself.

In this paper we look at accepted estimates of climate change impacts of ICT now and in the future (Section 2) and ask critical questions concerning efficiency: whether efficiency gains could