University of BRISTOL

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Use-of-system approaches for Electricity Footprinting of Digital Media Services

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Contents

- Context, Motivation for Environmental Footprting
- Understanding Environmental Impact of Whole Services
- Motivating energy intensity
- Use-of-System updates

Effects of ICT

https://www.greendigitalcoalition.eu/

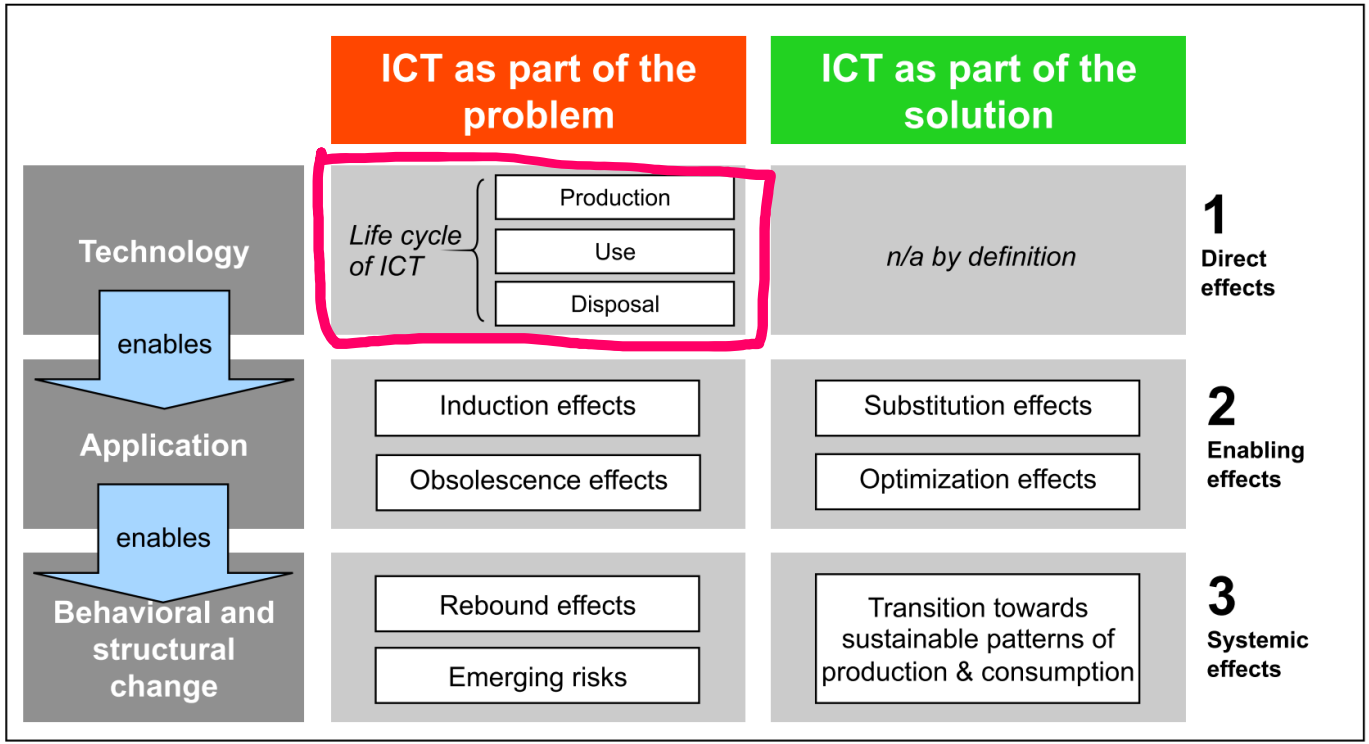
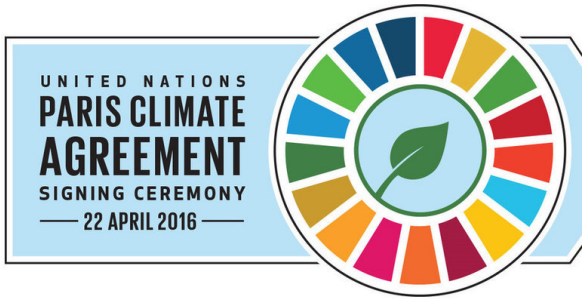


Fig. 6. A matrix of ICT effects, based on [67]

Hilty, L. M., & Aebischer, B. (2015). ICT for Sustainability: An Emerging Research Field. In *ICT Innovations for Sustainability* (Issue August 2014). Springer Berlin / Heidelberg.

NetZero

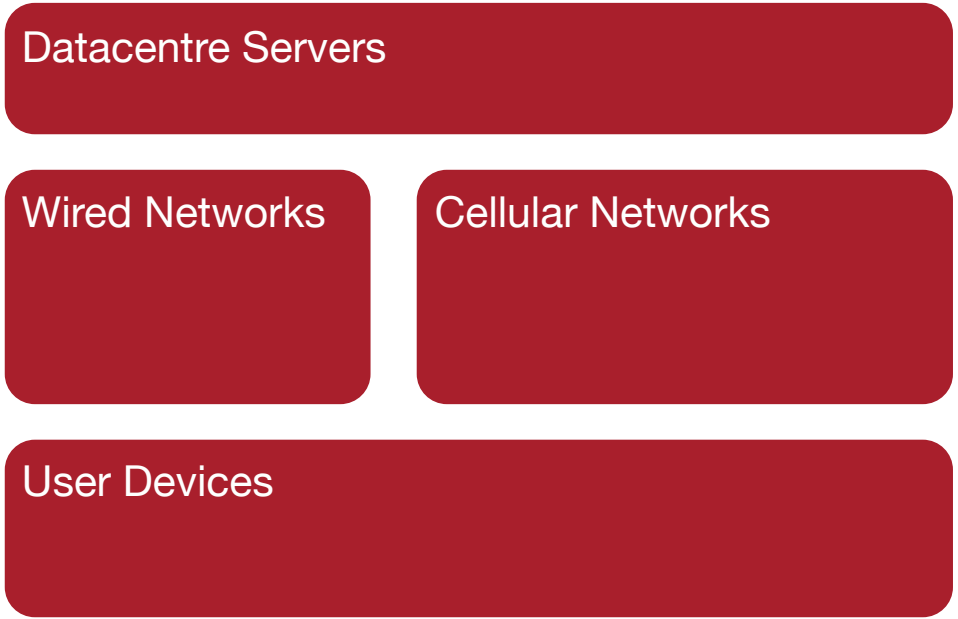
- ICT carbon emission 2-4% of global
- Carbon Reduction Targets
  - ITU 45% until 2030
  - BT NetZero 2045



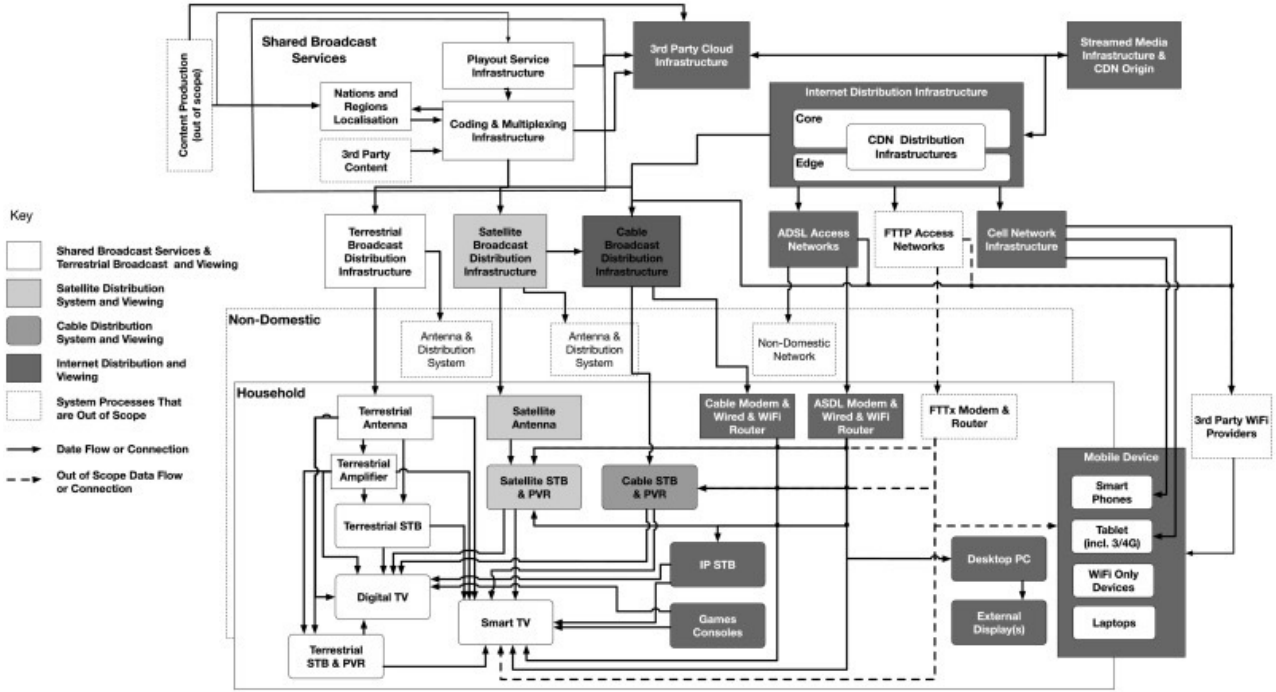
Our Work Assessing Digital Media Services

- Video, Games, Web, Metaverse, Crypto, AI, etc
- OTT

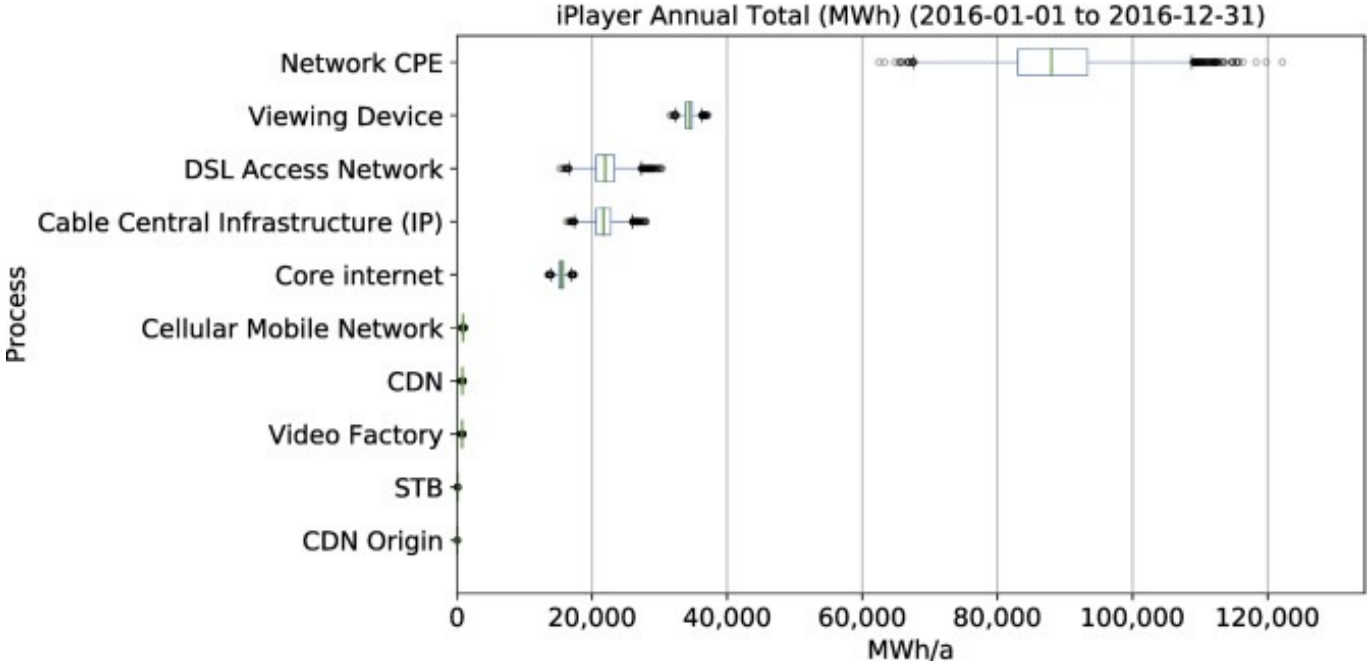
- 2011 theguardian
  - Transition from paper to digital
- 2015 BBC
  - Strategically evaluate move to video on demand



BBC as an Example



BBC as an Example



Schien et al. 2021. Using behavioural data to assess the enviro
https://www.sciencedirect.com/science/article/pii/S0195925521

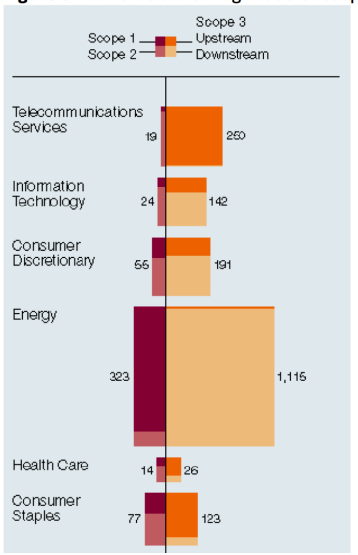
Understanding Whole Services

Science Based Targets initiative

SCIENCE BASED TARGETS
DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

- SBTi requires setting organizational targets in line with emissions reductions to keep warming to well below 2.0℃ or 1.5℃
- Most Digital service companies will need to report on energy and carbon “end-to-end”

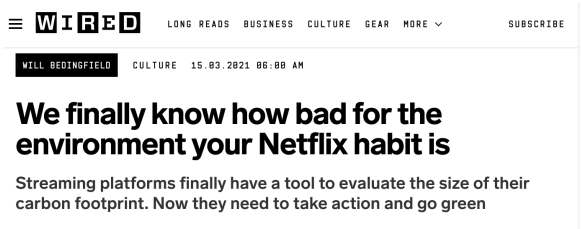
Figure 6-1: The Relative Magnitude of Scope 1, 2 and 3



CDP DISCLOSURE INSIGHT ACTION
UN GLOBAL COMPACT
WORLD RESOURCES INSTITUTE
WWF

DIMPACT

- /dimpækt/
- Environmental Reporting for Digital Services
  - Major UK TV channels
  - Publishers
  - Ad Networks
  - ISP


WIRED LONG READS BUSINESS CULTURE GEAR MORE SUBSCRIBE

WILL BEDINGFIELD CULTURE 15.03.2021 06:00 AM

We finally know how bad for the environment your Netflix habit is

Streaming platforms finally have a tool to evaluate the size of their carbon footprint. Now they need to take action and go green

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BBC BT Cambridge University Press

4 dentsu haymarket

informa IOP Publishing itv

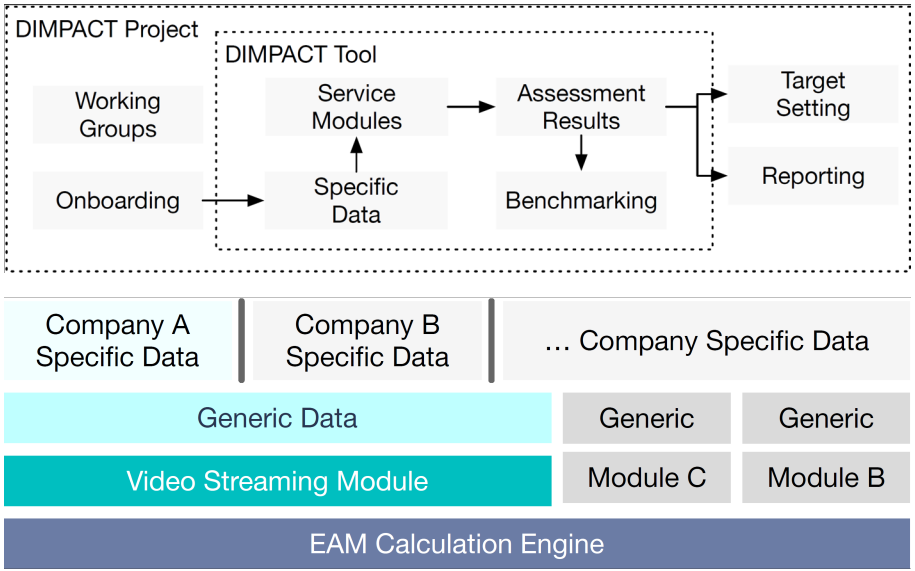
nordic entertainment group NETFLIX Pearson

RELX Schibsted sky

svt

DIMPACT

- Online tool
- Modules
- Corporate reporting and strategy
- Community working groups



Carnstone

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Understanding How Services are Used

Video Streaming

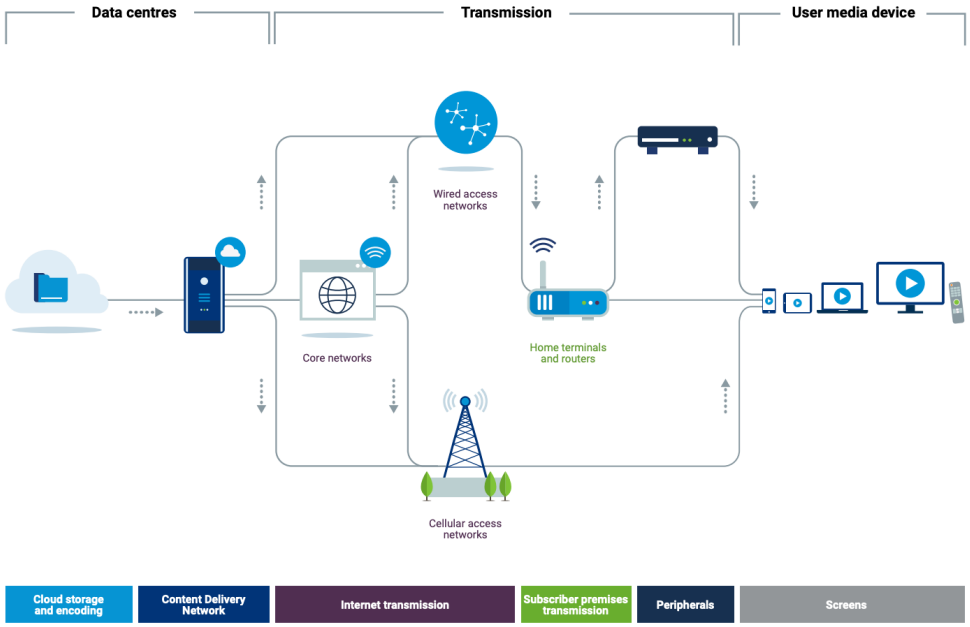
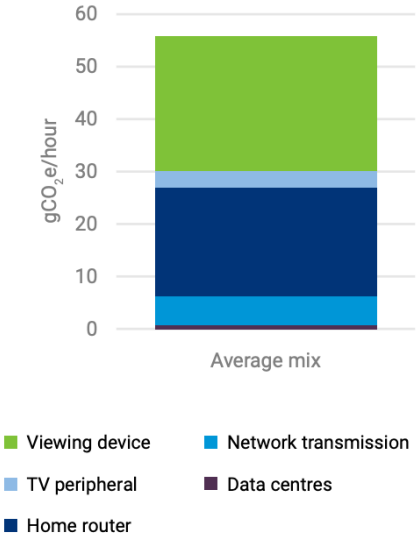


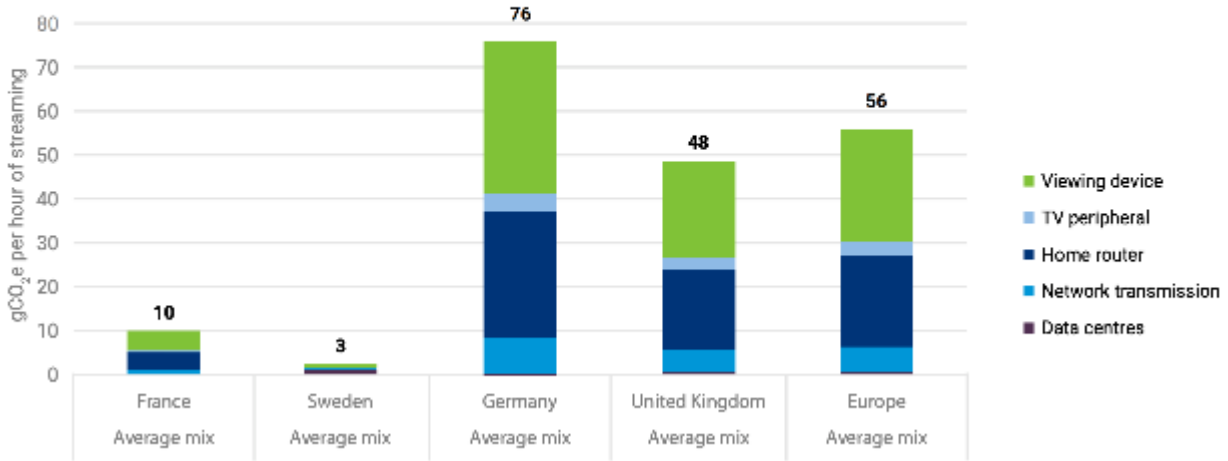
Figure 17. Estimated emissions from one hour of video streaming (European average in 2020)



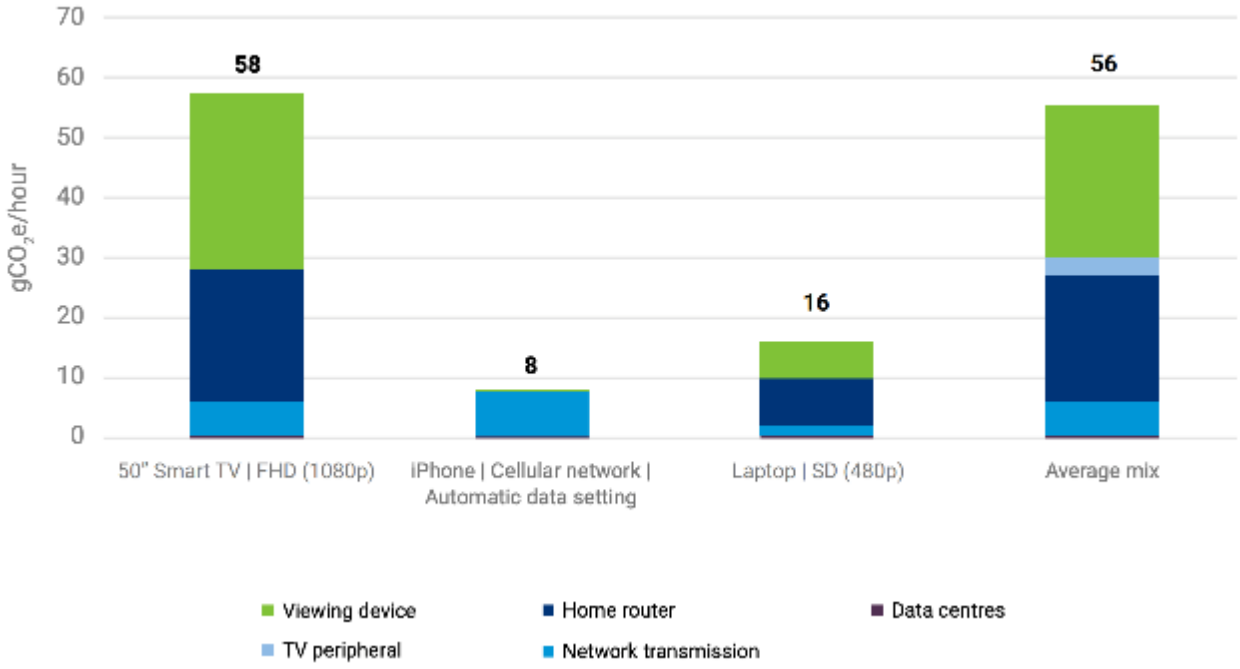
The Carbon Trust:
Carbon impact of video streaming
2021:

Effect of Electricity Carbon Intensity

Figure 19. Emissions from video streaming by region in 2020

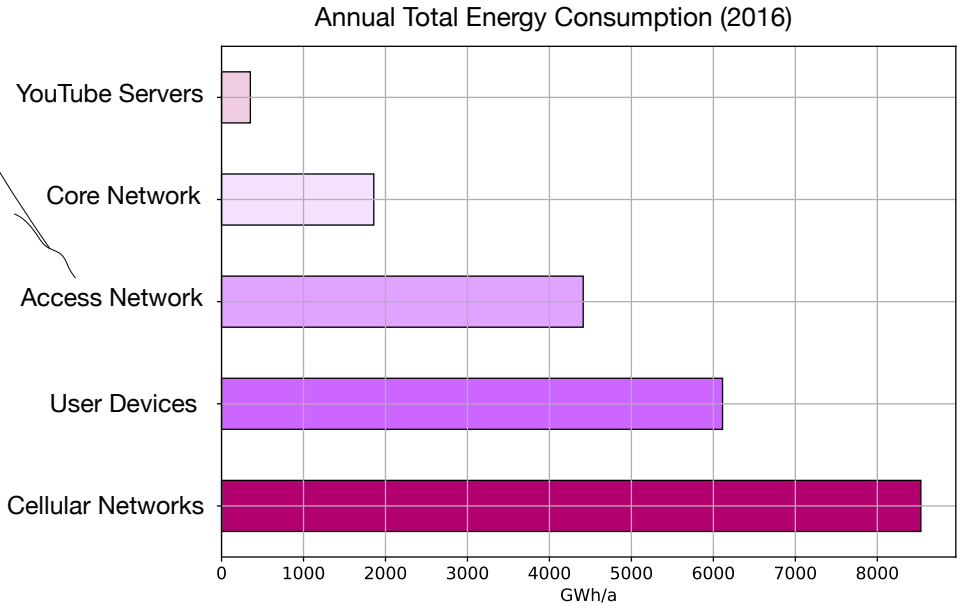


Effect of Choice of User Device

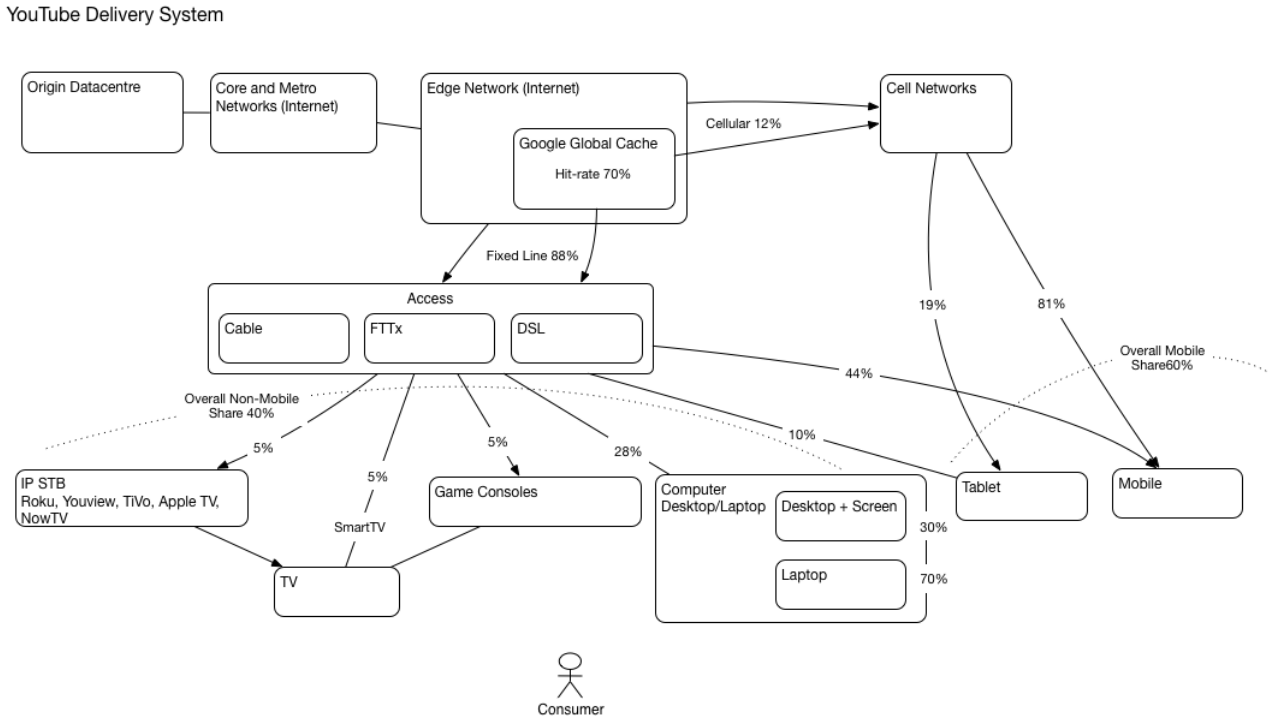


Interaction Design

Reducing Digital Waste



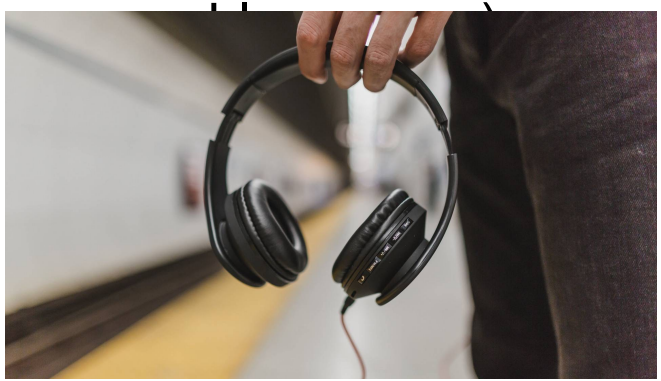
YouTube as an Example



Conservative Estimate of Carbon Emissions of YouTube distribution 2016

Electricity: 19.5 TWh, Carbon emissions: 10.0 $MtCO_2e$

(We assume all Google Data Centres and Global Cache use

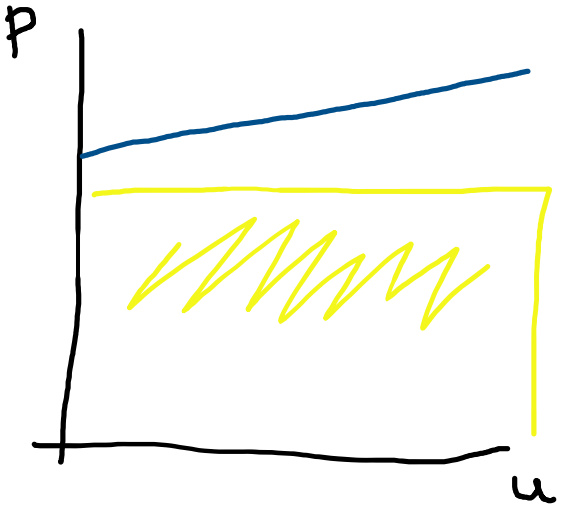


Share of Music Audio Only	Emissions Reductions ($KtCO_2e$)
10%	117
25%	293
50%	586

ELIMINATING VIDEO DIGITAL WASTE

Use-of-System Energy Intensity Metrics

Low Energy Proportionality



$$P_T = P_b + u \cdot P_u$$

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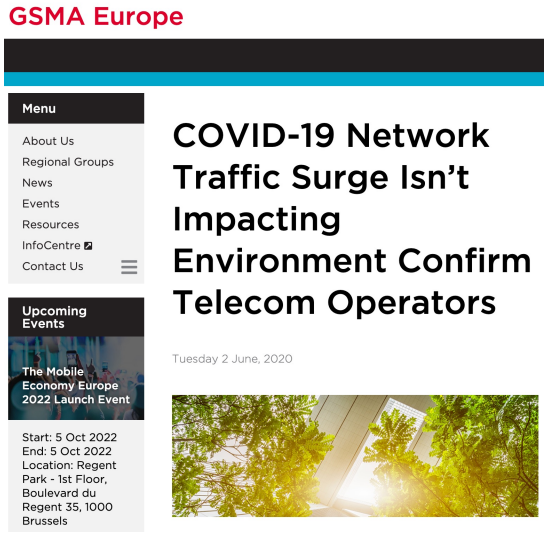
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Upcoming Events

The Mobile Economy Europe 2022 Launch Event

Start: 5 Oct 2022
End: 5 Oct 2022
Location: Regent Park - 1st Floor, Boulevard du Regent 35, 1000 Brussels

COVID-19 Network Traffic Surge Isn't Impacting Environment Confirm Telecom Operators

Tuesday 2 June, 2020

$$E = v \cdot I_v$$

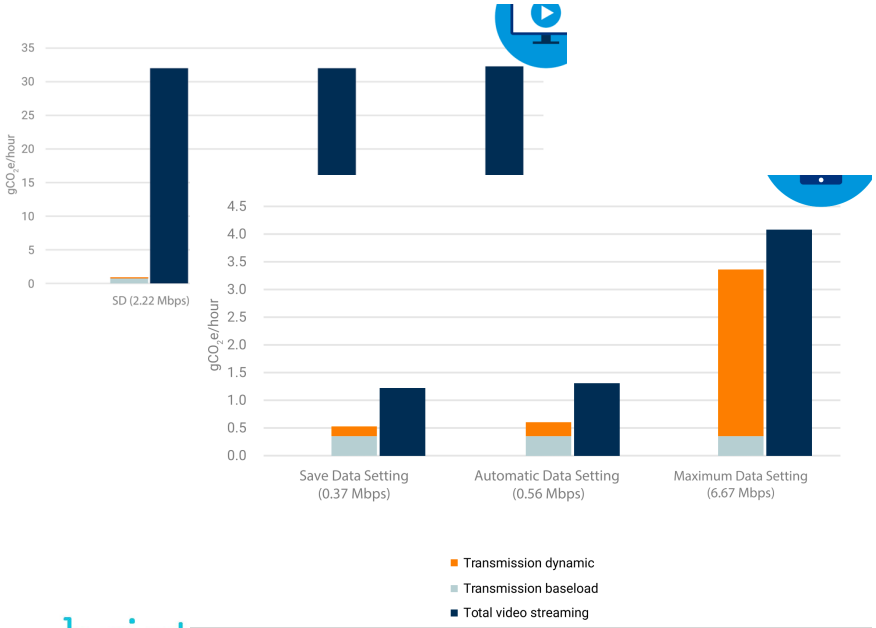
"their monthly carbon footprint would be 9.4 kg CO2e. Simply turning off the video, however, would reduce the monthly emissions to 377 g CO2e."

Renee Obringer, et al. **The overlooked environmental footprint of increasing Internet use**. *Resources, Conservation and Recycling*, 2021; 167: 105389
DOI: 10.1016/j.resconrec.2020.105389

Dynamic Power Model

$$E = P_b \cdot t + v \cdot I_v^d$$

Malmodin 2020



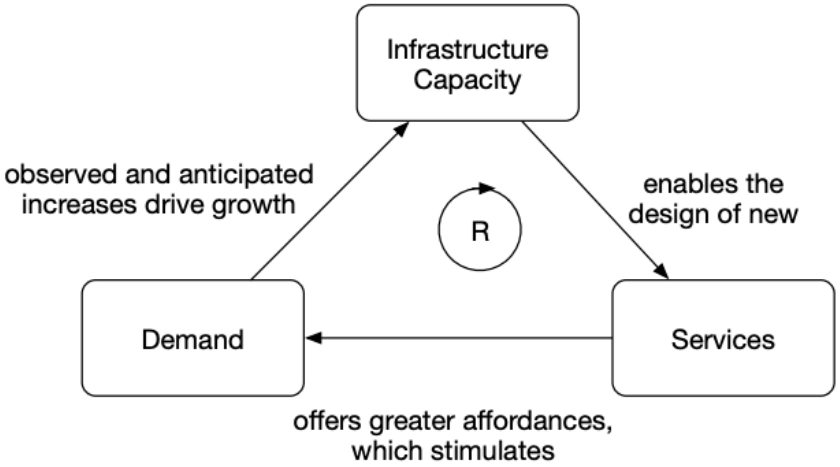
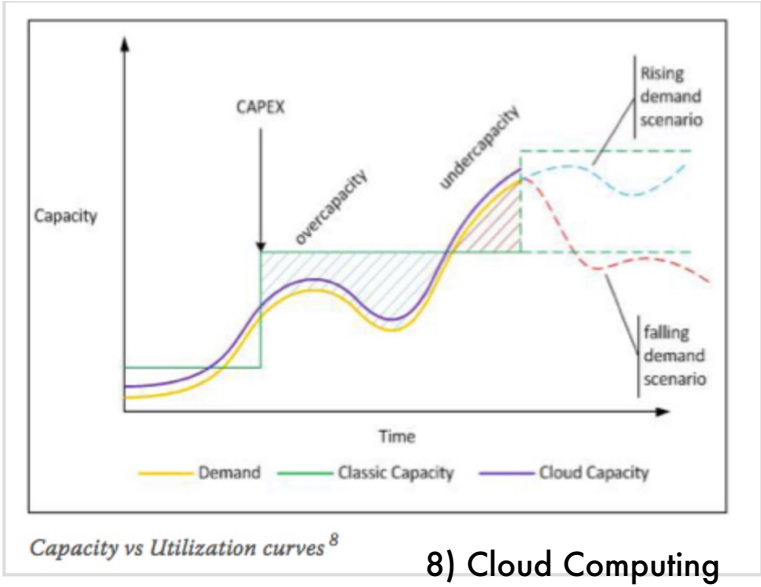


Figure 1: Reinforcing feedback stimulating Infrastructure Growth

Preist, C., Schien, D., & Blevis, E. (2016). Understanding and Mitigating the Effects of Device and Cloud Service Design Decisions. CHI 20916



Capacity vs Utilization curves [8]

8) Cloud Computing Emissions Comparison, Nucleus Research, 2010

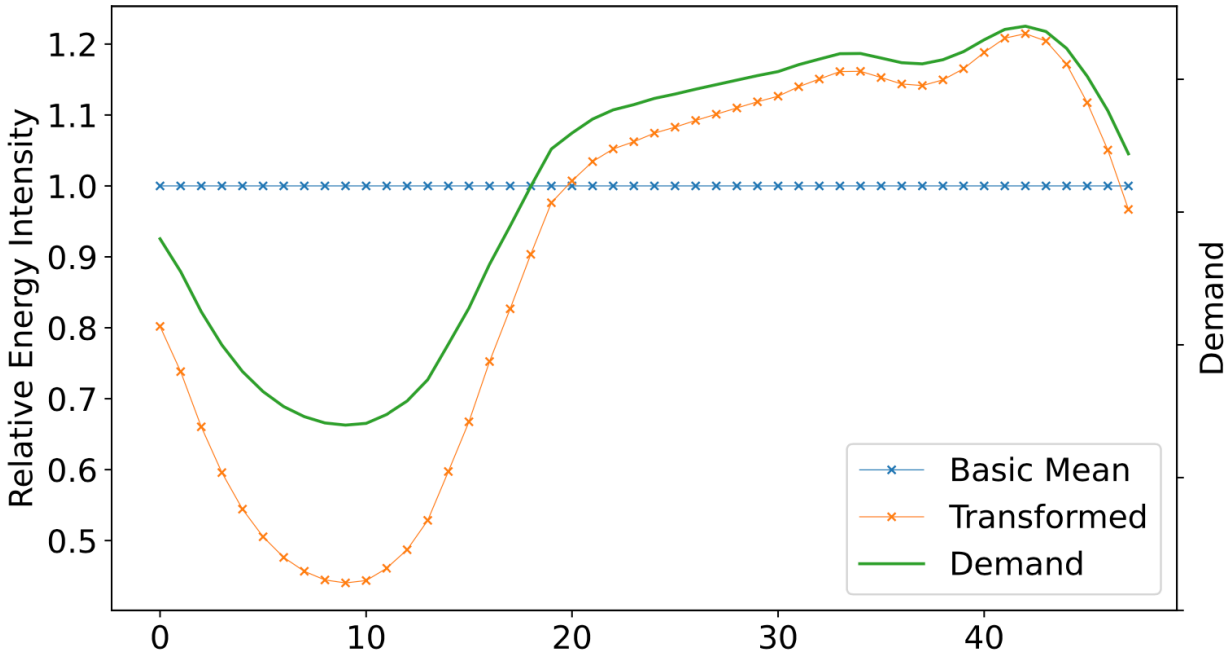
A CHANGE-ORIENTED INTENSITY METRIC

- IAB ’22, Dec 05–07, 2022, Online
- burden data traffic at peak time with proportionally higher share of the baseline power consumption than traffic at other times
- scales the data volume in each 30-minute time window inverse proportionally to peak traffic

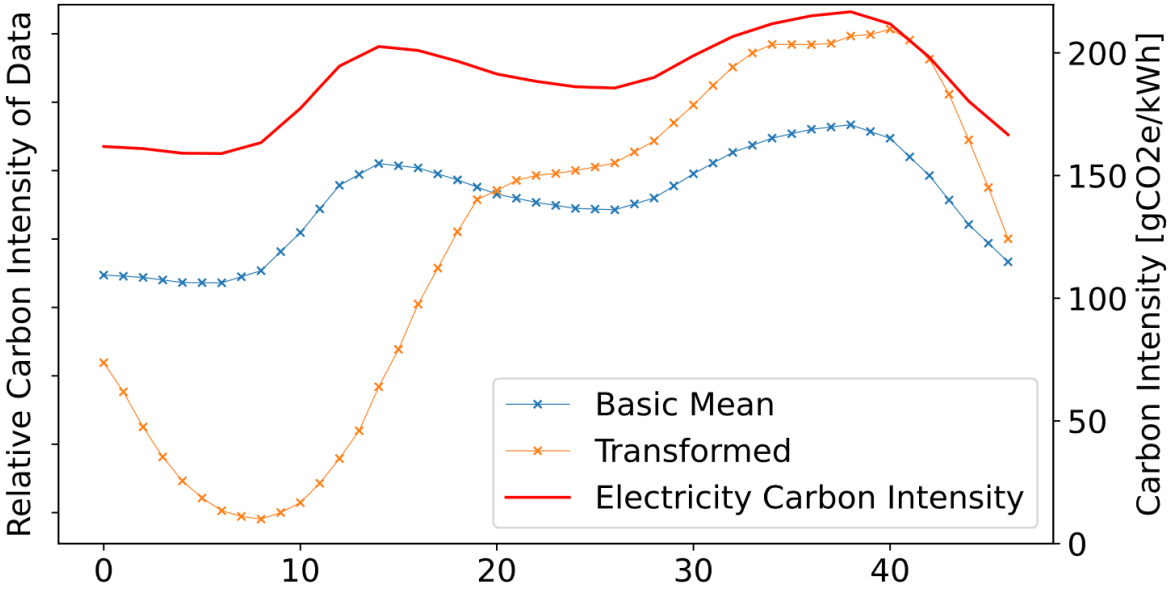
$$C_i = \frac{\left(\frac{V_i}{V_P}\right) \cdot V_i}{\sum_{i=1}^{48} \left[\left(\frac{V_i}{V_P}\right) \cdot V_i\right]}$$

$$E'_{b_i} = E_{b_i} \cdot C_i$$

Energy Intensity



Carbon Intensity



Future Work

- Evaluate specific services
- Apply to Data Centres
- Combine with Malmodin 2020

$$E_i = I'_{b_i} \cdot v_i + v_i \cdot I_v^d$$

Thank you