DIMPACT

Insight to action on digital carbon impacts

University of Bristol finds system-level factors shape network emissions

Background

The University of Bristol has been at the forefront of understanding the environmental impact of digital networks, with their leading research forming a key basis of the DIMPACT methodology. This latest article builds that foundation, applying advanced sustainability assessment models to explore what truly drives network energy consumption over time.

University of Bristol Research Paper: Causal allocation of fixed impacts in product systems: Assessing the effect of data demand on network energy consumption

Summary

This paper supports existing research (e.g. Malmodin, 2020 and Mytton et al. 2024) indicating that internet network energy consumption in the short term is only marginally impacted by marginal changes in real-time or average data volumes. The study illustrates that system-level factors, especially peak demand, shape long-term emissions, rather than average factors. Short-term energy use remains largely unaffected by traffic fluctuations. This is because internet networks have what the paper refers to as 'high baseload systems' and does not increase significantly with the amount of data flowing. That means that even though traffic has its peaks and troughs throughout the day, energy consumption of networks remains largely constant. This paper illustrates this point using real-world, live network data.

One key lever for decarbonizing internet networks is the decommissioning of legacy equipment, since older equipment consumes more energy (e.g. transitioning from copper networks to full fibre networks, or transitioning from 2G/3G to 5G mobile networks). As others have found, newer networks have significantly improved energy efficiency when compared to legacy networks (Telefonica LCA)

The paper notes that different components of digital service systems show distinct energy-use patterns. For example, while it focuses on the core internet network, it emphasises that trends in energy use by mobile networks and on-premises network equipment are influenced by different factors and would require separate analysis to understand their specific drivers.

Key Takeaways:

- Changes in average data volumes over internet networks only marginally impact internet network energy consumption
- Increases in peak data traffic is a key factor driving network energy consumption in the long term, because networks consume a high-baseload of energy during off-peak times. The level of high-baseload is dependent on the anticipated peak traffic – the higher the anticipated peak, the higher the baseload.

Call to action:

- Network operators and regulators should prioritize reductions in the rate of growth peak traffic demands in the medium- and long- term rather than reducing average data consumption.
- R&D and network engineering teams should focus on innovation that reduce network infrastructure base load energy consumption, so that networks consume less energy during off-peak hours