Bridging Models and Reality: Real-World-Oriented Methodologies for Estimating ICT Carbon Footprint at Imperial College London

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Abstract

As global efforts to de-carbonise intensify, the carbon footprint of Information and Communication Technology (ICT) continues to rise, contributing an estimated 2-3% of global emissions. With the rapid growth of AI, Big Data, and IoT technologies, this figure is expected to increase in the coming years. At Imperial College London, according to its 2022 Sustainability Report, ICT alone accounts for 77% of the campus's procurement-based carbon emissions, making it a critical area for sustainability efforts. Despite this, current models for estimating Scope 3 emissions - especially from software and computing services - remain insufficient and imprecise.

This study explores the challenges in accurately estimating Scope 3 emissions related to ICT at a higher education institution. Specifically, we focused on software suppliers and computing services, aiming to establish a robust methodology for calculating carbon emissions across Imperial's ICT supply chain. The lack of detailed, sector-specific emissions factors led us to initially adopt a proxy from the gaming industry, which resulted in an estimated multiplier of 1.5 kgCO2e/GBP. However, this generalised estimate posed significant limitations, prompting us to conduct a more detailed investigation.

Accurately accounting for the carbon footprint of ICT services poses several challenges. The indirect nature of Scope 3 emissions, often spanning across multiple layers of supply chains, complicates the measurement, especially in a university setting like Imperial College. Additionally, software and digital services vary significantly in energy consumption, further complicating the effort to establish a single carbon factor that represents the diversity of ICT services.

Through our study, we identified key suppliers of software services at Imperial College and sought to collect self-reported emissions data. While some suppliers provided Scope 1, 2, and 3 emissions data, the variety in the quality and completeness of this data underscored the difficulty in building reliable estimates. To tackle this challenge, we collected data from nine primary software suppliers and calculated customised emissions multipliers. The resulting multipliers ranged from 0.0048 to 0.1153 kgCO2e/GBP—significantly lower than the initial 1.5 kgCO2e/GBP benchmark. These figures reflect a more refined estimate based on real data rather than generalized industry-wide factors.

Our analysis revealed that using more tailored emissions multipliers significantly alters the estimated carbon footprint of ICT services. The discrepancies between the initial proxy and the custom-calculated figures indicate the importance of using sector-specific data in carbon reporting. Our work also offers a replicable methodology for estimating the carbon footprint of ICT services in higher education institutions. Moving forward, expanding the supplier dataset, refining testbed simulations, and exploring more granular

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categories of ICT services, such as cloud computing and high-performance computing, will be crucial steps in improving the accuracy and comprehensiveness of emissions estimates. Through this research, we aim to provide a model that other institutions can use to better understand and mitigate the carbon footprint of their ICT operations, helping to meet NetZero goals in a data-driven and scientifically rigorous manner.

Additional Key Words and Phrases: Scope 3 Emissions, ICT, Carbon Footprint, Higher Education Sustainability, Software Suppliers

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