Demo: The DIMPACT Tool for Environmental Assessment of Digital Services

DANIEL SCHIEN, University of Bristol, Great Britain
PAUL SHABAJEE, University of Bristol, Great Britain
JAMES WICKENDEN, University of Bristol, Great Britain
WILLIAM PICKET, Carnstone Partners Ltd., Great Britain
GLYNN ROBERTS, Carnstone Partners Ltd., Great Britain
CHRIS PREIST, University of Bristol, Great Britain

We present the DIMPACT /dɪmpækt/ tool for environmental assessments of digital services. The tool enables digital media providers to calculate energy consumption and associated environmental impact across the entire product system, including datacentres, networks and user devices. It is based on accepted standard methodologies and applies state-of-the-art research. The DIMPACT tool is used by major media organisations for environmental reporting and to support development of strategies to reduce environmental impact. It has significantly advanced the knowledge of carbon emissions of video streaming. The tool is part of the wider DIMPACT project of companies that collaborate to exchange knowledge, engage suppliers and expand the scope of the tool. In this text we provide an overview of workings of tool and its methodological foundation.

CCS Concepts: • **Human-centered computing** → **Empirical studies in HCI**; **HCI theory, concepts and models**.

Additional Key Words and Phrases: Environmental sustainability, environmental assessment, Internet energy consumption, video

ACM Reference Format:
Daniel Schien, Paul Shabajee, James Wickenden, William Picket, Glynn Roberts, and Chris Preist. 2022. Demo: The DIMPACT Tool for Environmental Assessment of Digital Services. In *ACM SIGCAS/SIGCHI Conference on Computing and Sustainable Societies (COMPASS) (COMPASS '22), June 29-July 1, 2022, Seattle, WA, USA*. ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/3530190.3542932

1 INTRODUCTION

The current climate crisis calls for transparency in the environmental impact of all types of products and services. A prerequisite to a sustainable society is that consumers and companies understand their own footprint so that they can prioritise actions to reduce it. Consistent with this, reporting of emissions is becoming a necessity for organisations, due either to legal requirements or to market forces. Global estimates suggest that in 2015 Information and Communication Technology (ICT) and consumer electronics, in particular TVs, were responsible for about 3% of total carbon emissions [7]. Reducing those emissions and effectively managing use of electricity in all societies, anywhere in the world, requires assessments that go beyond global estimates and provide detailed information about each service.

ICT user-services delivered over the Internet, such as the World Wide Web, video streaming or social media, depend on a product system in which user devices such as TVs, laptops or smartphones, are connected to an electronic supply chain, run by independent businesses. These separate businesses operate the infrastructure network of devices that exchange data when user-requests are being served; including servers and storage devices in datacentres, and routers in networks. The user-services are provided 'over-the-top' (OTT) of this infrastructure.

Assessing emissions of OTT Internet services has been challenging due to those large, fast-changing, and complex supply chains; and because the providers are reluctant to communicate the environmental impact associated to the operation of their infrastructure — among other reasons because electricity consumption is considered business-sensitive information. While some public cloud operators are slowly releasing customer-specific carbon emission data for cloud resource use, information on a per-service level is often presented in aggregate metrics that prevent like-for-like comparability of the carbon efficiency between services.

As no single organisation — be it the OTT-service providers, or the infrastructure operators — has visibility of environmental impact over the product system "end-to-end", efforts to assess the environmental impact require modelling, i.e. calculation based on abstractions. The majority of existing assessments of the environmental impact of Internet-based digital services for reporting are based on focused academic research and not able to provide a comprehensive perspective on the performance of the *entire* sector.

For environmental assessments of Internet services to become widely available, assessments must transition from bespoke studies to scalable and standardised, yet accurate, tools. The relevant environmental assessment standard — the GHG Protocol ICT sector guidance [3] — has been found to be impractical for assessments of Internet services, as it requires access to supply chain data that is not provided by cloud and network providers [8]. This lack of supply chain data and methodological foundations, together with weak stakeholder support, undermined previous efforts to close this gap; which typically traded generality over specificity [5].

In this text we present the DIMPACT project and tool (https://www.dimpact.org) for environmental impact assessment of digital services. It is based on the GHG Protocol ICT sector guidance and established academic research [10, 11], provides specific assessments to different types of Internet services, and has been adopted by a large number of organisations for their environmental reporting. We describe the tool, its underlying methodology, its development, and impact; and present the DIMPACT project of which the tool is a part.

2 THE DIMPACT TOOL

The DIMPACT tool is part of the membership-based DIMPACT project, an initiative by Carnstone Partners Ltd, an environmental consultancy in London, UK. As of May 2022, there were 20 member organisations in DIMPACT, including among others BBC, Cambridge University Press, The Economist, Netflix, and Sky.

Methodologically, the tool is built on the Life Cycle Assessment (LCA) standard [6]. The functionality of the tool can be mapped to the four steps in the LCA methodology: I. Goal and Scope setting, II. Inventory Analysis, III. Impact Assessment, and IV. Interpretation. Among these, steps II. and III. are handled entirely by the tool. Steps I. and IV. are owned by the user but supported by the tool. The tool supports an attributional methodology, compatible with GHG Protocol ICT sector guidance. For OTT service providers aiming to assess the environmental impact of their services, the tool overcomes barriers to the application of the GHG Protocol guidance, by providing end-to-end models of service product systems that include background supply chain data. The use of the tool is not limited to OTT providers. For all users, the tool reduces barriers to assessing services by simplifying and providing guidance to data collection, providing a conceptual structure, automating Inventory Analysis and Impact Assessment and providing granular results. Other benefits delivered by the encompassing DIMPACT project will be described below.

The Inventory Analysis uses a map of a service product system as a scaffold. A service product system is the set of all ICT processes that are involved in the provision and delivery of a service. For example, in the case of video streaming, among others: master encoding, transcoding, user analytics, CDN origin services in the data centre; content delivery and transport services in ISP networks; customer premise networking and user devices. The set of all relevant flows of

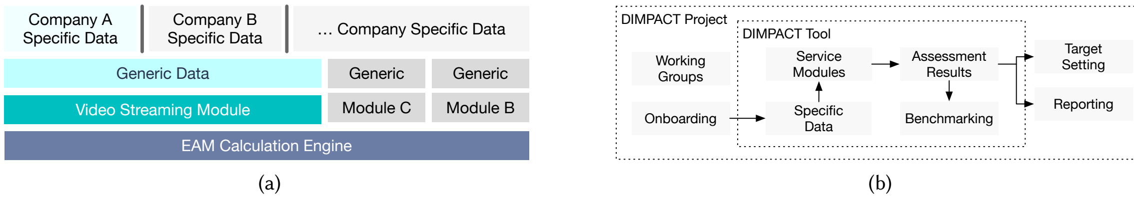

Fig. 1. a) High-level architecture of the DIMAPCT tool. Specific modules are provided for alternate digital services. These form LCA inventory models that are analysed by the EAM engine[12]. Generic background data is provided for each module. During an assessment, users provide the specific data and possible override generic data. b) The DIMPACT tool as part of the DIMPACT project: During onboarding users receive support and guidance on tool usage and collection for the company-specific data. The DIMPACT tool carries out calculations and provides assessment results that can then be used for reporting, target setting and sector benchmarking.

product and resources associated to those processes form the LCA assessment inventory. Default flow data is provided for background processes, such as energy intensity of networks. Service specific flow data for foreground processes, such as number of service-users or dwell time must be provided by the company user of the tool.

Once all flow data is entered, the tool carries out the calculation in steps II. Inventory Analysis and III. Impact Assessment. In the context of assessments of OTT-organisations that do not operate IT infrastructure themselves, the Impact Assessment calculates the "Scope 3" emissions of the service, according to the definition by the GHG Protocol. This refers to emissions that are not under direct operational control by the OTT business. The tool is not limited to Scope 3 but provides important value in this function. The tool presently only considers the LCA impact category Climate Change (kgCO2e). Among the LCA life cycle phases, the tool currently only assesses the use phase. The inclusion of emissions in other life cycle phases (e.g. Raw Material Extraction, Manufacturing, Transport and End-of-Life) is intended.

The tool provides calculation results in several levels of aggregation. Results of electricity consumption and carbon emissions are given on a per-process level (i.e. laptops separate from smartphones, etc). The service modules are designed to support assessment at regional or global scale. Users can specify input data broken down by individual countries. Results are then provided on a per-country level, accounting for regional differences in electricity carbon intensity. Assessments are carried out and reported for a specific time period — with a minimum duration of one calendar month.

Figure 1 (a) shows a diagram of the tool architecture. The foundation is a common calculation engine[12]. The service product systems are implemented in separate modules. Currently, modules for Video Streaming, Web Publishing and Video Conferencing are available. Each module is provided with generic background data. This background data is regularly updated to reflect the state of knowledge of environmental impact in the supply chain infrastructure. Additionally, background variables such as network energy intensity are consistently decreasing over time[1]. These improvement coefficients are automatically applied to match the assessment time frame. User input data is treated as average values over the assessment time frame. Tool users parameterise the modules with the company-specific data. Company data is private and each organisation only has access to their own data and assessment results. Some organisations have began to publish their results publicly, for example Netflix and Schibsted [9, 13, p.42].

3 THE DIMPACT PROJECT

The tool is provided to participants of the DIMPACT project 1(b). Within the project, participants are part of a forum that share experiences and best practices, collaborate in specific work streams, and drive joint initiatives and engagement. The DIMPACT project includes a participant advisory panel, who provide light-touch feedback and recommendations of the direction of the project, and an academic advisory panel to provide expert advice on the modelling approach. During development of additional modules for new digital services, the technical team works with relevant participant companies that operate such services to first create a generic product system map. The resulting document is a superset of the specific product systems of partner companies. From this, a new service module is then developed that can be calculated with the DIMPACT tool. The service modules are maintained and regularly updated, for example to accommodate changes to business processes change or alterations for newly joining partners. When working with the module for the first time, companies go through an onboarding process that includes training and support regarding data collection and tool use.

4 IMPACT AND DISCUSSION

The DIMPACT project has substantially advanced transparency for digital services. It has become a de-facto standard for the environmental assessment of video streaming services. Many of the largest video on demand streaming businesses are currently using DIMPACT for assessment of their services and have made a step improvement both in understanding within companies and in transparency of the sector. The results have been communicated in a White Paper [2].

While the major public cloud providers have released tools to estimate the electricity consumption and carbon emissions from data centre operations [4, e.g.] service providers benefit from use of the DIMPACT tool through the simplification that the mature tool provides. It provides structure and guidance to data collection and outsources modelling tasks. The DIMPACT tool also harmonises system boundaries and provides comparability to results and thus increases credibility of the environmental reporting for the sector at large.

REFERENCES

[1] Joshua Aslan, Kieren Mayers, Jonathan G. Koomey, and Chris France. 2018. Electricity intensity of internet data transmission untangling the estimates. *Journal of Industrial Ecology* 22, 4 (2018), 785–798. https://doi.org/10.1111/jiec.12630

[2] Carbon Trust. 2021. *Carbon impact of video streaming.* Technical Report. https://prod-drupal-files.storage.googleapis.com/documents/resource/public/Carbon-impact-of-video-streaming.pdf

[3] Carbon Trust and Global e-Sustainability Initiative (GeSI). 2017. *GHG Protocol ICT Sector Guidance.* Technical Report. https://ghgprotocol.org/sites/default/files/GHGP-ICTSG-ALLChapters.pdf

[4] Google. 2021. Google Cloud Carbon Footprint. https://cloud.google.com/carbon-footprint

[5] ICTFootprint.EU. 2018. ICTFootprint.EU Self-Assessment Tool. https://ictfootprint.eu/en/self-assessment-tool

[6] International Organization For Standardization. 2006. ISO 14044: Environmental Management - Life Cycle Assessment - Requirements and Guidelines.

[7] Jens Malmodin and Dag Lund. 2018. The Energy and Carbon Footprint of the Global ICT and E+M Sectors 2010 – 2015. (2018). https://doi.org/10.3390/su10093027

[8] David Mytton. 2020. Assessing the suitability of the Greenhouse Gas Protocol for calculation of emissions from public cloud computing workloads. *Journal of Cloud Computing* 9, 1 (2020). https://doi.org/10.1186/s13677-020-00185-8

[9] Netflix. 2021. The True Climate Impact of Streaming. https://about.netflix.com/en/news/the-true-climate-impact-of-streaming

[10] Chris Preist, Daniel Schien, and Paul Shabajee. 2019. Evaluating Sustainable Interaction Design of Digital Services: The Case of YouTube. In *CHI'19 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.* 1–12. https://doi.org/10.1145/3290605.3300627

[11] Daniel Schien, Paul Shabajee, Jigna Chandaria, Dan Williams, and Chris Preist. 2021. Using behavioural data to assess the environmental impact of electricity consumption of alternate television service distribution platforms. *Environmental Impact Assessment Review* 91, September (2021), 106661. https://doi.org/10.1016/j.eiar.2021.106661

[12] Daniel Schien, Paul Shabajee, James Wickenden, Tristan Warren, and Chris Preist. 2022. Demo: The EAM Environmental Modelling and Assessment Toolkit. In *ACM SIGCAS/SIGCHI Conference on Computing and Sustainable Societies (COMPASS)*. Seattle, Washington, USA. https://doi.org/10.1145/3530190.3542933

[13] Shibsted. 2021. Shibsted Environmental Report 2021. https://static.schibsted.com/wp-content/uploads/2022/04/07102011/Sustainability-Report-2021-FINAL.pdf