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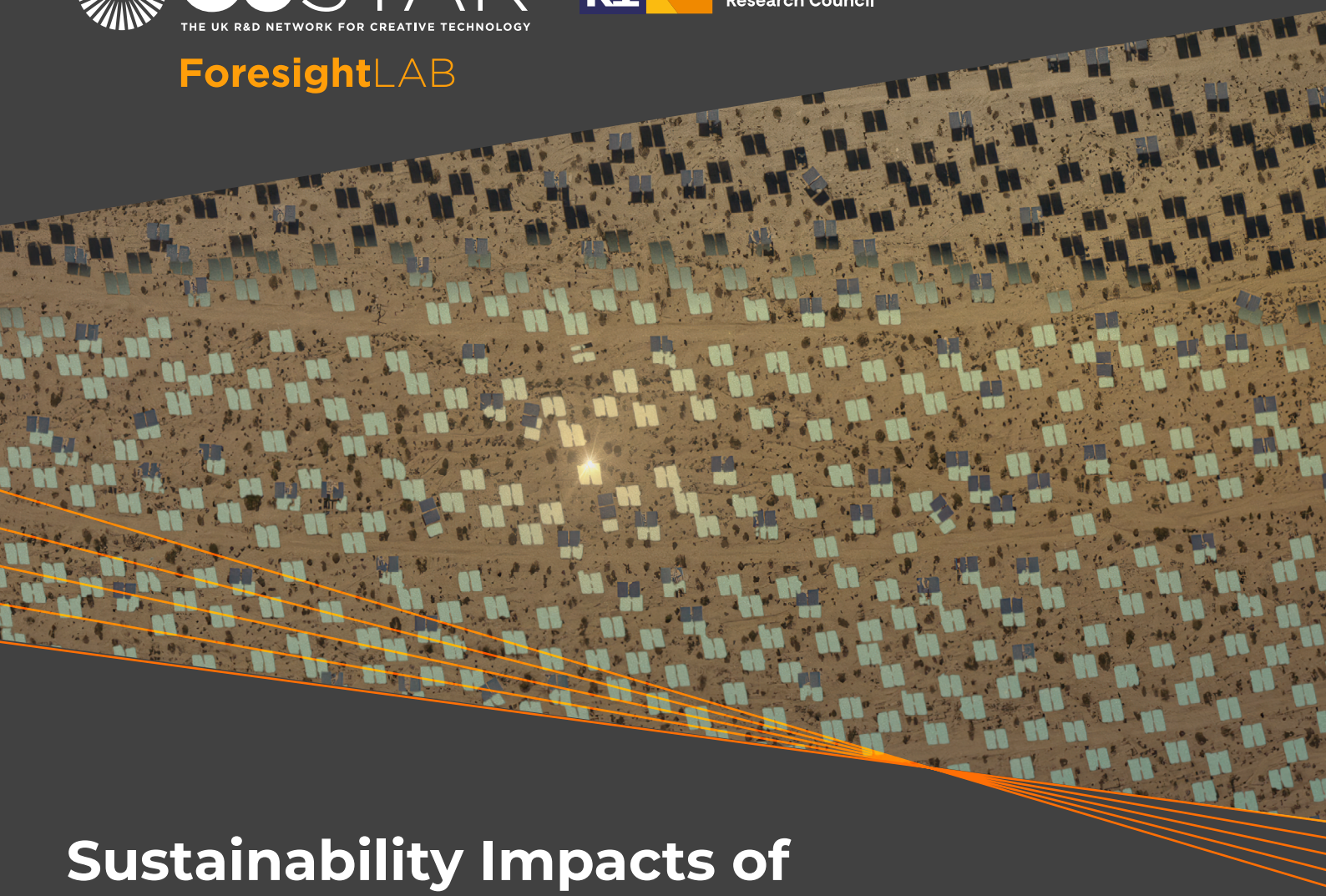

Sustainability Impacts of Convergent Technologies in the UK Creative Industries

A Foresight Lab policy briefing

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Dr Ekaterina Tarnovskaya, Dr Vicki Williams and Prof Graham Hitchen

BFI | The University of Edinburgh | Loughborough University | Goldsmiths University of London

The CoSTAR Foresight Lab

Driven by the UK's leading Creative Industries experts, the CoSTAR Foresight Lab is researching the adoption, use and impact of new, emergent and convergent technologies in gaming, TV, film, performance and digital entertainment.

Our findings will inform research, development and innovation across the Creative Industries, including the R&D taking place through the convergent screen technologies and performance in real time (CoSTAR) programme, the UK R&D network for creative technology.

CoSTAR is a £75.6 million national R&D network of laboratories that are developing new technology to maintain the UK's world-leading position in gaming, TV, film, performance, and digital entertainment. Delivered by the UKRI Arts and Humanities Research Council, the programme is supporting new innovations and experiences that will enrich the UK's creative industries, economy, and culture. The network comprises the National Lab, the Realtime Lab, the Live Lab, the Screen Lab and the Foresight Lab. CoSTAR is funded through UK Research and Innovation's Infrastructure Fund, which supports the facilities, equipment and resources that are essential for researchers, businesses, and innovators to do groundbreaking work. You can find out more by visiting www.costarnetwork.co.uk.

Foresight Lab partners and contributors

Core Partners:
Prof Jonny Freeman; Jac Sanscartier* (Goldsmiths, University of London)
Prof Frauke Zeller; Prof Melissa Terras; Dr Suzanne R Black; Gavin Inglis (University of Edinburgh)
Prof Graham Hitchen; Dr Ekaterina Tarnovskaya; Dr Vicki Williams* (Loughborough University)
Rishi Coupland; Keir Powell-Lewis*; John Sandow; Brian Tarran (BFI)

Delivery Partners:
Florence Mansfield (Arup)
Prof Hasan Bakhshi MBE; Dr Tom Cahill-Jones; Prof Giorgio Fazio; Dr Sarah Najm (Creative Industries Policy and Evidence Centre)
Brendan Miles (Data Thistle)
Chiara Badiali*; Natalie Highwood; Alison Tickell (Julie's Bicycle)
Noemi Ponzoni*; Anna Stewart; Lewis Turner-Brown (i2 media research)
Leon Forde; Marta Moretto; Emma Openshaw; Peter Cobb; Joshua Dedman (Olsberg•SPI)
Patrick Bradley (Station12)
Alice Fearn; Daniel Hodgkin; Luke Taylor (Verian)

The Foresight Board:
Prof Dave Bull; Prof Darren Cosker; Sarah Ellis; Steve Jelley; Gaby Jenks; Prof Greg Maguire; Prof Alex McDowell; Prof Sylvia Pan; Dr Romana Ramzan; Bill Thompson; Dr Lincoln Wallen; Nell Whitley; Deborah Williams OBE

The Lab is administrated by Petra Lindnerova; Dan McCarthy and Tom Steer.

* Indicates members of the Foresight Lab's **Sustainability Working Group**.

Cover image:
Film still from *The Great Endeavour*, directed and designed by Liam Young, 2024.

Introduction

The technologies of the future are reimagining and revolutionising the way content is created and consumed whilst also making this content more accessible. The *Sustainability Impacts of Convergent Technologies in the UK Creative Industries* report prepared by the CoSTAR Foresight Lab, in partnership with Arup, identifies key trends across film, live music, theatre, video games and events and provides an in-depth analysis of the sustainability impact of technology, and implications for the future of the Creative Industries. It uncovers the technological trends which are transforming the Creative Industries, such as the development of Virtual Production (VP), the growth of Artificial Intelligence (AI), the transformation and remediation of physical experiences into hybrid and virtual experiences, and the subsequent sustainability challenges. As the UK Creative Industries rapidly innovate and adopt convergent technologies, the report outlines areas that require further proactive investigation and analysis. In addition, it outlines recommended actions to manage carbon impact with case studies demonstrating successful implementation.

The full report is available at www.costarnetwork.co.uk/resources/sustainability-impacts-of-convergent-technologies-in-the-uk-creative-industries.

Key findings

Through literature review, ecosystem mapping and horizon scanning, the report explores four central technology areas:

- Virtual production,
- Generative AI,
- Hardware and wearables,
- Virtual existence.

For each area, it summarises positive and negative sustainability impacts, case studies and examples of sustainable development, identified research gaps, and recommendations.

1. **Virtual production:** *Is it truly more sustainable than traditional methods of production?*

- Whilst most of the research agrees that Virtual Production reduces carbon emissions compared to the traditional methods of production, Virtual Production presents three key processes that create significant carbon emissions: power consumption, hardware manufacturing and disposal, and software and cloud services.

- Due to the growing demand, the Creative Industries need to measure the full carbon footprint of Virtual Production and establish new methods for doing so (e.g. the embodied carbon of equipment, the supply chains, end-of-life emissions for LED walls etc).

- To reduce carbon emissions, some of the recommended methods outlined for measuring carbon impact include using energy-efficient hardware, renewable energy sources, efficient data and energy management systems, digital assets reuse, material efficiency, optimizing cloud computing, integrating (IT) carbon calculators, engaging sustainability experts, advocating for sustainability policy and collaboration.

2. **Generative AI:** *What is the role of the Creative Industries in building sustainability into the fluctuating and accelerating area of AI?*

- Although AI produces substantially less CO_2e than computer use to support humans doing comparable writing/illustrating tasks (AI systems emit between 130 and 1500 times less CO_2e per page of text generated compared to human writers; AI illustration systems emit between 310 and 2900 times less CO_2e per image than their human counterparts[1]), there are multiple sustainability risks associated with the rise of AI:

    - Carbon footprint: According to Stanford's Artificial Intelligence Index, it took the equivalent of 502 tons of carbon dioxide emissions to train GPT-3 in 2022 and close to 1,300 megawatt hours of power[2].

    - Water footprint: AI models consume many millions of litres of freshwater for electricity generation and for cooling the servers. By one estimate, global AI's combined operational water withdrawal may reach 4.2 – 6.6 billion cubic meters in 2027[3].

1 https://www.nature.com/articles/s41598-024-54271-x

2 Artificial Intelligence Index Report 2023, available on arXiv: https://arxiv.org/abs/2310.03715.

3 Li, P., Yang, J., Islam, M.A., Ren, S. (2023) Making AI Less "Thirsty": Uncovering and Addressing the Secret Water Footprint of AI Models https://arxiv.org/abs/2304.03271

- Consumer demand: The broadening of use cases for AI and the proliferation of ways that AI could impact each use case could lead to far greater demand for energy and water than today.

- To reduce the carbon and water footprint associated with the growing use of AI, the recommended interventions outlined in the report include promoting transparency by disclosing energy and water consumption, strengthening sustainable AI regulation and governance, promoting green AI certifications, using clean energy for training models, minimising computational costs by adopting energy-efficient models, adapting pre-trained models to new tasks/domains, and making data centres more efficient.

3. Hardware and wearables: *How can we sustainably manufacture, use and dispose of hardware that is essential for these emerging technologies?*

- There are several positive sustainability outcomes of increasing the use of hardware and wearables: LED walls can reduce the number of physical set pieces for film, TV, and theatre performances; designing sets and attending concerts virtually reduces physical waste; proper recycling of precious metals and re-usable materials prevent unnecessary e-waste from accumulating and offsetting the potential reduction in physical waste and resource usage.

- However, there are several negative sustainability outcomes, such as an increase in the overall resource and energy demand required to produce hardware. Globally, 62 billion kilogrammes of electronic waste were generated in 2022[4]. A significant volume, totalling around 3.3 million tonnes of e-waste, is shipped across borders to developing countries, leading to environmental and health-related issues[5]. Improper recycling is a threat to public health and safety. The prevalence of international e-waste policy, legislation or regulation is not accelerating in line with targets set by the ITU.

- To minimise the environmental and carbon footprint of hardware, the creative industries must reinvent the production of hardware and adopt more circular principles throughout its lifecycle.

4. Virtual existence: *How can we measure and manage the emissions associated with virtual existence as experiences transition away from their physical alternatives?*

- Positive sustainability outcomes of the 'virtual transition' in the Creative Industries include reduced movement and travel emissions relating to people/products, reduced waste from events, increased accessibility of entertainment, mitigation of biodiversity loss and other environmental impacts. However, multiple negative sustainability impacts exist, including a large amount of energy use and increased hardware requirements.

4 https://unitar.org/about/news-stories/press/global-e-waste-monitor-2024-electronic-waste-rising-five-times-faster-documented-e-waste-recycling

5 https://www.itu.int/en/ITU-D/Environment/Pages/Publications/The-Global-E-waste-Monitor-2024.aspx

- The following actions will help the Creative Industries manage the sustainability implications: develop capacity around carbon accounting, develop industry-wide standards, standardise data sharing, create data collection templates to simplify carbon accounting, develop a consistent methodology of carbon accounting for virtual events, conduct baseline studies, identify and promote the use of sustainable energy centres, set industry-guidance on the procurement of data centre services for virtual events, promote energy-efficient devices and digital infrastructure.

Key recommendations

The report explores the critical steps required to advance the sector toward a more resilient, innovative, and sustainable future. It identifies three key strategic areas to be tackled at both an industry and policy level: leadership, data gathering and integrated solution development.

1. *Directive Industry Leadership*

There is a pressing need for top-down direction when it comes to decarbonisation. In the UK Creative Industries, there needs to be a transformative approach to leadership, with a focus on driving innovation, collaboration, and systematic change to enable the creative sector to cut emissions and ensure their sustainable futures.

2. *Data Acquisition and Reporting*

To ensure a sustainable future for the UK's Creative Industries, a data-driven approach is critical. Acquiring accurate and comprehensive data on carbon emissions will enable the sector to truly understand the environmental impact of the use of convergent technologies. This will help the sector to identify and isolate high emissions areas and develop interventions to tackle them. Transparent reporting fosters accountability, ensures regulatory compliance, and encourages widespread adoption of sustainable practices.

3. *Integrated Solutions*

Reducing the negative sustainability impact of convergent technologies in the Creative Industries requires integrated solutions that address energy consumption, resource management, and waste across the entire production lifecycle. Key strategies include adopting energy-efficient technologies (like cloud computing powered by renewables), transitioning to circular economy models (for devices and physical assets), and promoting industry-wide collaboration and standardisation. A combination of technological innovation, policy frameworks, and sustainability-driven decision-making will be essential for guiding the Creative Industries toward a greener future.

R&D priorities

Based on the report findings, the CoSTAR Foresight Lab has established three strategic R&D priorities for further development:

1. Data/ measurement

- Explore feasibility of measurement of energy use for creative technology across the production workflow, methods to measure the impact of supply chain emissions associated with Virtual Production and other emerging technologies, and methods for productions to analyse and identify lower emission services from data centre providers.

2. Optimisation

- Investigate feasibility of software-controlled energy usage minimisation in studio/ across workflow across CoSTAR subsectors, approaches to minimise AI energy usage (small language models), detailed action research linked to specific projects or organisations coming into the Labs, to create new models and frameworks and ways the industry can support and scale low emission data processing and storage innovations.

3. Devices/ physical consideration

- Explore new approaches to the procurement, management and disposal of devices and hardware associated with convergent technology across production workflows; understand carbon capital cost of building and equipping new virtual production labs (using the CoSTAR labs as real-life examples).

CoSTAR Foresight Lab
Goldsmiths, University of London
New Cross
London SE14 6NW

costarforesightlab@gold.ac.uk
costarnetwork.co.uk/labs/foresightlab

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