



Creating a New Reality: A Sustainable Digital Transformation

University of Oxford

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition / Expansion
AI	Artificial Intelligence
CATS	Climate-Aware Task Scheduler
CLF	Central Laser Facility (STFC)
DEFRA	Department for Environment, Food and Rural Affairs
DNO	Distribution Network Operator
DRI	Digital Research Infrastructure
dRTP	Digital Research Technical Professional
DSIT	Department for Science, Innovation and Technology
ECR	Early Career Researcher
ENSURE	Environmentally Sustainable digital services and practices for Research infrastructures (EU project)
EPA	Environmental Protection Agency (US)
EPCC	Edinburgh Parallel Computing Centre
ESFRI	European Strategy Forum on Research Infrastructures
GUILT	Green Usage Impact Logging Tool
HPC	High-Performance Computing
IT	Information Technology
LCA	Life Cycle Assessment
NERC	Natural Environment Research Council
NetDRIVE	Network for Sustainable Digital Research Infrastructure Vision and Expertise
OERC	Oxford e-Research Centre
REACT	Recommendations for Enhancing Adoption of Carbon-footprinting Tool
RPO	Research Performing Organisation
SLURM	Simple Linux Utility for Resource Management (HPC workload manager)
SMART-DRI	Scenario Modelling and Assessment for Research Transition in Digital Research Infrastructure
SSI	Software Sustainability Institute
STFC	Science and Technology Facilities Council
UKCEH	UK Centre for Ecology and Hydrology

Acronym	Definition / Expansion
UKRI	UK Research and Innovation
UPS	Uninterruptible Power Supply
VM	Virtual Machine
WG	Working Group

Foreword from the PI

It was great, as always, to welcome a mix of new and familiar faces the NetDRIVE community meeting in Oxford. This was the 6th such event following two in the preliminary stage of NetDRIVE in 2024 and three last year.

The meeting started with delegates observing a minute's silence for the victims of the war in Iran, Lebanon, and neighbouring countries which had started in late February. A moment to reflect on the challenge of finding a path towards equitable, inclusive, and sustainable world, or, perhaps, identifying the next steps we should take that might lead us towards such a path.

Our meeting included a poster session for the first time, and a dedicated breakout session for early career participants, adding valuable new dimensions to the discussions.

On the immediate questions around the planning for the third and final NetDRIVE call, the meeting gave clear feedback on the basis of which we will split the call into an early component targeting social science engagement and projects starting in January 2027, and a later component targeting integration and projects starting around April 2027.

We heard some strongly held views on subjects as diverse as nuclear power (its untapped potential) and the need for academics to engage more constructively with estates officers and others engaged with day-to-day operations of buildings, technical infrastructure and human resources. We also heard concerns about the weakening of the net-zero goals in the UKRI 2025 Sustainability Strategy relative to those set in 2020 and how this reflected a broader societal and political retreat from past ambitions.

This last point throws light on the apparent, that is to say, superficial, contradictions between national, global, and academic aims. I term them as superficial because we have a clear responsibility as academics to form our own opinions and deliver uncomfortable truths when needed. To put it bluntly, entertainment is not our job. Globally, there is no retreat from net zero ambition. Nevertheless, delivering uncomfortable truths needs to be done with care. The good news is that public trust in academics remains high according to a 2022 British Academy survey¹, far above trust in politicians, businesspeople and journalists.

¹ <https://www.thebritishacademy.ac.uk/news/academics-top-trust-list-in-british-academy-poll/>

We also heard that the information technology sector is well placed to lead on net-zero because it is a high value sector which is, by many measures, awash with funds.

However, securing allocation of funds to sustainability goals remains a challenge. And while the sector as a whole is certainly witnessing a frenzy of investment few would claim that the UKRI Digital Research Infrastructure is awash with funds. It is also clear that the expectation that more compute power will lead to greater scientific achievements remains influential, though the award of best poster to a team working on digital sufficiency showed that an alternative perspective is starting to attract attention.

In many areas there is a strong tendency to shift from objective evidence-based discussion to exchange of beliefs about processes or emerging technology options, especially when evidence may be circumstantial and/or complex.

The emphasis on demand reductions has some immediate consequences. The 2025 National Energy System Operator (NESO) analysis of future supply, which is an illustrative estimate, suggests two days a week with significant gas usage in winter and spring months of 2030², and generally carbon free power outside those times. There are several factors which may disrupt this picture, especially new demands for power for artificial intelligence (AI) data centres which are not covered by NESO. Nevertheless, it provides a reference point: if we wish to cut Scope 2 emissions as defined by UK reporting obligations (i.e. based on the UK national grid carbon intensity) we should consider powering down machines for around two days per week for up to 6 months of the year; a cut in availability of around 14%.

The route to dealing with scope 3 emissions by demand reductions is less clear. The current focus is on using contractual levers to gain greater clarity about the supply chain emissions. This could potentially develop into a mechanism for favouring hardware with a lower embedded carbon content, but the implications of such an approach are extremely unclear at present.

The key issues around defining net zero are durability and timeliness. Durability is a challenge if there is a substantial reliance on carbon removals. Timeliness is hugely challenging on all fronts. Specific consequences of missing specific targets are not, unfortunately, included in the flood of data and climate projections. Despite huge advances in science, the pace of change is such that we learn most about our planet when we break things, like a child with a toy. We are moving into a climate regime which risks breaking the large-scale systems transporting heat and water vapour around the world and we have little understanding of the consequences.

² <https://www.neso.energy/document/346791/download>

A. Executive Summary

The NetDRIVE Community Meeting, *"Creating a New Reality: A Sustainable Digital Transformation"*, was held on 22–23 April 2026 at the University of Oxford. The meeting brought together 59 participants from 28 institutions, including researchers, infrastructure providers, policymakers, sustainability practitioners, and early career researchers, to advance collective thinking on the pathway to net-zero digital research infrastructure (DRI) in the UK.

Meeting purpose

The meeting was convened to address three principal issues:

- Practical approaches to community leadership and scientific credibility in defining and implementing net zero
- Understanding the shape, constraints, and opportunities of the emerging UK power supply
- Engaging across generations to help guide the digital transformation

Meeting format. The two-day programme combined keynote presentations, structured breakout discussions, community project presentations, and a poster competition. Day 1 addressed the scientific, institutional, and energy systems context for sustainable digital transformation. Day 2 focused on community engagement, flexibility in DRI service provision, support for early career researchers, and scenario planning for 2040. The meeting also served as a platform for NetDRIVE to share progress on the Third Call Part A and to gather community input on future priorities.

Key themes from keynote presentations. Professor Myles Allen (University of Oxford) set out the case for Geological Net Zero — a framework in which continued fossil fuel use requires equivalent active carbon removal, as well as passive offsetting — with direct implications for how UKRI and research institutions account for their emissions. Harriet Wallace (Imperial College London) presented Imperial's forthcoming sustainability strategy and ICT Sustainability Roadmap, demonstrating how a major research-intensive university is embedding net zero across operations, procurement, and research. David White (University of Oxford) challenged the community to address the structural reasons why sustainability is routinely deprioritised in IT decision-making. Professor David Wallom (University of Oxford) contextualised DRI within the broader UK energy system, highlighting distribution network constraints and the rapidly growing energy demand from data centres and AI workloads. Dr. Susan Simon, (Medical Research Council) addressed the practical challenges facing UKRI estates professionals in delivering net zero commitments across a complex, distributed research infrastructure estate.

Key themes from breakout and plenary discussions. Four structured sessions surfaced consistent themes across the two days. Participants broadly endorsed optimistic framings of

net zero but placed systemic levers – regulation, carbon pricing, and institutional incentives – above individual action as the primary drivers of change. On flexibility in DRI service provision, environmental impact was ranked the top priority over service quality or cost, though operational delivery capacity was identified as the most significant barrier to implementation. The dedicated early career researcher session produced a clear message: ECRs are willing contributors but face structural constraints, particularly short-term funding and limited influence over institutional decisions, that engagement alone cannot address. The scenario planning session identified decarbonisation of the national power supply as the single highest-impact factor for DRI to 2040.

Poster competition. From around 20 abstract submissions, 14 posters were selected for presentation, covering topics ranging from carbon monitoring and emissions accounting to digital sufficiency, carbon-aware scheduling, biodiversity in computing facilities, and governance frameworks for net zero DRI. The poster session generated significant engagement throughout the event, complementing formal sessions with space for detailed technical discussion and networking. The competition winner was *"Co-Designing Digital Sufficiency for Sustainable DRI"* by Oliver Bates, Marcia Smith, Kate Wright, Carolynne Lord, and Kelly Widdicks. Two Honourable Mentions were awarded: *"An Environmental Assessment of Computing Services in Higher Education"* by Tobias Fitschen and colleagues, and *"Environmentally Sustainable Digital Services and Practices for Research Infrastructures"* by Caterina Doglioni and collaborators.

Participant feedback. The meeting was very well received, with an overall rating of 4.5/5 from post-event respondents, 100% of whom would recommend it to colleagues. Networking (4.83/5) and poster display (4.8/5) were the highest-rated elements. Participants were broadly confident in NetDRIVE's direction and credibility, but less certain about what success looks like in practice and how to translate programme-level priorities into concrete action.

Priority actions and next steps. The meeting generated six concrete action areas: developing a UKRI policy brief on credible net zero accounting for publicly funded research; convening a targeted estates engagement workshop; continuing dedicated spaces for ECR involvement; embedding operational design of flexibility mechanisms as an explicit deliverable in future funded projects; progressing a Green Skills scoping study with partner programmes; and revising event registration practice to improve commitment rates. Three follow-on workshops are planned for mid-2026, covering the Third Call Part A and Part B consortium building processes and estates engagement.

B. Introduction

The Net-Zero Digital Research Infrastructure Vision and Expertise (NetDRIVE) programme addresses the challenge of transitioning the UKRI Digital Research Infrastructure (DRI) towards a sustainable, net-zero future. The programme recognises that the environmental footprint of the DRI is complex and distributed, spanning high-performance computing facilities, data infrastructure, software systems, and the behaviour of the individuals who design, operate, and use them.

The NetDRIVE Community Meeting, titled *“Creating a New Reality: A Sustainable Digital Transformation”*, was held on 22–23 April 2026 at the Martin Wood Lecture Theatre, Department of Physics, University of Oxford. The meeting formed part of the broader NetDRIVE programme, which focuses on delivering authoritative advice and evidence-based recommendations to UK Research and Innovation (UKRI) on sustainable digital research infrastructure and pathways towards net zero. Bringing together researchers, infrastructure providers, policymakers, sustainability practitioners, software engineers, and early-career researchers, the meeting provided a collaborative platform for interdisciplinary discussion on the technical, environmental, operational, and societal dimensions of sustainable digital transformation.

Across the two-day programme, participants explored both strategic and practical dimensions of achieving net-zero DRI through a combination of keynote presentations, technical talks, community project presentations, breakout discussions, poster presentations, and plenary sessions.

Day 1, titled *“Navigating the Challenges of Environmental, Digital and Social Transformation”*, focused on broader environmental, infrastructural, and societal dimensions of sustainable digital transformation. Discussions addressed the environmental implications of advanced digital services and research computing, the sustainability strategies within higher education and research institutions, the energy implications of advanced IT services, and the operational challenges associated with transitioning digital research infrastructure towards net zero. The day also included presentations from NetDRIVE community projects and breakout discussions exploring different perspectives and framings of the net-zero challenge.

Day 2, titled *“Getting Involved: Shaping the NetDRIVE Community and Future Actions”*, focused more directly on community engagement, future pathways, and practical implementation challenges. Sessions explored flexibility in DRI service provision, interactions between digital infrastructure and the evolving UK power system, approaches for empowering early-career researchers, and scenario-based discussions on future net-zero pathways for digital research infrastructure. The programme also emphasised collaborative discussion and community participation to help shape future NetDRIVE priorities and actions.

Throughout the meeting, poster presentations and networking activities provided additional opportunities for participants to exchange ideas, showcase emerging research and practical initiatives, and strengthen collaboration across the UK sustainable DRI community.

C. Keynote and Community Presentations

The meeting featured five keynote presentations and two community project presentations across the two days, covering the scientific, institutional, and operational dimensions of sustainable digital transformation. These were supplemented by two community project presentations on the Wednesday afternoon (SMART-DRI and REACT), which are summarised in the community project section. Full write-ups for all keynotes are provided below; the summary for Dr Susan Simon’s session is pending receipt of presenter materials.

Making Net Zero Real

Prof. Myles Allen, Head of Atmospheric, Oceanic and Planetary Physics, University of Oxford and Principal Investigator of Oxford Net Zero.

Professor Allen set out the scientific case for what he termed “Geological Net Zero”: the principle that continued fossil fuel use requires an equivalent volume of CO₂ to be captured at source or recaptured from the atmosphere and committed to geological-timescale storage. His central argument was that the prevailing convention of reclassifying passive carbon uptake — such as forest absorption — as active “removals” creates an accounting fiction that permits continued warming. Credible net zero requires balancing ongoing geological carbon sources with genuine geological sinks, a standard that most current carbon credit schemes do not meet.

For the digital research community, Professor Allen drew a pointed implication: the IT sector generates high revenue per tonne of CO₂ emitted and is therefore better placed than most industries to finance the transition to genuine geological storage. The most impactful action available is not renewables procurement or offsetting, but progressively reducing the net geological carbon intensity of the fossil fuels the sector continues to use. This framing and its implications for UKRI and institutional carbon accounting were carried forward into the Actions and Next Steps section of this report.

Forthcoming Sustainability Strategies at Imperial

Harriet Wallace, Director of Sustainability, Imperial College London

Ms Wallace presented Imperial’s forthcoming sustainability strategy — “Sustainable Imperial” — as a core component of the college’s wider “Science for Humanity” strategic framework. The strategy sets an ambition to minimise Imperial’s environmental footprint while maximising its positive “handprint” through research, education, and partnerships. Key

commitments include net zero carbon campuses by 2040 and the embedding of sustainability across procurement, travel, and academic practice.

The presentation covered Imperial's current carbon footprint (Scope 3 emissions comprising 83% of the total, dominated by procurement and student travel), its phase-one decarbonisation programme targeting 25% Scope 1 and 2 reductions by 2030, and specific initiatives including the Lenovo Iceberg liquid-cooled HPC deployment, an ICT Sustainability Roadmap (2026–2031) built around the principle of “buy less, buy better, use better, use for longer”, and a new Sustainability Sandbox enabling staff and students to pilot sustainability projects on campus. Ms Wallace also presented data on embodied carbon in IT devices, noting that 75% of lifecycle emissions from hardware occur at manufacture — a finding with direct relevance to DRI procurement policy.

Digital Transformation at Oxford

David White, Chief Digital and Information Officer, University of Oxford

Mr White framed the session around a central question: is sustainable digital transformation genuinely possible? He began with an analysis of how IT departments typically make decisions — prioritising cost, reliability, security, and predictability — and noted that sustainability tends to be treated as a secondary purchasing criterion, an ethical consideration of uncertain weight, or a factor in energy costs that remains a relatively small budget line. The structural result is that sustainability gets missed unless it is embedded in governance and management discipline rather than left to individual initiative.

Drawing on Oxford's own internal analysis, Mr White highlighted that people are the largest driver of carbon emissions in university IT: each additional person generates demand across devices, storage, compute, and video calls. He noted that 75% of IT hardware lifecycle carbon occurs at manufacture, driving Oxford's policy of extending device usable life wherever possible. His presentation then outlined Oxford's draft digital strategy, structured around six themes: Foundations (security, infrastructure, sustainability), Research Computing, Digital Education, Professional Services simplification, AI governance, and a “How We Do IT” principle of user-first, continuous improvement design. He closed with a challenge to the room: is the sustainability expertise in this community actually heard when institutional decisions are made?

Energy Implications of Advanced IT Services and Resourcing for UK Academic Research

Prof. David Wallom, Associate Director (Innovation), Oxford e-Research Centre, University of Oxford

Professor Wallom examined the energy system context within which DRI operates, arguing that the transition to net zero creates significant systemic risk as three parallel energy systems

(gas, electricity, and oil) are collapsed into a single electrified system. He presented data on UK electricity demand trajectories under electrification scenarios, distribution network congestion (with 35% of Oxfordshire primary substations already constrained for additional demand), and the rapidly growing contribution of data centres — currently around 2.5% of UK electricity consumption and projected to rise four-fold by 2030.

Critically, Professor Wallom noted that ICT infrastructure's contribution to energy demand is rising sharply — driven by artificial intelligence (AI) workloads in particular — and that distribution network limits may act as a physical brake on unconstrained growth. He presented research on smart grid approaches and demand response mechanisms as tools through which ICT can contribute to energy system flexibility rather than simply add to peak load, and closed with the observation that the same ICT capabilities driving demand growth could equally be deployed to improve the energy system itself.

Net Zero Challenges for UKRI Estates Professionals

Dr. Susan Simon, Director of Capital and Estates and Chief Environmental Sustainability Officer, Medical Research Council

Dr. Simon addressed the practical challenges facing UKRI estates professionals in delivering net zero commitments across a complex and geographically distributed research infrastructure estate. Her presentation drew on direct operational experience of managing sustainability transitions within UKRI, and contributed to the meeting's broader theme of the need for closer engagement between academic communities and the estates professionals responsible for implementing net zero at a facility level.

SMART-DRI: Scenario Modelling and Assessment for Research Transition in Digital Research Infrastructure

Zeynep Tekler, Assistant Professor in Digital Construction Management, Loughborough University and University of Oxford, and Abhishek Dasgupta, Programme Lead Oxford RSE, University of Oxford, on behalf of the SMART-DRI team.

Dr Tekler and Dr Dasgupta presented SMART-DRI, a project developing data-driven tools and analytical methods to support the transition to low-carbon digital research infrastructure. The presentation opened with the scale of the challenge: global data centre electricity demand stood at 415 TWh in 2024 and is projected to reach 945 TWh by 2030, with CO₂ emissions projected to nearly double over the same period. Against this backdrop, SMART-DRI addresses three interconnected problems — fragmented operational data, carbon-blind scheduling, and the absence of financial incentives for operators to treat sustainability as anything other than a cost.

The project is structured around three workpackages. WP1 is building a unified, multi-site open dataset integrating power telemetry, hardware specifications, electricity prices, and carbon intensity data, to serve as a shared foundation for the modelling and scheduling work. WP2 is developing adaptive green scheduling algorithms using game-theoretic and mixed-integer linear programming approaches, with early results showing that carbon-aware scheduling reduces both carbon emissions and peak load compared to conventional independent scheduling, with only a modest increase in system cost. Implementation will extend the existing CATS scheduler to support multi-job optimisation, with green-queue pilots planned at Queen Mary University of London and the National Oceanography Centre in Q3–Q4 2026. WP3 is quantifying the economic and environmental returns available when DRI facilities offer demand flexibility to the electricity grid, framing research computing as a potential provider of grid flexibility services rather than simply a consumer of power. Key outputs — including the open dataset, peer-reviewed publications, and pilot demonstrations — are planned for release through 2026 and into early 2027.

REACT: Recommendations for Enhancing Adoption of Carbon-footprinting Tool

Liz Ing-Simmons, Senior Research Software Engineer, King's College London, on behalf of the REACT team: Yee Van Fan (University of Oxford), Irufan Ahmed (Imperial College London), Sudha Ahuja (Queen Mary University of London), and Jiahong Zhao (University of Southampton).

Liz Ing-Simmons presented the REACT project, which addresses the fragmented landscape of user carbon footprinting (UCF) tools for HPC and cloud computing. While multiple tools exist to help researchers understand the carbon emissions of their compute jobs, uptake among DRI facilities remains low, methodologies are inconsistent, and Scope 3 emissions are rarely included. REACT aims to catalogue and technically evaluate available UCF tools, assess the motivations and barriers to their adoption among DRI operators, and develop a DRI-specific Scope 3 emissions framework grounded in life cycle assessment principles.

The project will combine literature review, surveys, and interviews with DRI users and operators, alongside hands-on technical testing against defined evaluation criteria covering methodology, ease of deployment, and interpretability of outputs. Key outputs will include a UCF tool catalogue with context-specific recommendations, a summary of adoption barriers and motivations, and practical guidance for facilities seeking to incorporate more comprehensive carbon accounting into their operations.

D. Breakout and Plenary Discussions

The meeting's breakout and plenary sessions were designed to move beyond presentation and into structured community dialogue, drawing on Mentimeter surveys to capture participant views in real time before opening discussion. The Survey Questions and Results are given in full in Appendix 4. Four sessions were held across the two days, each addressing a distinct dimension of the net zero challenge: how participants frame the problem, how DRI services can become more flexible, how early career researchers can be better supported, and what external factors will most shape the sector's trajectory to 2040. The summaries below synthesise the key themes and points of contention from each session; full survey results are included at Appendix 4.

Session 1: How do we view NetZero?

The task: Participants were presented with six framings of the net zero challenge – Tech Optimist, Restraint Optimist, Adaptation Optimist, Culture Change Optimist, Pessimist, and Fatalist — and invited to identify the framing they most closely held, consider the evidence behind it, and explore promising pathways and contrasting views without seeking artificial consensus. The definitions of each framing were in the session briefing note and as follows:

Box 1: Net Zero Framings — Session 1 Briefing

Framing	Description
Tech Optimist	New technologies will take us close net zero on UN timelines.
Restraint Optimist	We need significant restraints on resource usage
Adaptation Optimist	If net zero is late, we will adapt to climate impacts.
Culture Change Optimist	We can make positive changes which benefit everyone.
Pessimist	We are heading for a disaster beyond our control.
Fatalist	Humanity has run its course, and the world will go on

Discussion summary: Across the three rooms, most participants aligned with optimistic framings, though several noted that their actual positions were more pessimistic than those labels implied. A recurring tension was between structural and individual agency: participants broadly agreed that individual action is limited, and that systemic levers — regulation, pricing, institutional incentives, and procurement standards — carry more weight. The EU Emissions

Trading Scheme was cited as a workable model; carbon pricing for compute and time-of-use charging within research institutions were proposed as analogues for the DRI community.

Tech optimism attracted significant support, with participants pointing to developments in solar and green infrastructure, particularly in India, China, and parts of the Global South, as grounds for cautious confidence. However, a consistent counter-view held that technical solutions are advancing too slowly relative to UN timelines, that political will is inconsistent, and that financial incentives remain misaligned — illustrated by the observation that EVs may not reach carbon break-even before they are replaced, and that data centres are being built with on-site gas generation when grid connections are unavailable.

The data centre question generated substantive debate in its own right. Participants noted the scale of energy demand from AI infrastructure (140 data centres reportedly seeking grid connections in one case discussed), the lack of institutional-level visibility into energy consumption, and the tendency for compute to be treated as a "free good" with no carbon feedback to users. Proposed responses included carbon-aware coding standards, community benchmarks, compute budgets that decline over time, and awards or leaderboards that reframe competition around efficiency rather than usage.

Culture change and restraint optimism were seen as complementary rather than alternative framings, with participants noting that behavioural change tends to follow incentive structures rather than precede them. The global equity dimension was raised explicitly: any credible net zero pathway must account for the legitimate development aspirations of lower-income countries, and restraint frameworks designed in the Global North are unlikely to transfer without structural financial support. Adaptation was acknowledged as unavoidable rather than merely optional, particularly for those countries already facing climate impacts.

The dominant mood across rooms was one of constrained optimism — a view that meaningful progress is technically and institutionally possible, but that the research community's direct contribution to emissions is small relative to the infrastructure and policy environment it operates within, raising a question about where to focus effort.

Session 2a: Towards Flexibility in DRI Service Provision

Participants were asked to consider how DRI services should respond when demand flexibility is requested or encouraged, and what specific actions should be prioritised to enable this.

The survey results were unambiguous on the primary goal: 60% of respondents identified reducing power consumption as the top priority when flexibility is requested, with protecting service quality second at 20%, equity and fairness third at 13%, and minimising cost impacts last at 7%. This ordering — environmental impact first, user experience second — is notable given that research infrastructure communities often default to service quality as the non-negotiable, but is perhaps a reflection of the priorities of those who elected to attend this meeting.

On the question of reducing capacity during high carbon-cost periods, participants were broadly supportive across all five statements, with the strongest agreement reserved for the need for clear advance communication (9.3/10) and improved system sustainability (7.6/10). Financial trade-offs and acceptable user disruption both scored 7.2, suggesting participants see these as manageable. Operational manageability for operators was the lowest-scoring statement at 5.9, signalling that implementation complexity is the most significant concern — what participants are willing to accept in principle may be harder to deliver in practice.

The open responses on specific priority actions clustered into six themes. On the technical side, participants pointed to scheduler plugins and time-of-use tools, with one response referencing UK Power Networks' open data platform and another advocating a value-stack approach that bundles transformer cost avoidance, connection acceleration, time-of-use savings, contracted flexibility, and UPS arbitrage. Commercial engagement responses focused on working with DNOs to understand their evidence requirements and exploring whether commercial actors could be incentivised to accept flexibility in exchange for faster connection approvals. User behaviour responses emphasised a user-first rather than top-down approach, establishing consumption baselines, and using flexibility as a lever to prompt genuine reflection on what compute is actually needed — drawing an analogy with how animal research restrictions changed practice. On service delays, participants were open to 24-hour holding queues to enable day-ahead market access, while cautioning that storage, cooling, and geographic load-shifting should be exhausted before job delays are imposed. Equity and fairness responses called for heavier users to be curtailed first, with one participant explicitly extending the frame to global south impacts. Spatial analysis responses proposed investigating the geographic overlap between existing flexibility tenders and compute cluster locations, and called for service-wise feasibility studies and cost-benefit evidence along the lines of the SMART-DRI project.

Session 2b: Empowering the Future

This session was designed as a dedicated space for Early Career Researchers (ECRs) to voice their perspectives on digital research infrastructure and net zero, without the presence of senior colleagues. The survey data and open responses together paint a clear picture: ECRs see themselves as capable contributors to transformation but face structural barriers that consistently limit their influence.

Participants were broadly confident in the value ECRs bring. The highest agreement was for the statement that young researchers can help translate ideas into action (7.8/10), followed by being better placed to understand societal transformation (7.4/10) and digital transformation (7.3/10). Spotting sustainability opportunities scored slightly lower at 7.2, though still well above the midpoint. The pattern suggests ECRs are seen — and see themselves — primarily as implementers and connectors rather than originators, which itself may reflect internalised assumptions about their role worth examining.

On the barriers limiting ECR influence over digital transformation decisions, four categories tied at 11 responses each: limited influence in decision-making, time, workload and competing priorities, and funding, incentives and institutional priorities. Job insecurity and short-term contracts scored 10, hierarchy, exclusion and lack of mentoring scored 9, and skills or confidence gaps scored lowest at 8. The near-uniform distribution across structural and cultural barriers is significant — there is no single dominant obstacle, which makes targeted interventions harder to design.

When asked what NetDRIVE, institutions, DRI facilities, or UKRI should do next, responses clustered around three practical themes: increasing ECR visibility and voice (more funding opportunities, more presentation slots, advocacy for space in net zero work, pathways beyond NetDRIVE); embedding carbon accountability (carbon budgets aligned with funders, carbon reporting for research, carbon accounting treated with the same rigour as financial accounting); and improving communication and access (better outreach to labs, targeted events on writing projects aligned to NetDRIVE goals).

The priority vote was decisive: 77% selected funding as the first next step, with collaboration second at 46%, and mentoring, training, and organisational change each at 38%. Access to tools was the clear outlier at 15%. The funding result should be read carefully — it likely reflects both the material reality of short-term contracts and the recognition that without dedicated resource, ECR engagement in net zero work competes directly with career survival.

Session 3: NetZero Scenarios

The plenary session asked participants to look outward and forward, identifying the external factors most likely to shape net zero scenarios for DRI between now and 2040, and to consider what the field may be under-weighting in its current thinking.

On the question of which external factors matter most, participants distributed 100 points across four options, with a clear hierarchy emerging. Decarbonisation of the national power supply dominated at 45 points. Decarbonisation of the IT supply chain came second at 27, acknowledging that embodied carbon in hardware is a significant and often overlooked component. Effective, non-disruptive approaches to constraining user demand scored 18, and credible offsetting options came last at 10, suggesting participants are sceptical of offsetting as a serious pathway.

The likelihood-impact matrix reinforced this ordering but added nuance. Power sector decarbonisation was rated both high impact and relatively high likelihood — the most favourable quadrant. IT supply chain decarbonisation was seen as high impact but less certain to materialise by 2040. Demand reduction was rated lower on both axes, which sits in some tension with the attention it receives in practitioner discussions. Offsetting was placed in the low-likelihood, low-impact quadrant — effectively dismissed as a meaningful scenario factor by this audience.

The open question on additional factors generated the richest and most expansive set of responses in the plenary. On technological innovation, participants flagged disruptive net zero technologies in both digital and energy sectors, small modular nuclear reactors, continuity of Moore's Law, reuse and recycling of obsolete hardware, extending equipment lifespans and repairability, and the relative carbon footprint of research infrastructure versus emerging sectors such as AI and robotics. Resource availability responses highlighted geopolitical risks to hardware manufacturing supply chains, the impact of rising temperatures on free cooling availability, changing competition for data resources as AI scales, and the need to plan across a diversity of scenarios rather than a single pathway. Political factors included the need for broad-spectrum political support for net zero, regulation tied to planetary boundaries such as carbon budgets, and the asymmetric political economy of demand — where reducing demand in one area can stimulate it elsewhere.

Economic considerations centred on rebound effects, the role of different economic models in enabling or hindering progress, the economics of renewables, and a notable call to shift from an efficiency mindset to a sufficiency mindset. Awareness and education responses flagged misinformation as an active threat alongside the more familiar challenge of engagement. Infrastructure disruption responses called for moving away from proprietary platforms to extend digital infrastructure lifespans and invoked the right-to-repair principle. Leadership responses were pointed: participants asked not just for new leadership but for a specific kind — one capable of taking the community beyond technical solutions and what one participant called "data-ism." User behaviour, the smallest cluster, raised the question of how behaviour is externally shaped, as distinct from internally motivated.

Issues for further consideration by the community arising from the Discussions

Four issues are implicit across the day's discussions that are worth further thought as NetDRIVE looks for ways to deepen its impact across current and future grants.

The first concerns the gap between stated willingness and operational capacity. Participants across sessions accepted disruption, financial trade-offs, and demand constraints in principle — yet those closest to delivery consistently flagged that no one is currently resourced to design and run the mechanisms required.

The second concerns the structural position of Early Career Researchers. ECRs identified funding as their overwhelming priority, yet institutional and funder incentive structures were simultaneously named as a core barrier. Encouragement without resource is not empowerment.

The third concerns carbon accountability. Across multiple sessions, participants called for carbon to be treated with the same rigour as financial reporting — at individual, institutional, and funder level. The tools and mandates to do this do not yet exist at the necessary scale.

The fourth concerns strategic focus. If power sector decarbonisation — largely outside DRI's direct control — is the single highest-impact factor to 2040, NetDRIVE needs a clear position on whether its primary role is to influence that wider system or to optimise within it.

E. Poster presentations

Throughout the meeting, participants also engaged with a series of poster presentations showcasing ongoing research, technical innovations, policy perspectives, and practical tools related to sustainability in Digital Research Infrastructure (DRI). Integrated alongside the main meeting programme, the poster session created an interactive space for participants to explore emerging ideas, exchange experiences, and discuss practical challenges and opportunities related to reducing the environmental impacts of digital research systems and infrastructures.

We received around 20 abstract submissions for poster presentations from researchers and practitioners working across academia, research infrastructure organisations, and related institutions. Abstracts were required to clearly demonstrate their relevance to the UK DRI Net Zero Roadmap and explain how the proposed work contributes to sustainable digital transformation and progress towards net-zero digital research infrastructure. Contributions were encouraged from a broad range of disciplines and career stages, particularly early career researchers and those bridging technical, policy, operational, and community perspectives. Following the review process, 14 posters were selected for presentation and inclusion in the poster competition (Table 1).

Table 1. Poster presenters list

No.	Poster Title	Authors
1	How Much Evidence Is Enough? Managing Data Reuse and Analytical Uncertainty for Sustainable Digital Research Infrastructure	Alyssa Columbus, Brian Caffo, Martin Lindquist
2	Green Usage Impact Logging Tool	George Roe, David McDonagh, Kiran Jonathan
3	Towards Carbon Emissions Feedback for Users in STFC Cloud	Hieu Le, David McDonagh, Jessica Huntley
4	Measuring and Effectively Using Emissions Data Across DRI: A Dynamic Training Resource for Managers, Developers, Facilitators, Researchers and Users	Sarah Hanrahan, Jessica Huntley, David McDonagh
5	Co-Designing Digital Sufficiency for Sustainable DRI	Oliver Bates, Marcia Smith, Kate Wright, Carolynne Lord, Kelly Widdicks
6	Carbon Monitoring for Scientific Virtual Research Environments on the Ada Platform	Ashraf Hussain, Jessica Huntley
7	CATS: A Carbon-Aware Task Scheduler	Sadie L. Bartholomew, Lincoln Colling, Abhishek Dasgupta, Anthony J. Greenberg, Loïc Lannelongue, Thibault Lestang, Carlos Martinez-Ortiz, Colin Sauzé, Andrew M. Walker, Adam Stuart Ward
8	Scientific Sovereignty and the Compute Gap: A Mission-Oriented Policy Framework for Net Zero DRI	Debaarjun Dasgupta

No.	Poster Title	Authors
9	Organising Sustainable Digital Transitions: A Layered Reference Architecture for Managing Impacts of Data Analytics in Health Systems and Measuring Health Outcomes of Corporate Transitions	Natalia Efremova, Dimitrij Euler, Kristin Kostka, Jennifer Lane, Dennis West
10	Biodiversity at EPCC's Advanced Computing Facility	Lorna Smith, Paul Clark
11	An Environmental Assessment of Computing Services in Higher Education	Tobias Fitschen, Nicolás Labra Cataldo, Caterina Doglioni, Michael Sparks, Luis Miguel Villar Padruno, Ben Parkes, Sakshi Kumar, Alejandro Gallego-Schmid
12	SMART-DRI: Scenario Modelling and Assessment for Research Transition in Digital Research Infrastructure	Zeynep Duygu Tekler, Abhishek Dasgupta, Jin Zheng, Sudha Ahuja, Weibin Feng, Xun Jiang
13	Finding Synergies Between the ENSURE (Environmentally Sustainable Digital Services and Practices for Research Infrastructures in Europe) Project and NetDRIVE	Michael Sparks, Alastair Dewhurst, David Britton, Emanuele Simili
14	Environmentally Sustainable Digital Services and Practices for Research Infrastructures	Caterina Doglioni, Michael Sparks, David Britton,

The selected posters reflected the highly interdisciplinary nature of the meeting and covered a broad range of themes relevant to sustainable DRI. These included carbon monitoring and emissions accounting, sustainable cloud and computing services, carbon-aware scheduling systems, digital sufficiency, sustainability training resources, biodiversity considerations within computing facilities, governance and policy frameworks for net zero digital systems, and environmentally sustainable practices for research infrastructures. Several posters also highlighted collaborative international initiatives, practical implementation tools, and applied methodologies aimed at embedding sustainability principles into the design, operation, and management of digital research infrastructures and services.

The poster presentations generated significant engagement throughout the event and complemented the formal sessions by providing opportunities for more detailed technical discussions and networking among researchers, infrastructure providers, policymakers, and practitioners. Full poster abstracts are included in Appendix 3.

As part of the meeting activities, a poster competition was organised to recognise outstanding contributions. The winning poster was *“Co-Designing Digital Sufficiency for Sustainable DRI”* by Oliver Bates, Marcia Smith, Kate Wright, Carolynne Lord, and Kelly Widdicks, which highlighted participatory and user-centred approaches to reducing the environmental impacts of digital research infrastructure. Two posters received Honourable Mentions: *“An Environmental Assessment of Computing Services in Higher Education”* by Tobias Fitschen and colleagues, and *“Environmentally Sustainable Digital Services and Practices for Research Infrastructures”* by Caterina Doglioni and collaborators. These contributions were recognised for their relevance, methodological strength, and practical implications for advancing sustainability within digital research ecosystems.

F. Feedback

In the final session of the event, participants were asked to reflect on their confidence in NetDRIVE's progress, their own readiness to act, and what changes would most improve the programme's impact.

On confidence in NetDRIVE's progress, scores were moderately positive but revealed a clear gradient. Direction and credibility scored highest — overall direction at 7.3 and current progress at 7.1 — suggesting the programme has established a credible trajectory. Understanding what success looks like (6.4) and having enough community support to participate effectively (6.5) were notably lower, pointing to a gap between strategic clarity at programme level and operational clarity at community level. The lowest score by some margin was confidence that the net zero transition is achievable within the expected timeline (5.2), reflecting the broader scepticism about timelines visible throughout the day's discussions.

On personal readiness to act, scores clustered in a narrower and more cautious range. Feeling ready to act on currieis scored highest at 6.2, followed by having sufficient support to contribute (6.0) and confidence in making a meaningful difference (5.9). The two lowest scores — knowing what actions to take (5.4) and being able to use NetDRIVE to guide practical next steps (5.5) — point to the same gap: participants are broadly willing but insufficiently equipped with concrete, actionable guidance.

The open responses on what would most improve NetDRIVE's impact were dominated by community engagement (10 responses), with participants calling for broader reach beyond the already-engaged, stronger connections with estates directors and IT leadership, a dedicated landing space for ECRs to find funding and build community and more frequent sharing of project outputs and milestones. Communication strategies (6 responses) focused on clarity, practicality, and impact visibility — including dashboards for dRTPs and a call to focus on fewer, higher-impact areas rather than breadth. Environmental sustainability responses called for closer feedback loops with UKRI and DSIT, research performance metrics that link carbon accounting to publications, and clearer policy guidance that industry can follow. Research support responses highlighted the need for early career provision and for future funding calls to build explicitly on NetDRIVE outputs.

On the single action that would most improve readiness, practical actions attracted the most responses (8), converging on the need for clear, widely communicated recommendations with best practice guides and case studies — and a short-term actionable roadmap for UKRI and RPOs. Policy alignment responses emphasised top-down coordination between funding bodies, IT policy and cluster operators, and called for net zero to be embedded across all UKRI strategic priorities rather than treated as a standalone theme. White papers and project documentation responses pointed to the value of publishing past project outputs accessibly and producing stakeholder perspectives on the path forward. Training responses identified

responsible compute use and advocacy skills for influencing institutional leadership as priorities.

Conclusion

The feedback reflects a community that is broadly supportive of NetDRIVE's direction but is asking for greater practical clarity — on what success looks like, what actions to take, and how NetDRIVE outputs translate into things people can actually do. The consistent thread across confidence scores and open responses is the distance between strategic intent and operational guidance. Closing that gap through accessible documentation, concrete recommendations, and wider outreach, is where the community is most clearly looking to the programme to deliver.

G. Actions and Next Steps

Programme format and events

The meeting format — combining keynote presentations, structured breakout sessions with Mentimeter surveys, community project presentations, and a poster competition — worked well and generated substantive discussion. The poster session attracted strong engagement despite being constrained by the agenda, and future meetings should allocate more time to it. The Mentimeter-based breakout methodology drew out useful results and will be carried forward.

Registration practice will be revised for future events. Early opening of free registration generated a high number of sign-ups but a significant rate of non-attendance. Future events will open with an expression-of-interest form before formal registration opens closer to the date, to secure better commitment from attendees.

Three focused follow-on meetings are planned in the near term: a Third Call Part A consortium building workshop (online, June 2026); a Third Call Part B consortium building workshop (in person, July 2026); and a targeted session on estates engagement, planned in advance of the Bristol community meeting later in 2026.

Third Call

The meeting confirmed the programme team's intention to split the Third Call timeline, with social science projects (Part A) targeting a January 2027 start and integration projects (Part B) given additional preparation time with a later start date. The call structure and timelines were set out in the programme team's presentation on Day 2.

Geological Net Zero, Passive Uptake, and credible carbon accounting

Professor Allen's keynote presentation on Geological Net Zero and the critical distinction between passive carbon uptake, which is generated by natural systems responding to raised atmospheric CO₂ levels, and active removals of carbon from the atmosphere, through Direct

Air Capture or biochar production. The problem of confusion caused by widespread misleading and ambiguous claims about net zero and carbon offsets was also discussed. It was suggested that NetDRIVE should develop a policy brief to enhance transparency and credibility.

Estates engagement

Multiple sessions surfaced a deficit in communication and coordination between academics and estates professionals on net zero. NetDRIVE will address this through a targeted workshop, planned in advance of the Bristol community meeting. This reflects a broader recognition that effective implementation of net zero DRI strategies requires active engagement with the estates community rather than operating in parallel to it.

Early career researchers

The dedicated ECR breakout session (Session 2b) was well received. The programme team will continue to create dedicated spaces for ECR engagement at future events. Diversity more broadly — including career stage, institution type, and disciplinary background — will be a consideration for the Bristol meeting programme. The question of how to make ECR-led net zero work fundable rather than merely encouraged will be considered in the design of any future funding calls.

Green Skills Working Group

A proposal for a Green Skills Working Group, raised by Kirsty Pringle during the meeting, received passive approval from participants. A six-month UKRI-funded scoping study — run in partnership with DisCourSE, CHARTED, STEP-UP and NetDRIVE — is being progressed to map what green skills are needed across the sector and link those needs to existing and future training provision.

Appendix 1: Attendees

Henry Addison	University of Bristol
Sudha Ahuja	Queen Mary University of London
Sule Akkoyunlu	Rimini Centre for Economic Analysis
Ajmal Ibn Mohammed Althaf	Quantum X
Lucy Armitage	Medical Research Council
Rene Banares-Alcantara	Dept of Engineering Science, University of Oxford
Oliver Bates	Lancaster University
Roshni Bhagatkar	University of Bristol
Sarah Campbell	NERC-UKRI
Joel Cutting	University of Oxford
Debaarjun Dasgupta	University of Birmingham
Ollie Dawson	University of Bristol
Hanni Doctor	Paramagnetic Communications Ltd.
Caterina Doglioni	University of Manchester
Jun Dong	University of Oxford
Polly Eccleston	University of Bristol
Connor Enright	Norwich Bioscience Institutes
Dimitrij Euler	Greenings (greenings.org)
Aida Farah	Lebanese University
Weibin Feng	University of Bristol
Tobias Fitschen	University of Manchester
Abdu Gabban	University of Bristol
Sarah Hanrahan (online)	STFC
Jessica Huntley	STFC
Liz Ing-Simmons	King's College London
Alexander Jackson	University of Oxford
Geetika Jain	Keele University
Martin Juckes	University of Oxford
Gokmen Kilic	Durham University
Loic Lannelongue	University of Cambridge
Hieu Le	STFC
Liang Li	Centre for Sustainable Energy Use in Food Chains, Brunel University of London
Amani Maalouf	University of Oxford
Habib Maalouf	Lebanese University
Brian Matthews	STFC
David McDonagh	STFC
Erinma Ochu (online)	University of the West of England
Alex Owen	Queen Mary University of London
Edoardo Pasca	Science Technology Facilities Council
Chris Preist	University of Bristol
Haroon Rafique	STFC

G Roble	<i>No institution given</i>
Charles Roberts	University of Oxford
Daniel Schien	University of Bristol
Sarah Sharma	University of Oxford, Engineering Science
Andrea Sharpe	NERC
Susan Simon	UKRI
Lorna Smith	EPCC, The University of Edinburgh
Sarah Sparrow	University of Oxford
Yige Sun	University of Oxford
Zeynep Tekler	Loughborough University / University of Oxford
Songul Ucak	Marketing
Tariq Umar	University of the West of England
Harriet Wallace	Imperial College London
David Wallom	University of Oxford
David White	University of Oxford
Kate Wright	UK Centre for Ecology and Hydrology
Nobuko Yoshida	University of Oxford
Jin Zheng	University of Bristol

Appendix 2: Agenda

Day 1: Navigating the challenges of environmental, digital and social transformation

Wednesday 22 April 2026

Time	Session
10:00 – 10:30	Registration & Welcome Coffee
10:30 – 11:05	Introduction to NetDRIVE programme and meeting objectives Discussion of meeting objectives
11:05 – 12:30	Keynote presentations Making Net Zero Real <i>Prof. Myles Allen, Head of Atmospheric, Oceanic and Planetary Physics, Department of Physics</i> Forthcoming sustainability strategies at Imperial <i>Harriet Wallace, Director Sustainability at Imperial College London</i> Digital Transformation at Oxford (TBC) <i>David White, Chief Digital & Information Officer, Oxford University</i> Discussion of keynote presentations
12:20 – 13:50	Lunch Break (Poster Session)
13:50 – 14:40	Keynote presentation and talk Energy implications of advanced IT services and resourcing for UK academic research <i>Prof. David Wallom, Associate Director – Innovation of the Oxford e-Research Centre</i> Net zero challenges for the UKRI estates professionals <i>Dr. Susan Simon, Director of Capital and Estates and Chief Environmental Sustainability Officer at the Medical Research Council</i> Discussion of keynote presentations
14:40 – 15:30	NetDRIVE community project presentations SMART-DRI: Scenario Modelling and Assessment for Research Transition in Digital Research Infrastructure <i>Zeynep Tekler, (Assistant Professor) in Digital Construction Management</i> REACT: Recommendations for Enhancing Adoption of Carbon-footprinting Tool <i>Liz Ing-Simmons, Senior Research Software Engineer, KCL</i> Discussion of project presentations and breakout briefing
15:30 – 15:50	Coffee Break (Poster Session)
15:50 – 16:45	Breakout discussions: Session 1 (How do we view Net Zero)

16:45 – 17:00	Martin Wood Lecture Theatre (green), Audrey Wood Room (blue), Simpkins Lee Room (yellow) Closing remarks (plenary)
17:30	Informal drinks at the college bar, St Anne’s College, 56 Woodstock Rd, Oxford OX2 6HS (venue details below); followed by Event Dinner (also at St. Anne’s) at 18:30 for registered attendees

Day 2: Getting Involved: Shaping the NetDRIVE Community and Future Actions

Thursday 23 April 2026

Time	Session
9:00 – 10:45	Review of NetDRIVE project delivery
10:45 - 11:10	Coffee Break (Poster Session)
11:10 - 12:30	Breakout discussions: Session 2a (Towards Flexibility in DRI Service Provision) and Session 2b (Empowering the Future Researchers see below) Sessions 2a and 2b will run in parallel: delegates should choose their preferred topic.
12:30 – 14:00	Lunch Note: there is a fire alarm test scheduled for 13:00
14:00 – 14:15	Recap of meeting
14:15 – 15:30	Plenary discussion: Session 3 (Net Zero Scenarios)
15:30 – 16:00	Wrap-up and close

Appendix 3: Poster Abstracts

The following abstracts correspond to the 14 posters selected for presentation and inclusion in the poster competition. They are reproduced here as submitted, with minor formatting for consistency.

1. How Much Evidence Is Enough? Managing Data Reuse and Analytical Uncertainty for Sustainable Digital Research Infrastructure

Alyssa Columbus^{1,2}, Brian Caffo¹, Martin Lindquist¹

Affiliations:

¹ Department of Biostatistics, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, United States

² Department of Statistics, Ludwig Maximilian University of Munich, Munich, Bavaria, Germany

Large-scale datasets are increasingly reused across many studies, often to test new hypotheses, revisit prior findings, or explore alternative analytic decisions. In practice, this repeated use creates a tension: each additional analysis may appear to generate new insight, yet can also introduce instability in results, inflate false positives, and consume substantial computational resources with limited added value. This work develops a framework for assessing how much evidential signal a dataset has yielded relative to the analytic flexibility applied to it. The core idea is to treat data not as an inexhaustible input, but as a resource whose informational value can be partially depleted through repeated, unstructured reuse. I outline methods for quantifying the stability of findings across analytic choices, including specification curve and multiverse approaches, and introduce criteria for identifying when additional analyses meaningfully contribute new evidence versus when they largely reproduce existing variation. Using examples from large-scale epidemiological data, I demonstrate how these approaches can be implemented within reproducible workflows and used to prioritize confirmatory over exploratory reuse when appropriate. This has direct implications for reducing redundant computation, limiting spurious findings, and improving the reliability of downstream decisions that depend on these results. The work concludes with practical recommendations for integrating these ideas into research workflows and infrastructure design, including mechanisms for tracking analytic reuse, supporting structured replication, and defining stopping points for analysis. Taken together, these contributions offer a pathway toward more efficient, credible, and resource-aware data science practices.

2. Green Usage Impact Logging Tool

George Roe¹, David McDonagh¹, Kiran Jonathan¹

Affiliations:

¹ UKRI STFC Scientific Computing Department (STFC SCD)

For those who use High-Performance Computing systems, the environmental cost of their work is often overlooked. With no built-in tools for measuring or displaying carbon emissions, users are left in the dark about their energy consumption and its impact on the climate. GUILT (Green Usage Impact Logging Tool) is a CLI that wraps around the SLURM workload manager to provide users with data analytics about their carbon emissions, assisting in carbon budgeting and quantifying the carbon impact of projects. This project forms part of the STFC Scientific Computing Department Energy Efficiency Team strategy to transition the department towards net zero. The work aligns with the UK DRI Net Zero Roadmap by providing energy and emissions data at the job level (RoadMap Actions 59 and 67).

3. Towards Carbon Emissions Feedback for Users in STFC Cloud

Hieu Le¹, David McDonagh¹, Jessica Huntley¹
Affiliations:

¹ UKRI STFC Scientific Computing Department (STFC SCD)

This poster presents an initiative by the STFC Scientific Computing Department's Energy Efficiency Team to expose and quantify the environmental impact of user Virtual Machines (VMs) running on STFC Cloud.

STFC Cloud enables thousands of researchers to perform complex data analysis without the operational overhead of maintaining local infrastructure, primarily through OpenStack — an open-source platform for scalable infrastructure-as-a-service (IaaS) delivery across compute, storage, and networking. The platform currently hosts more than 3000 virtual machines (VMs). While a lot of work has already been done to actively monitor STFC resources, this is not currently applied at the user level, leaving scientists unaware of the environment consequences of their VM usage.

In support of STFC's Environmental Sustainability Strategy 2025-2030 and its commitment to the UKRI target of Net-Zero Digital Research Infrastructure (DRI) by 2050, this project develops a pipeline to assess the energy usage of VMs and report carbon emissions to users. The work aligns with the UK DRI Net-Zero Roadmap by contributing to Usage Metrics (Roadmap Action 14), through analysis of historical and current hypervisor power consumption data to inform power monitoring approaches and technical standards. It further aligns to Emissions Tracking (Roadmap Action 21) via the development of a VM carbon emissions calculator. By translating infrastructure measurements into actionable information for users, the project targets a gap between system monitoring and researcher awareness. Reporting carbon emissions data to users is intended to encourage awareness into best practice and change behaviour, supporting sustainable digital transformation and toward a net-zero DRI. Here I will summarise the progress of this project, including the challenges in mapping hypervisor power consumption to VM resource allocation.

4. Measuring and Effectively Using Emissions Data Across DRI: A Dynamic Training Resource for Managers, Developers, Facilitators, Researchers and Users

Sarah Hanrahan¹, Jessica Huntley², David McDonagh²

Affiliations:

¹ Hartree Centre, STFC

² Scientific Computing Department, STFC

Many organisations have targets to achieve net zero greenhouse gas emissions, and to reduce their environmental impact. Compute resources are both energy and water intensive, and data centres have negative impacts on the environments they are built in. Therefore, it is crucial that we use compute resources as efficiently and responsibly as possible.

There is a consensus in the sustainable computing community that measuring the energy (and therefore emissions) of computing is vital to know where to make the biggest impact, and for carbon budgeting. Despite this, this goal is far from being realised as there is a lack of tangible information for stakeholders. Many users are unaware of the environmental costs of their work or how to reduce their environmental impact. If they have the information, it can be unclear how it should be used. For developers and facilitators, it can be unclear which tools they should deploy for monitoring emissions, or if it would be a valuable use of their time. For researchers, it can be unclear if calculating emissions is valued by grant funders and what is expected in journal articles.

Through this project, we aim to provide targeted, practical information to facilitate change, and consolidate resources that are spread over multiple networks and forums. This will be achieved by developing a series of training modules explaining the current state of emissions monitoring for developers, managers, facilitators, and users, as well as providing a dynamic resource that the community can continue to update. This addresses the UK DRI Net Zero Roadmap actions 13 and 19, which focus on provision of training. We will build on current work within STFC's Scientific Computing Department, where projects have focused on monitoring carbon emissions in different contexts, and plan to engage with the wider community to gather additional information and feedback.

5. Co-Designing Digital Sufficiency for Sustainable DRI

Oliver Bates¹, Marcia Smith¹, Kate Wright², Carolynne Lord², Kelly Widdicks²

Affiliations:

¹ Lancaster University

² UK Centre for Ecology & Hydrology (UKCEH)

'Reimagining digital research infrastructure (DRI) in environmental science for a sustainable future' is a project asking scientists what is sufficient or "just enough" digital technology, data, and tools for DRI. Building on sufficiency transitions (Sandberg, 2021) and rebound effects in digital innovation and policy (Widdicks et al., 2023), we present digital sufficiency for reducing the negative environmental impacts of DRI by exploring five key questions:

1. What absolute reductions of volumes and amounts of DRI can be made that still support science effectively?
2. What shifts in the modes of doing research speak to doing “just enough”?
3. Where can the lives of DRI hardware, software, and the digital objects it serves (e.g., data, models) be extended beyond current norms?
4. What sharing practices and communities support sufficiency in action?
5. How can we remain conscious of rebound effects and unforeseen consequences?

To understand how digital sufficiency can be applied to DRI we explored the five areas through co-design workshops and design research – considering what futures of digital sufficiency in DRI can look like in terms of the day-to-day operations, policies, and strategic decision making for a research centre as an organisational case study.

We present a range of prototype tools for digital sufficiency grounded in workshops with researchers, practitioners, and leadership. These tools help map digital excess, consider what things are worth keeping, harness seeds of where sufficiency is already being pioneered, and design new policy and action plans for sufficient DRI.

We speak to the NetDrive Roadmap by contributing: 1) a novel approach for designing facility and research centre action plans; and 2) behaviour change interventions to reduce negative environmental impacts across a range of stakeholders (researchers, policy makers, funders, practitioners, and leadership) and operations (funding, procurement, project management, policy development, data management, scheduling, research).

6. Carbon Monitoring for Scientific Virtual Research Environments on the Ada Platform

Ashraf Hussain¹, Jessica Huntley²

Affiliations:

¹ STFC Daresbury Laboratory

² STFC Rutherford Appleton Laboratory

The Ada platform, operated by STFC at the Rutherford Appleton Laboratory, provides virtualised compute environments for researchers across ISIS, CLF, and Diamond Light Source. While such infrastructure offers flexibility, it obscures the energy and carbon costs of individual research activities, limiting the ability of researchers and operators to make informed decisions about sustainable resource usage. We present a carbon monitoring system for Ada that attributes energy consumption and CO₂ emissions to individual users and workspaces in near real-time. The system integrates Prometheus for CPU utilisation metrics, the UK Carbon Intensity API for half-hourly grid carbon intensity data, and Ada’s MongoDB for workspace-to-user attribution. Electricity consumption is estimated from CPU busy and idle time using empirically-derived power coefficients, and carbon emissions are calculated by combining this with contemporaneous grid intensity values. To make carbon data

actionable for researchers, the system includes an equivalency calculator translating emissions into relatable comparisons — smartphone charges, miles driven, hours of streaming — sourced from EPA and DEFRA conversion factors. Interactive Svelte-based visualisations provide stacked bar charts, GitHub-style heatmaps for longitudinal usage patterns, and per-workspace summary cards. A Carbon Intensity Forecast widget identifies the lowest-carbon time windows, enabling time-shifting of flexible workloads. This work directly supports the UK DRI Net Zero Roadmap’s priorities for embedding carbon awareness into digital research infrastructure. By providing per-user carbon attribution at the platform level, it delivers the granular measurement and reporting necessary for evidence-based emissions reduction across UKRI’s compute estate. The time-shifting capability aligns with the Roadmap’s emphasis on flexible infrastructure operations responsive to grid carbon intensity, while the generalisable, low-overhead approach offers a practical model for the standardised carbon accounting frameworks the Roadmap calls for.

7. CATS: a carbon-aware task scheduler

Sadie L. Bartholomew¹, Lincoln Colling², Abhishek Dasgupta³, Anthony J. Greenberg⁴, Loïc Lannelongue⁵, Thibault Lestang⁶, Carlos Martinez-Ortiz⁷, Colin Sauzé⁸, Andrew M. Walker³, Adam Stuart Ward⁸

Affiliations:

¹	National	Centre	for	Atmospheric	Science
²		University		of	Sussex
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⁴	Bayesic	Research,		Ithaca,	USA
⁵		University		of	Cambridge
⁶	CNRM,	Université		de	Toulouse
⁷	Netherlands			eScience	Center

⁸ National Oceanography Centre

Reducing energy consumption is vital for sustainable computing, but the carbon cost of a given workload also depends on the electricity grid’s carbon intensity at the time of use. Running computational jobs when carbon intensity is lower, typically during periods of higher renewable generation, can therefore reduce environmental impact for a set amount of energy use.

This principle led to the creation of CATS (Climate-Aware Task Scheduler) at the 2023 Hack Day of the Software Sustainability Institute (SSI) Collaborations Workshop. CATS is a lightweight Python package that schedules tasks based on real-time carbon intensity data from the relevant electricity grid.

Supported further by the SSI, we have continued development and released Version 1.0, which integrates with the Unix at command for small-scale local tasks, in mid 2024, and now

we are finalising a Version 2.0 for integration with the Slurm workload manager, targeting batch computing and high-performance computing (HPC) environments.

In this poster, we introduce CATS and demonstrate its use locally and on a SLURM-based cluster using Docker. We discuss our aspirations to work with system administrators at volunteer centres to incorporate CATS Version 2 into key UK HPC systems to provide users with the option to intelligently time shift their jobs through use of a 'green' queue.

At present CATS only interfaces with the UK's National Grid ESO API, but we are scoping for suitable APIs that can enable use of CATS elsewhere across the world, and we encourage ideas from the international audience to help with this.

Given HPC's substantial power demands, carbon-aware scheduling offers a practical mitigation strategy. By shifting workloads in time using CATS, users can reduce carbon impact without modifying code or reducing compute, requiring only a simple command-line wrapper around existing jobs.

8. Scientific Sovereignty and the Compute Gap: A Mission-Oriented Policy Framework for Net Zero DRI

Debaarjun

Dasgupta¹

Affiliations:

¹ University of Birmingham

The UK DRI Net Zero Roadmap is the bedrock of this poster. It covers the policy, governance, and supply chain barriers to sustainable digital research infrastructure. Government already treats compute access as a security and competitiveness issue: the "compute gap." But the UK grid has limited room left. Ofgem's connection queue rose from 41 GW to 125 GW between November 2024 and June 2025, against a national peak demand of just 45 GW. About 50 GW of that queue is data centre projects, and only around 20 GW have reached Final Investment Decision. This is not abstract: a £2bn Essex data centre with planning permission, Nvidia backing, and Microsoft as anchor tenant still has no grid connection date, because National Grid cannot connect it in time.

The supply chain makes this worse. Most UK research compute is fabricated by TSMC in Taiwan, which used about 101 billion litres of water in 2023 and draws over 6% of Taiwan's electricity. Fabrication is the most water- and carbon-intensive stage of the chip production process, and UK carbon accounting usually books it as Scope 3, that is to say, someone else's responsibility. Our modelling on a representative UK DRI archetype (IRIS/IRISCAST, baselined at ~2,100 tCO₂/yr) shows why this matters: under business-as-usual, embodied Scope 3 hardware emissions overtake Scope 2 electricity by 2032 and reach 85% of total emissions by 2040. The grid gets cleaner, but a growing hardware estate with under 8%/yr demand growth pushes total emissions back to roughly 2024 levels (2.12 ktCO₂/yr) by 2040. This is the Jevons paradox in DRI: more efficient GPUs cut energy per FLOP, but AI workload growth outpaces the savings.

We propose a mission-oriented procurement framework for UKRI. Funded facilities would report on embodied and operational emissions in accordance with the GHG Protocol ICT Sector Guidance, and non-disclosure would disqualify a tender. The procurement would require renewable power purchase agreements, demand-response clauses, a minimum 7-year hardware lifetime (up from 5), and a 20% reduction in embodied emissions per unit supplied. Under this "Mission" pathway, our modelling shows total emissions falling to 0.54 ktCO₂/yr by 2030 (a 65% cut versus business-as-usual) and 0.48 ktCO₂/yr by 2040 (a 77% cut). That clears the ITU-T L.1470 1.5°C benchmark of a 45% cut by 2030. Business-as-usual only reaches 26%.

This also solidifies the sovereignty argument. Moving compute to foreign low-carbon cloud providers lowers territorial emissions on paper but deepens dependence on infrastructure the UK doesn't control. Mission-oriented procurement keeps compute domestic while cutting emissions, thereby avoiding the trade-off. The poster closes with recommendations for coordination between UKRI, EU research councils, and the US NSF on shared low-carbon manufacturing standards, and for involving early-career researchers in DRI governance now.

9. Organising Sustainable Digital Transitions: A Layered Reference Architecture for Managing Impacts of Data Analytics in Health Systems and Measuring Health Outcomes of Corporate Transitions

Natalia Efremova¹, Dimitrij Euler², Kristin Kostka³, Jennifer Lane¹, Dennis West⁴
Affiliations:

¹ Queen Mary University of London

² Greenings Association

³ University of Oxford

⁴ Saïd Business School, Oxford Net Zero

Since the COVID-19 pandemic, the interdependence between business organizations and health systems has become structurally visible (1). At the same time, the UKRI Net Zero Digital Research Infrastructure (DRI) Roadmap calls for coordinated decarbonisation of digital systems underpinning research. Yet no shared framework exists to assess the environmental footprint of data-intensive health research alongside its broader value.

This project expands health data science for the acceleration of a net-zero digital research infrastructure. We propose a layered reference architecture that aligns federated health analytics, computational monitoring, and impact valuation as corporations transition to net zero.

This architecture comprises three integrated components. First, a standardised data layer utilizes the Observational Medical Outcomes Partnership (OMOP) Common Data Model within the Observational Health Data Sciences and Informatics (OHDSI) network. By enabling distributed execution rather than central warehousing, this model preserves patient privacy, reduces duplication and avoids excess computation (2), demonstrating how scalable analytics can operate within a lower-impact digital footprint. Second, analytics monitoring layer

Together, these layers form an interoperable framework connecting federated analytics, environmental accountability, and corporate transition strategy. We demonstrate how embedded sustainability as an architectural property of digital research systems can move beyond a mere external reporting exercise.

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Affiliations:

Data centres require land for construction and development, this can result in habitat loss and/or fragmentation. This in turn can lead to a reduction in wildlife and biodiversity. Careful planning can however reduce and potentially reverse this, allowing data centres to contribute to the Nature Positive goal of halting or reversing nature loss by 2030 [1].

The ACF site has a wetland area, areas of species rich grasslands and formal planting areas. The machine rooms have been built around a historic tree roundel and the site is bounded by woodland areas.

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Computer room four is currently being extended to accommodate the next national supercomputing service and biodiversity is a key consideration. The wetland area will remain untouched, while an orchard will be added, as will areas of wildflowers. Hedgehog friendly gaps will be left in security fences to provide wildlife friendly corridors across site.

This poster will present these and other biodiversity initiatives at the ACF.

11. An Environmental Assessment of Computing Services in Higher Education

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⁴ Indian Institute of Technology (BHU) Varanasi, working with the University of Manchester through the Google Summer of Code Program, 2025

Progress in engineering, physics, and data science increasingly depends on powerful computing infrastructure, from personal workstations to high-performance nodes. However, the environmental impacts across its full life cycle are often overlooked. This study evaluates the energy and resource efficiency of computing hardware and software within the Faculty of Science and Engineering (FSE) at the University of Manchester, supporting the university's Zero Direct Carbon Emissions (scope 1 and 2) by 2038 and Net Zero emissions (scope 3) by 2050 targets.

The study, performed by PDRAs, PhD students supervised by a dRTP and academics, combines life cycle assessment (LCA), hardware usage audits, and software energy profiling to compare three main computing setups: i) desktop computers with screens, ii) laptops and iii) high-throughput computing cluster nodes. System boundaries include component production and operational phases, analyzed with LCA software across 15-year scenarios.

Specialised compute nodes dominate most impact categories, particularly manufacturing-driven ones. Embodied impacts from material extraction, steel production, electronic circuits, and display components exceed operational electricity use across most indicators, highlighting manufacturing's growing importance despite grid decarbonisation. Sensitivity analyses show replacement strategies strongly influence outcomes, underscoring demand management and procurement policies' importance in reducing academic computing's environmental footprint.

This study aligns with the UK DRI Net Zero Roadmap by addressing facility-level carbon accounting including embodied emissions (Action #2) and evidence-based procurement

policy (Action #10), supporting the roadmap's emphasis on Scope 3 emissions and sustainable supply chains.

We intend to build bridges between environmental impact assessment of DRI and academic research, ensuring NetDRIVE tools and outputs are useful for research-intensive higher education institutions with large on-site compute clusters.

12. SMART-DRI: Scenario Modelling and Assessment for Research Transition in Digital Research Infrastructure

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Digital Research Infrastructures (DRIs), including high-performance computing clusters and large-scale data platforms, are essential for modern scientific discovery but are also rapidly growing sources of energy consumption and carbon emissions within universities and research institutions. As the UK research community advances towards net-zero commitments, the UK DRI Net Zero Roadmap[1] emphasises the need to better understand and monitor the carbon impacts of digital research infrastructure, develop tools and strategies to reduce emissions from computing and data operations, and implement technical changes that enable more sustainable use of digital infrastructure. In response to this need, SMART-DRI (Scenario Modelling and Assessment for Research Transition in Digital Research Infrastructure) develops data-driven tools and analytical methods to support sustainable digital research operations. The project integrates heterogeneous operational and environmental datasets, including cluster utilisation, power consumption, electricity prices, and carbon intensity, into a unified framework that enables evidence-based decision-making for DRI operators. Building on this foundation, SMART-DRI develops an innovative green scheduling approach that dynamically optimise computational workloads based on carbon intensity forecasts, electricity prices, and system conditions. The methodology combines optimisation techniques, including model predictive control and game-theoretic methods, with algorithmic scheduling strategies implemented in existing open-source HPC software, enabling practical deployment in real-world research computing environments. In parallel, the project investigates how DRIs can contribute to electricity system flexibility by shifting workloads in response to grid conditions and evaluates the associated environmental and economic benefits through scenario modelling. The project will deliver an open-access dataset, a novel green scheduling method and implementation, and guidance for integrating environmental metrics into DRI operations. By linking operational data, open digital research infrastructure practices, green scheduling, and energy-system interaction, SMART-DRI directly responds to priorities identified in the UK DRI Net Zero Roadmap[1] and provides practical tools and case-study evidence to support sustainable and net-zero digital research infrastructure.

13. Finding Synergies Between the ENSURE (Environmentally Sustainable Digital Services and Practices for Research Infrastructures in Europe) Project and NetDRIVE

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³ Rutherford Appleton Lab (RAL)

The digital transformation of science relies on large-scale Research Infrastructures (RIs) that process unprecedented data volumes, yet their environmental footprint-measured in energy, water, and carbon-is rapidly increasing. The ENSURE project (ENvironmentally SUstainable digital services and practices for REsearch infrastructures) addresses this, following the 4M cycle (Measure, Model, Monitor, Moderate), and raising environmental sustainability from an ad-hoc concern to a managed process to be co-designed with European Research Infrastructures.

ENSURE will develop a suite of open-access tools, including a modular impact assessment framework, a maturity-based certification programme, and digital twins for data centre simulation. A key technical result is the extension of environmental-aware workload management systems, enabling "green-aware" scheduling across federated compute resources. Co-designed and validated by major ESFRI landmarks such as High Luminosity LHC, the Square Kilometer Array, and the European XFEL, ENSURE will collect metrics and methodologies necessary to align European digital science with the Green Deal objectives, ensuring that scientific excellence is achieved without compromising climate neutrality.

Since ENSURE's planned project start is September 2026, we want to take the opportunity of presenting our plans, from both the wider project and the UK side, to the NetDRIVE community. This will allow us to find synergies between this upcoming work and the Community projects (especially in Topics 1a, 1b, 1c, 2a, 2b and 2e), as well as connecting with the NetDRIVE Champions. This will allow ENSURE to align with the UK DRI Net Zero Roadmap, and for the work to proceed in sync while maintaining the individual identities and goals of the projects. Following previous poster presentations with a similar purpose, the poster will include an open "interactive" section with post-its for feedback and networking purposes.

14. Finding synergies between the ENSURE (ENvironmentally SUstainable digital services and practices for REsearch infrastructures in Europe) project and NetDRIVE

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Appendix 4: Survey Questions and Results

NetDRIVE Community Meeting, Oxford — April 2026

This annex sets out the Mentimeter survey questions and results referenced in the Breakout and Plenary Discussions section of the main report, provided here for reference and clarity. Survey questions are given in full, together with the results captured at the meeting.

Session 1: How Do We View Net Zero?

Participants were invited to identify the framing they most closely held, consider the evidence behind it, and explore promising pathways and contrasting views.

Q: Which net zero framing do you identify with? (18 respondents)

Framing	Votes
Tech optimist	5
Restraint optimist	7
Adaptation optimist	3
Culture change optimist	7
Pessimist	7
Fatalist	3

Note: participants could select more than one framing, so totals exceed the number of respondents.

Q: What is the key evidence behind your response? (open responses, 16 respondents)

- Smart grids, dispatchable renewables, and a digital infrastructure transition will help, but we need to counter this promising tech with safety measures (such as cybersecurity, system stability).
- Technologies will evolve when facing new challenges.
- Scientists are clever.
- Optimisation and operational efficiency helps.
- Solutions exist, generally with huge co-benefits for society, but there is no political or economical willingness to follow them.
- Resource usage restraints possible but rebound effect needs tackling.
- Cleaner air, quieter streets encourages new ways of living; combatting overconsumption; increased equity and decentralisation of power; democratisation of infrastructure.
- This has been rumbling around for 30+ years and doesn't really seem to have got any better.

- Shifting blames on the Global South.
- Modern history.
- Cultural change is slow; political will favours economic growth rather than sustainability.
- History; AMOC collapse.
- We can make culture change — but it will have both benefits and downsides (and humans don't like change until they have got used to it).
- It has got better — but we have not finished the job yet.
- I have days of fear and pessimism, but that doesn't help us act.
- People are resourceful.
- Education.

Session 2a: Towards Flexibility in DRI Service Provision

Briefing questions:

- How should the DRI approach the Government requests flexibility in power usage and associated financial incentives?
- What would the implications be for users and operators of DRI services if capacity was reduced during periods of high carbon cost?

Q: What should DRI prioritise when demand flexibility is requested or encouraged?

Minimize cost impacts	Protect service quality	Reduce power consumption	Equity and fairness
7%	20%	60%	13%

Q: How strongly do you agree with these statements about reducing capacity during high carbon-cost periods?

Scale: 0 (strongly disagree) to 10 (strongly agree)

Statement	Mean score
It would improve overall system sustainability.	7.6
It would create acceptable disruption for users.	7.2
It would be operationally manageable for operators.	5.9
It would be worth the financial trade-offs.	7.2
It would require clear communication in advance.	9.3

Q: What specific actions for flexibility should we prioritise? (open responses, 9/15 participants, 22 comments)

- Technical tools (4 responses) — scheduler plugins, value-stack approaches (avoided transformer reinforcement costs, connection approval speed, time-of-use savings, arbitrage), infrastructure to manage demand spikes.
- Commercial engagement (4 responses) — building connections with commercial actors and DNOs, laying groundwork for time-of-use acceptance, understanding evidence requirements for flexibility.
- User behaviour (4 responses) — user-first rather than top-down approaches; measuring baseline consumption; challenging the treatment of cloud/HPC as infinite resources; discouraging 'speculative' test jobs.
- Service delays (4 responses) — increasing acceptance of scheduling delays and day-ahead markets; understanding allowable parameters (job speed, unavailability, scheduling delay, unpredictability); shifting jobs to lower-demand locations.
- Equity and fairness (3 responses) — curtailing/deprioritising heavier users; extending equity considerations to global-South impacts of over-use.
- Spatial analysis (3 responses) — investigating overlap between flexibility tenders and compute clusters; cost/benefit case studies (e.g. SMART-DRI); service-wise feasibility studies for acceptable flexibility.

Session 2b: Empowering the Future (Early Career Researchers)

Briefing questions:

- Are young researchers better placed to understand digital and societal transformations?
- Do they spot opportunities to use these changes for sustainability transformation?
- What practical steps can NetDRIVE, universities, DRI facilities, and UKRI take?

Q: How strongly do you agree with these statements?

Scale: 0 (strongly disagree) to 10 (strongly agree)

Statement	Mean score
Young researchers are better placed to understand digital transformation.	7.3
Young researchers are better placed to understand societal transformation.	7.4
Young researchers are more likely to spot sustainability opportunities.	7.2
Young researchers can help translate ideas into action.	7.8

Q: What should NetDRIVE, institutions, DRI facilities, or UKRI do next? (open responses, 8/19 participants, 10 comments)

- More funding opportunities for early career researchers.
- Set carbon budgets aligned with funders to drive carbon footprint reduction.
- Improve communication to get more researchers involved (explaining projects, speaking to labs).
- Help find pathways beyond NetDRIVE to encourage ECRs to continue this work.
- Emphasise carbon impact in research; help report carbon emissions for research.
- Organise events targeting how to write projects for NetDRIVE scoping aims and goals.
- Advocate for space and opportunities for ECRs to continue net zero work for DRI.
- Carbon accounting at the same level as financial accounting in all activities.
- More opportunities for ECRs to present at meetings.

Q: Which of these statements most closely represent the challenges that limit early-career opportunities to shape digital transformation decisions? (votes, out of up to 19 participants)

Challenge	Votes
Funding, incentives, and institutional priorities	11
Time, workload, and competing priorities	11
Limited influence in decision-making	11
Job insecurity and short-term contracts	10
Hierarchy, exclusion, and lack of support or mentoring	9
Skills, confidence, or knowledge gaps to influence change	8

Q: Which next step should we prioritise first?

Funding	Collaboration	Mentoring	Training	Organisational change	Access to tools
77%	46%	38%	38%	38%	15%

Session 3: Net Zero Scenarios (Plenary)

Note: the thematic groupings for the open-response questions below were generated by an AI clustering tool during the live session. Martin Juckes and Sarah Sparrow have flagged that these groupings require manual review and revision before they are finalised — see comments on the working draft. The groupings are presented here as captured on the day, pending that review.

Q: Distribute 100 points across the following external factors that could define scenarios by importance

Factor	Points
Decarbonisation of the national power supply	45
Decarbonisation of the IT supply chain	27
Effective, non-disruptive approaches to constraining user demand	18
Availability of credible offsetting options	10

Q: How likely and impactful will each of these factors be between now and 2040?

Presented as a likelihood/impact matrix. Approximate positioning of the four factors:

- Power sector decarbonisation — high impact, high likelihood.
- IT supply chain decarbonisation — high impact, moderate likelihood.
- Demand reduction — high impact, moderate-to-low likelihood.
- Offsetting — low impact, moderate likelihood.

Q: What other factors should we consider? (22/32 participants, 37 comments)

- Technological innovation (9) — disruptive net-zero innovation across digital and energy sectors; reuse/recycling of obsolete tech; continuity of Moore's Law; small modular reactors; industry collaboration; EV adoption.
- Resource availability (6) — hardware resource availability and geopolitical robustness; temperature-driven cooling demand; data-vs-material resource competition as AI grows; sufficiency mindset.
- Political factors (5) — geopolitics; political support for net zero across the spectrum; regulation within planetary boundaries; factors increasing demand in some areas even as it falls in others.
- Economic considerations (5) — economics and cost of renewables; rebound effects; how different economic models might enable or hinder progress; shifting mindset away from efficiency alone.
- Awareness and education (4) — public awareness and misinformation; engagement with the wider sustainability community; getting people to care.
- Infrastructure disruption (3) — disruption of infrastructure and funding; right to repair; moving away from proprietary platforms to extend digital infrastructure lifespan.
- Leadership (3) — need for new leadership and fairness; leadership that moves beyond technical solutions and 'data-ism'.
- User behaviour (2) — influencing and understanding external drivers of user behaviour.

Q: What are the possible outcomes within different communities? (16/32 participants, 25 comments)

- Community polarisation (6) — highly variable outcomes across communities; risk of disillusionment among ECRs and researchers in developing economies if restraint is over-relied upon; risk of polarisation within the DRI community; possibility of more joined-up, cooperative research communities.
- Sustainability integration (5) — carbon estimates and budgets built into standard grant cycles; flexible, integrated data centres supporting district heating; sustainability becoming integral to researcher and RTP roles.
- Behaviour change (5) — ranges from 'business as usual'/no change through to genuine change dependent on incentives, including removing the implicit assumption of infinite resource availability.
- Academic funding (4) — risk of fewer academic jobs and reduced funding, set against the case for properly costing DRI into research grants.
- Technology solutions (3) — low-emission solutions from technology; better remote/hybrid conferencing; risk that academic-developed solutions are simply adopted by big tech.
- Energy costs (2) — rising energy/hardware costs driving efficiency; continued reliance on fossil fuels increasing price volatility.

Q: What significant risks do we need to plan for? (21/32 participants, 37 comments)

- Climate policy (9) — shifting UKRI net zero goalposts; net zero seen as insufficient on its own; too many decision-making bodies pursuing 'endless growth'; risk of slow-walking decarbonisation of the grid.
- Political instability (9) — lack of political will to regulate; geopolitical conflict; UK political change reversing existing incentives; inability to measure project outcomes; over-zealous security policy hampering equipment reuse.
- Energy supply (6) — grid failing to reach 100% renewable; generative AI energy demand outweighing efficiency savings elsewhere; cybersecurity risk to smart grids; price shocks and blackouts.
- Resource scarcity (4) — HE demand collapse reducing student numbers and academic jobs; under-investment or misallocation of resources; hardware scarcity for DRI and wider academic research.
- Supply chain (2) — disruption from geopolitics or natural causes.
- Reputation risk (3) — reliance on offsets that may later be disallowed or seen as reputationally damaging; risk to academia's reputation and influence if UKRI fails to act.
- Extreme weather (2) — power supply disruption; extreme temperatures already exceeding the thresholds used in building design modelling (XMYs).
- Fossil fuels (2) — increasing global extraction and use; fossil fuel lobbying turning net zero into a greenwashing exercise.

Q: What are the key scenarios we should consider? (11/32 participants, 15 comments)

- Decarbonisation scenarios (4) — integrating scientific innovation with nature-based solutions; a Dynamic Adaptive Policy Pathway approach (per the Decision Making under Deep Uncertainty community); partial decarbonisation alongside rapid AI growth; a rapid, best-case decarbonisation scenario.
- Climate targets (5) — targets being missed vs. a 50% reduction by 2030 (UKRI interim target); sustainability becoming integral to research operations; a worst-case 'proceeding rapidly towards climate disaster' scenario.
- Policy changes (3) — a high-demand/low-control stress case; political shift away from net zero (e.g. driven by a change in governing party); a scenario of UK/US governmental reversal on climate policy.
- Geopolitical factors (2) — supply chain disruption and geopolitical shifts; the impact of a wartime economy.
- AI development (1) — collapse of the generative AI business case and a public shift back toward human-created content, freeing capacity for non-generative AI DRI use.

Appendix 5: Feedback on the Event

A post-event survey was circulated to all 47 attendees. Twelve responses were received (26% response rate). Summary results are presented below.

Headline figures

Element	Rating (out of 5)	Notes
Overall rating	4.5	
Networking	4.83	Highest-rated element
Organisation	4.67	
Keynote presentations	4.7	
Poster display	4.8	
Breakout sessions	4.5	
Plenary discussion	4.5	
Pre-event communications	4.6	
Timing and pacing	4.7	
Breakout contribution	4.6	
Relevance to work	4.3	
Online participation	4.0	<i>Lowest-rated element (n=4); expected for a primarily in-person event</i>
Would recommend to colleagues	100%	75% definitely, 25% probably

Most valuable elements (open responses): Networking and meeting people; Breakout discussions; Cross-project connections; Keynote presentations.

What participants said

Selected open responses from the post-event survey:

On the most valuable aspect: “Meeting other researchers involved in community projects — to see how each project could have cross-talk with the others and where they could collaborate. Also the two keynotes were very interesting to set the scene.”

Early career attendee: “The people. Really. It is a humbling experience to see full time researchers who devote so much time into helping ECRs find a footing in the market.”

On the poster session: “We found another project using some of the work we did! The poster session was quite useful — a structured explanation of the work.”

On networking: “It provides a brilliant opportunity for different community project teams to communicate their ideas, progress, and results towards the net zero DRI target.”

On programme content: “The programme was so useful for me to create my own project within the net zero landscape.”

Overall: “The event was amazing — everything was smooth and well-organised.”