Transformation Pathways Weds 1 July 2026

The Science Museum, London

DICE NETWORK+
DIGITAL INNOVATION & CIRCULAR ECONOMY

UKRI Engineering and Physical Sciences Research Council
University of Exeter
The University of Nottingham
The Open University
Queen's University Belfast
University of Salford Manchester
University of Sheffield
University of Southampton
University of Surrey
Swansea University Prifysgol Abertawe

Agenda

09:30	Registration and coffee
10:00	**Welcome** **Keynote: Adam Elman**, Head of Sustainability EMEA, Google, *Circularity at Google* **Panel discussion:** *Systems Drivers and Strategic Direction*
11.35	Break
11:55	**Interactive session**: *Wider Context & Future Outlook*
12:30	Networking Lunch
13:20	**Keynote: Lisa Rivalin**, Senior Staff Engineer, Meta, *From Measurement to Circularity: Standardizing Carbon Data for Datacenter Hardware Reuse* **Interactive session**: *Frontier Technology & Circularity*
14:30	Break
14:45	**Lightning Rounds** **Panel discussion**: *Building Scalable Circular Solutions* **Key Insights & Actions** **Closing Comments**
16:00	Close: networking until 16:45

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DIGITAL INNOVATION
& CIRCULAR ECONOMY

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DIGITAL INNOVATION & CIRCULAR ECONOMY

Welcome

Professor Fiona Charnley
DICE Network+ Lead
Co-Director of the Exeter Centre for the Circular Economy

Engineering and Physical Sciences Research Council
University of Exeter
The University of Nottingham
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University of Salford Manchester
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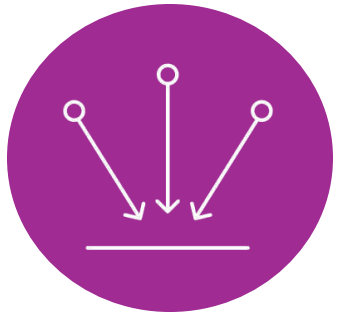
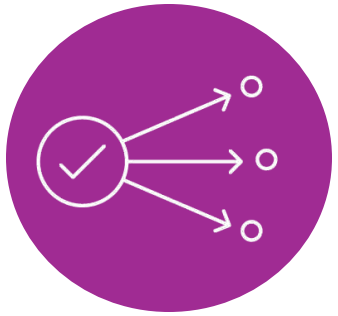
Digital Innovation & the Circular Economy

CHALLENGE AREAS



Embed

Embedding sustainability & circularity within the design & development of digital & communication technologies.



Enable

Realising the potential of the digital revolution to enable a circular economy across sectors.

DICE NETWORK+ DIGITAL INNOVATION & CIRCULAR ECONOMY

UKRI Engineering and Physical Sciences Research Council

THE ROLE OF DICE N+

DICE N+ accelerates circular economy adoption by generating insights, funding innovation, & translating research into practical solutions.

Our Network of Networks

We connect & convene communities.

Our key pillars of activity:

1. INSIGHT & EVIDENCE
2. CAPACITY BUILDING & KNOWLEDGE EXCHANGE
3. RESEARCH, IMPACT & LEGACY
4. INCLUSIVE COMMUNITY

Our progress

DICE NETWORK+

INSIGHT & EVIDENCE

300+ Accessed the Data Centre Policy Brief

- Convened 30+ stakeholders in Data Centre collaborative
- Produced 27 knowledge outputs, including case studies & thought leadership

CAPACITY BUILDING & KNOWLEDGE EXCHANGE

55+ ECR Community Members

- Engaged with 380+ partners & 20+ networks
- 80+ audience at Data Centre World panel discussion
- Launched Digital Traceability Working Group

RESEARCH, IMPACT & LEGACY

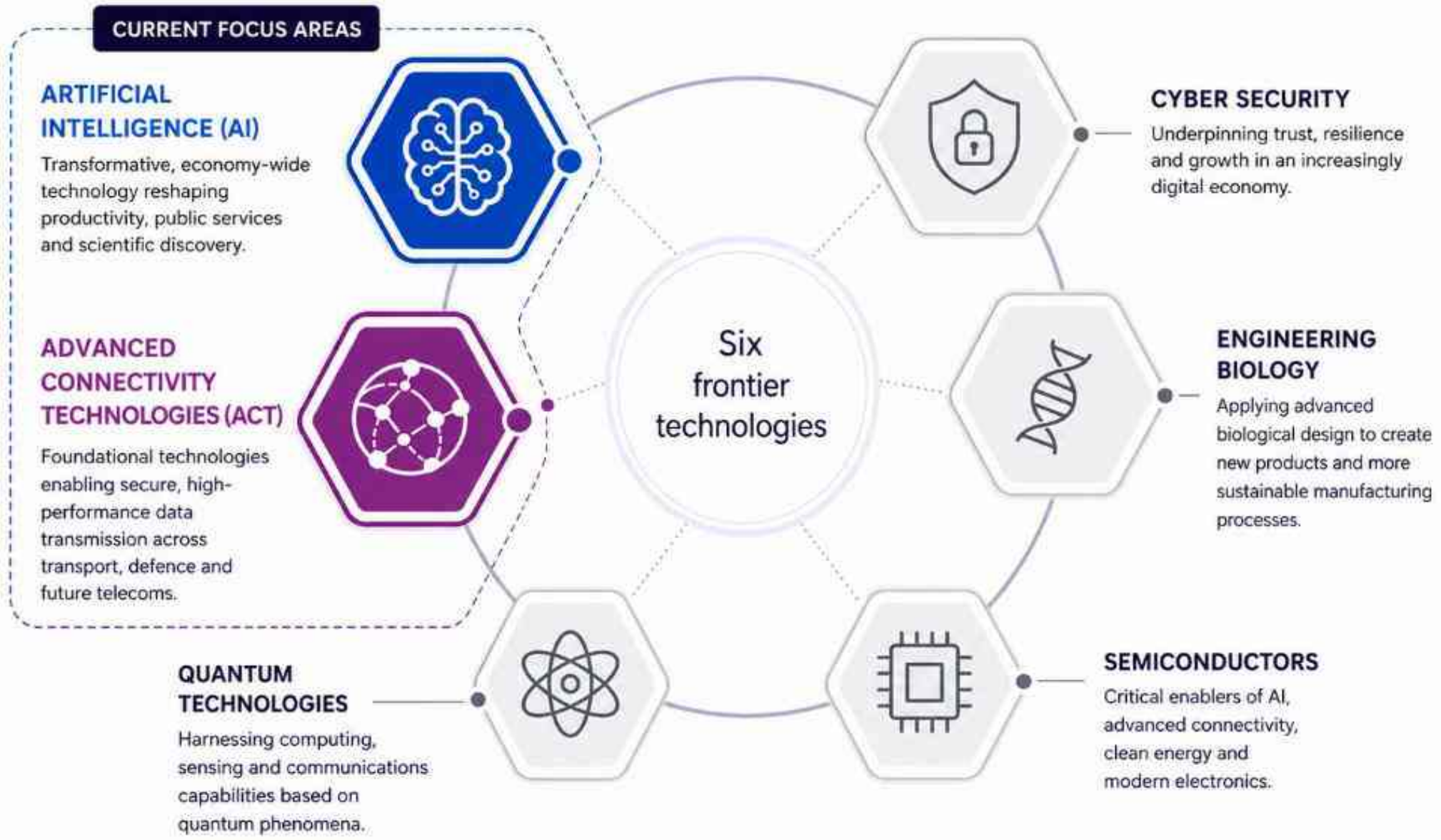
£435K+ Flex Funds awarded

- 17 active high-impact research projects with industry collaboration for real-world impact
- Informing policy through Government Buying Standards and APPG for Data Centres

INCLUSIVE COMMUNITY

Underpinning all activity, we build and coordinate an inclusive DICE Network+ community to enable and empower collaboration across diverse user groups

A focus on Frontier Technologies



AI & the demand for Data Centres

The deep dive explored **how to transition the data centre sector to a circular economy framework**.

- Convened experts from across the value chain
- Held a panel discussion at Data Centre World, March 2026
- Had findings referenced in the APPG for Data Centres Inaugural Insights

Identified 3 strategic levers to unlock circularity which will shape our discussions here today:

- Design for value retention
- Operate for maximum recovery
- Collaborate for systems change

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UKRI Engineering and Physical Sciences Research Council

Moving into Advanced Connectivity Technologies

Launching this month, our second deep dive will focus on the Telecoms and Space sectors

Data Centres **Advanced Connectivity (Telecoms & Space)**

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Keynote: Circularity at Google

Adam Elman

Head of Sustainability EMEA

Google

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Circularity at Google

DICE N+ Transformation Pathways

Adam Elman: Director, Sustainability EMEA

Google

Our Sustainability Strategy

Our Operations

Driving sustainability across our operations by advancing energy and accelerating resource efficiency

- Net Zero and Carbon Removals
- Efficiency and 24/7 carbon-free energy
- Water replenishment
- Data center Zero Waste to Landfill
- Circularity of Materials

Our Products

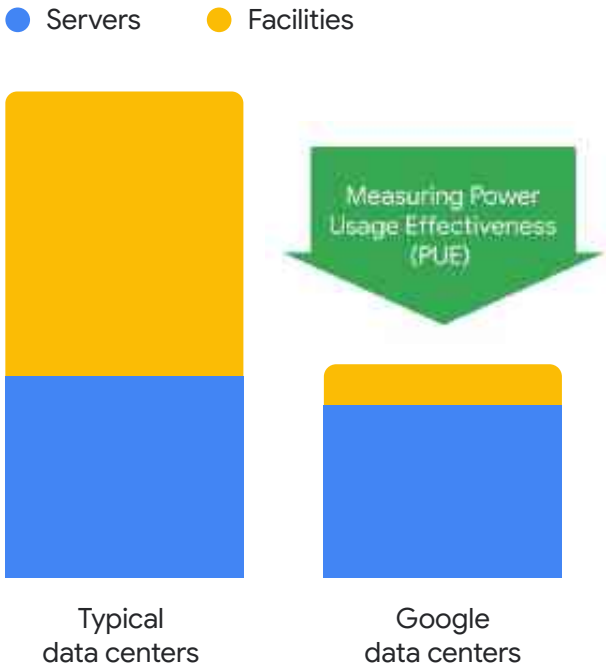
Empowering people with information to mitigate and adapt to climate change leveraging Google's unique capabilities

- AI for climate mitigation
- AI to ensure no one is surprised by a natural disaster
- AI to help people and nature flourish together
- AI for circularity

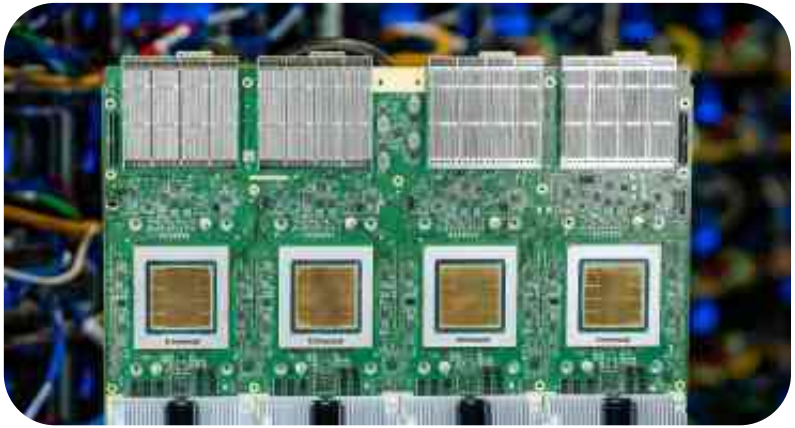
Google

Energy Efficiency

6X more computing power than data centers from 5 years ago with the same amount of electrical power



Google



Efficient Hardware

Ironwood, our seventh-generation TPU, is **30x** more power efficient than the first Cloud TPU from 2018

Efficient Models

In one year, Gemini's energy and carbon footprint efficiency improved by **33x** and **44x** respectively—making a single prompt more efficient than 9 seconds of television

Google

Clean energy procurement

Google is one of the largest corporate purchasers of clean energy with **agreements** to purchase over **35 GW** of clean energy generation and a roadmap towards **24/7 CFE**

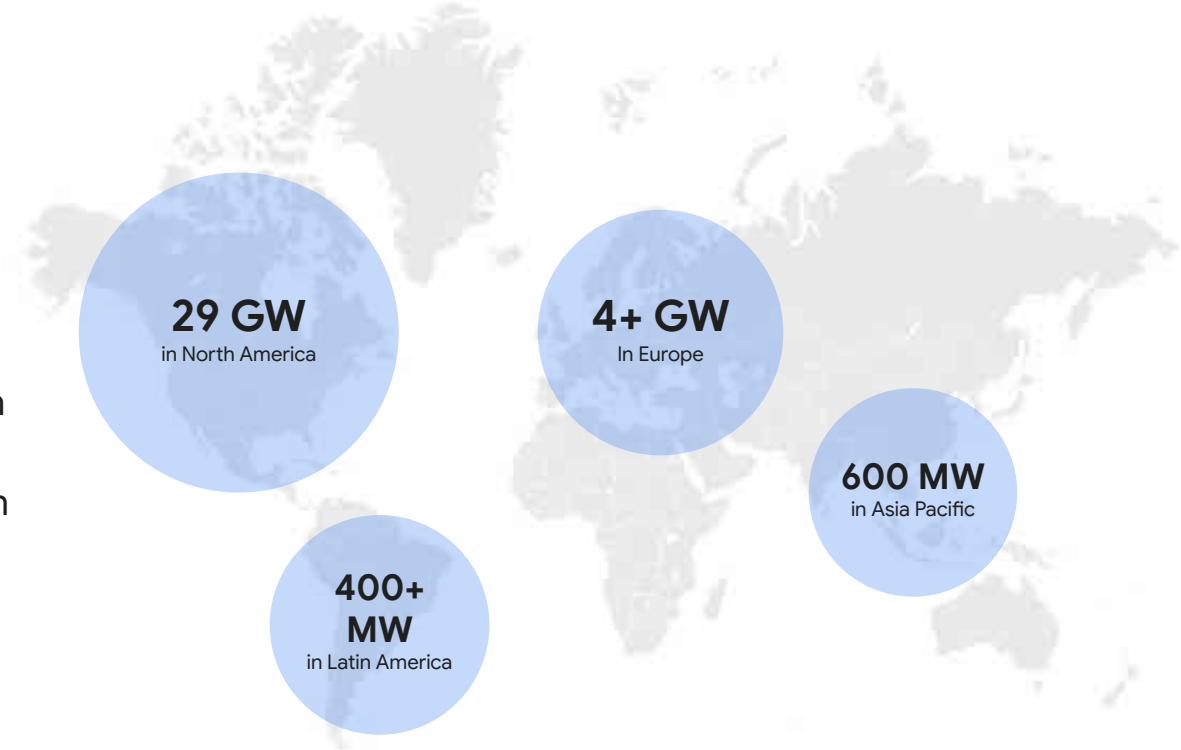


Figure. Clean energy agreement volume by region, as of the end of 2024

Google

Google's circular economy vision, mission, and goal

Launched in 2019

Vision

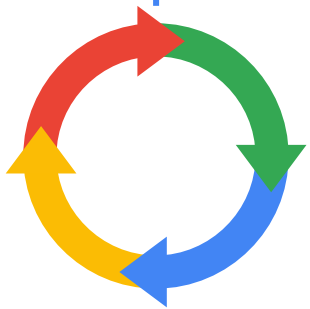
Become a Circular Google in a Sustainable World

Mission

To accelerate the transition to a circular economy in which business creates environmental, economic, and community value through the maximum reuse of finite resources

Multi-Year Goal

Maximize the reuse of finite resources across our operations, products, and supply chains and enable others to do the same



Google

Operations

Zero waste to landfill for our global data centers

Products

Incorporating reyclced content into our hardware

Supply Chain

Plastic free packaging

Enabling others to do the same

Google

Circularity and AI: A Dual Engine

Aligning hardware foundations with digital capabilities to drive systemic sustainability

EMBED

Circularity for AI

The Hardware Foundation: Before AI can deliver circular solutions, the hardware that powers AI has to itself be circular.

We must focus on embedding sustainability within the design and lifecycle of data centers and server infrastructure.

ENABLE

AI for Circularity

The Digital Revolution: Deploying AI to solve complex macroeconomic environmental challenges.

Using tech to optimize resource recovery, track material flows, and design out waste across entire industry supply chains.

Google

Circular Hardware

Components Harvested

7.5 million+

Components harvested from decommissioned hardware for reuse of resale.

Components Resold

2.6 million

Components resold into the secondary market for reuse by other organizations (including excess and obsolete equipment)

Diversion Rate

88%

Operational waste diverted from disposal across our global Google-owned and -operated data centers

Phone Cluster Computing

A low-carbon computing platform from retired phones

Google

Helping communities meet climate goals

A second life for EV batteries, clean energy for communities

WAYMO

Google

AI powered solutions designed to enable others

1

EDUCATION

Recycling Near Me

2

RECYCLING

Circular Net

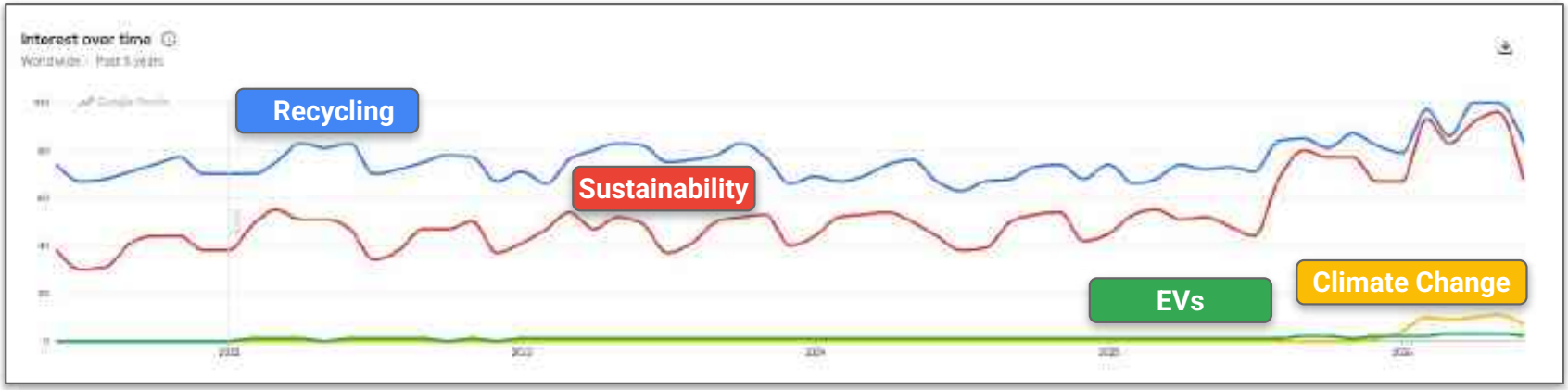
3

AI RESOURCE INNOVATION

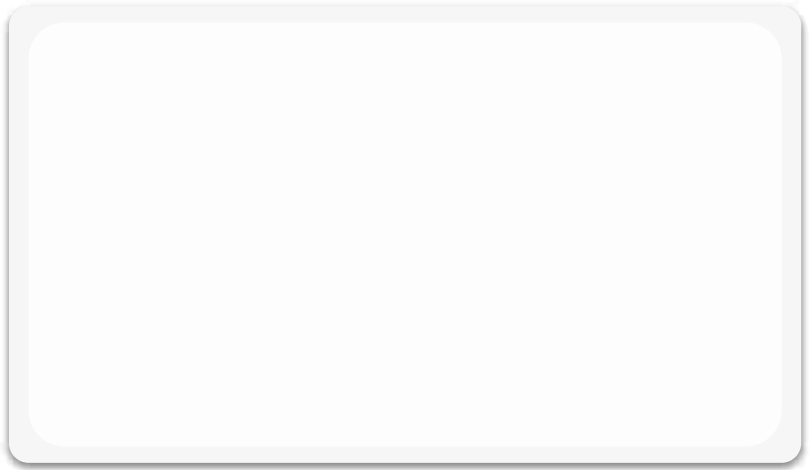
X, the Moonshot Factory

Google

Recycling is the most searched sustainability topic



Google



Recycling Near Me

Now, users can discover recycling drop-off points nearby on Google Maps and Search

Users are now able to easily discover businesses nearby who offer recycling drop-off services with a simple query like '*battery recycling near me*' in Google Maps and Search. Give it a shot and see if the following types of recycling are available near you!*

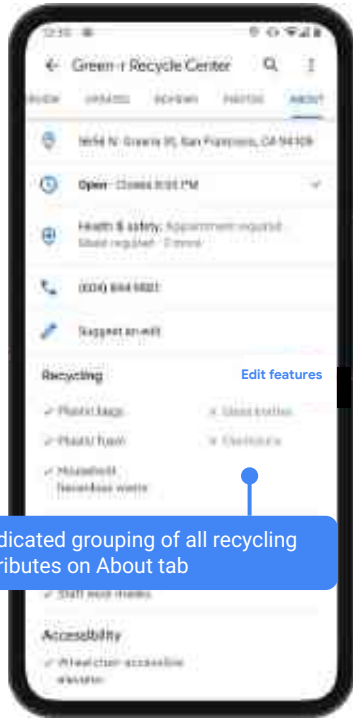
- Batteries
- Clothing
- Electronics
- Household hazardous waste
- Glass bottles
- Ink cartridges
- Light bulbs
- Plastic bags
- Metal cans
- Plastic bottles
- Plastic foam

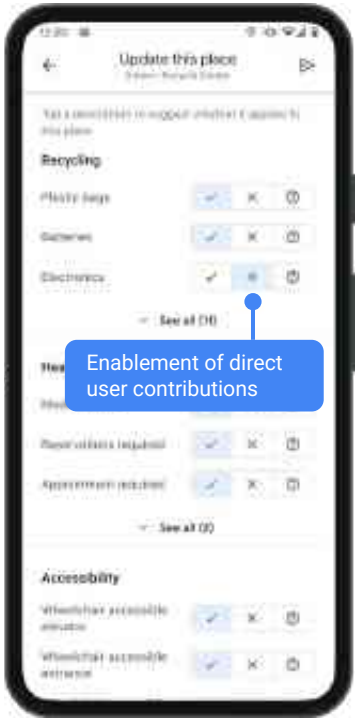
Google

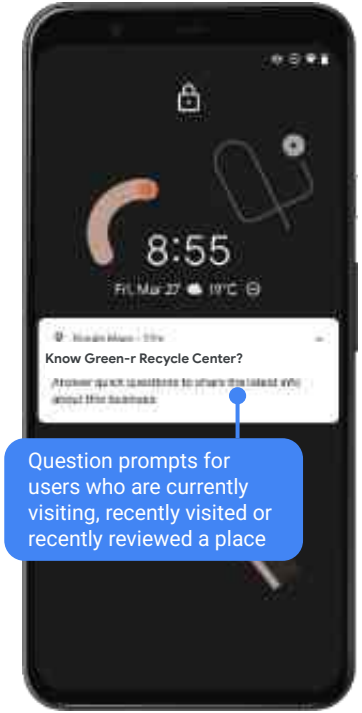
** Results dependent upon local coverage in your area*

https://blog.google/outreach-initiatives/sustainability/power-recycling-turning-searches-store-visits/

Combining user contributions and ML/AI tools help create the world's most comprehensive set of recycling drop off locations







Google

AI powered solutions designed to enable others

1

EDUCATION

Recycling Near Me

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RECYCLING

Circular Net

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AI RESOURCE INNOVATION

X, the Moonshot Factory

Google

Recyclers face critical challenges in organizing the world's materials

User Burden

Roughly 1 in 5 items are incorrectly recycled by confused consumers

Profit Leakage

Billions of dollars in materials are lost annually due to sorting costs

Infrastructure Lag

Packaging formats are changing faster than material sortation processes

Introducing CircularNet AI

CircularNet | A free, open-source ML technology to detect recyclable plastics with pixel-level detection.

Available today on GitHub.

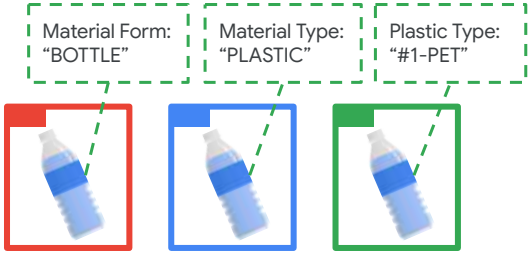
Google

CircularNet Key Features

Pixel-level detection

Real-time waste stream insights

Open-source computer vision



ML model trained on material form, material type and plastic type

Automated Waste Characterization Reporting

Global dataset

Transforming Waste into Value

Machine Learning

Pre-trained machine learning models use a technique called **pixel-level instance segmentation** to identify an object's precise shape—not just a box around it. They are open-source, and **free for anyone to use**.

Computer Vision

CircularNet models analyze images captured by **computer vision cameras**. The system is designed to be flexible; it can work with everything from simple GoPro cameras for audits to more advanced machine vision cameras for real-time sorting line analysis.

Automated Insights

The data generated by the models is used to power automated reporting and analytics. This allows operators to move away from slow, manual sampling and get a more **continuous**, or even **real-time** understanding of their material flows, contamination levels, and bale quality.

CircularNet empowers material recovery facilities and recyclers with continuous data and insights on material flows, contamination levels, and bale quality

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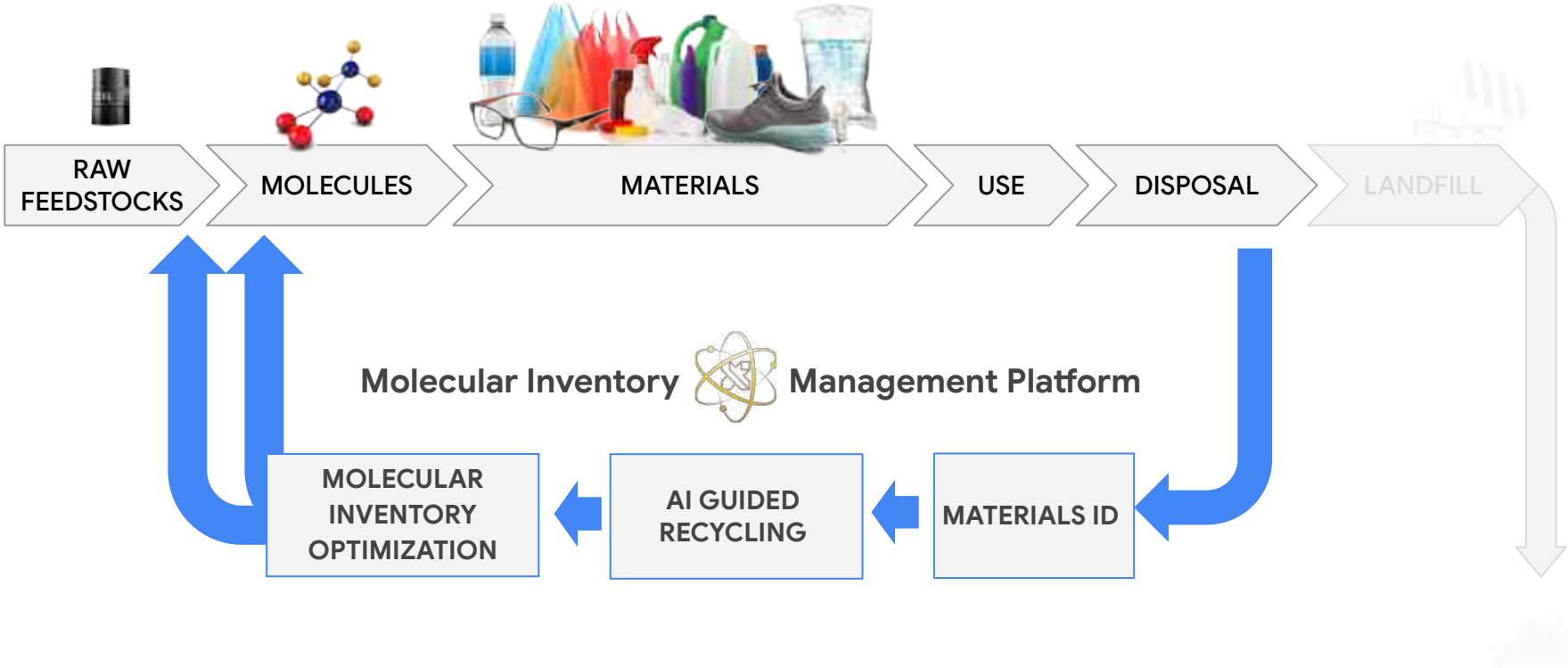
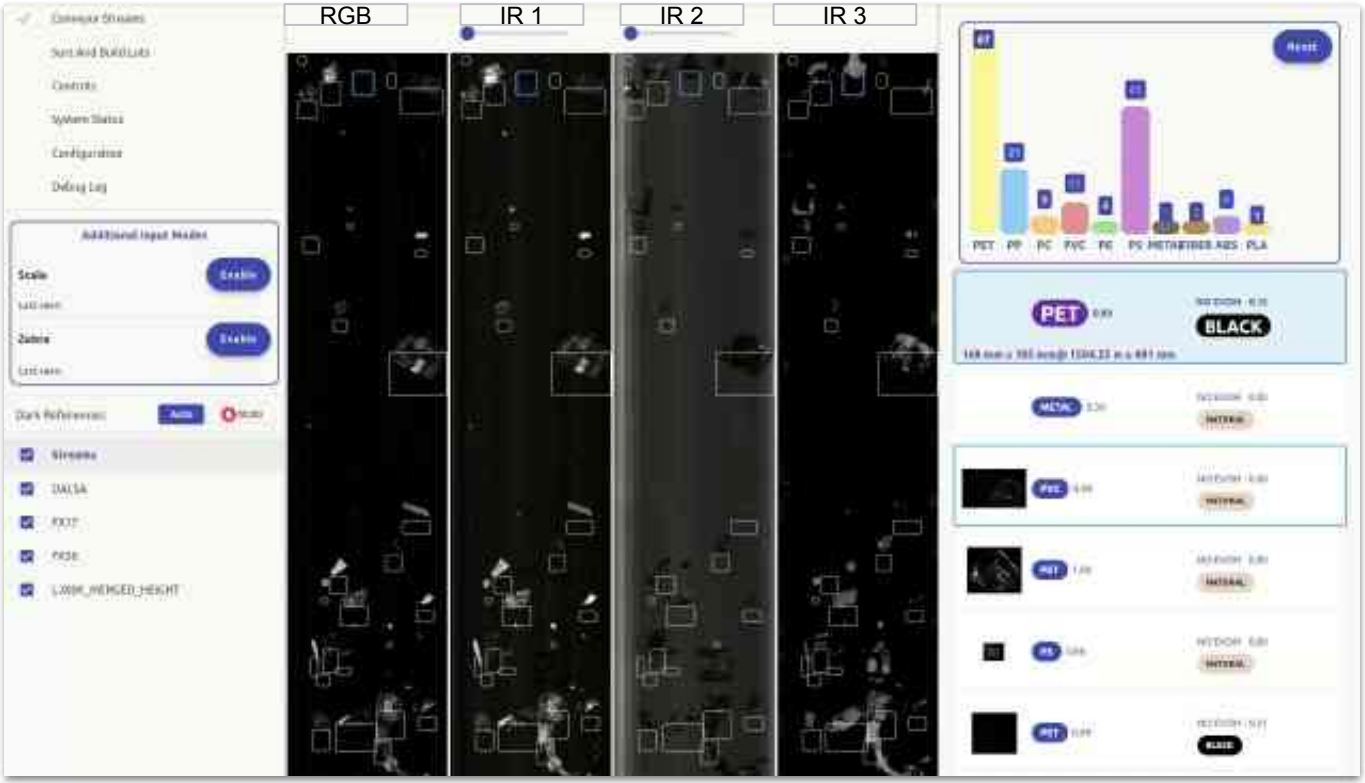
Our Vision: A sustainable future without waste
Our Aim: Revolutionize resource recovery
and decarbonize future materials


RAW FEEDSTOCKS
MOLECULES
MATERIALS
USE
DISPOSAL
LANDFILL
Molecular Inventory Management Platform
MOLECULAR INVENTORY OPTIMIZATION
AI GUIDED RECYCLING
MATERIALS ID

Google

Analytics on residual materials



Google

Advanced AI can radically improve recycling rates

Colored and Natural Plastic

>96% accuracy across all plastic types

Black Plastic

>93% accuracy across all plastic types

Camera Only Black Object Detection

Detect and sort on Black Object Presence with ~90% Detection Rate

Detect Multi-layer Composition

Detect and sort multi-layered materials

Google

Circularity and AI: A Dual Engine

Aligning hardware foundations with digital capabilities to drive systemic sustainability

EMBED -

Circularity for AI

The Hardware Foundation: Before AI can deliver circular solutions, the hardware that powers AI has to itself be circular.

We must focus on embedding sustainability within the design and lifecycle of data centers and server infrastructure.

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AI for Circularity

The Digital Revolution: Deploying AI to solve complex macroeconomic environmental challenges.

Using tech to optimize resource recovery, track material flows, and design out waste across entire industry supply chains.

Google

Thank you.

A view of our planet from Google Earth ©2020 Landsat/Copernicus

Systems Drivers & Strategic Direction

Dr David Greenfield, Vice-Chair, CE Institute (Chair)

Prof Frances Wall OBE, Camborne School of Mines/CMCC, University of Exeter

Lydia Tabbron, Defra

Laura McDonnell, ESRC

The Challenge of Critical Minerals

Prof Frances Wall OBE
Camborne School of Mines,
University of Exeter

(f.wall@exeter.ac.uk)

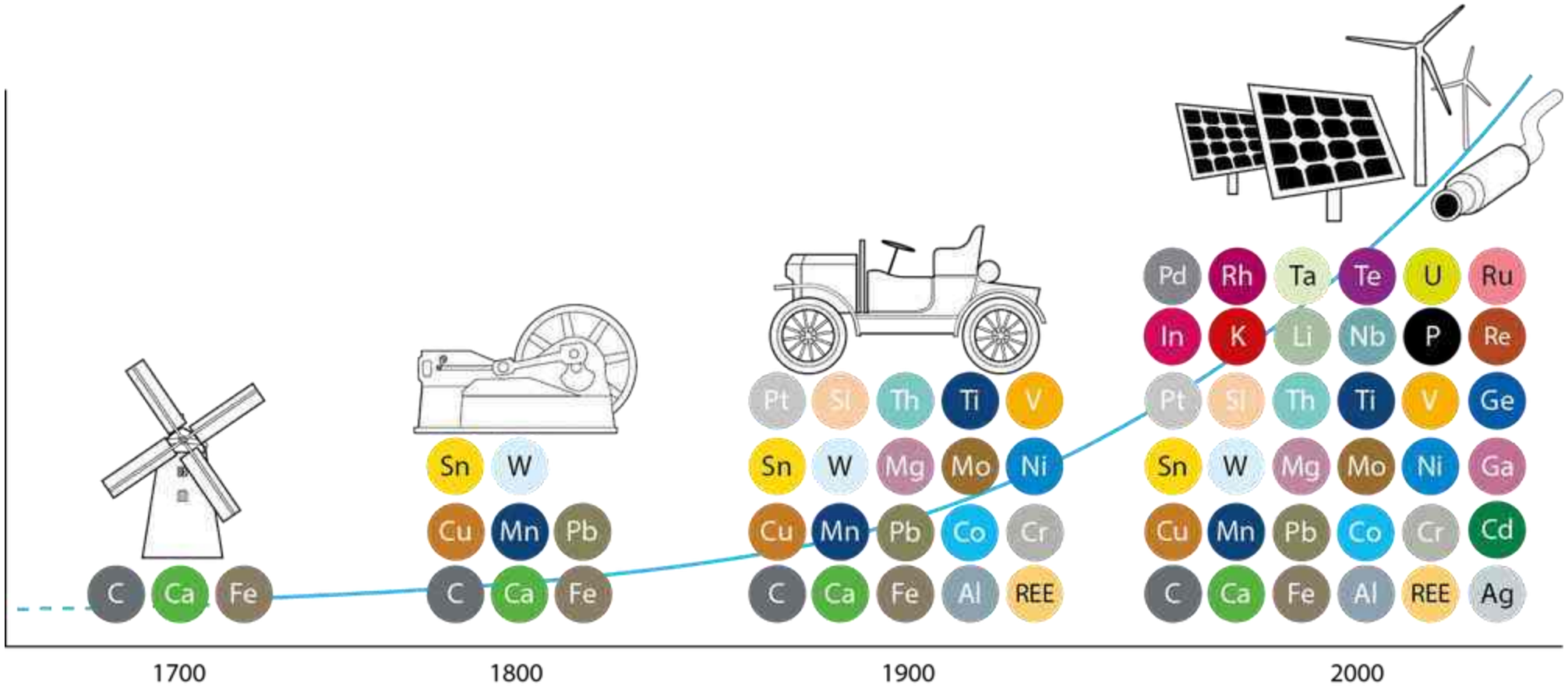
This work was supported by:
UK Research and Innovation (UKRI) Strategic Priorities Fund, Grant EP/V011855/1.
UK Research and Innovation (UKRI) Building a Green Future strategic theme, Grant 5052188.

Critical Minerals Challenge Centre

University of Exeter

UK Research and Innovation

Ages of Energy



Elements widely used in Energy Pathways

Zepf V, Reller A, Rennie C, Ashfield M & Simmons J, BP (2014): Materials critical to the energy industry.
https://theconversation.com/mining-for-metals-in-societys-waste-43766

University of Exeter

Photo by imgix on Unsplash

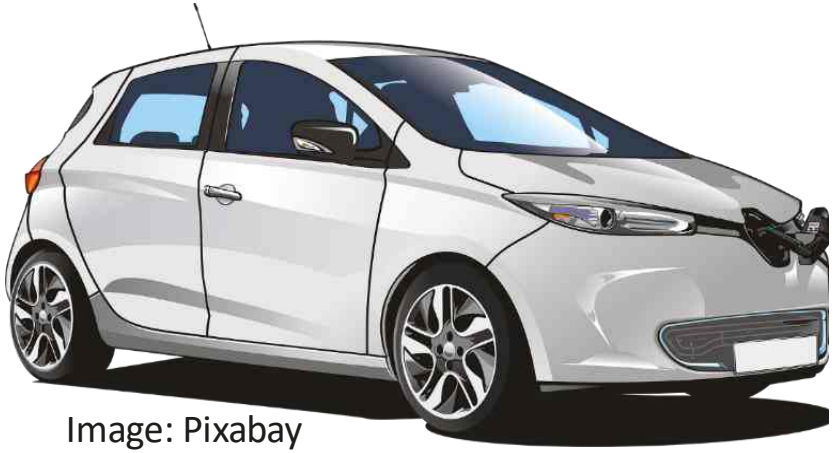
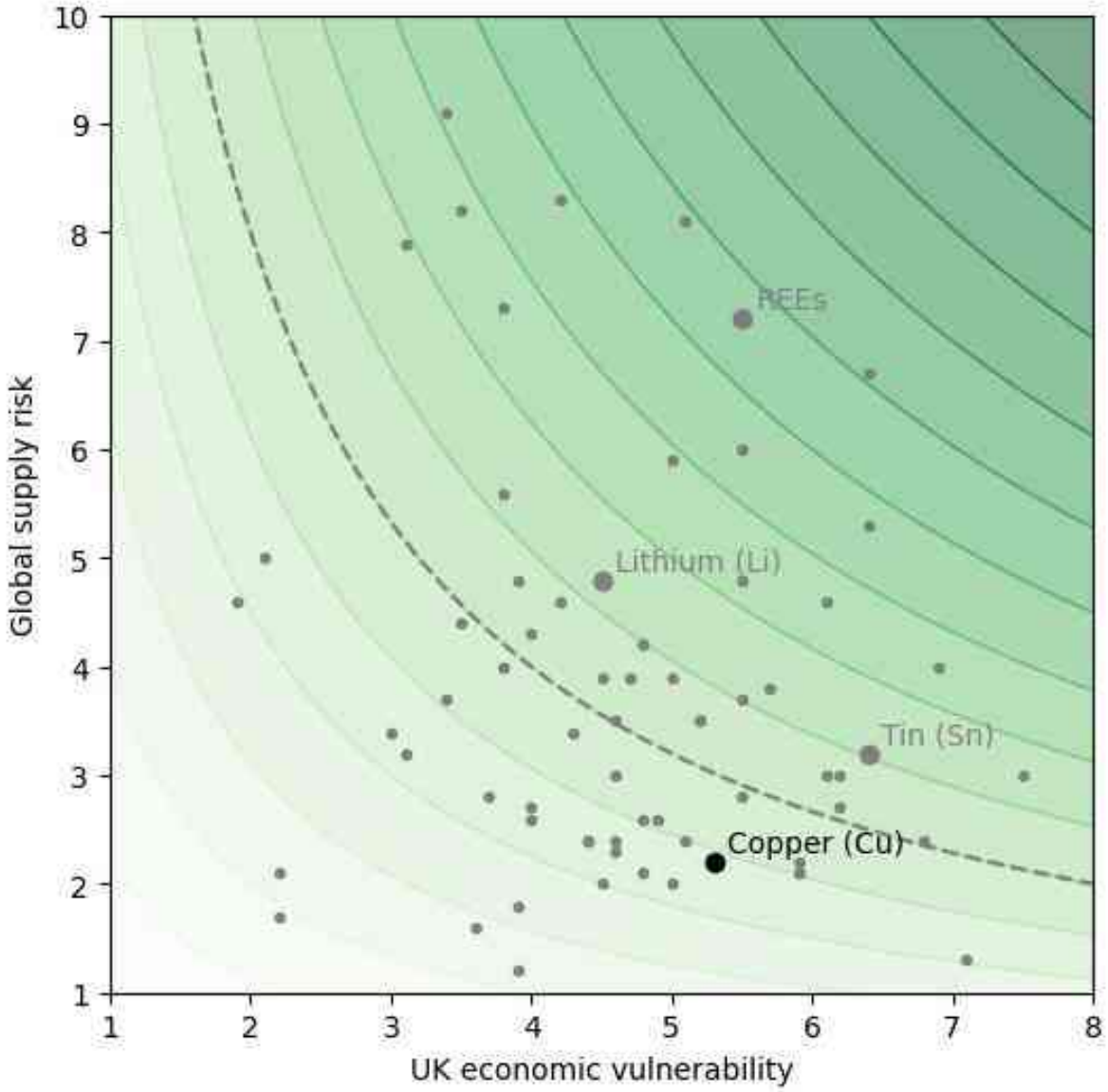


Image: Pixabay

UK critical minerals list



Source: Mudd et al. (2024) UK Criticality Assessment 2024.
British Geological Survey Open Report, OR/24/047. 235pp.


Aitik Mine, Finland, E.Marquis

Periodic Table of Criticality!

EU list 2023

USA list 2025

Both

UK list 2024

H																	He
Li	Be											B	C*	N	O	F*	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K*	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo*	(Tc)	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba*	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og

feldspar

phosphate rock

coking coal

borate

magnesite

Ba is barite, F is fluorspar, C is graphite, K is potash. Mo is not on EU, USA or UK list but is on Canada list

EU

European Commission list of CRMs, 2023 https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en

USA

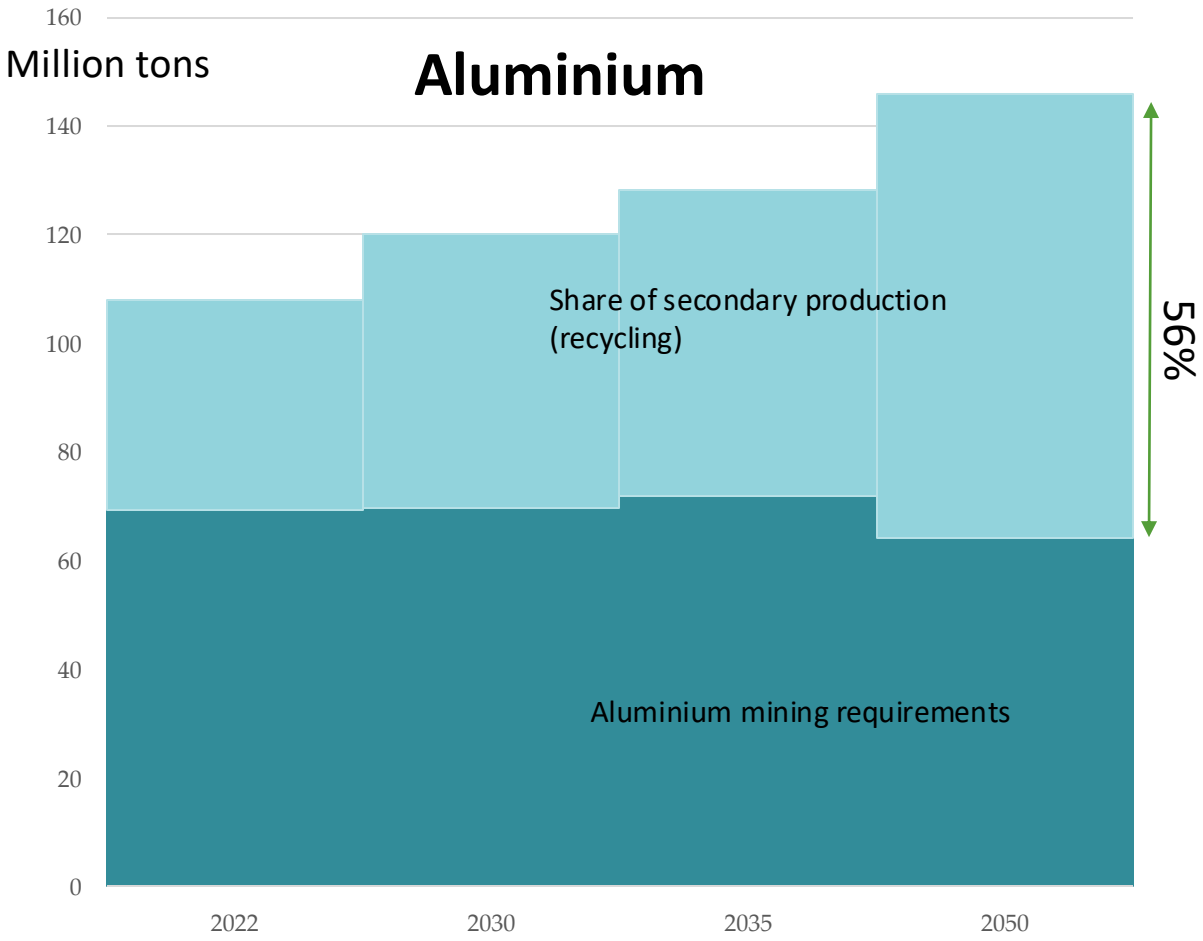
Federal Register / Vol. 90, No. 214 / Friday, November 7, 2025 / Notices . https://www.govinfo.gov/content/pkg/FR-2025-11-07/pdf/2025-19813.pdf

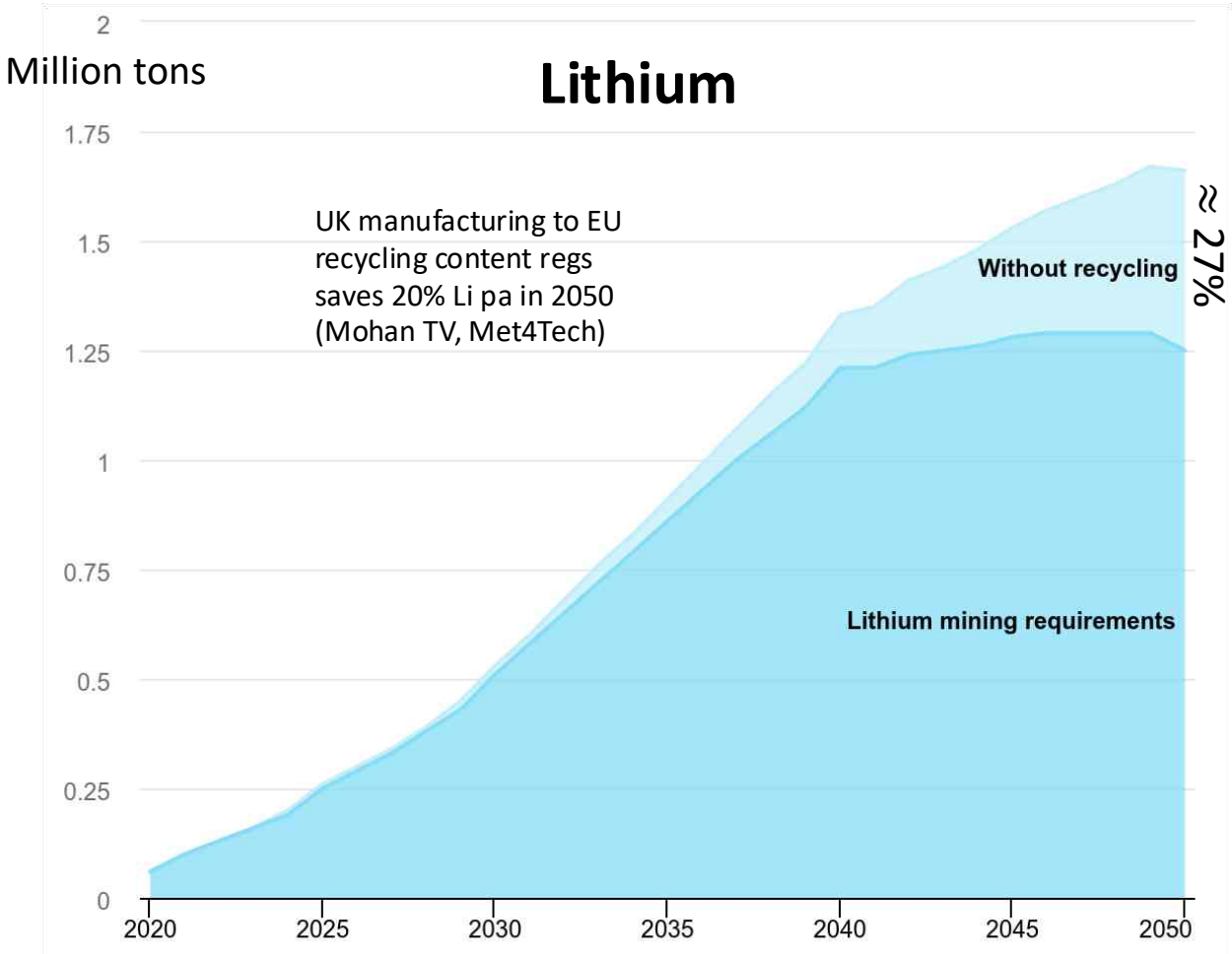
UK - Critical Minerals Intelligence Centre (2024) https://www.ukcmic.org/downloads/reports/ukcmic-2024-criticality-assessment.pdf

La	Ce	Pr	Nd	(Pm)	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Frances Wall

International Energy Agency global requirements for aluminium and lithium to 2050



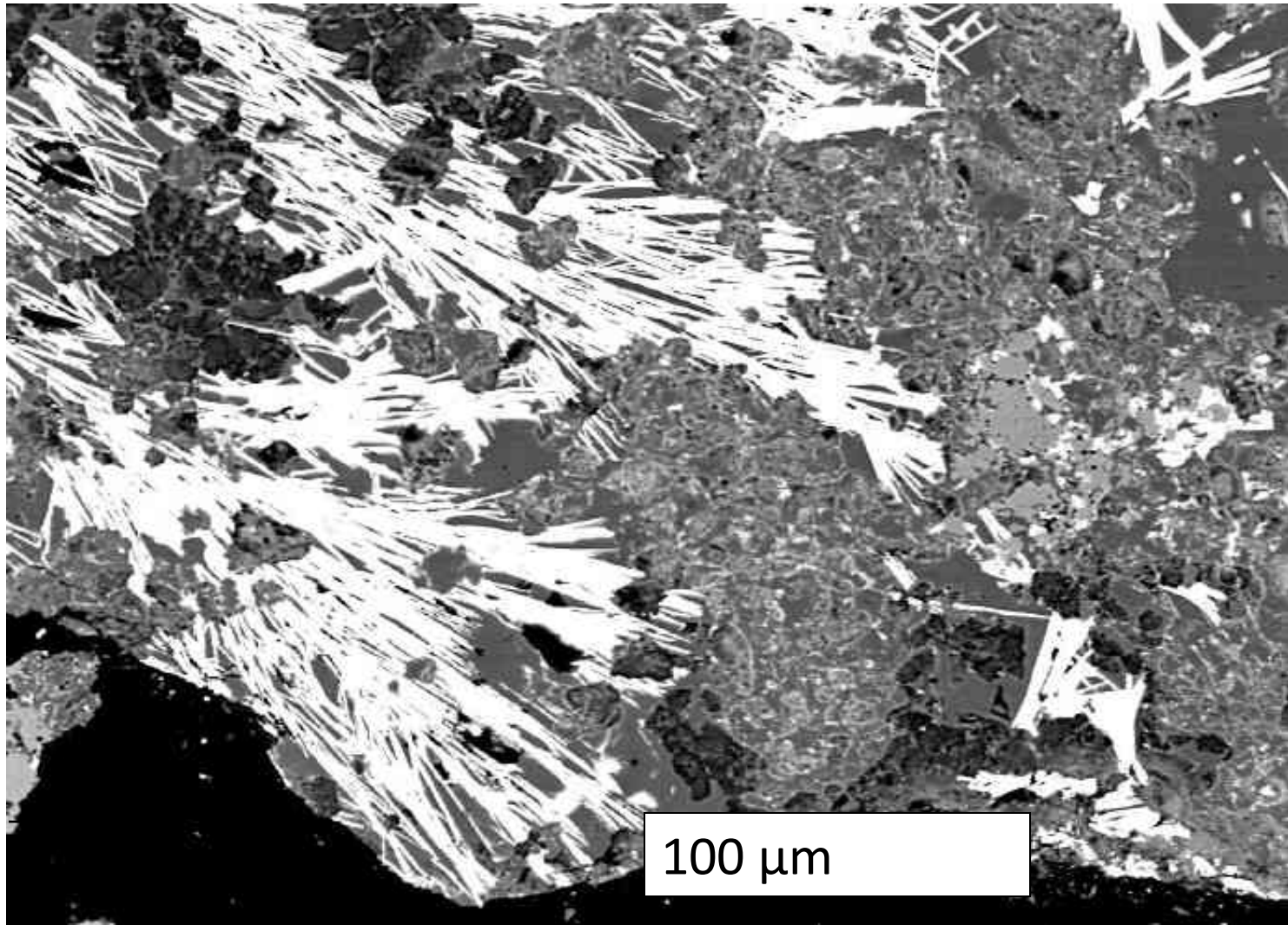


IEA (2024), Lithium: mining requirements in the Announced Pledges Scenario, 2020-2050, IEA, Paris https://www.iea.org/data-and-statistics/charts/, Licence: CC BY 4.0

IEA (2023), Steel and aluminium, IEA, Paris https://www.iea.org/reports/steel-and-aluminium, Licence: CC BY 4.0

Rare earth ores in carbonatite rocks – Songwe Hill, Malawi

Backscattered electron image of synchysite-(Ce) in ferroan dolomite



Critical Minerals Opportunity in the UK southwest region

Critical Minerals Challenge Centre transdisciplinary research

- Accelerate new critical minerals mines in SW England
- Ensure good sustainable development outcomes for people & environment (UN Resource Management System)
- Lead good practice globally

7 commercial projects developing critical minerals (Li, Sn,W) in Cornwall and West Devon, some combined with geothermal energy

> 100 related businesses: mostly small, many international

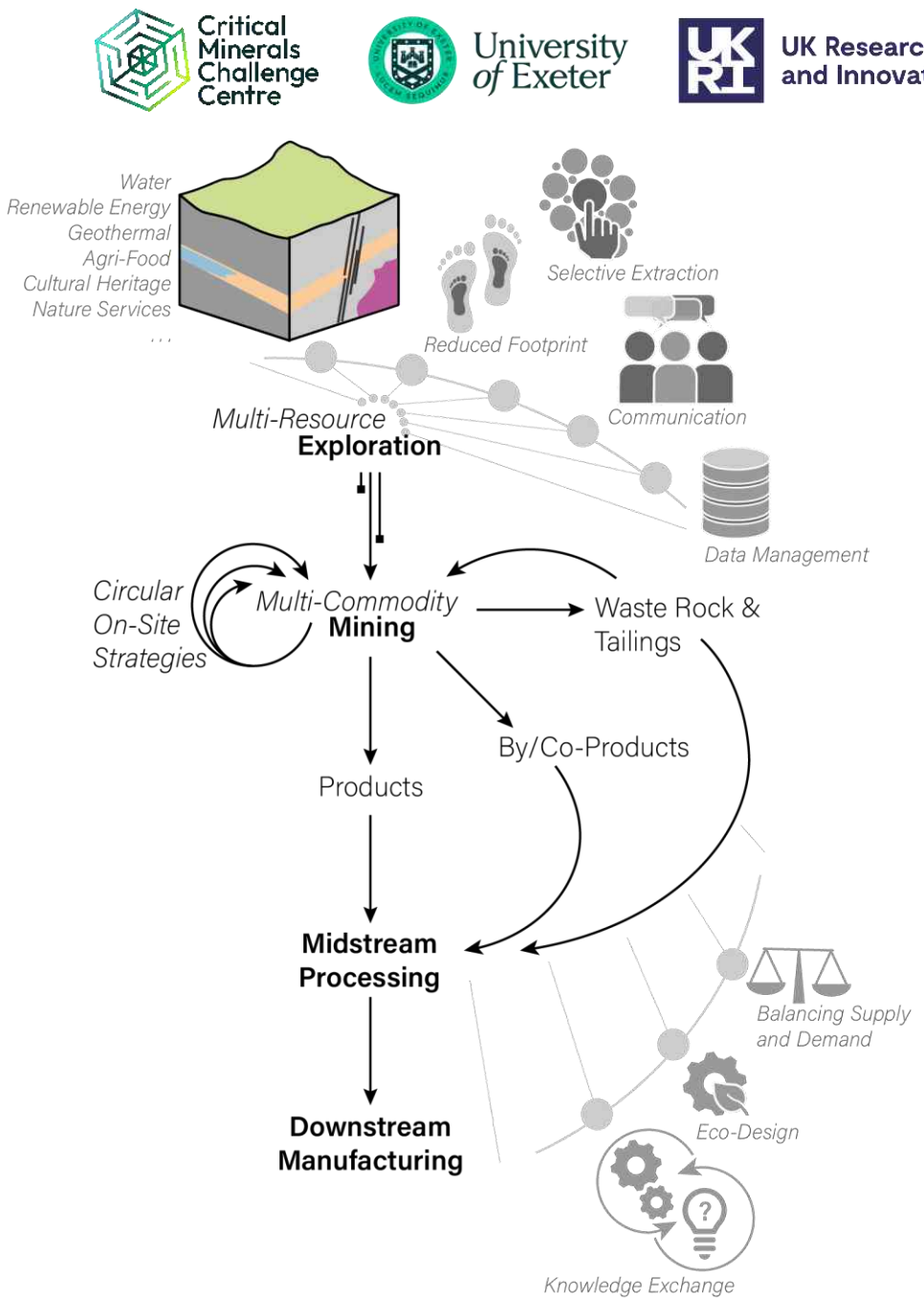
Accelerate Minerals foundation 2000-3000 direct jobs

Build supply chain and integrated circular economy value chain in southwest and nationally?

Marquis et al, 2024, Optimizing Resource Management for Critical Raw Materials: A Case Study of the Application of the United Nations Resource Management System with Cornwall Regional Government, United Kingdom, UNECE

Circular Economy Fundamentals

- All materials that are not of organic/agricultural origin are sourced though mining and extraction.
- We need to mine more - End-of-life stocks are insufficient to support manufacturing of current and emerging technologies.
- Good materials stewardship starts…
  - **… before ground has been moved.** CE includes the whole value chain and life cycle from exploration through to recycling
  - **… before materials have been designed.** Materials scientists, manufacturers and designers should consider the unintended consequences of their material choices.



Critical Minerals Challenge Centre

Critical Minerals Challenge Centre | University of Exeter | UK Research and Innovation

Thank you!

This work was supported by UK Research and Innovation (UKRI) Building a Green Future strategic theme, Grant 5052188.

Embedding Sustainability into Systems & Strategy

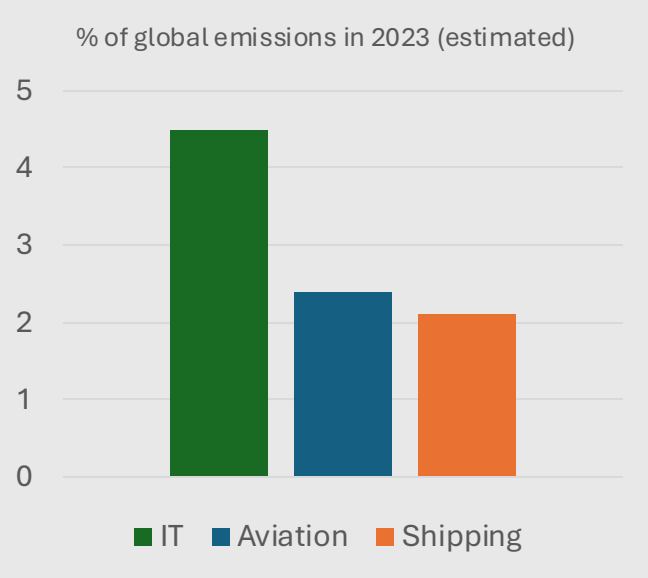
From ambition to action

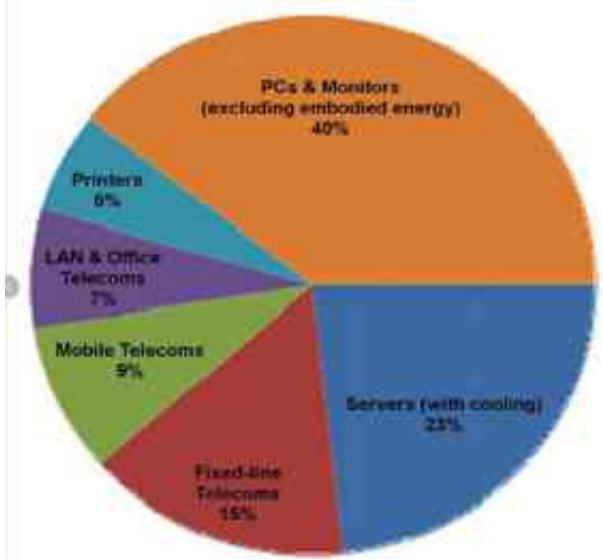
Lydia Tabbron

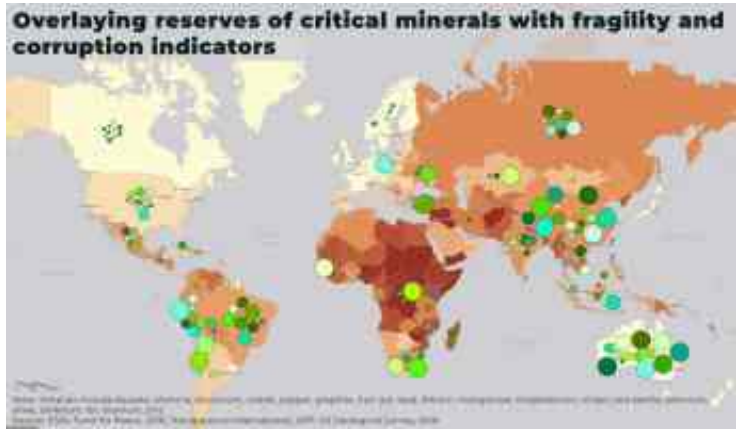
Defra, Digital Sustainability Lead

Department for Environment, Food & Rural Affairs

Environmental and social impacts from ICT

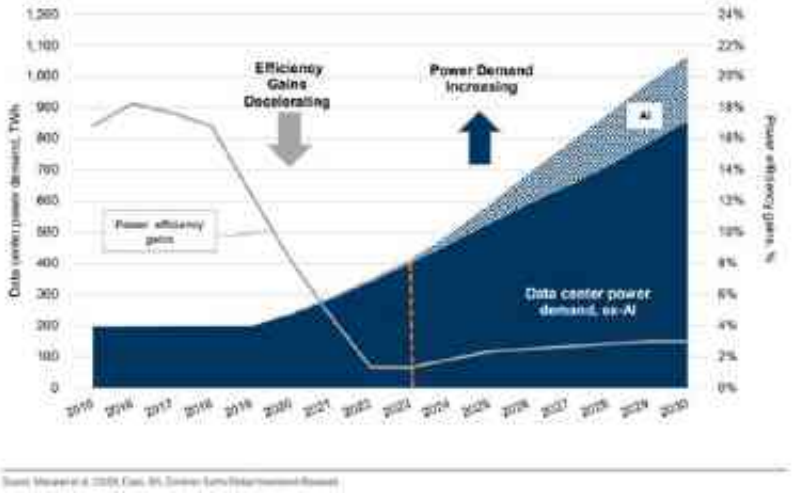






64bn terabytes of data stored globally

60% never used



Carbon = Cash

Department for Environment, Food & Rural Affairs

The unique position of UK Govt

Purchasing Power

Public sector digital and data spend in 2023 was estimated to be around **£26 billion**
£11 billion was spent by central government

Digitalisation of services

HMRC handles approximately **100,000 calls** each day, the DVLA processes around 45,000 letters daily, and Defra still manages over 500 paper form-based services.

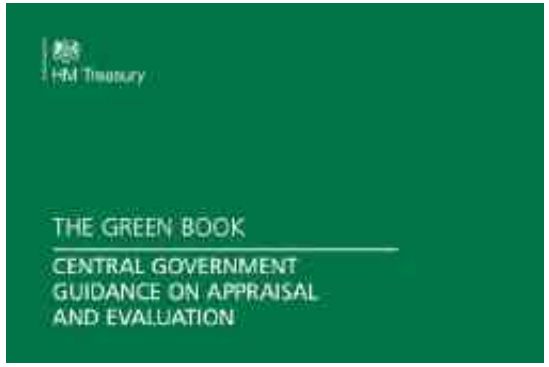
Scale

6.19 million people employed in the UK public sector. representing approximately 18% of the total workforce. **3.1m devices used in central government**

Centralised procurement and standards

Department for Environment, Food & Rural Affairs

Government Commercial Agency



What digital sustainability looks like in theory

- ✓User experience
- ✓Operational resilience
- ✓Security
- ✓Cost efficiency
- ✓Environmental and social impact reduced/avoided

Challenge = optimising one can impact another.

This is a systems problem, not a single solution.

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What digital sustainability looks like in practice (in Defra)

- Large, complex digital estate
- Diverse services and users
- High environmental ambition
- Need to lead by example across government

Defra is uniquely positioned to test and scale sustainable digital approaches

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Making the most of remanufactured and refurbished devices

The Defra group has over 30,000 colleagues and around 72,000 devices. At this scale, we have a significant opportunity to make a difference.

Over the 5-year life of the contract, 90% of Defra's laptops, phones, and tablets will be refurbished or remanufactured. This will include redeployment to keep existing devices until the end of their life.

The move will:

- reduce carbon emissions by 44%
- avoid the extraction of around 51,000 tonnes of raw materials
- save an estimated 12,000 megalitres of water

These savings are compared to buying new devices.

The financial case is also compelling. Refurbished devices offer cost savings of up to 40%. This frees up resources to reinvest in frontline services or new areas of innovation.

Partnerships are key

We responsibly manage devices at the end of their life, with our zero-to-landfill policy. Where appropriate, we donate equipment to social enterprises. This supports digital inclusion and extends the lifespan of devices. We recycle devices that have reached end of their life.

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- "second life" as default
- Shift from device refresh cycles → performance-based models
- Extending device life (laptops, mobiles)

User experience

"cant even tell its second hand" Defra user

Operational resilience

"AI data center demand is reducing the memory supply (RAM) for consumer devices"
Tech Radar, 2026

Security

"good security should instead be recognised as an enabler of digital sustainability… Good security practices can help to maximise the potential for enabling reuse" NCSC

Cost efficiency

40% savings compared to buying new

Environmental and social impact

How Defra in sustaina

Edd Parry, 30 September 2025

Edd Parry, Director of Grou Data Technology and Secu procure IT services, focusi experience.

In March this year, we annc end user IT services would elements of support, such

Corporate report

Defra digital sustainability strategy 2025 to 2030

Published 6 October 2025

Contents

Print this page

Purpose, scope and governance

Digital sustainability is the practice of using digital technology and solutions in a way that ensures long term environmental, economic and social sustainability. It is sometimes referred to as 'green IT' (information technology) or 'sustainable ICT' (information and communication technology). This definition recognises the 'green IT' or 'IT for green' dilemma – namely that technology can help address the climate crisis whilst also being a contributor to it.

The purpose of this strategy is to set out Defra group vision to minimise the environmental, economic and social impact of its ICT operations. It simultaneously contributes to overall enterprise sustainability goals and unlocks associated benefits. The strategy encompasses all aspects of ICT, including (but not limited to):

- data centres
- cloud services
- digital workplace devices
- software
- data
- supply chain and vendor relationships

The document outlines how this vision will be achieved over the next 5 years. In doing so, it serves several purposes as it:

- stops us over-committing to poorly managed and uncoordinated activity and gives others the chance to challenge our priorities if needed

Collaboration is essential

It takes a village

Government cannot do this alone

Working with:

- Government Digital Sustainability Alliance
  - Industry (suppliers, OEMs, SMEs)
  - Academia
- Cross-government networks & senior leaders

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Collective action accelerates progress

Taking our lessons learnt across government

- Embedding sustainability into governance
- Updating procurement criteria
- Sharing best practice across departments
- Early adoption of circular device strategies

Change is happening—and it's scalable.

Sustainability = efficiency, resilience and cost savings

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What we're focusing on next

Government Digital Sustainability Strategy 2026-2030:

1.Circularity and waste reduction

2.Net zero and emissions reduction

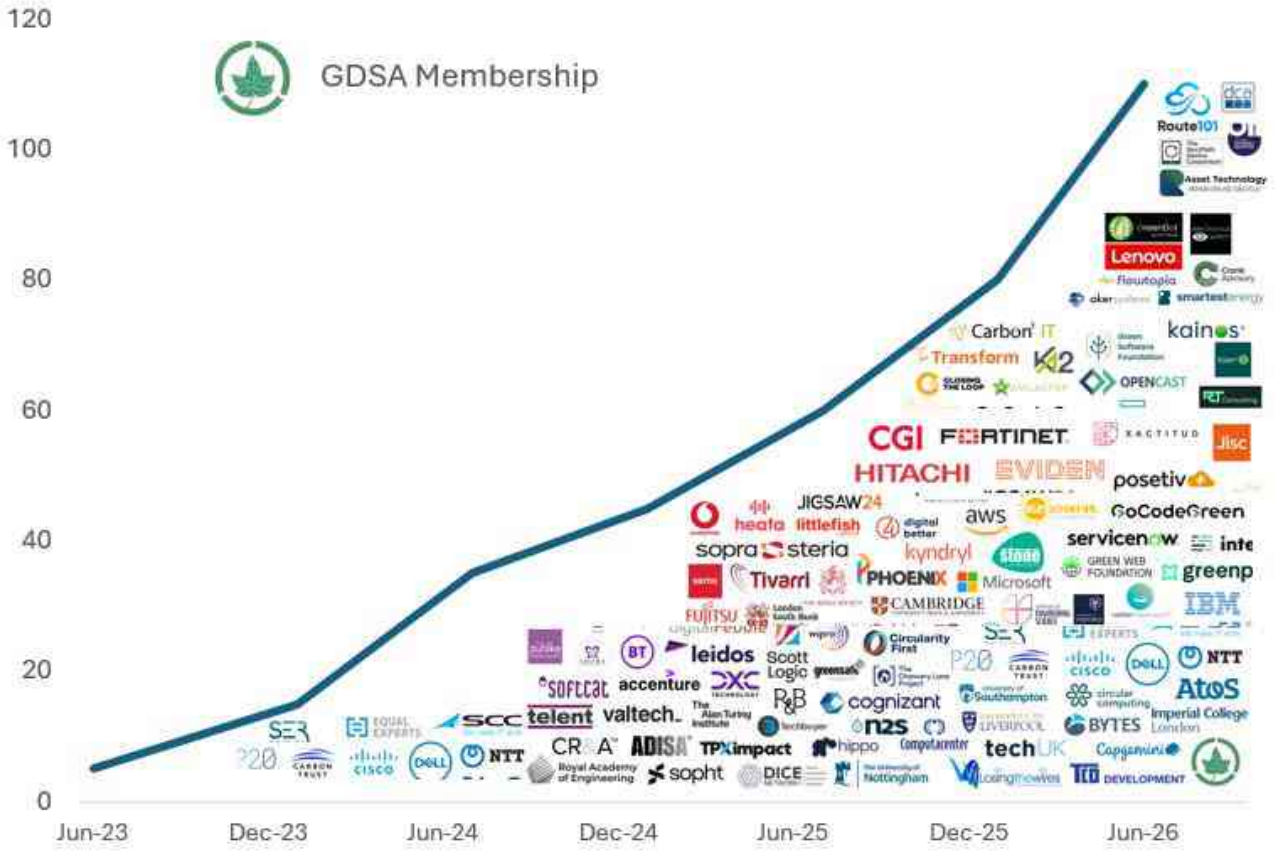
3.Addressing wider planetary impacts beyond carbon

4.Social risk management and social value

5.Climate resilience of governments digital estate

6.Sustainable disruptive and innovative technology

7.Embedding digital sustainability as business as usual



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What you can do...

Get informed

Challenge

Share

Thank you

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Engineering and Physical Sciences Research Council

Transformation Pathways

EPSRC

Laura McDonnell

Future Communications and ICT

UK Research and Innovation

Advance knowledge, improve lives, drive growth.

EPSRC's Structure

4 Directorates - Our directorates are the key route by which we define and deliver specific aspects of our mission

RESEARCH

Information and Communication Technologies

Talent and Skills

Engineering

Research Infrastructure

Healthcare Technologies

Mathematical Sciences

Advanced Materials

Physical Sciences

STRATEGY

AI & Robotics

Advanced Communication Technologies

Quantum Technologies

Sustainable Manufacturing and Mobility

Clean Energy

INNOVATION & PARTNERSHIPS

Business Engagement & Partnerships

Resilience and Security

Impact

International

Regional Engagement & Universities

OPERATIONS

Business Improvement

Governance & Planning

Corporate Development

Data

Evaluation & Analysis

PAN-UKRI FUNCTIONS

Commercialisation

Trusted Research and Innovation

UK Modern Industrial Strategy

Published on 23 June 2025

UK Research and Innovation

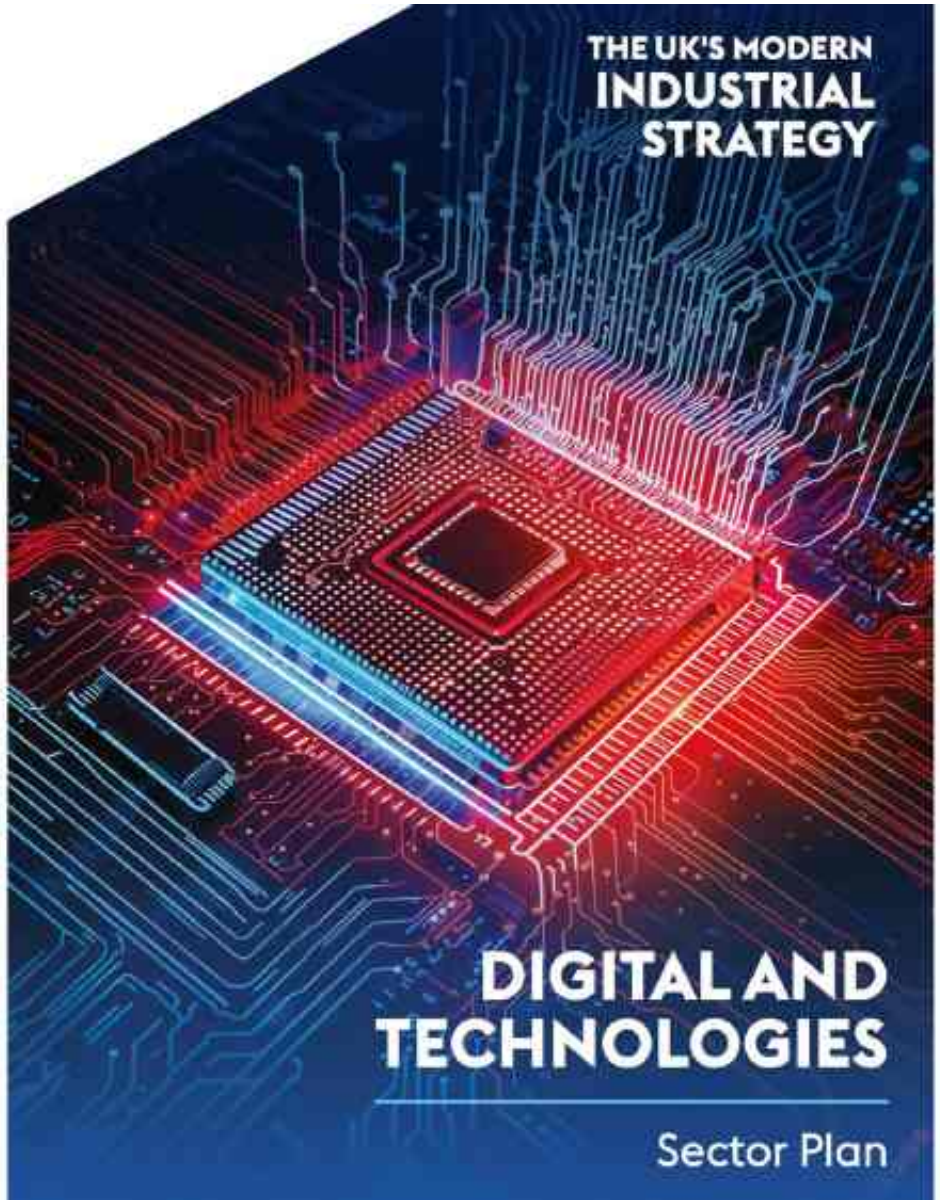
Eight sectors identified for growth, with sector plans detailing subsector priorities

Some associated funds announced but still more details to follow

Sectors include:

- Advanced manufacturing
- Clean energy industries
- Creative industries
- Digital and technologies
- Financial services
- Professional business services
- Life sciences
- Defence

10 Year vision for the Digital and Technologies Sector



Vision

By 2035, our vision is for the UK to be one of the top three places in the world to create, invest in and scale-up a fast-growing technology business.

- Secure the UK's first trillion-dollar technology business
- Reforming the business environment for digital and technology businesses, fully deploying all the levers of government
- more investment in commercial research and development (R&D) in the sector than any other country globally (excluding USA and China) by 2035

Frontier Technologies:

- Artificial Intelligence (AI)
- Cyber Security
- Advanced Connectivity Technologies (ACT)
- Engineering Biology
- Quantum Technologies
- Semiconductors

EPSRC Funding Delivery

Responsive Mode Schemes

Programme Grants
Value: £6m to £8m
Timescale: 4 to 6 years
Fund 2 per annum | Mid-Late

Standard Grants
(Inc. Networks and Lead Agency Agreements)
Value: £300k to £1m | Timescale: 3 years+
Fund 20+ per annum (~10%) | All Stages

New Investigator Awards
Value: £300k to £800k
Timescale: 3 years+
Fund 15+ per annum (~30%) | Early

Discipline Hopping
Value: £300k to £800k
Timescale: 3 years+
Fund 2+ per annum | All Stages

Talent and Skills Schemes

Doctoral Focal Awards
(CDT)
Every 5 to 8 years

Doctoral Landscape Award
(DTP)
Algorithmic allocation per institution

Industrial Doctoral Landscape Awards
(iCASE)
Algorithmic allocation per business

Other Schemes

Prosperity Partnerships
Value: £1m+ (Matched Funding)
Timescale: 5 years

UKRI Schemes
e.g. open calls (ICT), multidisciplinary, FLF, etc.

EPSRC calls – in addition to the standard mode opportunities we also like to highlight the following open calls:

Materials Innovation Programme Coordination Network Pluses – UKRI

Pre-announcement: NetworkPlus in property flood resilience – UKRI

EPSRC standard research grant, Nov 2023: responsive mode – UKRI

Engineering and Physical Sciences Research Council

ESRC Opportunities

ESRC Connect Awards (pilot) – UKRI - Apply for funding to connect with other researchers to scope, seed and grow emerging research fields and new areas of inquiry. Will require partners.

ESRC React Awards (pilot): outline – UKRI- Apply for responsive funding to generate time-critical research to support UK policymakers or frontline practitioners in public services.

Engineering and Physical Sciences Research Council

Successes

- Sprite - SPRITE+ | Security, Privacy, Identity, Trust, Engagement NetworkPlus
- Pro squared - Funding - pro² network+
- Joiner- JOINER
- Efutures - A UKRI Funded Network
- UKFin- UKFin+ Funding Research Collaborations for Wicked Problems in Financial Services
- Ignite- flexible funding

Engineering and Physical Sciences Research Council

Keynote: From Measurement to Circularity

Lisa Rivalin, PhD

Senior Staff Engineer

Meta

From Measurement to Circularity

Standardizing Carbon Data for Datacenter Hardware Reuse

Dice Network + Transformation Pathways event - July 2026

Lisa Rivalin
Senior Staff Systems Engineer
Hardware Design AI Systems

Meta

📝 Standardize

One common way to count carbon

Collaborate for systemic change

🌡️ Measure

Turn every component into actionable carbon data

🎯 Design

Design for sustainability and longevity

Design for value retention

♻️ Reuse

Keep hardware in service: the circularity tier

Operate for maximum recovery

Accelerating Demand

Over $600B of hyperscaler capex in 2026, 72% of it AI. The industry can't build fast enough.

Constrained Supply

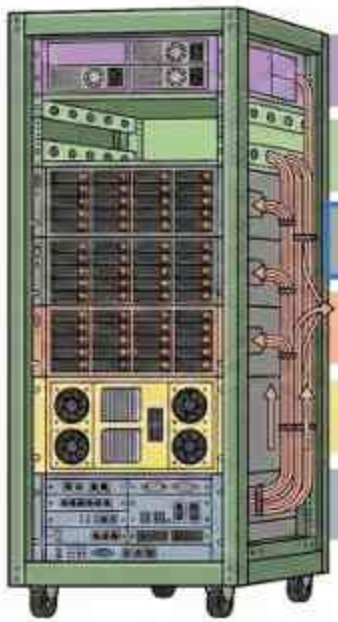
DDR5 spot prices up 298% in one quarter, demand outpacing supply. Reuse is supply resilience, not just sustainability.

Front-Loaded Carbon

About 80% of a server's lifecycle carbon is embodied in manufacturing. Efficiency can't recover it, reuse can (~1,500 kg CO2e avoided per reuse cycle).

OCP PCR Taxonomy

Create modular “Tray-level” and “PCBA-level” taxonomies that can be referenced by each rack-level assembly



POWER MANAGEMENT

MECHANICALS

PLATFORM TRAYS

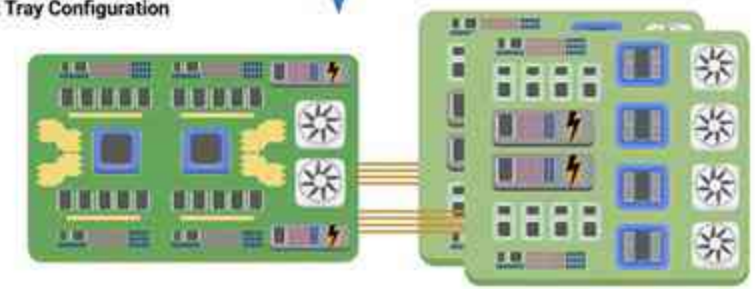
CONNECTORS AND CABLES

THERMAL MANAGEMENT

I/O MODULES

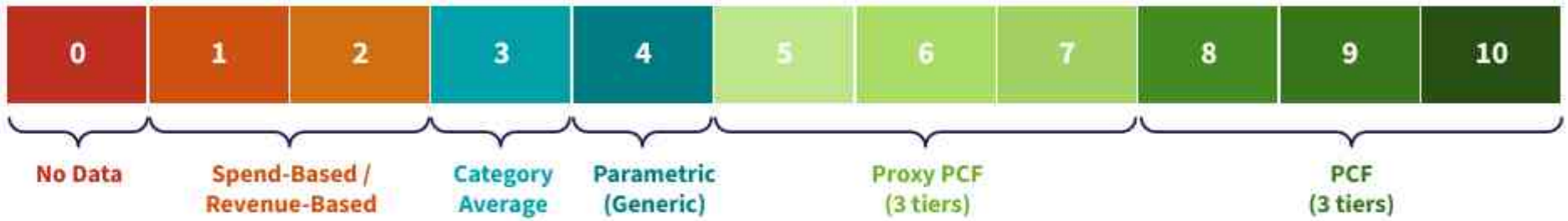
Example – AI Accelerator Tray

ML Accelerator / Host Tray Configuration



Commodities

OCP PCR Data quality score



Mechanical scoring

- Validate PCF prerequisites
- Qualitative PCF scoring
- Propagate scores

Score	Input Type	Example
8–10	PCFs: Primary-data PCF / Parametric model with specific inputs	Component-specific, cradle-to-gate PCF study / Verified PCF or high-fidelity parametric model
5–7	Proxy PCF / Parametric model with specific inputs	Similar product PCF applied
4	Top-level Scaling (Generic Inputs)	Proxy PCF aggregate, scaled by physical drivers
3	Category Average	Product category average based on representative PCFs
2	Supplier Emission Factor / High-Quality EEIO	Price-based e.g. CDP or geography-specific
1	Low-Quality EEIO	Spend-based industry average estimate
0	No data	Component not assessed — flagged as a gap

Design for Sustainability

1. ESTIMATE

- a Map rack specs to standard taxonomy
- b Match Emissions Data & Collect PCFs
- c Estimate NUDD Components
- d Create Baseline Rack Breakdown

2. PROPOSE

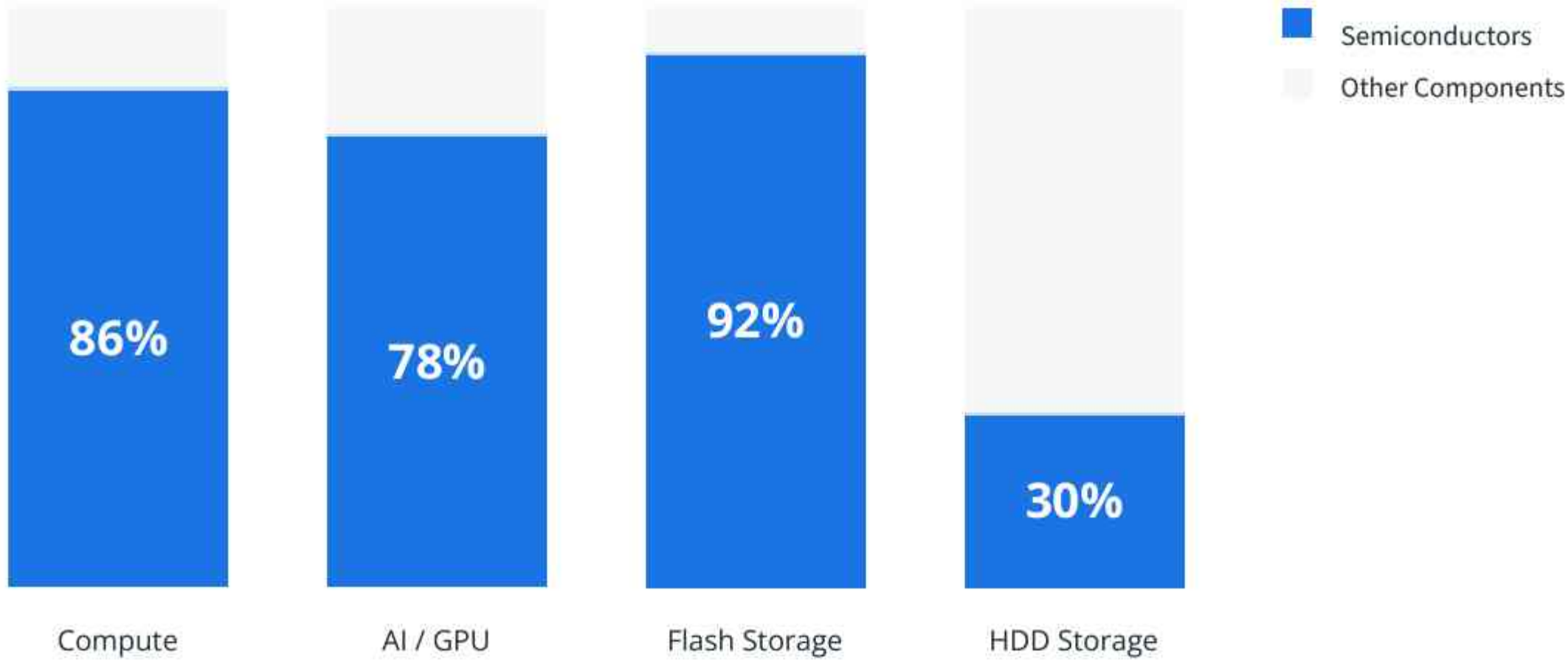
- a Cross-Domain Reduction Checklist
- b Evaluate Design Alternatives
- c Identify Reduction Strategies
- d Quantify Impact

3. TRACK

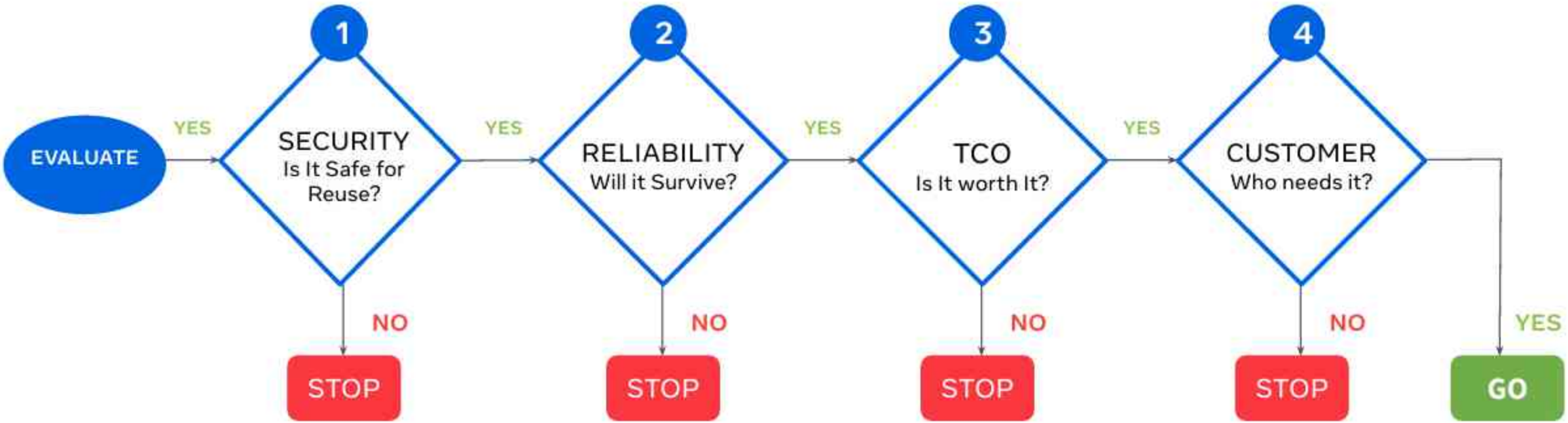
- a Component carbon estimate coverage
- b Progress at each exit stage
- c Automated Data Quality Monitoring
- d Audit-Ready Traceability

Applied iteratively: DA (Hack) | EVT | DVT | PVT | MP

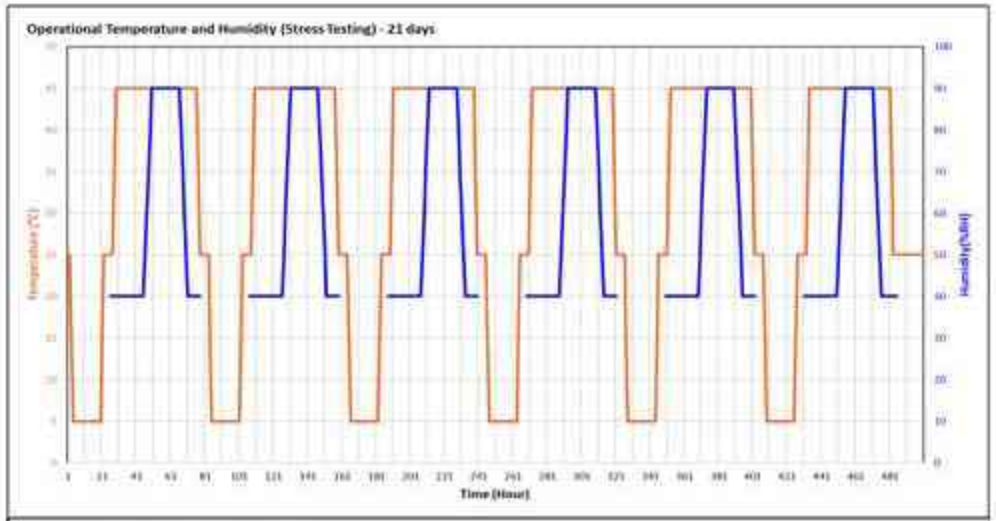
Why Semiconductors are the key challenge

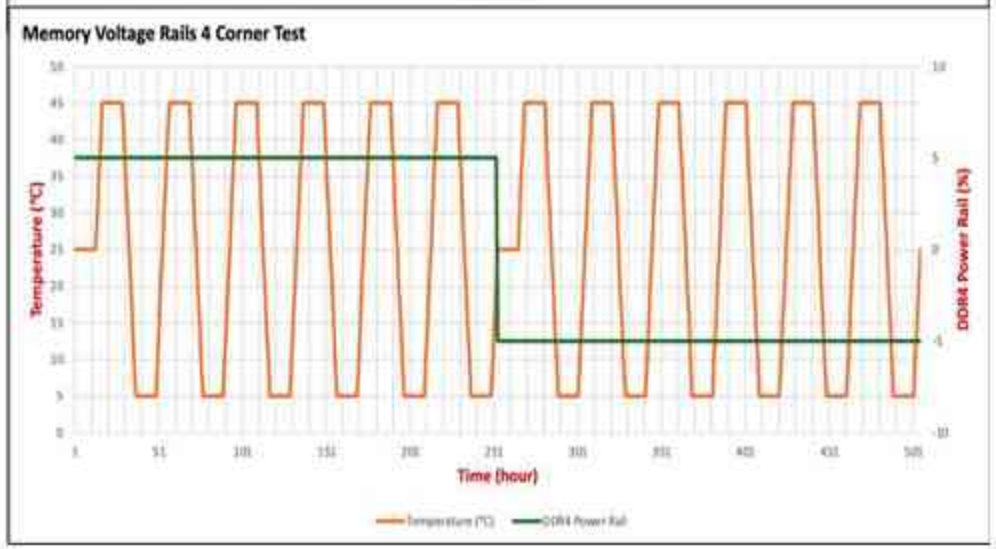


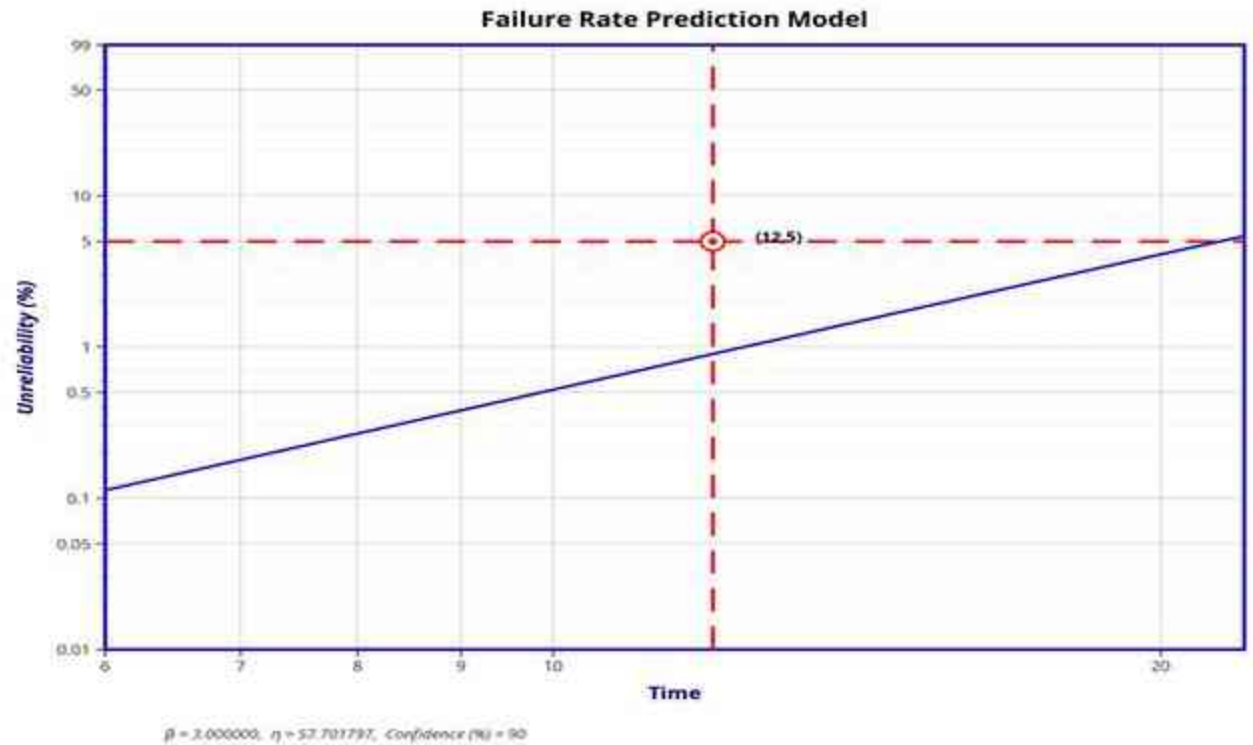
Hack, Pilot, Scale: Four Evaluation Gates



Reliability is the gatekeeper







Proven at Scale: What Passed, What Didn't.

Component	Status	Key Finding	Outcome
DRAM	SCALE	Reused DIMMs match new-buy failure rates	Fleet-wide deployment
Rack Frame	PILOT	Structural integrity validated	Pilot ready, Scaling in 2027
HDD	HACK	Mechanical wear introduces higher variance; SMART data helps but is imperfect	Under evaluation for cold-storage tiers only
NIC	PILOT	Firmware compatibility across generations is the main challenge	Pilot with same-gen reuse; cross-gen under study
BBU	NO-GO	Battery degradation is non-linear; capacity fade below safety thresholds	Recycled, not reused

Design Determines Destiny

Socketed → Soldered

Sanitisable → Must-destroy

Modular → Integrated

AI hardware is trending toward tighter integration, less separable, harder to reuse.

Design for reuse must be a constraint at NPI, not a question at end-of-life.

By end-of-life, the destiny is already set.

The Next Question: Who Gets the Credit?

Measure → Reduce → Avoid

Today there is no agreed method to:

- Allocate embodied carbon across successive owners
- Credit the organisation that enables reuse
- Track carbon benefits across organisational boundaries

Without a crediting method, the incentive to do the harder circular work is weak.

Two new OCP workstreams launching:

Carbon accounting for circularity

Operational aspects of circularity

This is a policy and standards gap, exactly where this room can help.

Four Pillars + The OCP Ecosystem

01 Multi-Lifecycle Planning

Design procurement around 2-3 deployments per component, not single-use.

02 Universal Qualification

OCP-backed standards for testing, grading, certifying reused components.

03 New Commercial Models

Performance-based SLAs instead of origin-based OEM restrictions.

04 Design for Reuse

Modular, socketed, telemetry-rich, built for multiple lifecycles from day one.

Ecosystem bridges: IMEC (semiconductor) · SNIA (storage) · PACT (data quality) · SEMI SCC (supply chain) · EU EED (regulatory) · DICE N+

Call to action

OCP Circularity open workstream

We are finalizing the “Ecosystem for Circularity in Datacenters” white paper. There is still time to contribute!

OCP future closed workstreams

Defining two workstreams:

- Circularity Carbon Accounting
- Operations for Internal Reuse

SNIA is creating circularity workstreams

SNIA is working on circularity workstreams for storage intensity metrics and reuse standards.

Creativity and Innovation

The industry will hit challenges across every aspect of system design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