How can life cycle assessment (LCA) support Hub activities and the ELLA methodology?

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GIRFT Greener Pathways: Learning and Networking Day | Bristol | 28 September 2026

CONTEXT

Where this talk fits

GIRFT Greener Pathways, the ELLA framework and the Sustainable Health Systems (SHS) Hub

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Greener Pathways

GIRFT programme

Redesigns care pathways to cut carbon, at equal or better quality.

ELLA framework

Environmental Lessons Learned and Applied

Pathway-level methodology for decarbonisation guidance.

SHS Hub

Sustainable Health Systems Hub

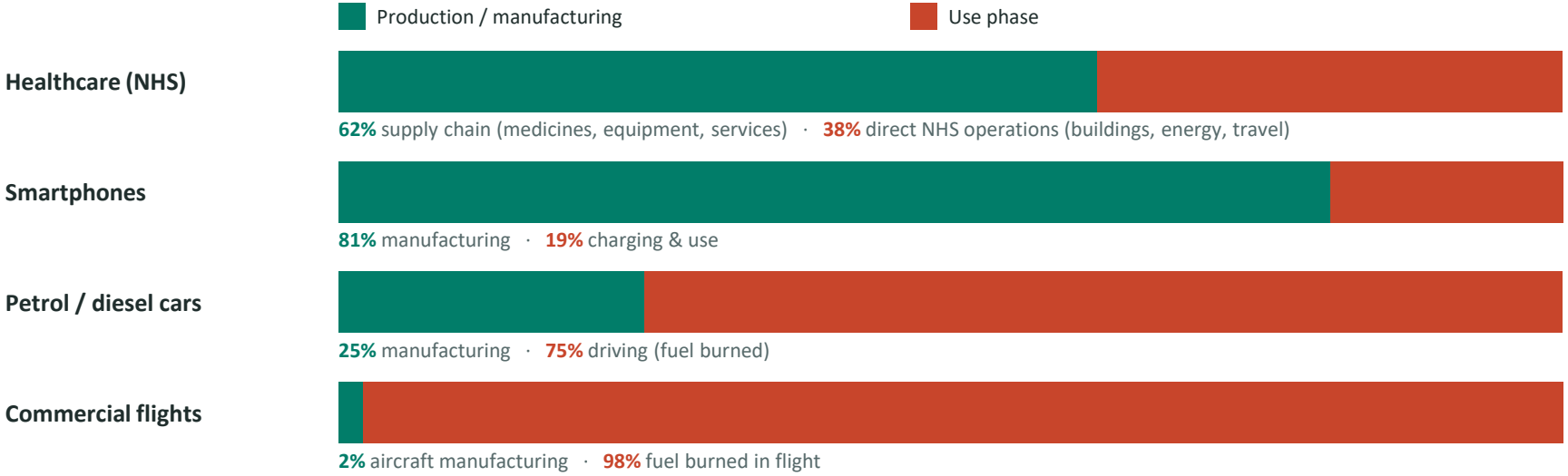
UKRI/NIHR-funded, based at Exeter, with GIRFT as a key partner.

This talk: how life cycle assessment can add rigour to the evidence behind sustainability decisions.

Sources: GIRFT (gettingitrightfirsttime.co.uk); John JB, Gray WK, Rizan C, et al. ELLA framework. BMJ Evid Based Med 2026, doi:10.1136/bmjebm-2025-113911; shs-hub.org.

CONTEXT

Where the carbon footprint sits



You can't manage what you can't see. LCA follows emissions back through the supply chain to where they actually arise.

Sources: NHS England, Delivering a Net Zero National Health Service (2020) and published smartphone, automotive and aviation life-cycle studies. Figures are illustrative and rounded.

THE METHOD

What is life cycle assessment?

In simple terms: LCA adds up the environmental impact of something — a product, an organisation, even a whole sector — across its entire life cycle, from raw materials to end of life. It follows an internationally agreed method (ISO 14040/14044), so results can be checked and compared.

Raw materials

Oil, metals and minerals for plastics, devices and active ingredients

Manufacture

Making and packaging a syringe, a drug or a surgical kit

Distribution

Transport, storage and the cold chain to the ward or clinic

Use

Energy, water, gases and sterilisation during care

End of life

Incineration, landfill, recycling or wastewater

Burden shifting: Burdens rarely disappear. They move somewhere else in the life cycle.

THE METHOD

Four steps of an LCA

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1

Goal & scope

Define the question, the functional unit and the system boundary.

What are we comparing?

2

Inventory

Collect data on all inputs and outputs: materials, energy, water, emissions.

The most data-hungry step

3

Impact assessment

Translate the inventory into impacts, such as kg CO_2e for climate change.

Many impact categories

4

Interpretation

Test assumptions, check uncertainty and draw conclusions.

Where decisions are informed

Iterative: findings feed back into goal and scope

The functional unit is the fair basis for comparison. Compare 'a year of asthma control', not per 'one inhaler'.

THE METHOD

Beyond carbon: many impacts

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Climate change

Greenhouse gases

Energy, anaesthetic gases, propellants

Water use

Freshwater consumed

Manufacturing, laundering, sterilisation

Resource use

Metals, minerals, fuels

Devices, electronics, plastics

Air pollution

Acidification, PM2.5

Combustion, transport, incineration

Eutrophication

Nutrient pollution

Food supply, wastewater

Toxicity

Human & eco harm

Chemicals, pharmaceutical residues

Why look beyond carbon?

A choice that cuts carbon can raise water use or toxicity. LCA makes these trade-offs visible before we lock them in.

Burden shifting between impact categories.

APPLICATION

How LCA is used across sectors

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Private sector

- Product design & labelling
- Compliance and risk
- Strategic planning

Ours: anaesthetic gases (SageTech); cups (Bunzl); rockets (Orbex).

Public sector

- EU product policy (PEF)
- Reporting rules (CSRD, CBAM)
- NHS supplier roadmap, social value

Academia

- New methods & open data
- Independent analysis & review
- Training practitioners

Ours: technologies, households to whole sectors.

For the NHS: buyers ask for footprints, suppliers produce them, and academics help make them robust.

IN HEALTHCARE

What LCA shows in healthcare

Anaesthetic gases

OUR WORK

Warming impact varies many-fold by agent. Our own LCA work, with SageTech.

Inhalers

Propellants drive ~20% of primary-care carbon.

Single-use vs reusable

No universal winner: depends on reuse rate and local electricity mix etc.

Care pathways

Telehealth saves travel only if it directly replaces a visit.

LCA is most useful when it identifies a hotspot and a credible alternative.

OUR RESEARCH

What our research tells us

Evidence review

- 88 studies claim carbon savings across hospital care
- Only 19 were full LCAs
- Quality was mixed, even among those full LCAs

Impacts in health terms

- LCA can convert impacts into health terms, not just carbon
- Global plastics study: 83 million DALYs under business as usual
- Cutting production mattered more than better recycling

Whole-organisation LCA

- Applied LCA to a whole organisation with the National Trust
- Built on carbon accounts already in place, not from scratch
- The same approach could work for an NHS trust

In the backup slides: the full charts, numbers and sources behind each study, ready for discussion.

From product to care pathway

Life cycle thinking along a patient pathway (illustrative hotspots)

Assessment	Initial treatment	Ongoing care	Follow-up	Discharge
• Imaging, lab tests • Travel	• Theatre energy, gases • Devices	• Ward energy • Medicines	• Outpatient visits • Remote vs face to face	• Community contacts *Least evidence in our review*

Functional unit: one patient taken through the pathway to the same clinical outcome.

Boundary: from referral to discharge and follow-up, including patient travel.

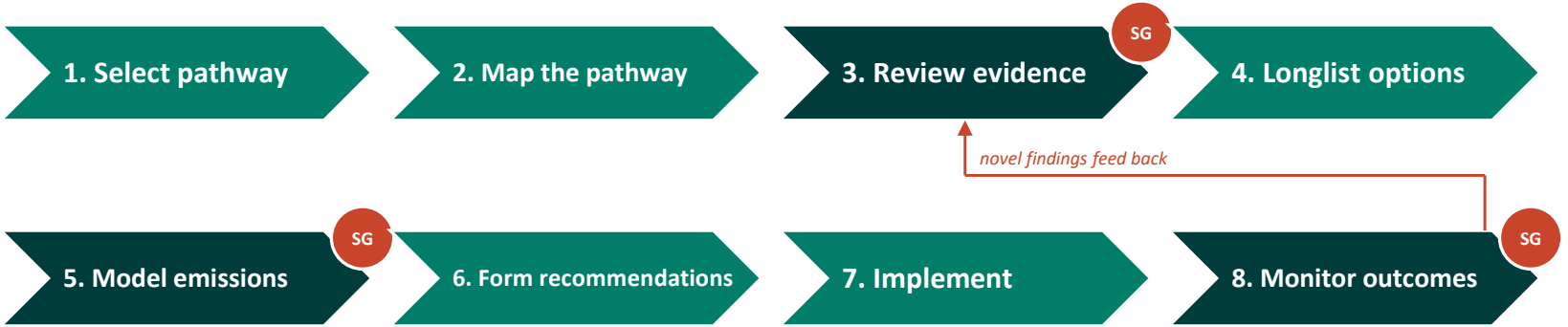
Compare: alternatives on the same outcome, checking for burden shifting between stages.

Pathway stages follow the evidence and gap map in Shaw et al., Campbell Syst Rev 2025;21(4):e70077.

THE FRAMEWORK

LCA within the ELLA framework

ELLA's 8 steps (John, Gray, Rizan et al. BMJ Evid Based Med 2026) and where LCA expertise plugs in



SCIENTIFIC REFERENCE GROUP (SG)

- LCA experts
- Behavioural science
- Health equity

- Secondary analysis of LCAs
- Advise on and verify or undertaking modelling
- Help design interventions
- Refine modelling and improve evidence

THE FRAMEWORK

Why this matters for ELLA and the Hub

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Trustworthy evidence

- LCA expertise judges whether a footprint claim is solid enough to act on
- Flags when a study's boundary doesn't fit the NHS context
- Sits in ELLA's “review evidence” step

Consistent modelling

- Adapts existing data, e.g. to a UK electricity mix
- Compares options on a fair, like-for-like basis
- Supplies the numbers for ELLA's “model emissions” step

A growing evidence base

- Monitoring findings feed back into the evidence review
- Each pathway studied builds the shared library
- Makes the next pathway faster to assess

THE VISION

What would it take?

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Better data

- Open datasets, e.g., shared via the Hub
- Verified supplier footprints
- Common methods across pathways

Joined-up evidence

- Alongside outcomes, cost, equity
- Linked to health economics
- Whole pathways, not one product

Skills & governance

- Experts alongside GIRFT Fellows
- LCA literacy, e.g., via the Academy
- Criteria in procurement

A pragmatic principle: fast screening for everyday choices; rigorous, reviewed LCA where the stakes are high.

HANDLE WITH CARE

Use LCA with care

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Boundaries decide the answer

- What's counted changes the ranking
- Manufacture-only view can differ from full life cycle
- Always compare like with like, on the same outcome

Data are imperfect

- Much LCA data is generic, not NHS- or UK-specific
- Every result carries uncertainty
- A small difference may just be noise

Watch for burden shifting

- A win on carbon can raise water use or toxicity
- Impacts can land in a different country to where a product is used
- Ask what moved, and to where

In the backup slides: the full data behind each caution, including real examples from our own research.

HANDLE WITH CARE

Questions to ask of any LCA

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1

What exactly was compared?

The same clinical function and the same functional unit?

2

What was left out?

Where are the system boundaries?

3

Where do the data come from?

Specific, generic or spend-based, and from which year and region?

4

How uncertain is the result?

Are sensitivity analyses or uncertainty ranges reported?

5

Which impacts were assessed?

Carbon only, or water, toxicity and resources too?

6

Who did it, and was it reviewed?

Following ISO 14040/14044, ideally with independent critical review.

Use LCA to inform decisions, not to make them. It does not replace clinical, economic and ethical judgement.

Take-home messages

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LCA gives numbers and checks

It reveals hidden hotspots in supply chains and pathways, and can express impacts in environmental and human health terms.

Build it into ELLA and the Hub

Pathway-level, linked to clinical outcomes, health economics and procurement, and built on existing carbon accounts.

Use it with care

Check scope, data and uncertainty, and watch for burden shifting. Inform decisions; don't outsource them.

Good enough to decide, honest about the limits.

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Thank you. Questions?

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Backup slides

Supporting evidence and detailed data

For discussion and questions

BACKUP · SYSTEMATIC REVIEW

What the evidence says

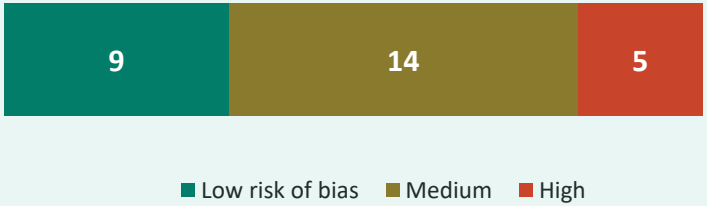
Our systematic review of carbon-reduction interventions in secondary healthcare

88 studies of carbon-reduction interventions across hospital specialities (33 in the UK)

28 used life cycle methods, and only 19 of those were full LCAs

26 were telehealth studies, and 23 of them used non-LCA methods

Risk of bias in the 28 LCA-informed studies



Telehealth: usually counted only the patient travel saved. Digital technology and clinic energy were often left out.

Reusable vs single-use: lower carbon in gastroenterology, but reversed and uncertain in urology, because of how reprocessing was counted.

Promising interventions, but stronger and fuller life cycle methods are needed.

Shaw L, Orr N, Lawal HM, Briscoe S, Yan X, Thompson Coon J, Melendez-Torres GJ, Martin-Pintado C, Garside R. Effectiveness of interventions to reduce carbon emissions within secondary healthcare: systematic review and evidence and gap map. Campbell Syst Rev 2025;21(4):e70077. doi:10.1002/cl2.70077

From emissions to health: plastics

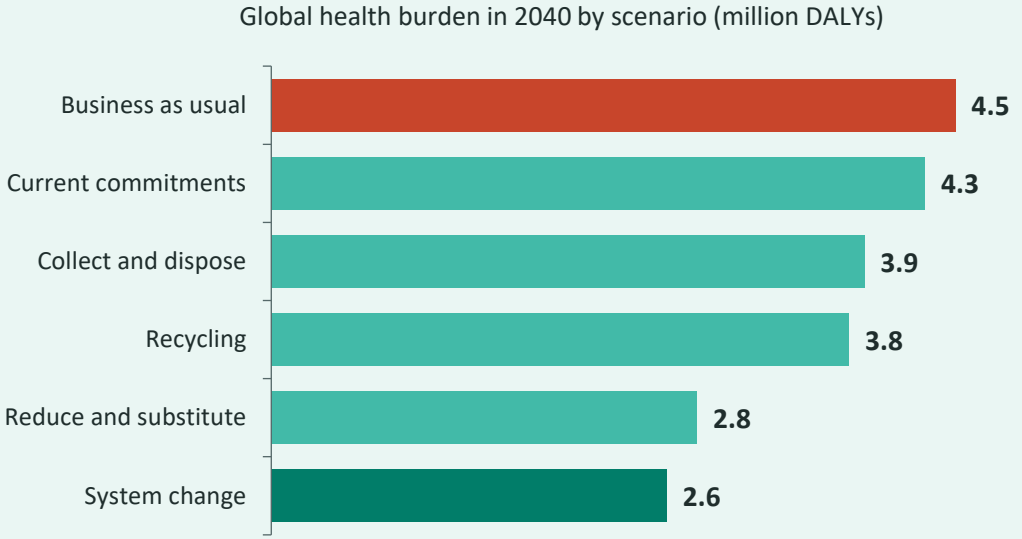
A global LCA of plastics in disability-adjusted life-years (DALYs)

83 million

DALYs from the global plastics system, 2016–40, under business as usual

–43%

annual DALYs in 2040 under 'system change', versus business as usual

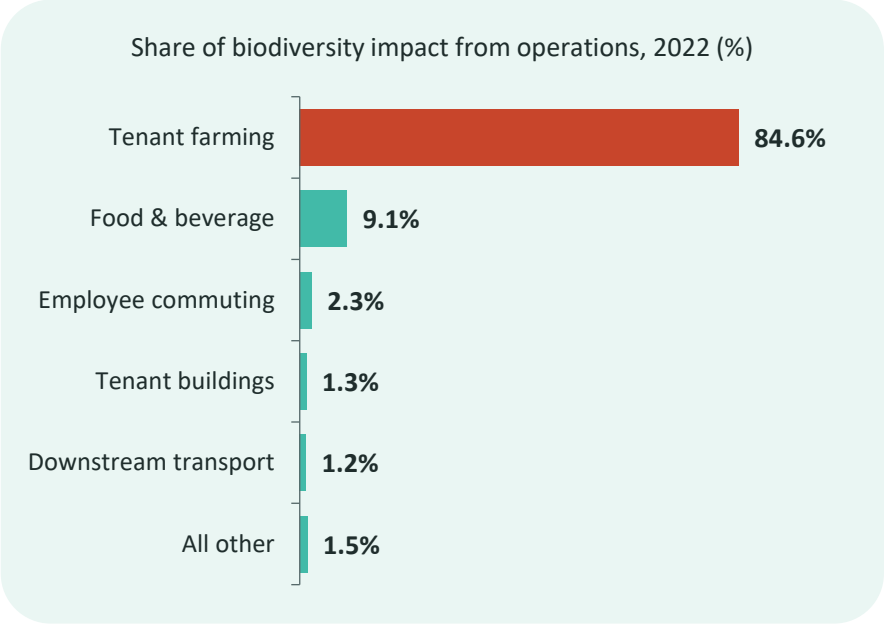


Cutting primary plastics production was the most effective single lever. Better waste management or recycling alone did far less.

Deeney, Hamelin, Vialle, Yan et al. Lancet Planetary Health 2026;10:101406.

Organisation-level LCA

The National Trust: finding biodiversity hotspots across a whole organisation



Start from what you already have. The Trust's existing carbon accounts (GHG Protocol scopes 1–3) formed the inventory.

Land use dominates. About 69% of impact, then climate (15–16%) and acidification (8–9%). Results were stable across 2020–22.

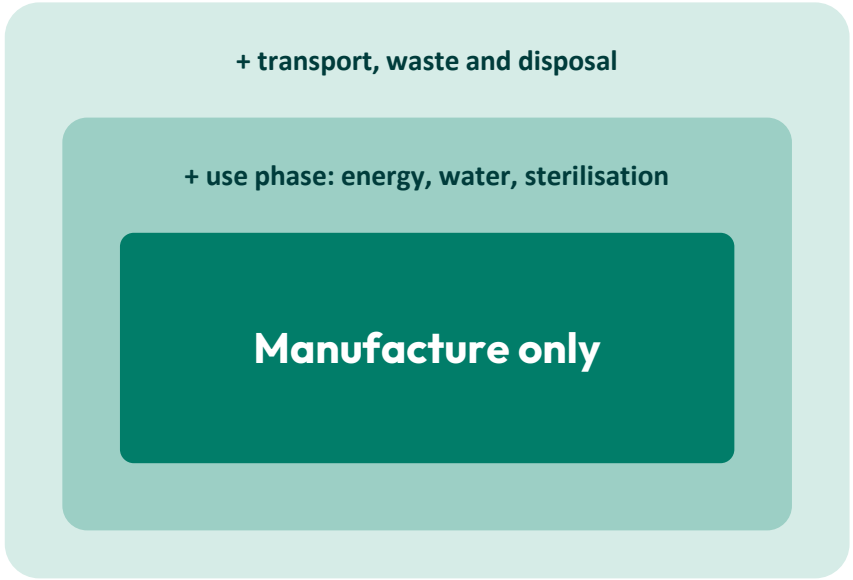
The healthcare parallel. A trust or integrated care system could build on its own carbon account, then add impacts beyond carbon.

Purchased goods and services, mainly construction, were assessed separately and added a substantial upstream burden.

Correa-Cano, Hails & Yan. Opportunities and challenges in using LCA for organisational-level biodiversity impacts. J Environ Manage 2026;402:129189.

BACKUP · BOUNDARIES

Boundaries decide the answer



Same product, three boundaries, three possible answers

Like with like. Same clinical function, same functional unit.

Boundaries matter. Leaving out sterilisation, transport or disposal can tilt the ranking.

Assumptions can flip results. Reuse numbers, electricity mix and disposal route are typical swing factors.

IN OUR WORK

Most telehealth studies in our review counted only patient travel saved.

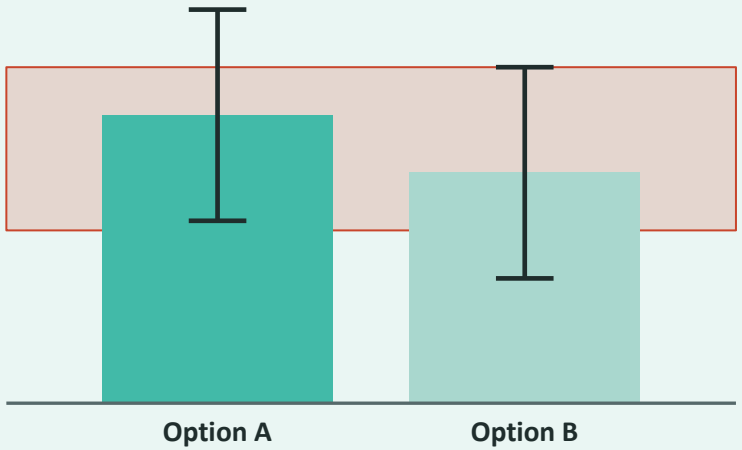
In our plastics model, the assumed paper-for-plastic substitution ratio moved the 2040 benefit between roughly 25% and 46%.

BACKUP · DATA & UNCERTAINTY

Data are imperfect and uncertain

ILLUSTRATIVE ONLY

Footprint per patient



Ranges overlap: the 'difference' may be noise

Generic, not local. Most background data come from other regions and years. Our plastics inventories were extrapolated from Europe and North America.

Gaps in the inventory. Chemicals in plastics are largely undisclosed, so health impacts may be underestimated by at least an order of magnitude.

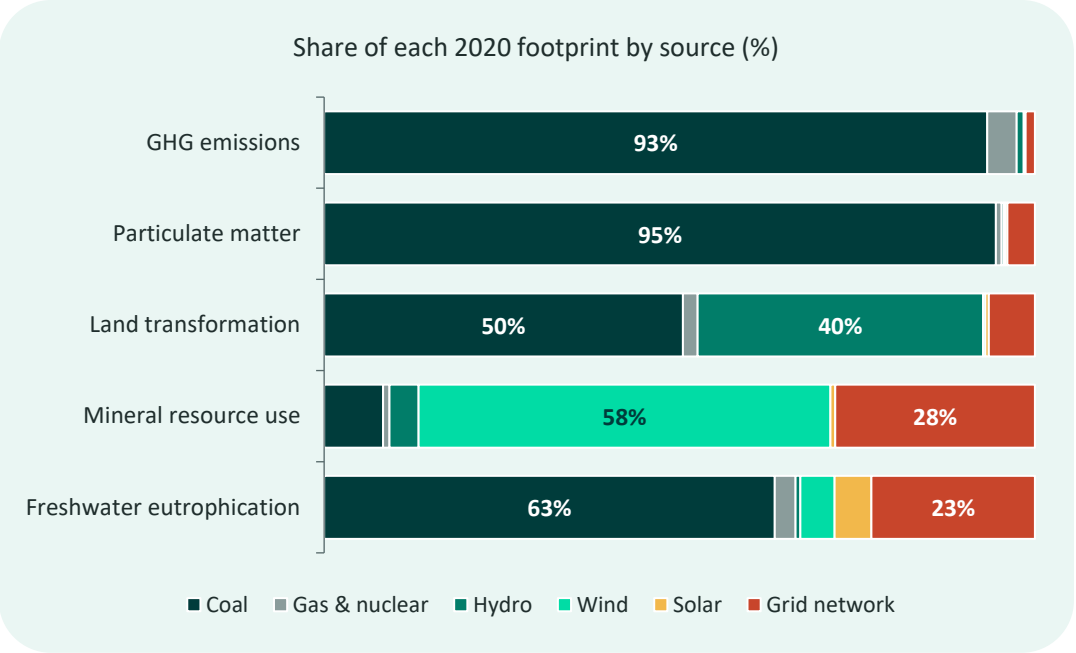
Spend-based shortcuts. Our National Trust study modelled purchases from spend, using 2011 input–output data adjusted for inflation.

Ranges matter. We ran Monte Carlo simulation on background data only, so uncertainty is still understated.

BACKUP · BURDEN SHIFTING

Watch for burden shifting

Our spatially explicit LCA of China's electricity supply



Coal dominates carbon and air pollution: 93% of greenhouse gases and 95% of particulates.

Other impacts sit elsewhere: wind is 58% of mineral use, hydro 40% of land transformation, and the grid itself 28% of mineral use.

Impacts land in different places: 99% of the carbon was in China, but over 60% of the freshwater eutrophication from solar power in Gansu occurred abroad.

The same logic applies to NHS supply chains: a product swap can shift impacts between categories and countries.

Liu, Shi, Gaston, Mueller & Yan. J Clean Prod 2025;520:146164. Shares calculated from the paper's Table 1.