FINDING A SUSTAINABLE SCIENCE

A GRASSROOTS PERSPECTIVE

Peter Millington

UKRI Future Leaders Fellow, University of Manchester

UK HEP Forum, Abingdon, 2024

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A GRASSROOTS PERSPECTIVE (AND AN UNAVOIDABLY PERSONAL ONE)

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The climate crisis is here.

“Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850-1900 in 2011-2020. Global greenhouse gas emissions have continued to increase, with unequal historical and ongoing contributions arising from unsustainable energy use, land use and land-use change, lifestyles and patterns of consumption and production across regions, between and within countries, and among individuals (*high confidence*).”

Excerpted from IPCC 2023 Synthesis Report, Summary for Policymakers.

It is not fair.

“Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred. Human-caused climate change is already affecting many weather and climate extremes in every region across the globe. This has led to widespread adverse impacts and related losses and damages to nature and people (*high confidence*). Vulnerable communities who have historically contributed the least to current climate change are disproportionately affected (*high confidence*).”

Excerpted from IPCC 2023 Synthesis Report, Summary for Policymakers.

And we are not on track.

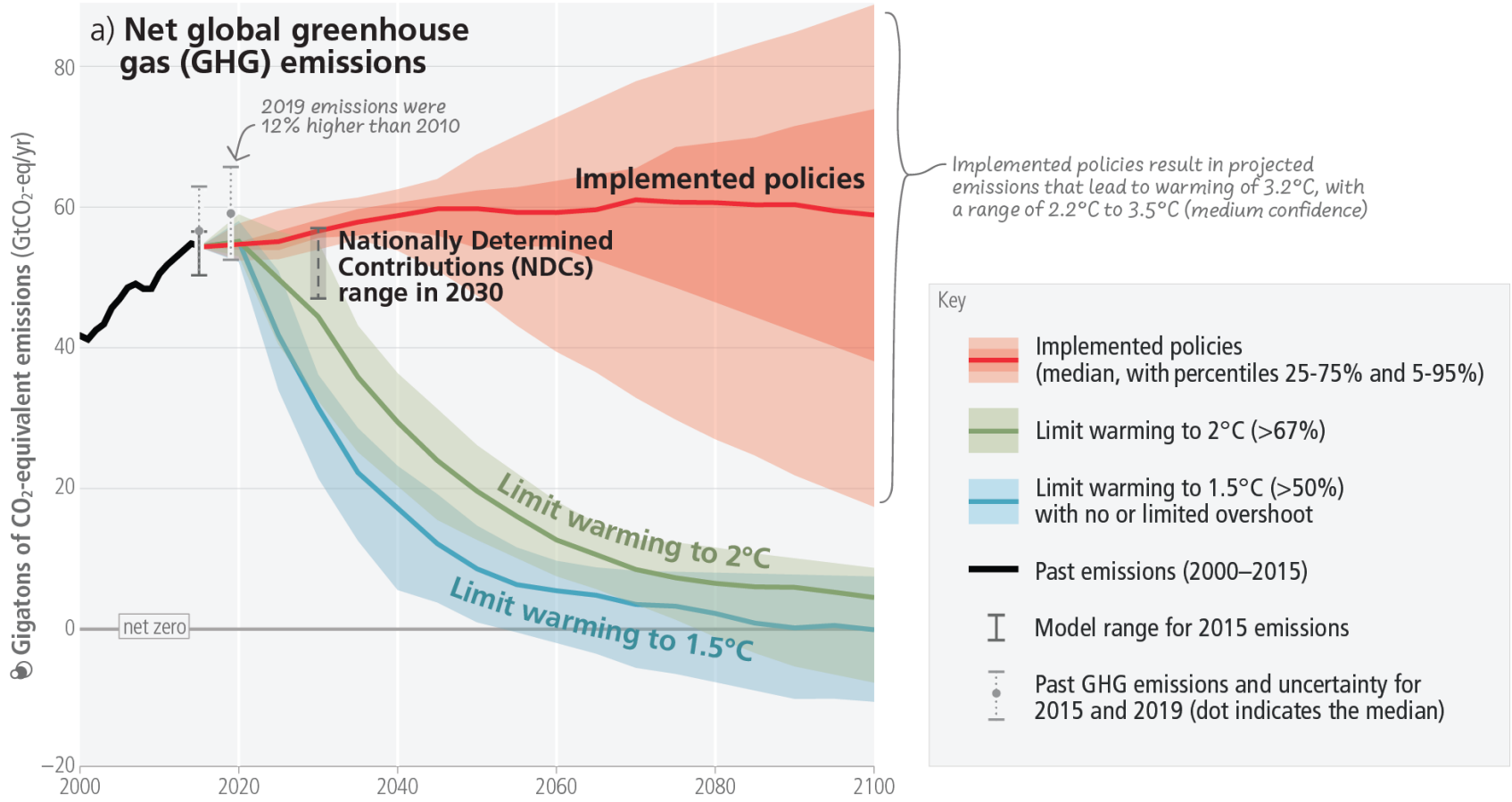


Figure excerpted from IPCC 2023 Synthesis Report, Summary for Policymakers.

Plans to commit to a bolder pledge in UK NDC are welcome.

81% reduction on 1990 levels in territorial emissions (excludes international aviation and shipping) by 2035.

But it needs to happen.

See https://www.gov.uk/government/news/uk-shows-international-leadership-in-tackling-climate-crisis

The ambitions of UKRI's Environmental Sustainability Strategy are welcome.

"embed environmental sustainability in everything we do"

"achieve 'net-zero' for our carbon emissions" by 2040

But it needs to happen.

See https://www.ukri.org/wp-content/uploads/2020/10/UKRI-050920-SustainabilityStrategy.pdf

We need to make it happen.

Who do I think I am?

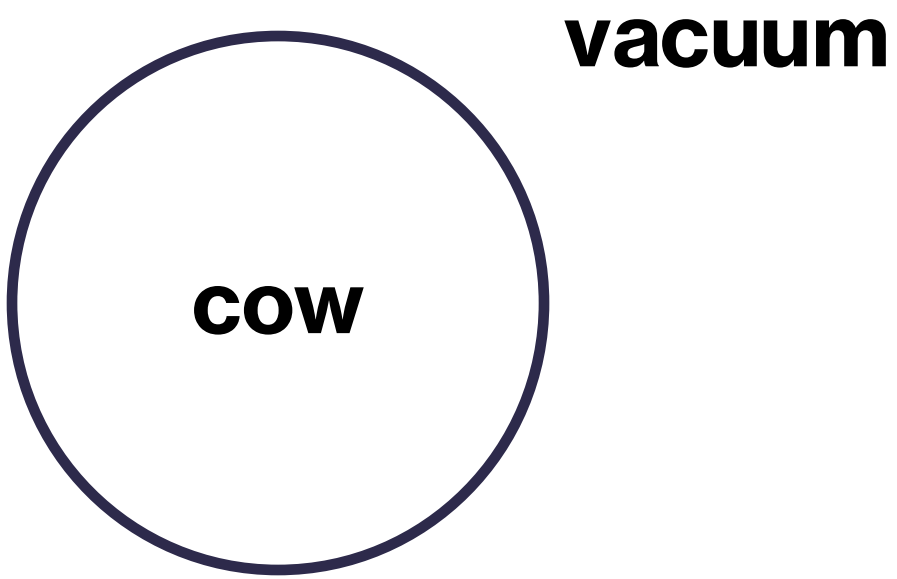
Who gets to talk about sustainability?

EVERYONE

So who do I think I am?

The perspective of a **theoretical physicist**,
working in **high energy physics, cosmology and astroparticle physics (HECAP)**.

There are no proxy problems when it comes to sustainability.



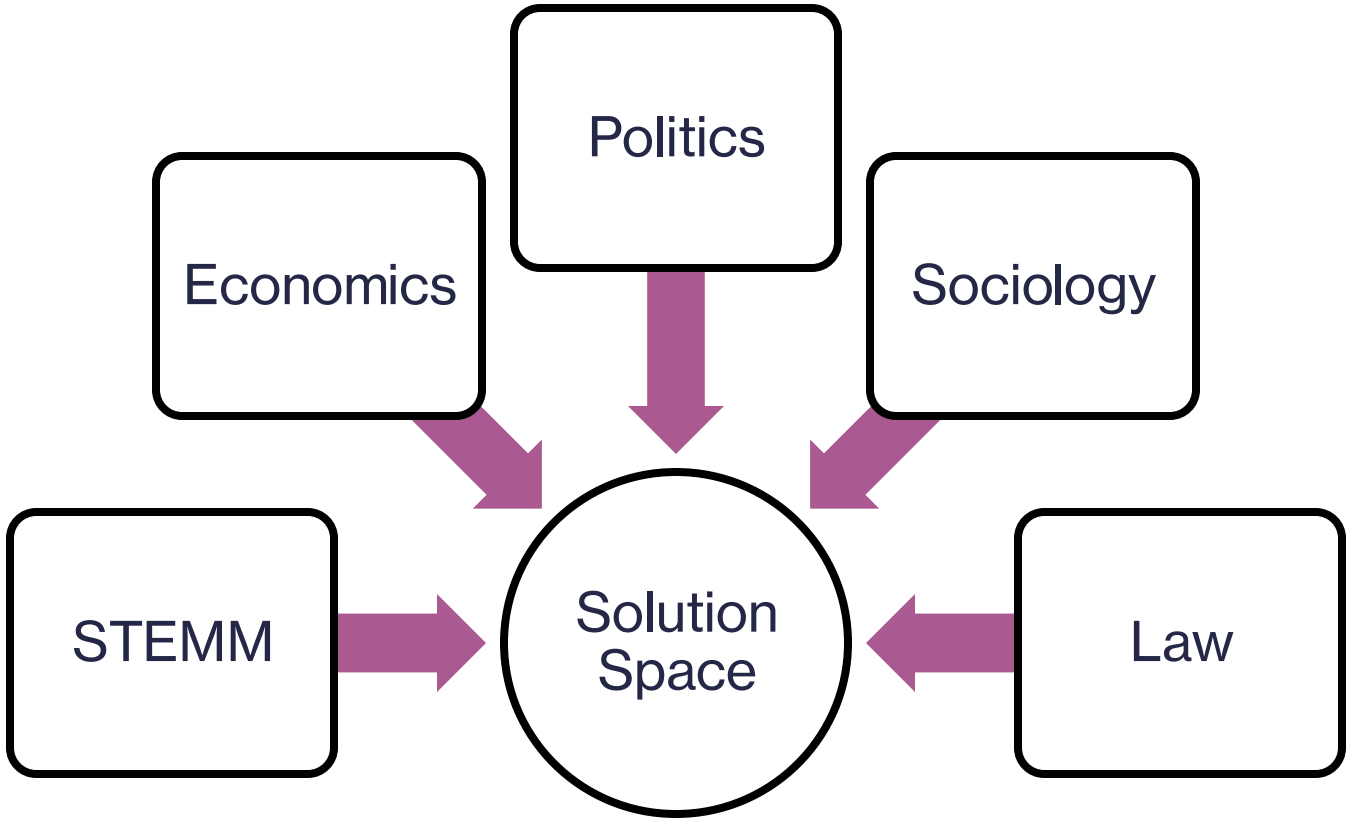
The climate crisis is a wicked problem.

A **wicked problem**:

1. No definitive formulation
2. No stopping rule
3. Not true-or-false, but good-or-bad
4. No solution test
5. No trial and error
6. No enumerable set of solutions
7. Essentially unique
8. A symptom of other problems
9. Numerous representations
10. No right to be wrong

(Rittel and Webber 1973)

The climate crisis is an interdisciplinary problem.



So what about us (HECAP)?

Beware: climate whataboutery

We have moral and pragmatic reasons to act.

- As scientifically literate citizens, we have a responsibility to lead by example and limit our negative environmental impacts.

- And if we believe our science is of value to society (and I do) then we want to be allowed to keep doing it.

Our social licence to operate is a fragile privilege.

The public, funders and governments entrust us with financial and material resources, and we are accountable for how we use them.

We need to take ownership of our positive and negative externalities.

An **externality**:

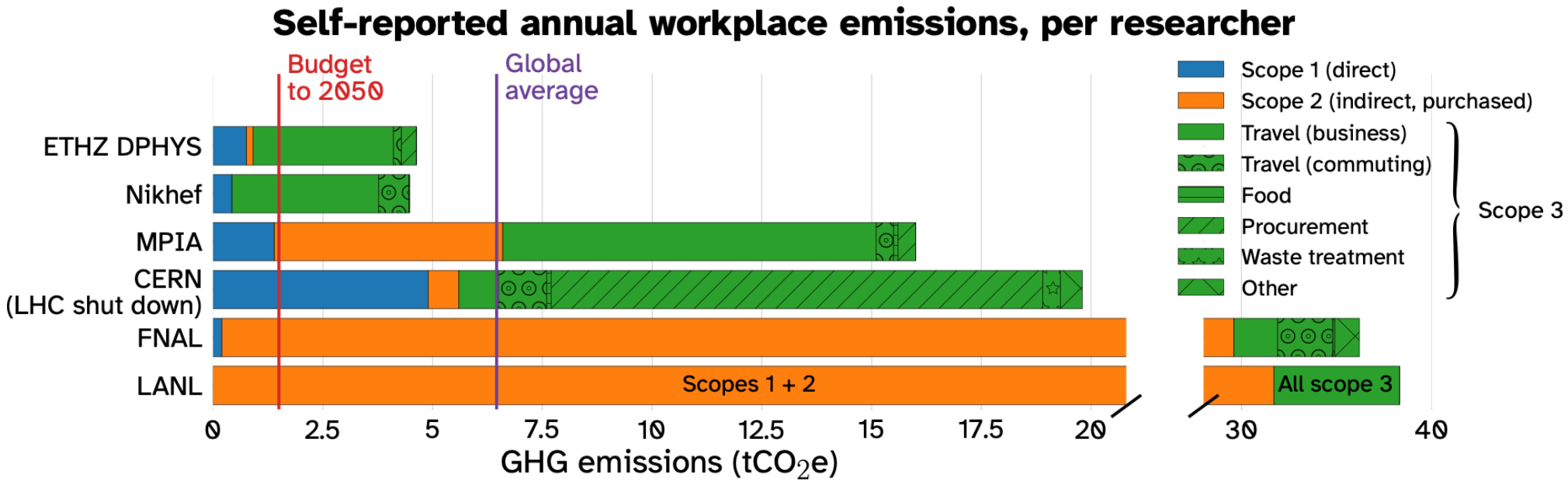
A cost or benefit caused by one party on another.

We need to ask:

How does our science **benefit** society?

How does our science **cost** society?

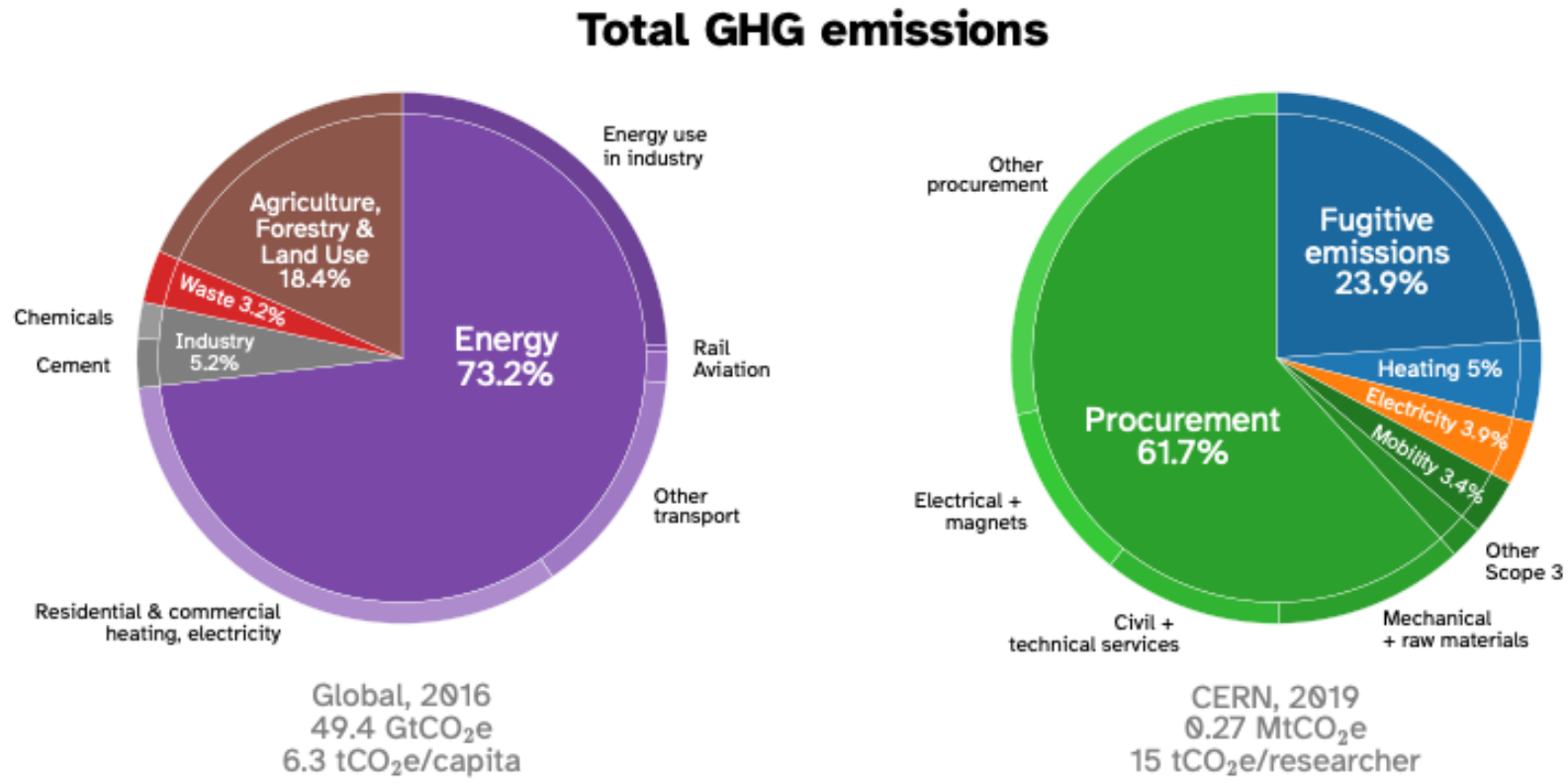
Our emissions are too high.



2019 data, save MPIA (2018), and ETHZ business travel (average 2016-2018).

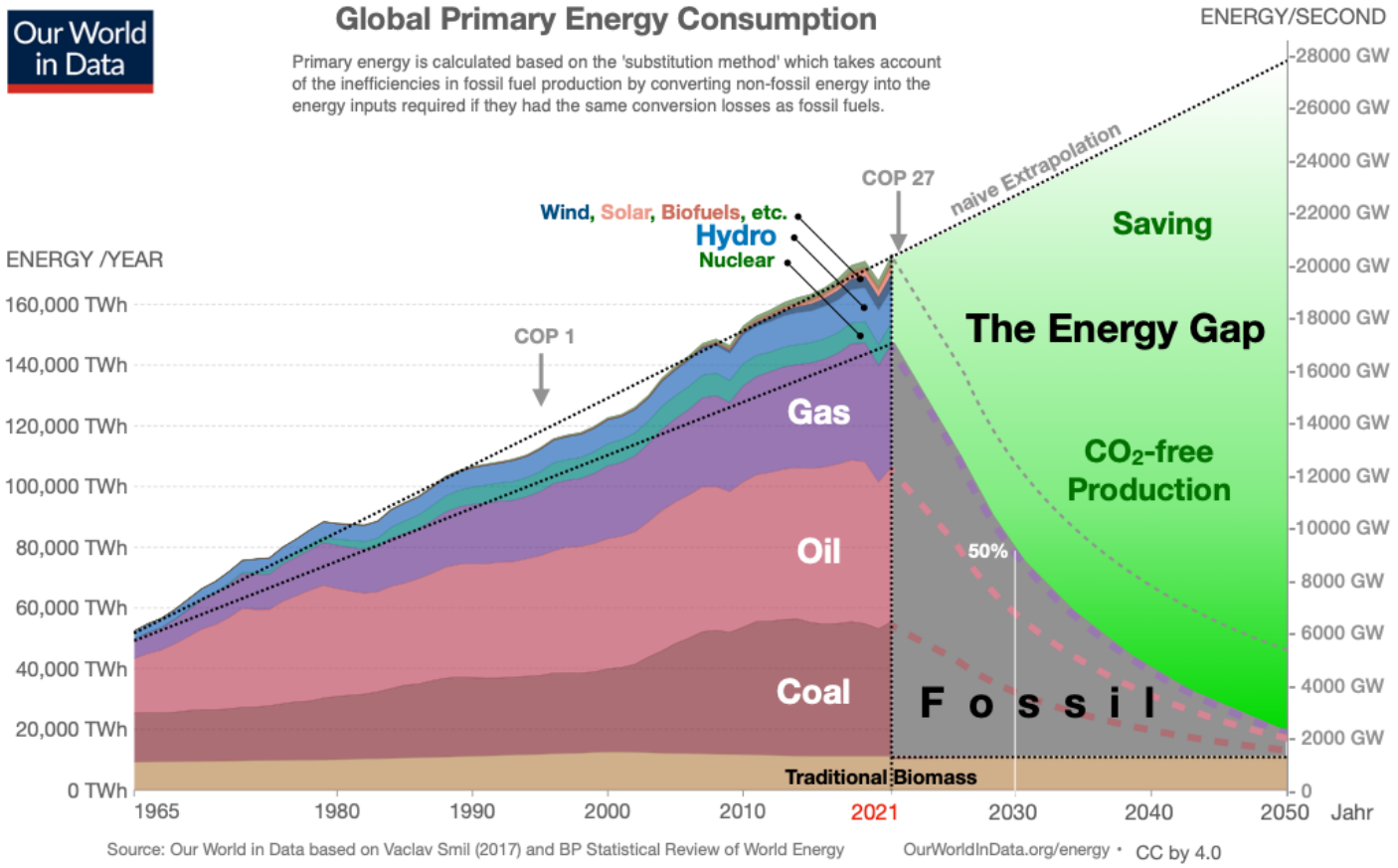
Based on self-reported data from institutional reports; see HECAP+ reflective document for full references.

Our emissions profile is different.



Based on H. Ritchie et al., “CO2 and Greenhouse Gas Emissions,” Our World in Data 2020 and self-reported data from institutional reports; see HECAP+ reflective document for full references.

Energy will be scarce & expensive.



From H Ritchie et al. “Energy”, Our World in Data 2020, reused and adapted in the HECAP+ reflective document under CC BY 4.0.

Environmental sustainability in basic research: a perspective from HECAP+

- arXiv:2306.02837 to appear in JINST (2024)
- Grassroots reflection on sustainability in the context of HECAP+: High Energy Physics, Cosmology, Astroparticle plus Hadron and Nuclear Physics
- Conceived at the 2021 Sustainable HEP workshop
- Relevance across big science

Environmental sustainability in basic research
A perspective from HECAP+

Sustainable HECAP+ Initiative

Abstract
The climate crisis and the degradation of the world's ecosystems require humanity to take immediate action. The international scientific community has a responsibility to limit the negative environmental impacts of basic research. The **HECAP+ communities** (**High Energy Physics, Cosmology, Astroparticle Physics, and Hadron and Nuclear Physics**) make use of common and similar experimental infrastructure, such as accelerators and observatories, and rely similarly on the processing of big data. Our communities therefore face similar challenges to improving the sustainability of our research. This document aims to reflect on the environmental impacts of our work practices and research infrastructure, to highlight best practice, to make recommendations for positive changes, and to identify the opportunities and challenges that such changes present for wider aspects of social responsibility.

Version 2.0, 18 August 2023
Please read this document in electronic format where possible and refrain from printing it unless absolutely necessary. Thank you.

Other sources are available.

- Young High Energy Physicists association, “yHEP recommendations on improvement of environmental sustainability in science”, 2020.
- Nature Astronomy, “The climate issue,” Nature Astronomy 4, pp. 811, 2020.
- ALLEA, “Towards climate sustainability of the academic system in Europe and beyond,” 2022.
- K. Bloom et al., “Climate impacts of particle physics,” in 2022 Snowmass Summer Study 3, 2022.
- V. Lang et al., “Know your footprint -- Evaluation of the professional carbon footprint for individual researchers in high energy physics and related fields”, 2024.
- J. Alimena et al., “Sustainable computing workshops in high-energy physics at DESY”, 2024.
- K. Bloom and V. Boisvert, “Sustainability and carbon emissions of future accelerators”, 2024.
- Astronomers for Planet Earth
- Labos1point5

We took a holistic approach.

Areas of focus:

- Hardware
- Software
- Data Centres

- Sources
- Saving
- Recuperation

- Conferences
- Canteens

- Commuting
- Conferences
- Collaboration

- Life Cycle
- F-Gases

- Consumables
- E-Waste

With recommendations targeted at:

Individuals

Groups

Institutions

There is no one-size fits all solution.

Sustainability is a **systems problem**.

Environmental sustainability and equity can be in tension.

An example: **limiting business air travel**

Positives

- Reduction in emissions

Negatives

- Further entrenching geographic disparities
- Disproportionate impacts on career progression
- Disproportionate impacts on those unable to take longer trips

The conclusion:

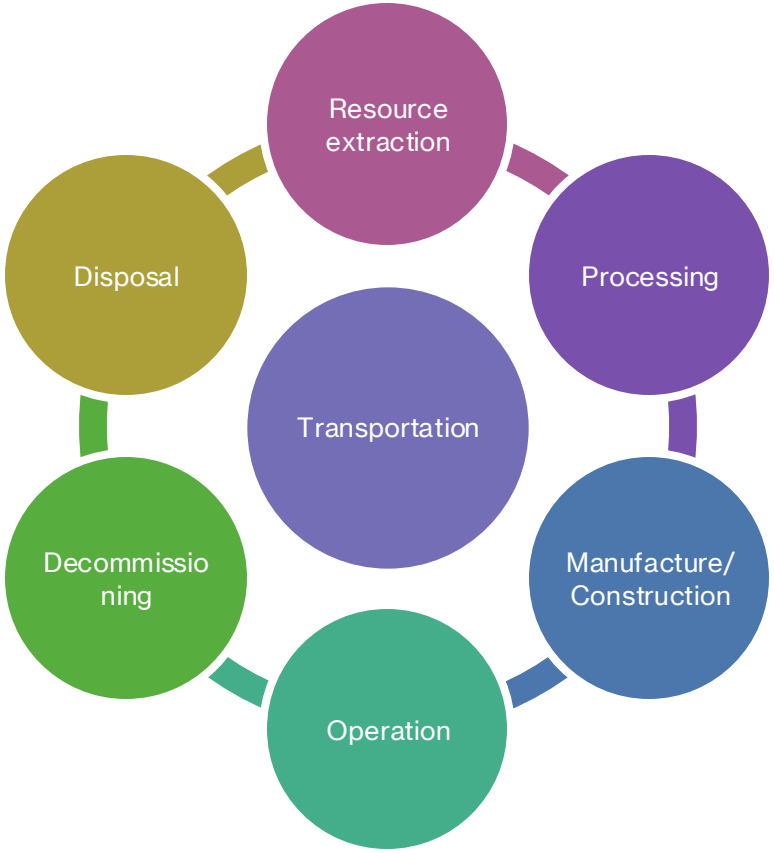
“Assessing, reporting on, defining targets for, and undertaking coordinated efforts to limit our negative impacts on the world’s climate and ecosystems must become an integral part of how we plan and undertake all aspects of our research.”

From HECAP+ reflective document

Life Cycle Assessment should be standard practice.

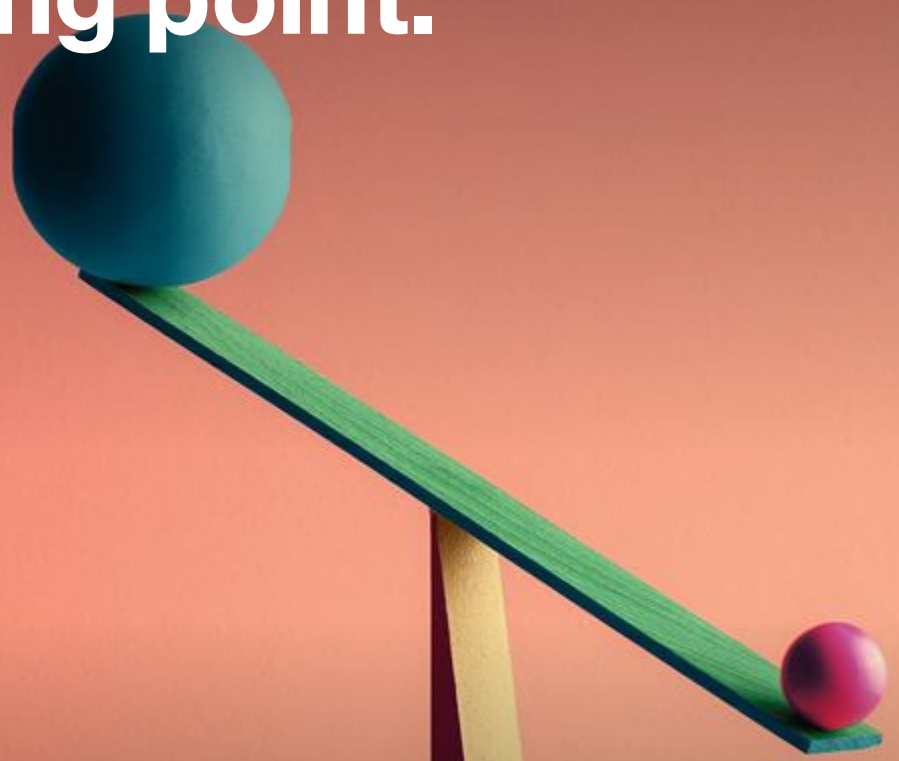
Assess the environmental impact of a project

over its entire life cycle, **cradle to grave**.



But this is only a start ...

We need to drive our field toward a social tipping point.



A **social tipping point**: small changes trigger a rapid shift in social norms.

There are good signs.

Governance	Strategy	Process	Platform	Research
collaborations	European Strategy Update in PP 2026	ILC and CLIC LCA (Evans 2023)	Dedicated conferences, e.g., Sustainable HEP	labos1point5
institutions	Snowmass 2021 and P5 Report 2023	ESO and GRAND LCAs	Plenary talks and parallel tracks, e.g., ICHEP2024	Innovate for Sustainable Accelerating Systems
funders	ICFA Sustainable Accelerators & Colliders 2024	CERN Environmentally Responsible Procurement Policy	**This UK HEP Forum!**	Reduction in F-gases (e.g. LHCb)
				Green computing

See accompanying references for links.

Are we ready to go further?

What can we achieve by addressing perverse incentives?

- Competition versus collaboration
- Hypermobility
- Metric-driven science

What can we achieve by siting infrastructure differently?

Climate

Ensuring proximity to sources of renewable energy.

Equity

Addressing systemic geographic disparities.

What does a truly sustainable, global and equitable cutting-edge science look like?

And how might we get there?

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