Green Labs and More

Martin Farley – Soon formerly UCL and LEAF, currently Green Lab Associates, and onto …

Quiz

Energy used to cost major London research institutions about £15 million per annum. What will it cost this year?

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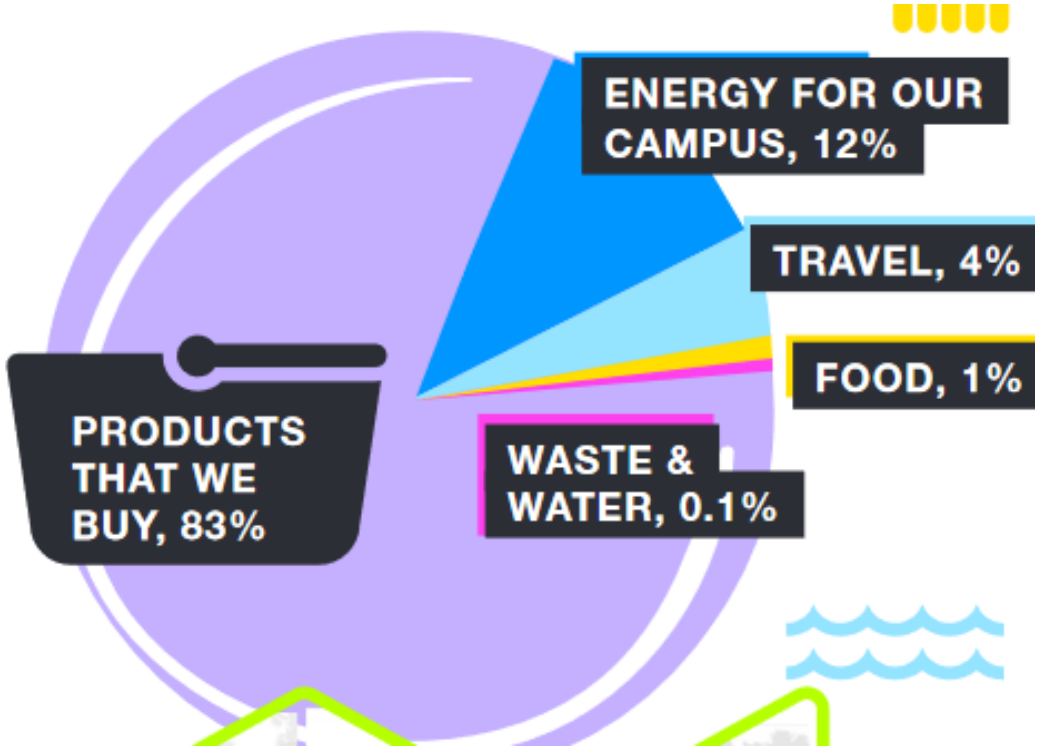
a. 15 million

b. 20 million

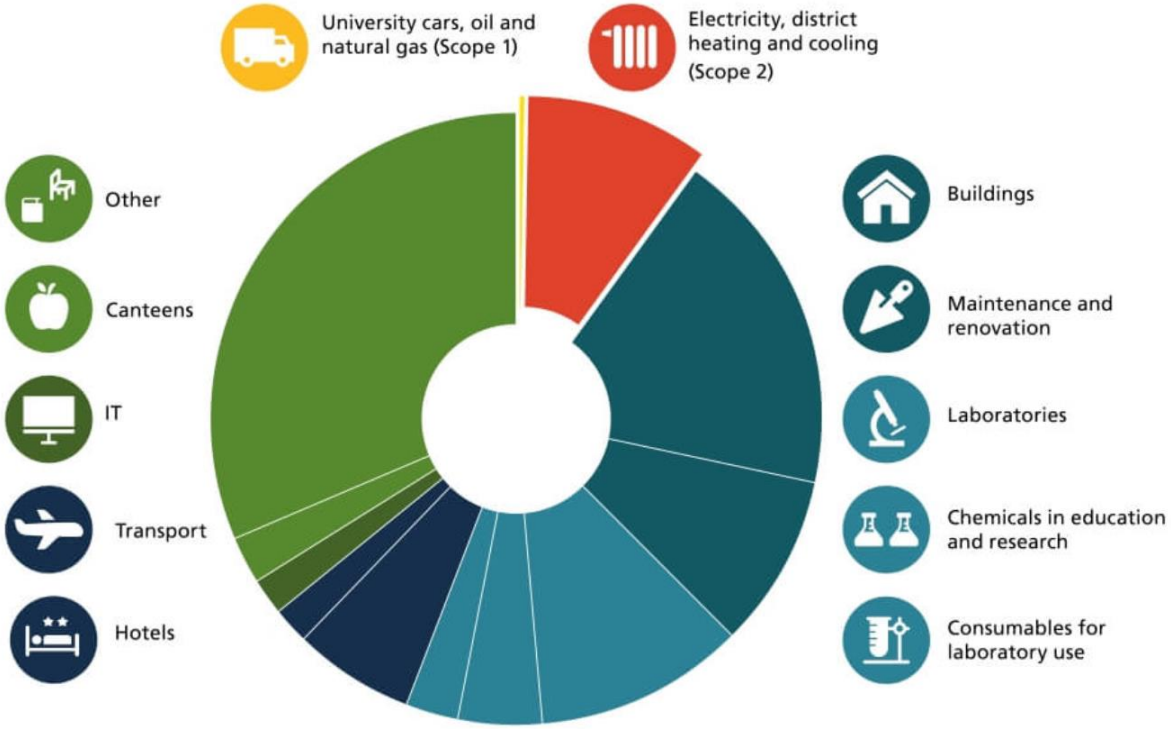
c. 25 million

d. 25+ million

Total CO2 Emissions from 2 European Institutions



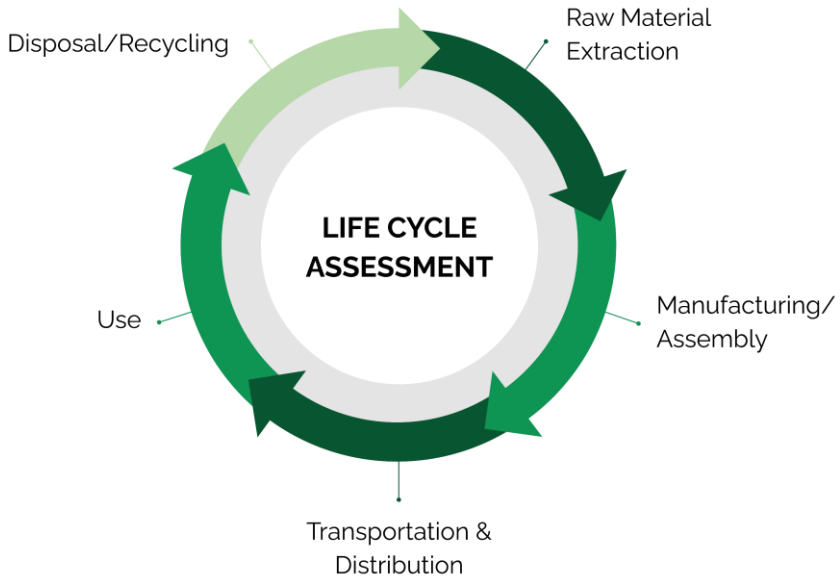
UCL, UK



University of Copenhagen, Denmark

LCAs for understanding science impacts

- Currently we have decent data on:
  - Travel (sometimes)
  - Energy (gas and electricity)
  - Spend (sometimes)
  - IT (https://www.green-algorithms.org/)
- We are now doing LCAs on:
  - Consumables (plastics)
  - Chemicals
  - Freezers (Matthew Graham's work)
  - TBC – Further equipment types



PLOS SUSTAINABILITY AND TRANSFORMATION

OPEN ACCESS PEER-REVIEWED

RESEARCH ARTICLE

Using life cycle assessments to guide reduction in the carbon footprint of single-use lab consumables

Isabella Ragazzi, Martin Farley, Kate Jeffery, Isabela Butnar

Published: September 29, 2023 • https://doi.org/10.1371/journal.pstr.0000080

Abstract

Scientific research pushes forward the boundaries of human knowledge, but often at a sizable environmental cost. The reliance of researchers on single-use plastics and disposable

So which of these will have the most CO2e?

- Deep-well Plate (PS)
- Deep-well Plate (PP)

So which of these will have the most CO2e?

- **Deep-well Plate (PS)**
- Deep-well Plate (PP)

What is the order in terms of CO2 emission magnitude?

- 15 ml tube
- PCR Plate
- Nitrile Gloves
- 96 x 100 ul tips (no tip box)
- 1 x Disposable gown

What is the order in terms of CO_2 emission magnitude?

- 15 ml tube - 16.01 g CO_2e
- PCR Plate – 38.5 g CO_2e
- 2 Nitrile Gloves – 41.5 g CO_2e
- 96 x 100 ul tips (no tip box) – 71.27 g CO_2e
- 1 x Disposable gown – 539.9 g CO_2e

What is the order in terms of CO2 emission magnitude (per L)?

- Acetone
- Ethanol
- Methanol
- Formic Acid
- Isopropanol

What is the order in terms of CO2 emission magnitude (per L)?

- Acetone **2- 1805 g CO2e**
- Ethanol **3- 1644 g CO2e**
- Methanol **5- 870 g CO2e**
- Formic Acid **1- 2575 g CO2e**
- Isopropanol **4- 1334 g CO2e**

Green Chemistry Resources

- Check out Chem21
- https://pubs.rsc.org/en/content/articlelanding/2016/gc/c5gc01008j#!divAbstract

Issue 1, 2016 Previous Article Next Article

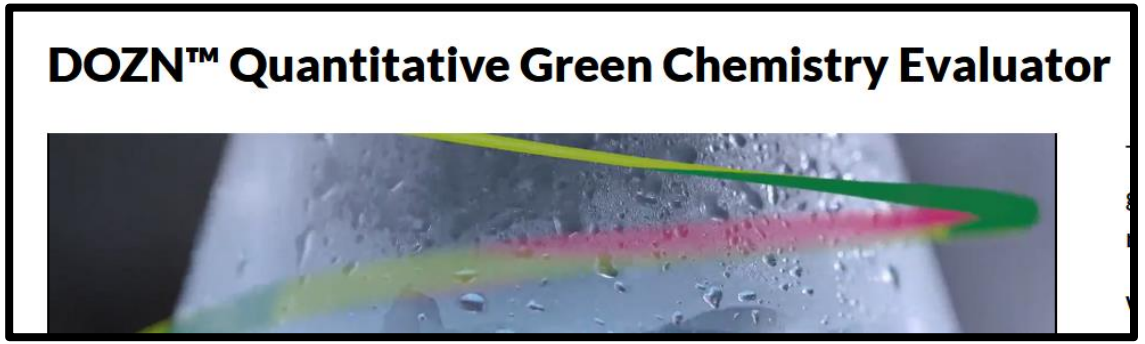
From the journal: Green Chemistry

CHEM21 selection guide of classical- and less classical-solvents†

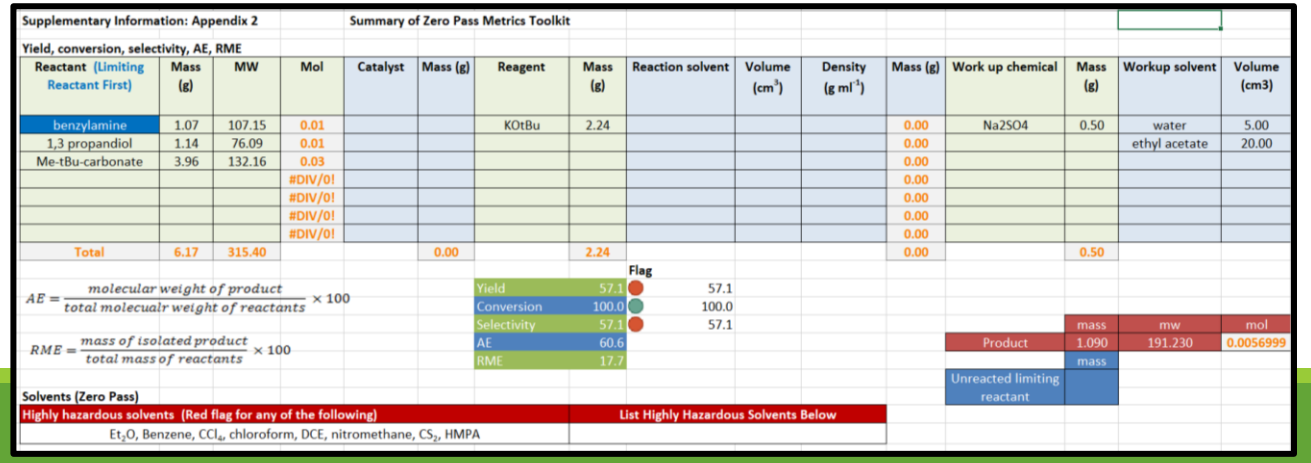
Check for updates

Denis Prat,*[a] Andy Wells,[b] John Hayler,[c] Helen Sneddon,[c] C. Robert McElroy,[d] Sarah Abou-Shehada[d] and Peter J. Dunn[e]

- Sigma have the DOZN tool



- UoYork "Metrics Toolkit" evaluates the sustainability of reactions



Supplementary Information: Appendix 2 — Summary of Zero Pass Metrics Toolkit

Yield, conversion, selectivity, AE, RME

Reactant (Limiting Reactant First)	Mass (g)	MW	Mol	Catalyst	Mass (g)	Reagent	Mass (g)	Reaction solvent	Volume (cm^3)	Density ($g\ ml^{-1}$)	Mass (g)	Work up chemical	Mass (g)	Workup solvent	Volume (cm3)
benzylamine	1.07	107.15	0.01			KOtBu	2.24				0.00	Na2SO4	0.50	water	5.00
1,3 propandiol	1.14	76.09	0.01								0.00			ethyl acetate	20.00
Me-tBu-carbonate	3.96	132.16	0.03								0.00				
			#DIV/0!								0.00				
			#DIV/0!								0.00				
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			#DIV/0!								0.00				
Total	6.17	315.40			0.00		2.24				0.00		0.50		

$$AE = \frac{molecular\ weight\ of\ product}{total\ molecualr\ weight\ of\ reactants} \times 100$$

$$RME = \frac{mass\ of\ isolated\ product}{total\ mass\ of\ reactants} \times 100$$

		Flag	
Yield	57.1		57.1
Conversion	100.0		100.0
Selectivity	57.1		57.1
AE	60.6		
RME	17.7		

	mass	mw	mol
Product	1.090	191.230	0.0056999
	mass		
Unreacted limiting reactant			

Solvents (Zero Pass)

Highly hazardous solvents (Red flag for any of the following)	List Highly Hazardous Solvents Below
Et_2O, Benzene, CCl_4, chloroform, DCE, nitromethane, CS_2, HMPA	

More Research is Needed!

What are the CO2 emissions of scientific pathways?

Where are the real balance points between sterile and reusable? Contaminated and not?

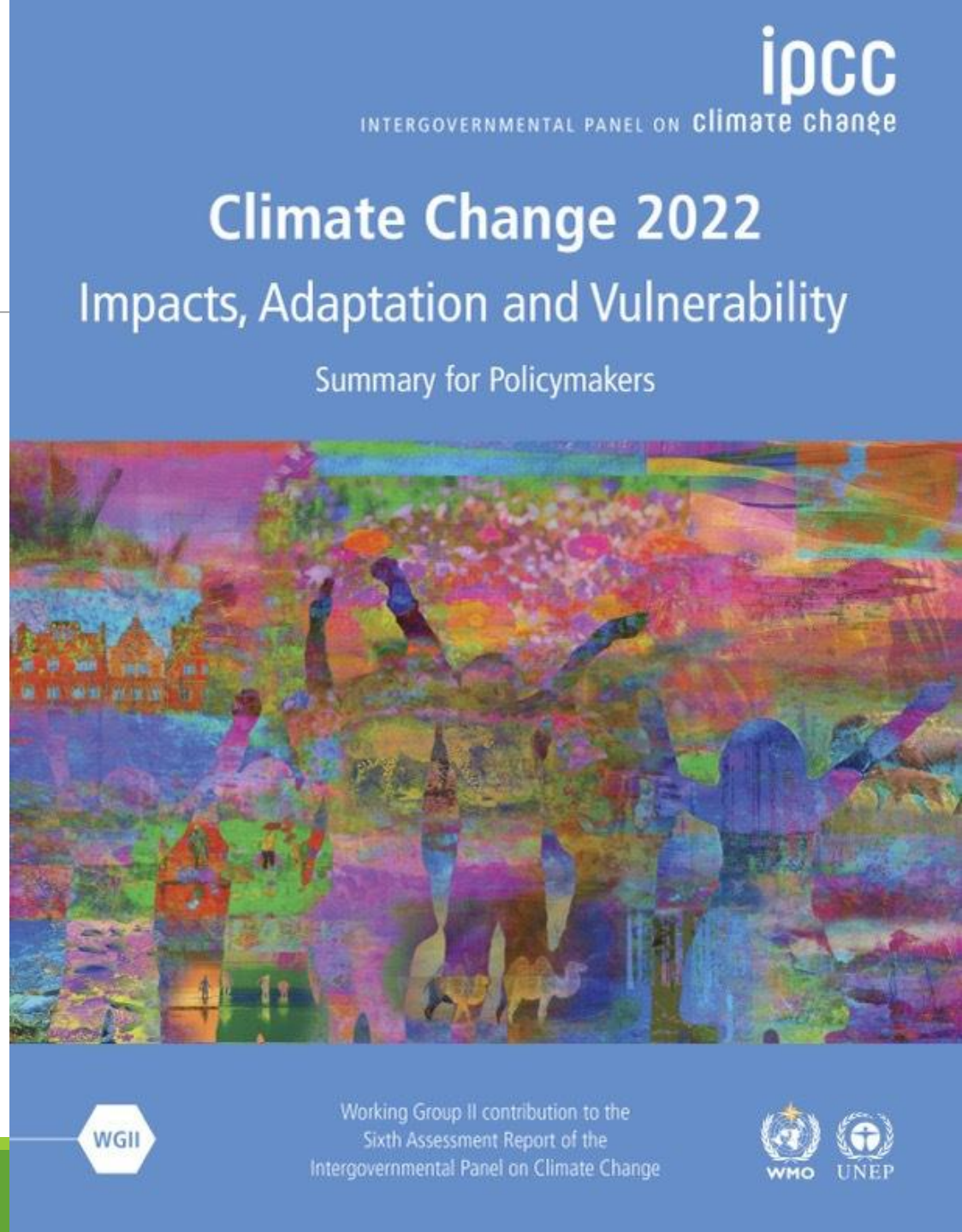
Storage temperatures

LCAs of so many products and processes still unknown

BUT

We need action now…..

We know reuse is better typically, and reduction is obviously better



There’s a reason we all follow H&S, but don’t all implement sustainable practices…

If there was a standard, what might it look like? How do we know if a lab is “green”?

LEAF: Laboratory Efficiency Assessment Framework

- Standard in Sustainable Laboratory Operations
- Criteria in areas like ventilation, equipment, people, facilities/space, procurement & waste, samples & chemicals, and research quality
- Bronze, Silver, Gold categories of criteria
- User-led initiative
- Crucially allows you to estimate impact in CO2 and money saved, with inbuilt calculators

LEAF Update

- Been online for 2.5 years
- 100 Institutions signed up from 16 countries. Over 4,300 users from 2,850 labs
- Stated target for MRC facilities to achieve Gold by 2025
- World's largest Green Lab Certification Programme

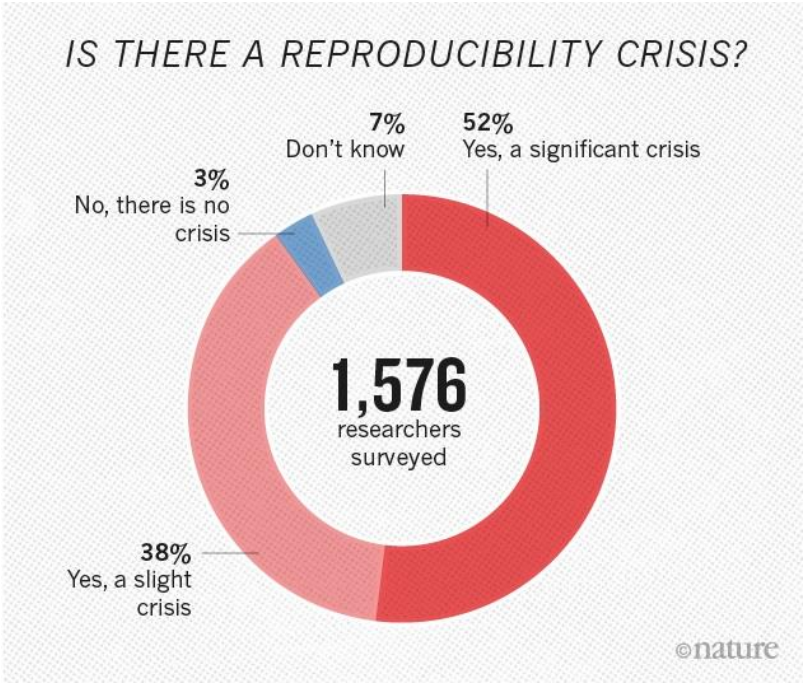
National Technician Development Centre for Higher Education

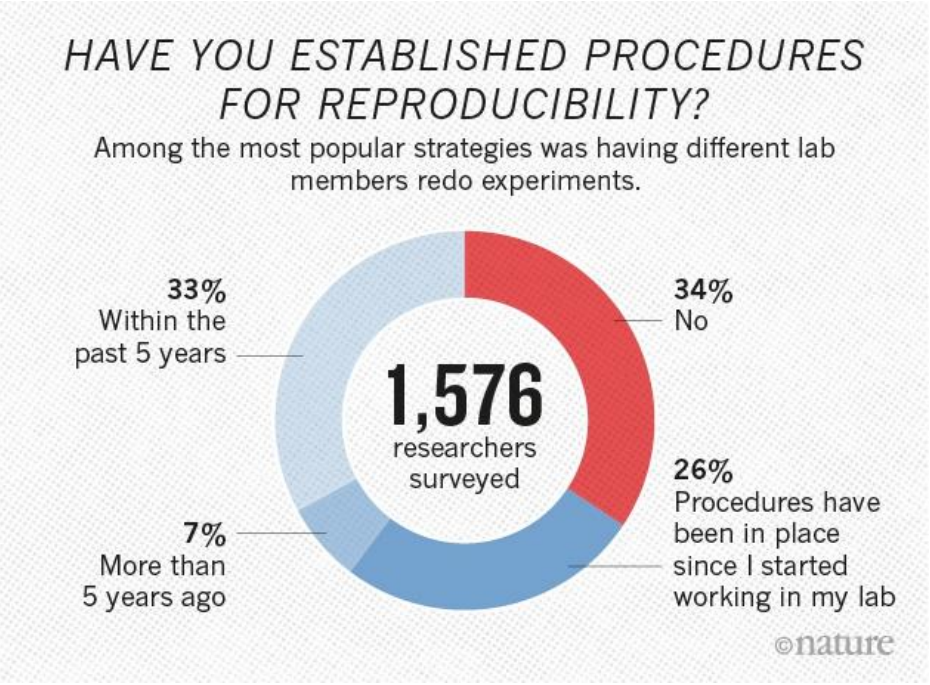
UK Research and Innovation

UKRN

MRC Medical Research Council

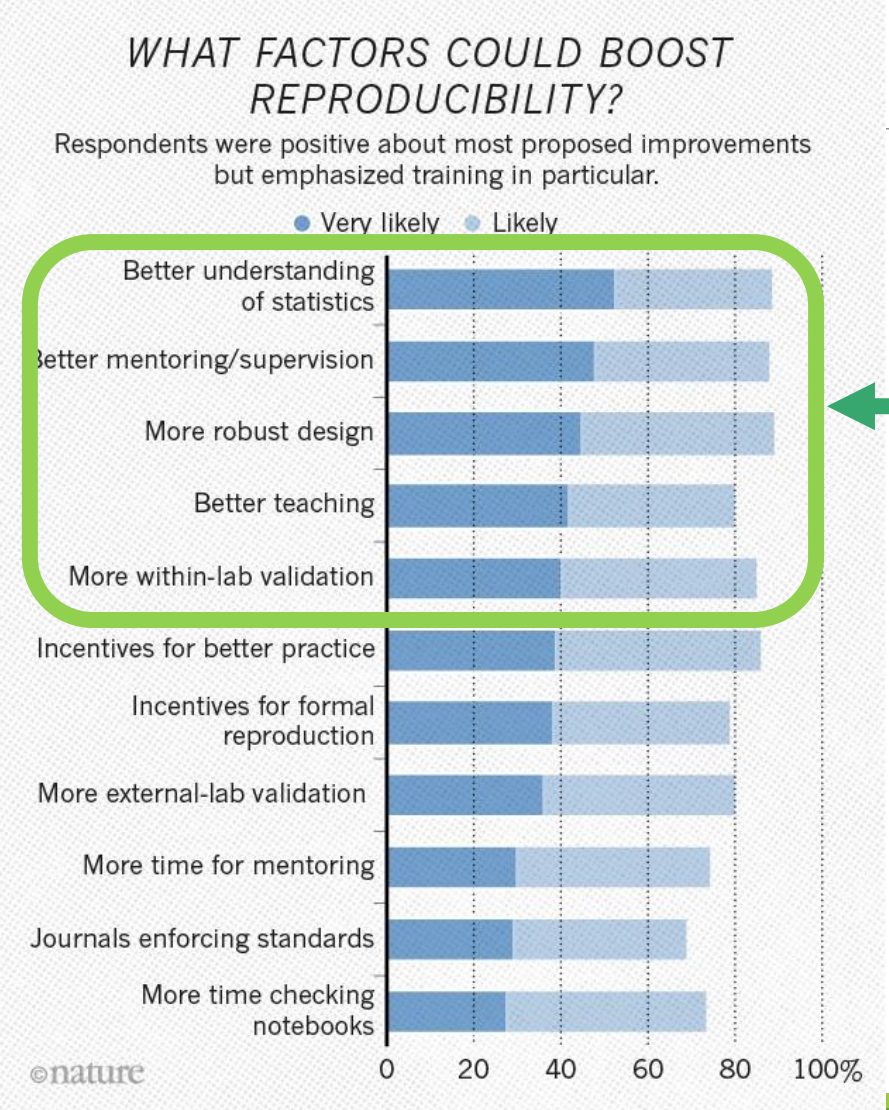
Crisis of Reproducibility





Ref: 1,500 scientists lift the lid on reproducibility – Baker, Nature. 16

Crisis of Reproducibility



Achieved by good laboratory management & procedures

Ref: 1,500 scientists lift the lid on reproducibility – Baker, Nature. 16

Quiz – Final Question

What % of research conducted gets published? Or shared widely?

Or is accessible? Or is reproducible?

What do we expect in return?

Much research in HE focuses on addressing health

But science, and sustainability to some extent is largely shaped by the funding that supports it, and is shaped by business forces – Funding sources can dictate what merits research, and manufacturers & suppliers have an interest to increase revenue

In 2019, there were 147,806 articles on AI, but just 2,500 on carbon capture

Ref: https://www.unesco.org/reports/science/2021/en

Resources to take action

- LEAN Network: https://www.lean-science.org/

- LEAF Resources (UCL)

- Check out resources from existing programmes at
  - Bristol
  - Cambridge
  - Oxford
  - Edinburgh
  - Georgia
  - Boulder Colorado

- **Check out Green Your Lab networks**

How we recommend a start to making your labs more sustainable – Engagement

- Start ‘Green lab groups’
- See what others are up to before embarking
- Set some goals *Watch out for greenwashing!*
- Engage the appropriate people *Get Technical Guidance*
- Estimate impact
- Share with senior management, your colleagues, everyone! Make them jealous
- Repeat

- Consider continuity of your projects!

Future of Sustainable Labs?

Technical staff will be hugely important, and will be supported to facilitate sustainability targets.

Services will be centralized, local

Carbon impacts will be understood, reporting methods will be standard at all levels/scopes

Guidance/standards on best practice will be standardised, including for design and refurb

Manufacturers will need a level of transparency, our tenders will use common language

All this will be required! Not voluntary

Thank you. Questions?

- Sources:
  - https://www.ucl.ac.uk/sustainable/about-us
  - http://greenlightlabs.co.uk/
  - https://journals.plos.org/sustainabilitytransformation/article?id=10.1371/journal.pstr.0000080
  - https://www.energystar.gov/products/ultra_low_temperature_freezer_technology_and_energy_efficiency_work_together
  - https://www.scientificlabs.co.uk/casestudies
  - https://physicsworld.com/a/open-source-tool-allows-researchers-to-calculate-their-labs-carbon-footprint/

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