

Introduction to Environmental Sustainability in healthcare

Dr Rob Chuter

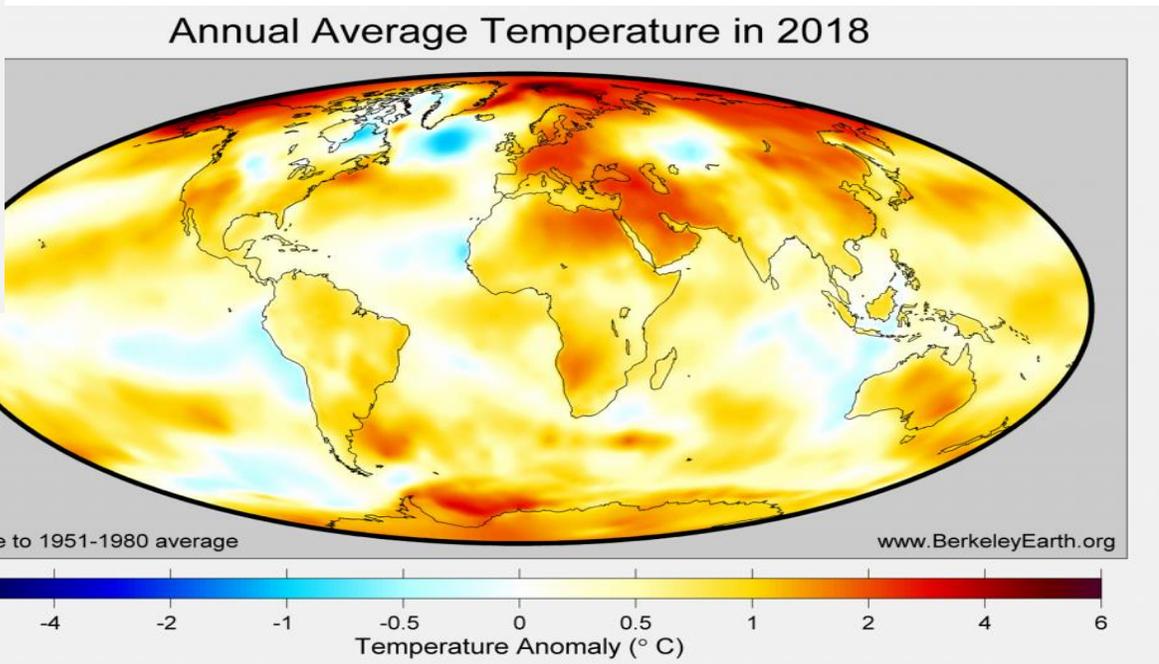
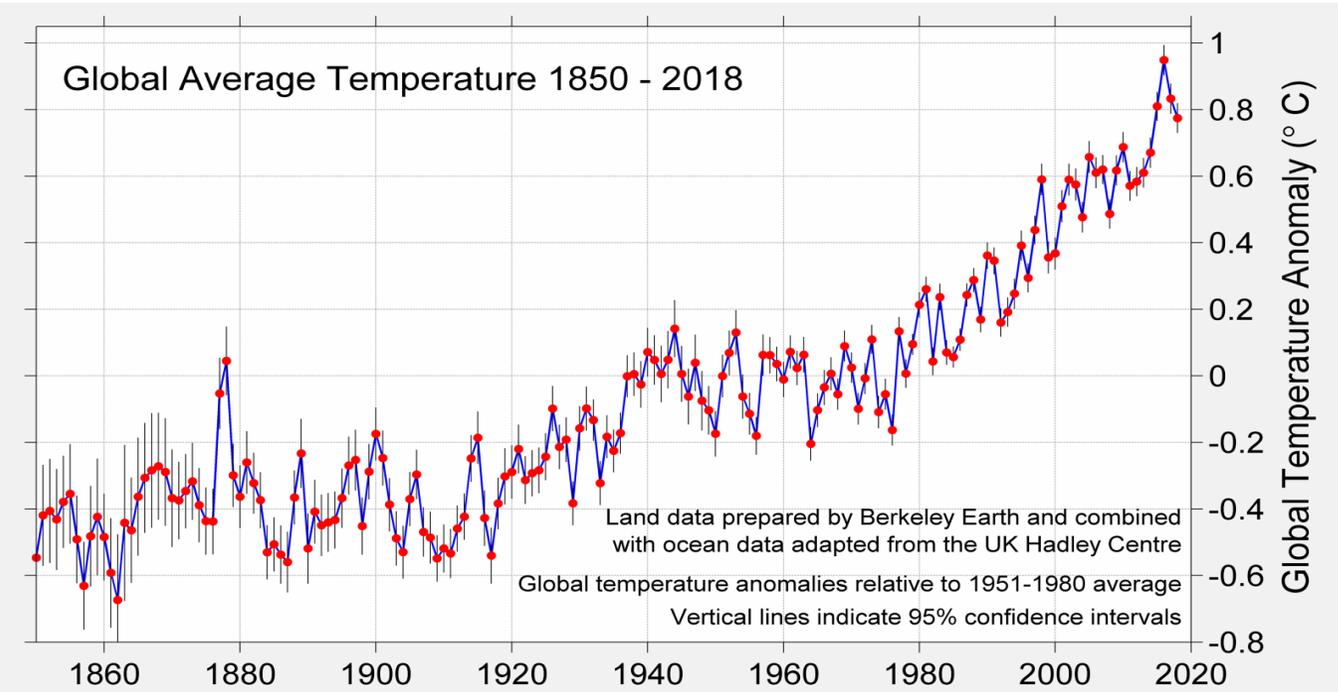
**The Christie NHS FT and University of Manchester
on behalf of the:**

IPEM Environmental Sustainability group

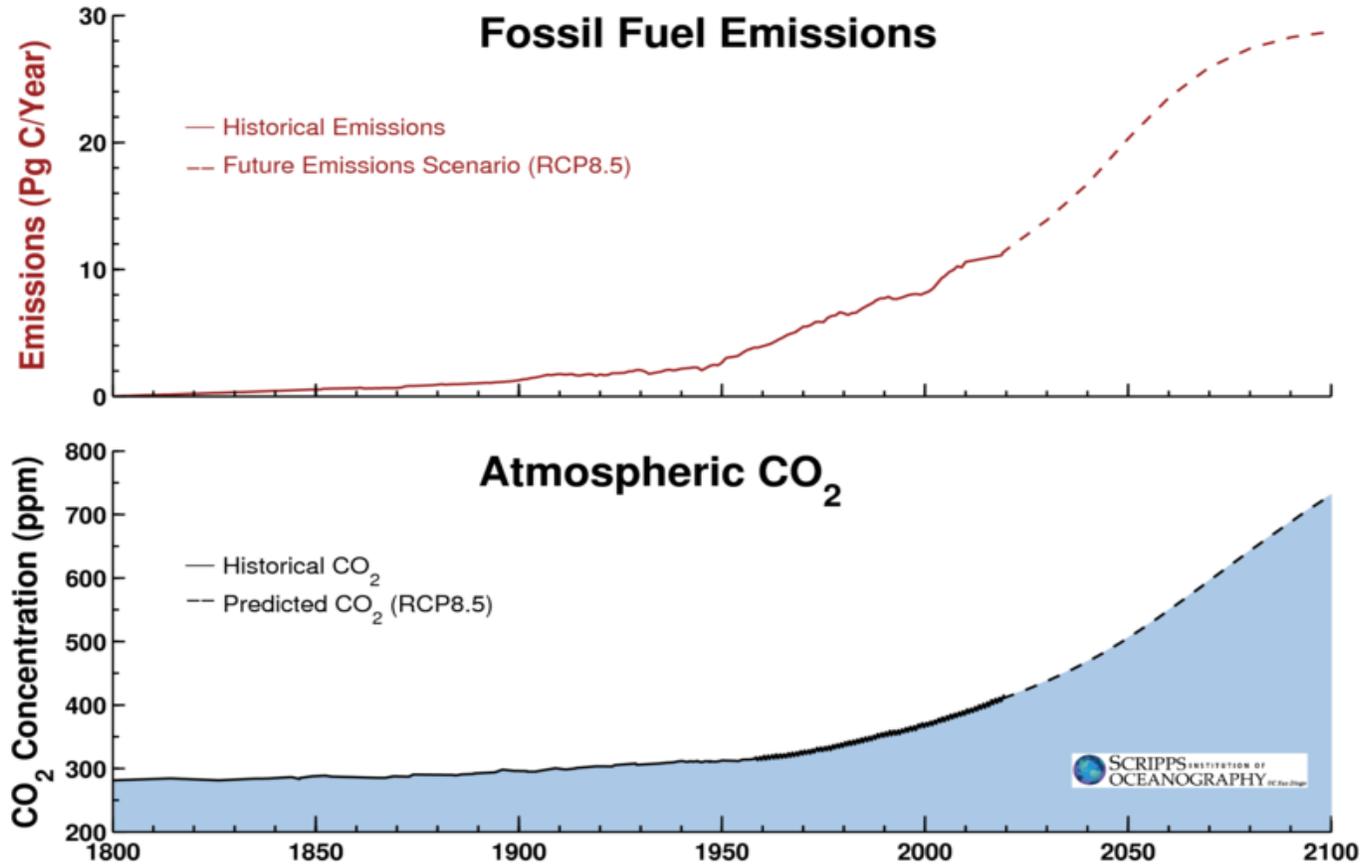
What will we cover?

- 1. Climate science - briefly**
- 2. Impact of climate change on healthcare**
- 3. Impact of healthcare on climate change**
- 4. What can you do about it personally?**
- 5. What can we do about it as medical physicists?**
 - a. IPEM Env Sus Group**
 - b. Carbon footprinting**
- 6. Summary**
- 7. Time for questions and discussion**

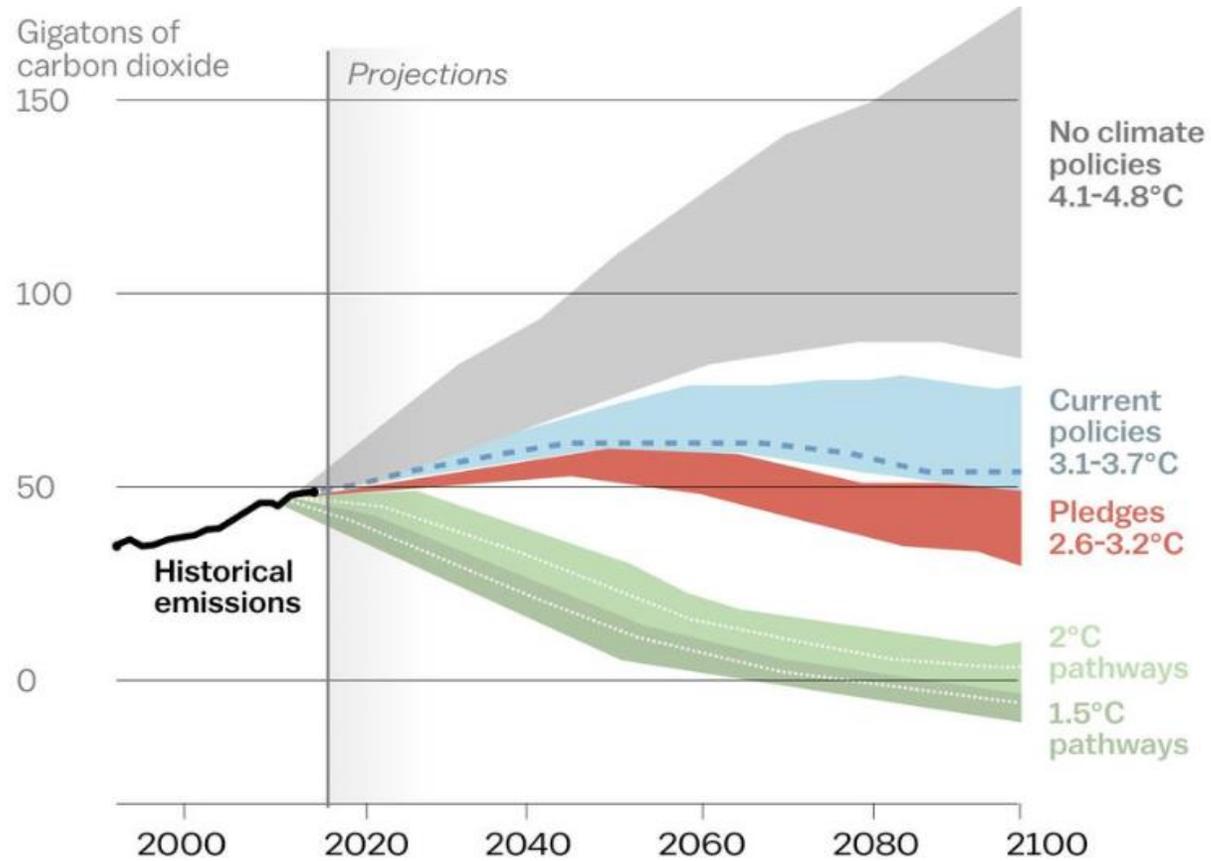
Introduction – climate science



Introduction – climate science



Introduction – climate science



Climate models of the different scenarios

Adapted from IPCC, 2018.

Introduction – climate science



CLIMATE RISKS: 1.5°C VS 2°C GLOBAL WARMING

EXTREME WEATHER

100% increase in flood risk. vs 170% increase in flood risk.

SPECIES

6% of insects, 8% of plants and 4% of vertebrates will be affected. vs 18% of insects, 16% of plants and 8% of vertebrates will be affected.

WATER AVAILABILITY

350 million urban residents exposed to severe drought by 2100. vs 410 million urban residents exposed to severe drought by 2100.

ARCTIC SEA ICE

Ice-free summers in the Arctic at least once every 100 years. vs Ice-free summers in the Arctic at least once every 10 years.

PEOPLE

9% of the world's population (700 million people) will be exposed to extreme heat waves at least once every 20 years. vs 28% of the world's population (2 billion people) will be exposed to extreme heat waves at least once every 20 years.

SEA-LEVEL RISE

46 million people impacted by sea-level rise of 48cm by 2100. vs 49 million people impacted by sea-level rise of 56cm by 2100.

OCEANS

Lower risks to marine biodiversity, ecosystems and their ecological functions and services at 1.5°C compared to 2°C.

COSTS

Lower economic growth at 2°C than at 1.5°C for many countries, particularly low-income countries.

CORAL BLEACHING

70% of world's coral reefs are lost by 2100. vs Virtually all coral reefs are lost by 2100.

FOOD

Every half degree warming will consistently lead to lower yields and lower nutritional content in tropical regions.

Ad



Introduction – climate science

Positive feedback loops:

→ Melting ice → reduces albedo → decreases reflected sunlight → heats up the area →

→ Melting permafrost → releases trapped methane gas → increase in temperature →

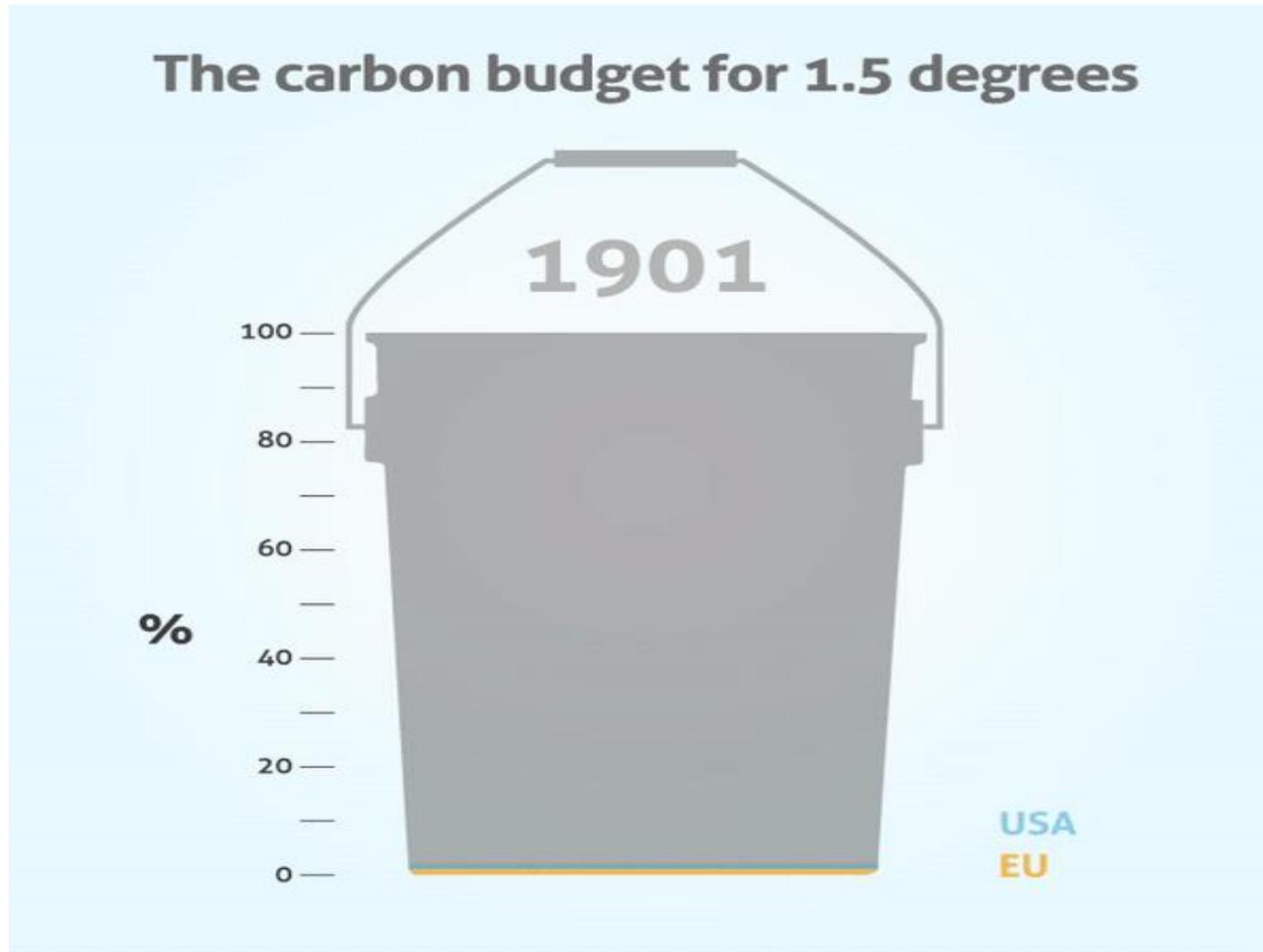
→ Increase extreme weather → more air conditioning/heating → increased CO₂ → increase in temperature →

Negative feedback loops:

A warmer climate → more water vapour → increase in cloudiness → reducing the sunlight → less heat absorbed → slow the increased warming.

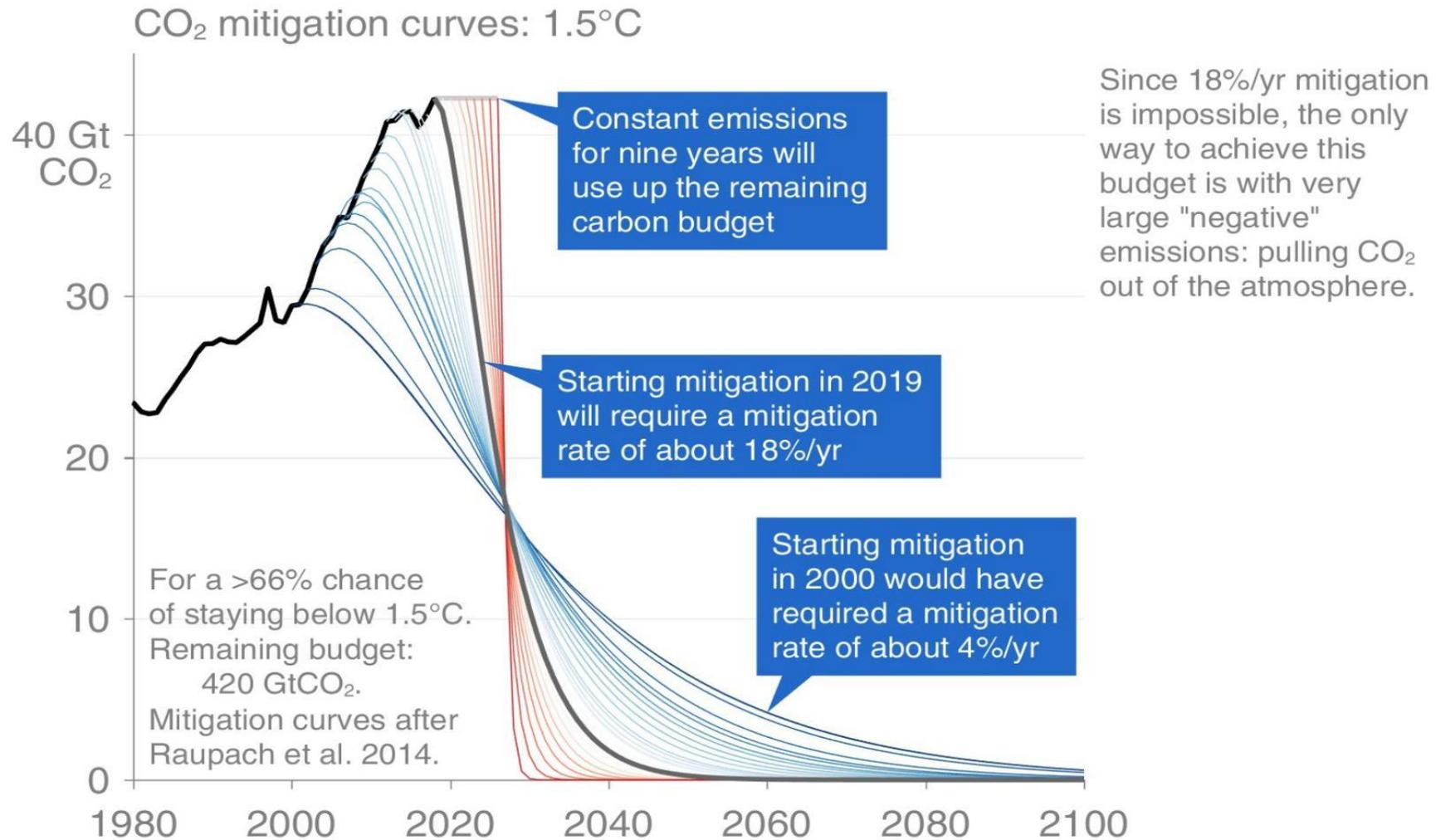
A warmer climate → more water vapour → increase in precipitation → more water vapour → increase in plant growth → removing carbon dioxide from the atmosphere.

Introduction – climate science



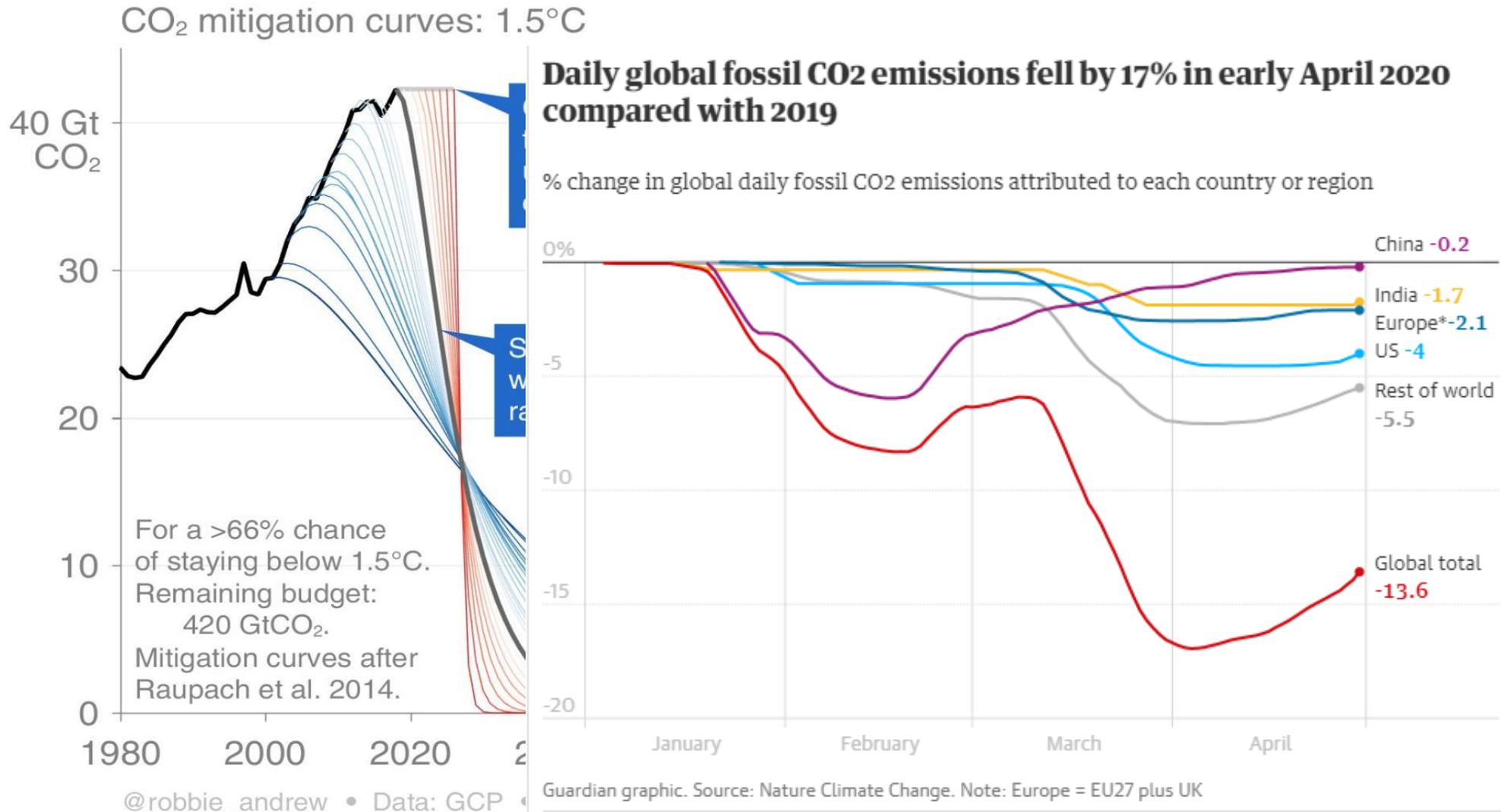
<https://www.globalcarbonproject.org/carbonbudget/index.htm>

Introduction – climate science

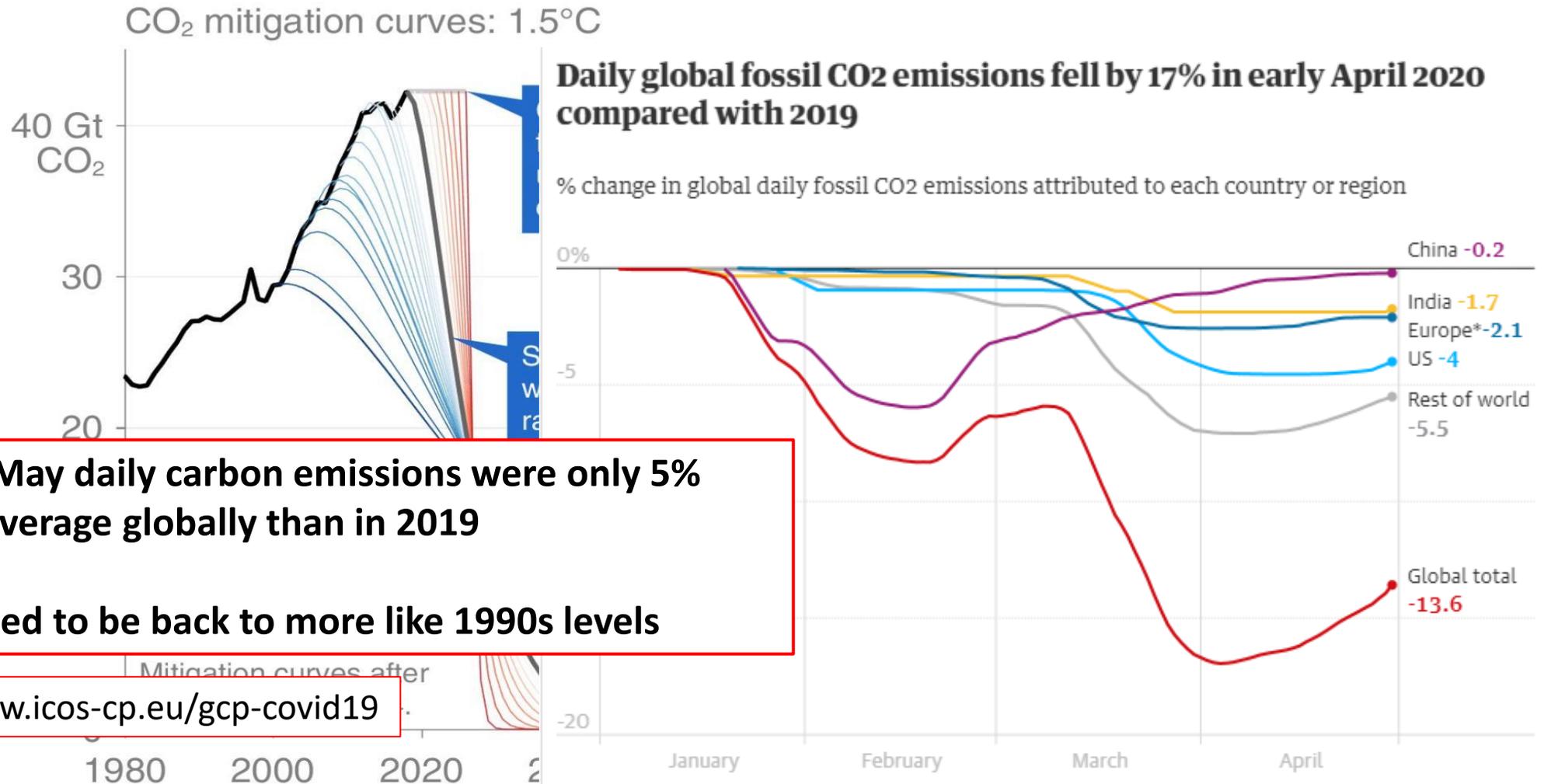


@robbie_andrew • Data: GCP • Emissions budget from IPCC SR1.5

Introduction – climate science



Introduction – climate science



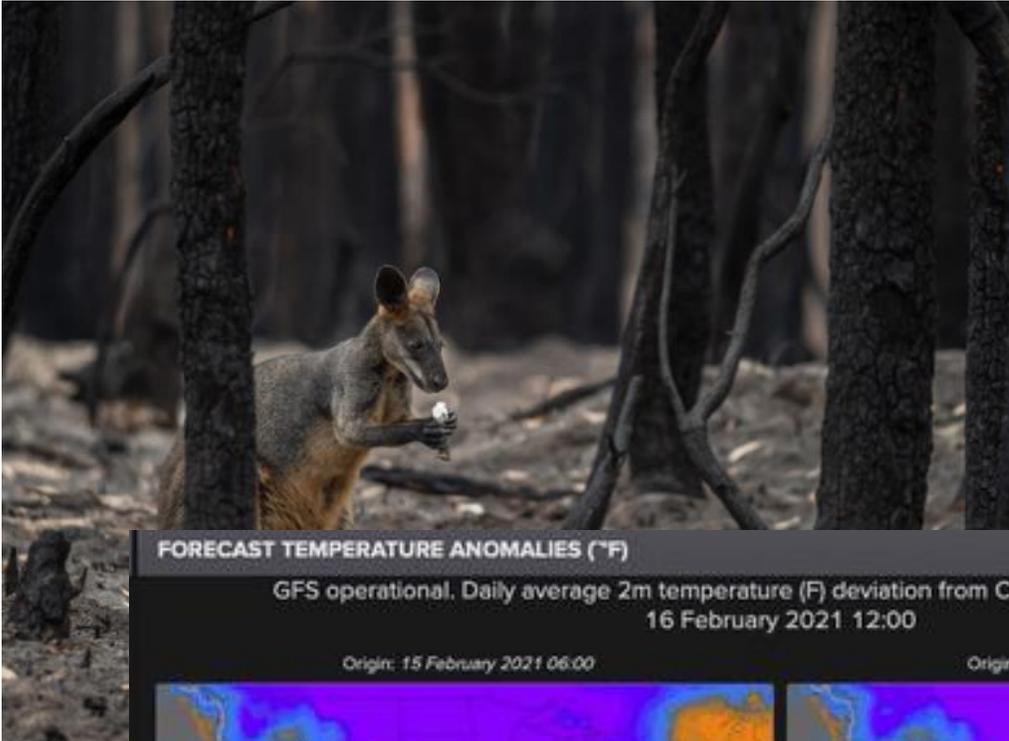
By end of May daily carbon emissions were only 5% lower on average globally than in 2019

And we need to be back to more like 1990s levels

<https://www.icos-cp.eu/gcp-covid19>

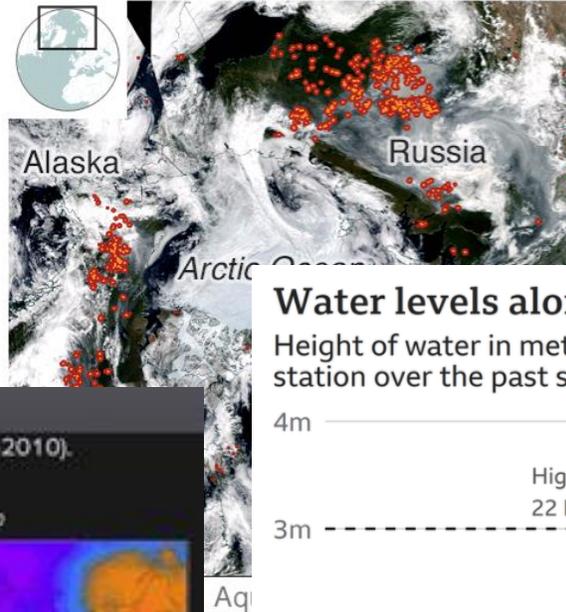
@robbie_andrew • Data: GCP • Guardian graphic. Source: Nature Climate Change. Note: Europe = EU27 plus UK

Climate change – extreme weather

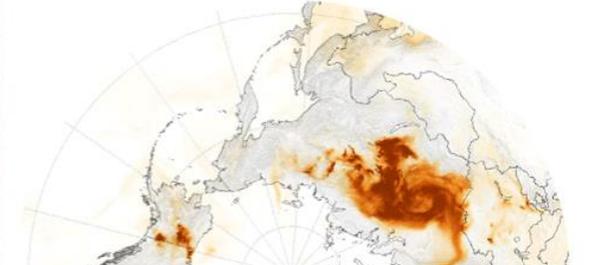


24 July

● Fires and thermal anomalies



Soot (black carbon) concentration
 0 1 >=2 (10⁻⁵ kg/m²)

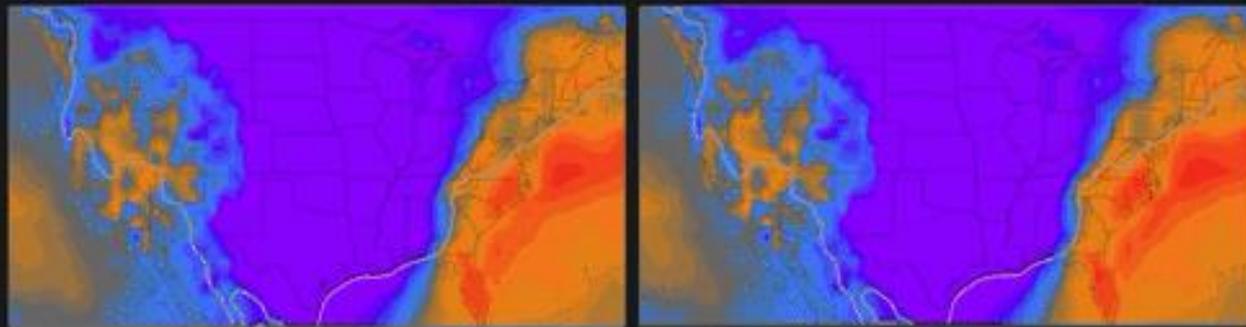


FORECAST TEMPERATURE ANOMALIES (°F)

GFS operational. Daily average 2m temperature (F) deviation from CFSR normal (1981-2010).
 16 February 2021 12:00

Origin: 15 February 2021 06:00

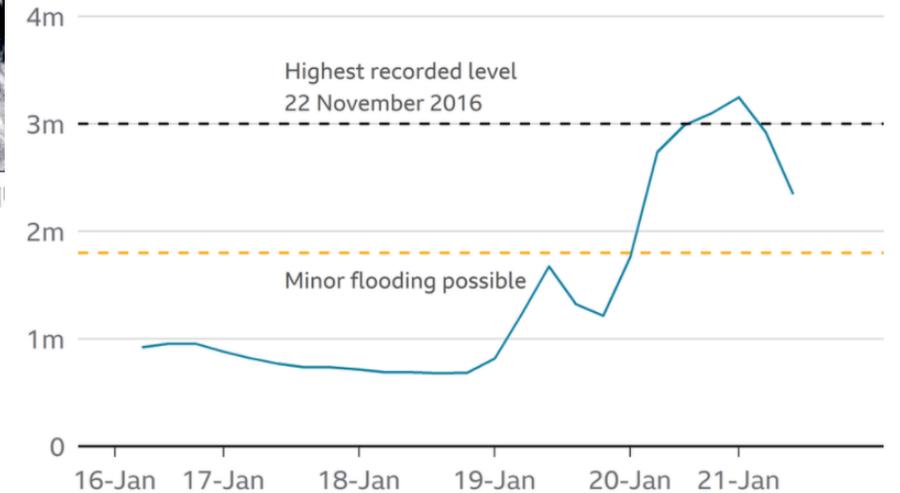
Origin: 15 February 2021 00:00



Right map origin offset: ● -24 hours ● -18 hours ● -12 hours ● -6 hours

Water levels along the River Mersey

Height of water in metres recorded at Northenden monitoring station over the past six days



Note: River levels recorded relative to average sea level

Source: Gov.uk flood warning information service

BBC



Impact on Healthcare



World Health
Organization



Dr. Margaret Chan, DG of WHO:

“For public health, **climate change is the defining issue for the 21st century**... The evidence is there, and it is compelling. Here is my strong view: **climate change, and all of its dire consequences for health, should be at centre-stage**, right now, whenever talk turns to the future of human civilizations. After all, that's what's at stake.”

15th September 2014

Impact on Health

Heat waves → deaths due to dehydration, cardiovascular and other diseases.

Extreme weather (inc. severe storms and fires) → reduce availability of clean food and water, damage infrastructure and strain emergency and healthcare services.

Animals displaced from their natural habitats (or habitats are invaded by human activity) → diseases carried by insects or other animals will spread.

Reduced accesses to clean water increase → incidence of waterborne diseases

Increased emissions (inc fine particulate) → rise in respiratory and cardiovascular diseases and cancer risk.

Healthcare footprint

Health care footprint as % of national footprint

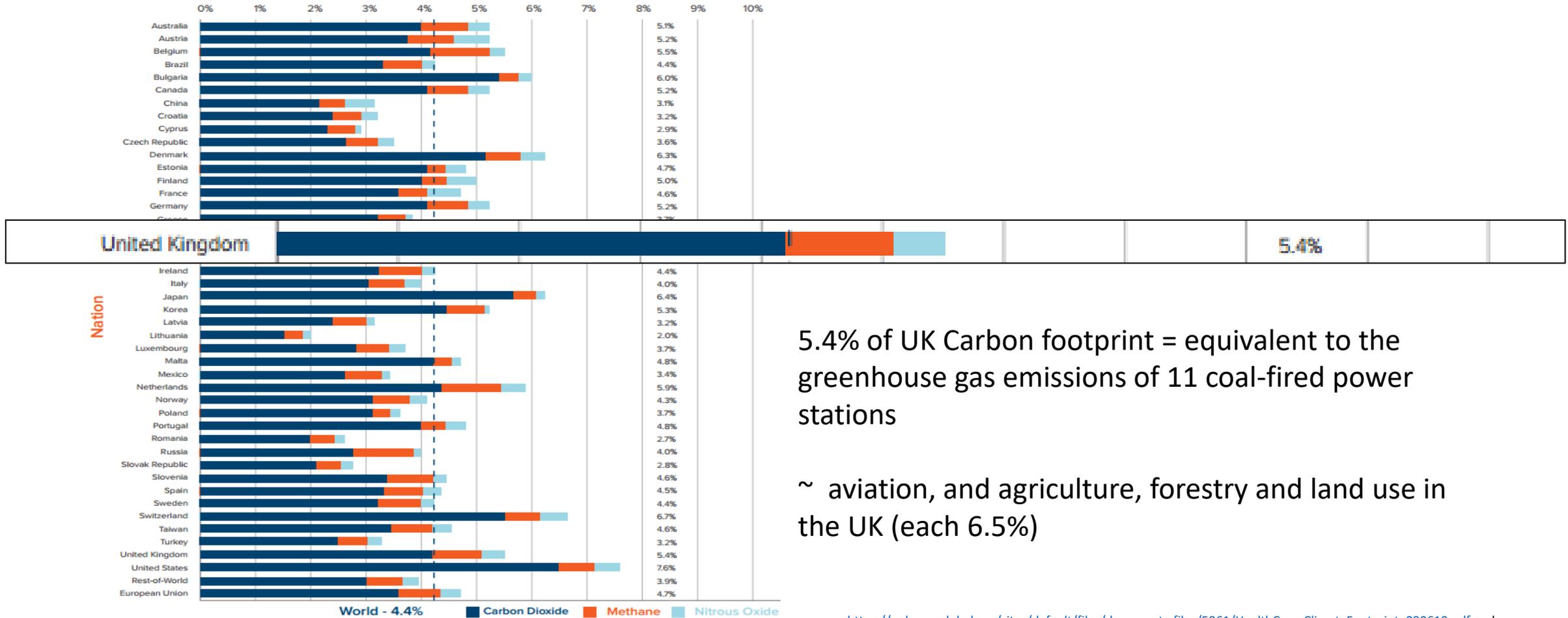


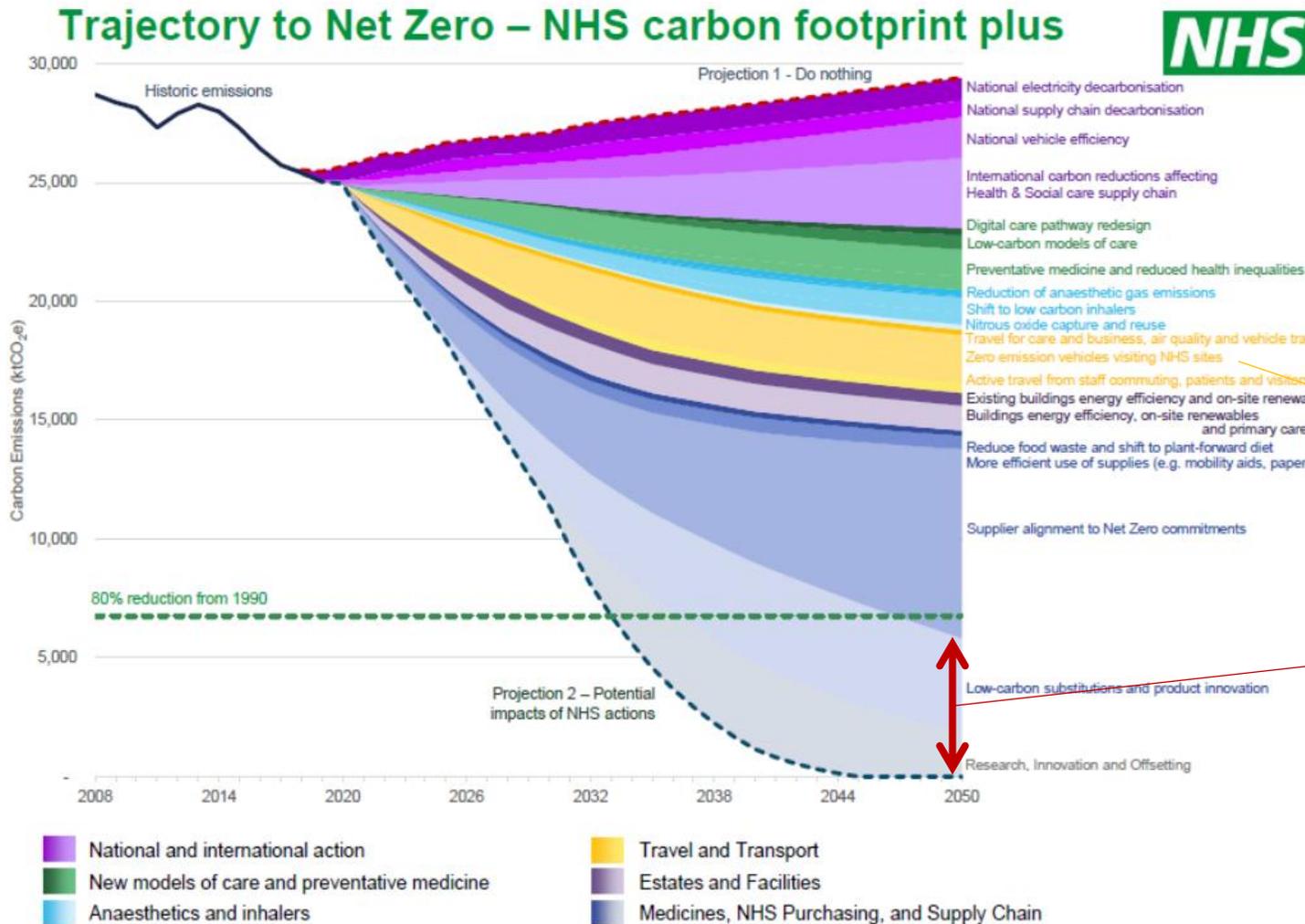
Figure 7: Health care footprint as a percentage of national emissions for all nations and regions covered in this study

5.4% of UK Carbon footprint = equivalent to the greenhouse gas emissions of 11 coal-fired power stations

~ aviation, and agriculture, forestry and land use in the UK (each 6.5%)

https://noharm-global.org/sites/default/files/documents-files/5961/HealthCaresClimateFootprint_090619.pdf and <https://www.theguardian.com/society/2019/sep/18/hospitals-planet-health-anaesthetic-gases-electric-ambulances-dialysis-nhs-carbon-footprint>

Healthcare footprint



Carbon footprint projections for NHS England – from 2008 to 2050.

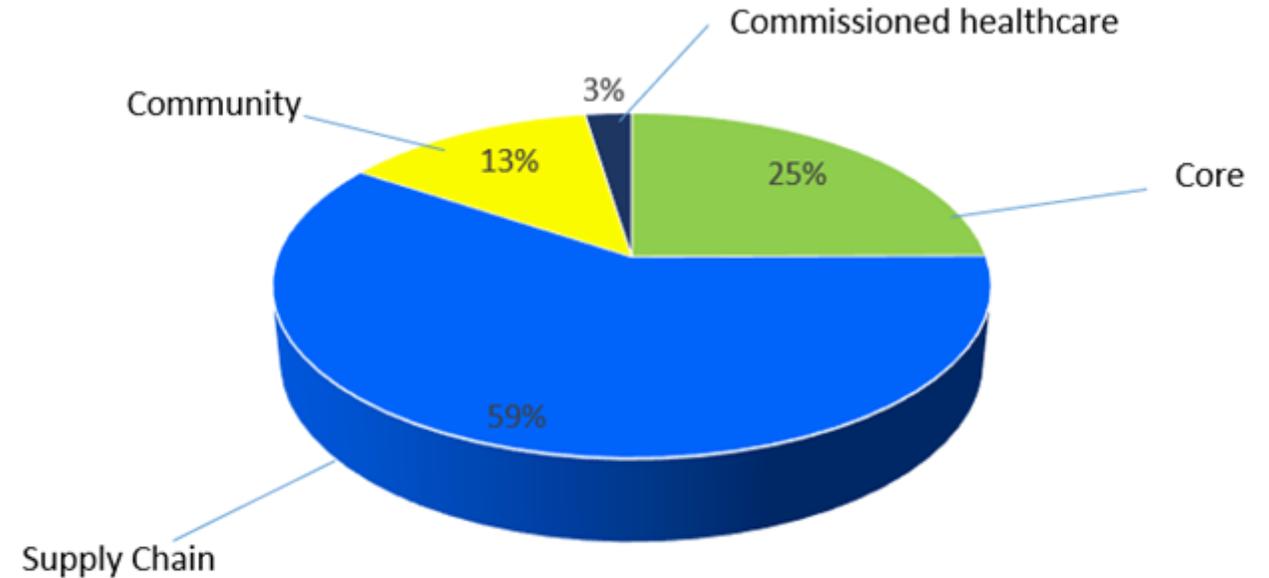
The red dotted line - explains how carbon emissions would increase if we did nothing.

Estimated that 1 in 20 road miles is related to the NHS

~ 25% is still “innovation”

Healthcare footprint

Procurement is very important as it makes up the majority of the footprint of the NHS



SDU 2018. Reducing the use of natural resources in health and social care 2018 report

$$\text{Sustainable value} = \frac{\text{Outcomes for patients and populations}}{\text{Environmental + social + financial impacts (the 'triple bottom line')}}$$

So what can you do about it?

Check our privilege

It is important to understand the context in which we are discussing environmental sustainability:

We:

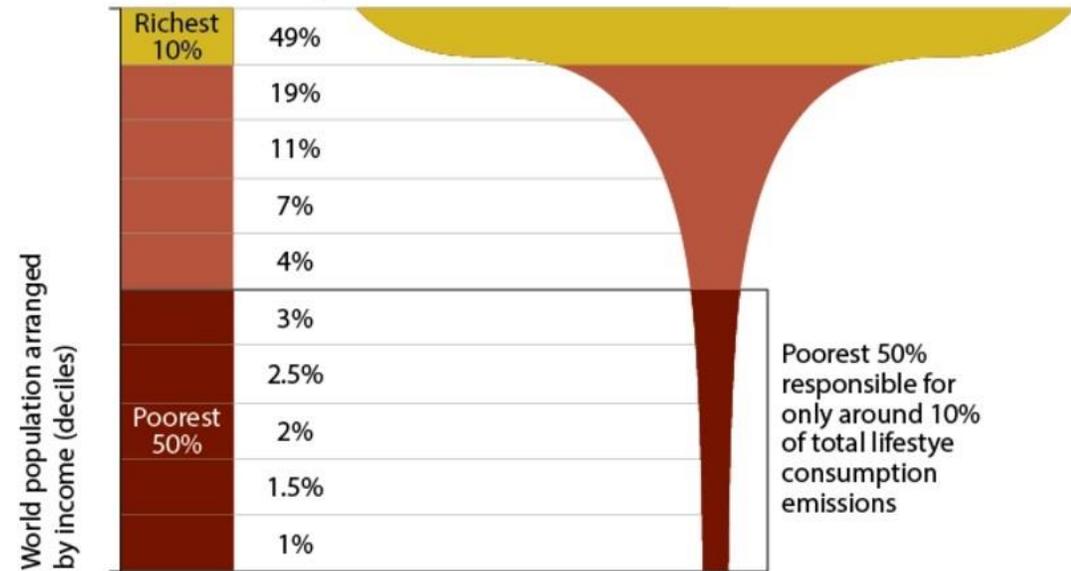
Live in the UK - with 7th highest GDP in the world

Have gained a lot from starting the industrial revolution – used carbon to develop

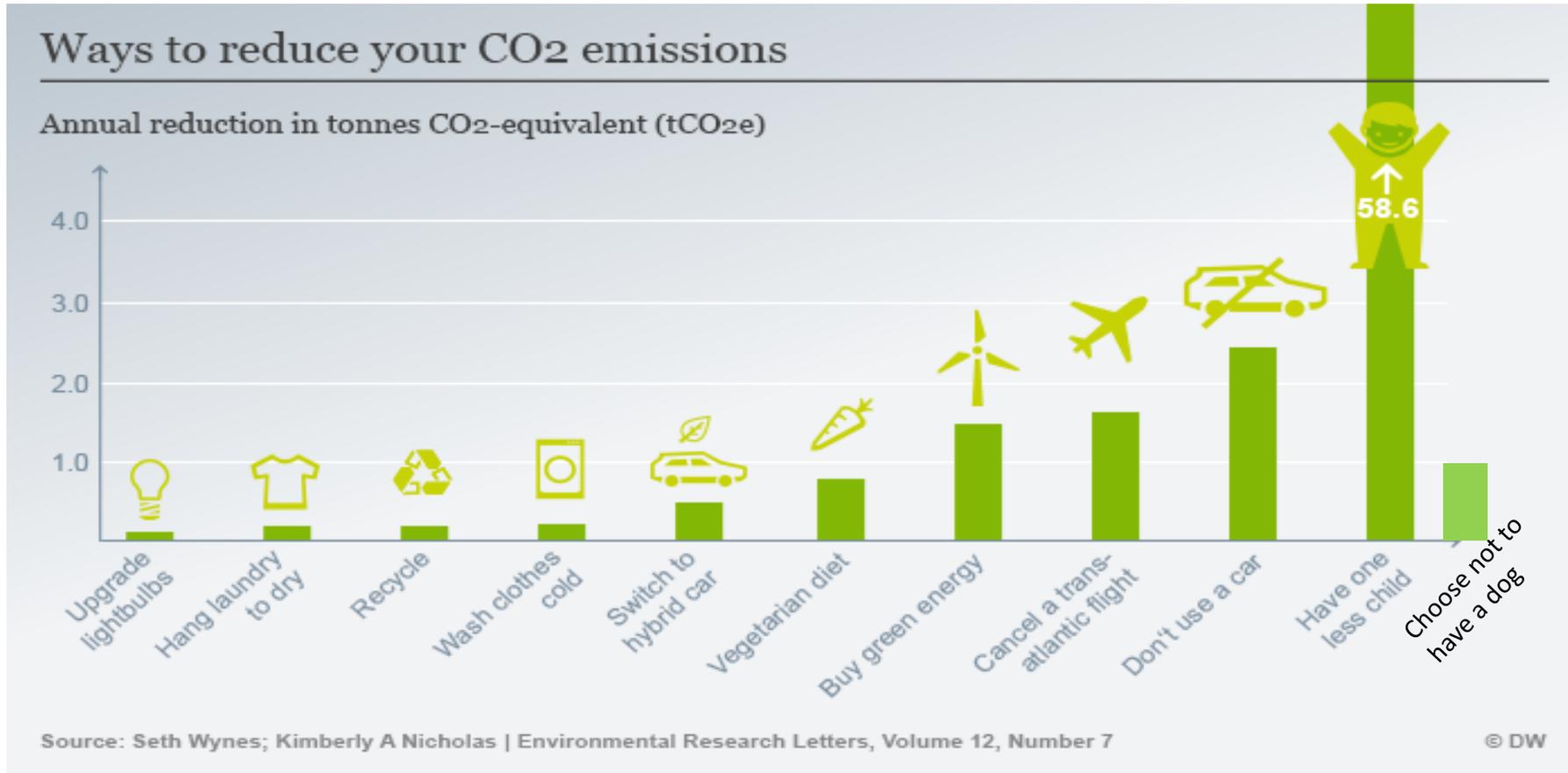
Are scientifically literate and good problem solvers

Have (reasonably) well paid professional jobs (or are training for them) - if we don't push for env sus it who will? – comfortable enough to be able to care

Worlds richest 1% cause double the CO₂e of the poorest 50% of the population (Oxfam study)



What can you do?



The world has ~ a billion dogs and several hundred million cats.

Cats - estimated to kill between 1.3 and 4 billion birds and between 6.2 and 22.3 billion mammals each year.

Manchester to Amsterdam = 0.15 tCO₂e
Manchester to Barcelona = 0.43 tCO₂e
Manchester to New York = 1.61 tCO₂e

CO₂ budget per capita is estimated ~ 1.6 tonnes per year to keep the global temperature rise within 2°C

What can you do? – An example

ESTRO 2020

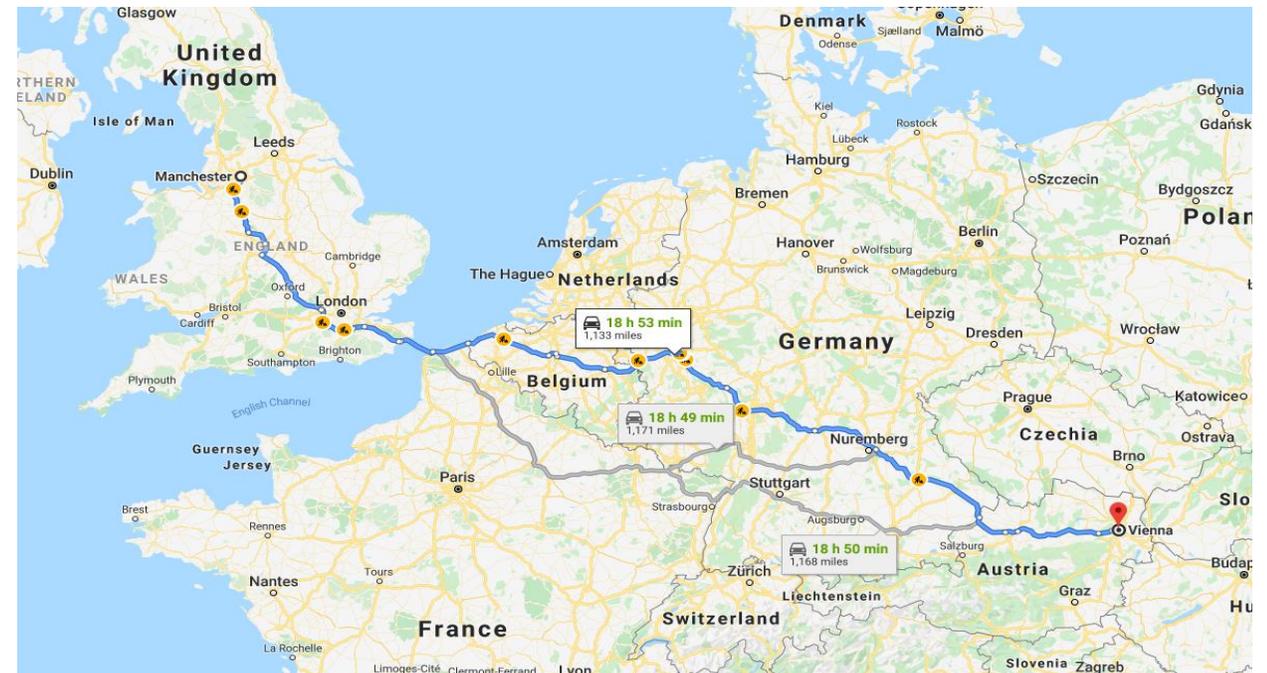
Manchester to Vienna = 1,130 miles (1,820 km)

Return **flight** to Vienna (direct) = 0.44 tCO₂e

Return **train** to Vienna = 0.02 tCO₂e

Going once every 22 years by plane = going every year by train

Online in the end – very low CO₂e



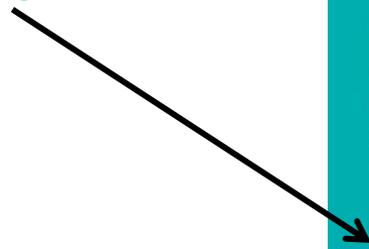
trainline

<https://www.thetrainline.com/trains/europe>

14th May 2021

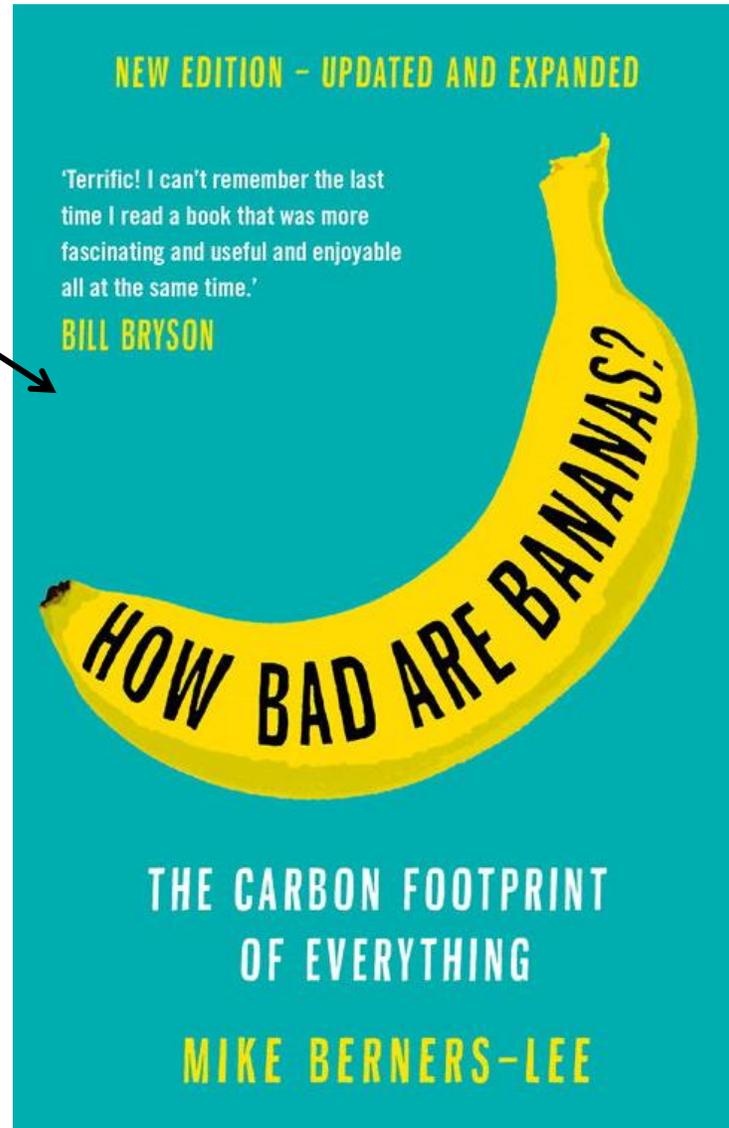
What can you do?

Read this book



Preferably buy it used from:

<https://www.alibris.co.uk/>

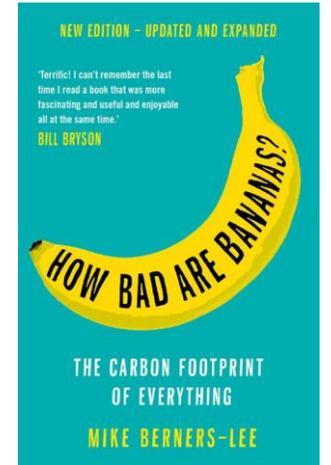
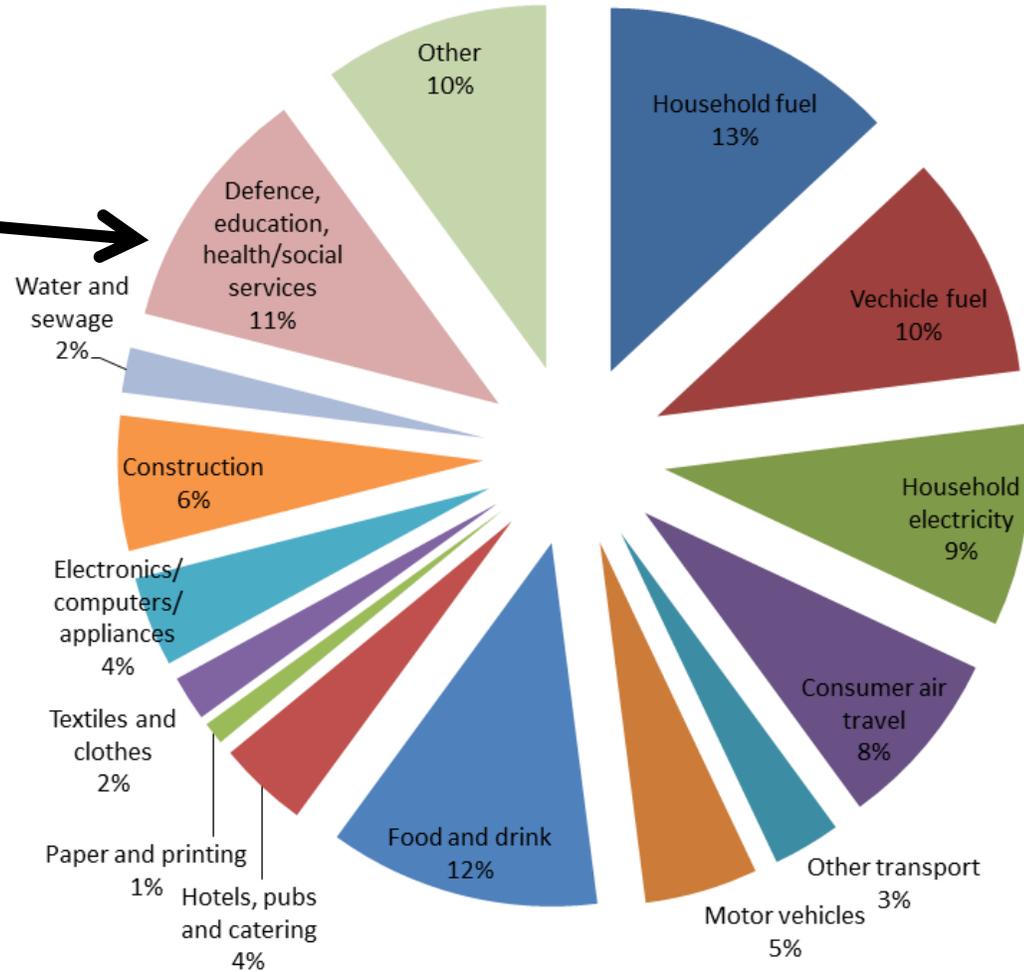
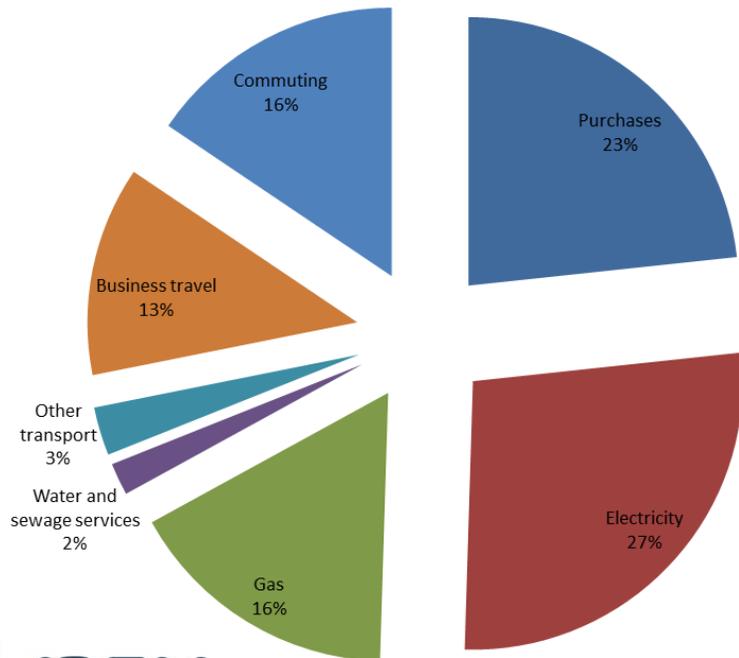


14th May 2021

What can you do?

Some Carbon footprint examples:

1. The UK – 862 million tonnes CO₂ per year
2. A University (~ a hospital?) – 72,000 tCO₂ per year



What can you do?

Some Carbon footprint examples:

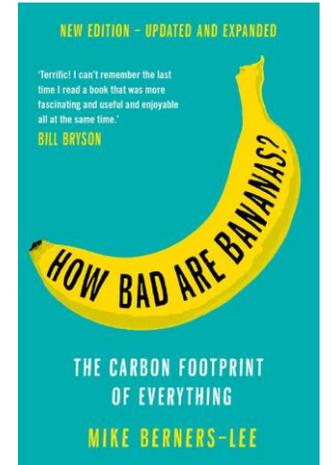
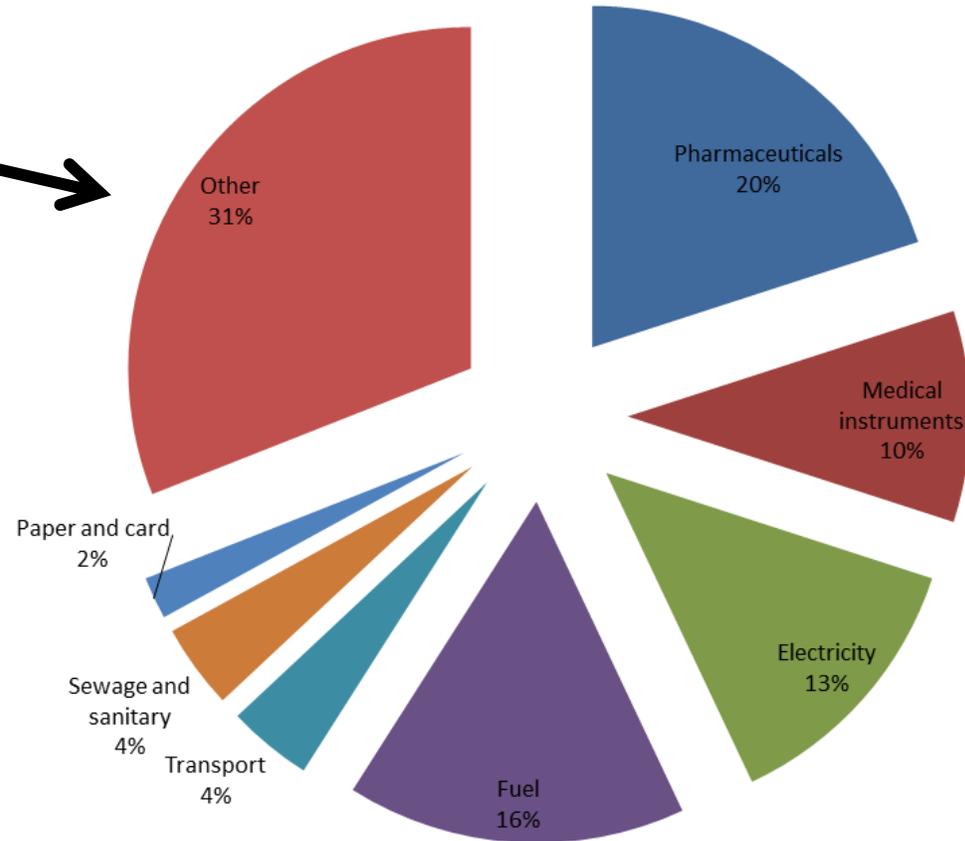
3. A heart bypass – 1.1 tCO₂
= to 2 return flights London to Madrid

4. A computer and using it

The machine	kg CO ₂
A Simple low-cost laptop	200
iMac	720
Hi-spec desktop	800

Electricity	g CO ₂ / hr
An energu efficient laptop	12
iMac	63
An old desktop	150

Use of servers/networks	50 g CO ₂ / hr
-------------------------	---------------------------



What can you do?

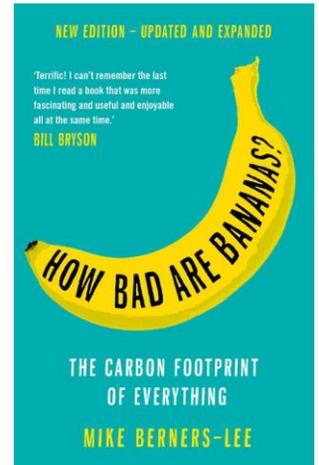
A:

	Items/processes	Carbon footprint (kgCO ₂ e)
G	1 email referral	0.004
B	1 banana	0.08
N	1 * 500ml bottle of water	0.16
L	1 letter referral (virgin paper & disposed of at landfill)	0.2
H	1 large cappuccino	0.235
F	1 cannula	0.54
D	1 toilet roll (virgin paper)	0.73
I	1 GP appointment	6
J	1 pair of jeans	6
E	1 Salamol inhaler	10
A	1 outpatient appointment	23
K	1 inpatient day - low intensity	37.9
O	1 return journey Oxford - London in an averaged sized car	40
M	1 cataract surgery in the UK	180
C	1 litre of Desflurane	3,720

50 times lower footprint than a letter.
Rebound effect – send more emails than we do letters

0.45 kgCO₂e recycled paper

126 kgCO₂e in a 4x4



What can you do?

Impacts of fast fashion

26.7kg

UK consumption of new clothing per head
(highest in Europe)

235m items of clothing sent to landfill last year

700,000 fibres released in a single domestic wash

1.2bn tonnes of carbon emissions produced by global fashion industry (2015)

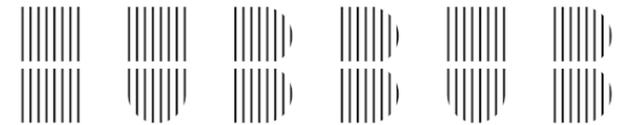
3,781 litres of water used in full lifetime of a pair of Levi's 501 jeans

Enviro Audit Committee submissions



- 160 kg of CO₂ per person in the UK on consumption of clothing
- Average age of an item of clothing in the UK is 2.2 years*
- Be aware of what you buy and from who.
- Your choices as a consumer and voter/citizen are important.

bank.green



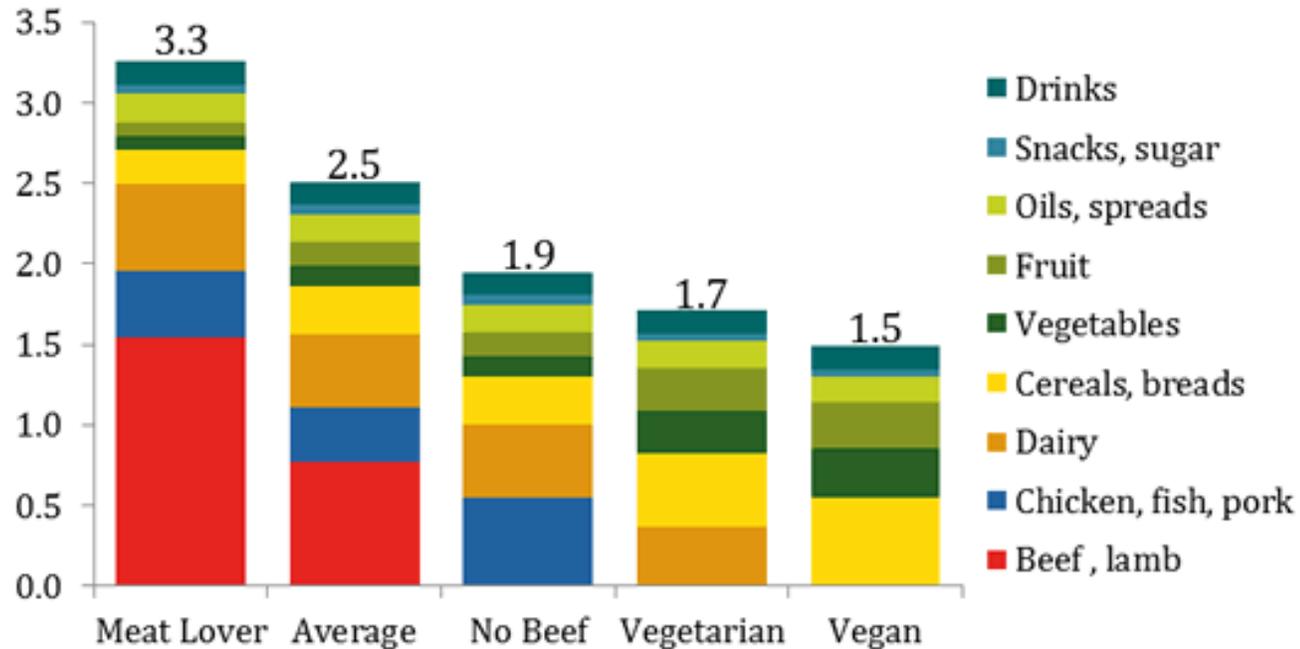
WWW.HUBBUB.ORG.UK

Registered Charity No. 1158700

*<http://www.wrap.org.uk/content/clothing-waste-prevention>

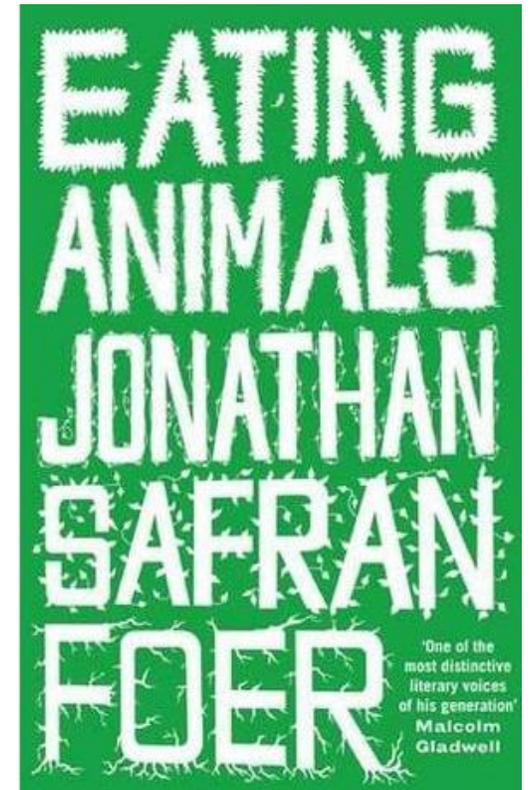
What can you do?

Foodprints by Diet Type: t CO₂e/person

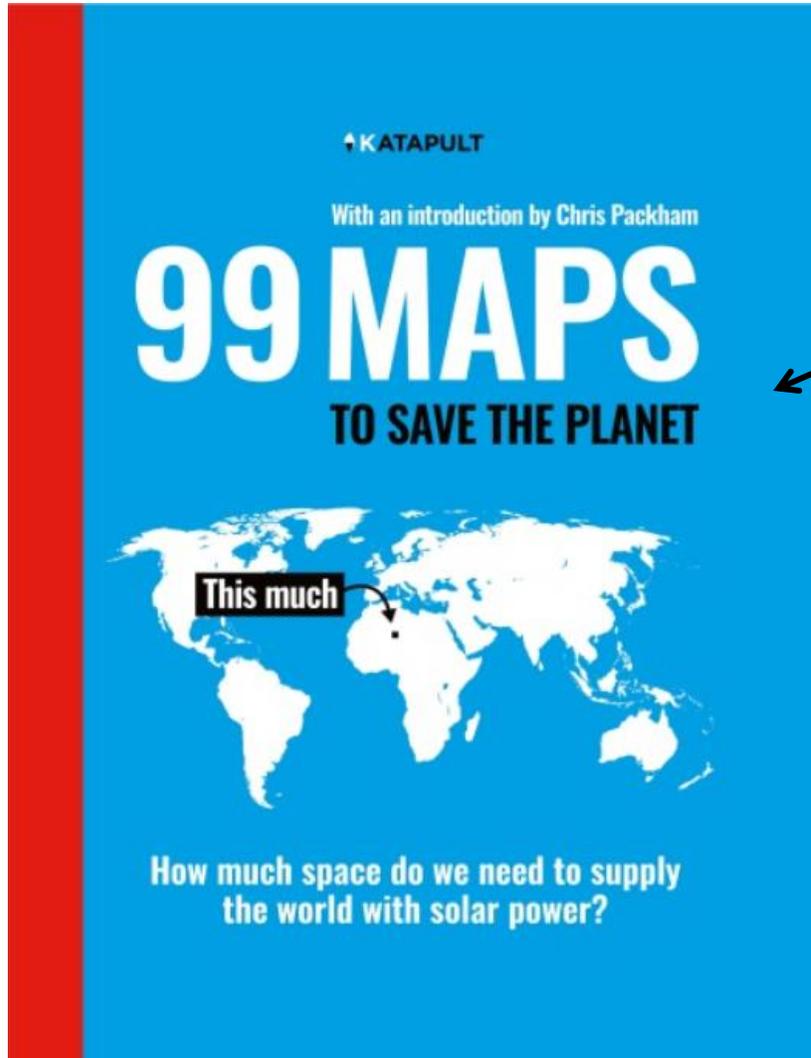


Note: All estimates based on average food production emissions for the US. Footprints include emissions from supply chain losses, consumer waste and consumption.. Each of the four example diets is based on 2,600 kcal of food consumed per day, which in the US equates to around 3,900 kcal of supplied food.

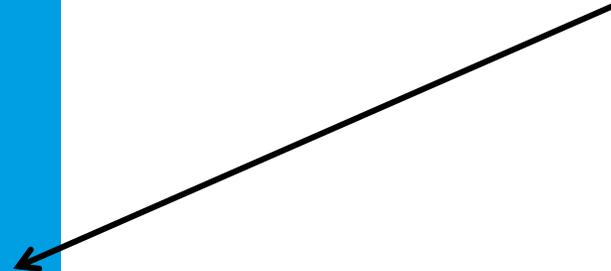
Sources: ERS/USDA, various LCA and EIO-LCA data



What can you do?



Read this book

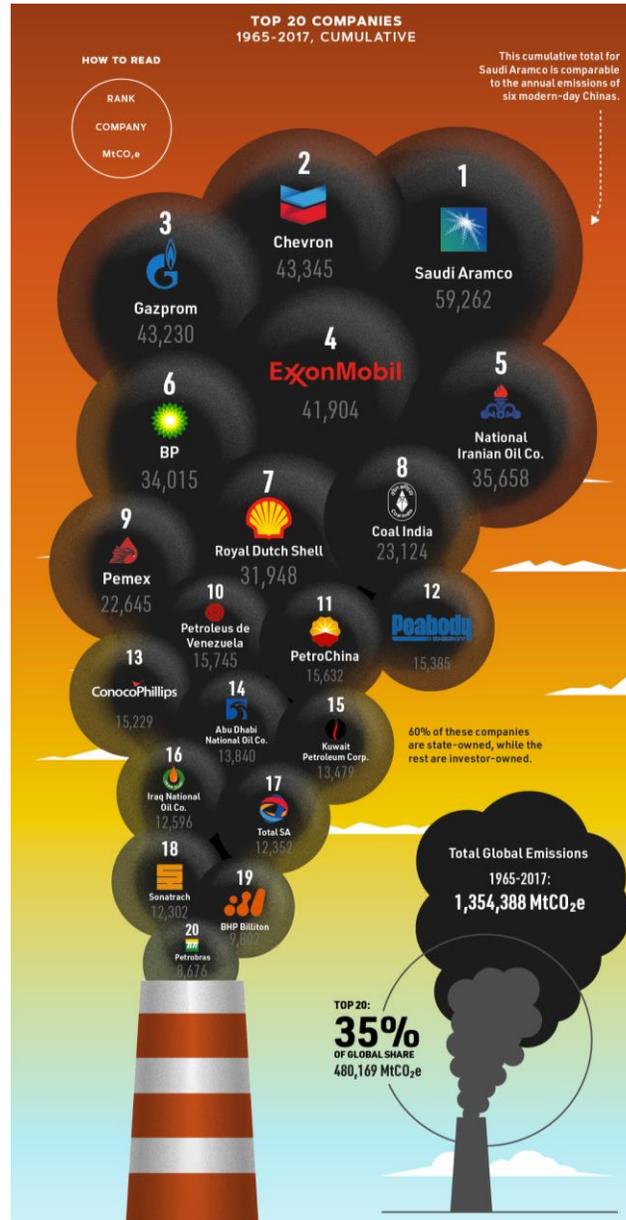


What can we do?

- These are all personal things that we can do
 - Often people have done a lot of these
 - The next thing we need to change is our workplaces and our organisations
 - **A lot of the personal things can be translated to work (its just harder)**
- So we started the IPEM Environmental Sustainability Group

*<http://www.wrap.org.uk/content/clothing-waste-prevention>

What can we do?



IPEM Environmental Sustainability Group

Started in February 2020

Key aims:

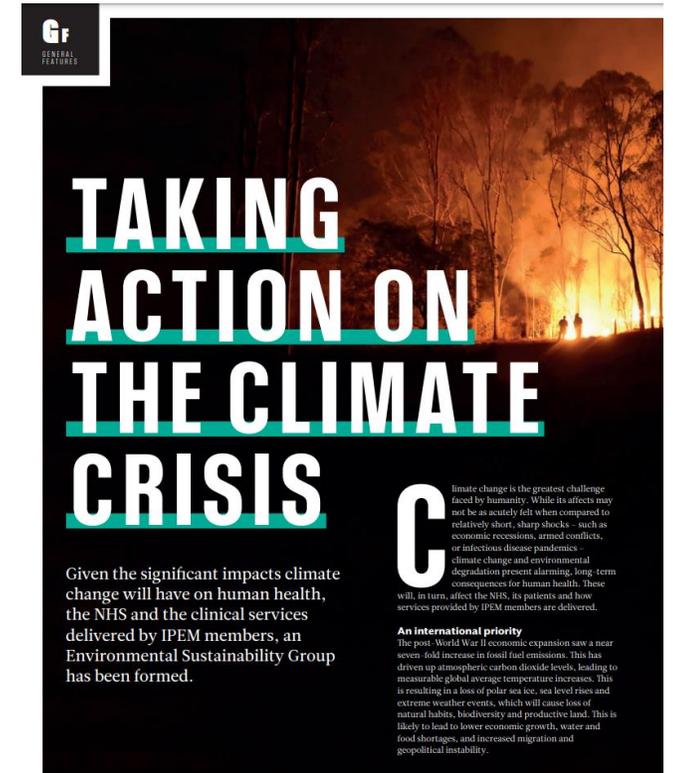
- Promote environmental sustainability to and within medical physics and engineering
- Engage and support members on environmental sustainability
- Advise IPEM Trustees on environmental sustainability
- Engage with others, including manufacturers and funding bodies, nationally and internationally on environmental sustainability

<https://www.ipem.ac.uk/AboutIPEM/SpecialInterestGroups/EnvironmentalSustainabilityGroup.aspx>

IPEM Environmental Sustainability Group

First achievements:

- Environmental sustainability survey conducted
- Environmental sustainability session at MPEC 2020
- Introduction to Env Sus at STP induction day/HSST lectures
- SCOPE article in March 2021 issue*
- Setting up carbon footprinting projects



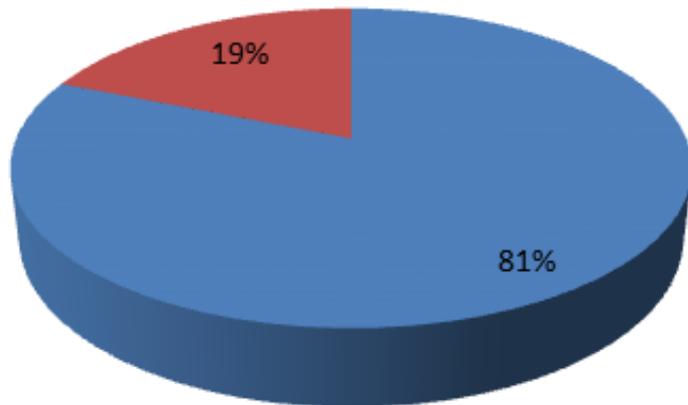
IPEM SCOPE 28 SPRING 2021

*<https://www.ipem.ac.uk/ScientificJournalsPublications/SCOPE/E-SCOPE.aspx>

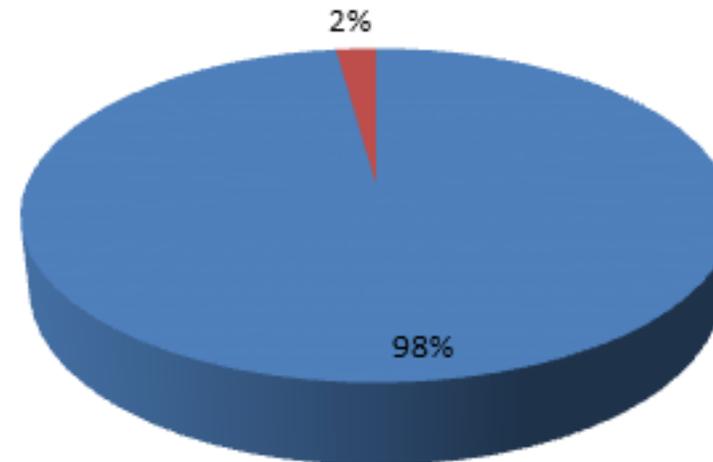
Results

Responses from 189 people!

Do you think that health and sustainability are linked?



Are you interested in environmental sustainability?



■ Yes
■ No

■ Yes
■ No

Results

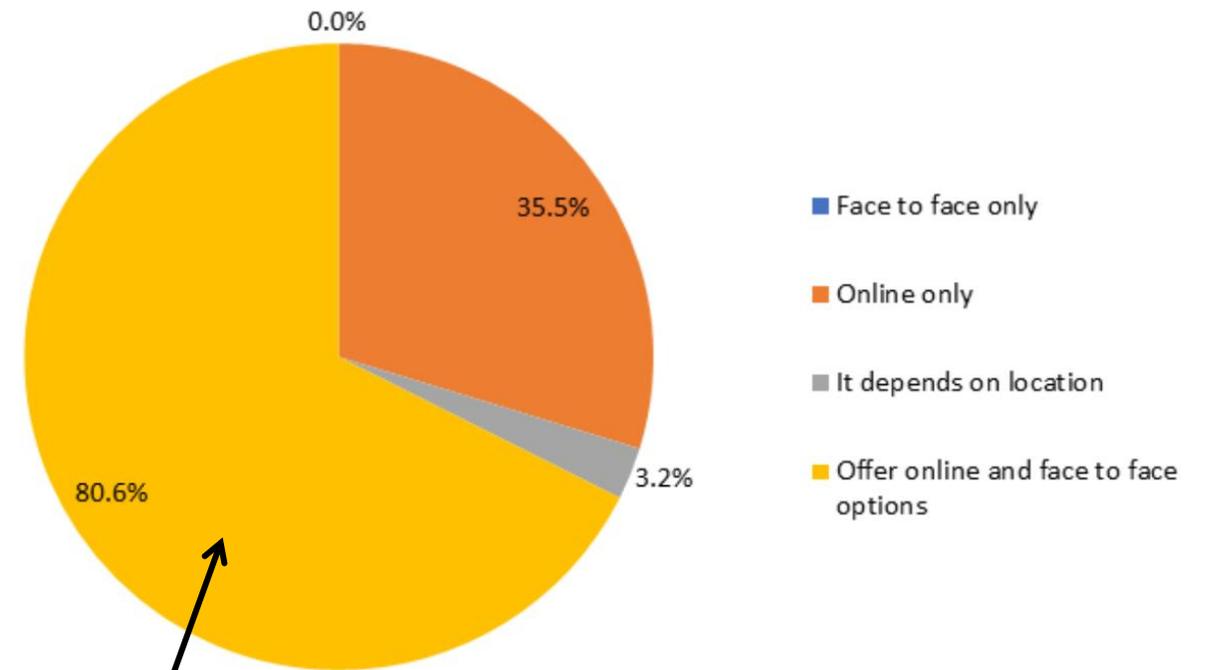
What change would you most like to see in your workplace in the next 5 years? (Free text response)

Improve recycling facilities	32
Continued remote working/meetings	19
Improve energy efficiency of the buildings	16
Improved cycling facilities (e.g. showers and secure bike parking)	14
Incentives for public transport use	14
Build environmental sustainability into every aspect of work	8
Go paperless	6
Flexible working	6
Install solar panels	5
Electric car charging facilities	5
Move to renewable energy supplier	5
Environmental issues as part of procurement process	4
Buy electric cars	3
Mandating environmental sustainability training with the Trust	3
Environmental and social costs included in the "triple bottom line"	3
Reduced single use items	3
Car sharing incentivised	2
Ban cars	2
Biodegradable materials used more often	2
Preventative medicine	2
Reduced paper use	1
Most free content	1
Environmental and social costs included in the "triple bottom line"	1
Preventative medicine	1
Telemedicine	1
Mandating environmental sustainability training with the Trust	1
Environmentally responsible pensions	1

Result - of MPEC Online feedback

- + More accessible to people that can't normally go to conferences
- + Cheaper for departments
- + Can invite more speakers from further a field
- + Reduces carbon footprint
- + Easier to see slides and hear speaker
- Less options to chat to colleagues and to network
- Potentially harder to get Study Leave/protected time

Ideally what would be your main preference in terms of how conferences are offered?



Or alternate? 2 years online then 3rd yr f-2-f?

N=38

Carbon Footprinting – introduction



CENTRE for
SUSTAINABLE
HEALTHCARE
inspire • empower • transform

- Use a CO₂ footprint as a measure of impact on climate change
- 7 greenhouse gasses considered:
 1. CO₂ – directly responsible for 86% UK's total climate impact
 2. Methane - is 25 times more potent per kg than CO₂ (responsible for 7% UK's climate impact)
 3. Nitrous oxide – is around 300 x CO₂ (responsible for 6% UK's climate impact) [anesthetic and analgesic]
 4. Hydrofluorocarbons (HFCs) = 560 – 12,100 x CO₂ depending on type of HFC
 5. Perfluorocarbons (PCFs) = 6000 – 7,400 x CO₂
 6. Sulphur hexafluoride (SF₆) = 22,800 x CO₂ [used in linacs]
 7. Nitrogen trifluoride (NF₃) = 17,200 x CO₂

all converted to CO₂ and called CO₂ e

Carbon Footprinting – introduction



CENTRE for
SUSTAINABLE
HEALTHCARE
inspire • empower • transform

- Two approaches to carbon footprinting:
 1. Top down (cost to CO₂e footprint) – emissions factors applied to spend
 - + includes everything
 - + simple approach
 - Doesn't identify specific hotspots
 - Reliant on emissions factors being published → BEIS/DEFRA database
 2. Bottom up – emissions factors applied to components of a process or product
 - + identifies specific items/processes that have a big footprint
 - + less reliant on emissions factors → Inventory of Carbon Energy (ICE) database
 - time consuming to do
 - easy to miss out important bits of process

Carbon Footprinting – introduction

Estimate what the CO2e footprint of a face-to-face conference vs an online conference

Face to face conference

Flights

<https://calculator.carbonfootprint.com/calculator.aspx?tab=3>
CO2e footprint of a return economy flight from Barcelona from:

	tCO2e	Proportion of people who would have flown	Total CO2e for all delegates flights
Amsterdam	0.36	0.9	248.3
London	0.34	0.95	215.7
Spain	Assume they didn't fly		
Berlin	0.41	0.9	165.1
Rome	0.24	0.95	92.1
Paris	0.24	0.8	71.8
Brussels	0.3	0.95	85.7
Bern	0.21	0.9	42.6
Mid europe (other) Munich	0.3	0.9	680.2
Darwin (Australia)	3.93	1	3124.4
New York	1.72	1	368.6
San Francisco	2.67	1	572.1
Baghdad	1.06	1	118.5
Rio de Janero	2.38	1	192.2
Kampala	1.54	1	47.8

Accommodation

A night in a hotel (Book: How bad are bananas, Mike Burners-Lee, p108)

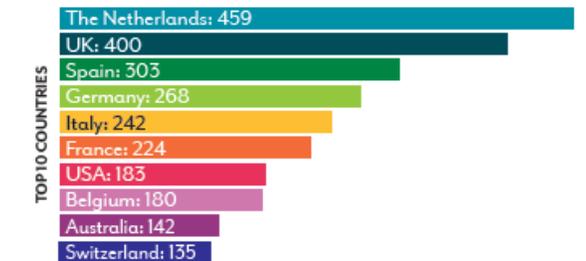
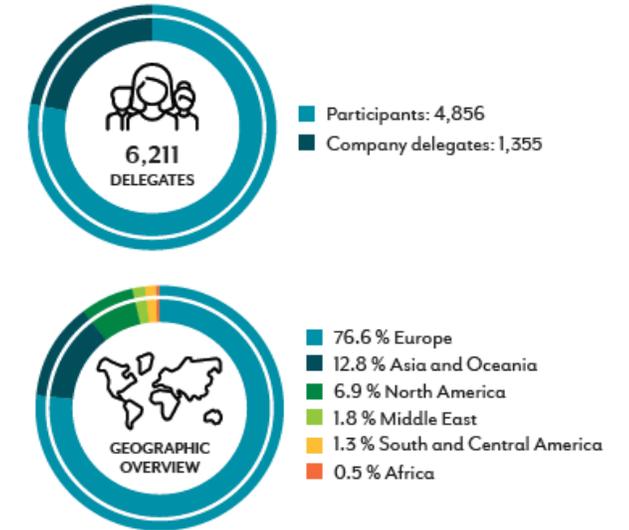
	kgCO2e	Proportion in each of these	
Low CO2e (inc BnB) (assume for AirBnB too)	3	0.5	9316.5
Average	25	0.4	62110.0
High end	60	0.1	37266.0

Event space

~ in proportion to a University (Book: How bad are bananas, Mike Burners-Lee, p156)

	tCO2e
Per each member of staff and student	8
Number of staff	100
Total	800

DELEGATES



Carbon Footprinting – introduction

Estimate what the CO2e footprint of a face-to-face conference vs an online conference

Online

Travel						
Travel (as assuming post COVID so some people are doing this from work)						
	Proportion	Time	Speed (km/h)	Distance (km)	kgCO2e	
Car Small car	0.47	0.5	40	20	28885.3	
Car expensive	0.19	0.5	40	20	38923.5	
Walk	0.09	0.25	4	1	44.4	
Rail	0.09	0.8	40	32	3218.2	
Bus	0.06	0.7	30	21	774.4	
Other (bike?)	0.04	0.3	4	1.2	23.7	
Work from home	0.05	0	0	0	0.0	

Energy usage				
Consumption of computer energy (Book: How bad are bananas, Mike Burners-Lee, p124)				
	kgCO2e	Proportion of people	Number of hour online	Total
Electricity consumption	per hour			
Energy efficient aptop	0.012	0.5	28	1043.4
iMac	0.063	0.3	28	3286.9
Old desktop PC	0.16	0.2	28	5565.1
Servers and networks	0.05 per hour		28	8695.4

DELEGATES



■ Participants: 4,856
■ Company delegates: 1,355

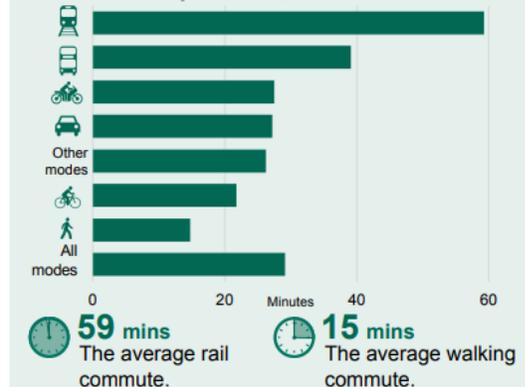
Usual mode of travel to work [TSGB0108-0109](#)

Travel to work mode share, Great Britain: 2016



Travel time to work [TSGB0111](#)

Travel time to work by usual mode, Great Britain: Oct-Dec 2016

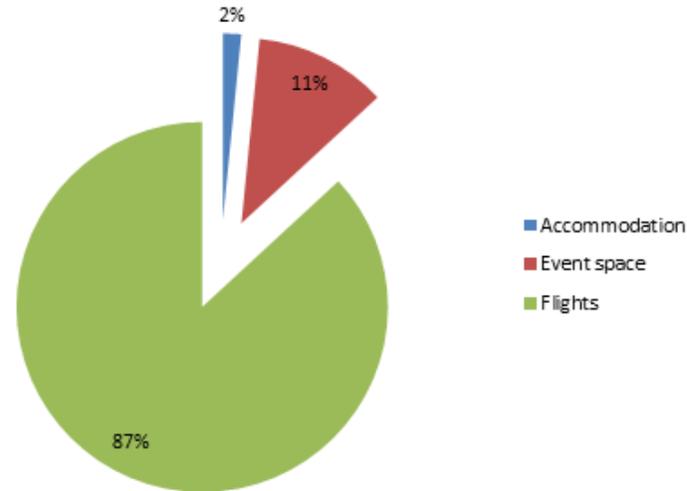


Carbon Footprinting – introduction

Estimate what the CO₂e footprint of a face-to-face conference vs an online conference

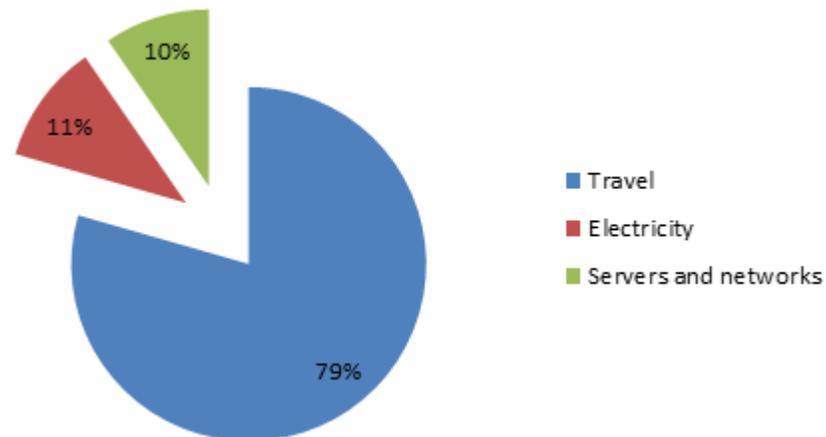
Face to face conference

Accommodation	108.693
Event space	800
Flights	6025.13
Total for face to face conference	6934 tCO₂e



Online

Travel	71.9
Electricity	9.9
Servers and networks	8.6954
Total for online conference	90.5 tCO₂e



~ 76 times bigger

We can argue about:

If at conference don't use energy at home

Food and drink

“Networking” events

Etc...

Carbon Footprinting – in healthcare

Q J Med 2010; 103:965–975
doi:10.1093/qjmed/hcq150 Advance Access Publication 18 August 2010

The carbon footprint of a renal service in the United Kingdom

A. CONNOR^{1,2,*}, R. LILLYWHITE³ and M.W. COOKE⁴

From the ¹The Campaign for Greener Healthcare, Oxford, ²Department of Renal Medicine, Dorset County Hospital, Dorchester, ³Warwick HRI and ⁴Warwick Medical School, University of Warwick, Coventry, UK

Address correspondence to Dr A. Connor, Department of Renal Medicine, Dorset County Hospital, Williams Avenue, Dorchester, DT1 1JY, UK. email: andrew.connor@kintoa.org

Published in final edited form as:

J Cataract Refract Surg. 2017 November ; 43(11): 1391–1398. doi:10.1016/j.jcrs.2017.08.017.

Cataract surgery and environmental sustainability: Waste and lifecycle assessment of phacoemulsification at a private healthcare facility

Cassandra L. Thiel, PhD, Emily Schehlein, MD, Thulasiraj Ravilla, R.D. Ravindran, MD, Alan L. Robin, MD, Osamah J. Saeedi, MD, Joel S. Schuman, MD, and Rengaraj Venkatesh, MD
Department of Population Health, Langone Medical Center, and Wagner Graduate School of Public Service (Thiel), New York University, and the Department of Ophthalmology (Schuman), New York University School of Medicine, New York, New York; the University of Maryland School of Medicine (Schehlein), the Department of Ophthalmology (Robin), University of Maryland, the

The impact of surgery on global climate: a carbon footprinting study of operating theatres in three health systems

Andrea J MacNeill, Robert Lillywhite, Carl J Brown

Summary

Background Climate change is a major global public health priority. The delivery of health-care services generates considerable greenhouse gas emissions. Operating theatres are a resource-intensive subsector of health care, with high energy demands, consumable throughput, and waste volumes. The environmental impacts of these activities are generally accepted as necessary for the provision of quality care, but have not been examined in detail. In this study, we estimate the carbon footprint of operating theatres in hospitals in three health systems.



Lancet Planet Health 2017; 1: e381–88

See [Comment](#) page e357

Division of General Surgery, University of British Columbia, Vancouver, Canada

Journal of Cleaner Production 286 (2021) 125446



Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

The carbon footprint of waste streams in a UK hospital

Chantelle Rizan^{a, b, *}, Mahmood F. Bhutta^{a, b}, Malcom Reed^b, Rob Lillywhite^c

^a Brighton and Sussex University Hospitals NHS Trust, Royal Sussex County Hospital, Eastern Road, Brighton, BN2 5BE, UK

^b Brighton and Sussex Medical School, Falmer, Brighton, BN1 9PX, UK

^c University of Warwick, School of Life Sciences, Gibbet Hill Campus, The University of Warwick, Coventry, CV4 7AL, UK

Carbon Footprinting – in Med Phys

Open Access

Research

BMJ Open Environmental and social benefits of the targeted intraoperative radiotherapy for breast cancer: data from UK TARGIT-A trial centres and two UK NHS hospitals offering TARGIT IORT

Nathan J Coombs,¹ Joel M Coombs,² Uma J Vaidya,^{3,4} Julian Singer,⁵ Max Bulsara,^{4,6} Jeffrey S Tobias,⁷ Frederik Wenz,⁸ David J Joseph,⁹ Douglas A Brown,¹⁰ Richard Rainsbury,¹¹ Tim Davidson,¹² Douglas J A Adamson,¹⁰ Samuele Massarut,¹³ David Morgan,¹⁴ Ingrid Potyka,⁴ Tammy Corica,^{4,9} Mary Falzon,¹⁵ Norman Williams,⁴ Michael Baum,⁴ Jayant S Vaidya⁴

Radiology

ORIGINAL RESEARCH · HEALTH POLICY AND PRACTICE

The Energy Consumption of Radiology: Energy- and Cost-saving Opportunities for CT and MRI Operation

Tobias Heye, MD • Roland Knoerl, MBA, B Eng • Thomas Wehrle, Dipl-Ing • Daniel Mangold • Alessandro Cerminara • Michael Loser, PhD • Martin Plumeyer, Dipl-Ing • Markus Degen, PhD • Rahel Lüthy, MSc • Dominique Brodbeck, PhD • Elmar Merkle, MD

From the Department of Radiology, University Hospital Basel, Petersgraben 4, Basel 4031, Switzerland (T.H., E.M.); Siemens Healthineers, Forchheim, Germany (R.K., M.L., M.P.); Building Management, University Hospital Basel, Basel, Switzerland (T.W., D.M., A.C.); and School of Life Sciences, University of Applied Sciences and Arts Northwestern (FHWN), Muttenz, Switzerland (M.D., R.L., D.B.). Received September 16, 2019; revision requested November 4; revision received January 20, 2020; accepted January 23. Address correspondence to T.H. (e-mail: tobias.hey@usb.ch).

Carbon Footprinting – in Med Phys

IPEM ESG – proposing a project for funding with title:

“A multi-centre study estimating the carbon footprint of the radiotherapy pathway”

Aim to determine the CO₂e of the patient's:

- travel
- imaging
- treatment on the linac
- medical interventions (antibiotics, Buscopan etc)
- immobilisation
- consultations

For 3 centres (The Christie, Mt Vernon and Worcester)

Still work in progress.....



Summary

Climate change is a huge issue – politicians don't lead they follow public opinion so we need to lead.

If climate change occurred over the same timescale as COVID we would be turning our lives upside down to solve it.

Healthcare makes up ~5% of UK carbon footprint

NHS aims to be net carbon zero by 2040

As scientists and scientists that work in healthcare we are uniquely placed to help develop solutions to these problems.

IPEM (and its network and ability to lobby government) is key to this

If you are keen to get involved or want to hear more please feel free to contact me:

robert.chuter@nhs.net or follow



@RobChuter or @IPEMEnvironment

Thank you for listening

Any questions?

robert.chuter@nhs.net



@IPEMEnvironment