



The environmental impacts of cognitive neuroscience, from liquid helium to big data: what's our footprint?

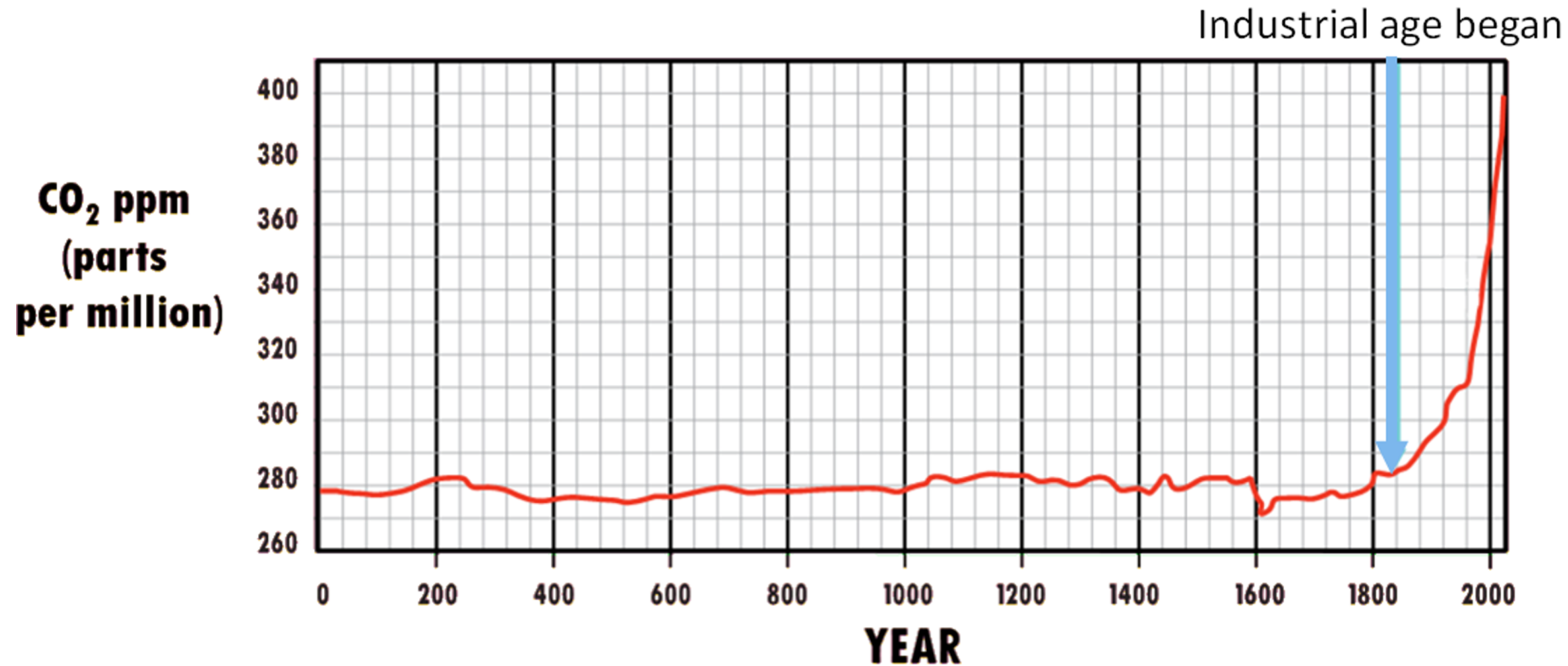
Charlotte Rae

University of Sussex, UK

Slides: anneur.ai.net/green-neuroscience



Greenhouse gas emissions are skyrocketing

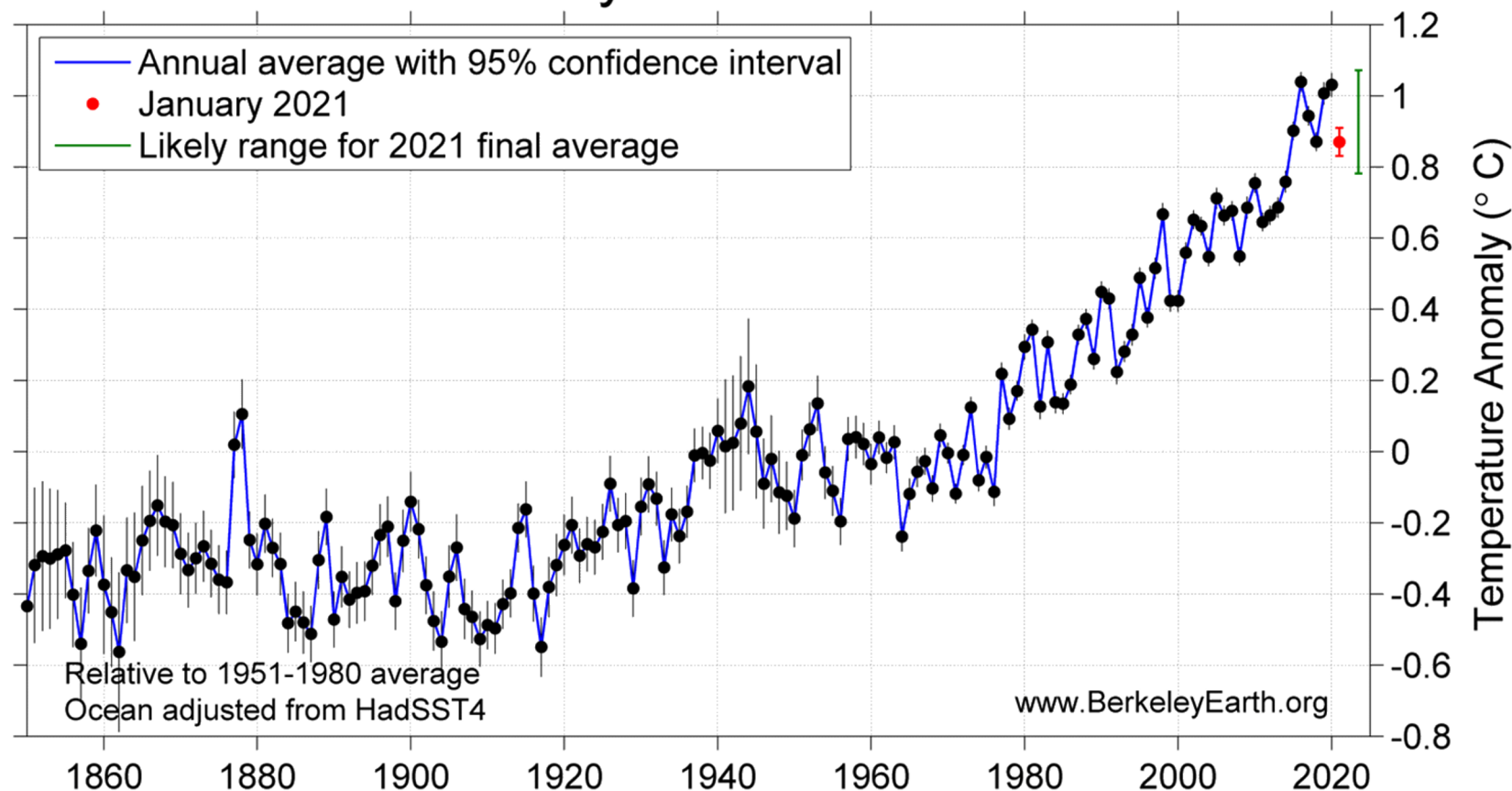


Graph adapted from <https://nas-sites.org/americasclimatechoices/more-resources-on-climate-change>



Global temperatures are skyrocketing

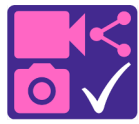
Berkeley Earth - Global



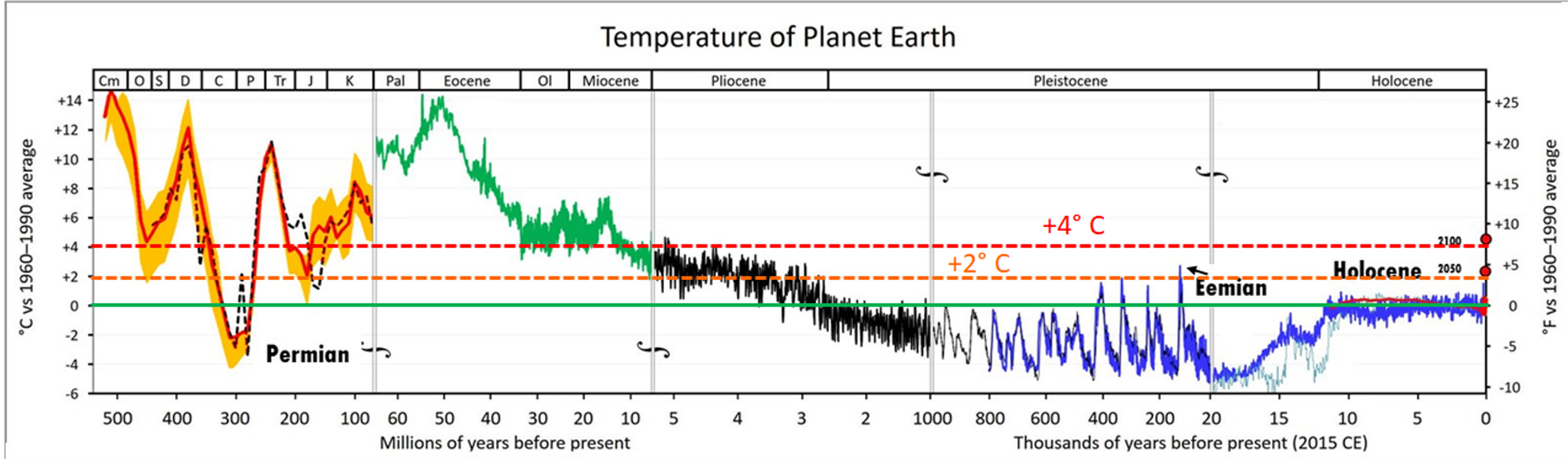
1°C doesn't sound much...

But during last Ice Age
(UK buried under ice)
global temperature
just 6°C lower than today

Tierney et al (2020) *Nature*

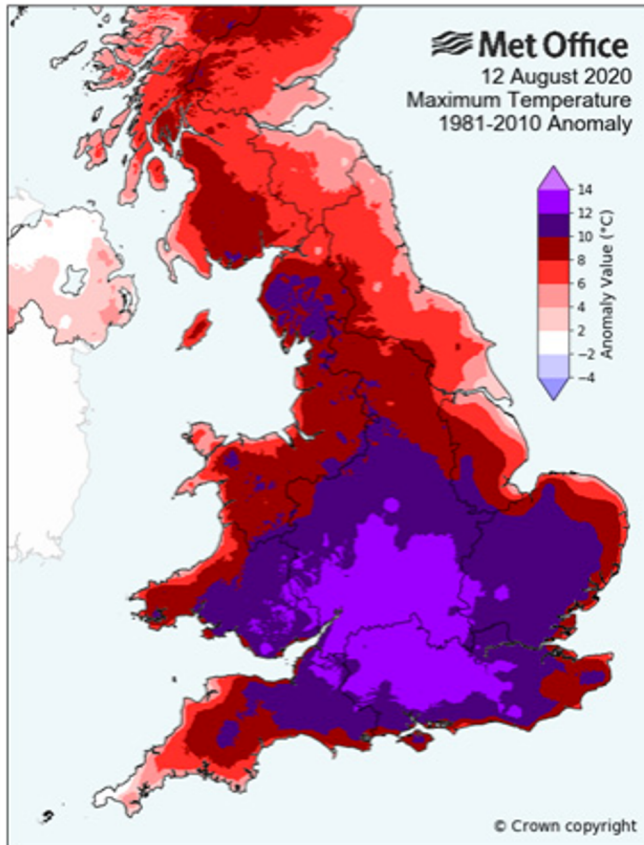


WE HAVEN'T SEEN $+2^{\circ}\text{C}$ FOR 130000 YEARS...
...and $+4^{\circ}\text{C}$ for several million years





Impacts already being felt globally





Intergovernmental Panel on Climate Change



NEWS • 08 OCTOBER 2018

IPCC says limiting global warming to 1.5 °C will require drastic action

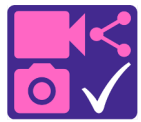
Humanity has a limited window in which it can hope to avoid the worst effects of climate change, according to climate report.



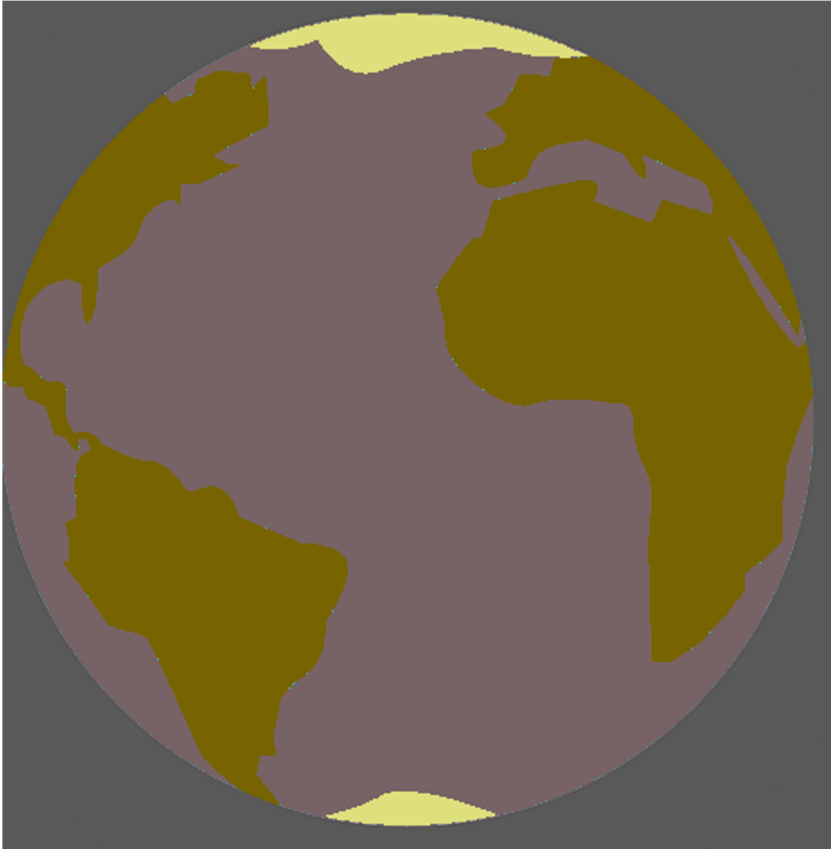
Consequences for 'business as usual'

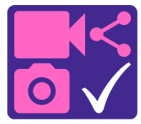


- Sea level rise due to melting ice; coastal flooding
- Changed weather systems; stronger storms, floods, droughts, wildfires, desertification, crop failure
- Deaths due to heat stress
- Famine, water shortages, displacement of people from their homes
- War



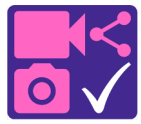
We are also destroying Earth's ecology





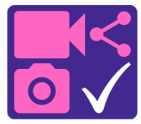
High intensity agriculture has replaced wilderness





Deforestation is reducing carbon sinks & biodiversity





By destroying ecology, we destroy our food webs





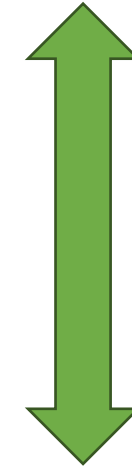
The climate crisis & ecological emergency

- Happening now
- We must act urgently
- The causes extend across all domains of human activity:
 - scientific research is one of these
- If we do not act, we will not be able to carry on doing science
- Think about what a public health emergency (covid) did to science...
- What will the even bigger environmental emergencies do?



The climate crisis & ecological emergency

- Our talks will address:
- Cognitive neuroscience research (*Charlotte Rae*)
- Wet lab research (*Martin Farley*)
- Academic communities & institutions (*Anne Urai*)
- Influencing public & politicians (*Kate Jeffery*)



**These levels of
action influence
each other**



Cognitive neuroscience: what's our footprint?



hardware

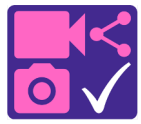


data



**open
science**

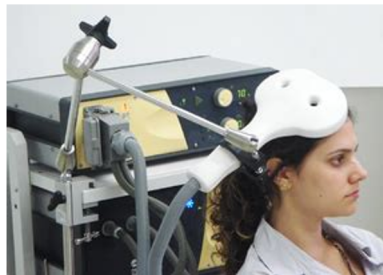


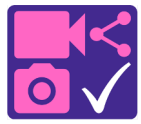


Cognitive neuroscience: what's our footprint?



hardware





Liquid helium



NB. OPM-MEG: no helium required



Recommendations – liquid helium

- Work with physicists to develop future non-helium technologies
- Value your MRI & MEG data more (especially high reuse potential)
- Install a helium recycling tank (captures some boil-off)



Cognitive neuroscience: what's our footprint?



hardware



data



**open
science**





Data centres: construction

> The building “shell”

Quantified for a 1MW data center

Concrete

Masonry Brick, stone, grout

Metals Steel beams, lead pipes, copper wires, aluminum sheet metal, stairs, railings, floor plates, grates, nails, screws, bolts, aluminum flashing, sheet metal, aluminum ventilation, louver systems

Wood, plastic, composite

Room framing, wire coatings, doors, windows

Thermal/moisture protection

Insulation, vapor barriers

Water Cleaning, cooling, fire suppression

Chemicals Glue, glycol, cleaners, water repellants sealants, fire suppression

Glass

Tar Roofs, roads, sidewalks, parking lots

Shingles, tiles

> The data center

Quantified for a 1MW data center

Electricity 177,000,000 kW-hr

Water 60,000,000 gal (227,000,000 l)

Copper 145,000 lbs (65,771 kg)

Lead 21,000 lbs (9,525 kg)

Plastic 33,000 lbs (14,968 kg)

Aluminum 73,000 lbs (33,112 kg)

Solder 12,000 lbs (5,443 kg)

Steel 377,000 lbs (171,004 kg)

Assumptions: 10-year lifetime, high redundancy, two IT refreshes, includes power/cooling/racks/IT, does not include the building

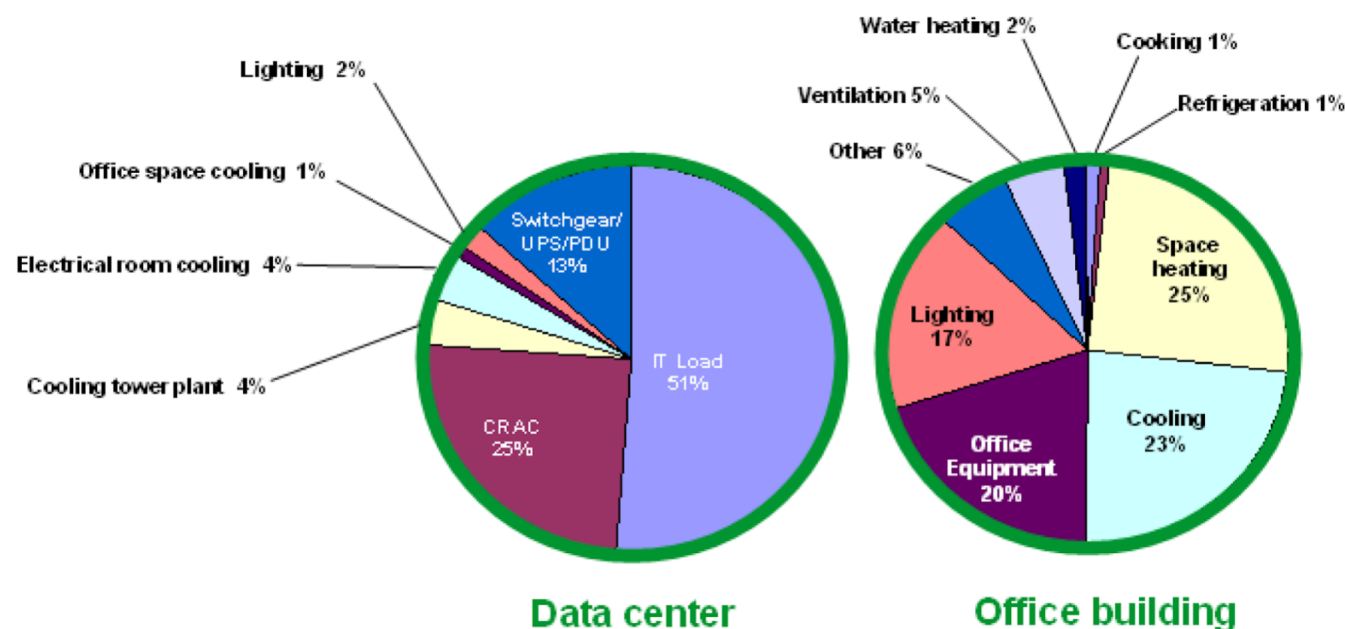
“10 year
lifetime”

“2 IT
refreshes”



Data centres: energy

“Data centres can be **40 times** as energy intensive as an office building”

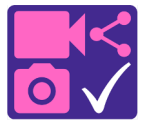




Data centres: energy

3 key factors

- IT load
 - more activity, more energy required
- Location
 - extremes of temperature require more cooling
- Power Use Efficiency
 - centre & system design; local vs cloud



Data centres: energy

...where is the energy coming from?





Open science repositories



- Uses Google: 100% renewable



- Uses Amazon Web Services
- AWS currently ~50% renewable; non-renewable storage offset*
- NeuroVault looking at switching to guaranteed renewable



- Uses AWS

*offsetting very problematic



Recommendations – data analysis & sharing

- The more data you acquire, store, analyse and share, the bigger your environmental costs
- Consider carefully how much you really need to acquire, store, analyse, share
- ‘Reduce, reuse, recycle’
- Make use of existing, popular, shared datasets (e.g. HCP, Biobank)
- OSF ‘green standard’ for data sharing
- For likely low reuse datasets, possibly share summary on Neurovault



What's our footprint?

- In the new OHBM **Sustainability & Environment Action Group**,
- We are quantifying the footprint of human neuroimaging pipelines,
- From data acquisition to analysis & sharing



hardware



data



**open
science**

...join us!



Thank you



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