

Sustainable day-to-day computing

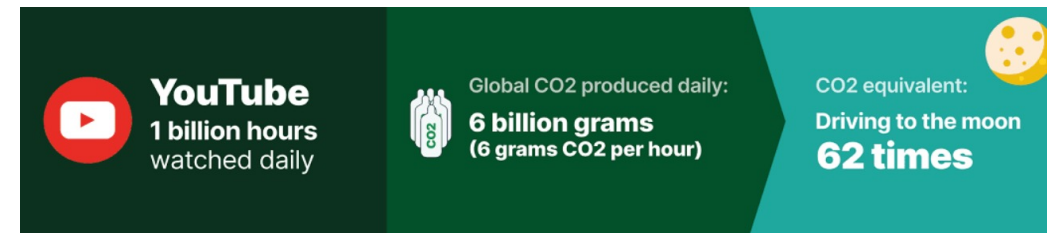
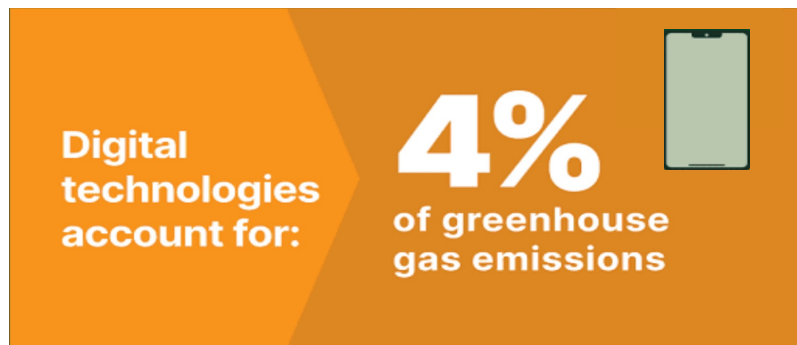
Margarita Pertseva on behalf of SIB

22.02.2022



Why it matters

- IT sector was responsible for 2% - 6% of global CO₂ emissions in 2020 and it is predicted to grow by 20% by 2030 [1].



1. Copenhagen Centre on Energy Efficiency. Greenhouse gas emissions in the ICT sector: Trends and methodologies [Internet]. 2020. Available from: <https://c2e2.unepdtu.org/wp-content/uploads/sites/3/2020/03/greenhouse-gas-emissions-in-the-ict-sector.pdf>

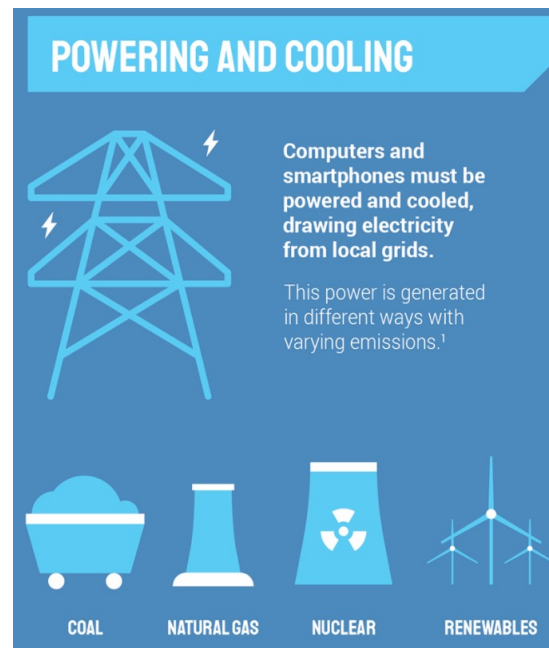
Sources of environmental impact

The environmental impact of computing can be broadly divided between:

The life cycle footprint of the hardware



The carbon footprint of powering & cooling



The impact of long-term data storage



MANUFACTURING AND SHIPPING



Technology companies must manufacture and ship the internet's hardware including



COMPUTERS



SMART

The hardware footprint

Sustainable hardware: things to consider



- CO₂ & environmental costs are much higher for **producing new devices than for using it.**

CO₂ emissions for MacBook Pro life cycle:

- 76% Production
- 6% Transport
- 17% Use

- Consider to buy a refurbished or second-hand laptop or phone
- Buy a repairable & upgradeable device (replace a battery, hard drive, RAM):
 - Repairability Scores: <https://www.ifixit.com/laptop-repairability>
 - TCO certified: <https://tco certified.com/product-finder/>
 - Responsible mineral sourcing & avoiding dangerous toxic chemicals

Side note: IFIXIT (<https://www.ifixit.com/>) is a great source of instructions on how to fix any electronic device

Sustainable hardware: examples

HP, Dell, Lenovo

- ✓ easy to repair
- ✓ extensive sustainability reports

Framework

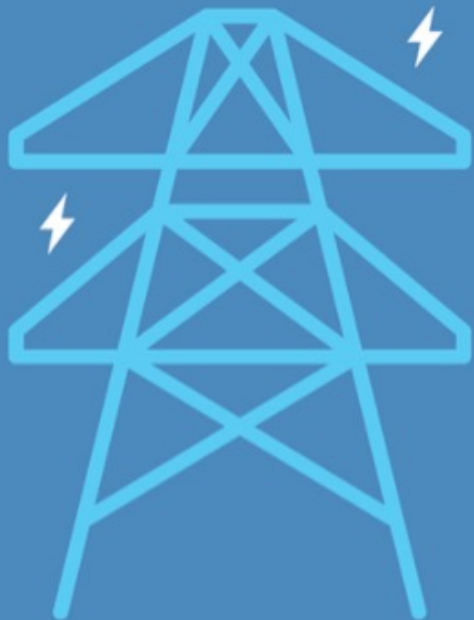
- ✓ highly modular
- ✓ easy to repair & modify

MacBook

- ✓ carbon-neutral supply chain by 2030
- ✓ sustainable & recycled materials
- ✗ low repairability (but this slowly starts to change)



POWERING AND COOLING



Computers and smartphones must be powered and cooled, drawing electricity from local grids.

This power is generated in different ways with varying emissions.¹



COAL



NATURAL GAS



Powering & usage footprint

Powering & usage footprint



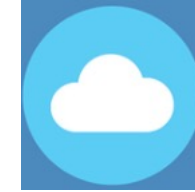
Power & electricity consumption

- ✓ **Dim the monitor**
 - dimming to 70% can save up to 20% of the energy
- ✓ **Unplug devices**
 - computers continue to draw energy when powered down
- ✓ **Use sleep mode & turn off**
 - set up a sleep mode after several minutes
 - shut down if away for > 2 hours



Internet

- ✓ **Unsubscribe from irrelevant newsletters**
- ✓ **Avoid videos where you only need audio** (music)
- ✓ **Try alternative search engines**



Computing

- ✓ **Use cloud computing**
- ✓ **Calculate & improve computational footprint**
- ✓ **Use latest software versions & optimise the code**

Sustainable search engines

- A single query generates 0.2 grams of CO2



- Solar powered
- All revenues are invested:
 - 20% renewable energy, regenerative agriculture
 - 80% protecting & planting trees
- 45 searches ~ 1 tree



- Hydro-electricity powered
- 60% of revenues are invested into Operation Posidonia & The Big Ocean Cleanup



- Removes plastic from the oceans
- 5 searches (17 tabs) ~ 1 bottle recovered

Sustainable computing

PLOS COMPUTATIONAL BIOLOGY

EDITORIAL

Ten simple rules to make your computing more environmentally sustainable

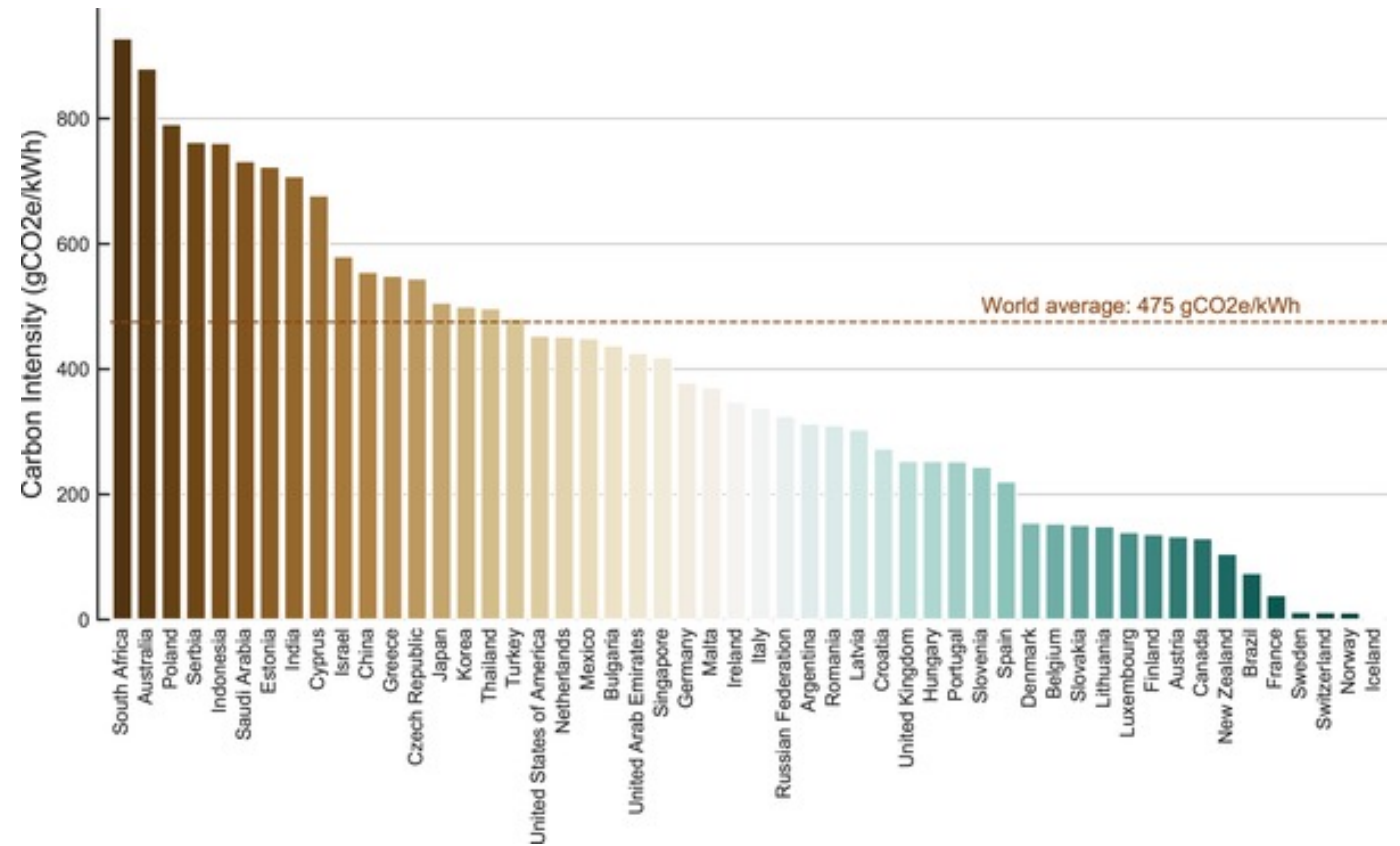
Loïc Lannelongue ^{1,2,3}, **Jason Grealey** ^{4,5}, **Alex Bateman** ^{6*}, **Michael Inouye**^{1,2,3,4,7,8}

1 Cambridge Baker Systems Genomics Initiative, Department of Public Health and Primary Care, University of Cambridge, Cambridge, United Kingdom, **2** British Heart Foundation Cardiovascular Epidemiology Unit, Department of Public Health and Primary Care, University of Cambridge, Cambridge, United Kingdom, **3** Health Data Research UK Cambridge, Wellcome Genome Campus and University of Cambridge, Cambridge, United Kingdom, **4** Cambridge Baker Systems Genomics Initiative, Baker Heart and Diabetes Institute, Melbourne, Victoria, Australia, **5** Department of Mathematics and Statistics, La Trobe University, Melbourne, Australia, **6** European Molecular Biology Laboratory, European Bioinformatics Institute (EMBL-EBI), Wellcome Genome Campus, Hinxton, United Kingdom, **7** British Heart Foundation Centre of Research Excellence, University of Cambridge, Cambridge, United Kingdom, **8** The Alan Turing Institute, London, United Kingdom

Electricity carbon footprint & cloud computing

- With cloud computing & data storage you can reduce environmental impact
- But choose the facility wisely (location, energy source & energy efficiency)
- Google Cloud (especially for ML/AI); Amazon Web Services

Carbon intensity (i.e., the carbon footprint of producing each kWh of electricity) for different countries, in gCO₂e/kWh.



Lannelongue L, Grealey J, Bateman A, Inouye M (2021) Ten simple rules to make your computing more environmentally sustainable. PLOS Computational Biology 17(9): e1009324.

<https://doi.org/10.1371/journal.pcbi.1009324>

<https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1009324>

How green are your computations?

1) You can estimate the carbon footprint of you computations on <http://www.green-algorithms.org/>

Details about your algorithm

To understand how each parameter impacts your carbon footprint, check out the formula below and the [methods article](#)

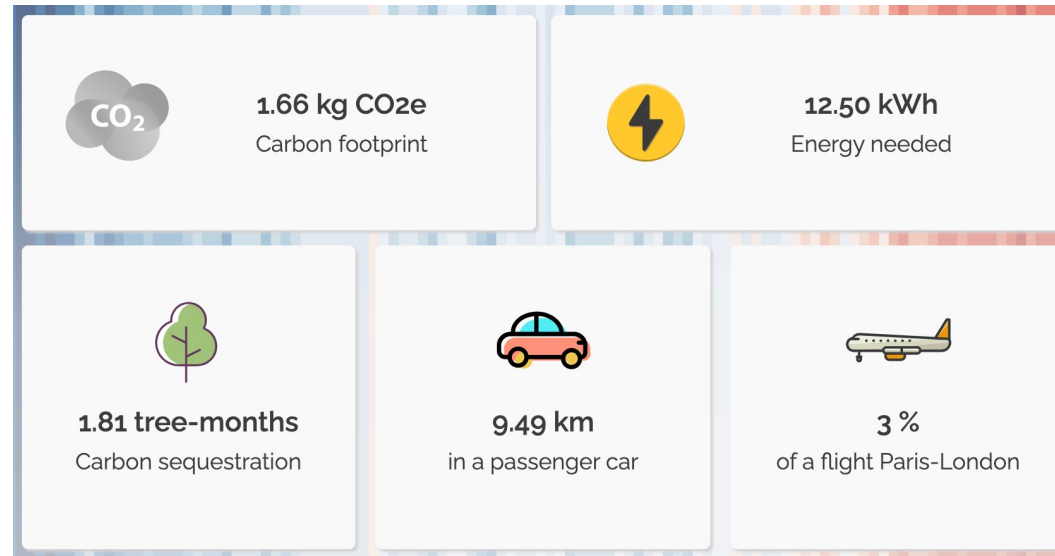
Runtime (HH:MM)

Type of cores

Number of GPUs

Model

Memory available (in GB)



- 2) Think of possible ways to reduce it:
- allocate as much memory as you need
 - use latest software version
 - optimise the code for memory & runtime



The impact of
long-term data
storage

Data storage footprint is relatively small

The cradle-to-grave carbon footprint (including manufacturing, operation, and disposal) of hard drive storage is *10 kgCO₂e per year and per TB of data* [2].



[2] Nguyen B, Sinistore J, Smith JA, Arshi PS, Johnson LM, Kidman T, et al. Architecting Datacenters for Sustainability: Greener Data Storage using Synthetic DNA. Available from: <https://www.microsoft.com/en-us/research/publication/architecting-datacenters-for-sustainability-greener-data-storage-using-synthetic-dna/>

Take-home messages

- ✓ Consider getting a second-hand or refurbished devices and/or devices what are easily repairable & upgradable
- ✓ Modify your online habits: try alternative search engine, don't listen music on youtube, unsubscribe from irrelevant newsletters
- ✓ Consider cloud computing, but choose the facility wisely (location is important)
- ✓ Educate yourself!



Thank you for your
attention!