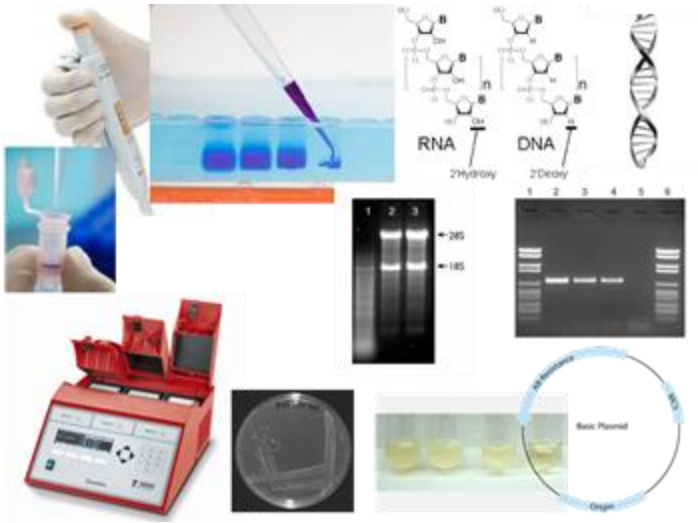
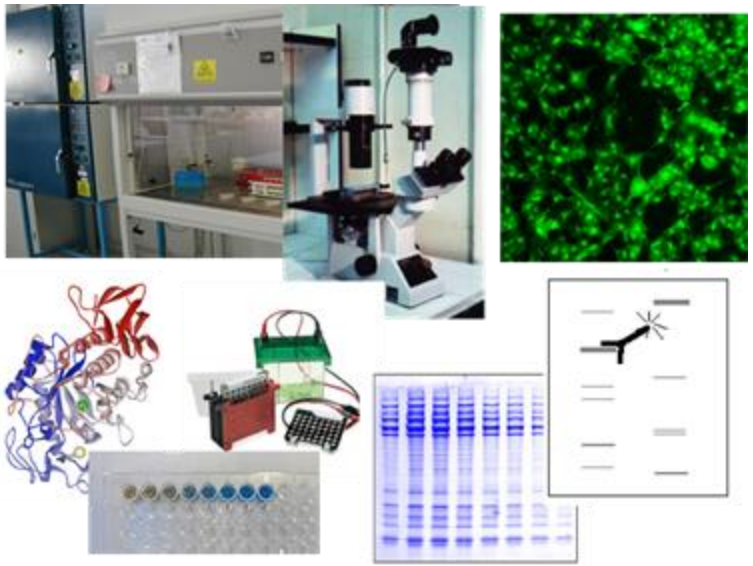
autumn
Lab 1-5

Molecular Biology: RNA, DNA, Bacteria



spring
Lab 6-11

Biochemistry: Human Cells, Proteins



How to Estimate the Carbon Footprint

BIO-204 Case study

Cell Culture

Alexandra Bezler
SV Sustainability Office
SV Workshop

2025

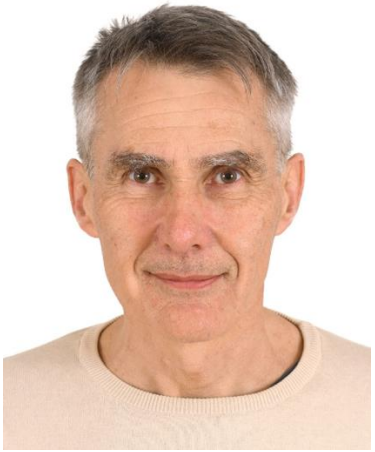
Advice From

- SV Sustainability Office

Mai-Phuong Dinh

- SV Workshop

Grégory Defferrard



John Blanc

Real-World Challenge
Reduce Carbon Footprint of Teaching Lab

- By gut feeling
- take actions based on assumptions

Calvin & Hobbes by Bill Waterson

Tentative Menu

Today

- Intro Carbon Footprint 1h
- Collect + analyse data 2h
  - expert advice from
  - SV Sustainability Office
  - SV Workshop

- How to cite in Life Sciences 1h
  - by EPFL Library

Tomorrow

- Collect + review data 2h
- Write Summary ‘report’ 2h

1. Your choices
2. Data

Its's Your Turn:
Sort by Price from Small to Large

pair of jeans

a pizza

coffee to go
(black)

bottled water

bus ride (one-way, full fare)

video streaming 2h

Sorted Price:

video streaming 2h

bottled water

bus ride

coffee to go

a pizza

pair of jeans

0,20 — 1,80 CHF — 2,80 CHF — 4 CHF — 20 CHF — 100 CHF

It's Your Turn:
Sort by Carbon Footprint from Small to Large

video streaming 2h

bottled water

bus ride

coffee to go

a pizza

pair of jeans

Sorted by Carbon Footprint:

bus ride

coffee to go

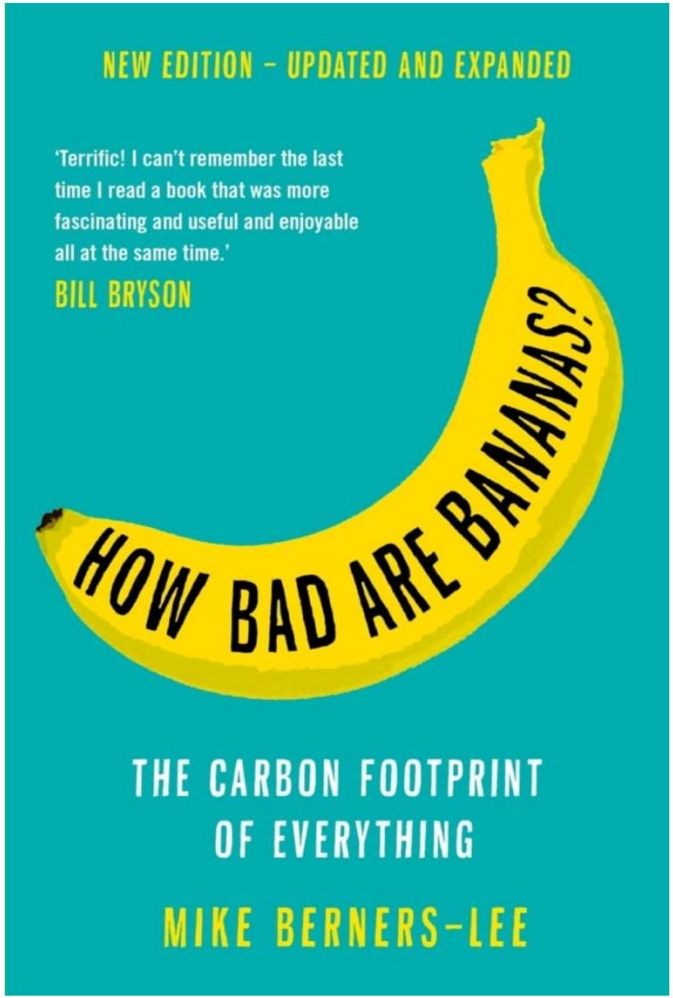
video streaming 2h

bottled water

a pizza

pair of jeans

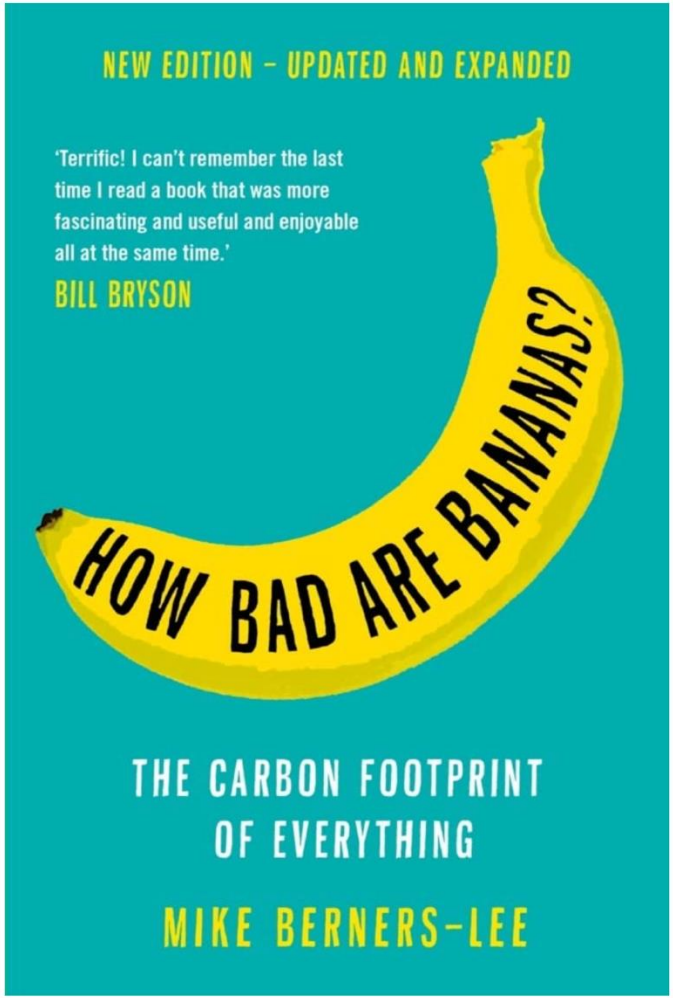
50 g CO2e | 200 g CO2e | 260 g CO2e | 400 g CO2e | 1.5 kg CO2e | 19 kg CO2e


NEW EDITION – UPDATED AND EXPANDED
'Terrific! I can't remember the last time I read a book that was more fascinating and useful and enjoyable all at the same time.'
BILL BRYSON
HOW BAD ARE BANANAS?
THE CARBON FOOTPRINT OF EVERYTHING
MIKE BERNERS-LEE

ton

kg

g



ton

- a person-annual footprint
- long distance flight

kg

- using a smartphone
- a pair of jeans

g

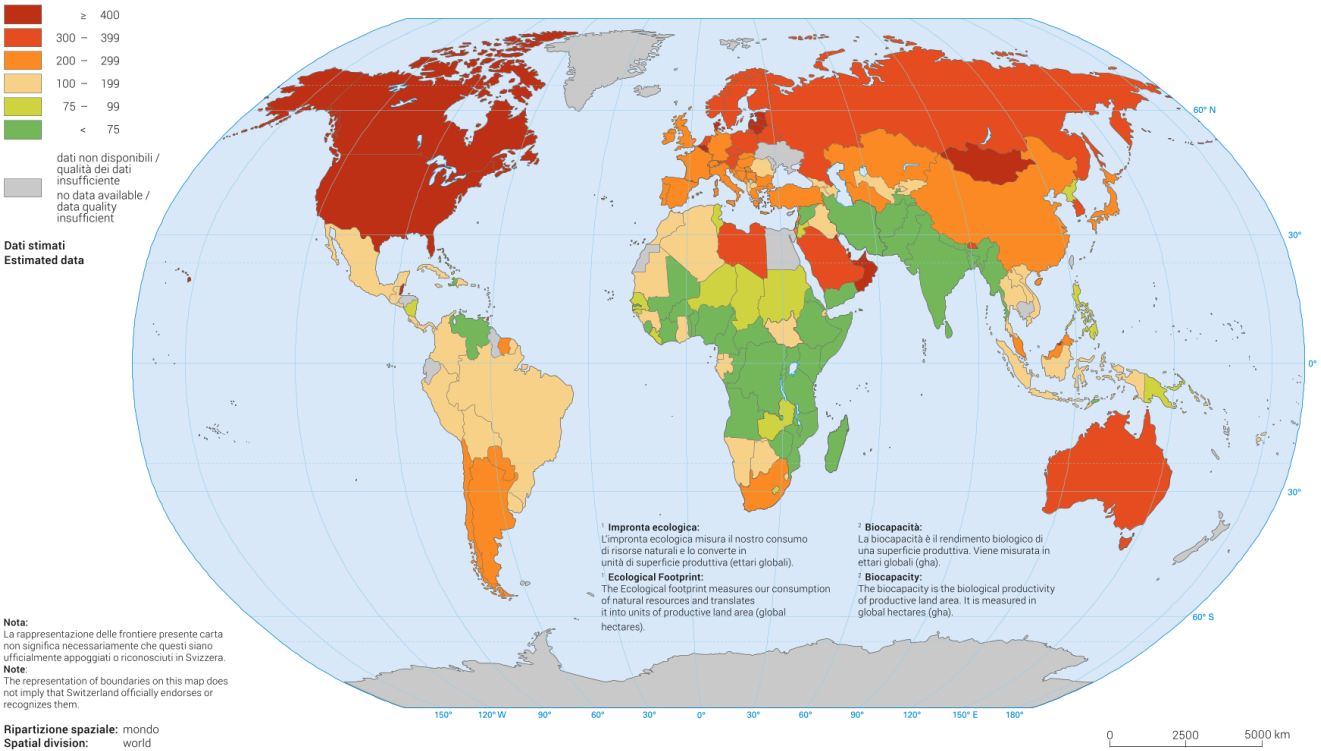
- 1h watching TV
- 1 mile by cycle or train
- a google search

Why it Matters

Why it Matters: Ecological Footprint

Ripartizione globale dell'impronta ecologica nel 2022
Global distribution of the ecological footprint, 2022

Impronta ecologica[1] in rapporto alla biocapacità[2] media mondiale disponibile pro capite, in %
Ecological footprint[1] in proportion to the average worldwide biocapacity[2] available per person, in %



Nota:
La rappresentazione delle frontiere presente carta non significa necessariamente che questi siano ufficialmente appoggiati o riconosciuti in Svizzera.
Note:
The representation of boundaries on this map does not imply that Switzerland officially endorses or recognizes them.

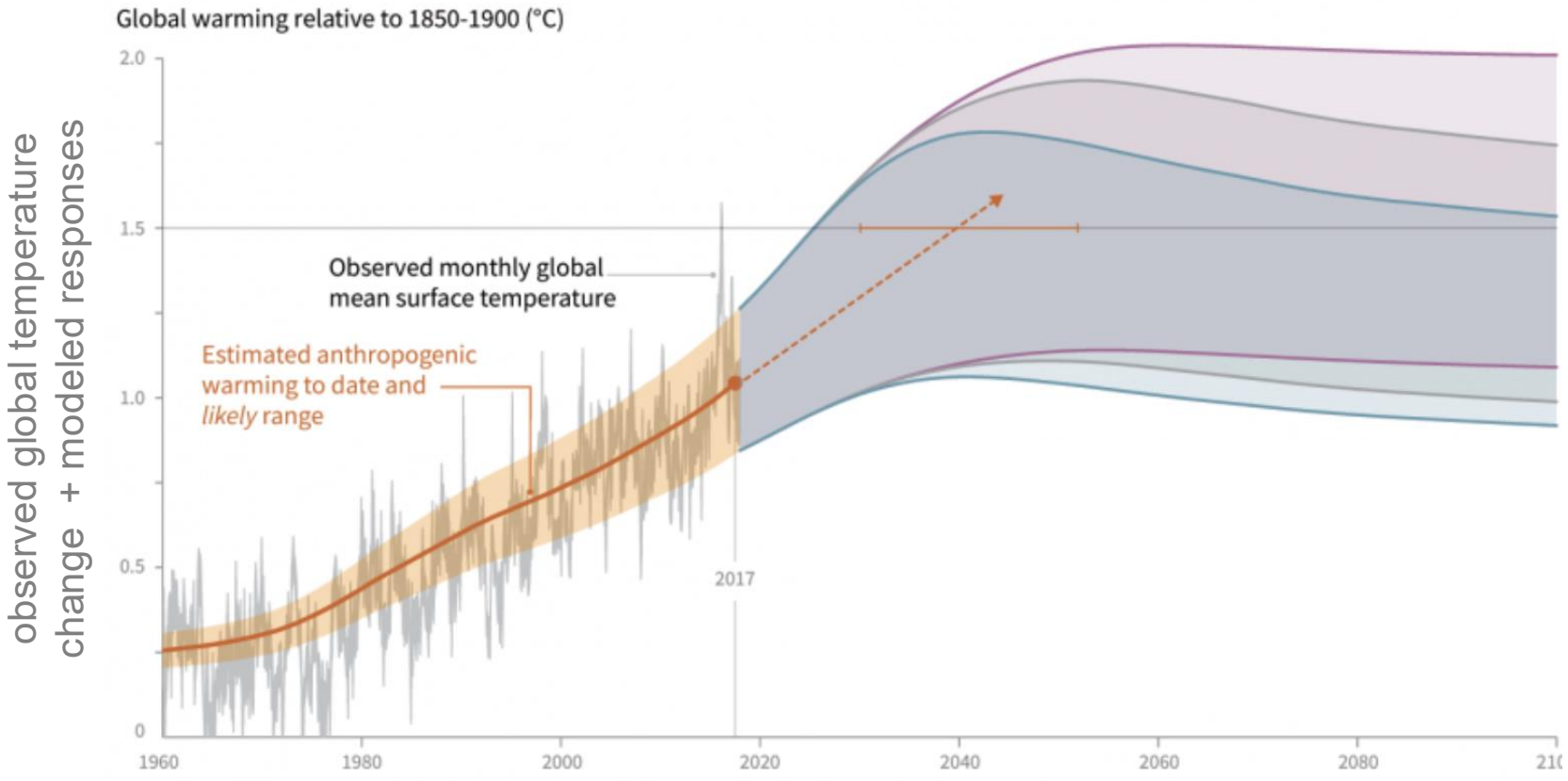
Ripartizione spaziale: mondo
Spatial division: world

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Departement des Innern EDI
Département fédéral de l'intérieur DFI
Bundesamt für Statistik BFS
Office fédéral de la statistique OFS

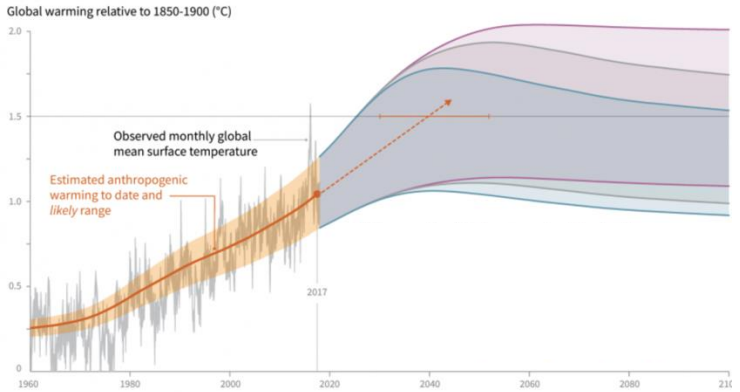
Fonte: Global Footprint Network
Source: Global Footprint Network

Global Warming > Heating



https://www.ipcc.ch/sr15/chapter/spm/

The Paris Agreement

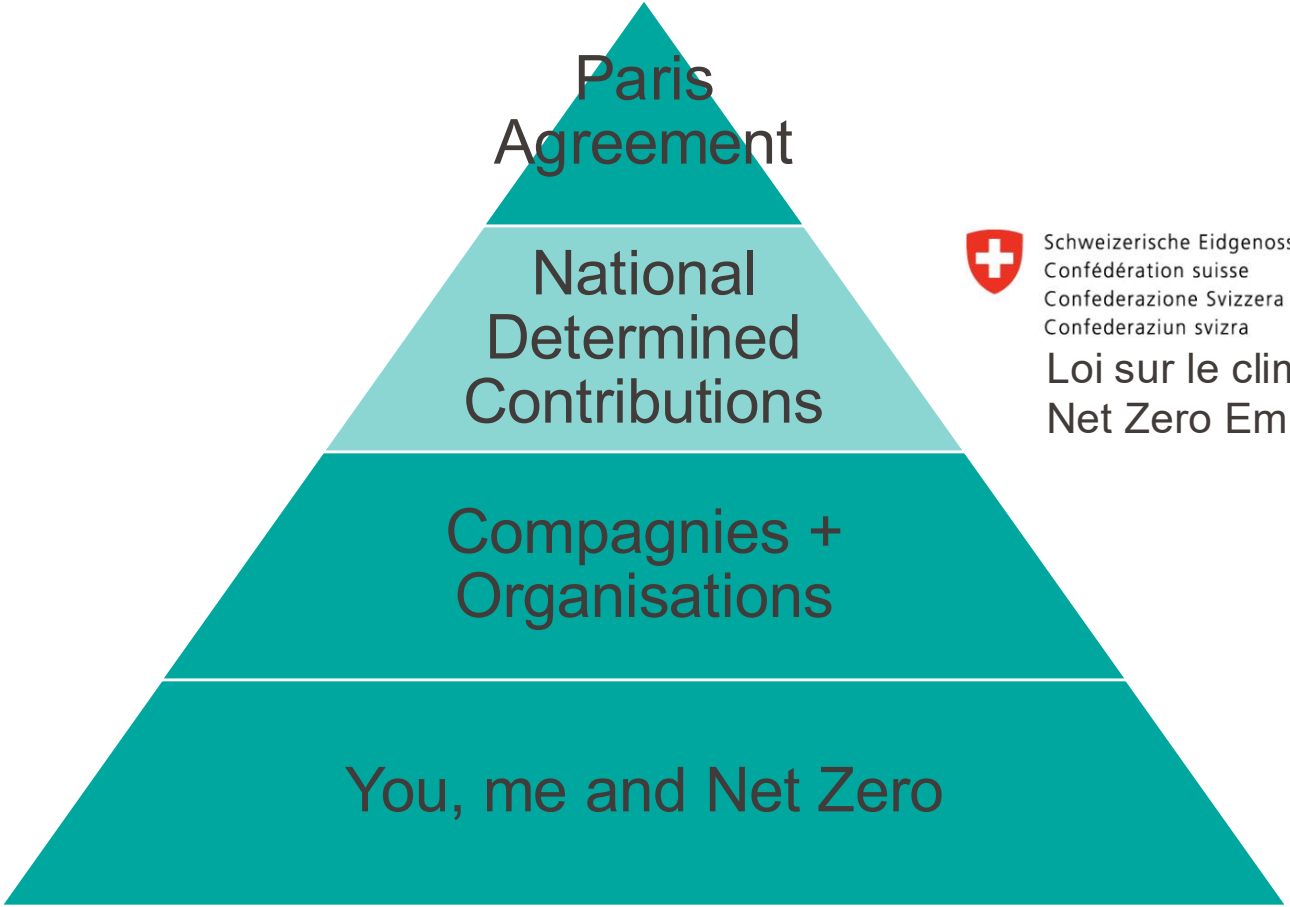


- Internation treaty on climate change
- adopted by 196 countries in 2015
- UN Convention on Climate Change COP21

Goal:

limit the global average temperature increase to 1.5-2° C above pre-industrial levels

From Global to Local Action



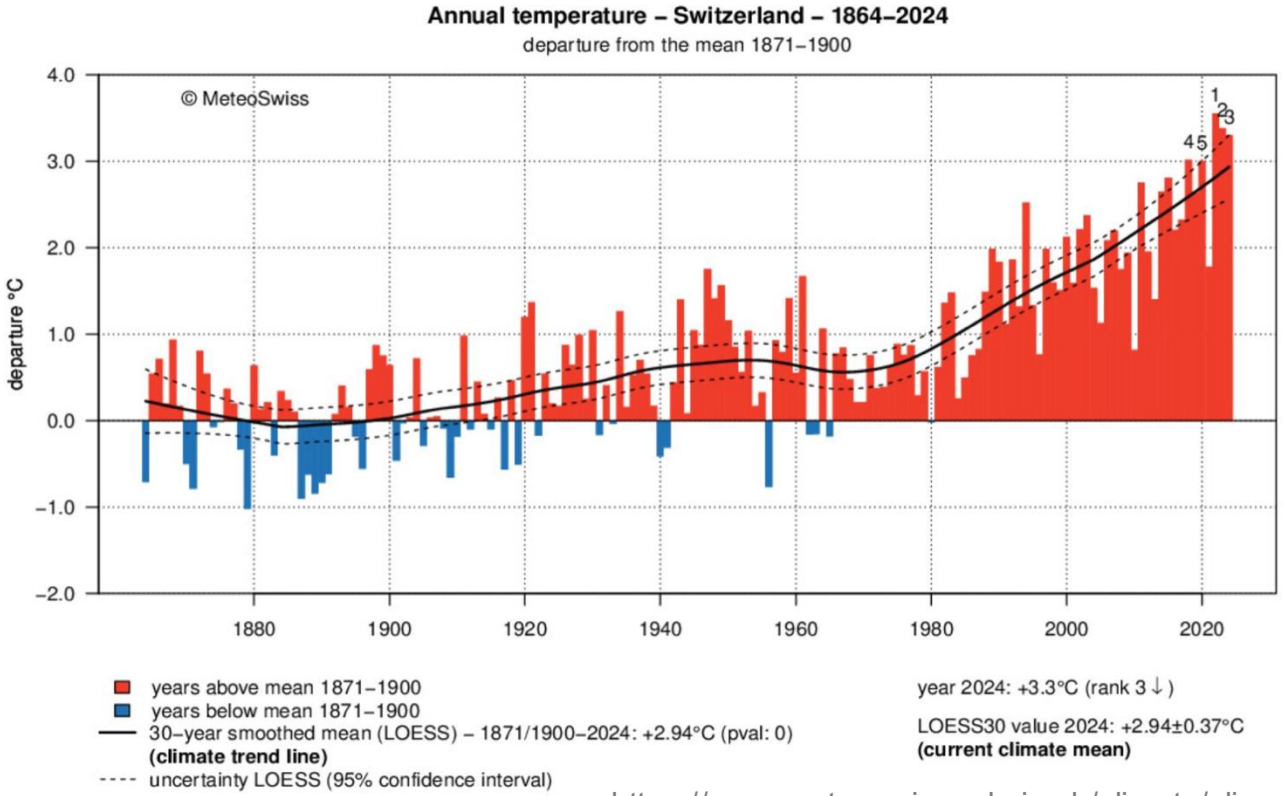
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Loi sur le climat et l'innovation
Net Zero Emission 2050

Let's look at Switzerland

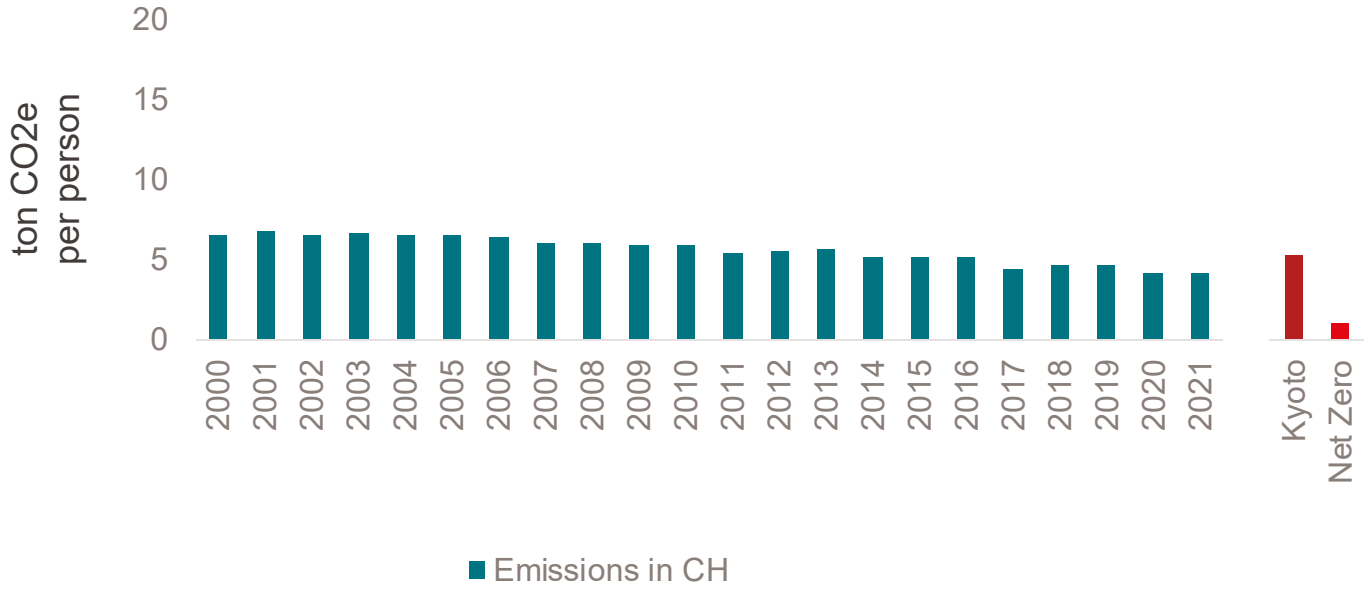
Switzerland is Heating Faster

1864 2024



https://www.meteoswiss.admin.ch/climate/climate-change.html

Emissions IN Switzerland



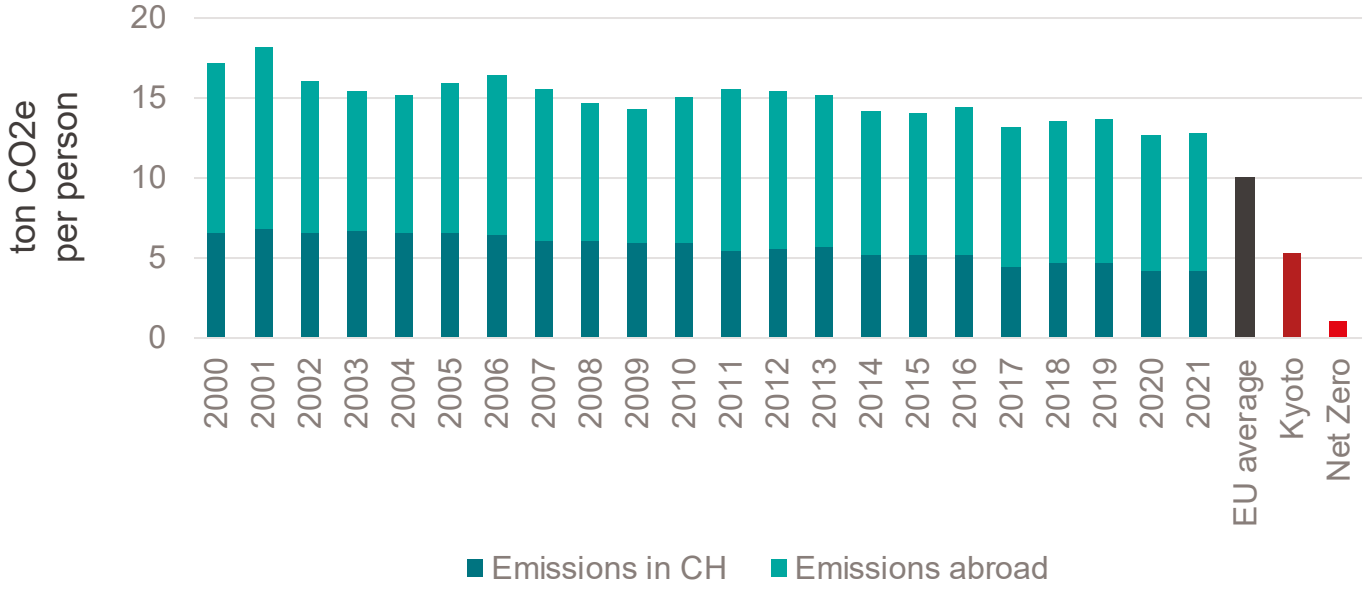
reduction since 2000

-35%

https://www.bafu.admin.ch/bafu/en/home/topics/climate/in-brief.html

https://ec.europa.eu/eurostat/statistics-

Switzerland's Emissions



reduction since 2000

-18%

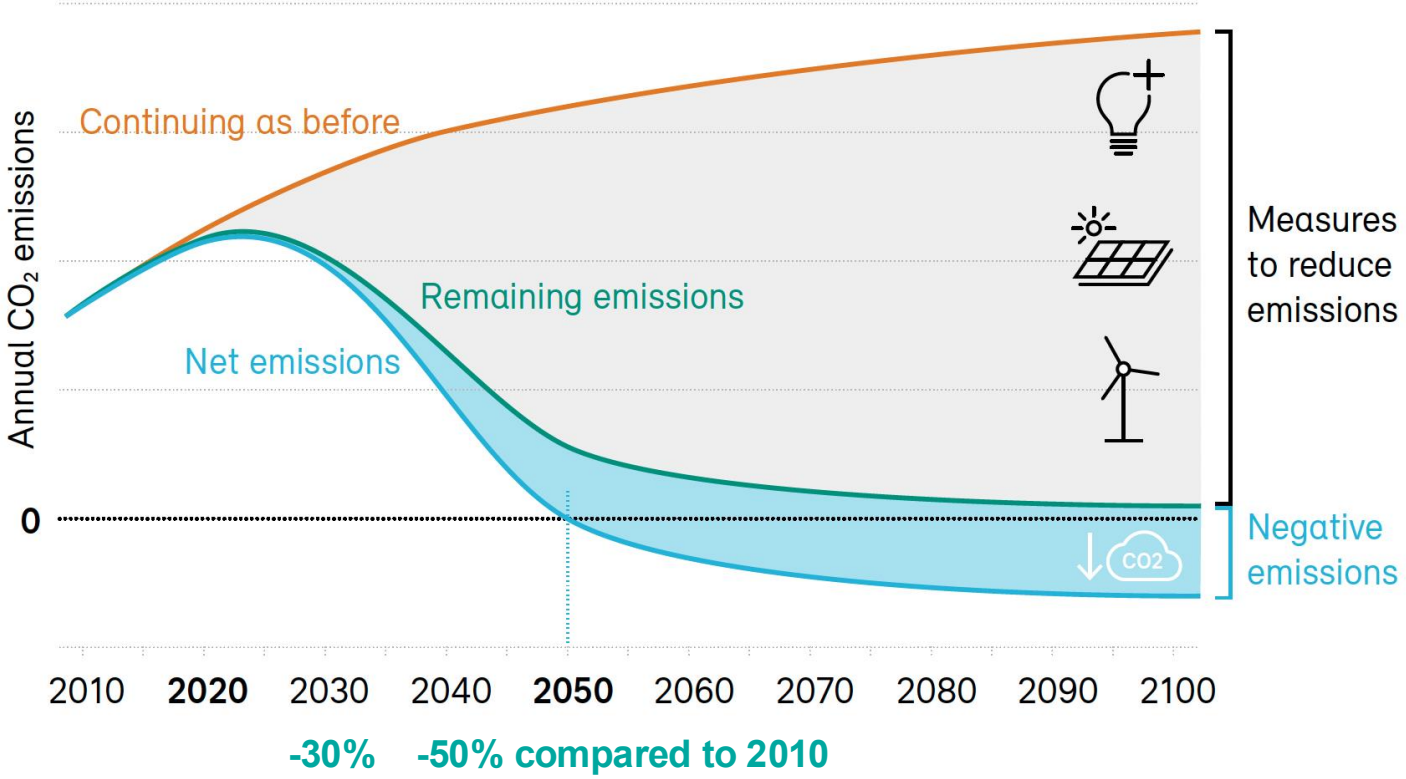
-35%

https://www.bafu.admin.ch/bafu/en/home/topics/climate/in-brief.html

https://ec.europa.eu/eurostat/statistics-

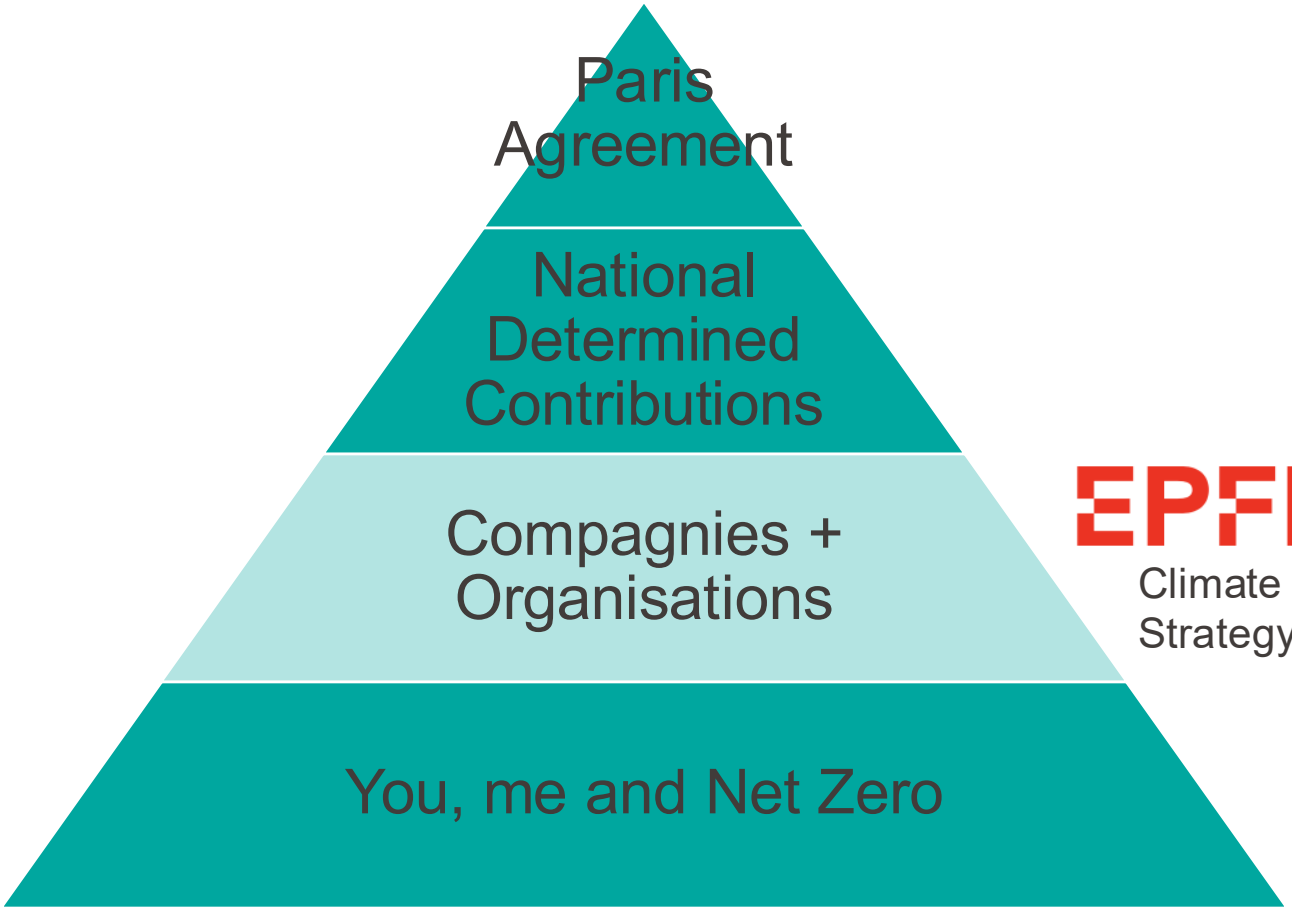
image
https://wedocs.unep.org/bitstream/handle/20.500.11822/43922/EGR2023.pdf?sequence=3&isAllowed=y

Switzerland's Climate Strategy Net Zero 2050



https://www.bafu.admin.ch/bafu/en/home/topics/climate/

From Global to Local Action



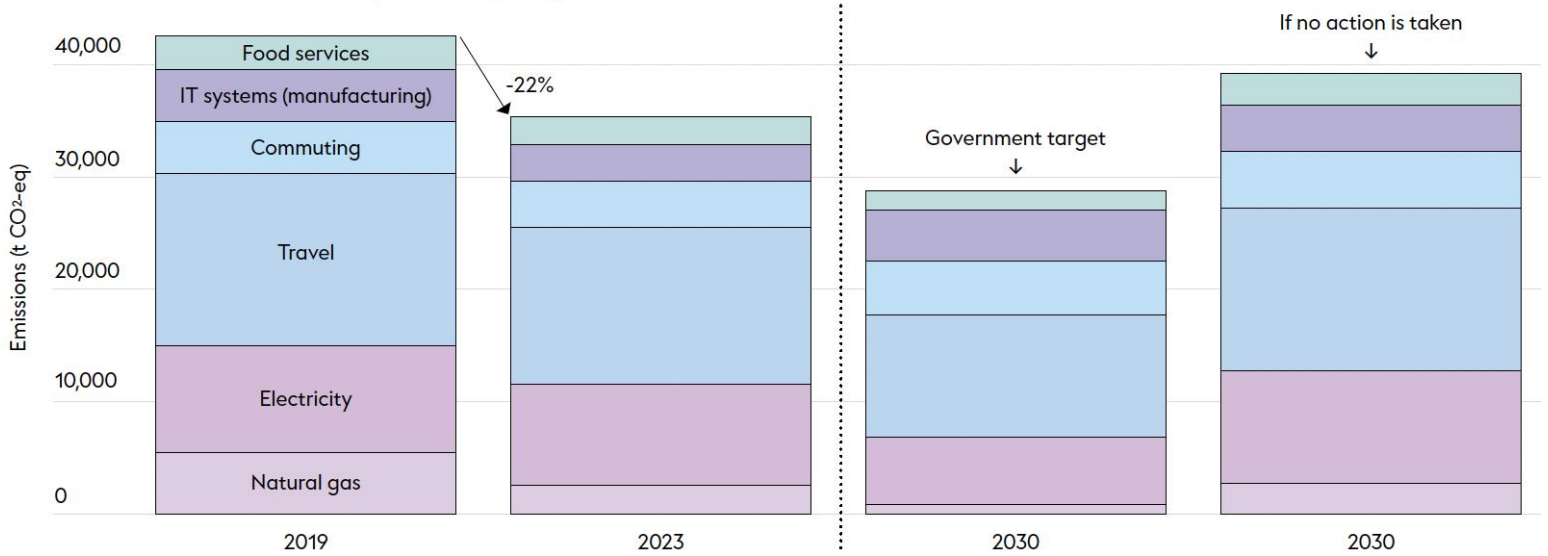
EPFL

Climate Sustainability Strategy 2023

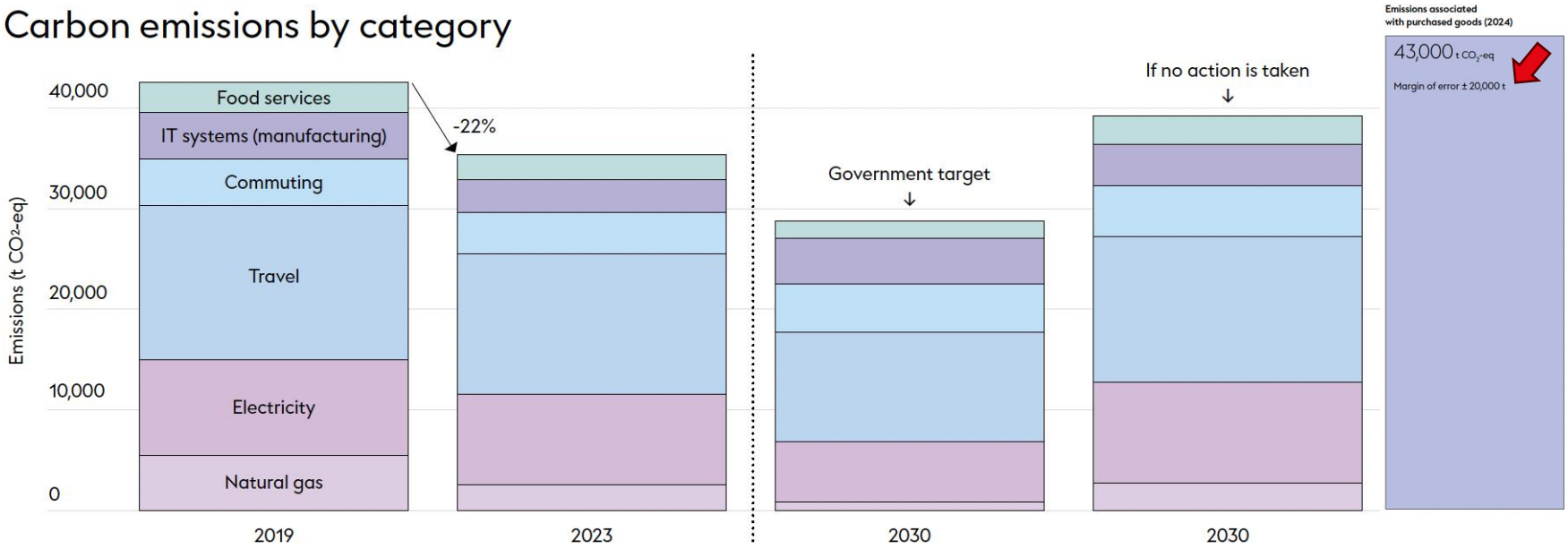
What is the Carbon Footprint of SV Labs?

EPFL's Carbon Footprint Without Purchase

Carbon emissions by category



EPFL's Carbon Footprint



RESEARCH ARTICLE

Purchases dominate the carbon footprint of research laboratories

Marianne De Paepe[1], Laurent Jeanneau[2], Jerôme Mariette[3], Olivier Aumont[4], André Estevez-Torres[5,6]*

RSC Sustainability

ROYAL SOCIETY OF CHEMISTRY

PERSPECTIVE

View Article Online
View Journal | View Issue

Check for updates

Cite this: *RSC Sustainability*, 2024, 2, 1300

The relevance of sustainable laboratory practices†

Thomas Freese, [a] Nils Elzinga, [b] Matthias Heinemann, [c] Michael M. Lerch *[a] and Ben L. Feringa *[a]

nature

Technology Feature | Published: 20 September 2023

Greening the lab

Check for updates

Making biological research more sustainable requires an accurate assessment of its environmental impact, both at the bench and on the computer.

By Caroline Seydel

nature

SPOTLIGHT | 25 September 2024

THE TRIALS AND TRIUMPHS OF SUSTAINABLE SCIENCE

With efforts to promote sustainability on the rise, researchers are making gains – but doing science in a green way isn't always easy. **By Chris Woolston**

Science & Society

TRANSPARENT PROCESS | OPEN ACCESS | CHECK FOR UPDATES

EMBO *reports*

What's in our bin?

Labs kick off and demand the transition towards a circular economy for lab plastics

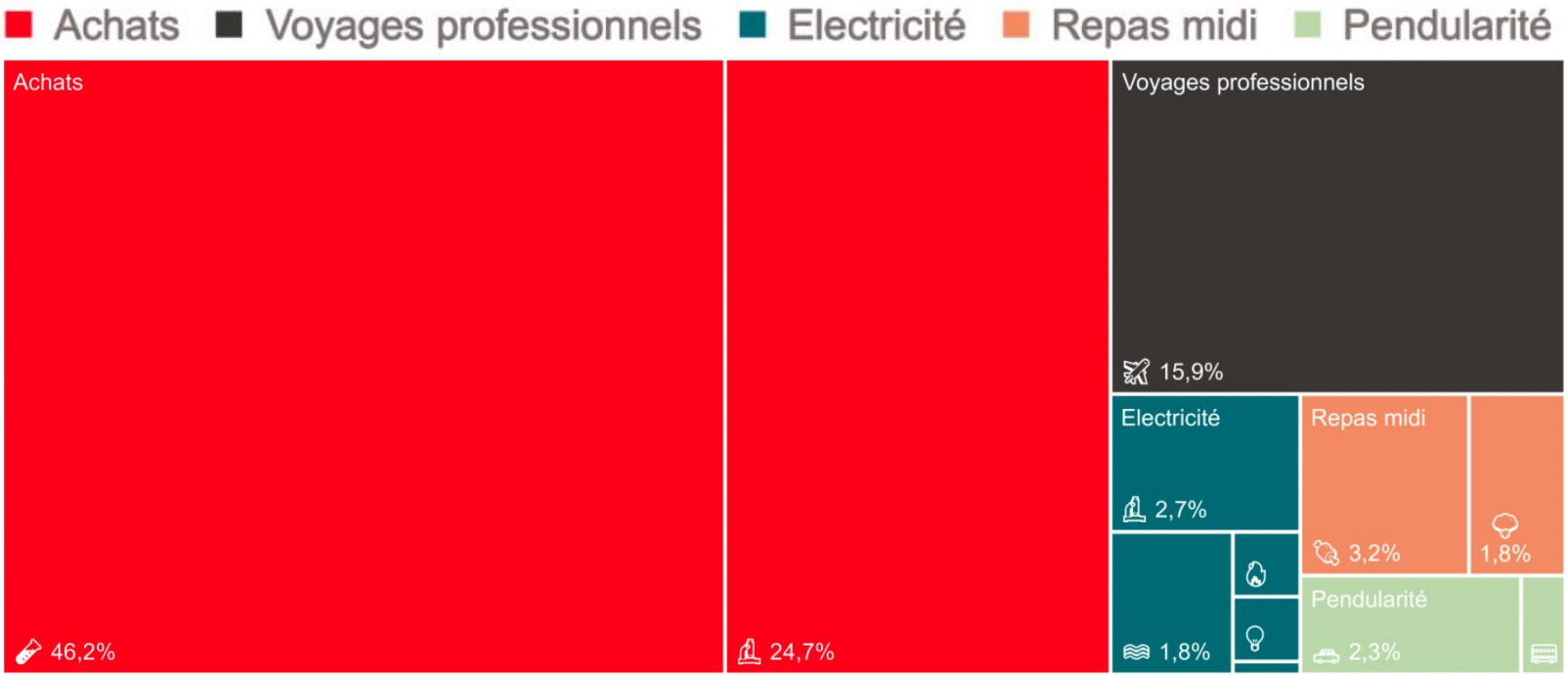
Philipp M Weber [1,3,4], Cleophea Michelsen[2,4] & Melina Kerou [1,4]✉

Carbon footprint of SV Lab

- by SV Sustainability Office
- two research labs analysed
- pilot 2019-2021
- Lab CO2 calculator

https://www.embopress.org/doi/epdf/10.1038/s44319-024-00360-x

Carbon footprint of SV Research Lab



Estimation du bilan carbone d'un laboratoire SV
220 tCO2eq/an, soit **15 tCO2eq/personne/an**
SV Durabilité

How to Quantify Emissions

Greenhouse Gases

carbon dioxide

methane

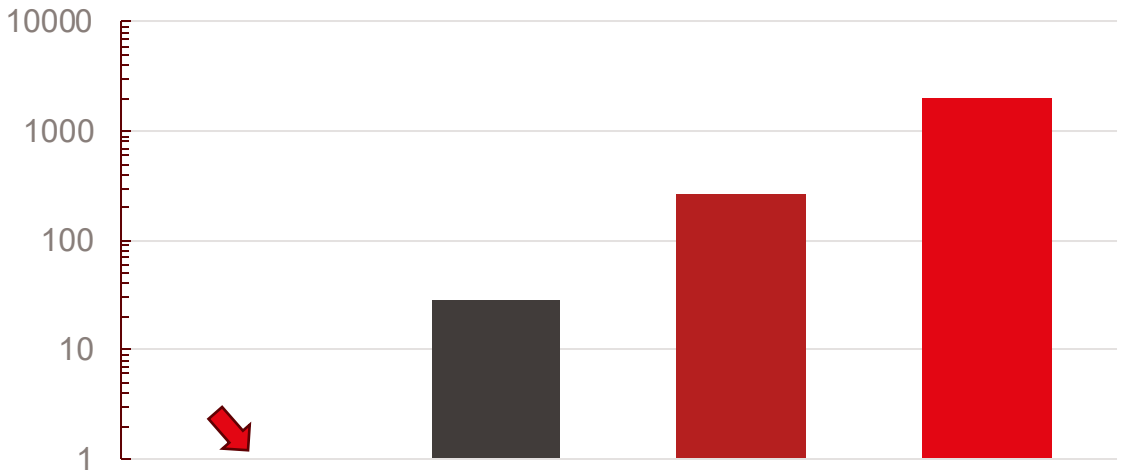
nitric oxide

refrigerant gases

image https://ghgprotocol.org

Relative Impact of Greenhouse Gases

carbon dioxide | methane | nitric oxide | refrigerant gases



Relative impact on global warming over 100 years

image https://ghgprotocol.org

Carbon Dioxide Equivalent

carbon dioxide | methane | nitric oxide | refrigerant gases

unit carbon dioxide equivalent = CO2e

The total climate change impact of all greenhouse gases of an item or activity in terms of carbon dioxide over a 100-year period

image https://ghgprotocol.org

Classification of Emissions Scope 1, 2, 3

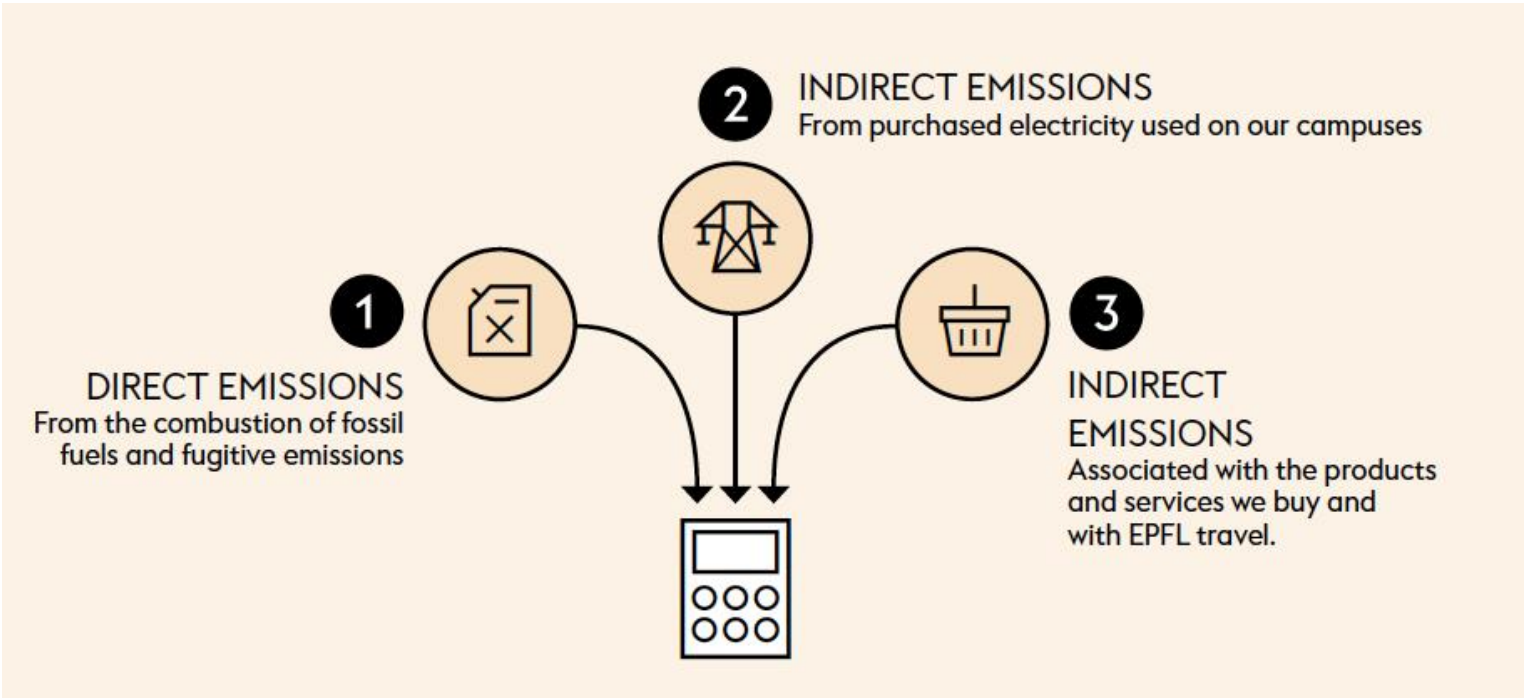


image EPFL sustainability report 2024

This is how to make it look complicated

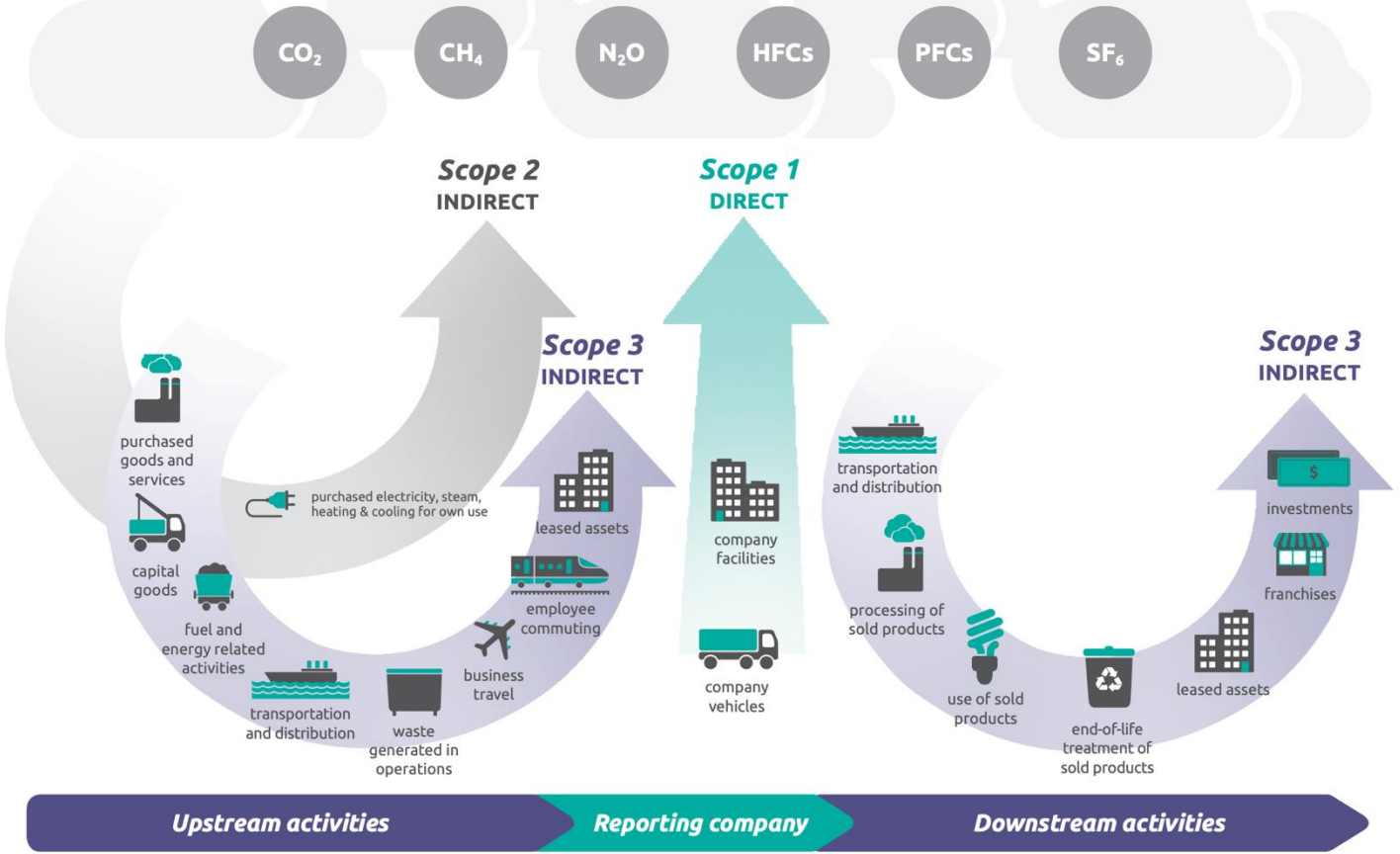


image https://ghgprotocol.org

Reduce
Recuse
Recycle

Minimizing Wet Lab Footprint

before during after

Minimizing Wet Lab Footprint

Experiment

before

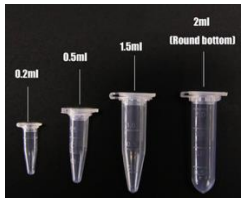
Materials

- HEK293T cells in T25 flask (about 80% confluent)
- CO_2 incubator (5% CO_2, 37°C, 95% humidity)
- Dulbecco's Modified Eagle Medium (DMEM), supplemented with 10% Bovine Serum; Invitrogen
- PBS
- Trypsin + EDTA; Invitrogen
- Disposable cell counting chamber (hemocytometer)
- Tally counter
- Inverted light microscope
- 0.4% Trypan Blue solution; Sigma
- 15 ml tube

Procedure

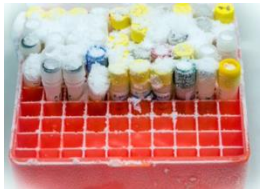
- optimize amounts
- grouped purchasing

during



- pilot (small scale test)
- use glass

after



- sample storage
- waste/ recycling

Examples LISV
Minimizing Footprint

Experiment

REDUCE

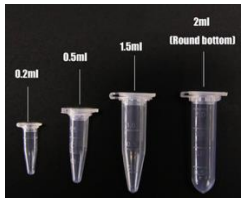
Materials

- HEK293T cells in T25 flask (about 80% confluent)
- CO_2 incubator (5% CO_2, 37°C, 95% humidity)
- Dulbecco's Modified Eagle Medium (DMEM), supplemented with 10% Bovine Serum; Invitrogen
- PBS
- Trypsin + EDTA; Invitrogen
- Disposable cell counting chamber (hemocytometer)
- Tally counter
- Inverted light microscope
- 0.4% Trypan Blue solution; Sigma
- 15 ml tube

Procedure

- reduce volumes
- work in groups
- run gel together
- share 96 well plates
- group A spits cells for B

REUSE

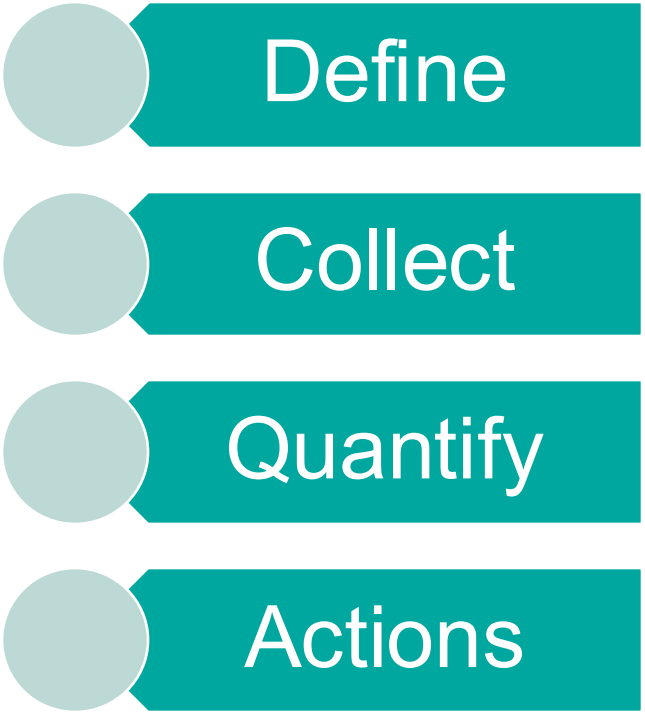


- tip boxes
- transfer buffer
- Ponceau S staining

RECYCLE

- sample management (SLIMS)
- clean up, give away unused material
- recycling
  - paper/ cardboard
  - aluminum
  - tip boxes

How to do Carbon Accounting



Carbon Accounting Methods

Spend based

- find price of good or service
- relies on average emissions
- **CO2e=price X emission factor (kg CO_2e per CHF or €)**

Activity (mass) based

- record data in kilograms, liters, kWh, km
- more accurate + more difficult
- **CO2e=quantity X emission factor (kg CO_2e per km)**

Carbon Accounting Methods

Spend based

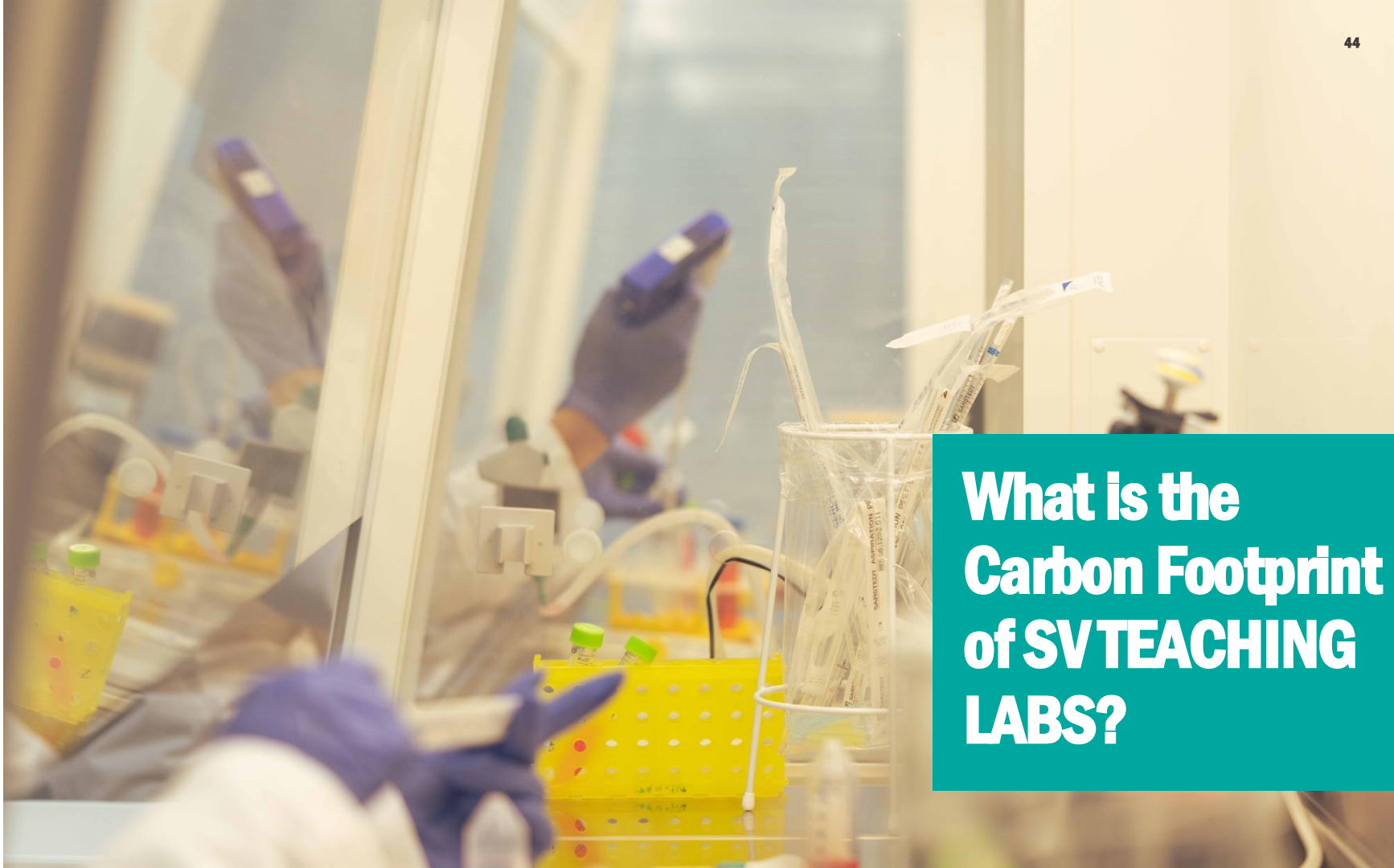
- find price of good or service
- relies on average emissions
- **CO2e=price X emission factor**

Activity (mass) based

- record data kilograms, liters, kWh, km
- more accurate + more difficult
- **CO2e=quantity X emission factor**

Hybrid

- were possible use activity based
- supplement with spend based
- recommended



What is the Carbon Footprint of SV TEACHING LABS?

What to quantify? Your turn to collect ideas

Let's start:

- Define
- Collect
- Quantify
- Actions

The Carbon Footprint Teaching Lab

Define

Boundaries

- one year TP
- (alternative: one wet lab session)
- wet lab sessions in 4 groups (repeats)
- workshops, ELN, exam
- 180 students
- 10 assistants x 2 repeats
- 1 teacher x 4 repeats

What to quantify? Your turn to collect ideas

The Carbon Footprint of Teaching Lab

Define

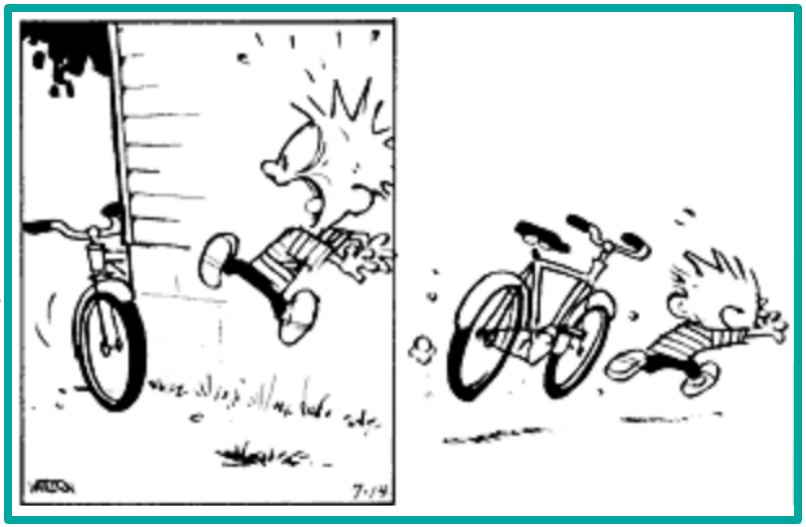
What

- Commuting
- Food
- IT
- Infrastructure
- Electricity
- Consumables
  - -tips
  - -gloves
  - +your ideas

The Carbon Footprint

- Define
- Collect

How do we Commute?



Calvin & Hobbes by Bill Waterson

muscle

private combustion engine

public transport

Your Commute

- mobitool.ch
- return journey (km)
- record total emissions (g)

mobitool
Calculateur environnemental
Comparaison en ligne des bilans environnementaux de moyens de transport

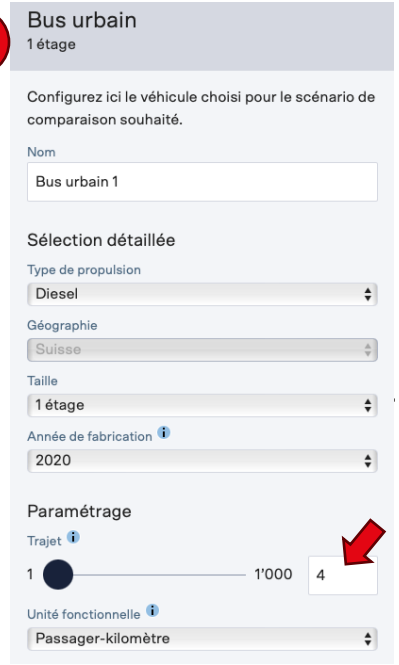
1

Vous n'avez pas trouvé le bon véhicule ?

Lancez une recherche dans la liste pour consulter le grand choix de véhicules disponibles répartis dans les catégories « Transport de personnes », « Transport de marchandises » et « Autres ».

2

3



My Commute:

- 4 km/ day by bike

Vélo 1

Vélo

Suisse | Conventionnel, régional

Type de propulsion
-

Chargement
1.0 Personnes (100%)

Consommation pour 100 km
-

Poids
12.0kg

Norme d'émission
-

Année de fabrication
2020

Passager-kilomètre
4

Trotinette électrique 1

Trotinette électrique

Suisse | <1kW

Type de propulsion
Batterie électrique

Chargement
1.0 Personnes (100%)

Consommation pour 100 km
2.3kWh

Poids
11.9kg

Norme d'émission
-

Année de fabrication
2020

Passager-kilomètre
4

Bus urbain 1

Bus urbain

Suisse | 1 étage | 1 étage

Type de propulsion
Diesel

Chargement
10.0 Personnes (16%)

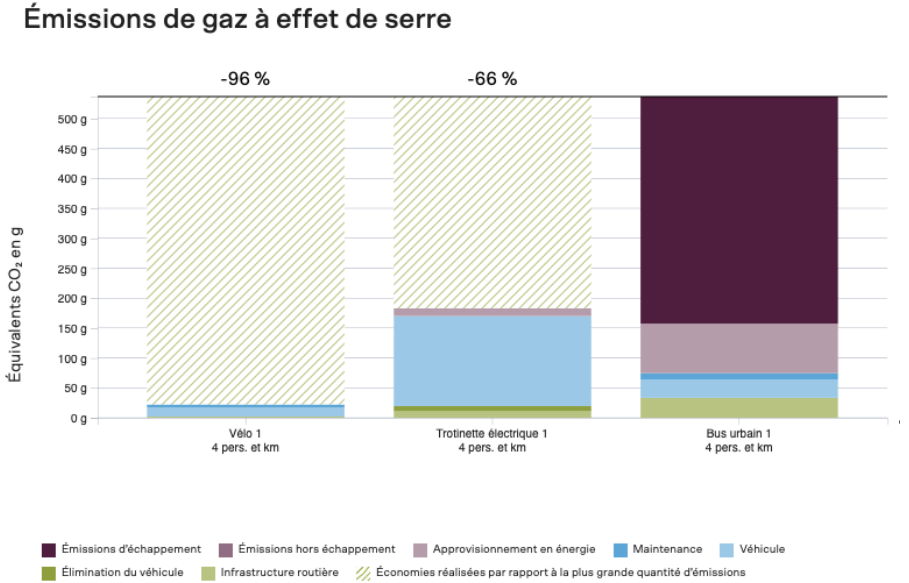
Consommation pour 100 km
38.2l

Poids
11'954.1kg

Norme d'émission
EURO-6

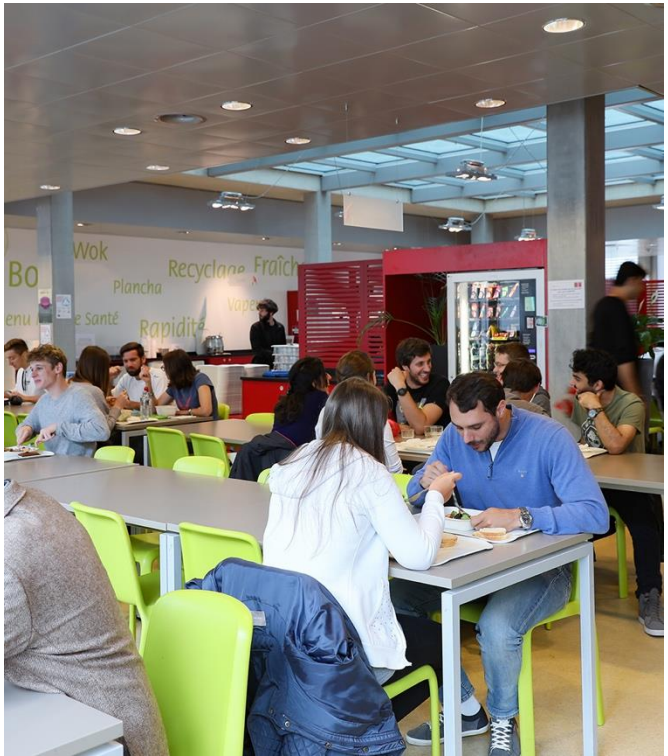
Année de fabrication
2020

Passager-kilomètre
4



Food

What do we Eat?



- typical week
- food consumed on campus
- homemade or purchased
- vegetarian/ omnivore

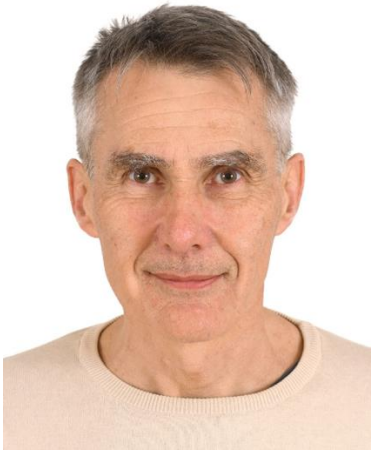
Advice From

- SV Sustainability Office

Mai-Phuong Dinh

- SV Workshop

Grégory Defferrard

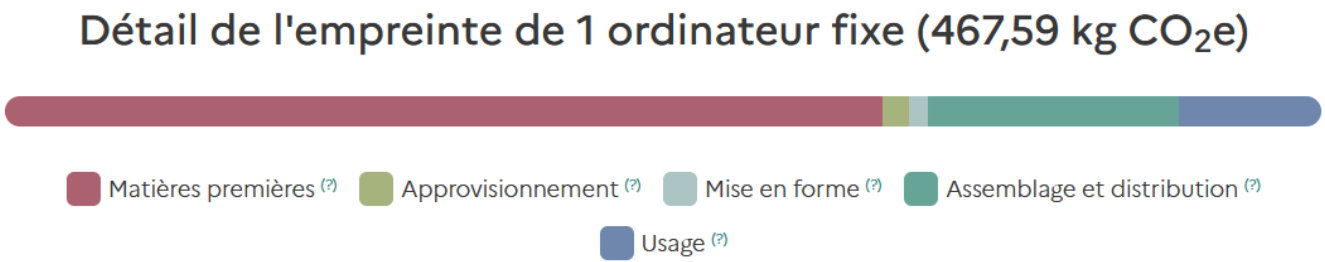


John Blanc

IT

IT equipment

- personal laptop
- personal tablets
- (servers excluded)
- (lab computers excluded)



Electricity

Stand-by Consumption

5-10% of lab electricity consumption

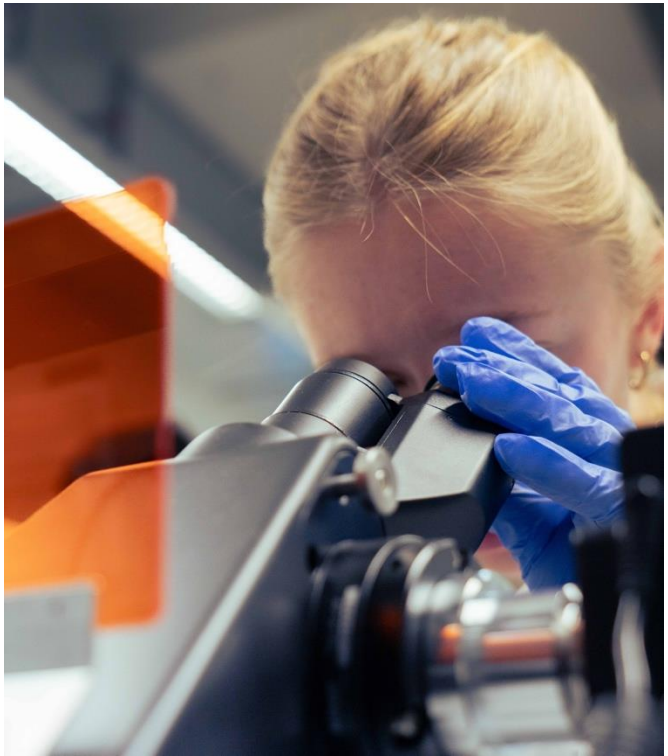
- large instruments
  - microscope, hood
- small instruments
  - tabletop centrifuge, shaker
- lights etc

Calvin & Hobbes by Bill Watterson

ALWAYS turn off

Community action: talk to your peers

Energy Consumption



- freezers -20
- freezer -80 (small part)
- fridges
- hoods
- small equipment

Emissions associated with purchased goods (2024)

43,000 t CO_2-eq

Margin of error ± 20,000 t

Emissions by category

Total	34,166 t CO_2-eq
Food services	2,343 t CO_2-eq
Commuting	3,753 t CO_2-eq
Travel	13,684 t CO_2-eq
IT systems* (manufacturing)	2,939 t CO_2-eq
Energy	11,446 t CO_2-eq
Electricity	8,732 t CO_2-eq
Natural gas	2,397 t CO_2-eq
District heating	237 t CO_2-eq
Fuel	80 t CO_2-eq

Purchased Goods and Services

Calvin & Hobbes by Bill Waterson

Minimizing Equipment Footprint

before

- check whether equipment is available
- share
- before buying: test!

during

- maintenance
  - defrost freezers
  - clean (filters etc)
  - workshop
- use longer!

after

- switch off stand-by
- not needed- donate?
- waste disposal

Examples LISV
Minimizing Equipment Footprint

Experiment

SHARE

- gel imager
- plate reader
- Lab 8 in DLL
- central services (autoclave)

REPAIR

- microscopes
- hoods
- centrifuges
- GeneGnome (2003)

TURN OFF

- NO stand-by
- combine storage
  - 2 fridges off
  - 1 freezer off

Purchased Goods and Services

- tips
- serological pipettes
- gloves
- 1.5 ml tubes
- 15 ml/ 50 ml tubes
- cell culture flasks
- cell culture medium
- fetal calf serum
- lipofectamine
- (small equipment excluded)

Questions

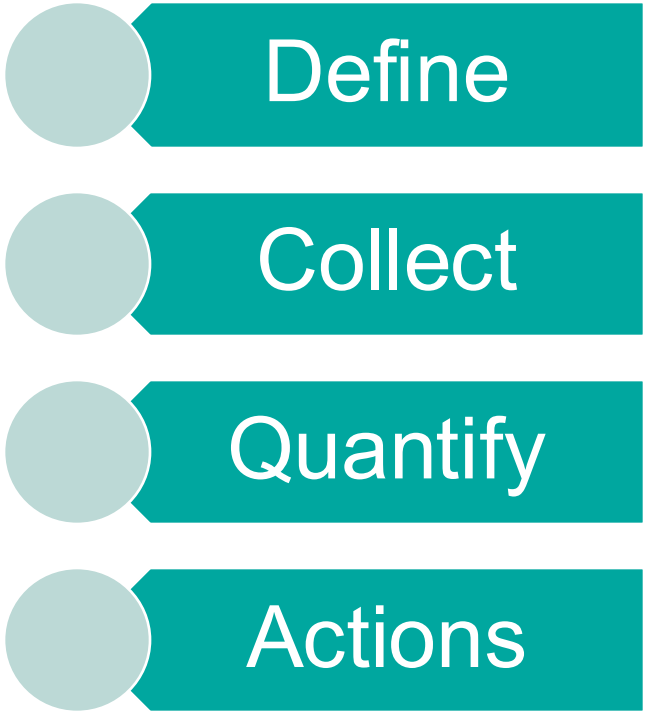
Course Evaluation Moodle 5 minutes

See you tomorrow 8:15-12:00

INF 1

INF 2

Analyse Data and Propose Actions



Speaker