Sustainable Research in Physics

Panelists:

- Tomoko Muranaka (EPFL)
- Mike Seidel (PSI, EPFL, CERN)
- Anna Soter (ETHZ)
- Philipp Treutlein (UNIBAS)

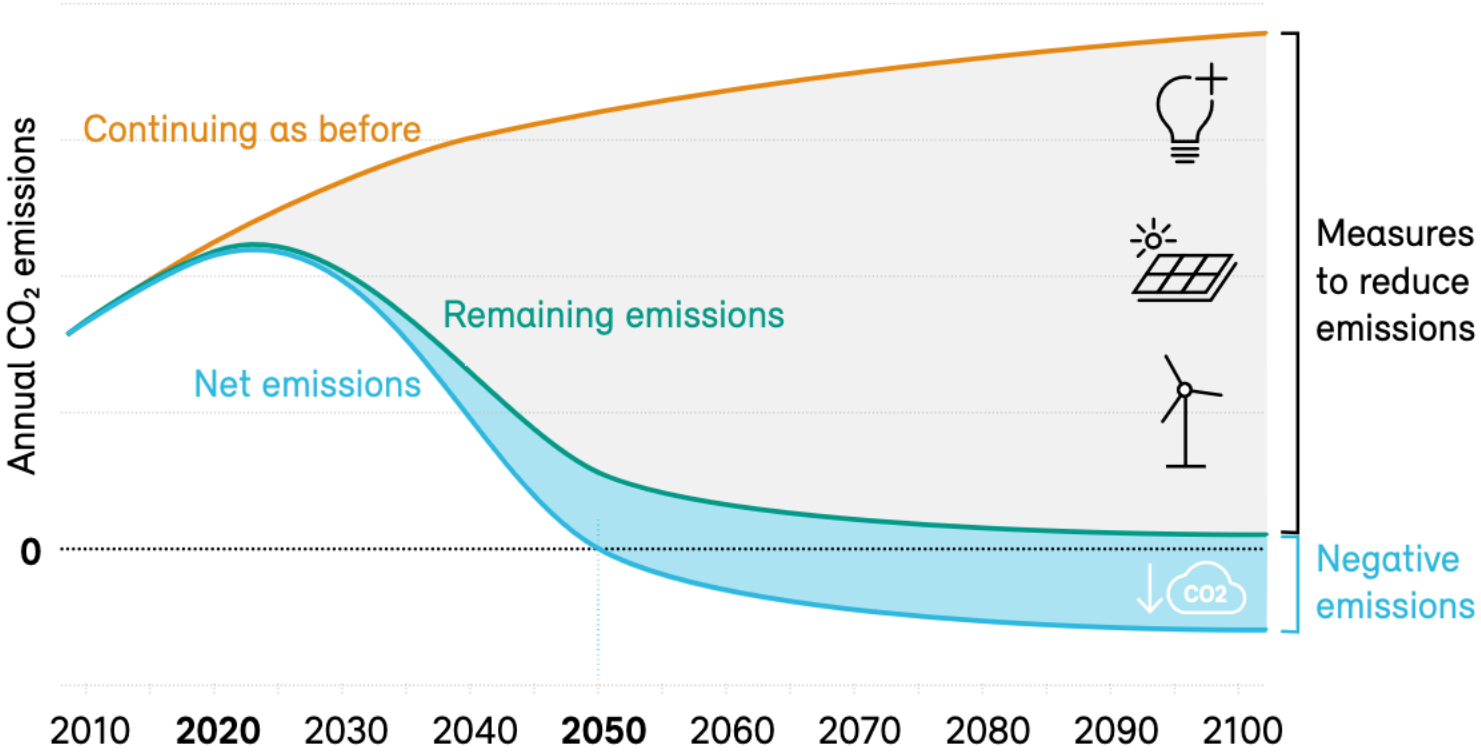
Moderation: Hugo Zbinden (UNIGE)

Towards Net Zero – Assess and Go Beyond

MURANAKA Tomoko
School of Basic Sciences
EPFL

Achieving the net zero target by 2050

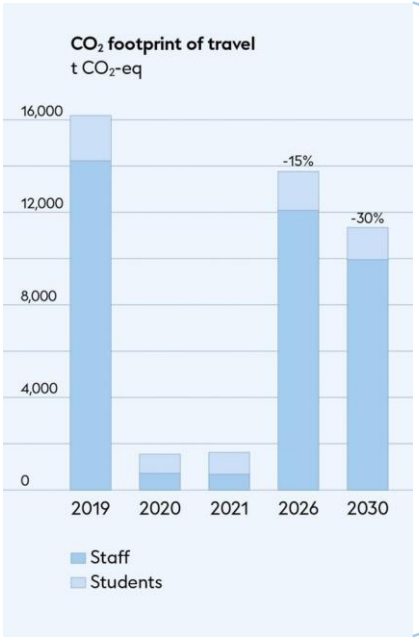
MURANAKA Tomoko

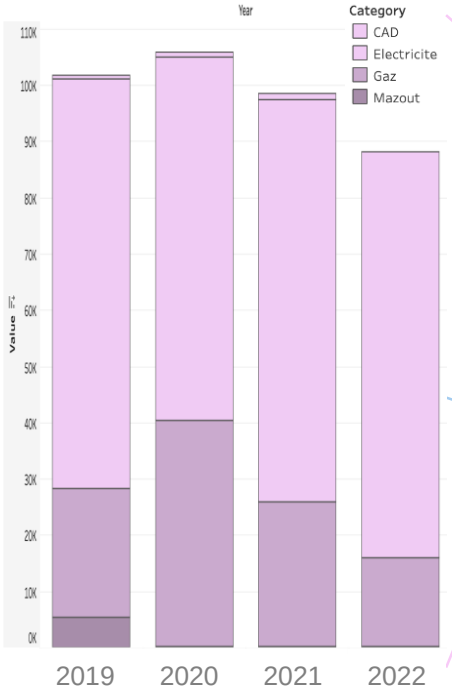


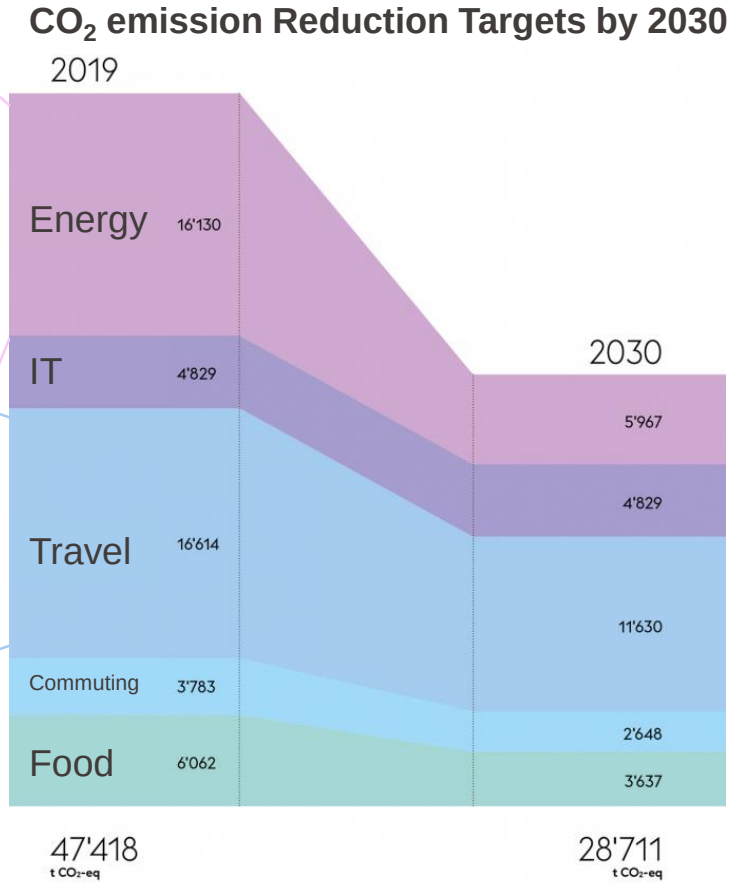
- Federal Office for the Environment (FOEN) Factsheet: Long-term climate strategy, www.bafu.admin.ch/climate-strategy-2050

MURANAKA Tomoko

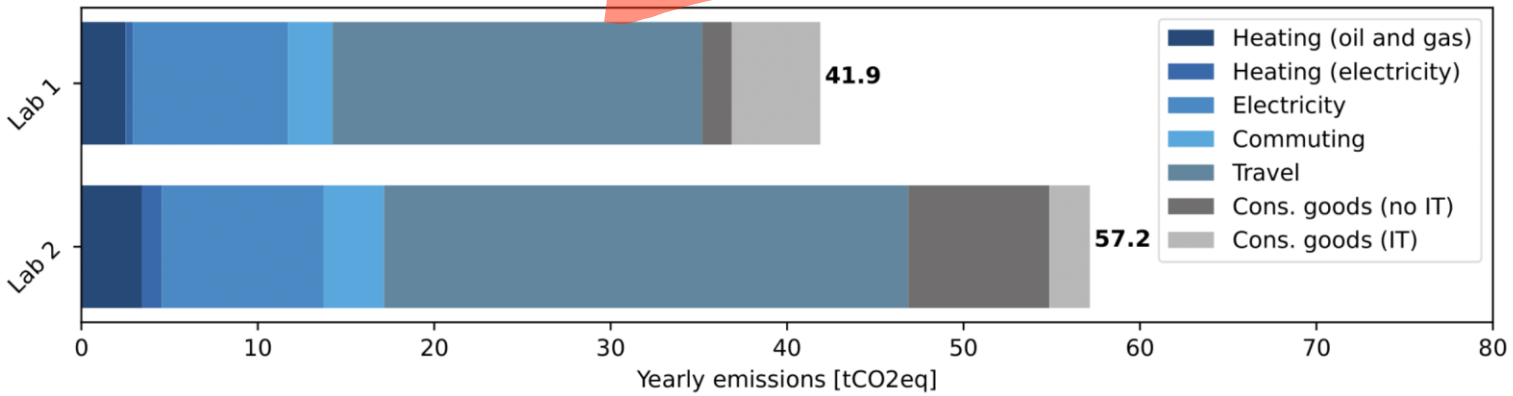
Emission and Strategy in EPFL







Improve Sustainability Performance



Carbon emissions for two labs at EPFL Lausanne. Data taken from EPFL and Zero Emission Group (2020)

World View | Published: 09 August 2023

Academia should go beyond carbon accounting and take action on climate

Astrid Eichhorn

Nature Reviews Physics (2023) | Cite this article

87 Accesses | **4** Altmetric | Metrics

Organisational efforts

QS WORLD UNIVERSITY RANKINGS

Rankings focused on social and environmental sustainability performance in higher education institutions.

SNSF

we will focus more on how we can measure the CO_2 footprint of projects and keep it as small as possible

nature

ongoing collection brings together articles from Nature Reviews journals about how physicists can contribute to environmental sustainability

IOP Institute of Physics

Environmental Statement (2020)

2022 2023 IYBSSD International Year of Basic Sciences for Sustainable Development

IDSSD

International Decade of Science for Sustainable Development

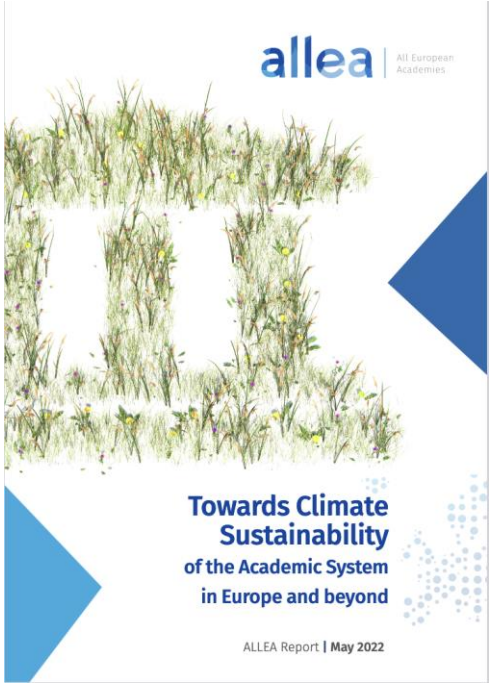
Actions to take

- Generate awareness by discussing climate sustainability of the academic system
- Work with your colleagues
- Consider all your opportunities for leverage
- Consider the climate impact of research and research equipment
- Consider reducing the number of long-haul flights for conference and meetings
- Consider hybrid modes for local seminars and colloquia
- Be inspired by sustainability initiatives

ex. Million Advocates for Sustainable Science,

Labos1point5

GREEN LAB. CH



my green lab.

I²SL
International Institute for Sustainable Laboratories®

Labos 1point5

Actions to take

- Generate awareness by discussing climate sustainability of the academic system
- Work with your colleagues
- Consider all your opportunities for leverage

+ Capture, Remove and Permanently Store greenhouse gases

- Consider hybrid modes for local seminars and colloquia
- Be inspired by sustainability initiatives

ex. Million Advocates for Sustainable Science,
Labos1point5
GREEN LAB. CH

my green lab.

I²SL
International Institute for Sustainable Laboratories®

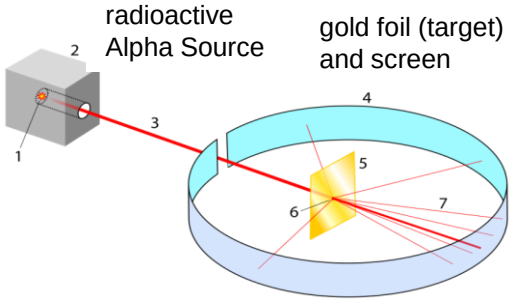
Labos 1point5

- 'Physics should acknowledge its environmental impact and act on it', *Nat. Rev. Phys.*, vol. 5, no. 3, pp. 133–133, Mar. 2023, doi: 10.1038/s42254-023-00568-1.
- '**IOP** Climate Change Position Statement', IOP, 2021. https://www.iop.org/sites/default/files/2021-09/IOP-Climate-Change-Position-Statement-Sep-2021.pdf
- 'Towards Climate Sustainability of the Academic System in Europe and beyond - ALLEA', **ALLEA**, Berlin, 2022. Accessed: Jun. 21, 2023. https://allea.org/wp-content/uploads/2022/05/ALLEA-Report-Towards-Climate-Sustainability-of-the-Academic-System.pdf
- **SNSF** Sustainable development, https://www.snf.ch/en/3DEoAgSx2yMXZaAX/topic/sustainable-development
- 'Carbon Accounting in Research Activities in the School of Life Sciences', Zero Emission Group, 2020. https://zeroemission.group/wp-content/uploads/2021/02/rapport_final.pdf
- **Million Advocates for Sustainable Science** https://www.sustainablescienceadvocates.org/
- **My green lab.** https://www.mygreenlab.org/
- **International Institute for sustainable laboratory** https://www.i2sl.org/
- **Labos1point5** https://labos1point5.org/
- **GREEN LAB. CH** https://greenlab.ch/

Sustainability of Accelerator Driven Research, M.Seidel (EPFL and PSI)

Classical Scattering Experiment

Resolution $\propto 1/p$

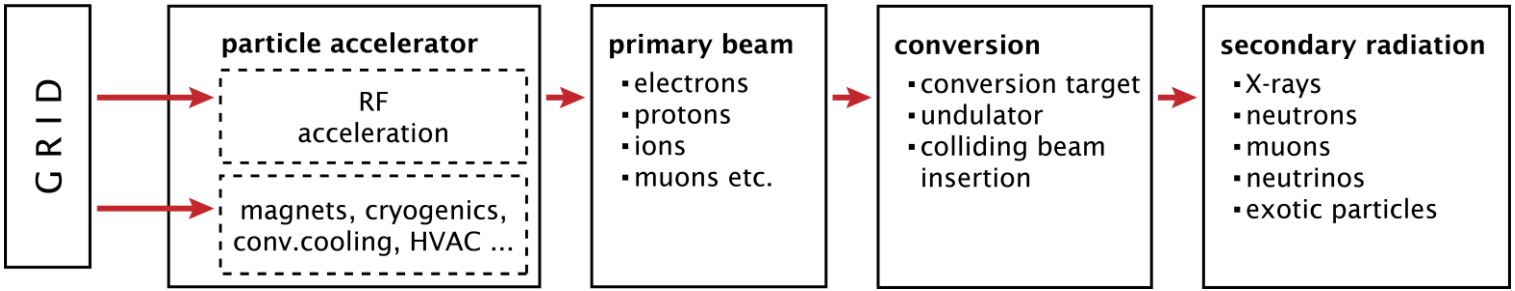


Lord Rutherford, 1927 @ Royal Society:

"I have long hoped for a source of particles more energetic than those emitted from natural radioactive substances".

Today we use particle accelerators to generate specific secondary radiation for research.

The quest for higher energy and statistics leads to larger grid power consumption.



LHC / CERN – the largest accelerator today

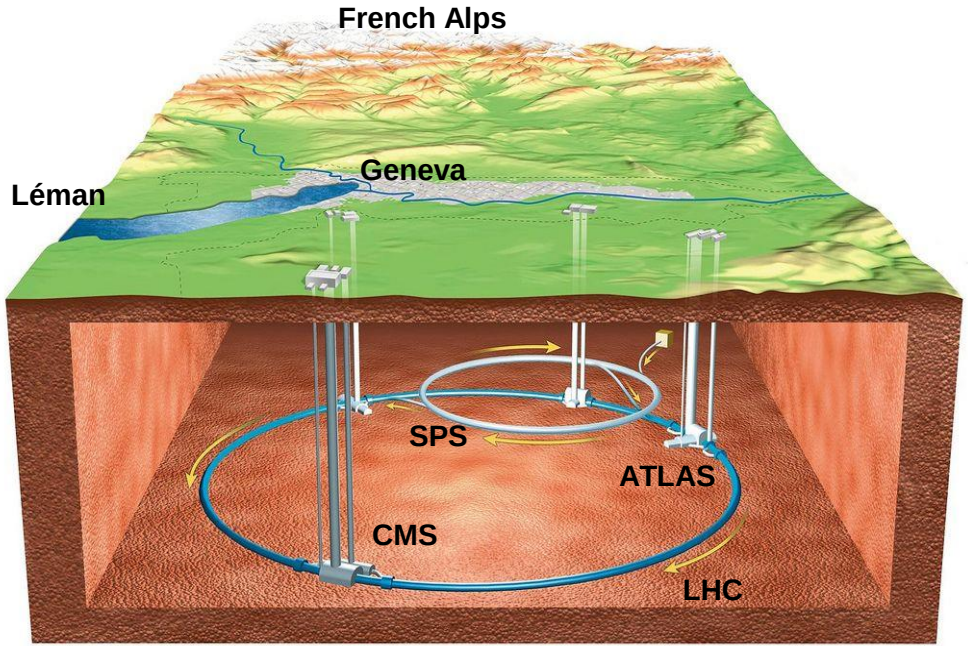
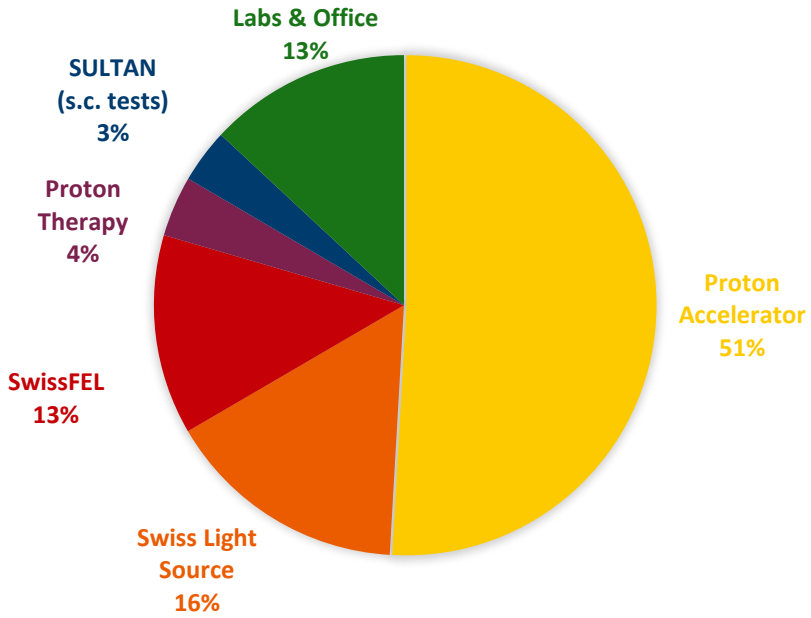


Image: Philippe Mouche

- 27 km circumference, 100 m below ground
- 6.8 TeV per beam
- 1232 bending magnets, 8.3T, 1.9K
- **up to 120 MW from grid**

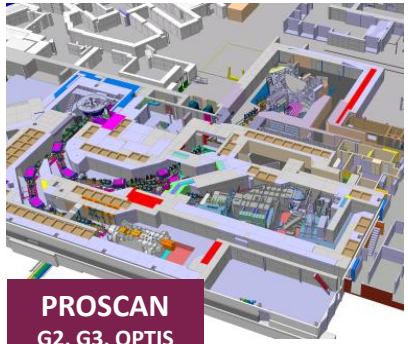
  CERN total: ca 1.3TWh/y
- **ca 10^9 collisions/sec; Higgs: 1/sec**
- ongoing HL-LHC upgrade will improve L/P_{grid} by an order of magitude
- CERN: 23 Member states; ~50 country cooperation agreements; >11.000 ext. users

PSI Energy Consumption



Total PSI: 139 GWh/y (2022)

HIPA
SμS, SINQ, CHRISP



PROSCAN
G2, G3, OPTIS

SLS
16 beamports

SwissFEL
ARAMIS, ATHOS

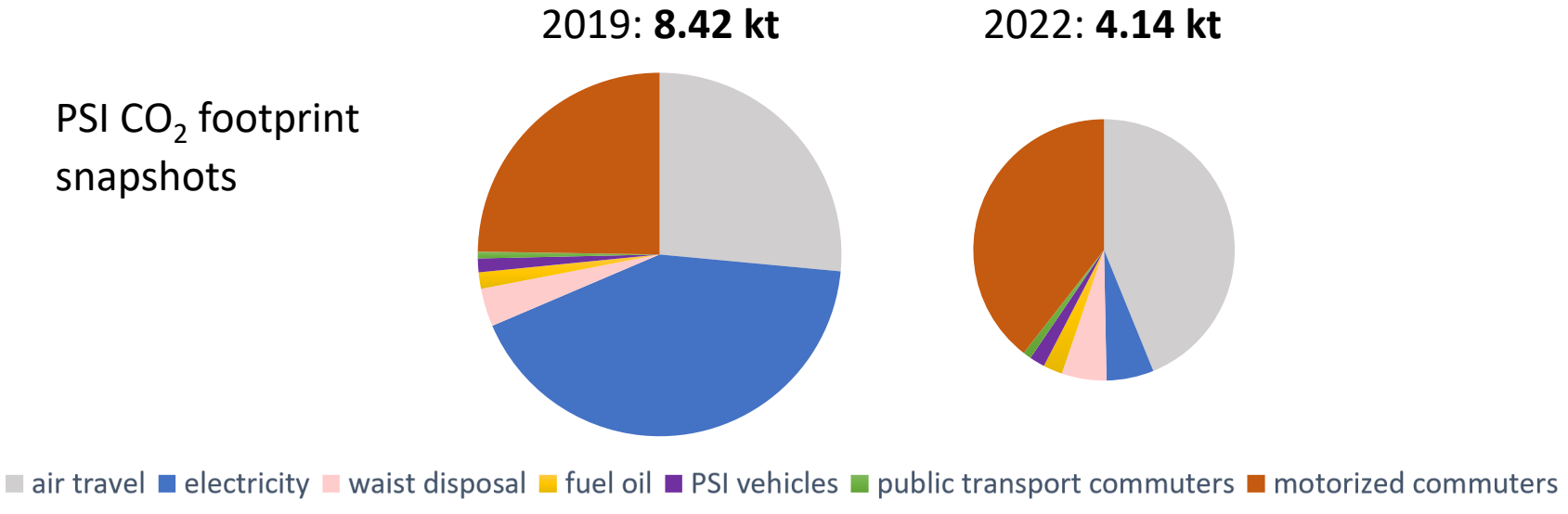
Sustainability@PSI: towards a net-zero campus

electricity: **SLS2.0: -30%**(!); procure power with low CO2; photovoltaics: 0.4 → 0.6%;

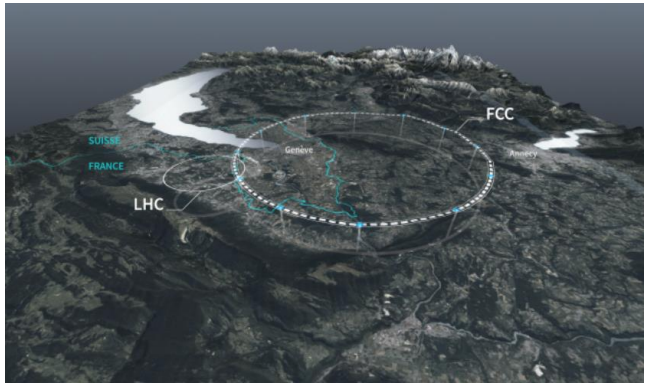
heating: further improve heat recovery – heat pump option; < 50% external sources, but CO_2 free

mobility: 30% reduction of air travel; support public transport / electric cars

PSI CO_2 footprint snapshots



Outlook: Next Particle Collider @ CERN



Future Circular Collider (FCC)

Electron/Positron, Higgs factory and up to top quark energy

L = 91km, grid power dominated by synchrotron radiation (50MW p.b.)

Energy efficiency and sustainability have high priority for the study.

Examples include:

using renewable energy sources; re-using waste heat

maximising specific luminosity per beam intensity; high bending magnet fill factor; exploring dynamic operation

potential use of high temperature superconducting magnets also for low fields; efficient RF sources, s.c. resonators

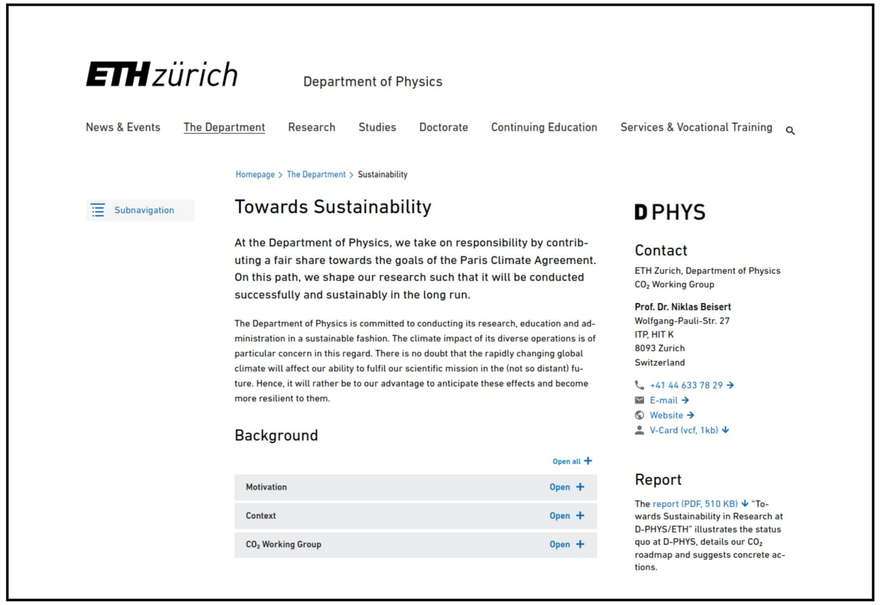
Carbon footprint of concrete is significant, but improvements can be expected from developments on general civil construction.

Updated FCC-ee energy consumption	Z	W	H	TT
Beam energy (GeV)	45.6	80	120	182.5
Max. power during beam operation (MW)	222	247	273	357
Average power / year (MW)	122	138	152	202
Total yearly consumption (TWh)	**1.07**	**1.21**	**1.33**	**1.77**

M.Benedikt, 6/2023

The planned yearly energy consumption is significant, but not too far from CERN‘s consumption today.

Glossary of efforts at ETHZ - D-PHYS



ETH zürich Department of Physics

News & Events | The Department | Research | Studies | Doctorate | Continuing Education | Services & Vocational Training

Homepage > The Department > Sustainability

Subnavigation

Towards Sustainability

At the Department of Physics, we take on responsibility by contributing a fair share towards the goals of the Paris Climate Agreement. On this path, we shape our research such that it will be conducted successfully and sustainably in the long run.

The Department of Physics is committed to conducting its research, education and administration in a sustainable fashion. The climate impact of its diverse operations is of particular concern in this regard. There is no doubt that the rapidly changing global climate will affect our ability to fulfil our scientific mission in the (not so distant) future. Hence, it will rather be to our advantage to anticipate these effects and become more resilient to them.

Background

Open all +

Motivation	Open +
Context	Open +
CO_2 Working Group	Open +

D PHYS

Contact

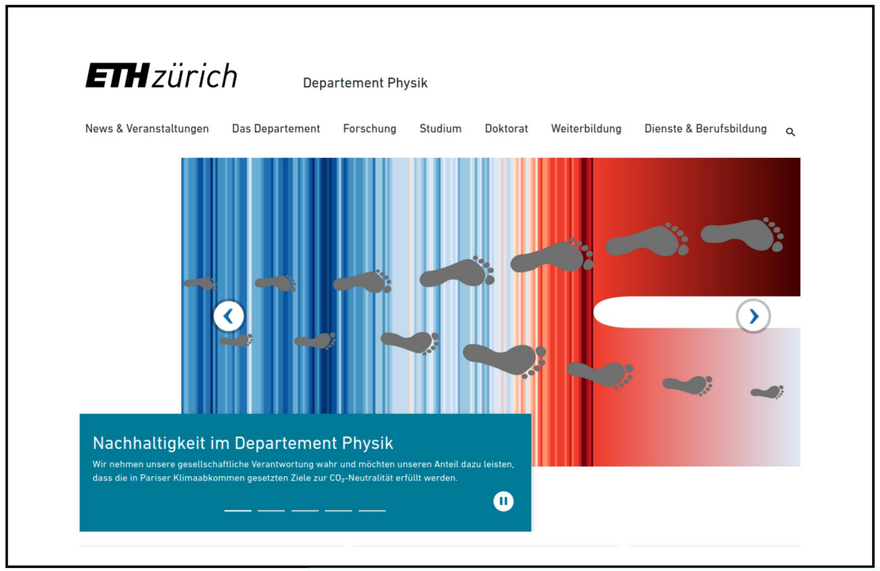
ETH Zurich, Department of Physics
CO_2 Working Group

Prof. Dr. Niklas Beisert
Wolfgang-Pauli-Str. 27
ITP, HIT K
8093 Zurich
Switzerland

+41 44 633 78 29 →
E-mail →
Website →
V-Card (vcf, 1kb) ↓

Report

The report (PDF, 510 KB) ↓ "Towards Sustainability in Research at D-PHYS/ETH" illustrates the status quo at D-PHYS, details our CO_2 roadmap and suggests concrete actions.

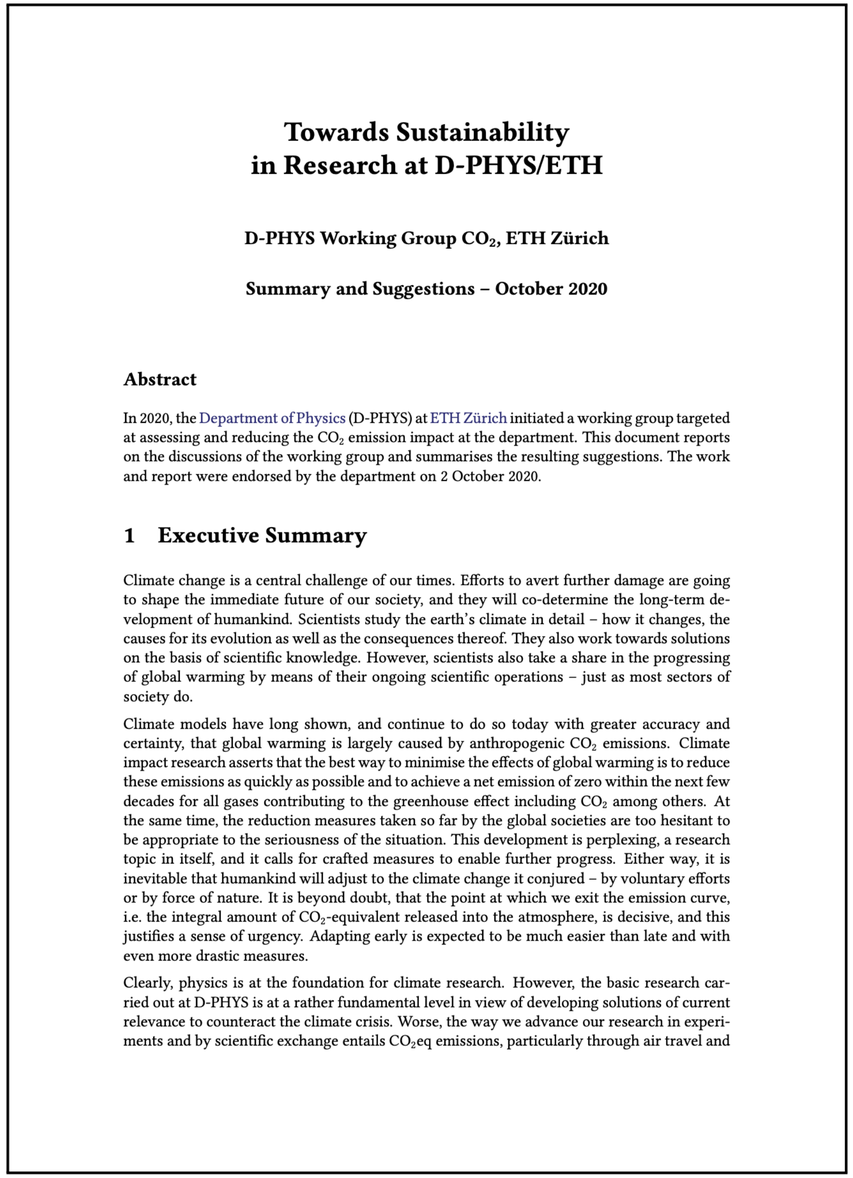


ETH zürich Departement Physik

News & Veranstaltungen | Das Departement | Forschung | Studium | Doktorat | Weiterbildung | Dienste & Berufsbildung

Nachhaltigkeit im Departement Physik

Wir nehmen unsere gesellschaftliche Verantwortung wahr und möchten unseren Anteil dazu leisten, dass die in Pariser Klimaabkommen gesetzten Ziele zur CO_2-Neutralität erfüllt werden.



Towards Sustainability in Research at D-PHYS/ETH

D-PHYS Working Group CO_2, ETH Zürich

Summary and Suggestions – October 2020

Abstract

In 2020, the Department of Physics (D-PHYS) at ETH Zürich initiated a working group targeted at assessing and reducing the CO_2 emission impact at the department. This document reports on the discussions of the working group and summarises the resulting suggestions. The work and report were endorsed by the department on 2 October 2020.

1 Executive Summary

Climate change is a central challenge of our times. Efforts to avert further damage are going to shape the immediate future of our society, and they will co-determine the long-term development of humankind. Scientists study the earth's climate in detail – how it changes, the causes for its evolution as well as the consequences thereof. They also work towards solutions on the basis of scientific knowledge. However, scientists also take a share in the progressing of global warming by means of their ongoing scientific operations – just as most sectors of society do.

Climate models have long shown, and continue to do so today with greater accuracy and certainty, that global warming is largely caused by anthropogenic CO_2 emissions. Climate impact research asserts that the best way to minimise the effects of global warming is to reduce these emissions as quickly as possible and to achieve a net emission of zero within the next few decades for all gases contributing to the greenhouse effect including CO_2 among others. At the same time, the reduction measures taken so far by the global societies are too hesitant to be appropriate to the seriousness of the situation. This development is perplexing, a research topic in itself, and it calls for crafted measures to enable further progress. Either way, it is inevitable that humankind will adjust to the climate change it conjured – by voluntary efforts or by force of nature. It is beyond doubt, that the point at which we exit the emission curve, i.e. the integral amount of CO_2-equivalent released into the atmosphere, is decisive, and this justifies a sense of urgency. Adapting early is expected to be much easier than late and with even more drastic measures.

Clearly, physics is at the foundation for climate research. However, the basic research carried out at D-PHYS is at a rather fundamental level in view of developing solutions of current relevance to counteract the climate crisis. Worse, the way we advance our research in experiments and by scientific exchange entails CO_2eq emissions, particularly through air travel and

https://phys.ethz.ch/sustainability

- Working group to suggest policies for CO2 reduction
- Lead by Prof. Dr. Niklas Beisert, the data is from him
- Report in 2020-21
- Website "Towards sustainability"
- General endorsement of D-PHYS
- Implementation and enforcement is still a question

CO2 emissions @ ETHZ

Recorded emissions ETHZ in t [CO2eq] /year: (mean: approx. 30,000)

Jahr	1990	2000	2006	2012	2018
Heizung	14'500	14'500	11'800	6'800	7'100
Elektrizität			3'000	1'600	1'400
Mobilität			13'400	18'500	18'400

Additional emissions from Real Estate, Procurement, Equipment, Operations…

Implemented infrastructure measures:

- Building infrastructure, conversion to renewable energy sources
- "Anergienetz" (geothermal heat, storage, from 2013): −5,000 t [CO2eq] / year
- Green electricity, hydropower: 14 g/kWh (electricity mix D: 400 g/kWh)

Air travel:

- Emissions by air travel: 16,500 t [CO2eq] / year
- per employee: 1.8 t [CO2eq] / year / FTE
- Percentage of air travel from mobility emissions: 93%
- Percentage of long-haul routes (1,600 km and more): 85%

Sustainability @ ETHZ

Sustainability office ETHZ

- 7 MA, Staff President; delegated professor for sustainability
- Events, websites on SDGs (broader than air travel, climate)
- https://ethz.ch/nachhaltigkeit
- ”ETH Zurich lives sustainable development in its four core areas of research, teaching, campus and in dialogue with society.”

Student sustainability commission (SSC)

- Part of VSETH (the student association)

Mobility platform / air travel project: (from 2016)

- 2 MA, Staff Vicepresident of Infrastructure
- Data management, coordination of emissions from air travel
- Websites: information, documentation, knowledge databank
- https://ethz.ch/flugreisen
- https://ethz.ch/mobilitaet

(One) of the elephants in the room: CO2 emissions from flights

Creation of the air travel project (after the Paris Agreement)

- 2017 / 2018: Setting objectives
- 2016 – 2018: baseline data
- 2019 – 2025: reduction phase

Objectives

- Departments discuss reduction targets (bottom-up), declaration
- This contains the set ambition (0% – 20%, 11% mean), methods, agreement

Data recording and monitoring

- Data entry for all financed flights
- Current emission data can be requested for each cost center

Methods for reduction

- Flights with good reason, grouping programs
- More efficient aircraft, direct flights (caution!), trains, travel planning tools
- Abandonment of business class flights
- Taxation, compensation (few departments)

One discussion singled out: (Semi)-virtual conferences

Principle of the idea:

- All scientific meetings, workshops and conferences at D-PHYS has to offer the opportunity for virtual participation for speakers and participants.
- Among such, one invited plenary talk should go to a remote participant

Pro:

- International conferences have a huge CO2 impact
- The quality of the online talks is high, the tech is there since the pandemic
- Many senior or high profile speaker from overseas may be available for an online talk, and not in presence
- Would give opportunity to keep better work-life-balance for scientists with young children

Con:

- Networking is not possible (?) ie coffe-room-discussions
- May disadvantage early career scientists

Comments on the execution

Discussions in D-PHYS:

- basic insight, agreement (applied physics...)
- concrete data are missing (reduction compared to what?)
- Implementation? Enforcement?
- Conflict of interest: evaluation (international presence, networking)
- Impairment of one's own research?
- Important: No career disadvantages for young scientists!
- Speculation: 20% reduction without relevant restrictions possible.
- For example: more events with a focus on participants, less travel

Execution:

- After decision: Attention on how to do it
- Who implements? How? Awareness?
- Administrative hurdles: How/who maintains data? How to do taxation?
- Delays: Current data (only) available from the end of 2020
- Data 2019: realized reductions very variable (selectively)
- Data for the years of pandemic: anomalous (but interesting)

Universität Basel

A grassroots approach to sustainable research

Philipp Treutlein, Department of Physics, University of Basel

Climate protection group at Basel Physics Department

~20 people: from **Bachelor** students to **professors**

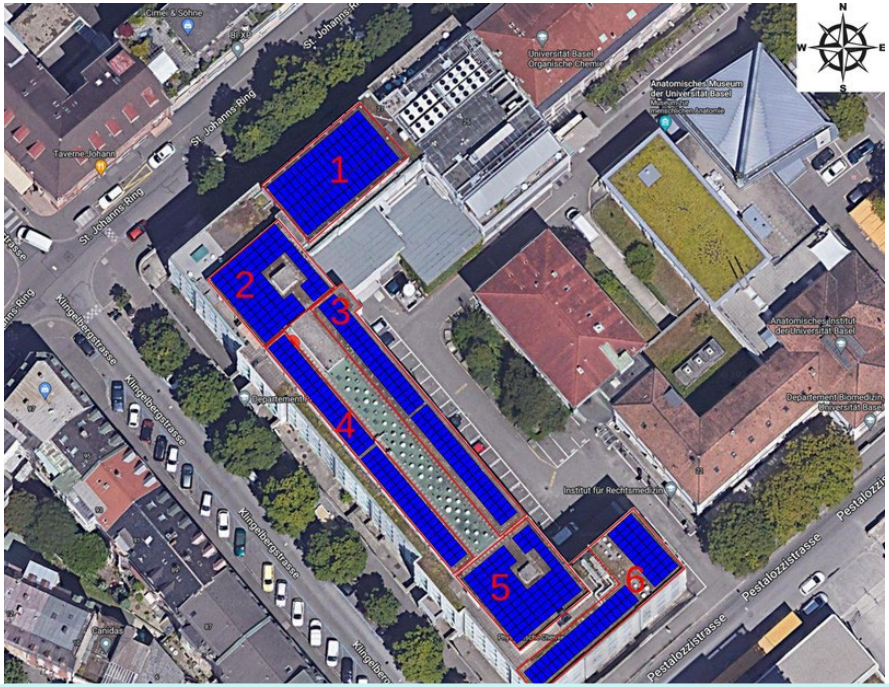
- Reduce **emissions**
- Increase **efficiency**
- **Incentivize** colleagues
- Share **information**

1. **Equipment** (Wiki platform for e.g. used laptops)
2. **Mobility** (flight reduction survey/ regulations)
3. **Information and Communication** (commuting survey, newsletter)
4. **Resource Management** (electricity /heating/helium consumption)
5. **Coffee** (survey for kitchen 4th floor)

Discussion and decision process at Department level

- Ideas and proposals for regulations from bottom-up initiative
- Discussion in the Department assembly
- Action items for administration
  - Wiki platform for used equipment
  - Develop measures to reduce flight related CO2 emissions by at least 30%
  - Inform about travel regulations in welcome package for new employees
  - Communicate travel related CO2 emissions to individual research groups
  - Energy certificate for the physics building
  - Improve thermal isolation of the building
  - Photovoltaics on the roof of the building
- Departmental energy saving week
  - reduce energy usage in the building without reducing scientific productivity
  - moderate success (4.4% reduction) highlights need for technical solutions

Example: photovoltaics on physics building



PV on KLB80/82 roof

- Decision: **June 2023**
- Potential start of construction: **2025**
- **~200 MWh/a** production (no battery needed!)

Request: The department requests an acceleration of the construction of the PV.