

Labos 1point5

Reducing the environmental footprint of our research activities

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NUCLÉAIRE
& PARTICULES



What is Labos 1point5 ?



1. A grassroots collective action « to understand and reduce the environmental footprint of research » :

- Created in March 2019
(op-ed in French leading newspaper *Le Monde* & website with call for participation)
- Networks of people, labs and initiatives
~4000 following our work



2. A research project called GdR (Groupement de Recherche)

- Created in November 2021
- ~250 participating in research activities (all gender, discipline, age)
- Scientific publications on the evaluation and analysis of research carbon footprint

Research and environmental footprint

A very present topic (I kept the quotes in French) :

Recommendation of the CNRS biology Scientific Council: November 2021 [[here](#)]

« La recherche ne peut s'affranchir de la prise de conscience de son impact environnemental »



Tribune
Labos1point5

« Notre objectif est d'imaginer un nouvel horizon pour le monde académique, qui s'affranchisse d'une compétition frénétique reposant sur l'illusion d'une énergie abondante et sans limites. »

Recherche : pour une éthique environnementale, Le Monde, 15 mars 2022
(<https://labos1point5.org/reflexion/RechercheEthiqueEnvironnementale>)

COMETS advice (CNRS ethics committee): December 2022 [[here](#)]

« Integrating environmental issues into research practices – An ethical responsibility »

MESR [French ministry of higher education and research] Climate and biodiversity plan : November 2022

HCERES [French research evaluation committee] adds questions on environmental issues in institution evaluation : October 2023

And laboratories are moving forward
(often faster than institutions)

The « principles » of Labos 1point5

- It is essential to quantify and understand the carbon footprint of research, its determinants, uncertainties and heterogeneity
- Implementing locally designed and deliberated solutions in research laboratories, to re-appropriate our laboratories as decision-making places
- Organize reflexive work on the coherence, responsibility and ethics of research in relation to the low-carbon transformation of our societies (carbon emissions main but not only focus)

→ Reinventing a way of doing research compatible with planetary boundaries

(keeping in mind that fundamental/physics research may not be considered essential to a society in crisis...)

Computing carbon footprint - before



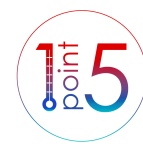
- Carbon footprint
 - ▶ One indicator to quantify GHG release in atmosphere by one activity

- Different methods
 - ▶ From physical flows
 - ▶ From cash flows

- Different tools
 - ▶ GHG Protocol (scope 1, scope 2, scope 3)
 - ▶ Bilan Carbone©
 - ▶ Regulatory GHG inventory (scope 1 and 2 of the GHG Protocol)

- Situation
 - ▶ Need for harmonisation
 - Scope, method, emission factors
 - ▶ No such standard tool for research activities

GES 1point5: a tool to measure the carbon footprint of laboratories



■ GES 1point5:

- ▶ 1 free & online tool to carry out GHG inventory of laboratories
- ▶ 1 methodology
- ▶ 1 GHG inventory = 1 year & 1 laboratory
- ▶ Recommended by



■ Emissions categories:

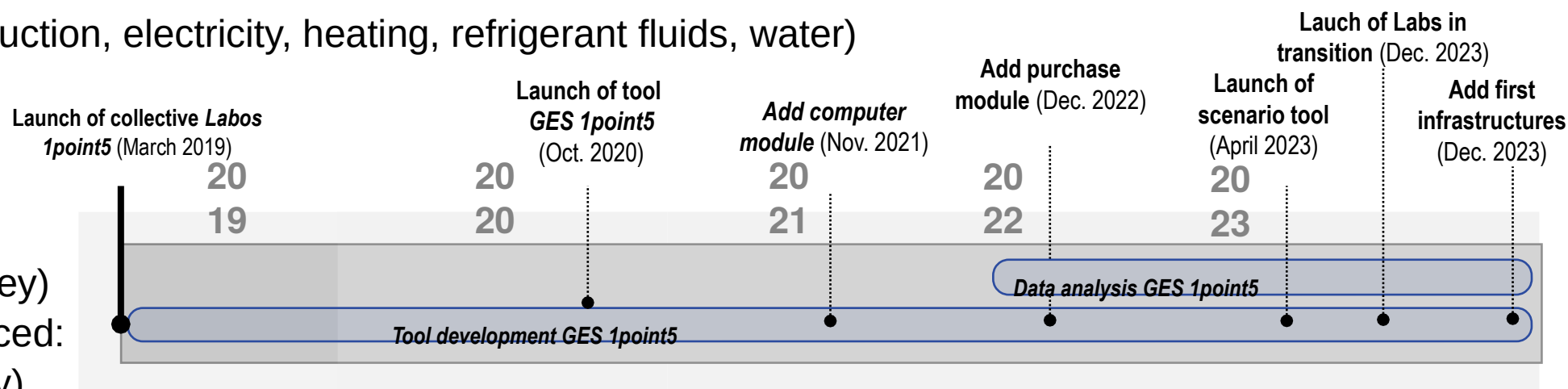
- ▶ Buildings (construction, electricity, heating, refrigerant fluids, water)
- ▶ Purchases
- ▶ Digital devices
- ▶ Lab vehicles
- ▶ Business travels
- ▶ Commutes (survey)
- ▶ Recently introduced:

- Food (survey)

- Research infrastructures (CERN, GENCI [HPC], astronomical observatories)

- Farming activities (fertilisers, livestock)

- More to come soon (WLCG?)



GES 1point5: a free and online tool



DOCUMENTATION

- Methodology
- Help
- Data protection
- The team *GES 1point5*

DATA

- Introduction**
- Boundaries
- Buildings
- Purchases
- Digital devices
- Vehicles
- Business travel
- Commuting

RESULTS

- Regulatory inventory
- Carbon footprint & submission

Introduction

GES 1point5, developed by *Labos 1point5*, is a tool aiming at calculating the carbon footprint and building the greenhouse gas (GHG) inventory of your laboratory.

The goal of this tool is twofold:

- Carry out scientific studies relating to the carbon footprint of French public research. Our current research field is limited to France, including its overseas territories.
- Bring food for thought on the levers for action to reduce the impact of research activities on GHG emissions, at the national as well as at the local level of the laboratory.

Thank you for **carefully reading the guidelines** (methodology and help) before starting and contacting us.

How to cite *An open-source tool to assess the carbon footprint of research.* Jérôme Mariette, Odile Blanchard, Olivier Berné, Tamara Ben-Ari. bioRxiv 2021.01.14.426384; doi: <https://doi.org/10.1101/2021.01.14.426384>.

Why use *GES 1point5*?

- Contribute**: Contribute to an emerging scientific field.
- Involve**: Involve the staff members.
- Share**: Share a common methodology.
- Account for**: Account for the specificities of the research laboratories.
- Promote**: Promote open access digital tools.

Internationalisation of tools:
US, Chile, Germany

J. Mariette et al 2022
An open-source tool to assess the carbon footprint of research
Environ. Res.: Infrastruct. Sustain. 2 035008

GitLab source code:
<https://framagit.org/labos1point5/l1p5-vuejs>

Available standalone simulators:

- ▶ commute
- ▶ travels
- ▶ food

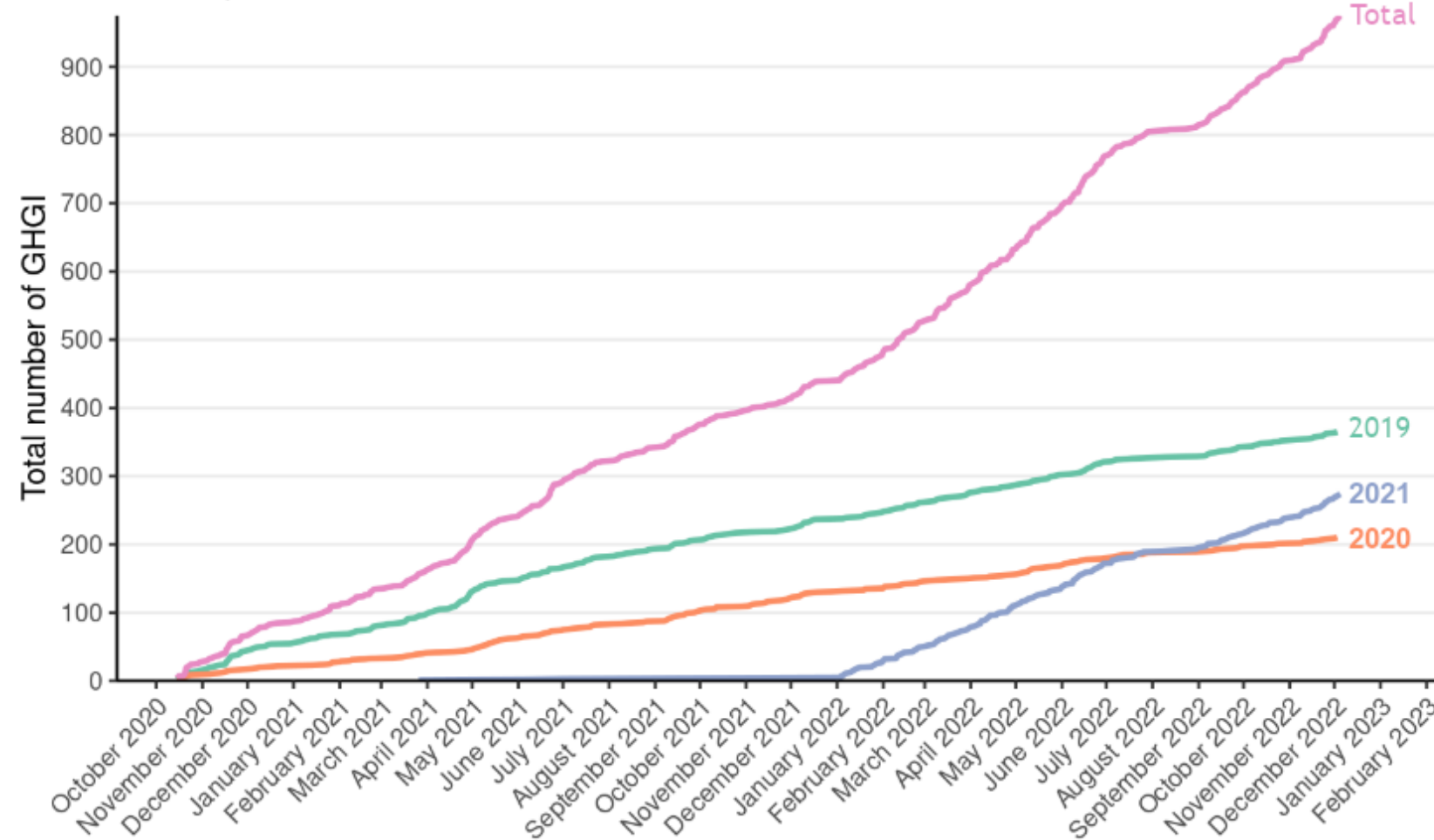
<https://apps.labos1point5.org/ges-1point5>

Footprint: GES 1point5 as a GHG common base



GHG inventories creation evolution

For the years 2019, 2020 and 2021

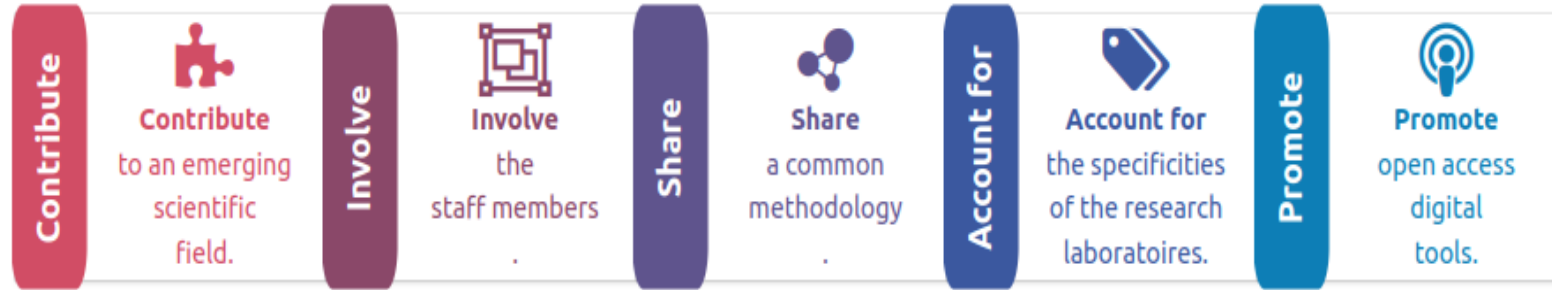


Data source: GES 1point5

- High adoption rate and increasing
- Already >1100 labs (out of ~ 2000 labs/UMR) and >2400 GHG inventories

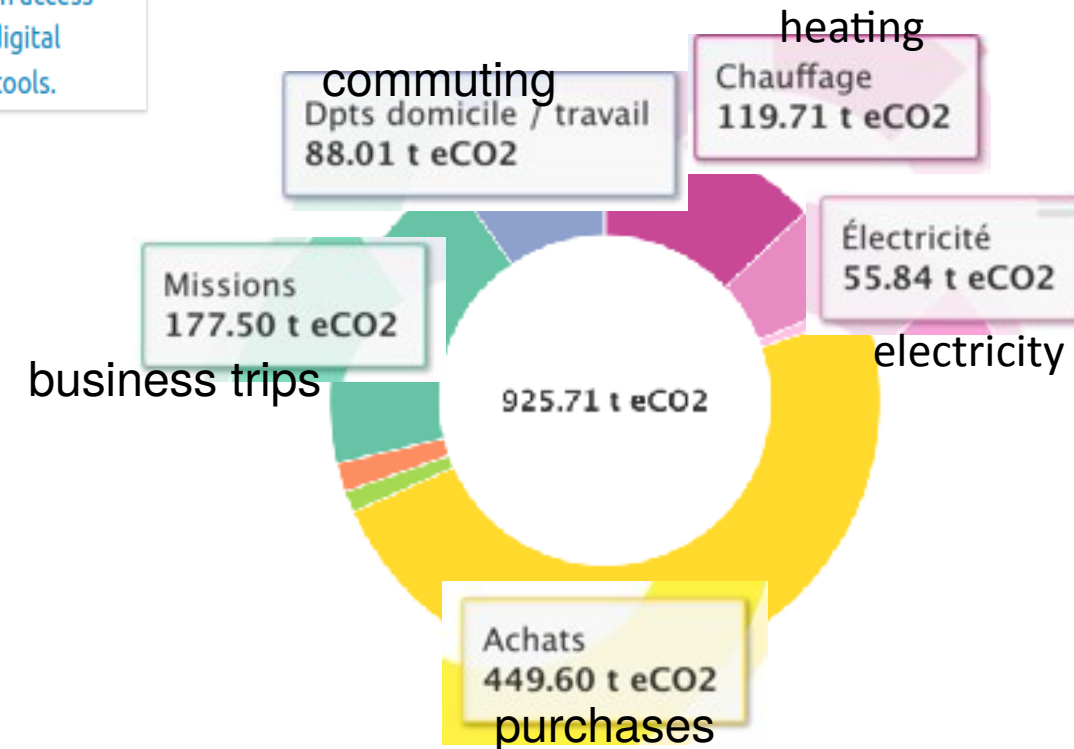
[J. Mariette et al (2022)]

Why use GES 1point5?



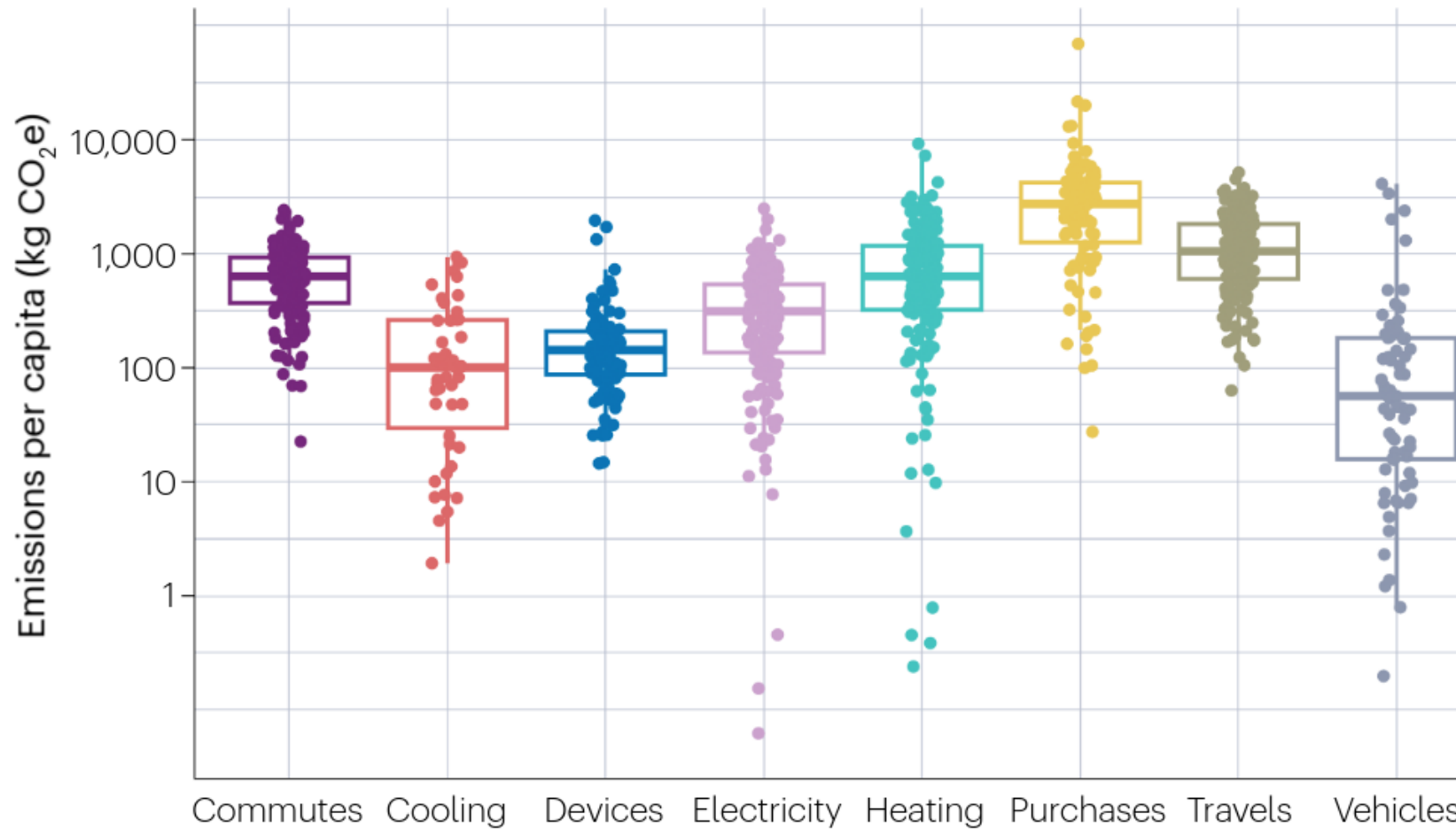
- Several papers out already [list], e.g.:
 - ▶ **Travels**: *Flight quotas outperform focused mitigation strategies in reducing the carbon footprint of academic travel*
[Tamara Ben-Ari et al 2024 Environ. Res. Lett. 19 054008]
[EarthArXiv]
 - ▶ **Procurement**: *Purchases dominate the carbon footprint of research laboratories* [bioArXiv]

Estimation of the annual carbon footprint of a fictive laboratory



<https://apps.labos1point5.org/ges-1point5>

Distribution of the carbon footprint of laboratories



- Year 2019 (~150 labs)
- Validated reports
- Heterogeneity between laboratories
- Purchases (40%) and travels (25%) dominate the laboratories footprint
- Infrastructures not included here

~1000 t CO₂e / year per lab

~7,3 t CO₂e/year per capita

~1 250 000 t for the total sector

[T. Ben-Ari, *How research can steer academia towards a low-carbon future*, Nat Rev Phys 5, 551-552 (2023)]

Travels

Flight quotas outperform focused mitigation strategies in reducing the carbon footprint of academic travel

[T. Ben-Ari et al 2024 Environ. Res. Lett. 19 054008]

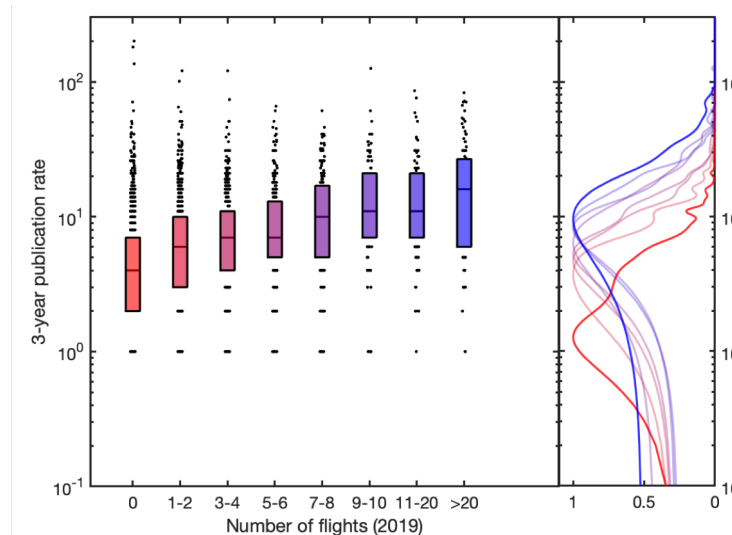
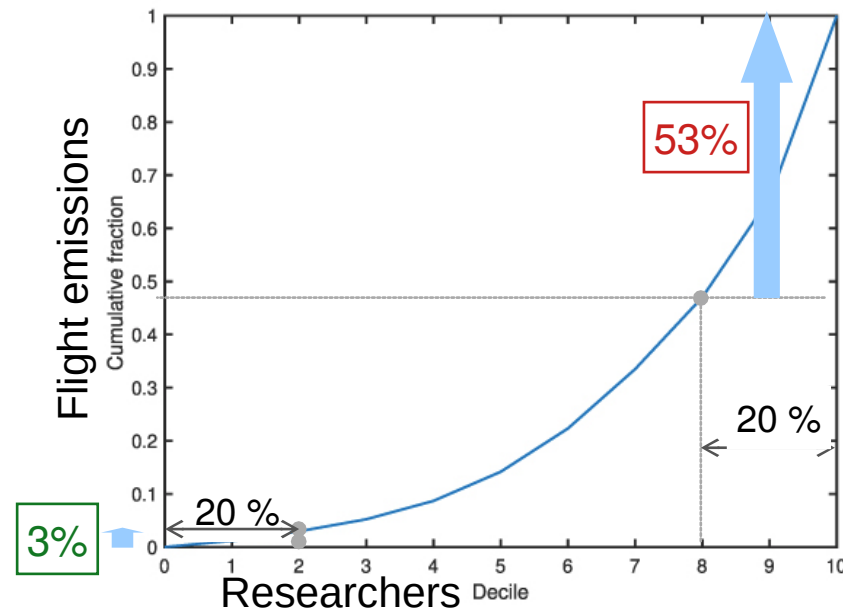
- 137k travels
- Planes ~95% of emissions
- Evaluate replacement of air travel by train
- 50% by 2030

Current ministerial guideline

Minimum Allowable Distance (in distance or approximate duration) for Air Travel Clearance

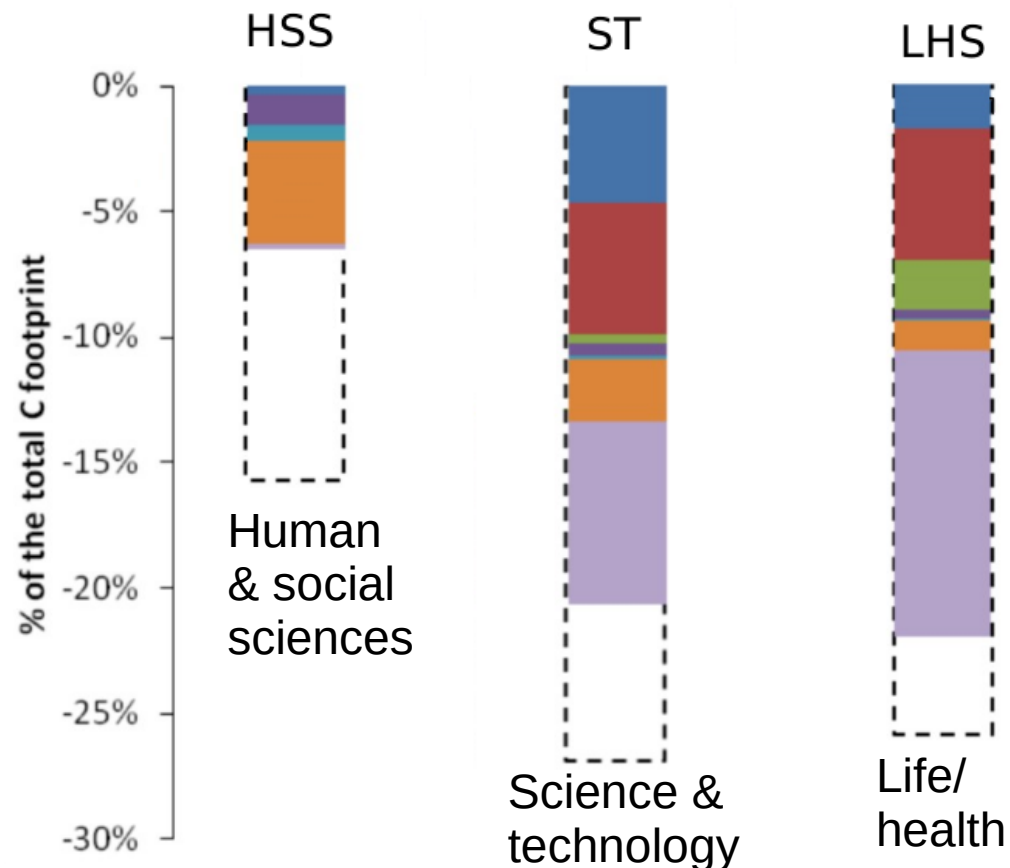
	No modal shift policy	375km (~2h30)	600km (~4h)	In mainland France	900km (~6h)	1000km (~6h40)	1200km (~8h)	1500km (~10h)
No moderation policy	0	0.3	3	8	12	15	18	21
Reduce air travel number for conferences	20% fewer trips	8	10	13	17	20	23*	26*
	50% fewer trips	19	21	24	27	30	32	34
	1 r. trip/3 years	14	13	17	18*	19*	21**	22**
	1 r. trip/4 years	18	18	19	22	22	23*	23**
Reduce long-haul air travel number	20% fewer trips	13**	14**	16**	21**	26**	32**	35**
	50% fewer trips	32**	33**	35**	40**	44**	51**	53**
	1 r. trip/4 years	28**	28**	31**	35**	40**	46**	49**
	1 r. trip/6 years	37**	38**	40**	45**	50**	56**	59**
Reduce air travel mileage	20% decrease	20***	20***	22***	26***	30***	32***	37***
	50% decrease	48***	49***	50***	52***	54***	56***	59***
	5800km/year	38***	38***	39***	41***	42***	44***	46***
	4500km/year	47***	47***	48***	50***	51***	52***	53***
Reduce air travel number	20% fewer trips	19	20*	22*	25*	29*	31*	36**
	50% fewer trips	48	48	49	52	54	55	58*
	1 r. trip/year	36*	36*	33	32*	29*	28**	27***
	1 r. trip/2 years	61	61	58	57	51*	50*	44**

The carbon footprint of scientific visibility
[O. Berné et al 2022 Environ. Res. Lett. 17 124008]



- Difficult to quantify properly
- Using monetary emission factors:
 - ▶ Good for large-scale orders of magnitude
 - ▶ Tricky at smaller scales
 - ▶ Large uncertainties

- Relies on French procurement system with ~250 categories (Nacres)
 - ▶ Single EF per category
- Serious limitation
 - ▶ “good” practice costs more → “more” emissions



Purchases dominate the carbon footprint of research laboratories [bioArXiv]

Demand-based strategies can achieve a 20% reduction in the total footprint (-40% in the purchasing footprint).

Evaluating the impact of using CERN's infrastructures

- Discussed with CERN HSE department in March 2023 about:
 - ▶ What we want to achieve (attribution by experiment membership to each physicist)
 - ▶ What we need as inputs

- Positive meeting but CERN hierarchy not willing to reach such granularity
 - ▶ Data available but want to avoid finger-pointing
 - CERN policy: promote best practices while preserving first goal of infrastructures (research)
 - ▶ CERN has acces to detector and cooling system emissions, but not to simulation/reconstruction/GRID/storage/reproducibility/etc.

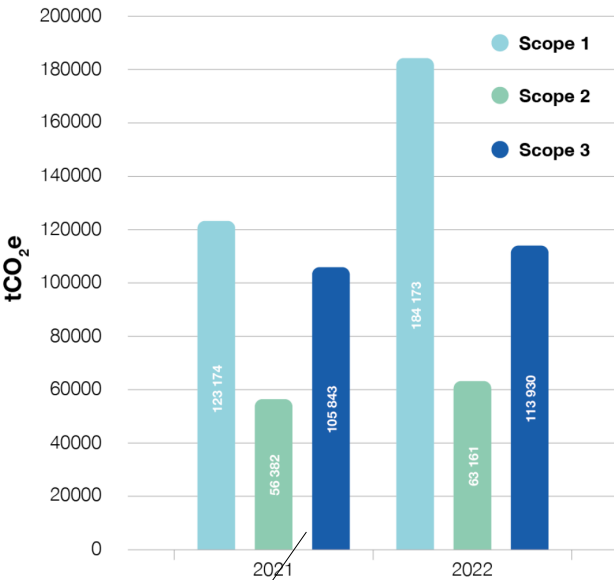
- In the end, only access to official numbers from CERN environment reports
 - ▶ <https://hse.cern/environment-report>

Splitting the impact among users

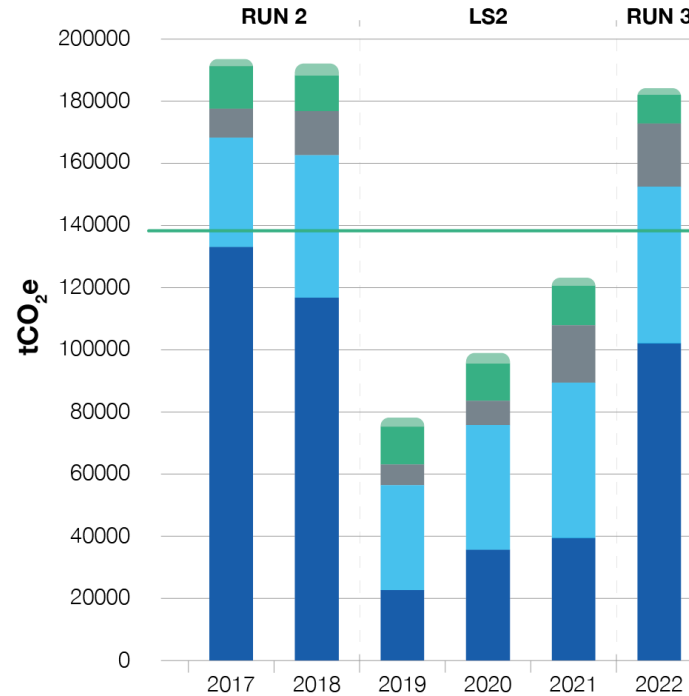
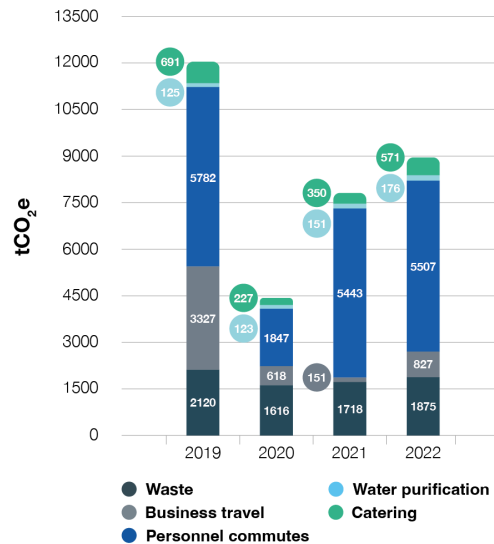
- Non trivial given the available inputs
 - ▶ Share of accelerators?
 - No accelerator = no physics in detectors
 - ▶ Fair share of LHC emissions:
 - $\frac{1}{4}$ per experiment?
 - By number of physicists?
 - By integrated luminosity?
 - By construction cost?
 - ▶ Scope 3 not available with experiment split → how to share?
- Account for LHC construction?
- Account for tunnel construction?
- Average over data-taking and Long Shutdown years or accept yearly variations?
- Count only physicists, or also technicians, engineers, etc?
- In the end, keep it simple for GES 1point5 users

Inputs, last CERN environmental report

➤ <https://hse.cern/environment-report-2021-2022/emissions>



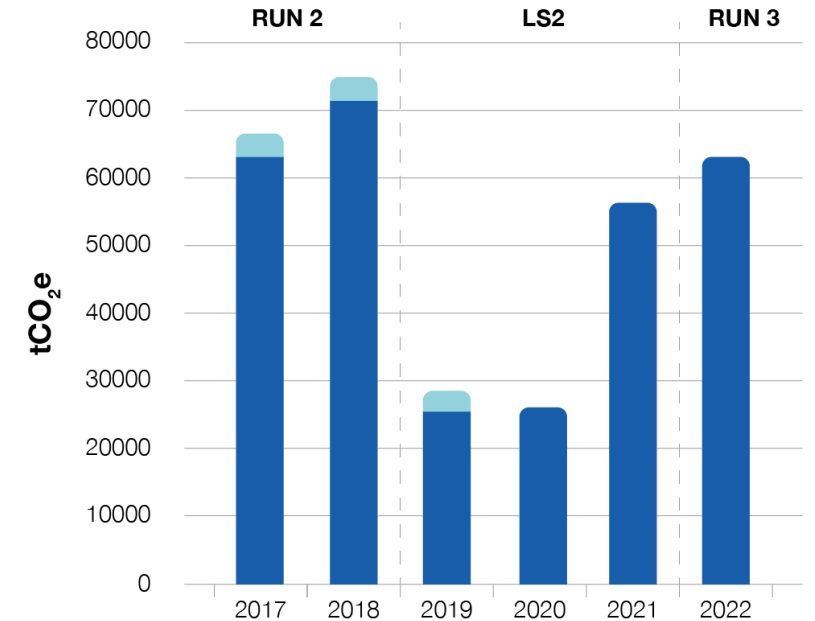
Scope 3 includes procurement for past two years



- LHC experiments - Particle detection
 - LHC experiments - Detector cooling
 - Other experiments
 - Heating (gas + fuel)
 - Other
- Target: max 138 300 tCO₂e

Scope 1

Scope 3 (excluding procurement)



- Electricity consumption (at CERN)
- Electricity consumption (Budapest, Hungary)

Scope 2 (previous years recomputed)

Personnel statistics

- How to distribute the footprint?
 - Share it among the physicists using CERN
 - CERN's goal is to provide them data
 - Well known numbers, by CERN and labs
 - PhD student, post-doc, staff on 31st Dec

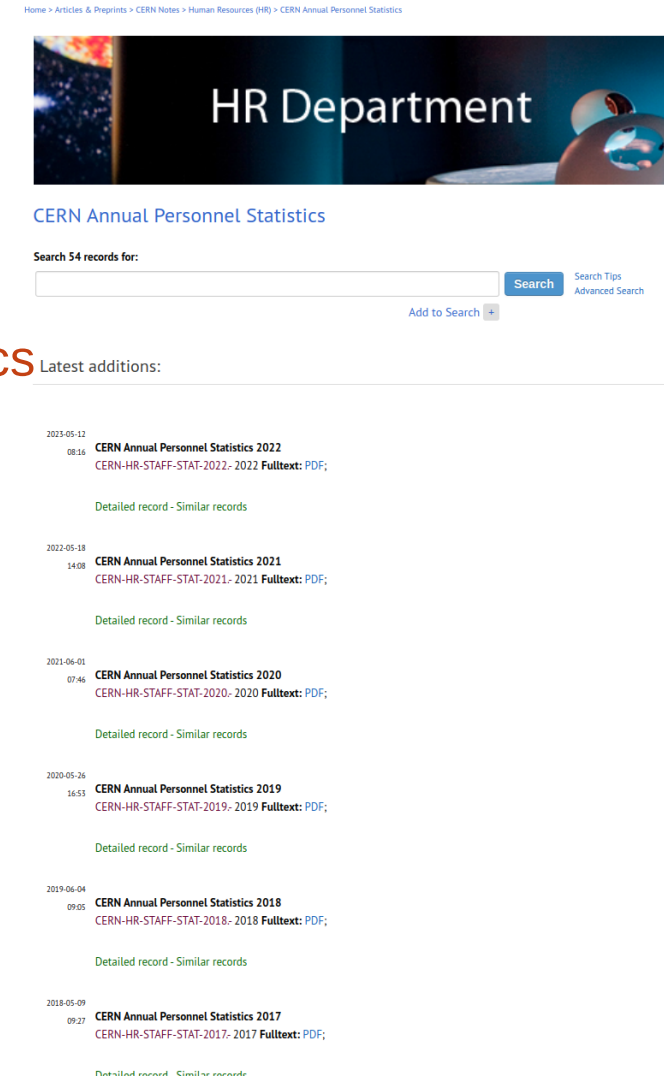
► <https://cds.cern.ch/collection/CERN%20Annual%20Personnel%20Statistics>

	2017	2018	2019	2020	2021	2022
1						
2	Runs	Run 2	Run 2	LS2	LS2	Run 3
3	Users CERN (31-déc.)	12236	12569	12428	11399	11175
4	Atlas	3912	3971	3983	3699	3517
5	CMS	3076	3092	3055	2862	2749
6	Alice	1314	1320	1329	1180	1159
7	LHCb	870	913	946	887	910
8	->Exp LHC	9172	9296	9313	8628	8335
9		74,96%	73,96%	74,94%	75,69%	74,59%
10	LHC	78				
11	SPS	733	745	718	676	695
12	PS	219	229	204	179	177
13	-> Acc	1030	974	922	855	872
14		8,42%	7,75%	7,42%	7,50%	7,80%
15	--> Autres Expe	2034	2299	2193	1916	1968

LHC experiment users

Accelerator sector
→ added to “other experiments”

Other-experiment users



Home > Articles & Preprints > CERN Notes > Human Resources (HR) > CERN Annual Personnel Statistics

HR Department

CERN Annual Personnel Statistics

Search 54 records for:

Search Add to Search Search Tips Advanced Search

Latest additions:

- 2023-05-12 08:16 **CERN Annual Personnel Statistics 2022**
CERN-HR-STAFF-STAT-2022- 2022 Fulltext: PDF;
Detailed record - Similar records
- 2022-05-18 14:08 **CERN Annual Personnel Statistics 2021**
CERN-HR-STAFF-STAT-2021- 2021 Fulltext: PDF;
Detailed record - Similar records
- 2021-06-01 07:46 **CERN Annual Personnel Statistics 2020**
CERN-HR-STAFF-STAT-2020- 2020 Fulltext: PDF;
Detailed record - Similar records
- 2020-05-26 16:51 **CERN Annual Personnel Statistics 2019**
CERN-HR-STAFF-STAT-2019- 2019 Fulltext: PDF;
Detailed record - Similar records
- 2019-06-04 09:05 **CERN Annual Personnel Statistics 2018**
CERN-HR-STAFF-STAT-2018- 2018 Fulltext: PDF;
Detailed record - Similar records
- 2018-05-09 09:27 **CERN Annual Personnel Statistics 2017**
CERN-HR-STAFF-STAT-2017- 2017 Fulltext: PDF;
Detailed record - Similar records

Scope 1

1		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
2	Runs	Run 2	Run 2	LS2	LS2	LS2	Run 3	Run 3	Run 3	Run 3	LS3
18	Emissions (tCO2eq)	373,542	380,366	220,270	231,057	285399	361264				
19	scope 1	193600	192100	78169	98997	123174	184173				
20	Exp-Detec LHC	133029	116690	22597	35537	39355	101850				LHC
21	Exp-Refr LHC	35312	46122	33665	40383	50171	50475				LHC
22	Other Exp	9132	14068	6918	7846	18325	20430				nonLHC
23	Heating	13700	11300	12221	12000	12618	9012				any
24	others	2130	3921	2768	3231	2704	2403				any
25	->LHC	168341	162812	56262	75920	89526	152325				
26	-> non LHC	9132	14068	6918	7846	18325	20430				
27	-> anyexp	15830	15221	14989	15231	15322	11415				

38	scope 1 LHC/user	18.35	17.51	6.04	8.80	10.74	17.53
39	scope 1 nonLHC/user	2.98	4.30	2.22	2.83	6.45	6.44
40	scope 1 any	1.29	1.21	1.21	1.34	1.37	0.96

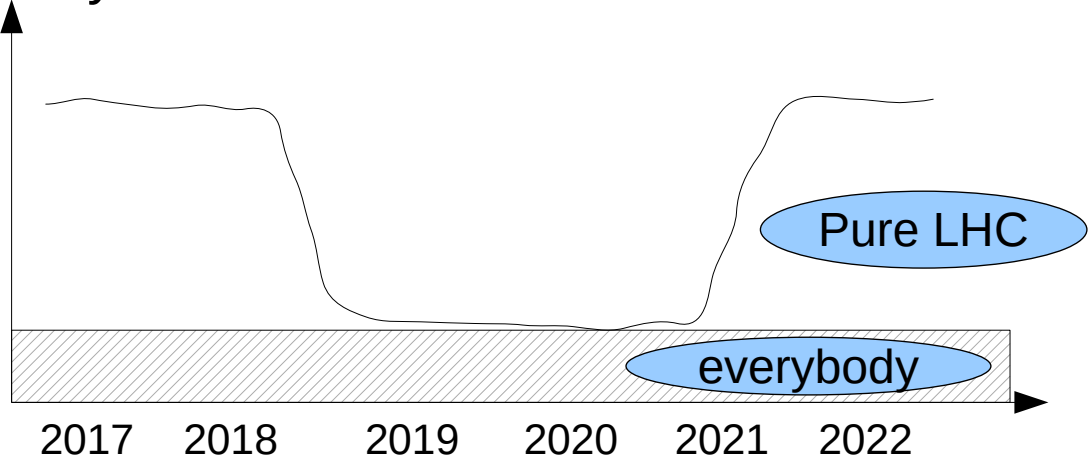
18.35t/phys (for LHC experiment users)

2.98t/phys (for non-LHC experiment users)

+ 1.29t/phys (LHC or non-LHC)

Scope 2 (mostly electricity)

Global tendency:



Numbers retroactively increased (2017-2020) in latest report 2021-2022

Hypothesis: during shutdown electric consumption per physicist for non-LHC experiments is similar to LHC physicist consumption

Cooling!
→ LS with high consumption

		2017	2018	2019	2020	2021	2022	2023	
1									
2	Runs	Run 2	Run 2	LS2	LS2	LS2	Run 3	Run 3	
30	scope 2	66589	74913	28554	26127	56382	63161		
31	scope 2 (any)	27340,5	27340,5	28554	26127	27340,5	27340,5	Ave (19',20	27340,5
32	scope 2 (LHC)	39248,5	47572,5	0	0	29041,5	35820,5		

Scope 2 (mostly electricity) - **Uncertainties**

- Evaluate with another sharing:
 - ▶ LHC data production: largest part of scope 2 → give it all to LHC users

1		2017	2018	2019	2020	2021	2022
2	Runs	Run 2	Run 2	LS2	LS2	LS2	Run 3
41	scope 2 for LHC	7.26	8.06	3.07	3.03	6.76	7.27
42	scope 2 (any)	2.23	2.18	2.30	2.29	2.45	2.31
43	scope 2 (LHC)	4.28	5.12	0.00	0.00	3.48	4.12

- ▶ Comparing the two methods:
 - LHC: [15, 27%] → 30%
 - Non-LHC : [10,16%] → 20%

Scope 3

Some assumptions for early periods

	Run 2	Run 2	LS2	LS2	LS2	Run 3		
	2017	2018	2019	2020	2021	2022		
Waste	1875	1875	2120	1616	1718	1875	2017/8: use running condition (2022)	
Business travel	3327	3327	3327	618	151	827	2017/8: use pre-covid condition (2019)	
Commute	5782	5782	5782	1847	5443	5507	2017/8: use pre-covid condition (2019)	
Water	176	176	125	123	151	176	2017/8: use running condition (2022)	
Catering	691	691	691	227	350	571	2017/8: use pre-covid condition (2019)	
Sub-total	11851	11851	12045	4431	7813	8956		
procurement	101502	101502	101502	101502	98030	104974	<2021: Average(21', 22')	101502
Total	113353	113353	113547	105933	105843	113930		

Adding **procurement**, from recent years
(not available in reports before 2021)

Construction of LHC

- Not clear how to handle it
 - ▶ Tunnel already existing (LEP)
 - ▶ Amortisation period (how long?) or single shot at construction time?
 - ▶ How to take into account the upgrades ?

- Order of magnitude

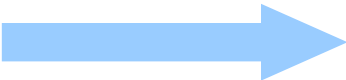
12	cost:	4.50E+09	euros	LHC+4 experiments (CHF=euros)
13	years:	2008	2040	32 years
14				1.41E+08 euros/year
15	EF:	0.3	kg/euros	
16	Co2eq:	4.22E+04	tonnes	
17	physicists:	8600		
18		4.91	t/phys	

→ Much smaller than yearly usage → choice to **ignore** it

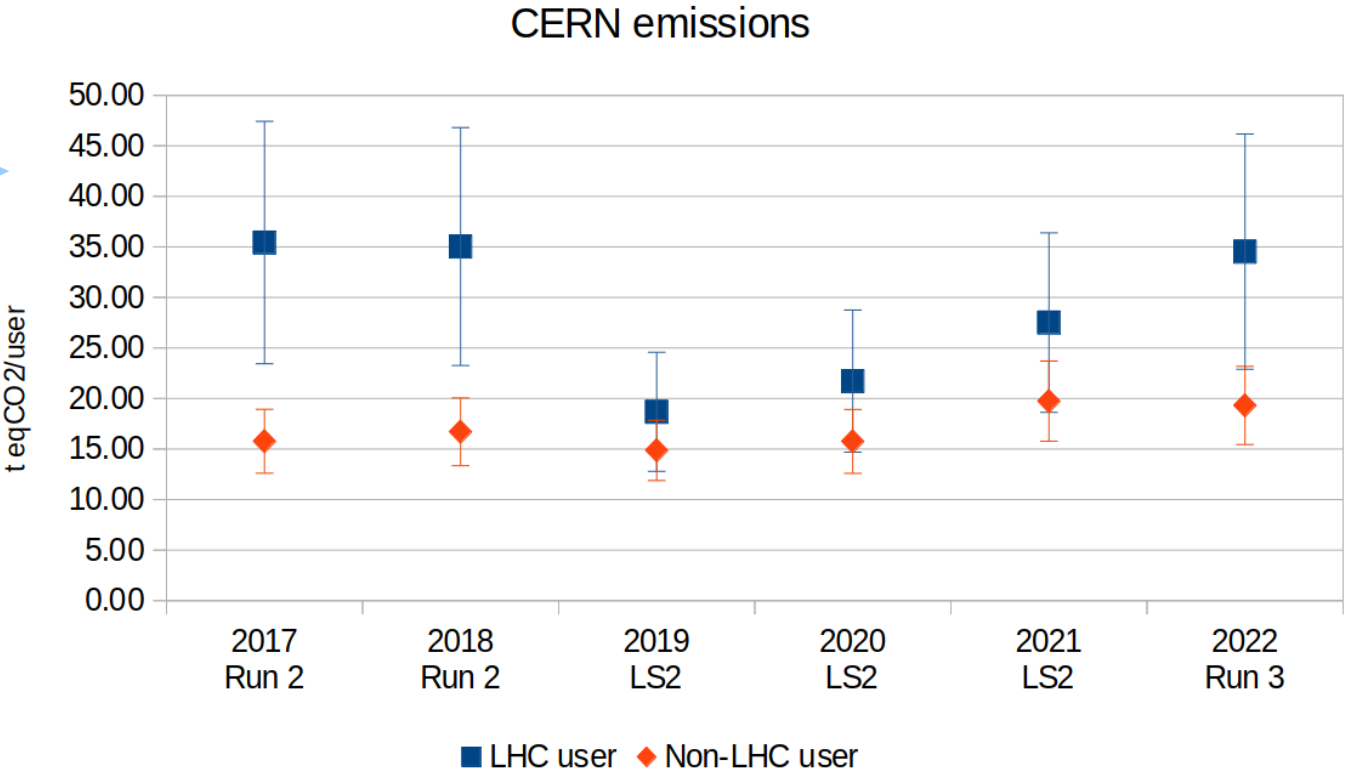
- ▶ Philosophically not crazy: what matters today is new emissions

Results & Uncertainties

- ◆ Uncertainties
 - Methodology:
 - Comparison btw 2 methods:
 - LHC: [15, 27%] → 30%
 - non-LHC : [10,16] → 20%
 - Emission factors: (from GES1point5)
 - Gases : 30%
 - Electricity (FR): 10%
- ◆ Results:
(computing still to be included...)



1		2017	2018	2019	2020	2021	2022	2023
2	Runs	Run 2	Run 2	LS2	LS2	LS2	Run 3	Run 3
52	FE t/user (LHC)	-0,15	-0,17	-0,27	-0,23	-0,24	-0,20	-> 30%
53	FE t/user (CERNuser)	0,16	0,15	0,09	0,10	0,10	0,14	->20%

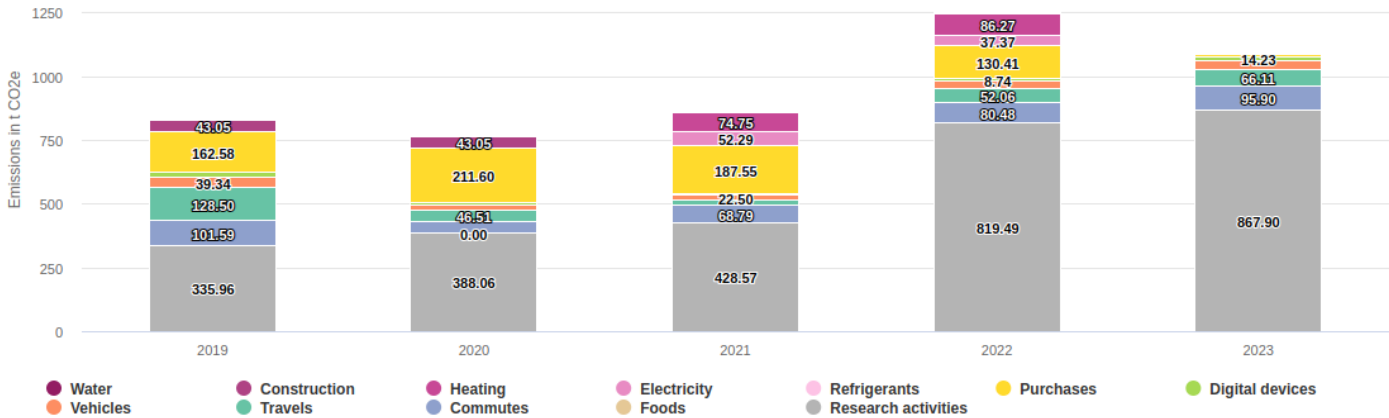


Results for LPCA



Just a single number to be provided:

- ▶ Number of LHC users that year



Category	Type	Sub-type	Amount	Unit	
Research facilities	CERN	LHC experiment	32	User(s)	
Research facilities	Astronomy	STEREO, TESS, GAIA, GALEX, WISE...		Utilisation	
Research facilities	Astronomy	STEREO	0.1	% facility usage	
Research facilities	Astronomy	TESS	0.01	% facility usage	
Research facilities	Astronomy	GAIA	0.01	% facility usage	
Research facilities	Astronomy	GALEX	0.02	% facility usage	
Research facilities	Astronomy	WISE	0.01	% facility usage	
Research facilities	Astronomy	HST	0.01	% facility usage	
Research facilities	Astronomy	SWIFT	0.01	% facility usage	
Research facilities	Astronomy	Fermi	0.04	% facility usage	
Research facilities	Astronomy	Pic-du-Midi Observatory	2.74	% facility usage	
Research facilities	Astronomy	Anglo-Australian Telescope	0.06	% facility usage	
Research facilities	Astronomy	VLT (Paranal)	0.01	% facility usage	
Research facilities	Astronomy	GTC	0.09	% facility usage	
Research facilities	Astronomy	TAROT	2	% facility usage	
Research facilities	Astronomy	VLA	0.01	% facility usage	

10 persons

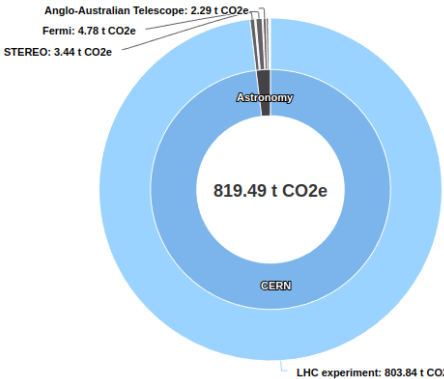


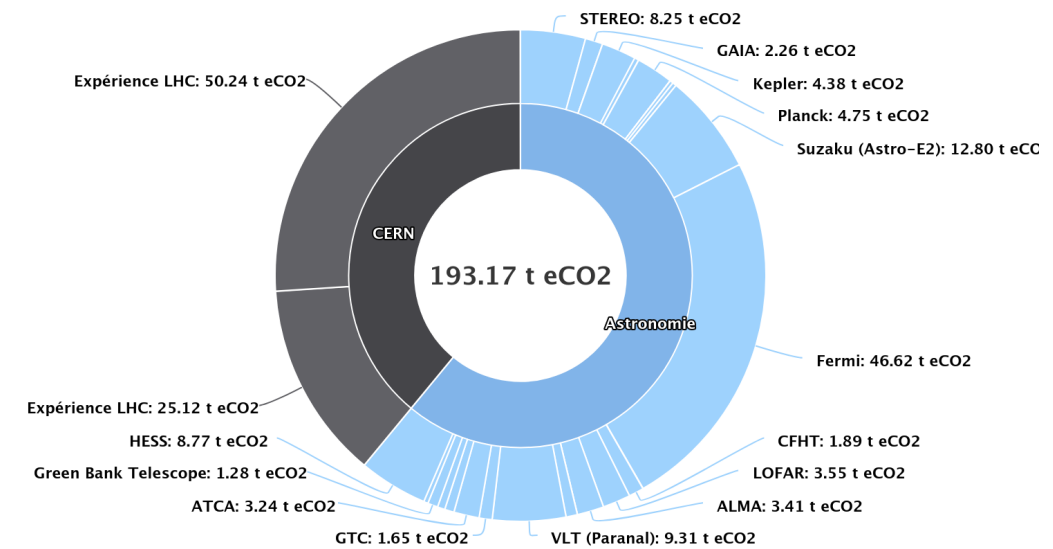
Figure : Carbon footprint of laboratory research activities separated by their types.

Type of research activity	Emissions (t CO2e)	Share of the research activity footprint
CERN	803.84 ± 297.42	98 %
Astronomy	15.64 ± 12.52	2 %

- Takes into account **telescopes (in space and on Earth)** used in laboratory's publications
- Easy to use: **just provide lab's name**
- Emissions attributed with ratio of **lab authors who published articles citing infrastructure** and **all authors in the world who published articles citing the same infrastructure**
- **Amortisation** : 38 years for telescopes and 18 years for satellites
- **Bibliometric data** extracted from **ADS**
- Does not include yet recent infrastructures like Euclid, CTA, LSST, etc.
- Ref : **arXiv: 2201.08748 [astro-ph.IM]**

$$EC_{\text{infra}} = \frac{GES_{\text{construction}}}{\text{amortissement}} + GES_{\text{opérations}}$$

$$EC_{\text{labo}} = \sum_i (EC_{\text{infra}_i} \times \% \text{utilisation}_{\text{infra}_i}^{\text{labo}})$$

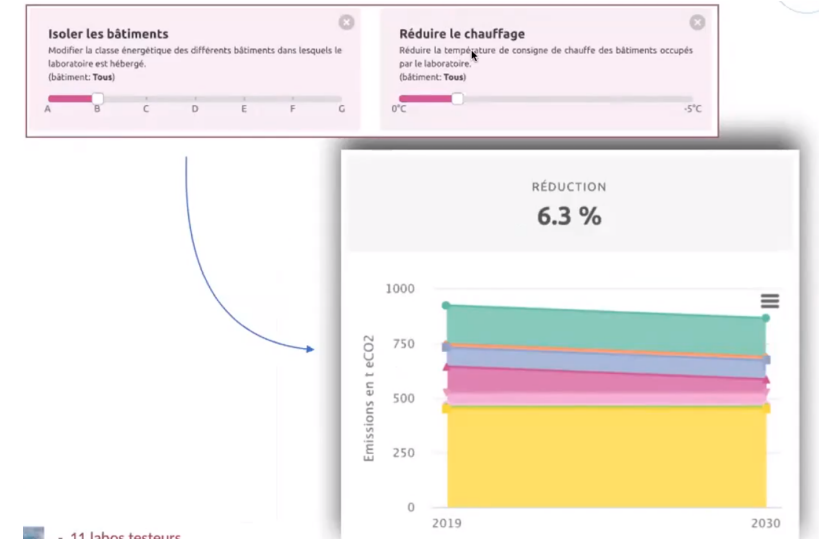


CPPM (fake LHC to see astro)

Implementing CERN reduction in Scenario1point5

➤ That will ...

- Answer to
“our biggest GHG emission source is CERN,
and they're going to cut back on gas,
so we don't have much left to do for our 50% reduction?”
- Raise awareness of the long-term consequences of our technological choices
(especially as the FCC proto-collab will be launched next year).

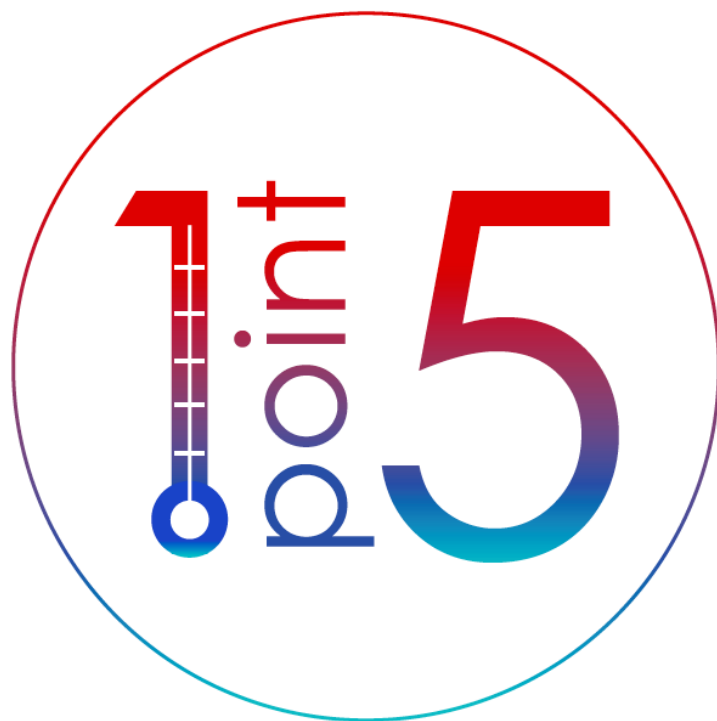


➤ So ... What will the CERN footprint be in 2030?

- CERN plans to reduce Scope 1 by 28% (wrt/ 2018) by 2025
→ $\text{Scope 1}(2018) \times 28\% / \text{nb of phys} = -5.8\text{t}$
- To be applied only if the reference year is not a LS

Conclusion

- French research community got together in **Labos 1point5** to tackle climate change:
 - ▶ All research areas involved
 - ▶ Started as grassroots initiative, now supported officially and encouraged by funding agencies
 - ▶ Provides tools, methods, webinars, scientific papers, etc
- First step: **standardised GHG emissions** for all labs with single tool: **GES 1point5**
- Large database to analyse structure of research emissions:
 - ▶ Importance of purchases
 - ▶ Impact of various scenarios on travel emissions
 - ▶ Large impact of big research infrastructures
 - Includes already astronomy, CERN, HPC center
 - More to come
- From this knowledge, call for action
 - ▶ Labs designing GHG emission reduction plans (goal: -50% by 2030), simulating impact with **Scenario 1point5**
 - ▶ Sharing experience with **Transition 1point5**



<https://labos1point5.org/>

- Numbers from slide 22

55		2017	2018	2019	2020	2021	2022		
56		Run 2	Run 2	LS2	LS2	LS2	Run 3		
57	FE t/user (LHC)	35.43	35.04	18.68	21.72	27.51	34.53	divide all 3 scopes	
58	30%	10.63	10.51	5.60	6.52	8.25	10.36	methodology	
59	30%	5.51	5.25	1.81	2.64	3.22	5.26	gases	
60	10%	0.65	0.73	0.23	0.23	0.59	0.64	electricity	
61	total uncertainty	11.99	11.77	5.89	7.03	8.88	11.64		
62									
63	FE t/user (exp non-LHC)	15.77	16.70	14.86	15.75	19.74	19.31		
64	20%	3.15	3.34	2.97	3.15	3.95	3.86	methodology	
65	10%	0.22	0.22	0.23	0.23	0.24	0.23	electricity	
66	total uncertainty	3.16	3.35	2.98	3.16	3.96	3.87		