Assessing the CO_{2eq} footprint on an institute level

-

more sustainable science practice by cutting emissions in computing and flying

Jan Rybizki (born 346 ppm) | Max Planck Institute for Astronomy (MPIA) Heidelberg
Sustainable HEP | Impulse Talk - 30th June 2021 (418 ppm)

Structure

Introduction

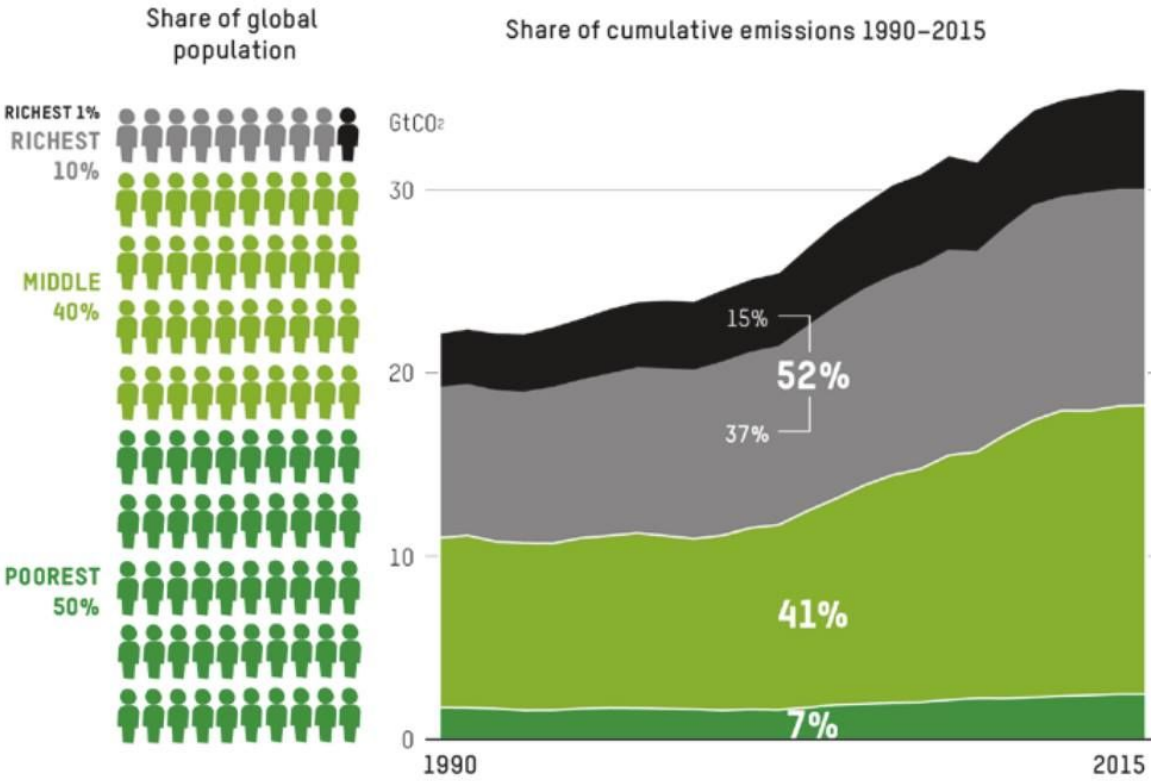
Overview MPIA emissions

Computing

Flying

Way forward

Introduction



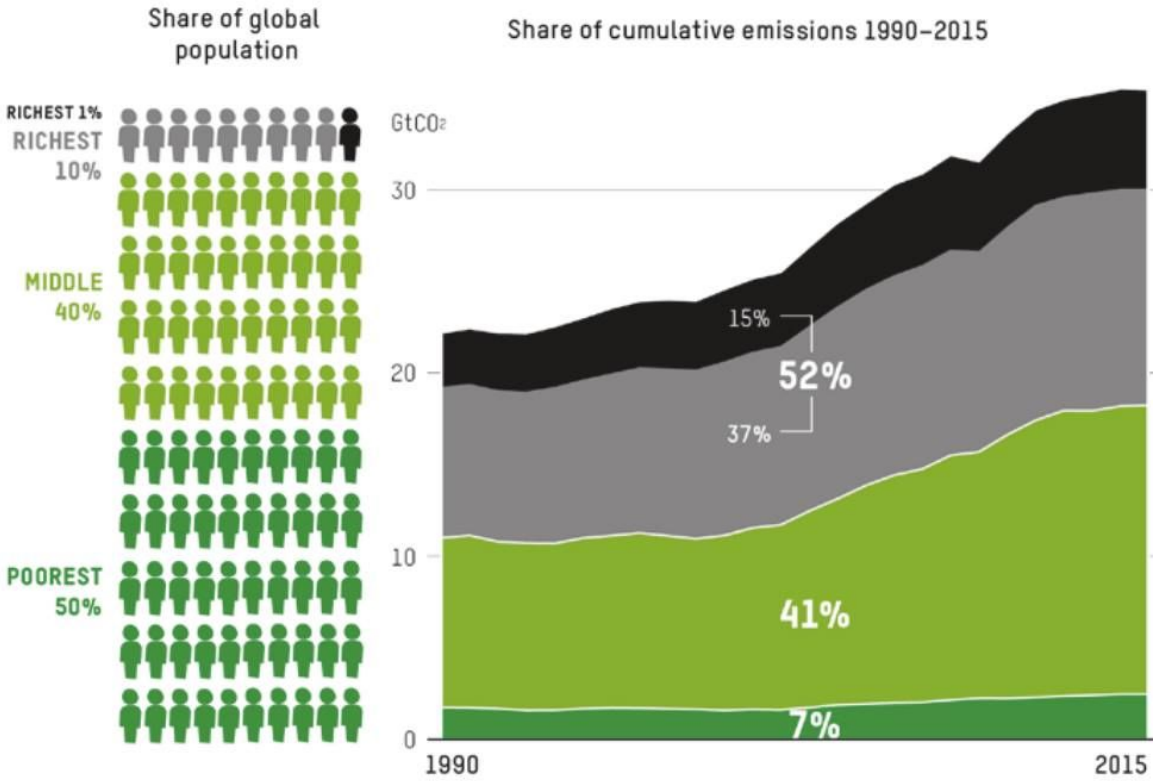
Oxfam

Introduction

> 100k € / yr
> 35k € / yr

> 5k € / yr

< 5k € / yr



Oxfam

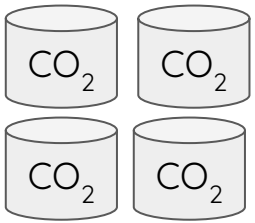
annual tCO_{2eq} per MPIA researcher

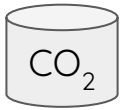
annual tCO_{2eq} per MPIA researcher

From our CO_{2eq} assessment: Jahnke et. al (2020)

annual tCO_{2eq} per MPIA researcher

Flying





= 1 tCO_{2eq}

annual tCO_{2eq} per MPIA researcher

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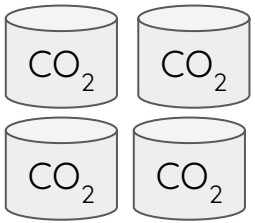
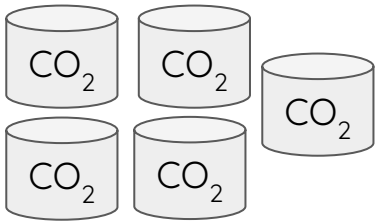
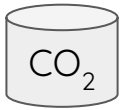


Electricity





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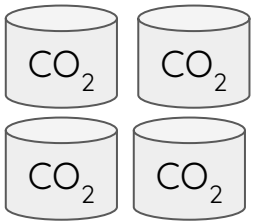

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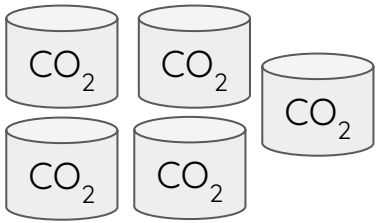
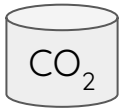


Supercomputing facilities make up **~80%** of electricity usage



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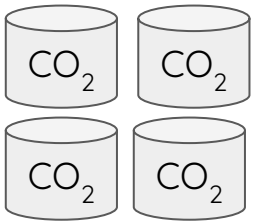

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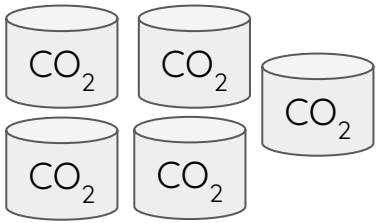
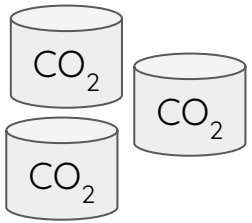
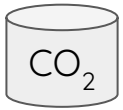


Heating





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Carolin Liefke, HdA

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annual tCO_{2eq} per MPIA researcher

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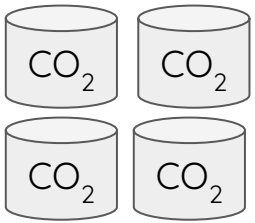

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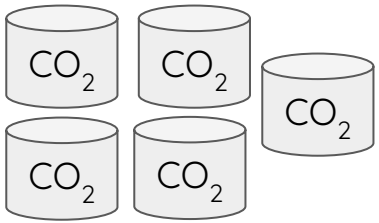

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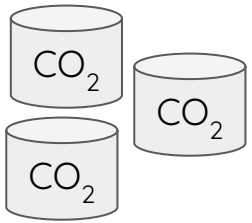

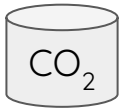

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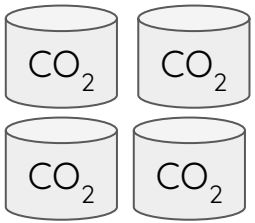

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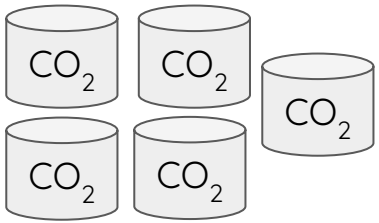

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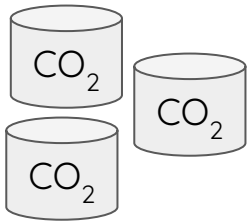

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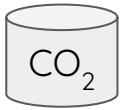

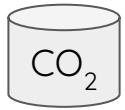

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annual tCO_{2eq} per MPIA researcher

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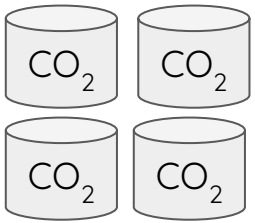

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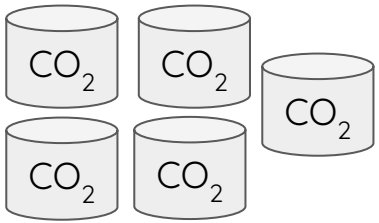

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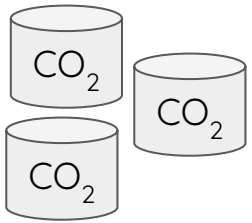

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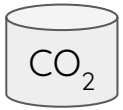

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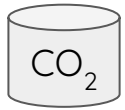
Infrastructure



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annual tCO_{2eq} per MPIA researcher

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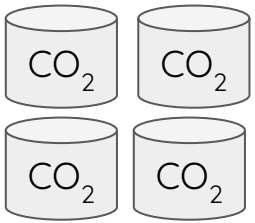

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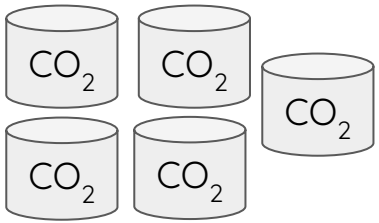

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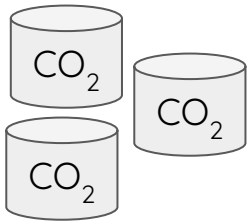

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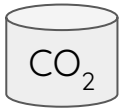

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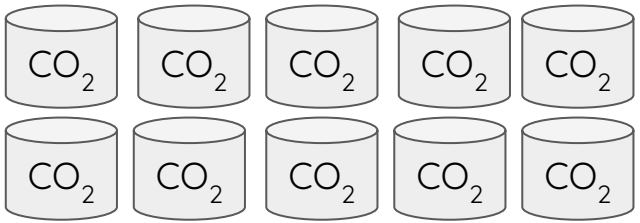
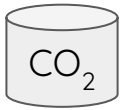
Infrastructure

German yearly average





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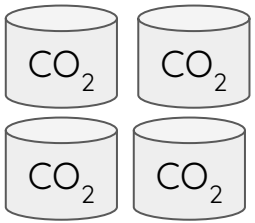

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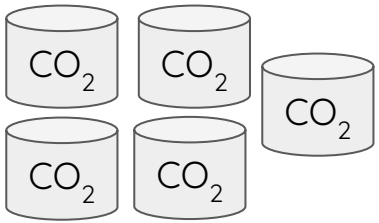

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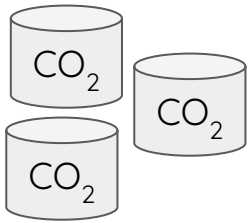

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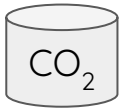

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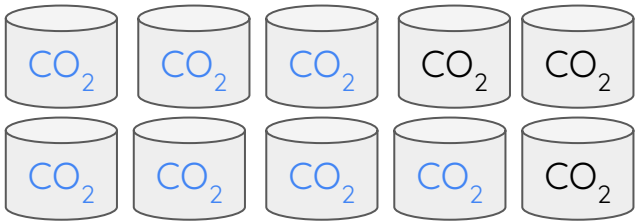
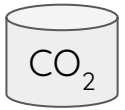


German Pledge 2030



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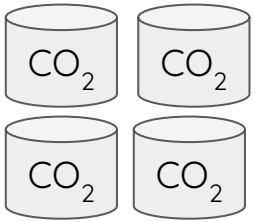

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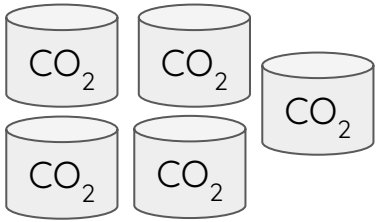

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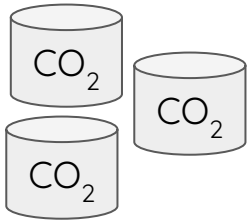

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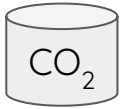

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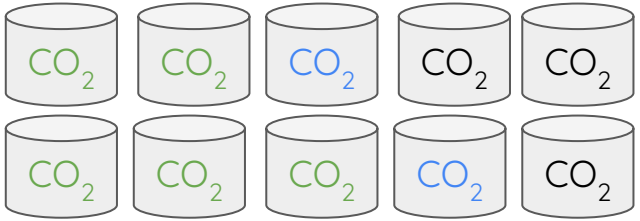
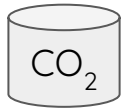
Infrastructure

German yearly average



German Pledge 2030 (old)



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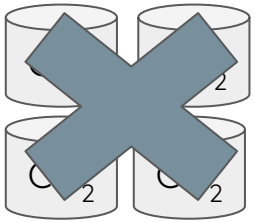

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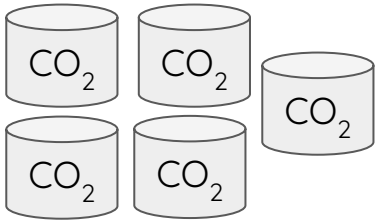

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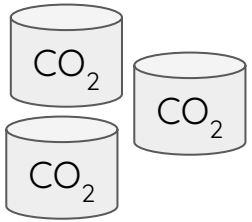

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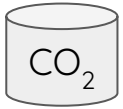

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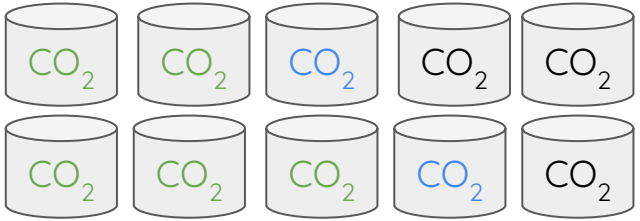
Infrastructure

during **COVID** times

German yearly average



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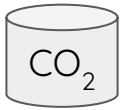

= 1 tCO_{2eq}

Question to the audience I

- What is the yearly average CO_{2eq} emission in your country?
- Bonus: How does the above number change if you include imported /exported goods' CO_{2eq} emissions

!! quick disclaimer !!

I am *not against* computing,
we just need to plan ahead
to be able to
adequately compute in the future 😊

Germany + electricity consumption

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Question 1: how much electricity does Germany consume?

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→ 488 TWh (2019)

→ 5.9 MWh per person per year

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Question 2: how much CO_{2eq} does this emit?

Germany + electricity consumption

Question 1: how much electricity does Germany consume?

→ 488 TWh (2019)

→ 5.9 MWh per person per year

Question 2: how much CO_{2eq} does this emit?

→ ?? kg CO_{2eq} / MWh

Germany + electricity consumption

Question 1: how much electricity does Germany consume?

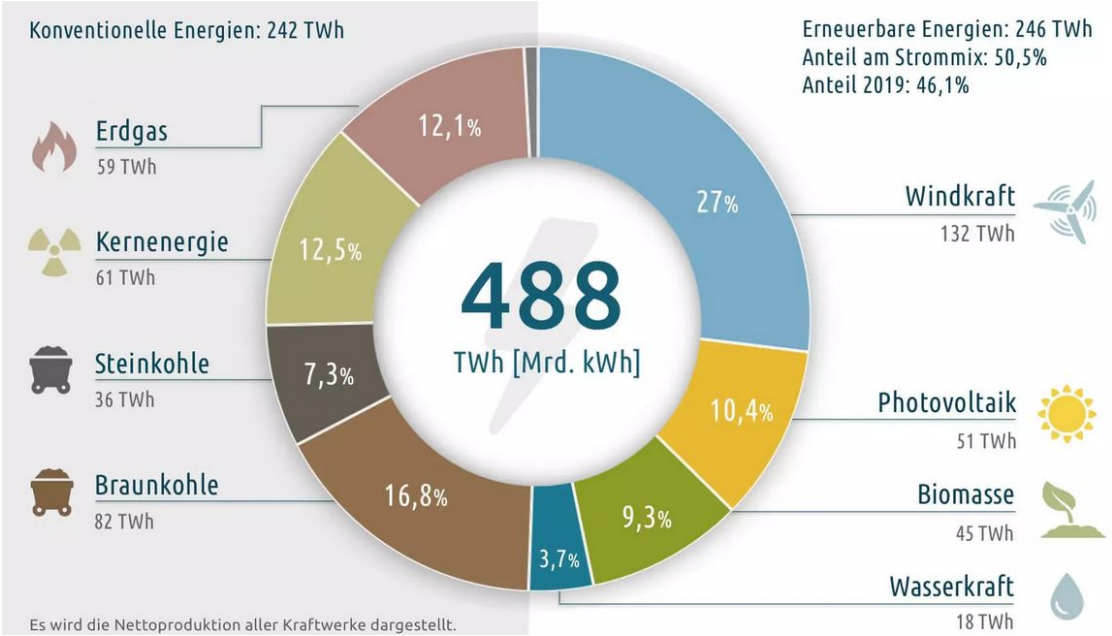
→ 488 TWh (2019)

→ 5.9 MWh per person per year

Question 2: how much CO_{2eq} does this emit?

→ ?? kg CO_{2eq} / MWh

a look into Germany's **electricity mix...**



*each country has a different mix of electricity sources

CO_{2eq}-Emissions German electricity mix [kg / MWh]										Quelle: EUPD Research 2021		
	Jan	Feb	Mrz	Apr	Mai	Jun	Jul	Aug	Sep	Okt	Nov	Dez
00:00	349	227	297	294	314	362	408	413	450	368	433	396
01:00	346	222	293	287	305	348	399	401	443	362	429	390
02:00	342	217	293	284	301	341	390	393	438	352	425	387
03:00	341	216	290	284	302	340	385	393	437	359	426	385
04:00	343	220	297	290	306	344	386	399	442	368	430	388
05:00	355	232	310	301	319	357	393	414	455	389	441	400
06:00	367	247	322	304	318	360	389	421	464	407	451	414
07:00	373	253	311	288	295	342	360	403	449	407	450	418
08:00	374	253	290	263	268	318	327	373	419	400	440	419
09:00	367	247	273	235	242	294	296	346	393	386	430	416
10:00	359	239	253	203	216	274	273	322	366	372	420	410
11:00	354	232	240	183	200	259	257	302	341	361	412	407
12:00	350	229	235	172	192	250	247	291	324	351	412	409
13:00	353	228	238	167	189	245	242	288	315	349	424	419
14:00	364	233	246	168	189	245	242	292	320	356	444	431
15:00	380	244	263	176	197	251	250	306	340	374	469	437
16:00	389	258	292	198	210	265	269	328	377	398	476	429
17:00	379	264	323	239	240	288	300	360	420	413	460	417
18:00	373	260	335	279	276	320	333	390	454	411	454	418
19:00	372	259	333	301	305	352	364	414	462	404	456	421
20:00	368	254	330	306	324	376	393	427	462	400	460	422
21:00	363	246	326	307	332	388	409	431	468	394	456	418
22:00	359	243	323	305	333	386	413	432	468	386	454	416
23:00	351	235	316	296	326	383	417	432	457	373	448	409

Germany + electricity consumption

Question 1: how much electricity does Germany consume?

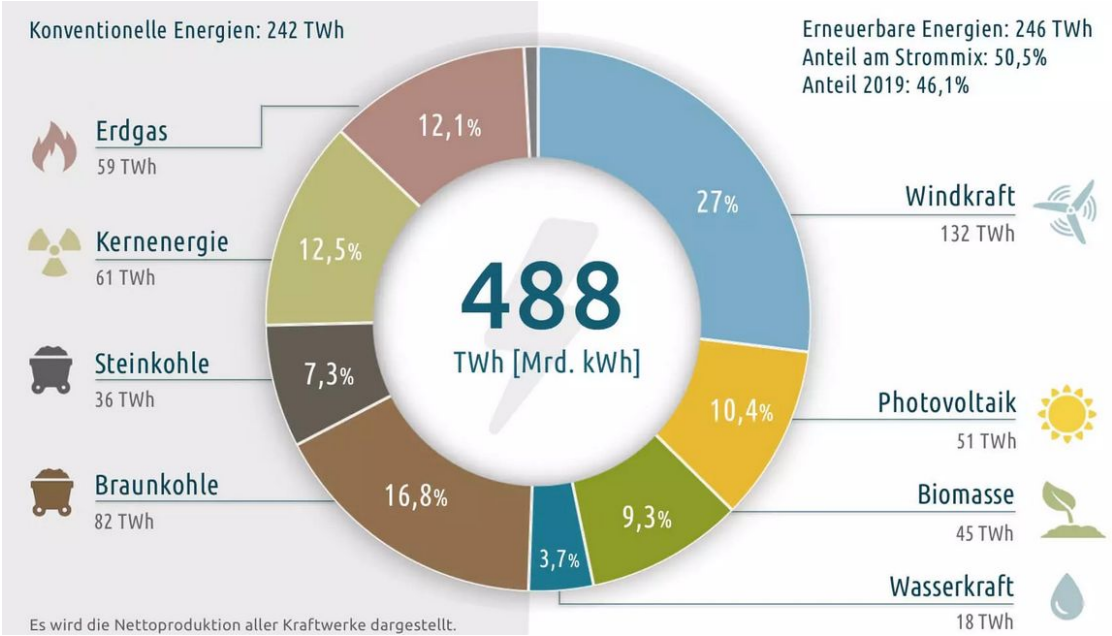
→ 488 TWh (2019)

→ 5.9 MWh per person per year

Question 2: how much CO_{2eq} does this emit?

→ 400kg CO_{2eq} / MWh

a look into Germany's **electricity mix...**



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→ **2.4 tCO_{2eq}** per person per year

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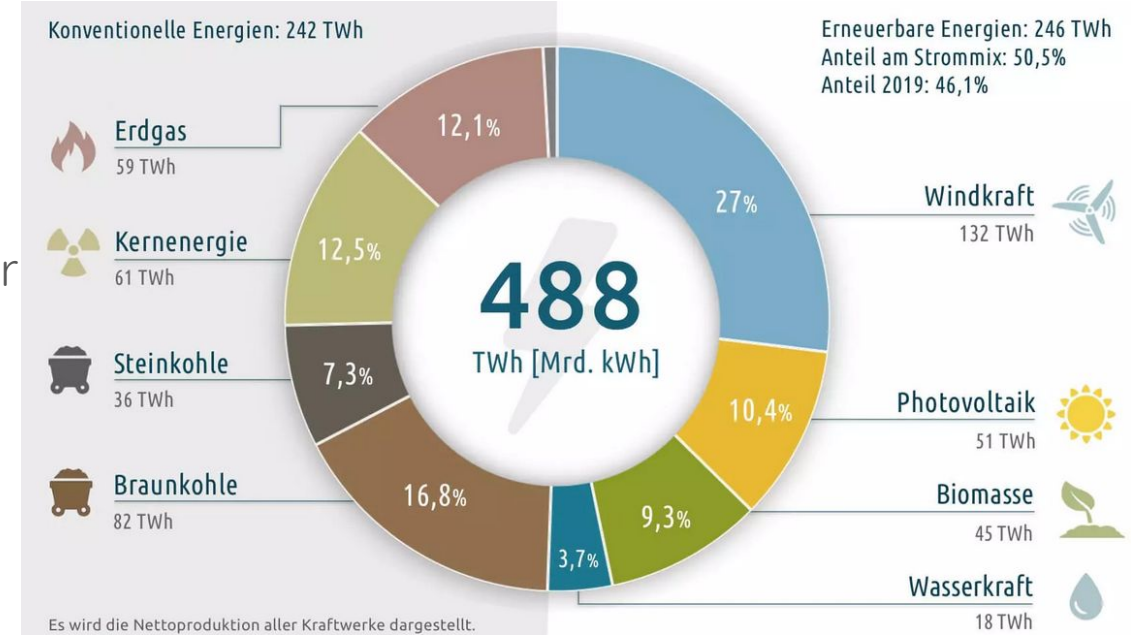

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Supercomputing put into perspective

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(1 water kettle)
all year long...

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Amount of cores is an average - some use much more, some much less

Top MPIA users of MPCDF cluster in August 2020

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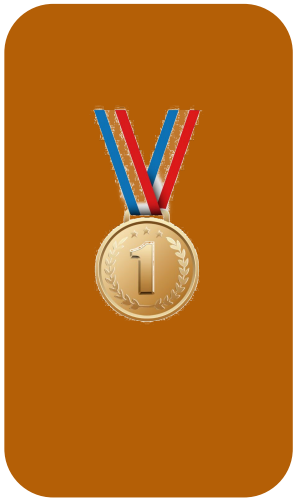
1 800 cores



20 MWh put into perspective

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20 MWh

Question to the audience II

- What is the yearly average CO_{2eq} intensity for electricity in your country?
- At which time of the day/year does your institute consumes most/least electricity?

MPIA distribution of computing power

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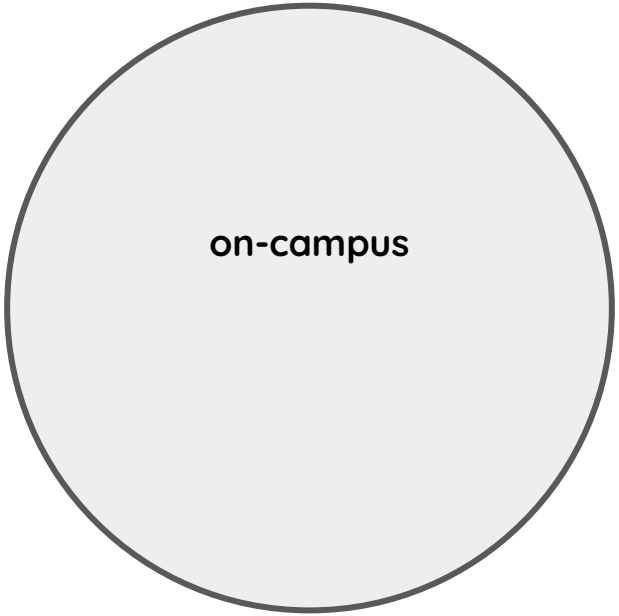

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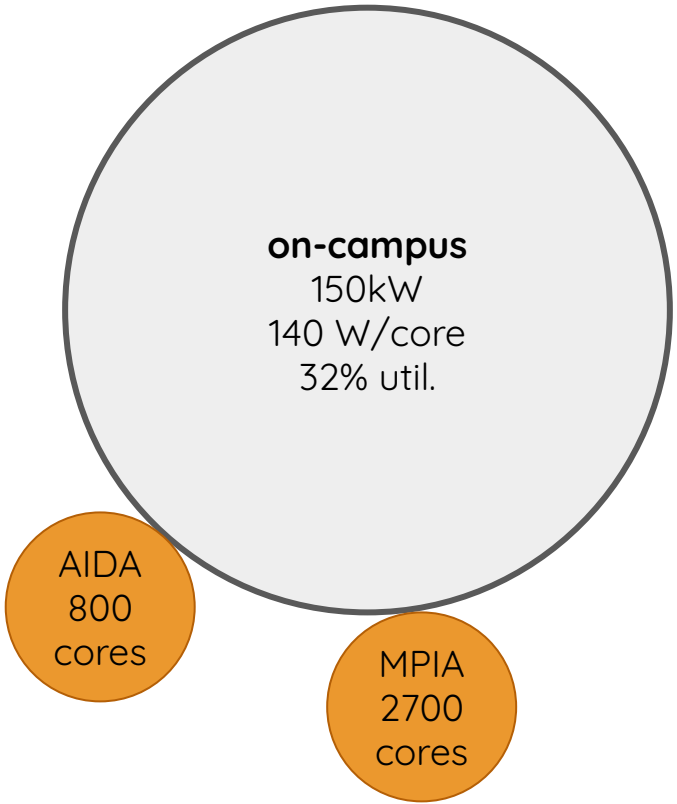

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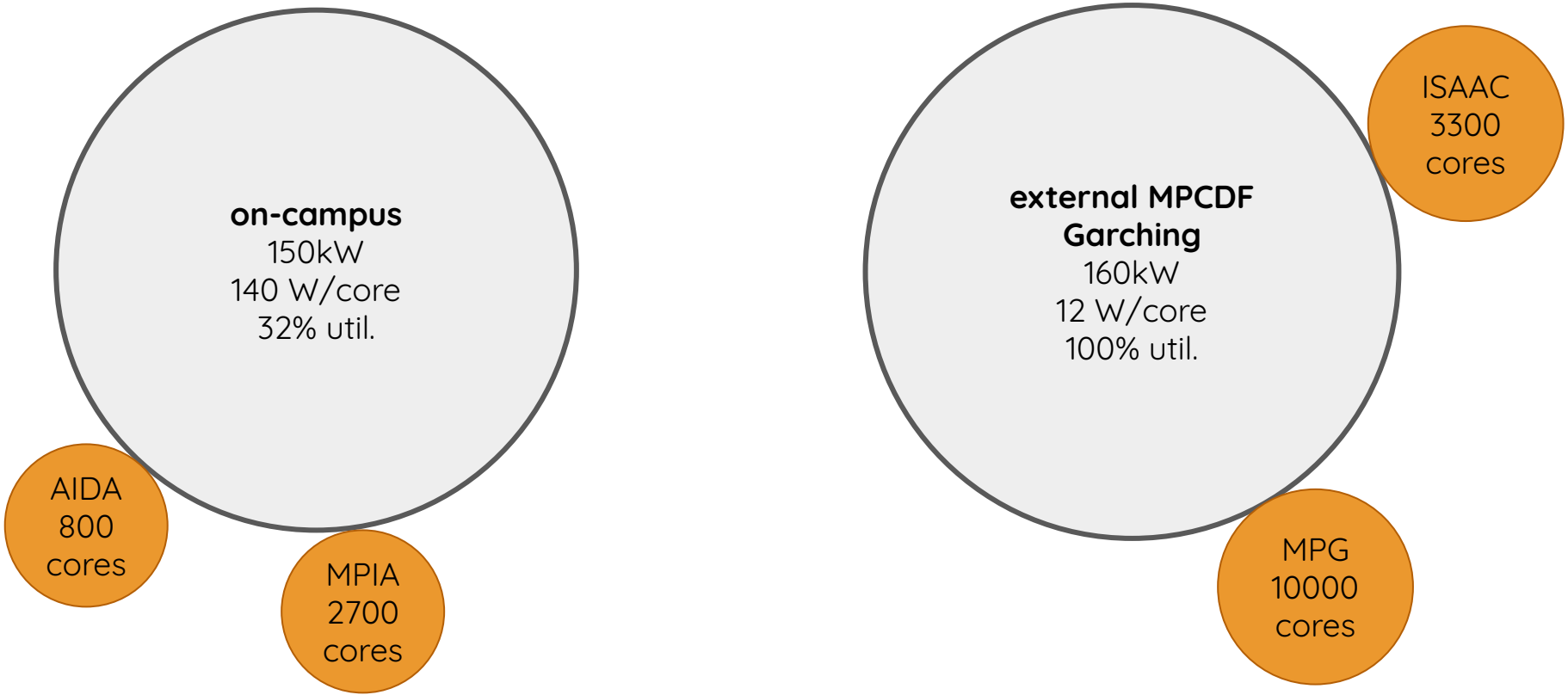

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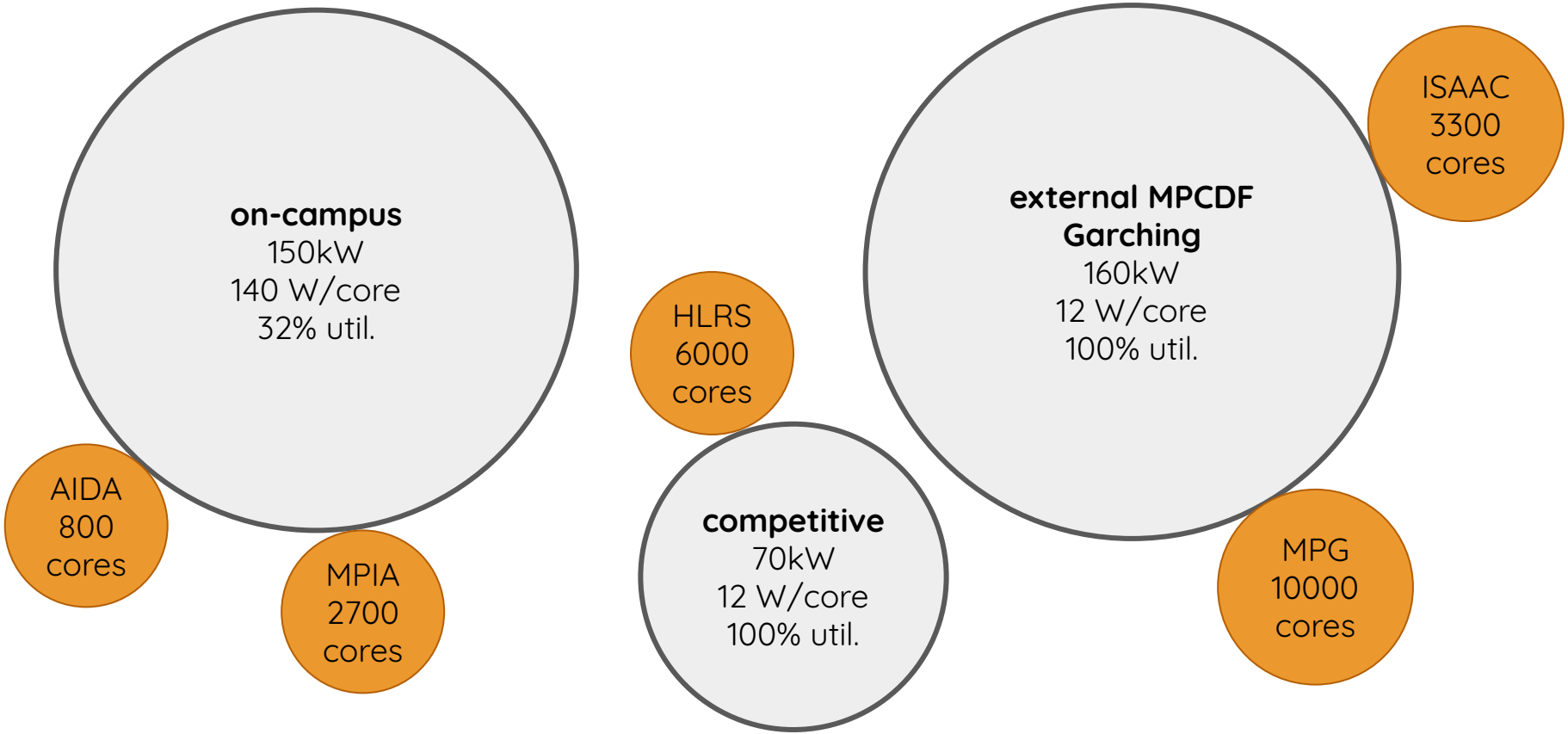


Question to the audience III

- What are the main computing resources you/your institute have/has access to?
- How much electricity is consumed there on your behalf and what are the resulting CO_{2eq} emissions?

Hardware life-cycle*

Hardware is used 5 years, after which maintenance gets really expensive

Production and shipping add 20-30% CO_{2eq} costs (at 100% utilization)

For office equipment it can be 50% or more

Check: https://ecoinfo.cnrs.fr/ecodiag-calcul/ to get life-cycle estimates

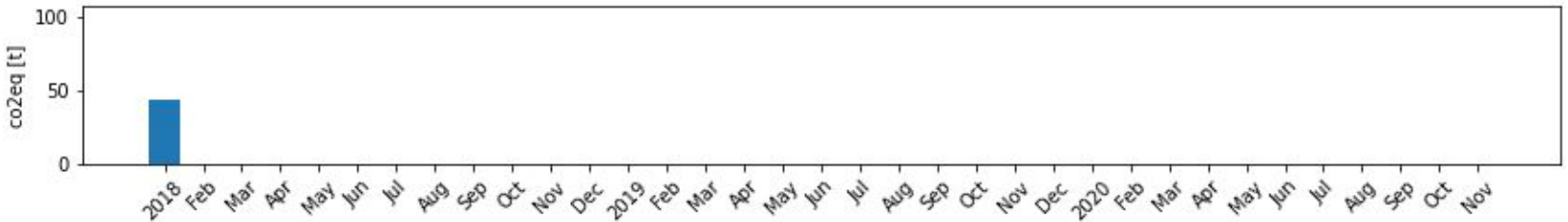
*mostly production and shipping vs. consumption

Electric supply - boundary conditions in the near future

- heating and mobility will get electrified → more demand
- nuclear and coal and gas need to be reduced → less supply
- CO_{2eq} price tag will increase → electricity will be more expensive
- share of renewables will increase → volatile supply

An assessment of MPIA's travel activities

2018-2020



How do we get our data?

From the
SAP system...

How do we get our data?

From the
SAP system...

City

Country

Duration

End date

Reason for journey

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From the
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we can get the

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which we put into

...our python
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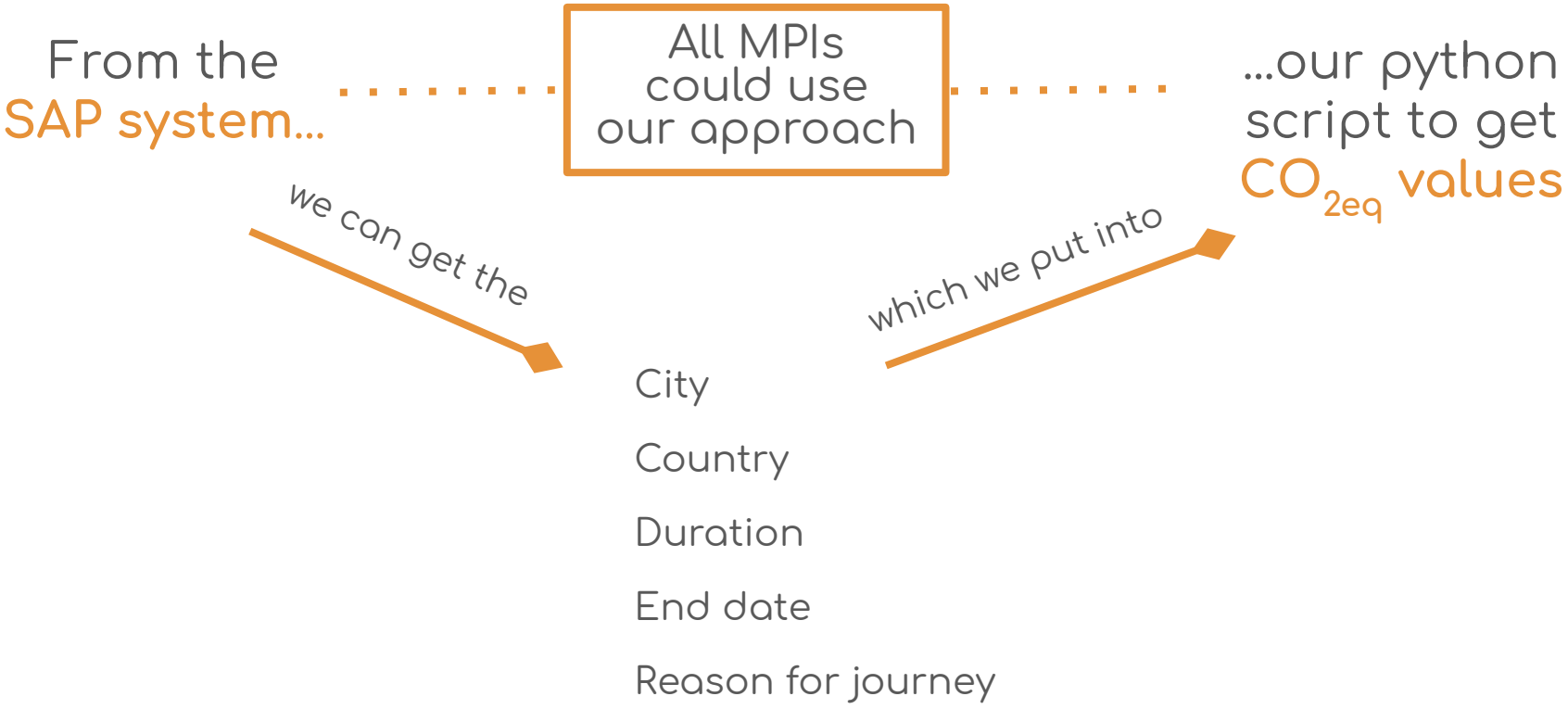

How do we get our data?

From the SAP system...

All MPIs could use our approach

...our python script to get CO_{2eq} values

we can get the

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City

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took the longest travel:
'Leiden und Boston, NL' → 'Boston, US'

misspellings:
'Noordwyjk, NL' → 'Noordwijk, NL'

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misspellings:
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classified this manually
- Collaboration
- Conference
- Commissioning
- Observation
- Other

Question to the audience IV

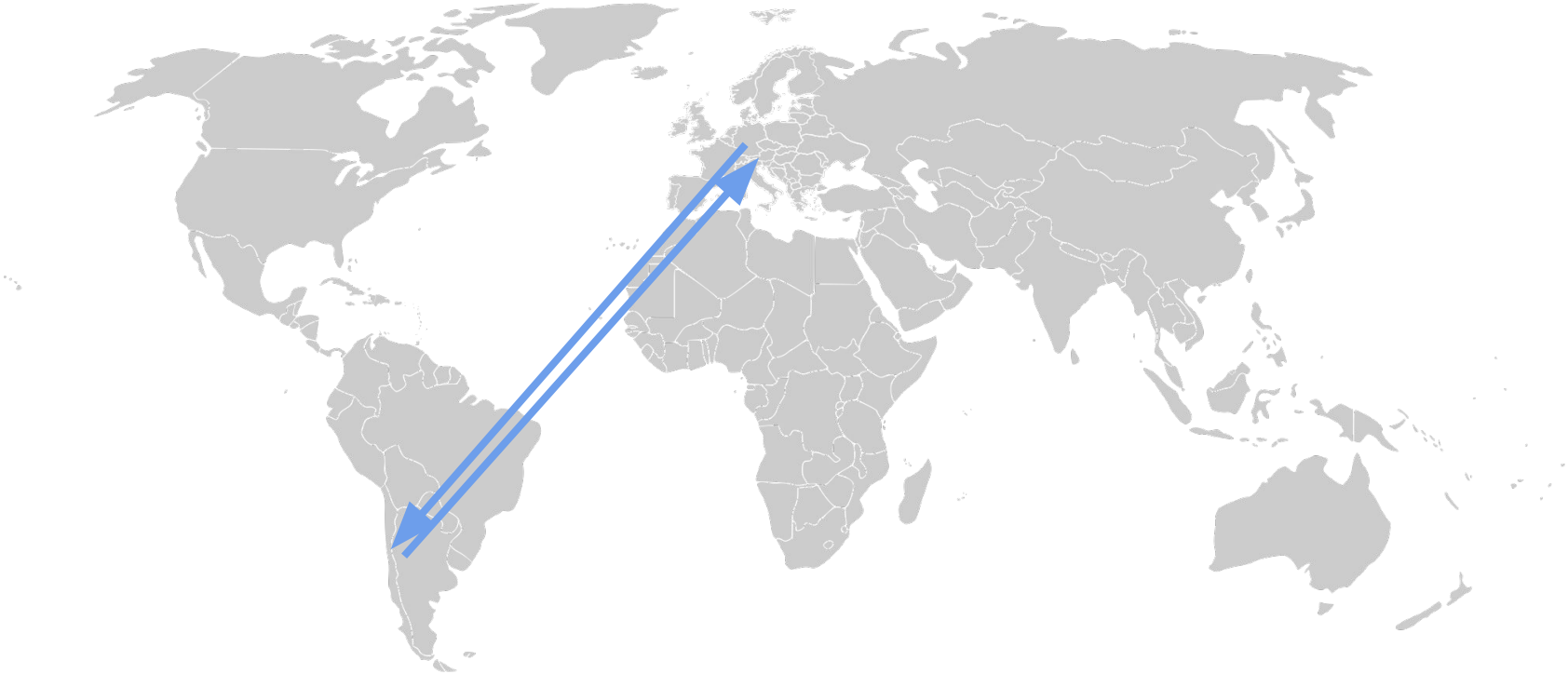
- Do you have (can get) a list of business travel destinations for your institute?
- Guess how much more CO_{2eq} a senior Researcher emits compared to a PhD-student?

Assumptions

we draw a direct line on the globe

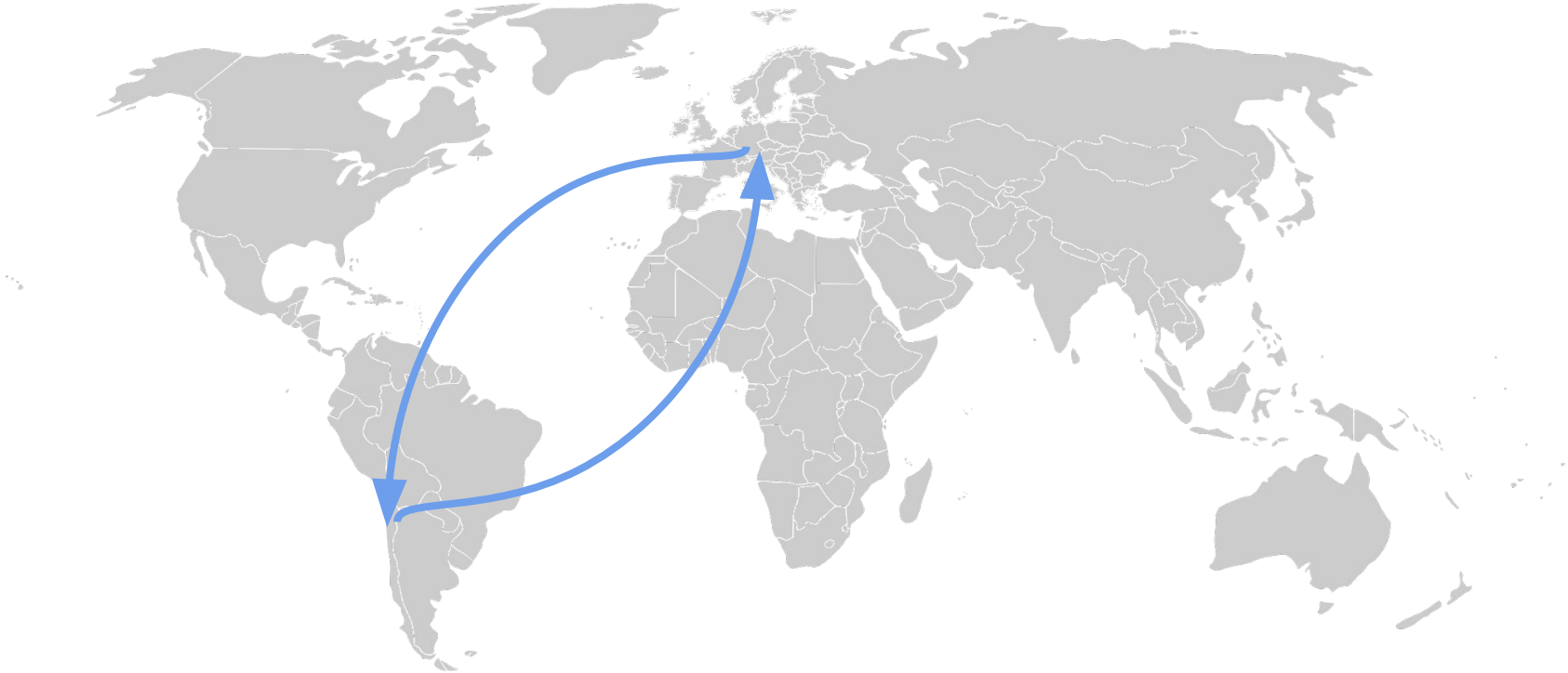
Assumptions

we draw a direct line on the globe → we assume return flight



Assumptions

we draw a direct line on the globe → we assume return flight → we add 20%



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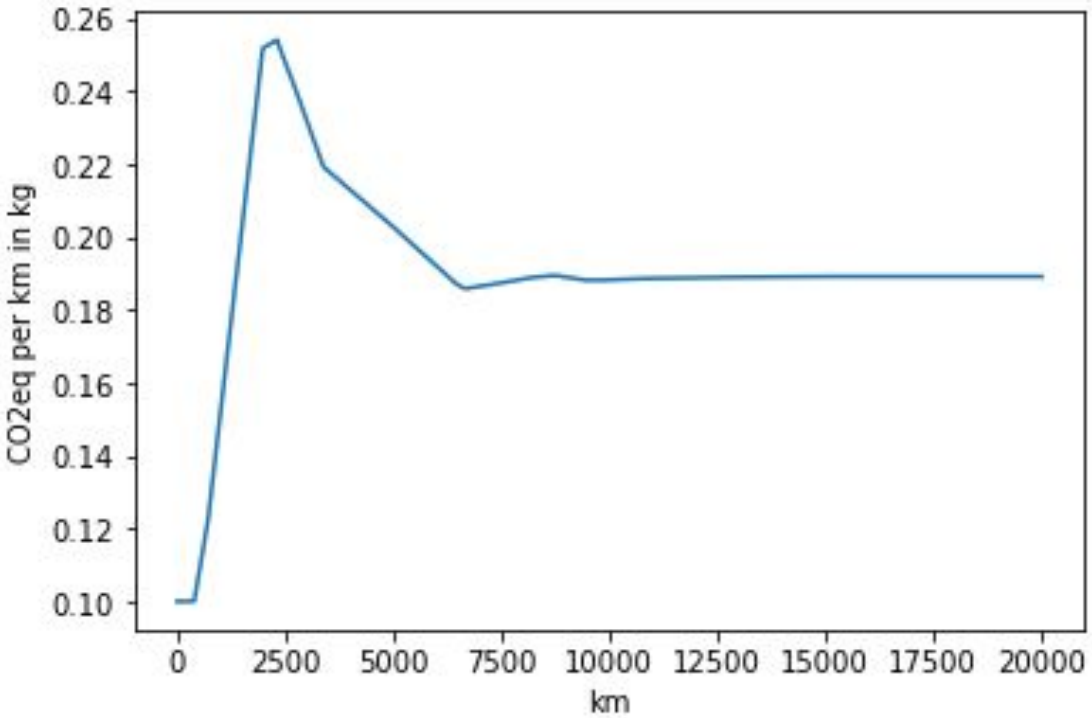


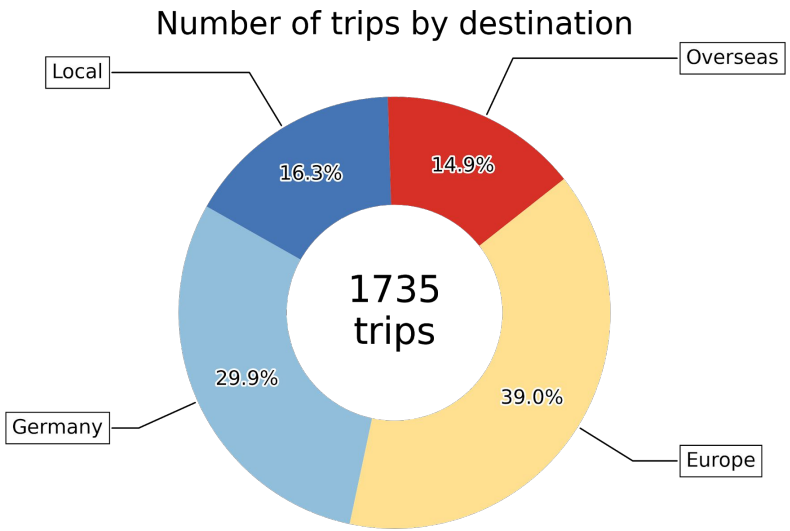
< 500 km = no flights

> 2000 km = 100% flights

We calculate the **CO_{2eq} emissions** from: travel-footprint-calculator.irap.omp.eu

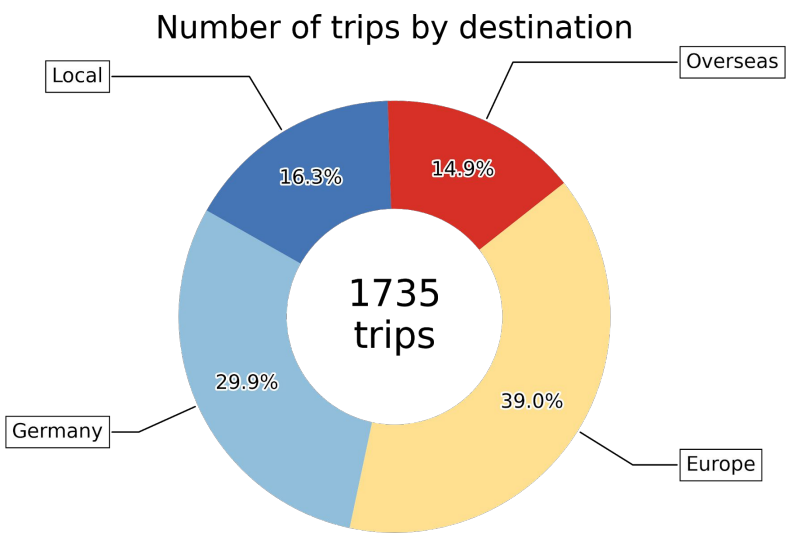
So where is MPIA flying to?

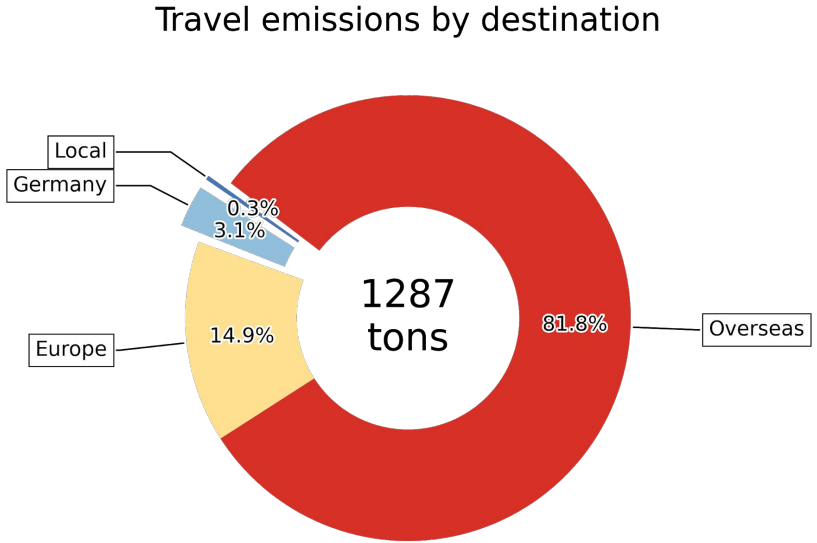
Number of flights vs. CO_{2eq} emissions by destination



Overseas make up **15%** of trips by number...

Number of flights vs. CO_{2eq} emissions by destination

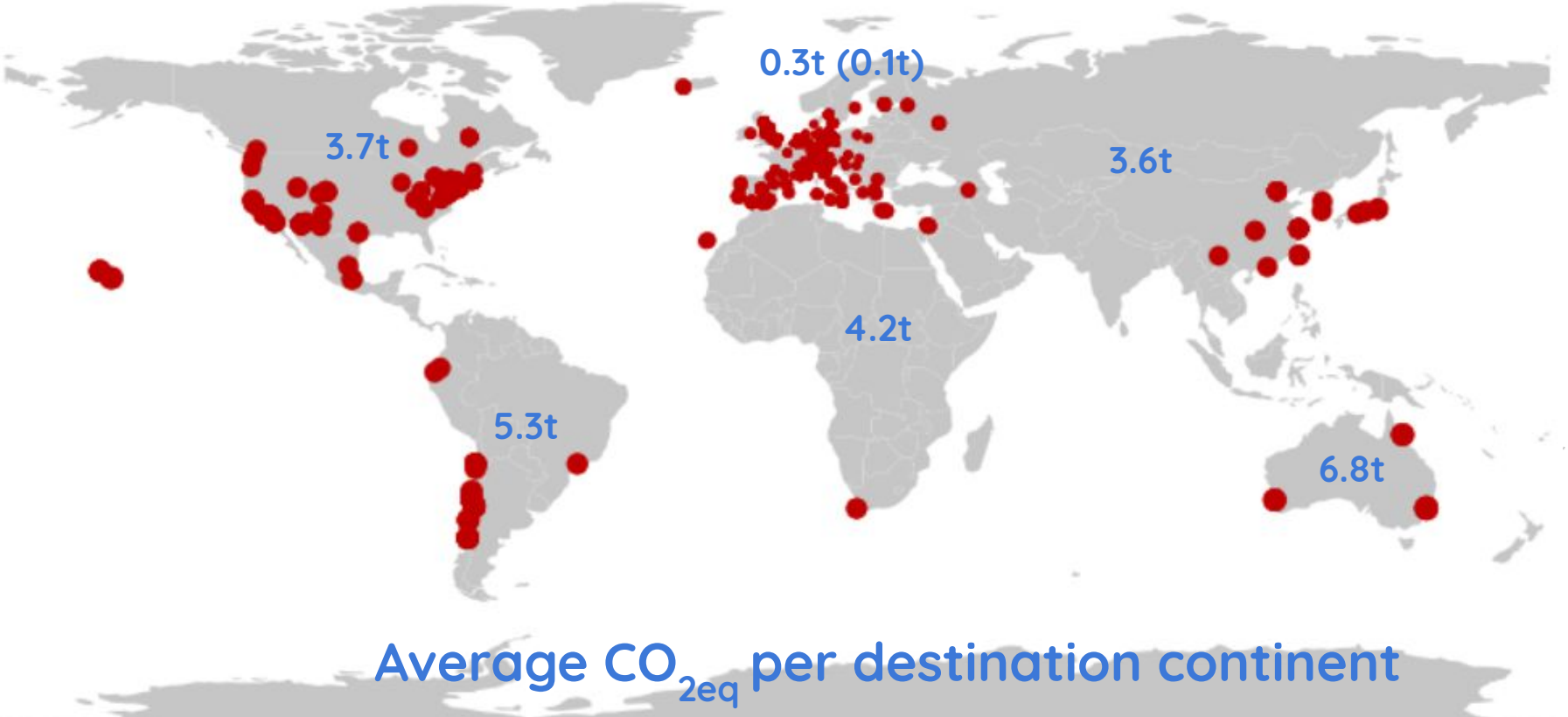




Overseas make up **15%** of trips **by number...**

...but **82%** of trips by CO_{2eq} **emissions.**

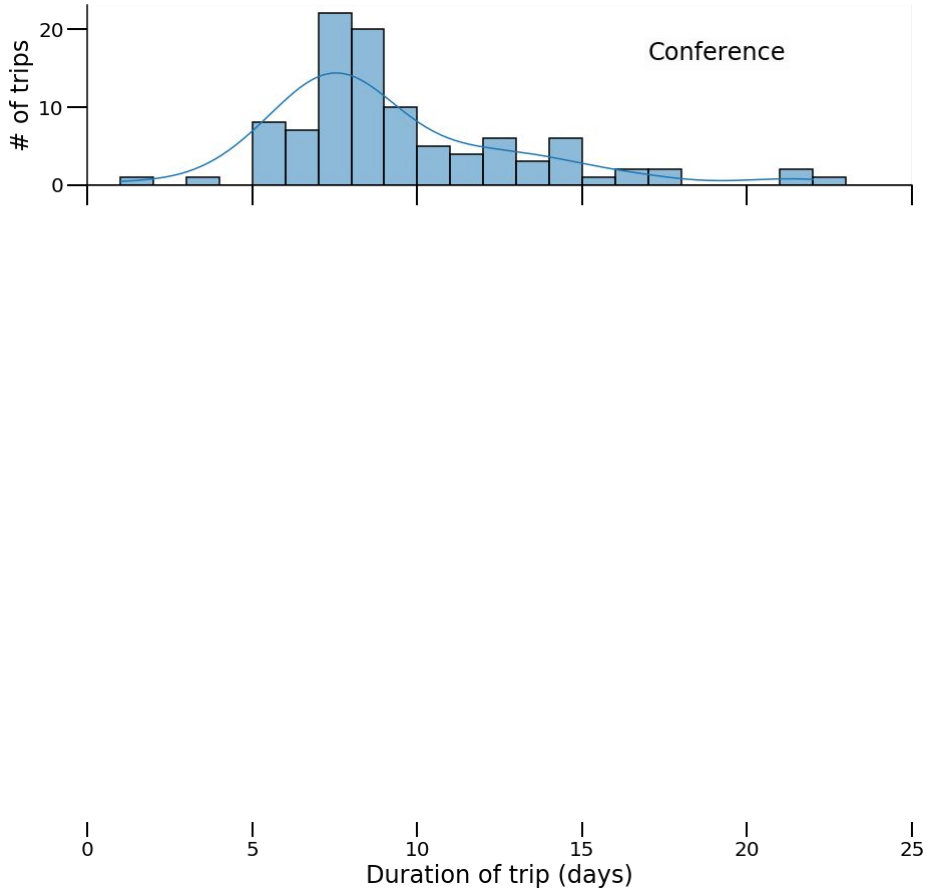
What if we want to travel to …?



Average CO_{2eq} per destination continent

Duration of travel by reason for trips overseas

101 trips



380t

3.8t/trip

Duration of travel by reason for trips overseas

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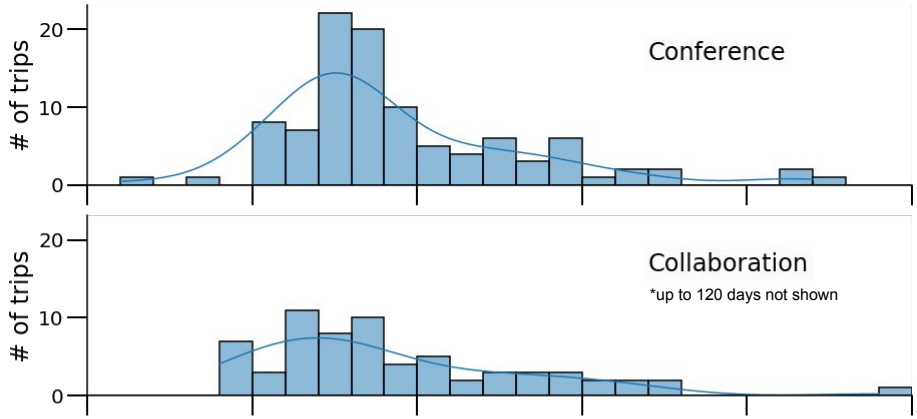

79 trips

307t
3.9t/trip

Duration of travel by reason for trips overseas

101 trips

380t
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79 trips

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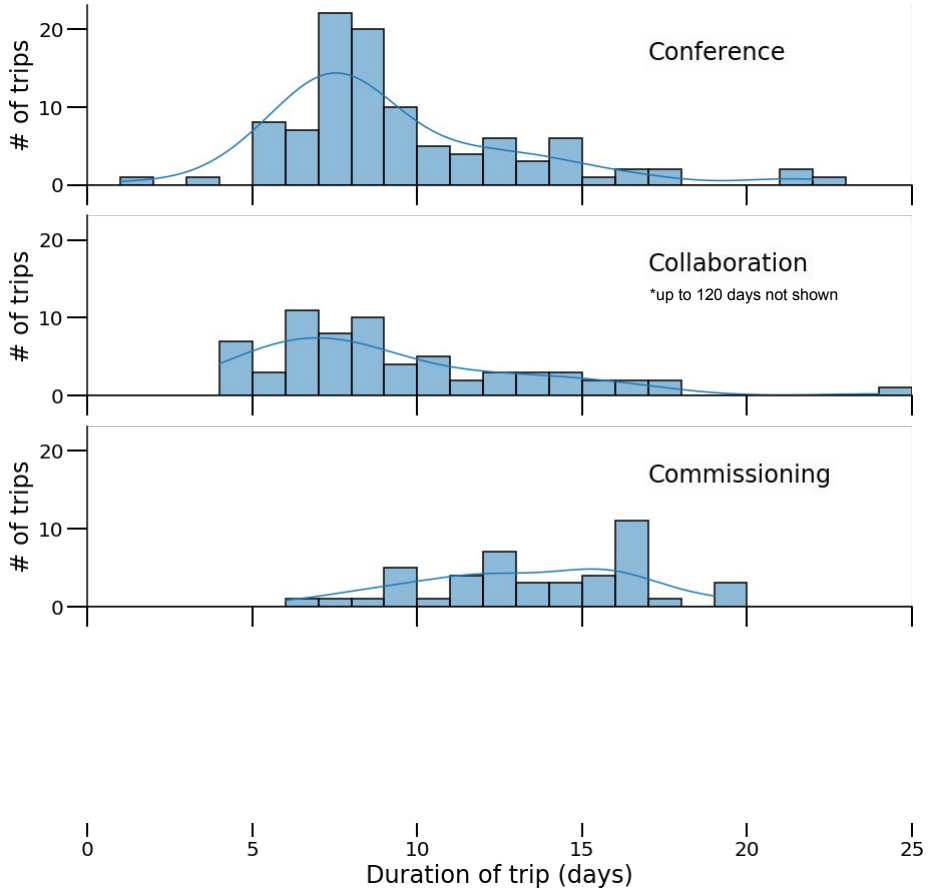
3.9t/trip

45 trips

196t
4.3t/trip



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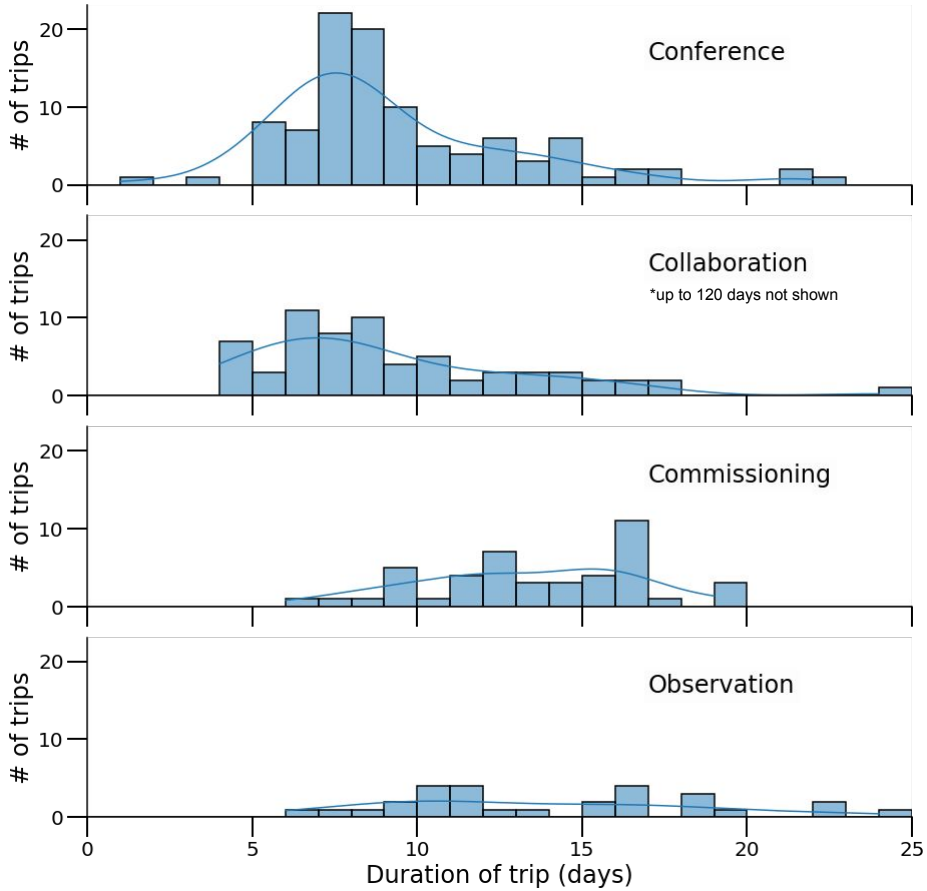

380t
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307t
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196t
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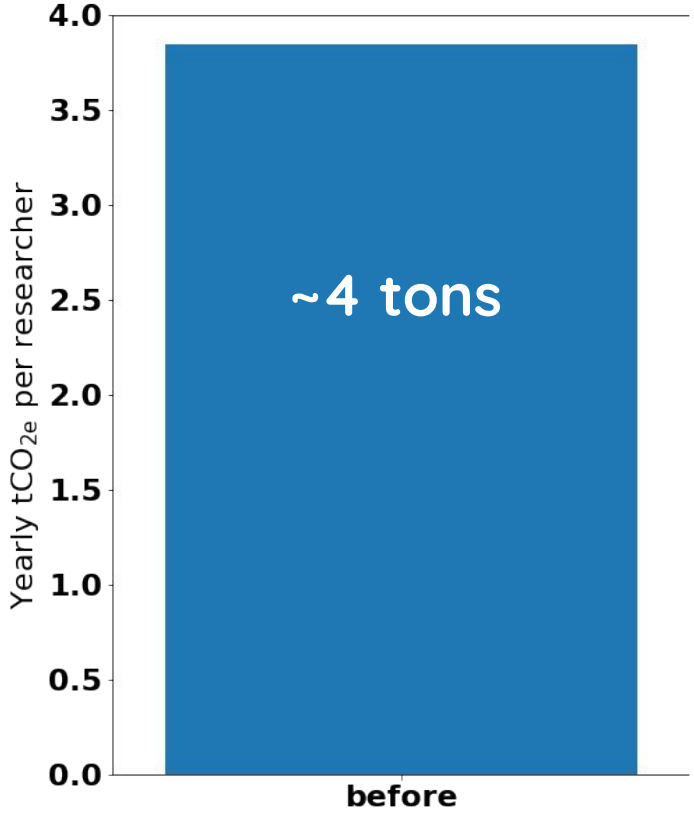
150t
5.2t/trip

Per year and researcher we have ~0.75 overseas flights (outside of the pandemic)

How did the pandemic affect us



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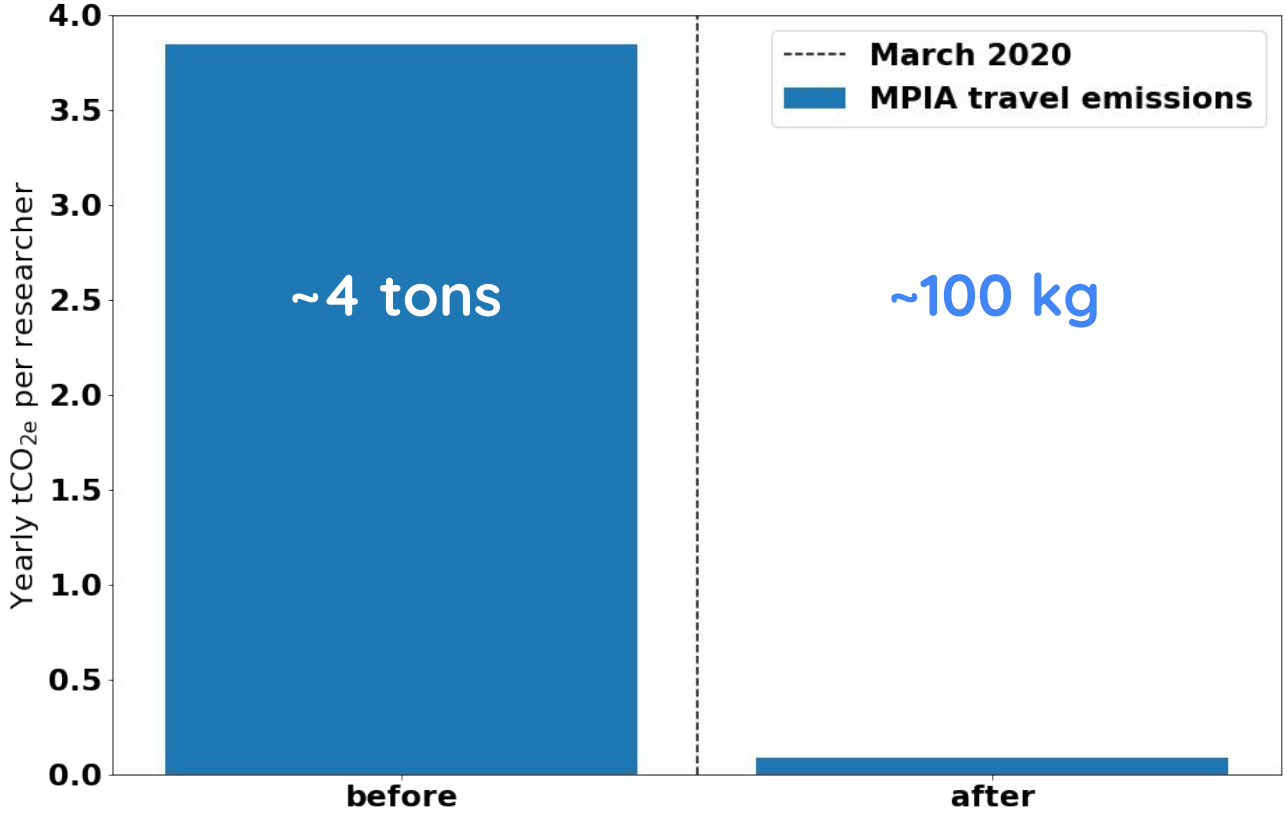

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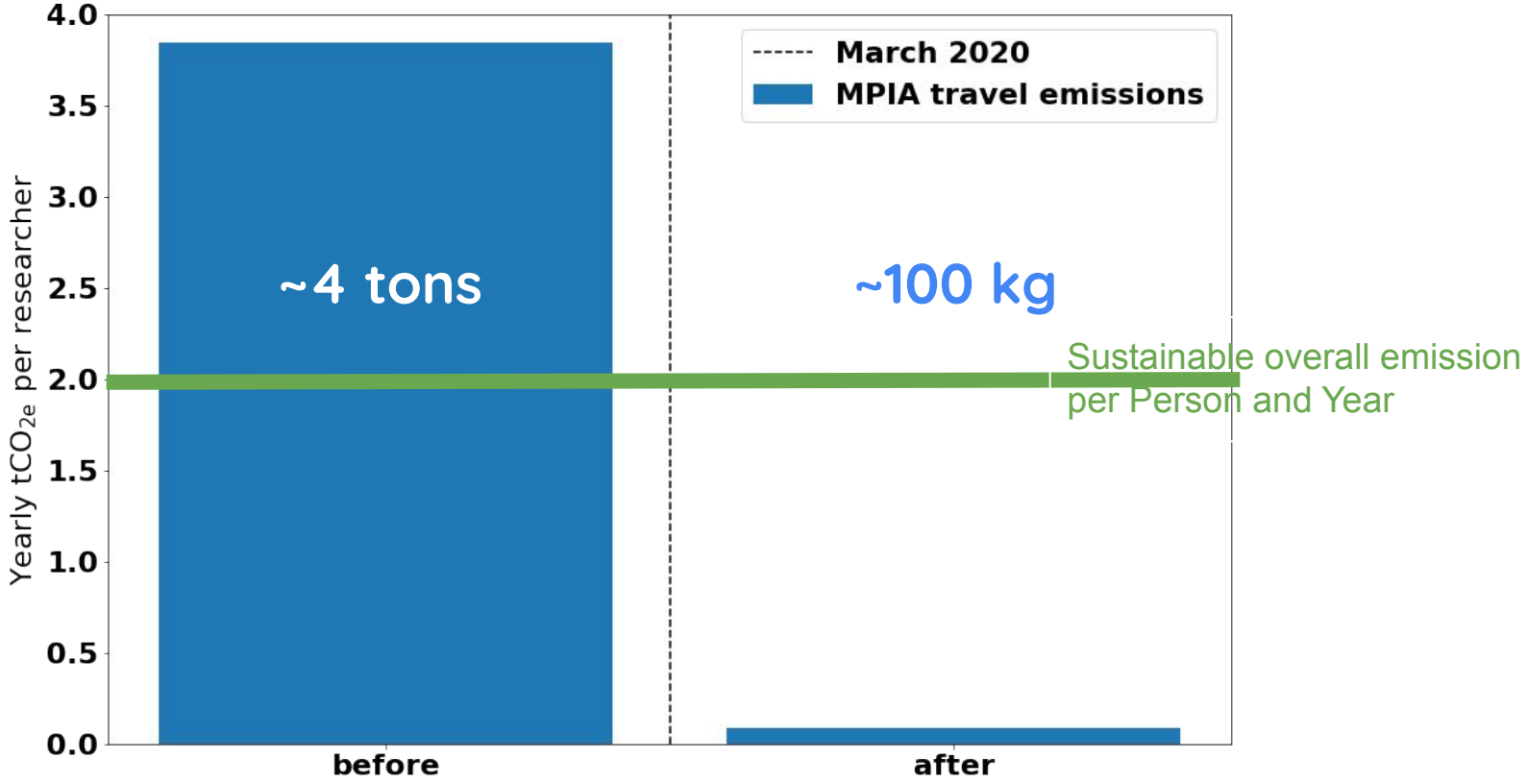

The way forward

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Assessing the CO_{2eq} emissions:

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Having an **aim**:

- reduction plans per category of emissions
- orientation with general policy (e.g. 1/2 by 2030, 0 by 2040)

The way forward

Let **actions** follow:

The way forward

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- implement specific CO_{2eq} emission reduction plans at your institute

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Monitoring and Re-evaluation:

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Monitoring and Re-evaluation:

- monitor emission trends on a yearly basis per category

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- implement specific CO_{2eq} emission reduction plans at your institute
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  - computing policy
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Monitoring and Re-evaluation:

- monitor emission trends on a yearly basis per category
- evaluate your policy and adopt/change following reality check

The way forward

General ideas **flying**

The way forward

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- don’t fly (use train or virtual participation)

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- don’t fly very far (look for conferences on your continent)
- when flying far make the most out of your stay
- allow for remote participation when organizing a conference

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General ideas **computing**

The way forward

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- reduce CO_{2eq}-intensity of the electricity (put solar panels on our roofs)

The way forward

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- use computing waste heat
- adapt codes to GPU usage
- teach efficient programming

Thank you for your attention!

Resources

Institute-wide infrastructure

https://labos1point5.org/

Travel emissions

https://travel-footprint-calculator.irap.omp.eu/

https://github.com/jan-rybizki/Business_trips_carbon_footprint

https://www.atmosfair.de/en/offset/flight/