CO₂ footprint of EPFL business air travel: analysis and reduction opportunities

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• Travel habits at EPFL
• Direct vs. indirect air travel
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Air business travel produces 1/3 of EPFL’s CO₂ emissions

Business travel is responsible for 36 % of EPFL’s total CO₂ emissions

87 % of business travel is done by plane

CO₂ level needed to halt climate change
- 2 tons CO₂ / person/ year

Average EU citizen
- 9.1 tons CO₂ / person/ year

Return flight Geneva- New York (direct, economy)
- 2.3 tons CO₂ / person/ year

*FTE: full-time equivalent
Impact of air travel on climate change: It’s not only CO₂

**CO₂ emissions**

- Kerosene combustion: 3.15 kg CO₂/kg
- Kerosene production: 0.5064 kg CO₂/kg \[\text{[1]}\]
- Taxying, take-off and landing: 30-40 kg CO₂/passenger
- Airplane fabrication: ~5 g CO₂/passenger/km

**Other effects**

- NOₓ è Tropospheric O₃
- Condensation trails (contrails)
- Cirrus clouds

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Business Travel at EPFL: a necessity for research, with overlooked environmental costs

**EPFL researchers experience almost no financial barriers to travel**

Relatively low travel costs in Switzerland lead to nourishment of international collaborations, as well as other types of business travel (e.g. conferences, workshops, etc).

**Green Innovation cannot keep up with the researchers’ need to travel**

The Confederation: exemplary in energy: Decrease carbon footprint of the business air travel to less than 20% by 2020

**Aims: addressing this environmental cost of business travel in the EPFL community**

1. Studying travel habits and quantifying carbon footprint of EPFL research community
2. Estimation of potential carbon footprint reduction levels and proposal of the concrete steps towards carbon footprint mitigation
The larger faculties emit the most, but ENT has the largest footprint per capita

Our data: all EPFL air travel with Carlson Wagonlit Travel (CWT) between 2014-2017 is 80% of total air travels (20% booked by credit card)

- External people contribute significantly
- Larger faculties emit the most CO₂

ENT has the largest footprint per capita, but less than half the staff is academic

*Normalized per academic full-time equivalent (FTE)
Professors have the biggest CO₂ impact

The professors have the biggest footprint

They are main users of business and first class

Footprint increases with seniority

1 Professor = 10 PhDs = 5 Postdocs
The inequality in EPFL air travel is larger than for worldwide income

The 10% biggest travelers emit 60% of all CO₂

The Gini coefficient for CO₂ emission is 72% showing large inequality

\[ G = \frac{A}{A + B} \]

Worldwide income distribution:
\[ G = 0.65 \text{ (2013)} \] [1]

\[ S_{10\%} = \text{Share of the 10% largest consumers} \]

There is a large inequality between unit’s travel habits

**The 10 % most traveling units emit 40% of all CO₂**

<table>
<thead>
<tr>
<th>Biggest consumer</th>
<th>Smallest consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Money spent</td>
<td>Distance travelled</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total travel footprint per unit in 2014-2017 (CHF/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10^6</td>
</tr>
<tr>
<td>10^5</td>
</tr>
<tr>
<td>10^4</td>
</tr>
<tr>
<td>10^3</td>
</tr>
<tr>
<td>10^2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cumulative footprint per lab (2014-2017) (% of total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
</tr>
<tr>
<td>80</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S_{10%} =</th>
<th>42.3 %</th>
<th>40.2 %</th>
<th>39.0 %</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>G =</th>
<th>0.622</th>
<th>0.607</th>
<th>0.588</th>
</tr>
</thead>
</table>

**No clear relation between lab size and CO₂ emission**

- **Big units:** 886 kg CO₂ per unit average
- **Small units:** 1167 kg CO₂ per unit average

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How much can we save?

- **Indirect trips**: Replace by direct
- **Business and first class trips**: Replace by economy
- **Short distance trips**: Replace by train
Business and first class flights emit 2 to 3 times more CO₂ per km than economy class.

Average emission:
- In economy class: 0.123 kg CO₂/km
- In business and first class: 0.278 kg CO₂/km
CO₂ emissions and costs can be reduced respectively by 17 % and 22 % if all business and first class flights are replaced with economy

Substituting all business and first class flights with economy

**Reduction of 800 ton CO₂/year (17 %)**

- Actual travels in 2014-2017: 10,24 ktons
- Replaced by economy class: 10,24 ktons

**Reduction of CHF 850,000/year (22 %)**

- Replaced by economy class: CHF 7,79 M

Business and first class flights’ emissions within Europe are negligible.
CO₂ emission could be reduced by approx. 15 % (upper bound) replacing all short-distance flights with train

15 % of CO₂ emissions on continental trips, 78 % on intercontinental

15 % of total emissions are coming from short trips and flights < 800 km

Replacing all flights up to approx. 600 km (5h train ride) è -9 % CO₂

Indirect trip = multiple flights
Direct trip = one flight
Return journey = two trips

- GVA-ZRH: 504 flights/year (1.2% of CO₂)
- GVA-CDG: 333 flights/year (0.85% of CO₂)
- GVA-FRA: 420 flights/year (1.1% of CO₂)
CO₂ emissions could be reduced by 8.6 % if we would replace all indirect trips by direct.

Indirect trips cover many redundant kilometers

...and emit a lot of redundant CO₂

**Travelled distance** Distance (shortest between departure and destination)
How much can we save? The answers!

<table>
<thead>
<tr>
<th></th>
<th>Full potential</th>
<th>Half of the potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Avoided flights</td>
<td>???</td>
<td>???</td>
</tr>
<tr>
<td>• Indirect è Direct</td>
<td>-8.6 %</td>
<td>-4.3 %</td>
</tr>
<tr>
<td>• Short trips è Train</td>
<td>-15 %</td>
<td>-7.5 %</td>
</tr>
<tr>
<td>• Business and first class</td>
<td>-17 %</td>
<td>-8.5 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>-19 %</td>
<td></td>
</tr>
<tr>
<td>• The 10 % largest emitters</td>
<td>-29.1 %</td>
<td>-14.6 %</td>
</tr>
<tr>
<td>reduce their travel by half</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>-30.8 %</td>
<td></td>
</tr>
</tbody>
</table>

For a climate-neutral EPFL

ë Compensation of remaining emissions
Ticket price correlates mainly with CO₂ emissions and service class, less with the distance travelled

- Ticket price correlates more with service class than with distance
- Average prices:
  - In economy class: CHF 0.094/km
  - In business and first class: CHF 0.257/km
- Ticket price is proportional to CO₂ emission

Reducing costs = reducing CO₂

1.22 kg of CO₂ for every CHF spent on air travel
The price of CO₂: Companies like Myclimate allow to compensate CO₂ emission

Projects in developing countries

Projects in Switzerland

Monte Rosa Hut

CHF 30 per ton CO₂
è Air travel prices +7 %*

At least 50 % to projects in Switzerland:
CHF 100 per ton CO₂
è Air travel prices +24 %*

Production (including M):
820/M CHF/ton CO₂

*Including multiplication factor of 2
What should we make EPFL travellers aware of?

<table>
<thead>
<tr>
<th>CO$_2$ reduction factor</th>
<th>Other advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Can I stay at home?</td>
<td>∞</td>
</tr>
<tr>
<td>Video conference?</td>
<td>No time wasted traveling</td>
</tr>
<tr>
<td>is the event really interesting?</td>
<td>No money on tickets</td>
</tr>
<tr>
<td>• Can I take the train?</td>
<td>10 (including M)</td>
</tr>
<tr>
<td></td>
<td>More comfortable</td>
</tr>
<tr>
<td></td>
<td>More useful time (reading, working)</td>
</tr>
<tr>
<td></td>
<td>Less cosmic radiation</td>
</tr>
<tr>
<td></td>
<td>Arrive directly in city center</td>
</tr>
<tr>
<td>• Can I take a direct flight?</td>
<td>2 - 3 - 4 depending on routing</td>
</tr>
<tr>
<td></td>
<td>Faster</td>
</tr>
<tr>
<td></td>
<td>No time lost waiting for connection</td>
</tr>
<tr>
<td></td>
<td>Less chance of lost luggage</td>
</tr>
<tr>
<td>• Can I take economy class?</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>A lot cheaper</td>
</tr>
</tbody>
</table>
Carbon footprint compensation policy

Is the final destination reachable by train*

- yes
  - Which transportation mode is chosen?
    - rail
    - air
      - ** Extra CO₂ compensation for choosing air instead of rail
      - *** Extra CO₂ compensation for choosing business over economy

- no
  - CO₂ emission calculation (CWT) including M

- Presented to the traveller before itinerary choice
- No compensation

- ** Up to 5 hours by train

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Summary:

- Analysing EPFL business travel data, we have shown that there is large large inequality and that CO₂ footprint increases with seniority of EPFL research staff.

- It is possible to reduce CO₂ footprint by 20-30%. Favouring economy class over business would cover largest portion of the reduction.

- We have proposed a CO₂ footprint compensation policy and the travellers’ mindset which should be promoted when choosing travel itinerary.