Carbon footprint of research
Summer School HIC 2022

Committee for sustainable development and social responsibility
Mathieu Bongrand, Jacopo Ghiglieri, Marlene Nahrgang

Subatech

cnrs

Nantes Université

IMT Atlantique
Bretagne-Pays de la Loire
École Mines-Télécom

Talking about climate change…

… is complicated, because:

- It is a very complex subject.
- It is a very frightening subject.
- It has become a very political, even a partisan issue.

Even among the most educated people it is a difficult subject.

Most scientist agree that global warming is real and human made, but many are not aware of the severity of the problem.

Concerning climate change communication, the advice one finds over and over again is

“Describe the severity and the urgency of the problem - without sounding too apocalyptic.”

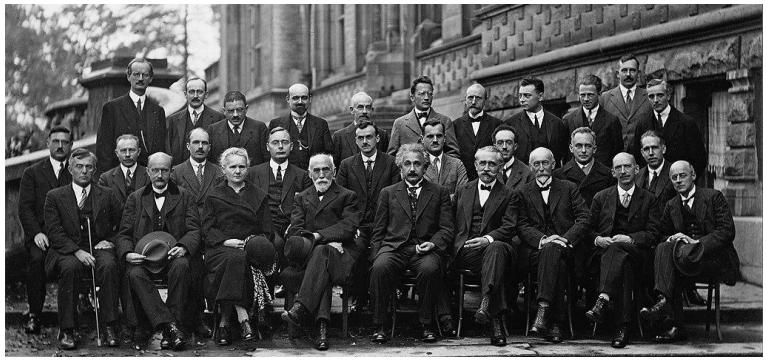
There are more urgent problems. The rich are too rich, tax them, everything will be good.

We are smart. Once the problem is there, we will invent something!

I trust in the young generation to solve the problems of their time.

Talking physics over a beer is so much more productive than zoom…

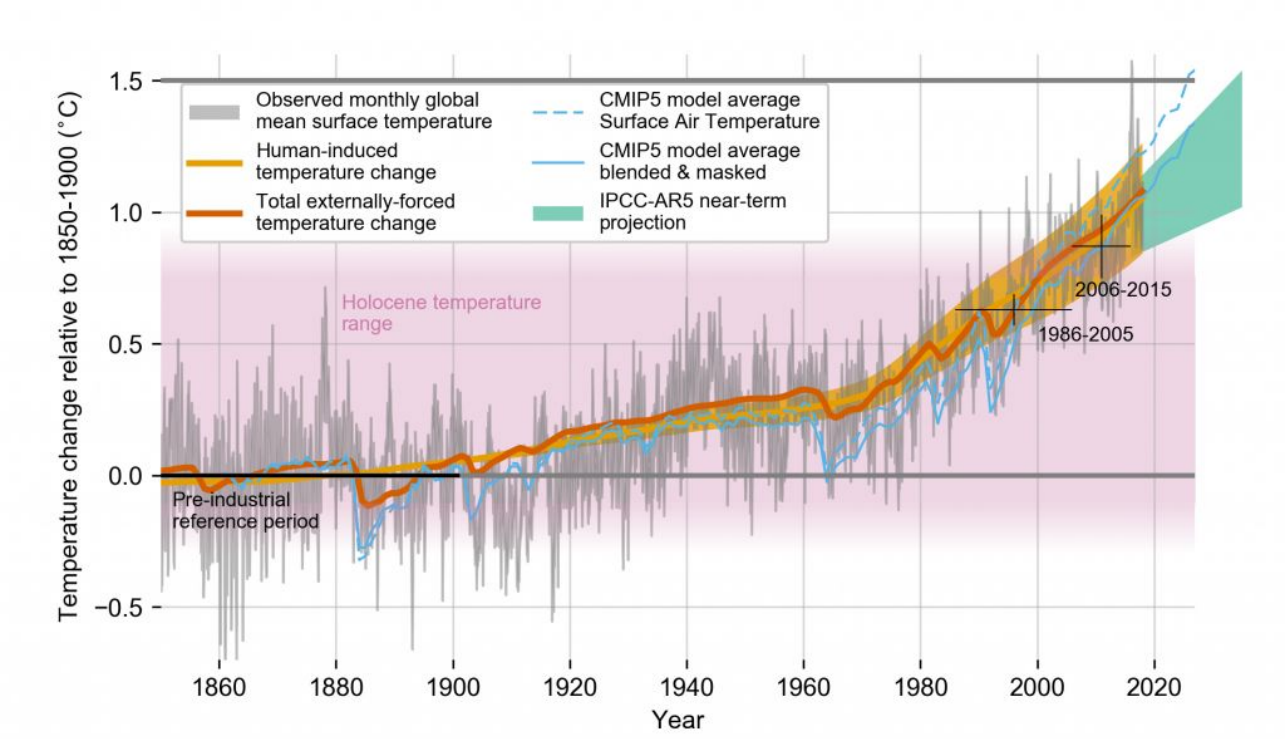
But the main problem is the fossil fuel industry!



of course none of these guys said any of that!

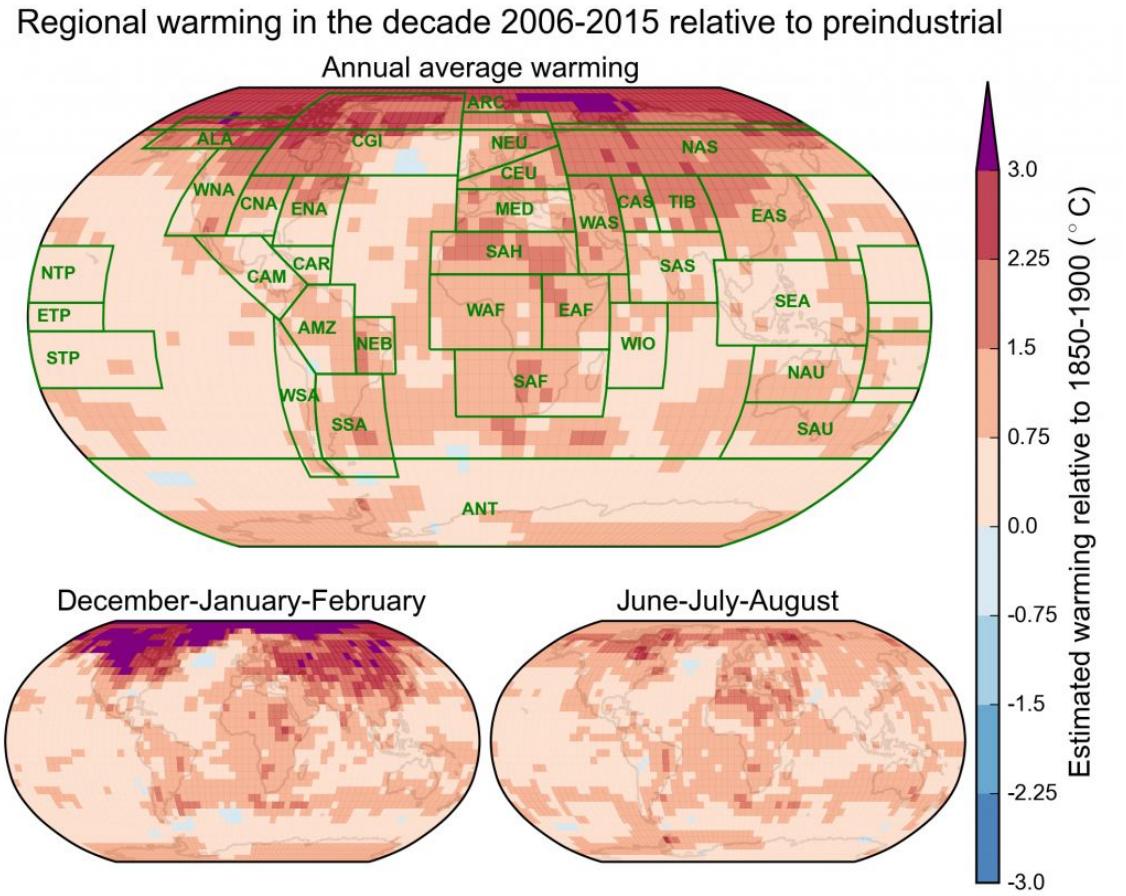
Climate change - global warming

Since the 18th century meteorologists register the temperature. These records show that our planet is warming (with respect to the pre-industrial reference period).



IPCC special report “Global warming of 1.5°C” https://www.ipcc.ch/sr15/chapter/chapter-1/

Climate change - global warming



Global warming is neither regionally nor seasonally homogeneous.

An increase of the average temperature of
1,5°C is accompanied by a net increase of more than 1.5°C on land and less than 1,5°C in most ocean regions.

A local decrease in temperature does not contradict the fact that the planet as a whole is heating up.

IPCC special report “Global warming of 1.5°C” https://www.ipcc.ch/sr15/chapter/chapter-1/

Climate changes in the history of the Earth

Drilling in ice cores is one of the most efficient method to reconstruct not only temperature but also the composition of atmospheric gases.

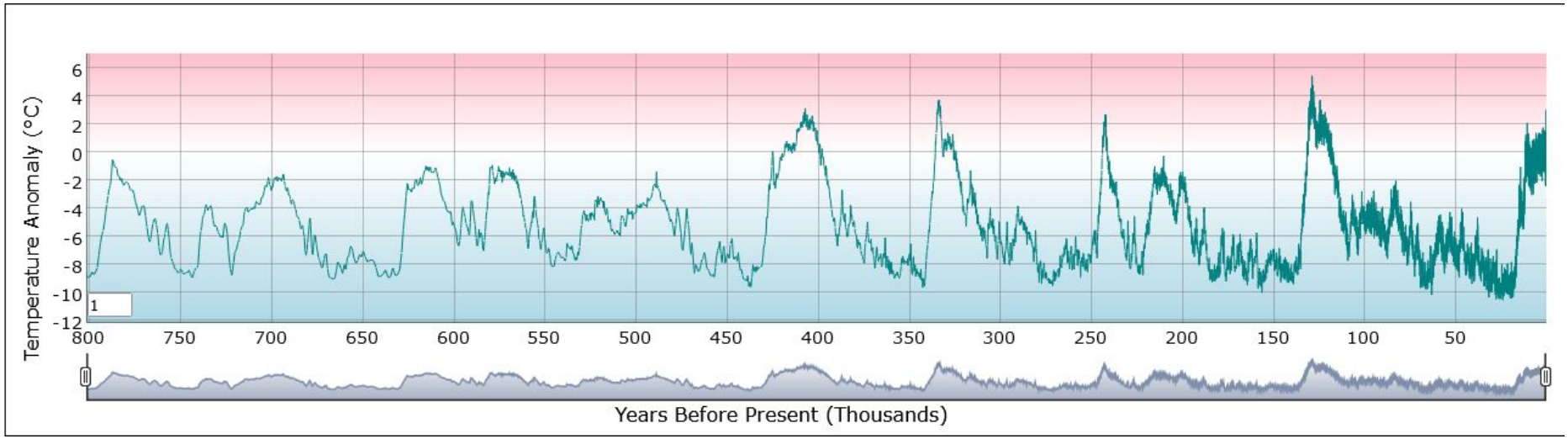
One of these projects is **EPICA** in the Antartica .

Thibaut Vergoz, Institut polaire français, CNRS

A global warming - not like the others

Our planet has already known climate changes: the mean temperature of the Earth has fluctuated all along its 4.54 billion years history. Cold periods and warm periods alternate on a 100,000 years cycle for at least the last one million years. For the last 11,000 years the temperature was relatively stable

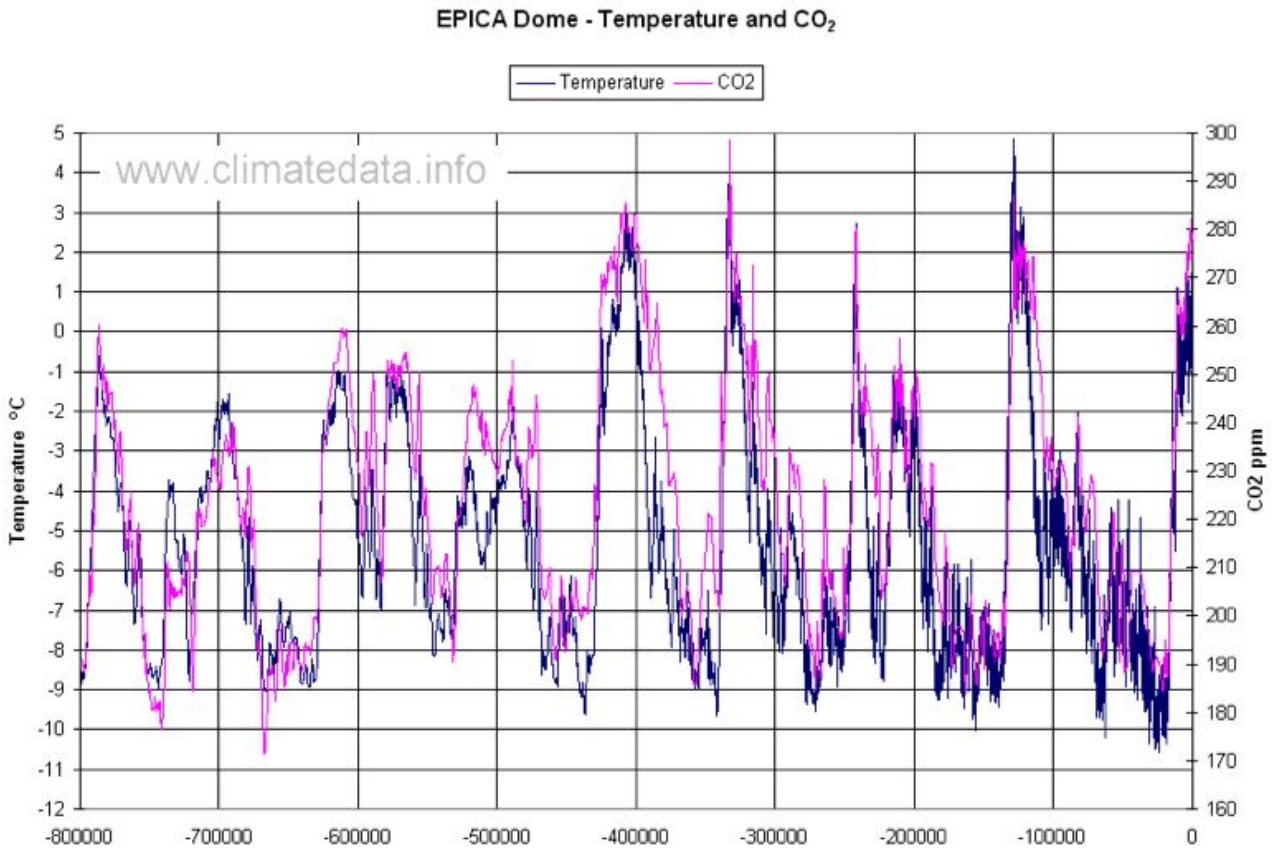
- Today's temperature increase is happening at a rate much faster than any temperature change during the last 11,000 years. And probably faster than at any point during the warm periods over the last one million years.



http://www.ces.fau.edu/nasa/module-3/temperature-changes/exploration-1.php

Relation to atmospheric gases

EPICA also tells about the gases in the atmosphere.

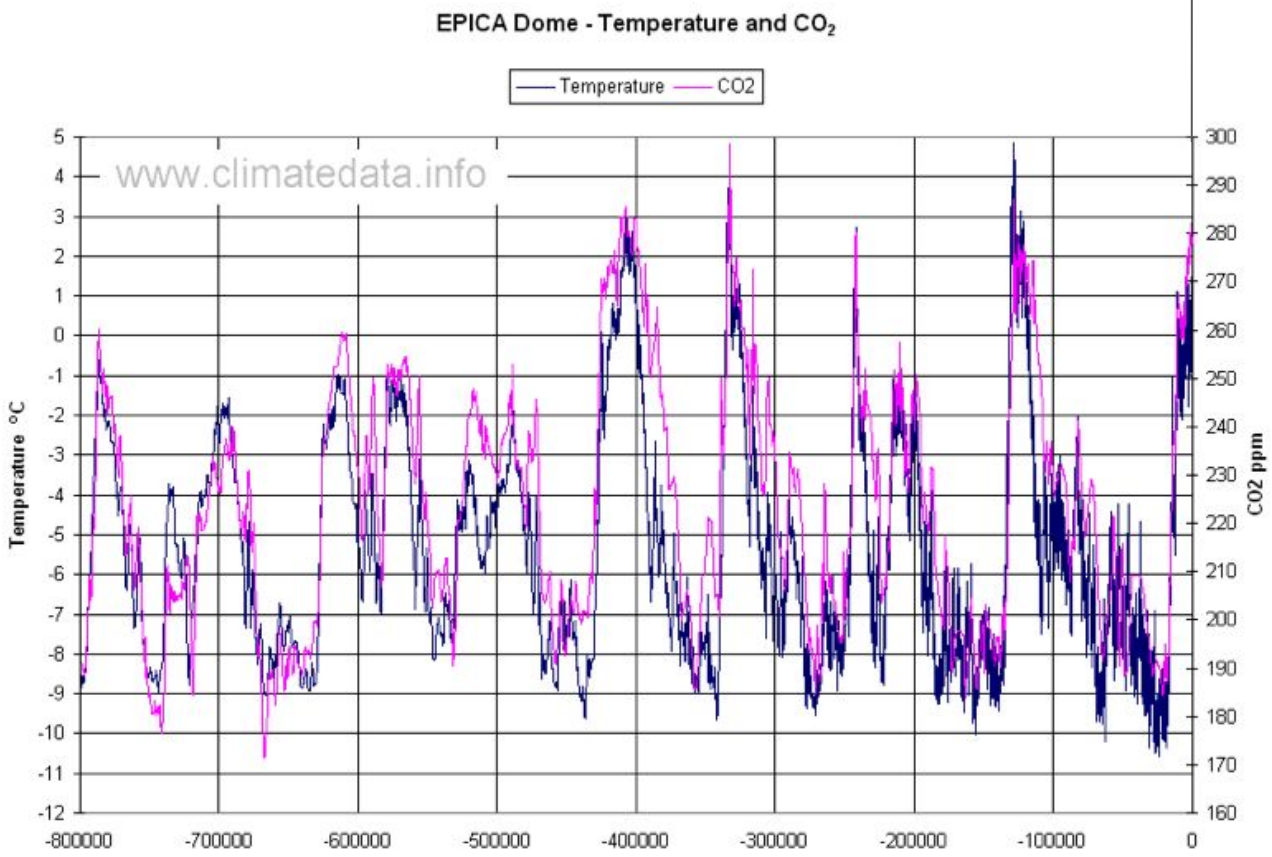


today?

412,5

Relation to atmospheric gases

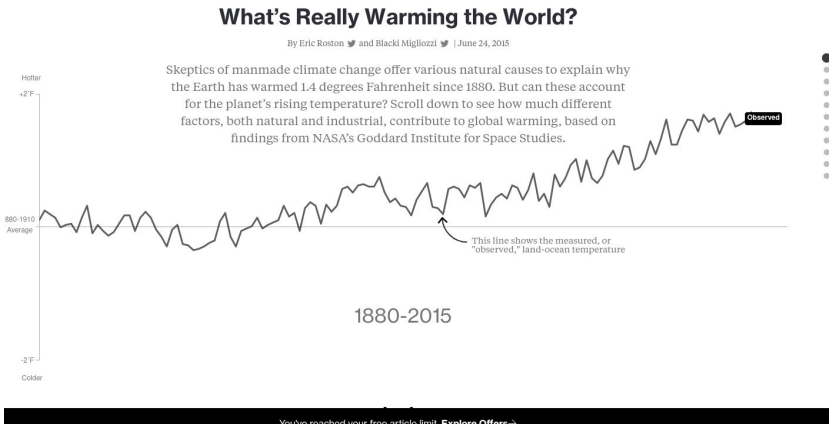
EPICA also tells about the gases in the atmosphere.



aujourd'hui

What is it that's warming the planet?

- the sun
- natural sources for CO2, methane, etc: respiration, volcanic activity, …
- human activity: burning of fossil fuels to produce energy

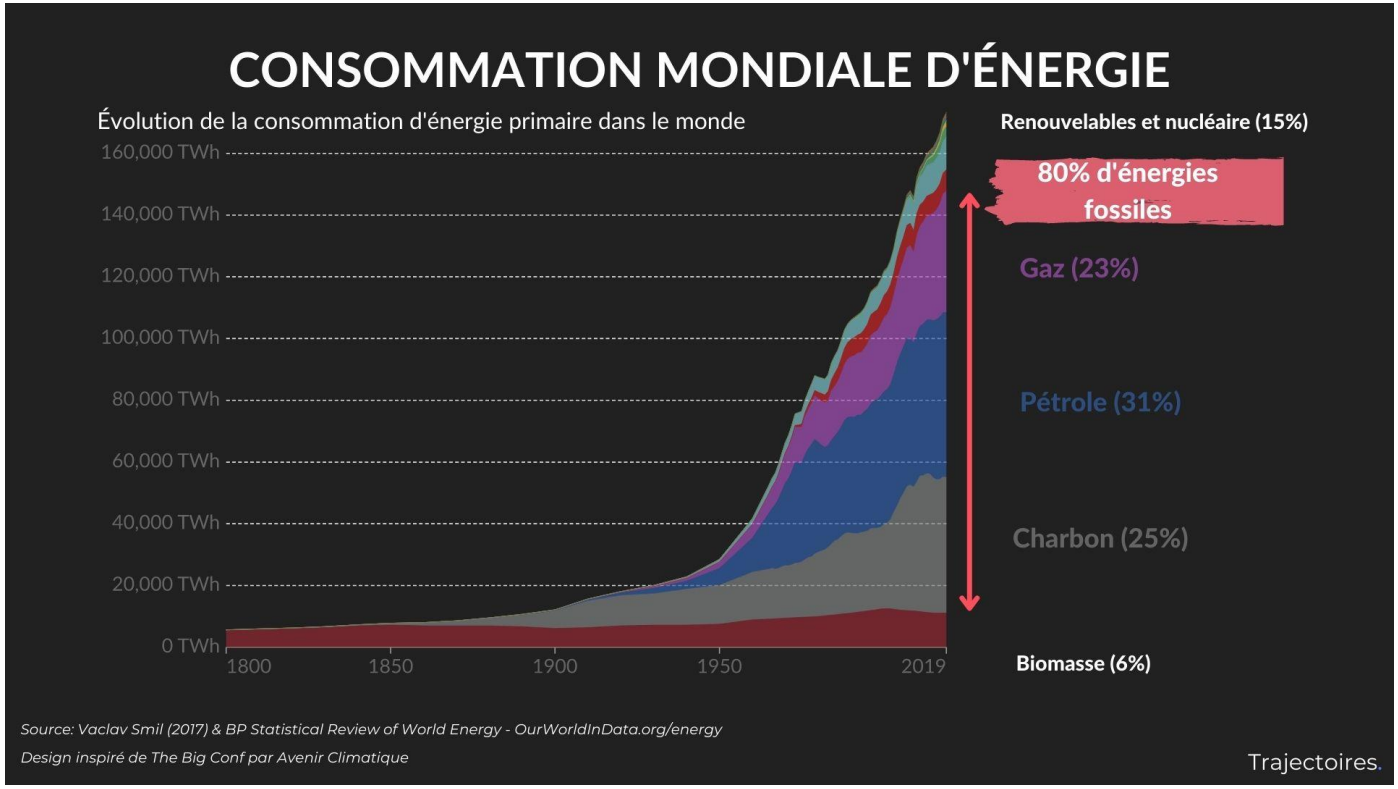


https://www.bloomberg.com/graphics/2015-whats-warming-the-world/

There is no doubt that human activity causes our planet to warm up.

Energy consumption by origin

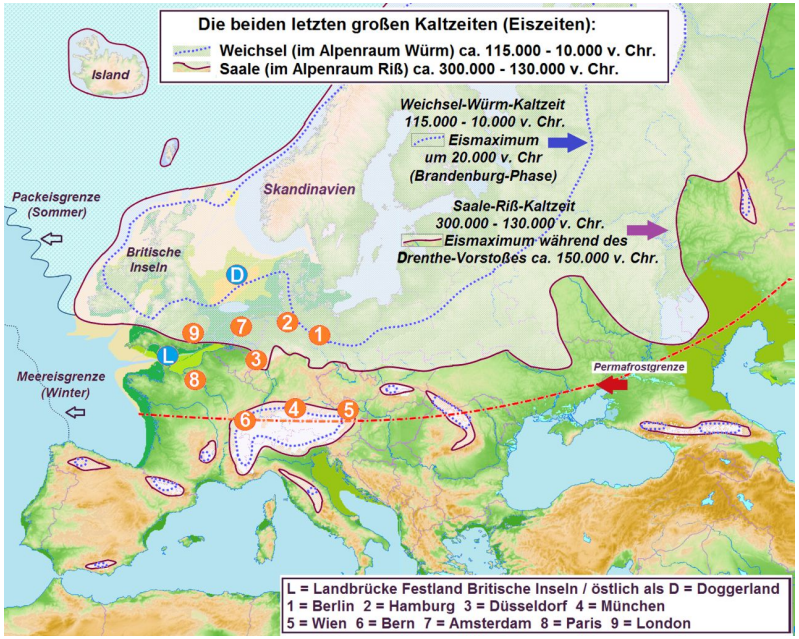
- Energy measures the transformation of the world. Today, we use a gigantic amount of energy to transform the world faster than ever.
- 80% of the consumed energy is of fossil origin (gaz, charbon, pétrole).
- Energy from fossil fuel has created our world of today and our level of life.



https://www.trajectoires.media/l/effet-de-serre-et-gaz-a-effet-de-serre

The impacts of climate change

+1.1°C - might seem a little. But it has enormous consequences. 21000 years ago we lived in the last ice age and the average temperatures were only 3-6° lower:



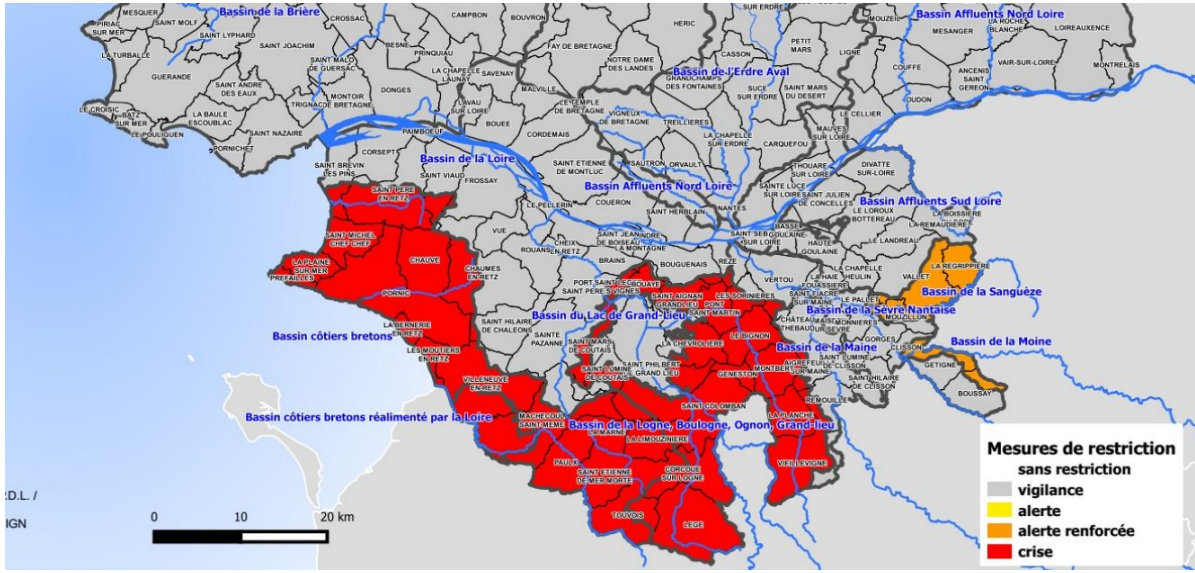
- Nantes was on permafrost.
- The sea level was 130 m lower than today
- The north-east of the US was covered by more than 1 000 m of ice.

Global warming and climate change impacts us today already (not just in 10, 20, or 50 years). And it will get worse in the coming decades.

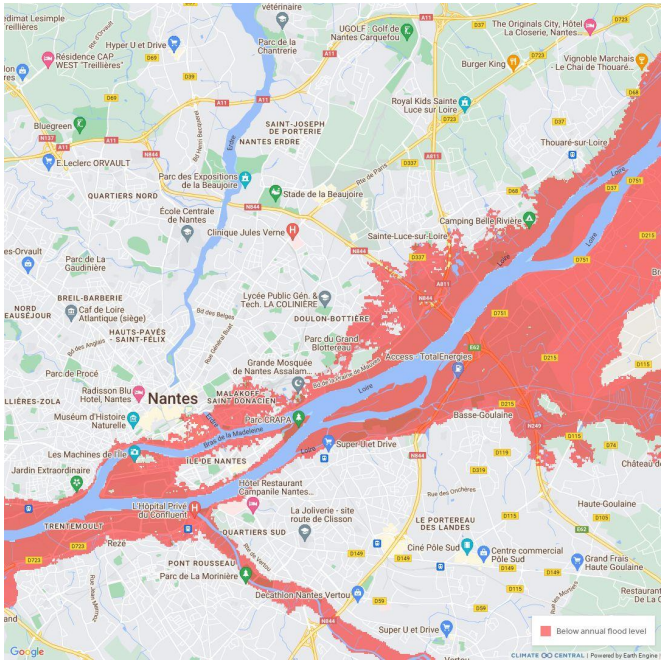
The impacts of climate change in Loire-Atlantique

Summers become hotter, longer and dryer

- drought alerts have been put in place since a couple of years
- in “crisis” mode the use of tap water is allowed for basic needs only
- 2019 Loire Atlantique was largely red = under crisis alert



current drought alert map in Loire Atlantique



Sea level is rising.

- In 2030 important parts of Nantes will be under the annual flood level = statistically over a 10 years period 10 floodings are expected that go to annual flood level.
- The coastal region in Loire Atlantique will be particularly hit and large parts will be below the tide level.

The impacts of climate change

Un océan qui se réchauffe et monte
À mesure que l'océan se réchauffe, son volume augmente car l'eau se dilate à mesure qu'elle se réchauffe. De plus, l'océan absorbe du CO2 et plus de CO2 rend l'océan plus acide, ce qui met en danger la vie marine et les récifs coralliens.

Des températures plus chaudes augmentent les maladies liées à la chaleur. Les incendies de forêt démarrent plus facilement et se propagent plus rapidement.

Tempêtes plus violents sont devenues plus intenses et plus fréquentes dans de nombreuses régions.

Augmentation de la sécheresse exacerbe les pénuries d'eau dans des régions déjà en situation de stress hydrique. Les déserts s'étendent, réduisant les terres pour cultiver de la nourriture.

The impacts of climate change

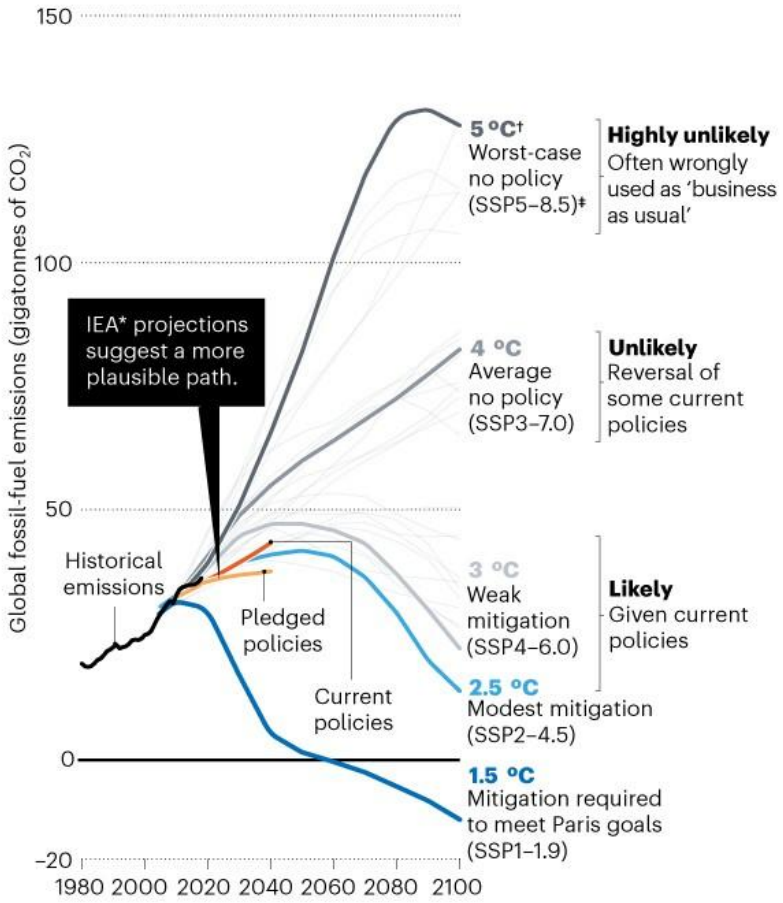
Perte d'espèces
Le monde perd des espèces à un rythme 1 000 fois plus élevé qu'à tout autre moment de l'histoire de l'humanité. Un million d'espèces risquent de disparaître dans les prochaines décennies. Les incendies de forêt, les conditions météorologiques extrêmes et les ravageurs et maladies envahissants comptent parmi les nombreuses menaces.

Pas assez de nourriture
Les pêcheries, les cultures et le bétail peuvent être détruits ou devenir moins productifs. L'océan devenant de plus en plus acide, les ressources marines qui nourrissent des milliards de personnes sont menacées. Le stress thermique peut diminuer l'eau et les prairies pour le pâturage.

Plus de risques pour la santé
Les impacts climatiques nuisent déjà à la santé, à travers la pollution de l'air, les maladies, les phénomènes météorologiques extrêmes, les déplacements forcés, les pressions sur la santé mentale, l'augmentation de la faim…

Pauvreté et déplacement
Le changement climatique augmente les facteurs qui placent et maintiennent les gens dans la pauvreté. Les événements liés aux conditions météorologiques ont déplacé environ 23,1 millions de personnes en moyenne chaque année (2010-2019).

The predictions for future warming



Article 2 of the Paris Climate Agreement:

(a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;

https://media.nature.com/lw800/magazine-assets/d41586-020-00177-3/d41586-020-00177-3_17600472.jpg

Actions against climate change

Collective - systemic - international

adaptation

collective - systemic - local

mitigation

Adaptation means the efforts to adapt to the impacts of climate change, like growing drought-resistent crops or building dams.

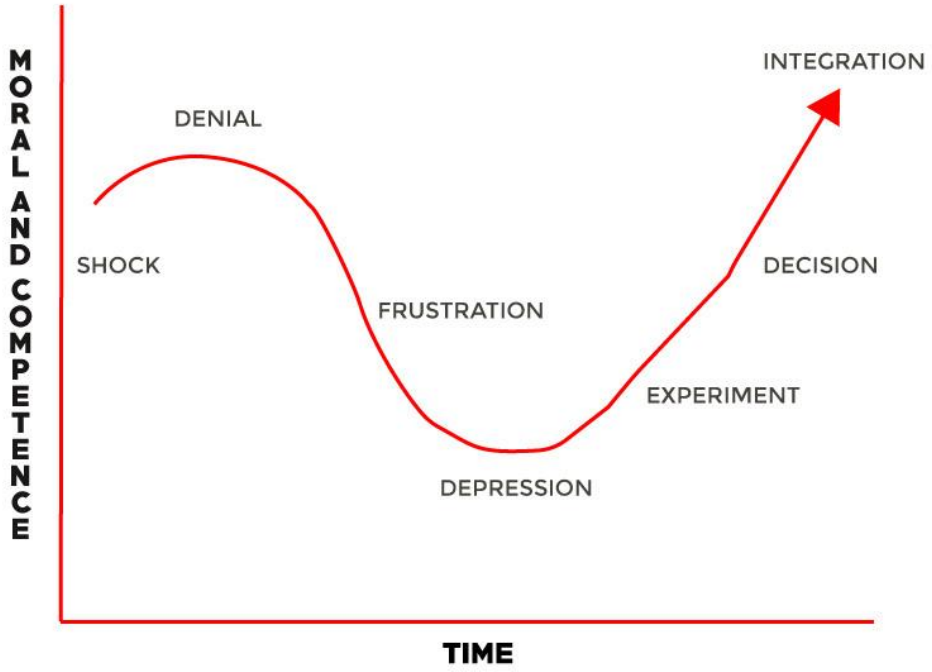
Mitigation describes the efforts to reduce the CO2 emissions and improve the CO2 sinks.

individual

Which effort is needed for the 1.5°?

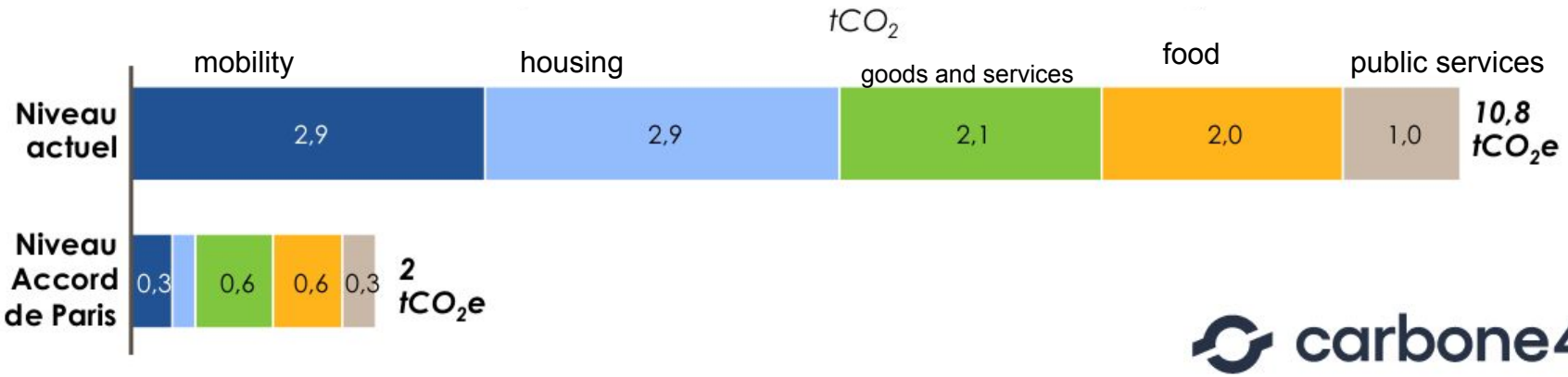
The resistance of human beings to change grows exponentially with the part they have to do themselves.

The resistance of human beings to change decreases with the understanding that the impact is equally distributed to everyone.



Which effort is needed for the 1.5°

Carbon footprint of the average person in France



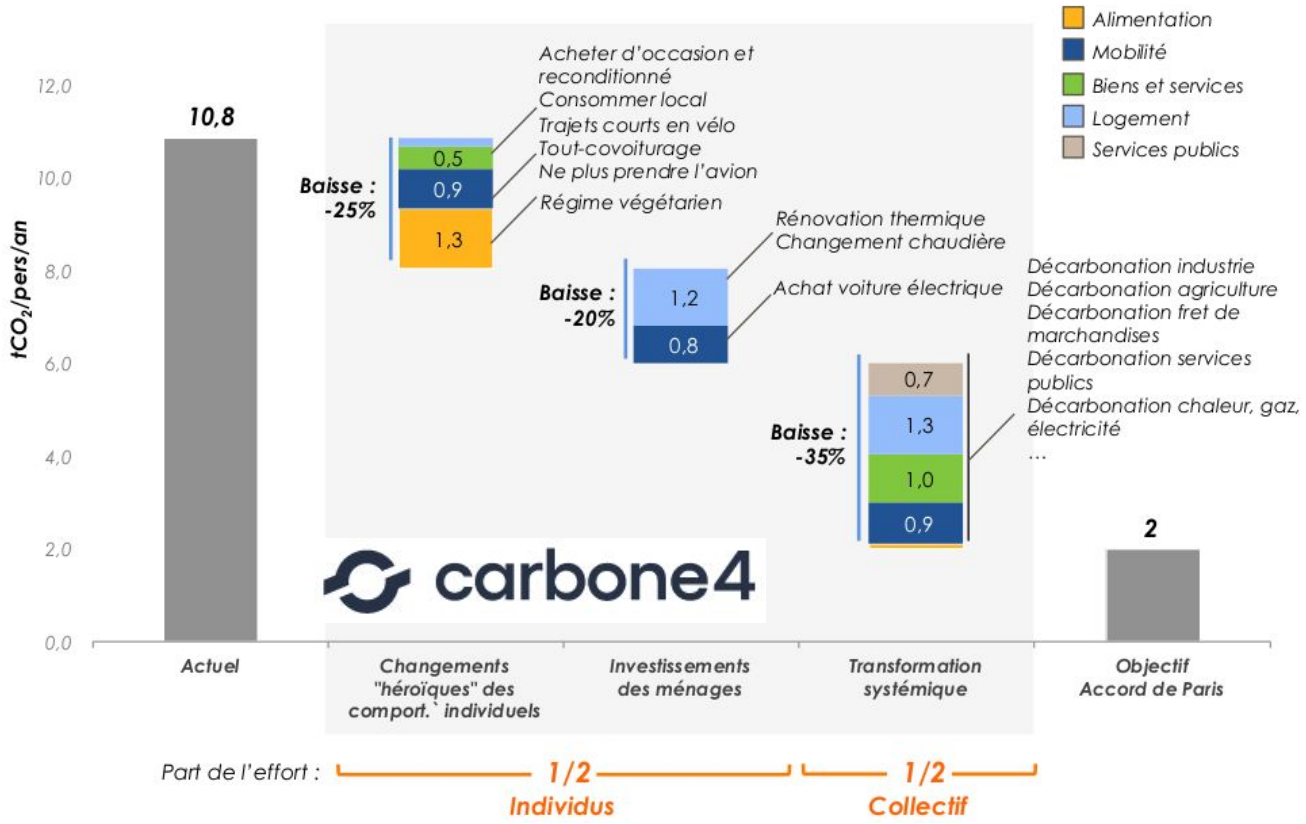
In order to achieve the goals of the Paris Agreement:

- Reduce to 2 t eCO_2 / year / capita in 2050
- Already a 40 % reduction in 2030

https://www.carbone4.com/publication-faire-sa-part - June 2019

Un équivalent CO_2 (CO_2e ou eCO_2) est une unité de mesure utilisée pour normaliser les effets climatiques de divers gaz à effet de serre. Cet indice exprime l'effet de réchauffement d'une certaine quantité d'un gaz à effet de serre sur une période donnée (généralement 100 ans) par rapport au CO2.

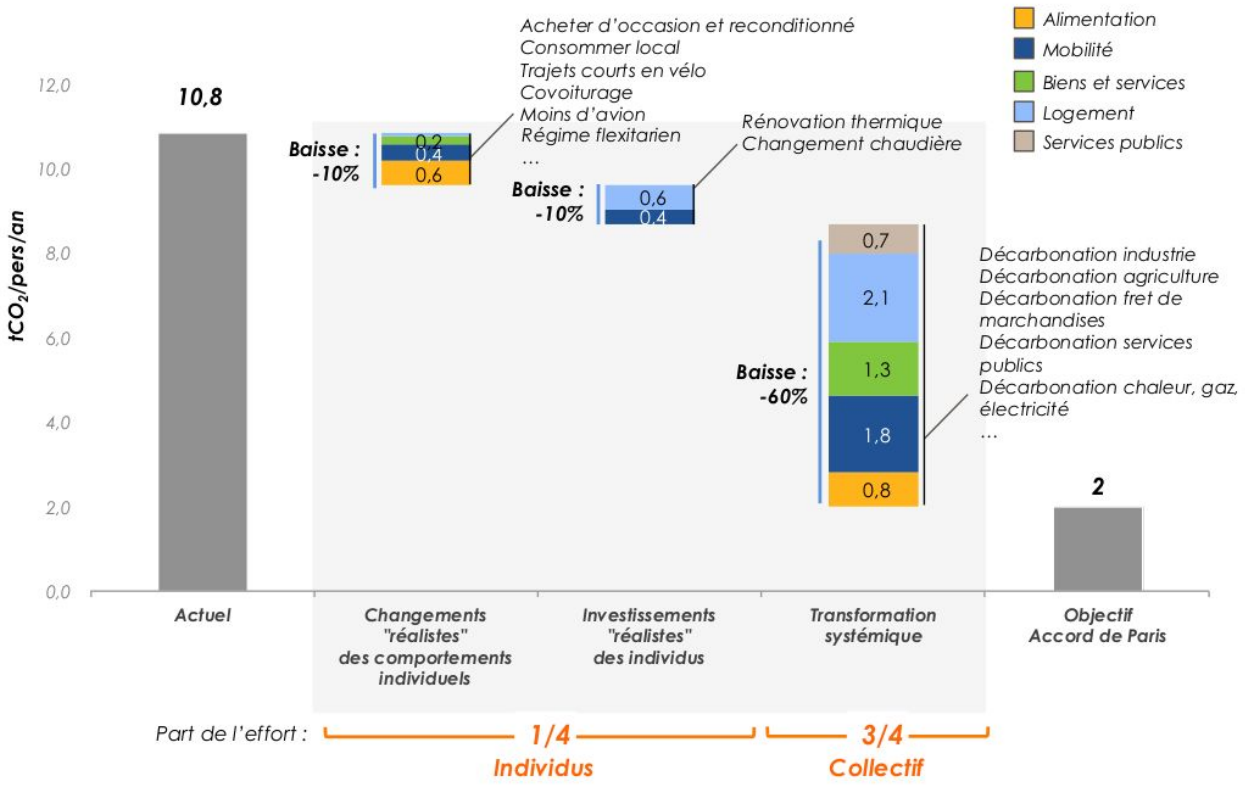
“Heroic” personal commitment



https://www.carbone4.com/publication-faire-sa-part
- juin 2019

“Realistic” personal commitment

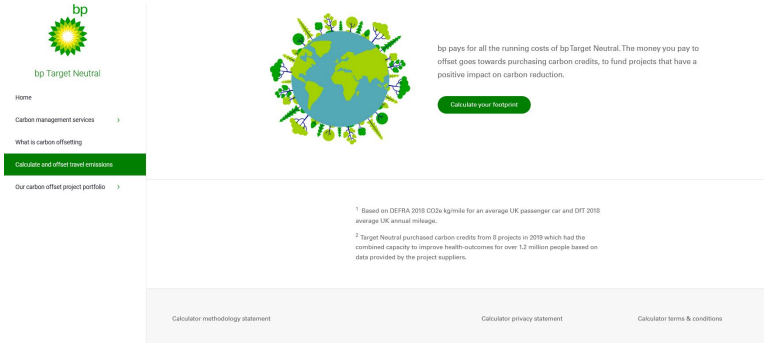
https://www.carbone4.com/publication-faire-sa-part
- June 2019



- Individual action (change of habits and investments) can contribute ¼ of the reduction.
- ¾ of the reduction of emissions must be systemic

Personal carbon footprint - does it make sense?

In 2004, it's British Petroleum, who sets up the first personal calculator for the carbon footprints of individuals on their webpage.



They communicate:
"Climate change is not the fault the fossil fuel industry, but of everyone individual"

(*) British Petroleum is the third largest fossil fuel company world wide. BP

- it's the 6th largest CO2e emitting company world wide since 1965, with a CO2 equivalent of 34,02 billion tons.
- has spent 53 million dollars per year since 2015 for lobbying against policies fighting climate change.

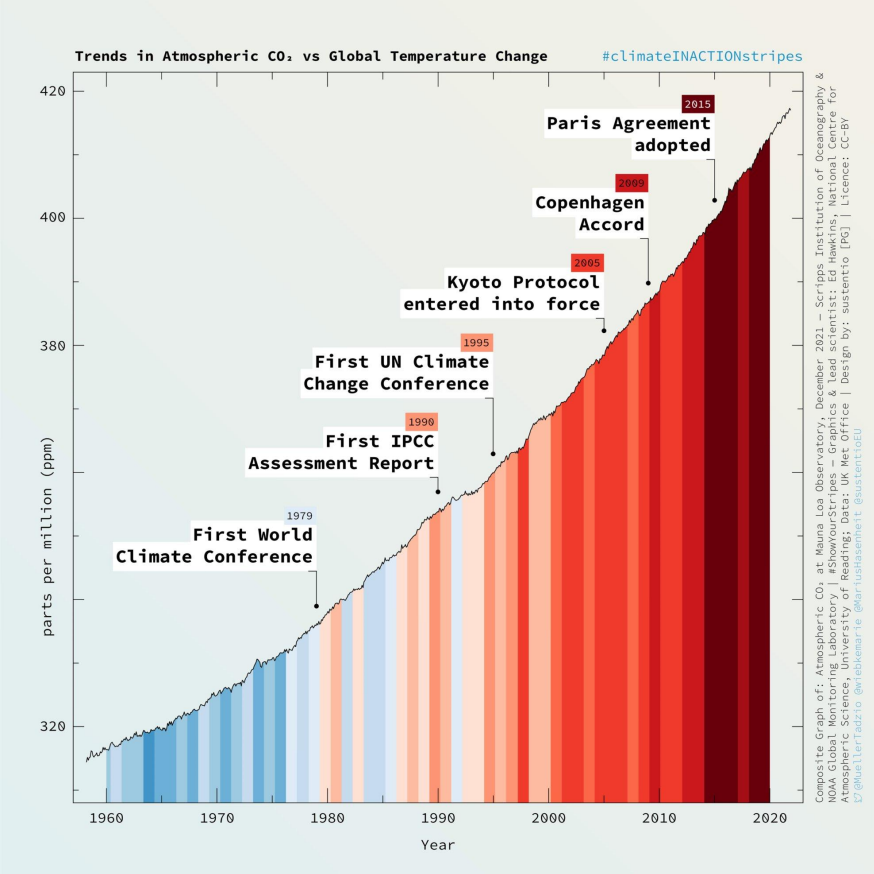
➔ Personal choices supporting a climate friendly way of living are good, but all three pillars (personal, private sector and public sector) have to act together.
➔ Without pressure from the public, systemic changes are hardly expected.

Local actions in the Chantrerie area

- Installation of a biomass power station serving the surrounding institutions (public and private).
- Improvement of the bicycle lanes, extension of the bus line C6, a boat crossing the Erdre river, etc.
- Soon to come, solar panels over the parking spaces.

AFUL Chantrerie

Les (in)actions globales pour limiter les émissions

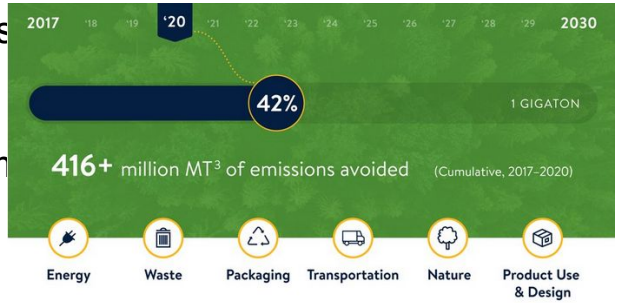


Inondation en Allemagne 2021, premier ministre: "Parce qu'aujourd'hui est un tel jour, vous ne changez pas la politique (sur le changement climatique)"

Global actions to fight climate change

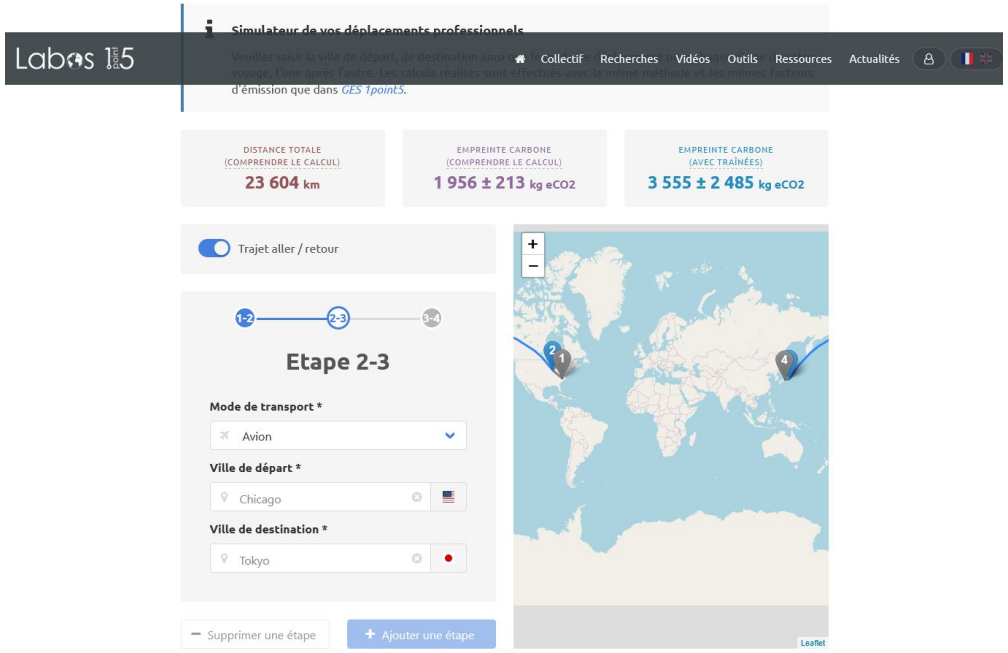
There are good news :
Every day there are more and more individuals, organisations, companies, governments who react to the crisis.

- The solutions we need for a zero-carbon future exist already! The technology of solar panels, wind power plants and batteries at low costs follow exponentially profitable trajectories and if kept should be sufficient to reduce emissions due to energy production by half in 2030.
- The European Union wants to ban the combustion engine from 2035 on.
  If politics strongly supports electric cars the growth of this sectors permits to fill 90% of the market in 2030.
- A growing number of companies join the fight against climate change and act to reduce their carbon emissions, e.g. the Walmart Gigaton project.
- A growing global movement ready to take concrete action to mitigate the worst impacts of climate change.



The role of research

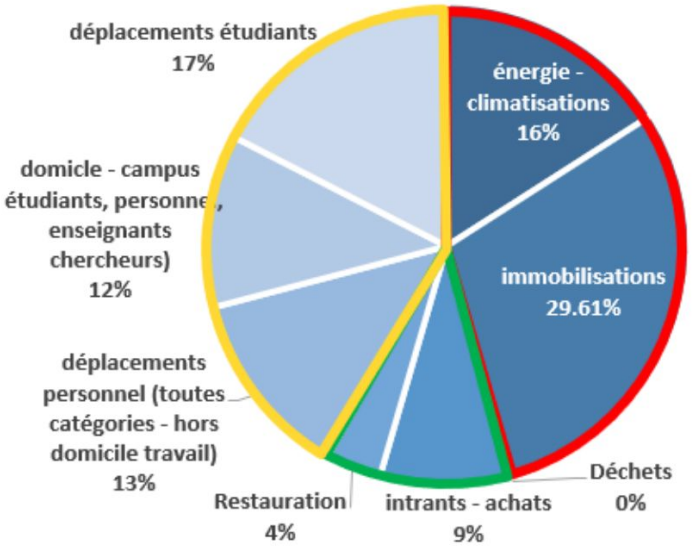
- The research community is very international and workshops/conferences and schools (!) take place all over the world.
- Large consumption in equipment.
- While most scientists agree about the science behind climate change, many are not aware of how bad the situation actually is.



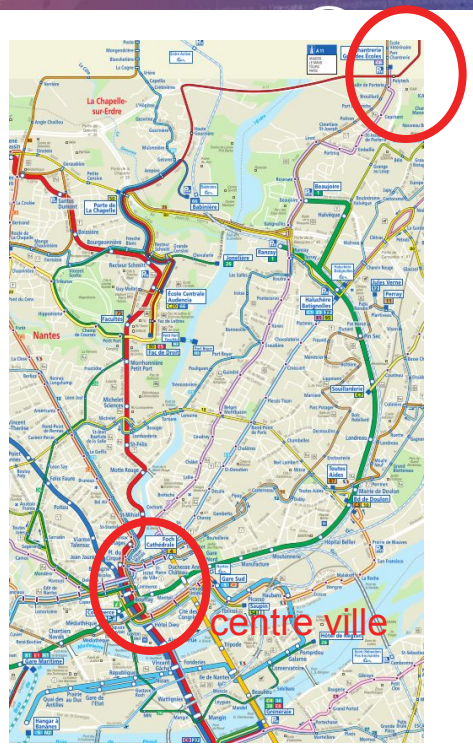
My plenary presentation at "Quark Matter 2015" has a carbon footprint of 2-3.5 tons eCO_2 = all or even more of my CO_2 budget in 2050!

Carbon footprint of Subatech laboratory

Carbon footprint of l'IMT Atlantique 2019



Tool used:
www.labos1point5.org



We first focused on the following points:

- daily commutes home - work
  - survey sent to all of Subatech personnel
  - define 2 typical days per week
  - applied to the year 2019 (pre Covid)
- travel to conferences, etc.
  - all travels paid for by CNRS
- analysed by two Bachelor students in 01/2022 (Valentin Denier et Raphael Tapadinhas)

Daily commutes

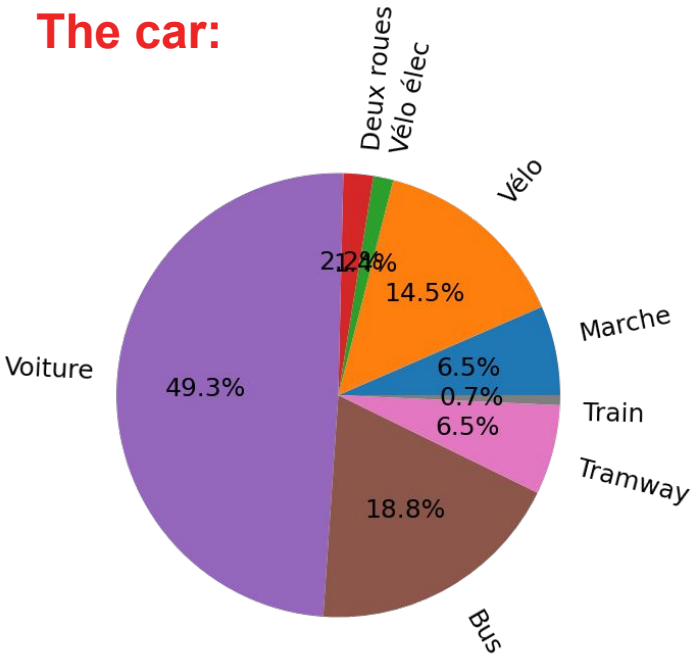
Estimate for the total daily commutes in 2019 : **173.05 ± 104.21 tons eCO2**
(correction applied to represent 100% of the personnel, based on returns equal to ⅔ of the personnel)

Average CO2 emissions : **930 kg eCo2 / person / year**

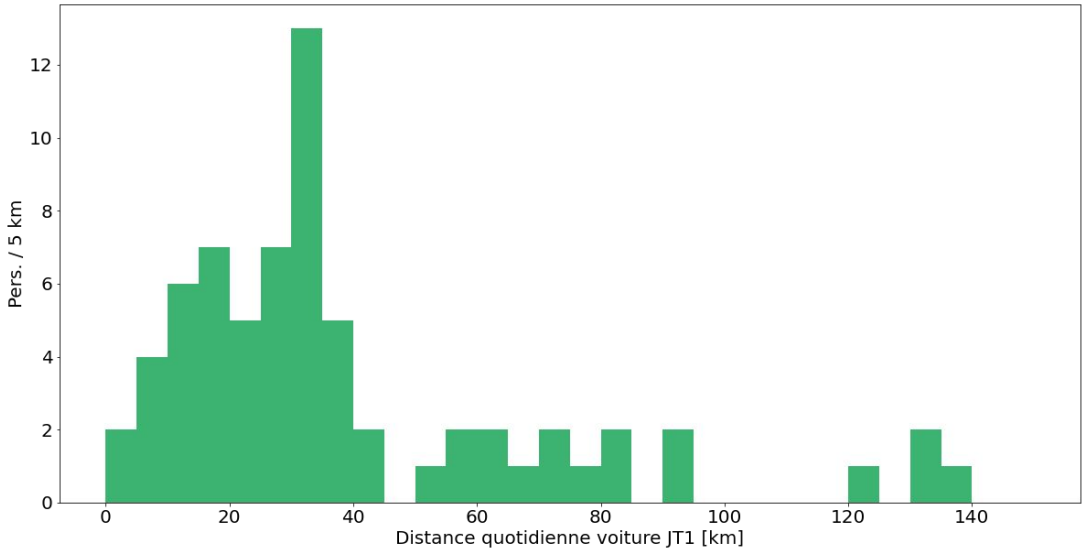
In order to align with the goals of the Paris agreement:

- ↘ **372 kg eCO2 / person / year in 2030**
- ↘ **93 kg eCO2 / person / year in 2050**

The car:



Emissions : 102 t eCO2/year for 68 / 115 pers.
Extrapolated to 186 pers : 164 / 173 t eCO2 (95 %)



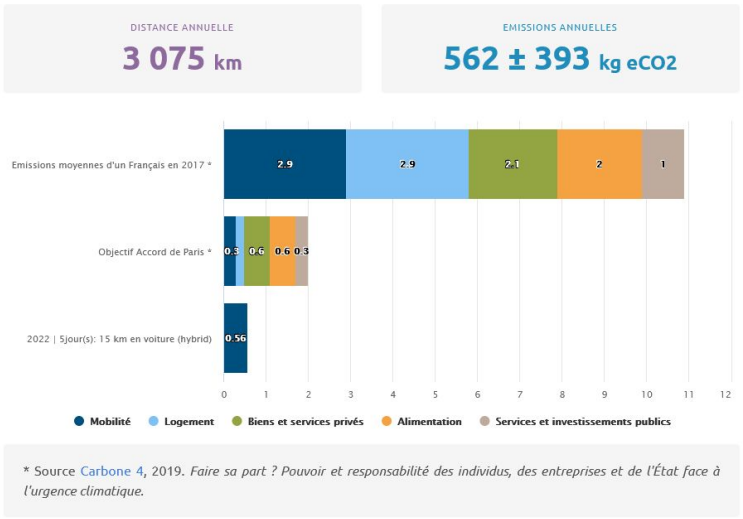
Daily commutes - a personal example

- Type 1 day:
  5 days per week, total of 15km
  in a hybrid car

- Type 1 day:
  4 days per week, total 15km
  with a cargo bike
- Type 2 day:
  1 days per week, total of 15km
  in a hybrid car

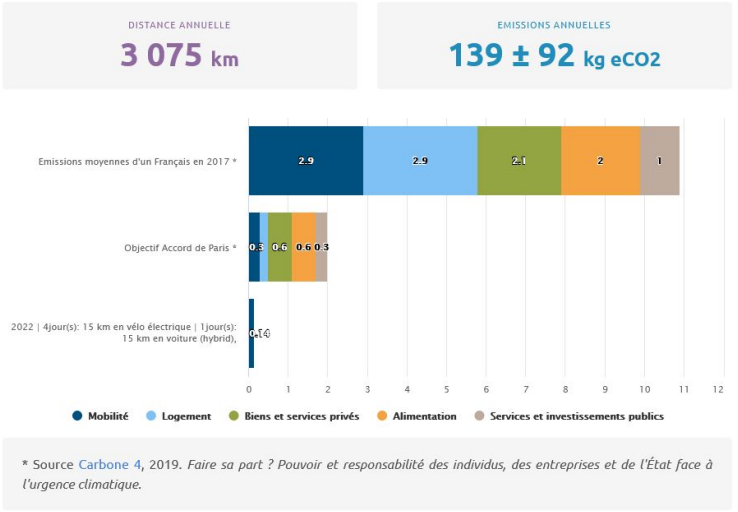
Daily commutes - a personal example

- Type 1 day:
  5 days per week, total of 15km
  in a hybrid car



* Source Carbone 4, 2019. *Faire sa part ? Pouvoir et responsabilité des individus, des entreprises et de l'État face à l'urgence climatique.*

- Type 1 day:
  4 days per week, total 15km
  with a cargo bike
- Type 2 day:
  1 days per week, total of 15km
  in a hybrid car



* Source Carbone 4, 2019. *Faire sa part ? Pouvoir et responsabilité des individus, des entreprises et de l'État face à l'urgence climatique.*

+ emission reduction by a factor 4!
+ lots of fun with the kids - they love our cargo bike!

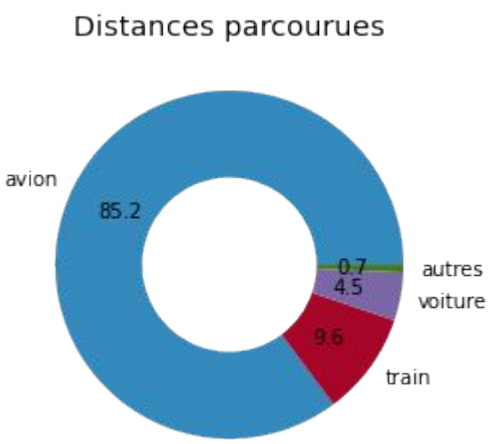
Some solutions for the daily commutes

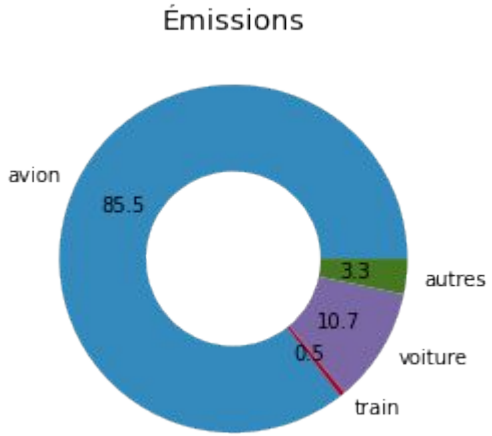
- 1 or 2 days of **home office** per week (when ever possible) leads to a réduction de ↘ 23 t eCO2 ou ↘ 49 t eCO2
  - number of people working in home office has increased over the past years
- Use the bike for shorter distances :
  if everyone living at a distance < 10 km uses the **bike**: ↘ 20 t eCO2
  taking the bike is a personal choice which would be accompanied by systemic changes such as
  - enhancement of the bike lanes and their security, as well as the bike parkings
  - bonus paid to employees
  - access to a shower at the lab
  - …
- **Car sharing** with colleagues and other employees on site
  https://aful-chantrerie.fr/covoiturage-domicile-travail/

Travel to conferences

- Total distance: 1,78M km (3x 🌍↔🌒)

- Carbon footprint of travel to conferences, etc. (paid for by CNRS, ⅔ of all travels) is 173.13 ± 29.67 t eCO2.
- taking the contrails into account this increases to: 296.06 ± 204.56 t eCO2
- for the Paris agreement: reduce to 17.3 - 29.6 t eCO2





The train is by far the most ecological means of travel (less than a ton eCO2)

Carbon footprint of HIC school 2022, Nantes

Thanks for having responded to our survey in advance of this event!

- 15 answers received
- knowing the origin of the remaining participants, the most likely means of travel was assumed.
- not a great sample to do statistics on, should be better for a conference like Quark Matter
- travel should be dominant source of CO2 emissions

Again, the tools of www.labo1point5.org have been used to calculate the approximate carbon emission due to travel to the conference.

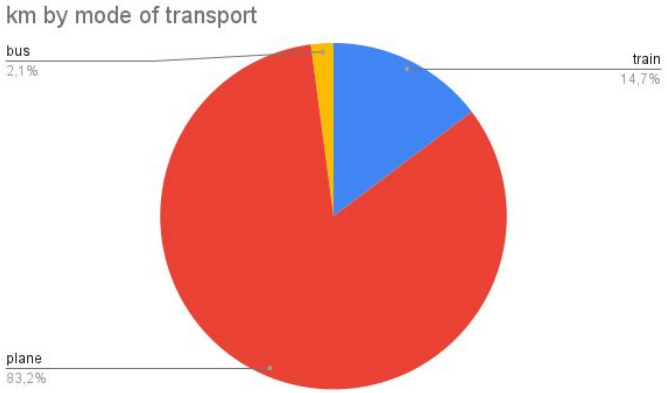
total number of km traveled:	total CO2 emissions in ton eCO2:	total CO2 emissions in ton eCO2 with contrails:
154.000	**11.9 ± 1.3**	**21.3 ± 14.8**

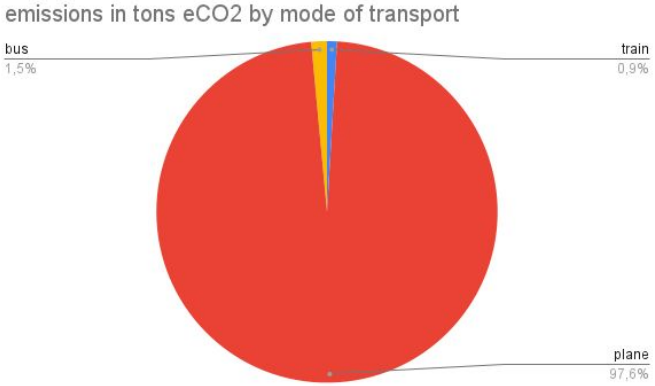
Carbon footprint of HIC school 2022, Nantes

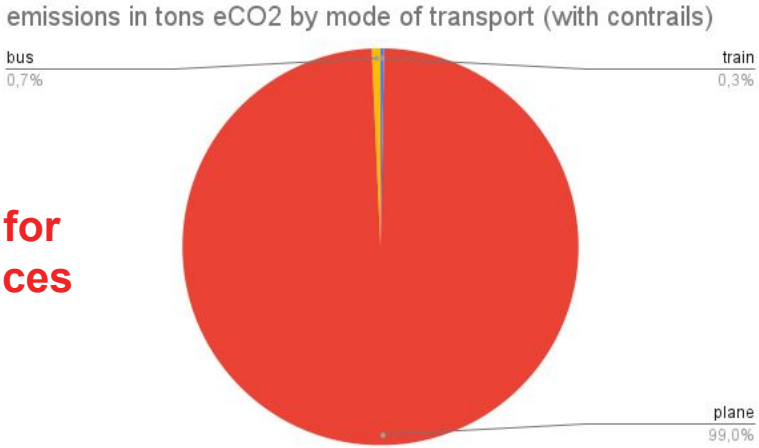
total number of km traveled:
154.000

total CO2 emissions in ton eCO2:
11.9 ± 1.3

total CO2 emissions in ton eCO2 with contrails:
21.3 ± 14.8







To be repeated for larger conferences in the field!

The train is by far the most ecological means of travel.

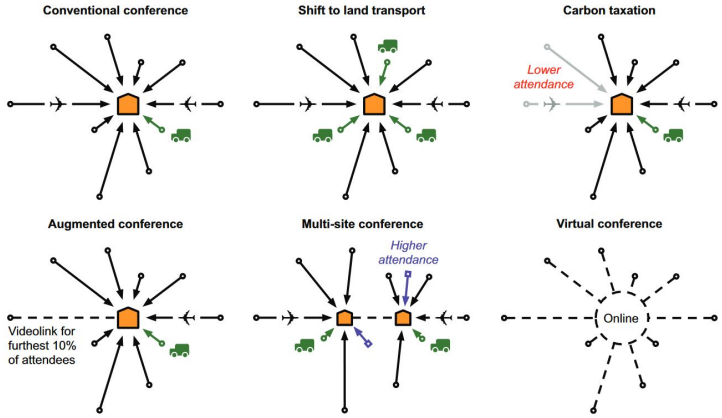
Now, who explains to Volker that next time, he takes the train…?

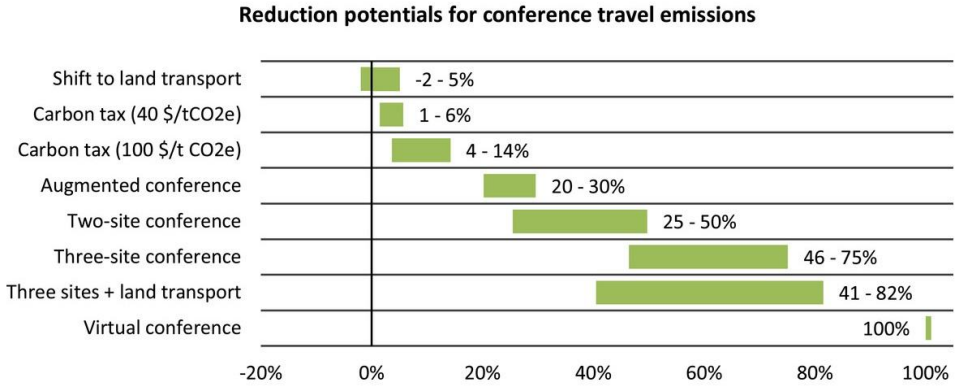
How do we organise research in the era of fighting climate change?

- How should reimbursement work? Aviation is heavily subsidized, train often more expensive…
- In addition to having a financial budget, what about a carbon budget?

starts to be introduced in some French labs

- Keeping some sort of hybrid format for conference.





S.v. Ewijk, P. Hoekman, Journal of Industrial Ecology (2021) 25

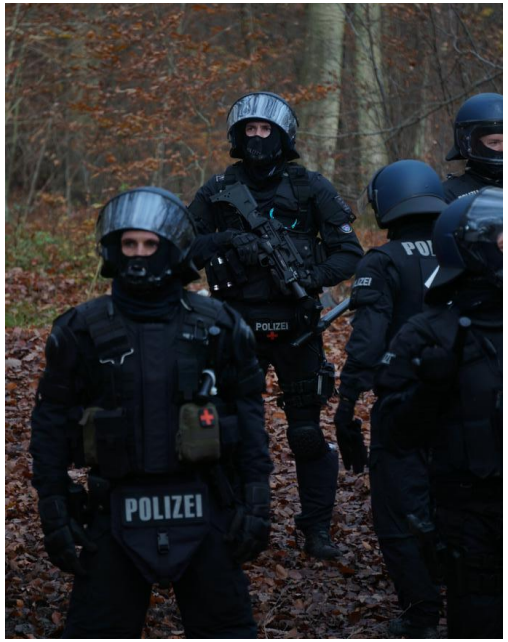
- Alternating between hybrid and in-person for every conference series.
- Advocating for a better train system, e.g. night trains within Europe.

Awareness action gap

Humanity is aware of the problem, but does not act.

Sometimes it takes a community initiative or experiencing a personal impact.

Cutting right through 2 intact, old, beautiful forests close to my home place to finish a 40 years old highway project.



These forests

- were guardians of a drinking water reservoir providing clean water to over half a million people.
- stored in their roots high explosives dating from large WW2 factories.
- provided a cooling spot in the area to keep temperatures down in the city.