

# Climate, energy, resources : sustainable development in engineering education

Marc Vedrines

Mechanical Engineering



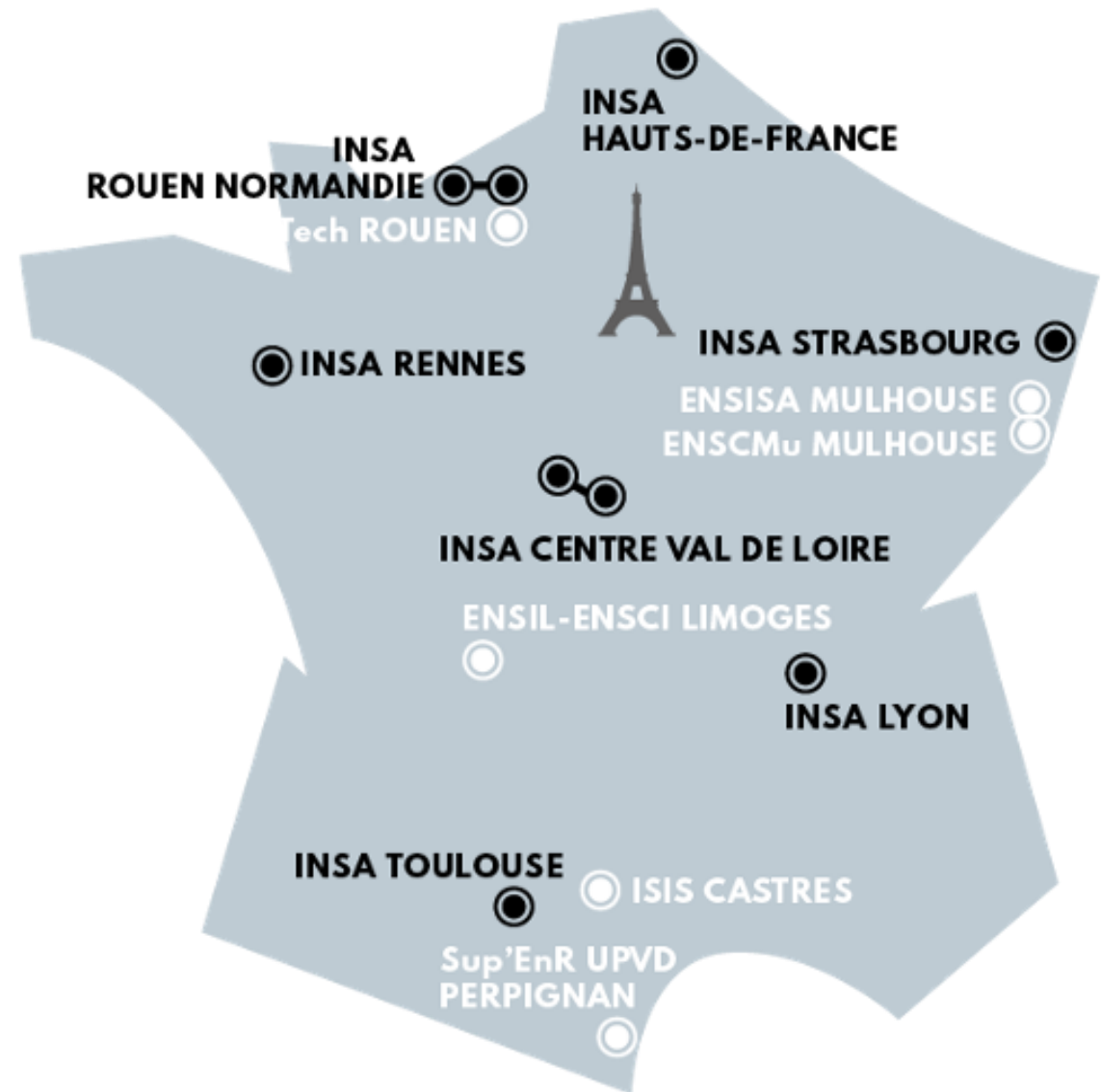
# INSA Group

3 400 graduate each year

63 specialities

22 000 Students

1 300 professors and  
researchers

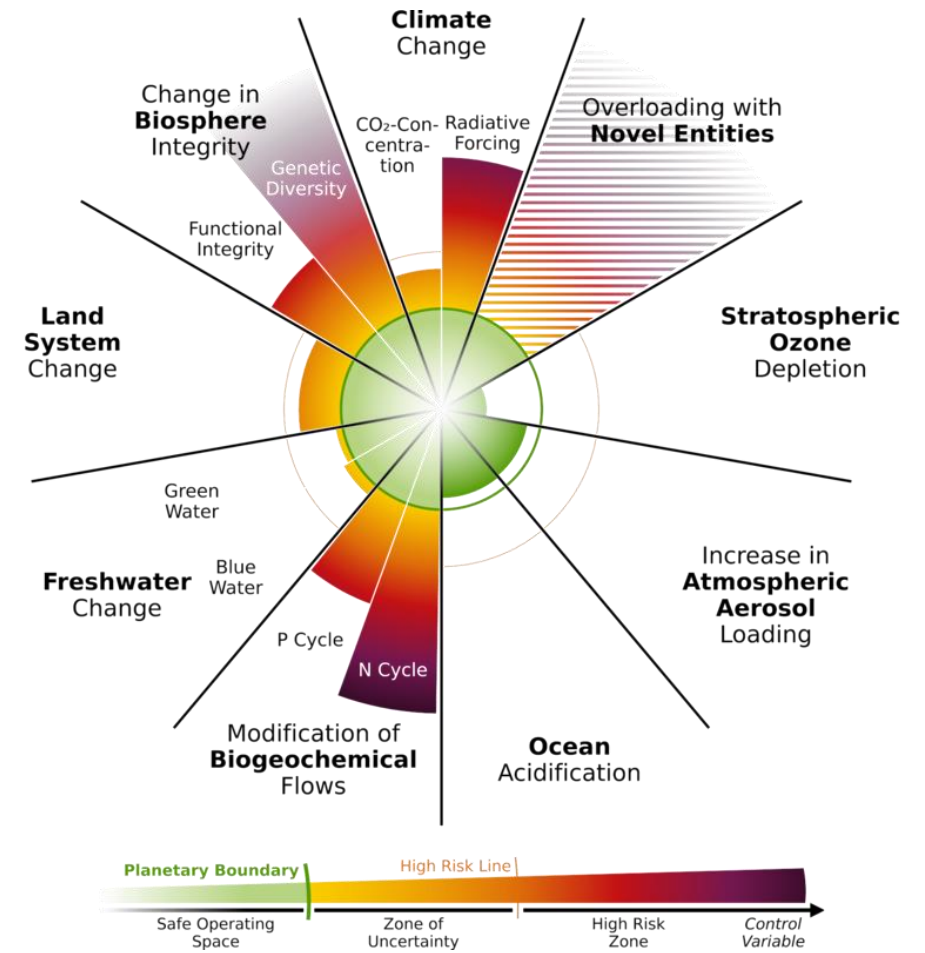
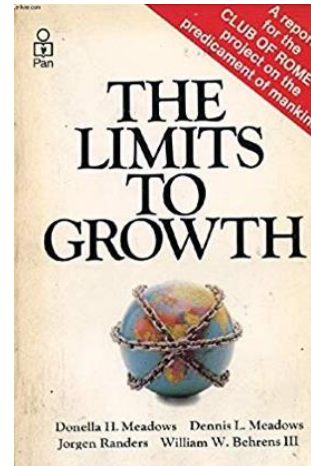
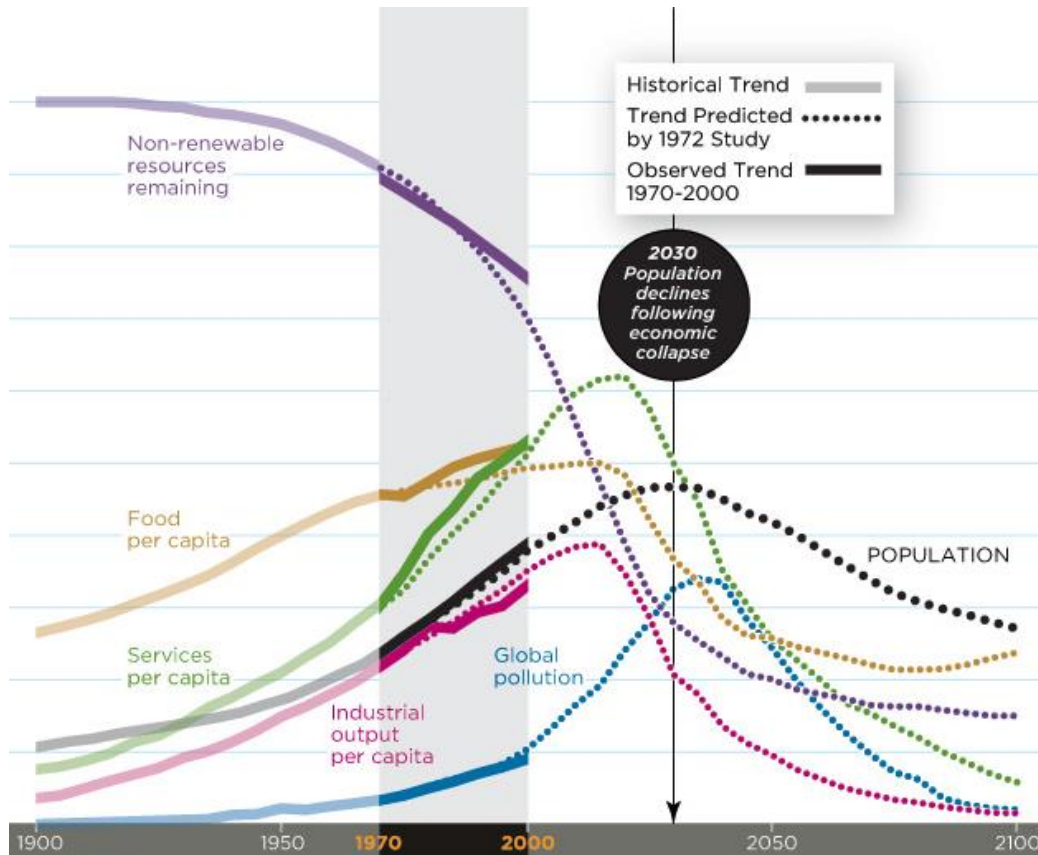


# Summary

- Historical situation
- Proposals for evolution
- Present situation
- Practical implementation
- Personal feedback

# Some basic frameworks

- Planetary Boundaries (since 2009)
- Limits to growth (since 1972) - Meadows report



Sicco Mansholt

President of the European Commission

1972 (the Mansholt Commission) -letter

"It is clear that tomorrow's society cannot be concentrated on growth, at least not as far as material goods are concerned"

# History (very uncomplete)

- 1853 first 'park' in the world foret fontainebleau (« rserve artistique »)
- 1967 national parks
- 1971 Ministry for environment
- 1974 Rene Dumont ran for President (the first ecologist candidate) - engineer in agronomy, sociologist
- 1976 law for protecting the seaside
- 2002 Pdt Chirac Earth Summit Johannesburg "Our house is burning and we're looking away"
- 2008 2010 Grenelle de l'environnement...
- Classical movements (Greenpeace, Fridays for future...)
  - Focus on particularities

# Recent students positions

speeches on ecology and climate change given by students at their graduation ceremonies (since approx. 10 years) especially those made by Clément Choisine at Centrale Nantes (2018) and by the "deserters" at AgroParisTech (2022) term "bifurcate"



two questions:

should people "diverge", "bifurcate", "desert", "boycott", or should they change the system from the "inside"?

tension between a vision of the engineer : modernist figure (control, design solutions, no emotions) - or an ecological figure (listen, doubt, care and make ones feelings explicit)



### Appel à désertter - Remise des diplômes AgroParisTech 2022



Des agros qui bifurquent

7,46 k abonnés

S'abonner

32 k



Partager

Clip

Enregistrer



988 k vues il y a 2 ans

Discours d'un groupe d'agros qui bifurquent à la remise des diplômes d'AgroParisTech 2022.

EDITED : ENGLISH, SPANISH & GERMAN SUBTILES

Contact : agros.bifurquent@protonmail.com ...afficher plus

2 573 commentaires

Trier par




# Students associations and movements

[Employers](#) ▾ [Education](#) ▾ [Blog](#) [Advocacy 2022](#) [Public services](#) [The collective](#) ▾ [Donate](#) ↗

## Taking action for an ecological awakening !



Regarder sur  YouTube

[Wake up your employer](#)

[Wake up your university](#)

[Wake up public service](#)



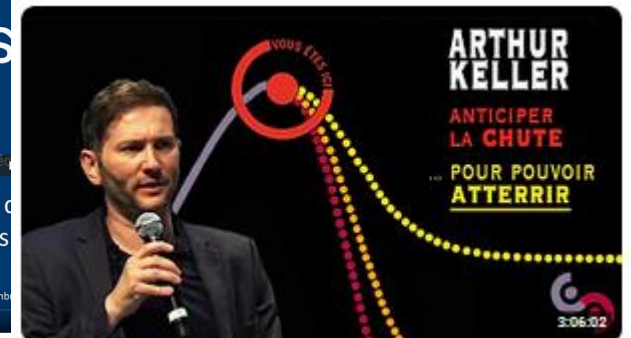
- Studies and first job: getting actively involved in a wake-up call on the environment
- Since 2018, over 30,000 students have signed the “Wake up Call on the environment: A Student Manifesto.”
- concern for the ecological emergency
- integrate these issues into our daily lives as students, and jobs.
- guide “How to choose your job : the right questions to ask”.
- Anti-Greenwashing Guide
- Do you want your school to teach you more about ecological issues?

<https://pour-un-reveil-ecologique.org/en/>

# Keynotes and courses in engineering and business schools

many French “personalities” in engineering and economy agree that

- The contemporary industrial civilization, and the biosphere as a whole, are on the verge of a global crisis of unprecedented proportions.
- the process is already under way.
- “opinion leaders” based on strong scientific knowledge (many engineers and scientists)



BECOMING RESILIENT IN A WORLD EXPOSED TO UNPRECEDENTED SYSTEMIC RISK • KEYNOTE TALK BY ARTHUR KELLER



Arthur Keller  
10,3 k abonnés

S'abonner

👍 293



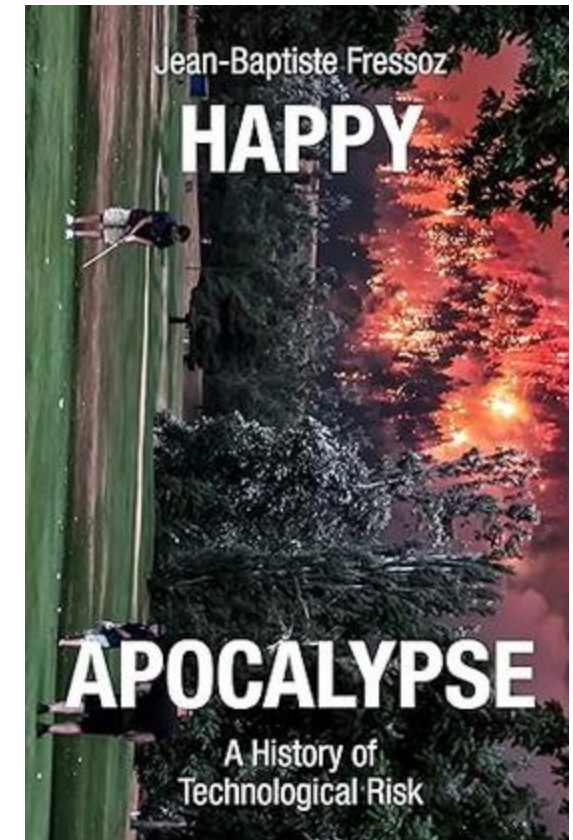
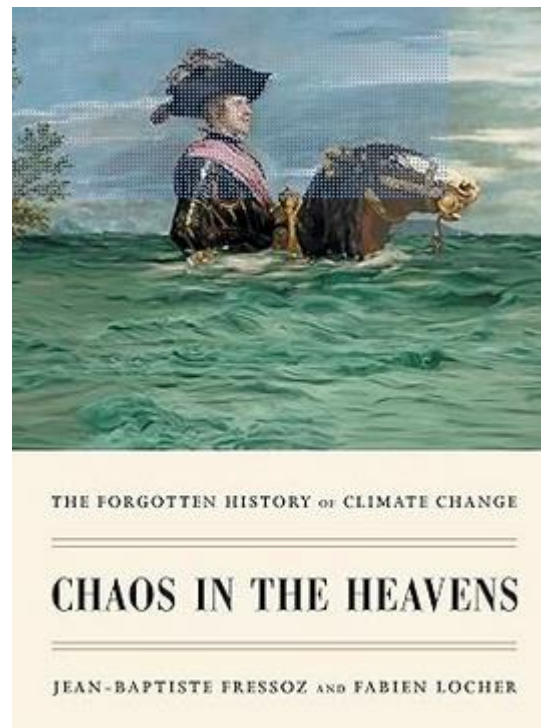
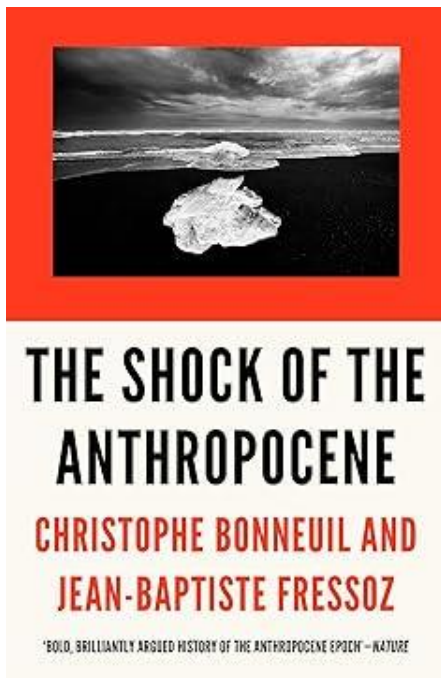
🔗 Partager

✂️ Clip



8,6 k vues il y a 7 mois

This keynote was given in September 2023 in front of 350 executives of the Altrad group, world leader in the provision of industrial services.



first critical history of the Anthropocene  
shaking up many accepted ideas:  
our supposedly recent “environmental awareness”  
the manufacture of ignorance and consumerism  
the so-called energy transitions  
not a sudden awakening but a process of modernising environmental disinhibition.

# Think tanks

- Association of engineers
- Economy specialists
- Based on scientific knowledge

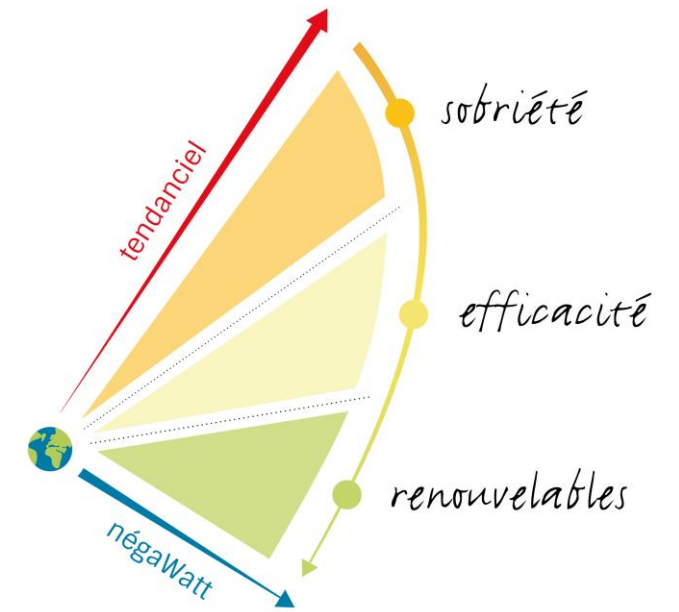
- La fabrique écologique
- Fondation nature et homme

- HOP halte obsolescence programmée
- <https://www.stopobsolescence.org/>

- Campus de la transition
- New trade union : « printemps écologique »
- New landscape with a few « opinion leader », science based
  - A lot of young highly graduate people

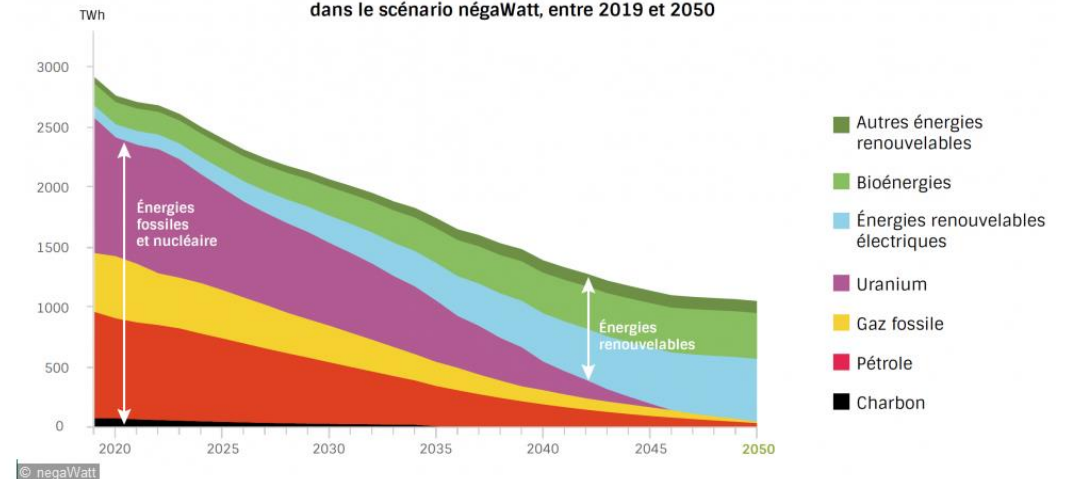


- Association / institut Negawatt (2001) France – Switzerland
- non-governmental French think tank
- the organisation has developed an energy transition scenario for the country,
- which reaches 100% renewables by 2050
- and dramatically reduces greenhouse gas emissions.



©Association négaWatt - [www.negawatt.org](http://www.negawatt.org)

Évaluation de la consommation d'énergie primaire pour les usages énergétiques et les usages matières dans le scénario négaWatt, entre 2019 et 2050



- **The Shift Project**

- is a French [nonprofit](#) think tank created in 2010 (and association Shifters 25000 members)

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- aims to [limit](#) both [climate change](#) and the dependency of our economy on [fossil fuels](#)
- advocates a progressive phase out of fossil fuels from our economy
- focused on spreading scientific knowledge about energy and climate change

Le plan de transformation  
de l'économie française



How changes in energy requirements  
and production will shape our world!

Monday 30 May 2022 | 7:15 pm CET (90min)  
INSEAD Europe Campus  
Amphi Christoph Rubeli and Online



Jean-Marc Jancovici  
President of The Shift Project

# Proposals for teaching in management and finance (main reports in english)

- <https://theshiftproject.org/en/article/training-tommorows-economic-actors/>
- <https://theshiftproject.org/climatsup-finance-former-pour-une-finance-au-service-de-la-transition/>



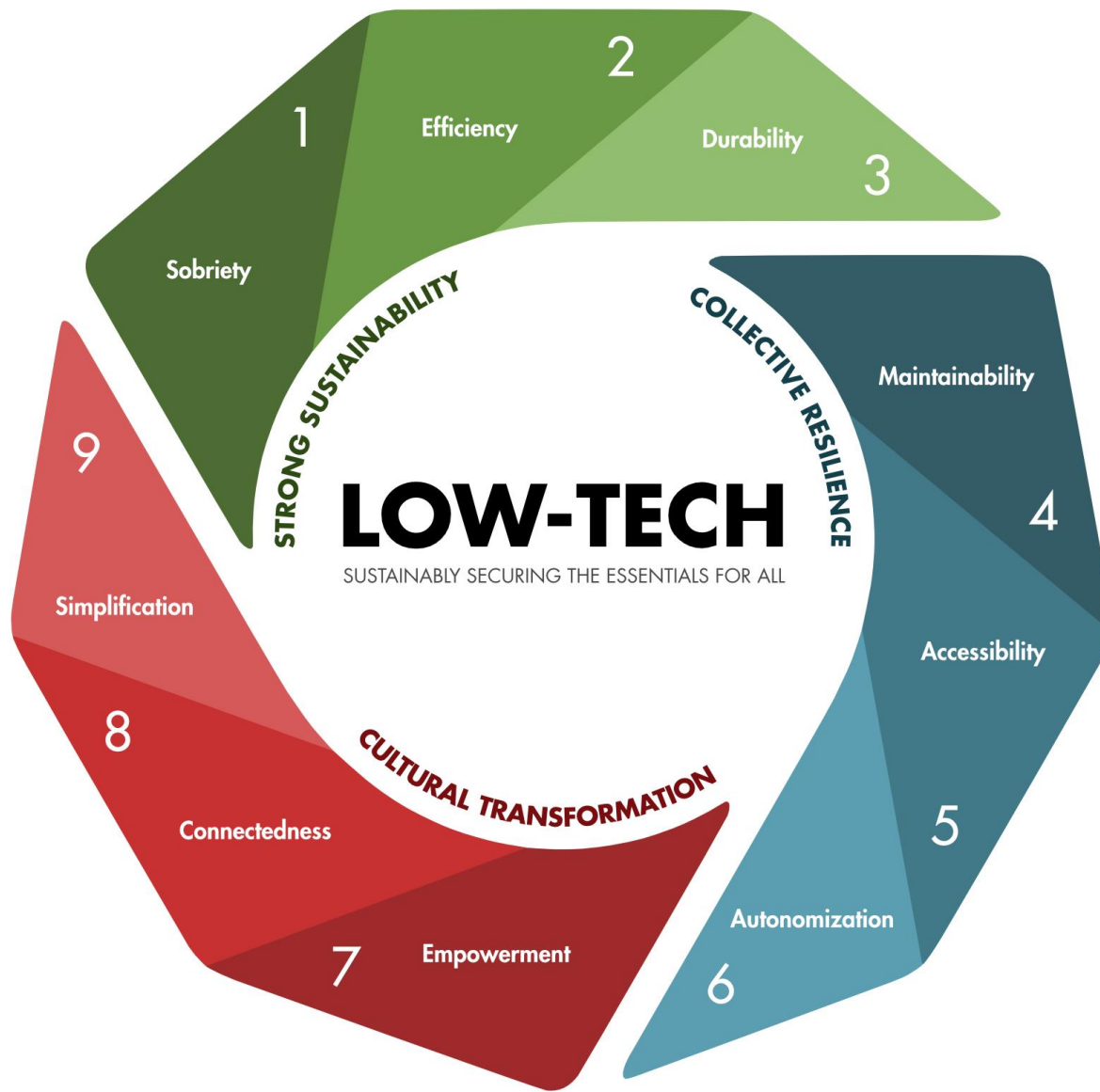


# « Low Tech » movement

- « Appropriate technology »
- as opposed to *high technology*.
- Open source knowledge
- At the Low-tech Lab
- ‘low-tech’ to define the techniques, technologies, services and know-hows
- Useful. Accessible. Sustainable.
- <https://lowtechlab.org/en>



The Age of Low Tech: Towards a Technologically Sustainable Civilization (English Edition)  
1er Édition, 2020 - Philippe Bihouix 19



**THE CRITERIA FOR ANY LOW-TECH INNOVATION APPROACH:**

**STRONG SUSTAINABILITY**

**1 Sobriety**

Refocuses on the essentials and tends toward the technological optimum: lowest technological intensity and greatest simplicity ensuring needs be met with a high level of reliability

**2 Efficiency**

Minimizes the consumption of energy and resources, from extraction of raw materials through production, distribution and use to end of life

**3 Durability**

Presents maximum technical, functional, ecological as well as human viability in the short, medium and long term

**COLLECTIVE RESILIENCE**

**4 Maintainability**

Can be maintained and repaired by users themselves so far as possible, using standard parts and materials

**5 Accessibility**

Offers maximum ease of use

**6 Autonomization**

Is made from resources that are exploited and transformed as locally as possible

**CULTURAL TRANSFORMATION**

**7 Empowerment**

Facilitates appropriation by the greatest number, gives power to citizens and communities

**8 Connectedness**

Promotes the sharing of knowledge and know-how, cooperation, solidarity, social cohesion and links between communities

**9 Simplification**

Decomplexifies society at the socio-economic and organizational levels based on reflection about needs and vulnerabilities

*Design: Arthur Keller and Emilien Bournigal*






- Farmer's workshop (atelier paysan)
- Mobilab (open source hardware designer with and for farmers)



# Companies / business changes

- Not so common to discuss organisational changes with engineering students
  - first science and technology, management after some years of experience
  - Little interest in economy, organisation, law, finance..
- Most engineers come to environment issues only after a few years of professional practise

# EY a new economy report 05/2024(Ernst and Young)

-  «Consider the concept of endless growth in biological terms. Our bodies don't grow indefinitely and, if our cells do, it's profoundly abnormal (we call it cancer). »
-  « The **global economy continues to overvalue financial aspects** and fails to value much else, disincentivizing the pursuit of businesses and economies that operate within planetary boundaries, and perpetuating trade-offs between sustainability and financial targets.
- « All of this paints a dire diagnosis of a patient that's sick and getting worse, yet we still see cause for optimism in the growing movement for economic transformation. »
-  « **Redefining value requires expanding our view beyond financial returns and monetary measures, embracing a multicapital model of value**, which recognizes the multiple dimensions of a thriving economy and society. »
- « **We recognize that most (if not all) businesses today would find their business models not only misaligned but, in many cases, even in conflict with these principles.**
- After all, it is a given that a business cannot be truly sustainable in an unsustainable system.
- Achieving the changes needed will require a fundamental transformation of our global economy and therefore businesses and markets themselves. »

# « New companies » ( Worker cooperative : SCOP SCIC...), société à mission

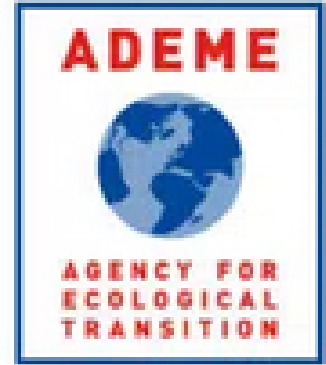
- **Société coopérative d'intérêt collectif**
- Change of business models + change of technical models
- MobION (electric motorbike made in France, highly repairable...)
- Commonx



# Actions in higher education

- Compulsory :
  - Carbon footprint
- Staff (Employees, professors, researchers...)
- Students

# Carbon accounting assessment (« Bilan carbone »)



- 2004 : Bilan Carbone method by [ADEME](#) (The French Agency Ecological Transition, created in 1991, around 900 employees),
- 2008 2010 Laws (Grenelle I and II) make it compulsory to carry out a [report on greenhouse gas emissions](#) (BEGES) for the largest companies, local authorities and public establishments.
- 2011, creation of ABC (Association Bilan Carbone) with the aim of continuing the development of the Bilan Carbone method as well training.
- -2018 ABC version 8 makes the link with other initiatives such as the [Science Based Targets initiative](#) or [the ACT methods](#)



# Bilan global des émissions

University of Strasbourg

**90 040 tCO<sub>2</sub>e**

*incertitude : 18%*

émises par l'Université de Strasbourg sur l'année 2021

C'est équivalent à :

- 9 900 tours de la terre en voiture ;
- La consommation annuelle d'une ville française de 9 800 habitants ;
- La combustion de 30 500 000 litres de pétrole ;
- La photosynthèse annuelle de 14 600 ha de forêt, soit près de 2 fois la superficie de Strasbourg.



**1,61**  
tCO<sub>2</sub>e/étudiant



**10,8**  
tCO<sub>2</sub>e/personnel



**165**  
kgCO<sub>2</sub>e/m<sup>2</sup>  
de patrimoine immobilier

# Bilan global des émissions

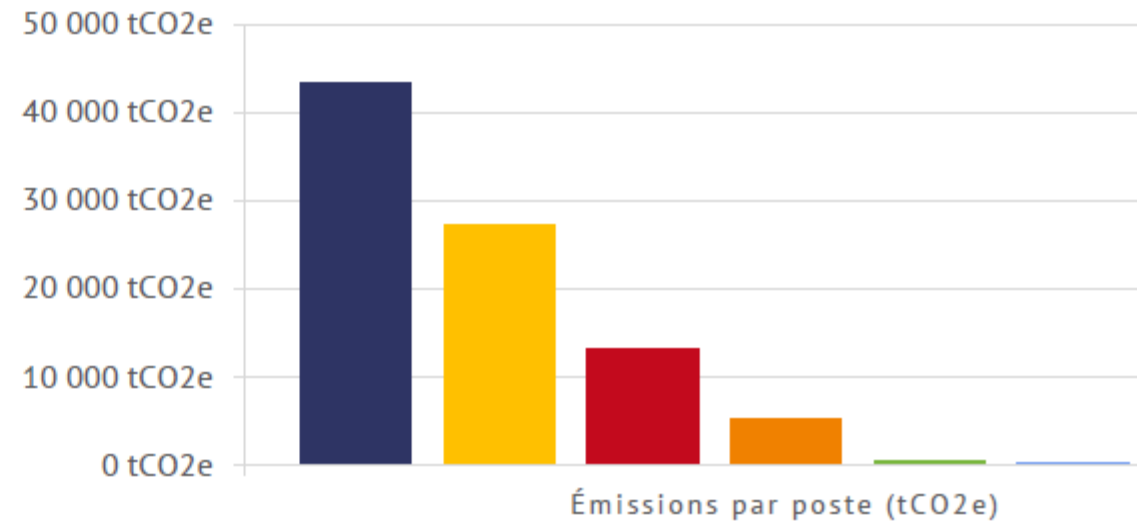
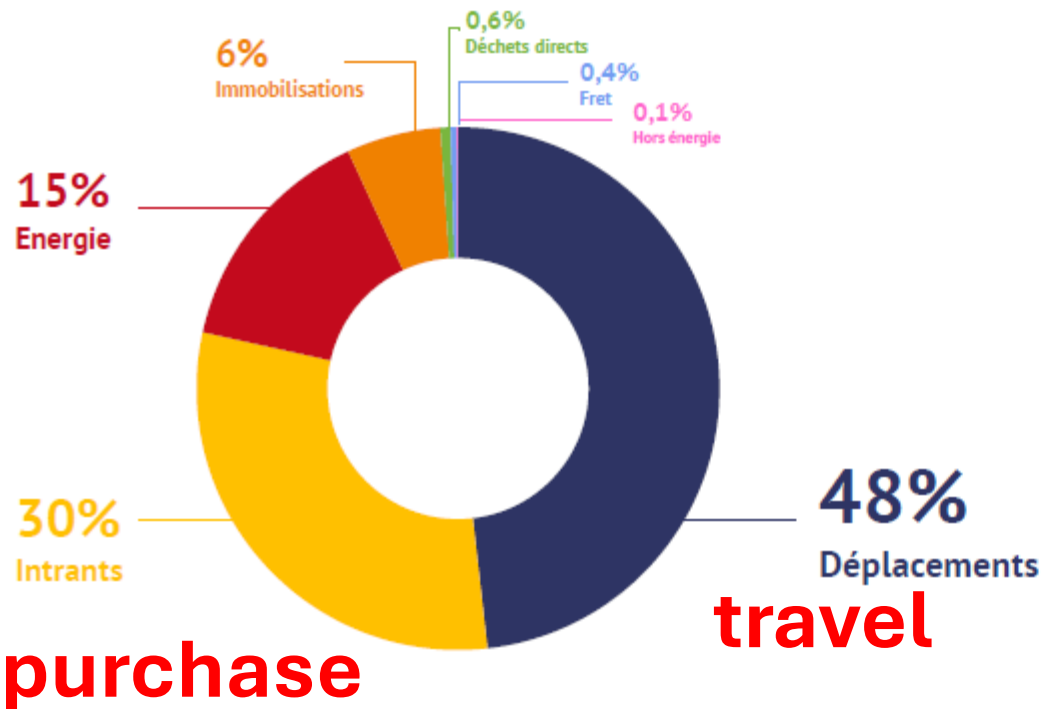
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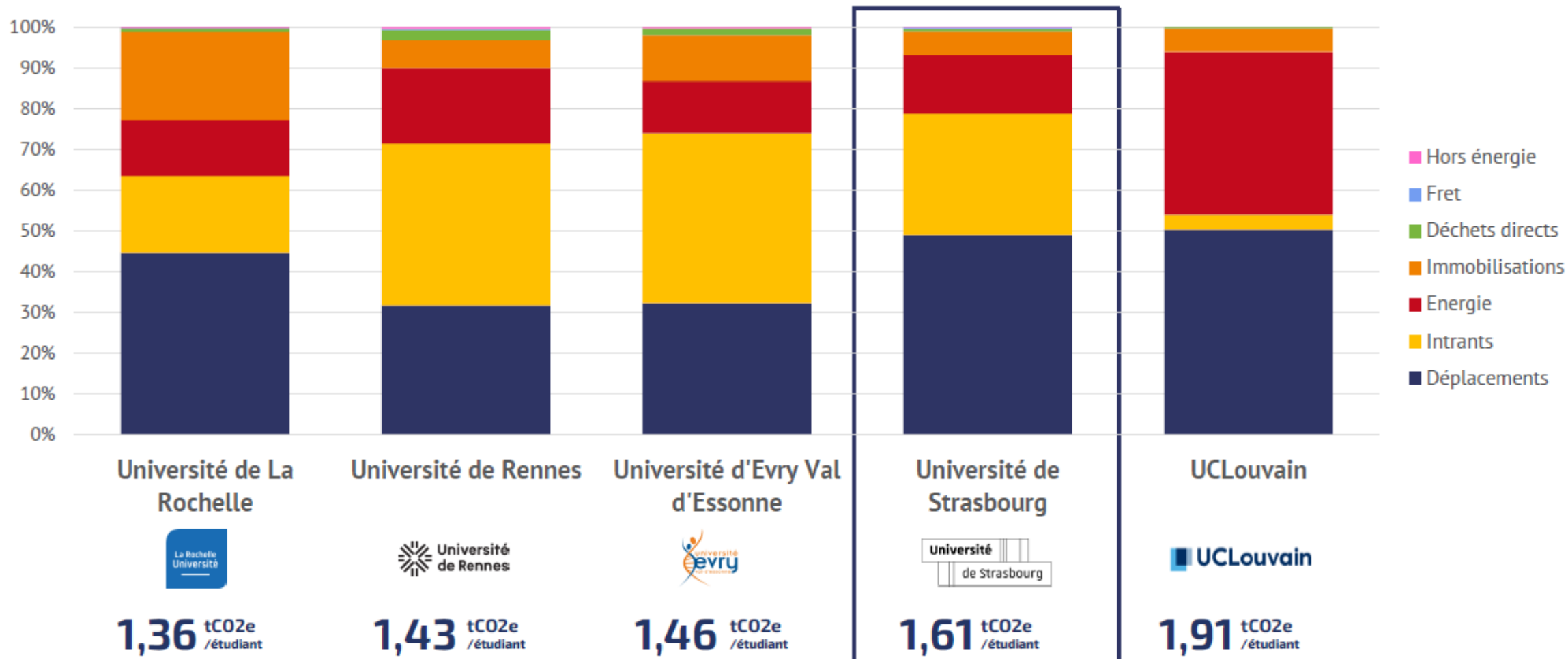
## Répartition des émissions par poste



■ Déplacements (48%) ■ Intrants (30%) ■ Energie (15%)  
■ Immobilisations (6%) ■ Déchets directs (0,6%) ■ Fret (0,4%)  
■ Hors énergie (0,1%)

# Comparaison avec d'autres universités

## Répartition des émissions par poste



- Actions for or by members of the staff
- professors / serearches



Centre national de la  
recherche scientifique

Agence publique

# Reducing the environmental footprint of our research activities

Labos 1point5 is an international, cross-disciplinary collective of academic researchers who share a common goal: to better understand and reduce the environmental impact of research, especially on the Earth's climate.

- <https://labos1point5.org/>
- Created in 2019, recognised in 2021
- By the researchers themselves
- More than 2000 researchers,
- transdisciplinary

**Social sciences study day - Towards a greening of higher education and research:**

- 📅 Wednesday 19 June 2024
- 📍 Laboratoire interdisciplinaire sciences innovations sociétés (LISIS), Noisy-le-Grand
- 📄 [Schedule and registration](#)

**Conference - Teaching ecological and social transitions in higher education (ETES):**

- 📅 9 and 10 July 2024
- 📍 Bordeaux
- 📄 [Schedule and registration](#)

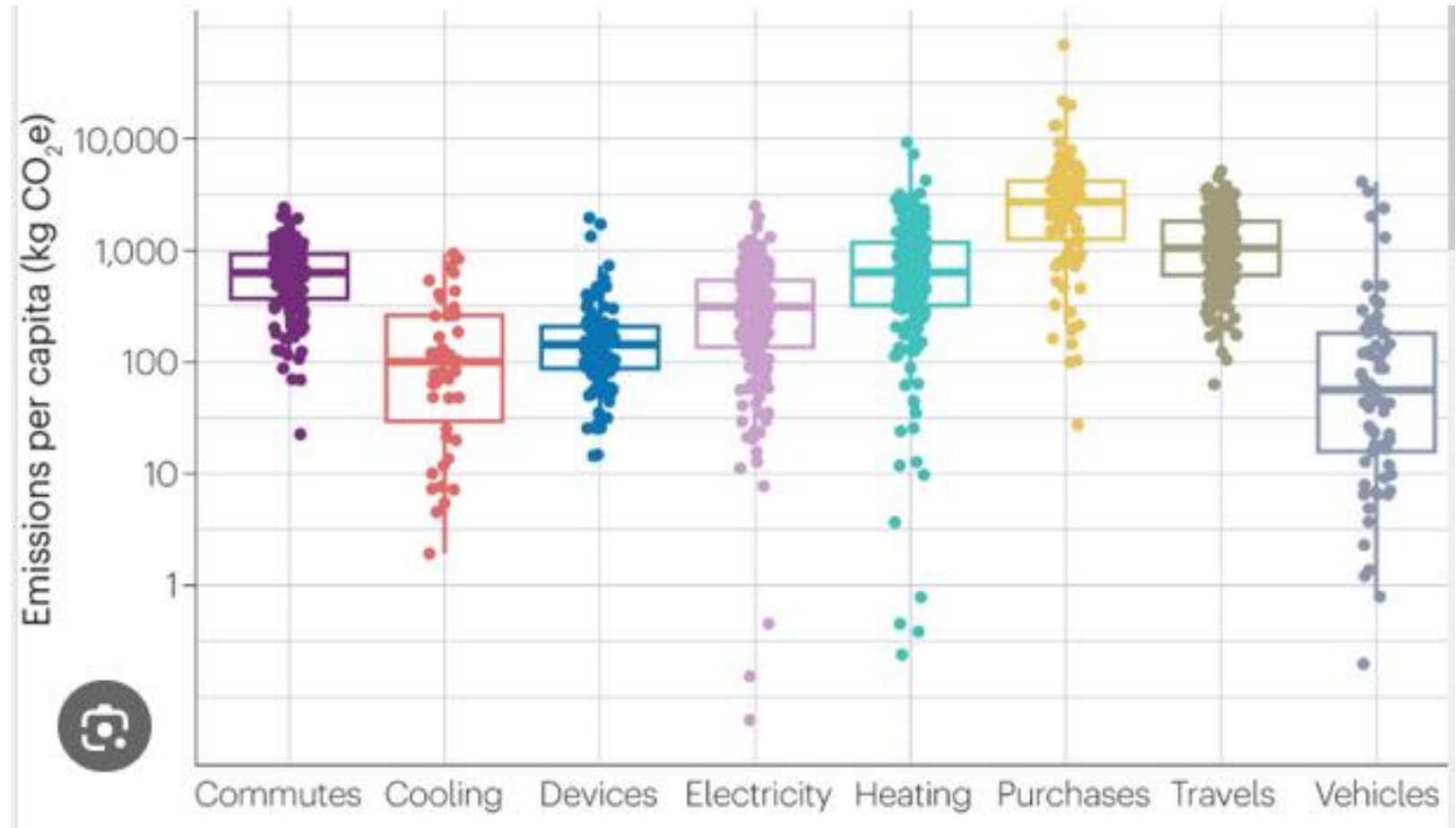
**Conference - Journées Labos 1point5 2024:**

- 📅 5, 6, 7 November 2024
- 📍 Paris and on line
- 📄 [Schedule and registration](#)

# Labo1point5

## Carbon footprint of laboratories

- Mostly Purchase
- Then travels
- => exchange platform of products between labs...



# Workshop of Political Ecology



## Réseau des Ateliers d'écologie politique :

- Montpellier : [Atécopol Montpellier](#)
- Marseille : [Atécopol Aix-Marseille](#)
- Bordeaux : [Abécopol Bordeaux](#)
- Paris & Ile de France : [Écopolien](#) "Atelier d'écologie politique francilien"
- Rennes : [Épolar](#) "Ecologie politique en Armorique"
- Lyon : [La Fabrique des questions simples](#)
- Dijon : [Atécopol Dijon](#) "Penser les transitions"

## Collectifs "amis" partageant des valeurs et des orientations similaires ou complémentaires :

- [Labos 1point5](#) (GDR du CNRS)
- [EcoInfo](#) (GDS du CNRS)
- [Sciences Citoyennes](#)
- [Scientifiques en rébellion](#)
- [Mouvement des savoirs engagés et reliés](#)
- [Communauté Archipel](#)
- Grenoble : [Campus d'après](#)
- Nice : [Observatoire de la Transition Écologique et Citoyenne Côte d'Azur](#) (OTECCA)
- Espagne (Barcelone) : [Research & Degrowth](#)
- Belgique (Louvain) : [Groupe de réflexion interdisciplinaire sur la crise écologique](#) (GRICE) et son [Séminaire interdisciplinaire de recherche](#)

## ATECOPOL

Pluridisciplinarity groups of scientists working and exchanging on impact of ecological changes

Rather informal





# EDUCATION situation in « universities »

- framework note from the Ministry of Higher Education of July 2023
- recommends of 30 hours of teaching
- dedicated to environmental themes and the “ecological transition” (biodiversity, climate, planetary limits etc.), in the first years of all higher education courses.
- It is about providing a basic general contribution to make students literate in these issues and their systemic nature.
  
- REFER TO THE GREEN COMP
- **GreenComp, the European sustainability competence framework**

# Engineering universities

## CTI (accreditation commission) 2022 2024

- R&O (Rules and orientations)
- (focus on carbon assessment
- , même pas energie)

# Practical implemtations



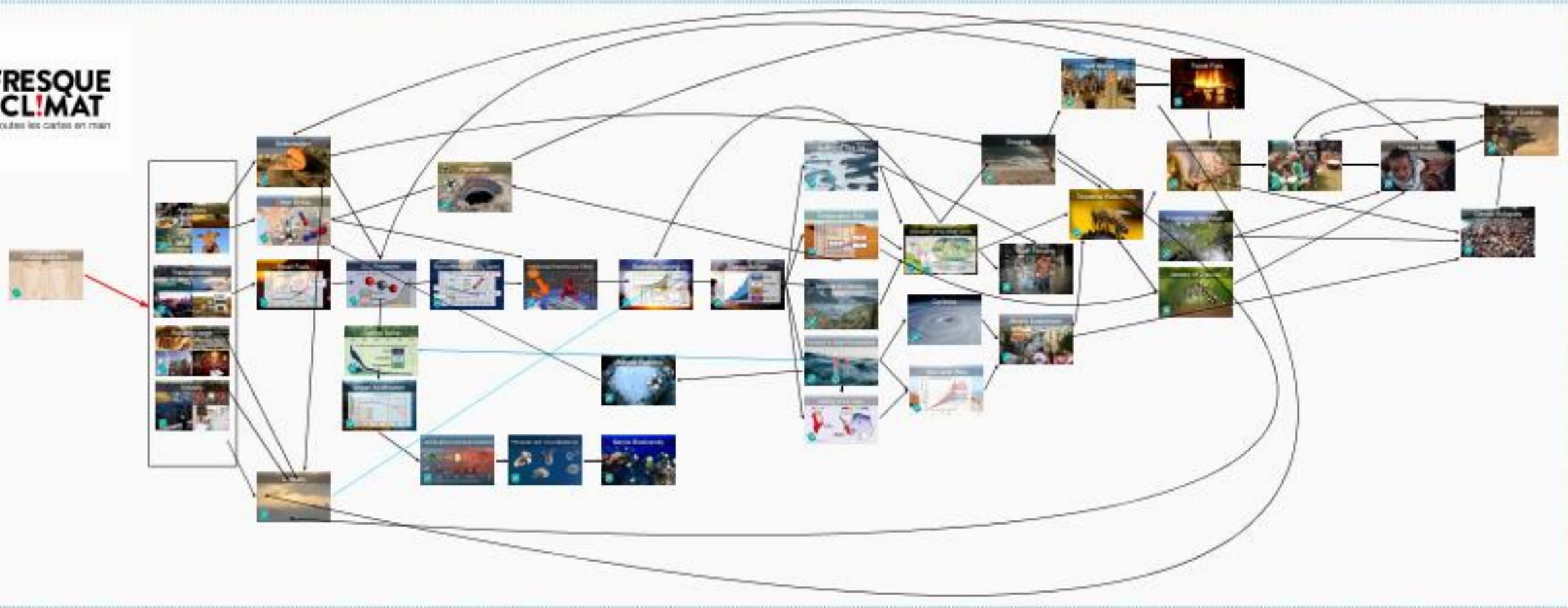
- Fresques du climat
- collaborative Climate Fresk workshop
- teach the fundamental science behind climate change
- empower you to take action
- 3 hours



1.7 million  
participants

162  
countries

**LA FRESQUE  
DU CLIMAT**  
Vous avez toutes les cartes en main



# Changes in curriculum

- Change of strategy => improves ranking of university
- a way of attractiveness
  
- Orientation of topics of projects : renewable energies, reuse of components...
- Focus companies visits on energy, materials, waste and resources management, and also organisation
- Low tech projects with fablab and users (high motivation)
- Courses on
  - Life cycle assessment (LCA)
  - Materials, technologies for recycling...

# Actions in engineering schools

- Polytech schools : « green scholarship »:
- Eligibility criteria:
  - Use means of transport with low carbon impact
  - Choose an internship or study theme linked to one of the 17 UN Sustainable Development Goals
- INSA Lyon (faculty of energy engineering and environment)
- Pass carbone
  - A maximum carbon footprint of 5 tons is set for each student for their travels during the study (5 years).
  - If more than 5 tonnes: the student must write a report to explain....



# DU The Eco-responsible Engineer

- Over three years
- Optional (one third of students)
- trains engineers, who upon completion of the diploma will be able to measure the ecological impact of their activity.
- 2 certifications recognized at least nationally :
  - IFC/ABC Carbon Assessment Certification
  - Responsible Digital Knowledge Certification
- dedicate report on environmental issues related to the master thesis or internship



# My personal feedback and courses experiments

- A few students are highly motivated
- Most students are mainly passive
  - educated with those subject since elementary school
  - no point of comparison few historical and societal knowledge,
  - few communication with former and older generations
  - lack of connection with nature and practical objects
  - Always increasing complexity of technical products (can not be repaired)



# Low Tech / intermediate - appropriate technology

# Order of magnitude

- Order of magnitude (CTI demand)
- An order of magnitude is an approximation of a value relative to some contextually understood reference value.
- Standard value”
  - (example : pizza)
- => learn by heart (from memory)
- => make small practical calculations
- => exercises connected to everyday life (heating, household appliances, transport...)

# Let's start !

- Human food energy per day (little activity) = 2100 kCalories (chemical energy, transformed into movement and eventually heat)
- So  $2100 * 4185$  Joules per day (amount of energy per day = stock)
- A mean consumption  $(2100 * 4185) / (24 * 3600) = 102 \text{ J/s} = 102 \text{ Watts}$  (Watt = J:s)
- which is heat = approx 100 W (flow of energy = power)

=> A human (inactive) is a heater of 100 W

toaster 1000 W, electric radiator 2000 W, Little flame 100 W

Human mechanical power = 100W (movement, can be converted in electricity) during a day of work

Drill machine = 500 to 1000 W

# Homework for students : technical and social evolution

- Ask students to compare their current situation with 50 years ago (when their grand parents were young) : on technological and social point of view
- Technology : few changes except information technology and digital technologies,
- Society : major changes (rights) / mass consumption
  
- Aim of the exercise
- => societal changes (and also infrastructures) take time
- => smaller footprint and less consumption is possible without major renonciation
  
- responses :
  - « technology » = information technologies
  - New « ecological awareness »
  - Mass consumption, dispose of products....
  
- => compare with 100 years ago, give more time (and put pressure)

# « environment literacy »

- New knowledge to be built
- In energy ‘order of magnitude’, or standard value, to avoid approximative knowledge
  - Comparison with Medicine : need numbers « speak with data »
  - Increase level : Stop stupid comparisons

Need for critical thinking

# Some feedbacks

- Bigger problems than CO2 ??
  - Biological collapse
  - Information disaster
  
- Even if aware of the situation
- people find it difficult to change their job at university
- Need for people with general and rather deep knowledge

- Thank you !