CARBON IMPACT OF CENTRALE NANTES

SUMMARY

CARBON NEUTRALITY SPECIALISATION

APRIL 2020

CENTRALE NANTES

NCO_2 NEUTRALITE CARBONE

SCHOOL YEAR 2019-2020

ECOLE CENTRALE DE NANTES

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This document aims to summarize the "Carbon Impact of the Ecole Centrale de Nantes" report of the "Carbon Neutrality" specialization. Its purpose is to summarise the main results, levers for action and reflections on the subject. The potential "rebound effects" have not been taken into account in the quantification of the greenhouse gas emission reductions allowed by the proposed levers of action: these figures are only order-of-magnitude estimates. The methodology used to calculate the "Bilan Carbone" and many additional information are in the global report.

Thank you for your interest in our work.

The abbreviation "ECN" refers in the following to the "Ecole Centrale de Nantes".

Figures in infographics are given in **tCO_2eq** (see boxed text page 3).
Slight inconsistencies might appear in the numbers presented, due to rounding.

This document is a translation from the French version. Some original sources are not provided here, as they are only available in French.

A "**Bilan Carbone**" is a carbon footprint analysis with a detailed protocol.

1 Context

1.1 Climate change and international objectives

The **Intergovernmental Panel on Climate Change** (IPCC) in its report "Global Warming by 1.5°C"[1] proposes scenarios for limiting greenhouse gas (GHG) emissions **to keep global warming below 2°C or even 1.5°C.** The 2°C scenario would require a 25% reduction in emissions by 2030 compared to 2010 and the achievement of carbon neutrality by 2070. For the 1.5°C scenario, the reduction is greater, still by 45% by 2030 compared to 2010, making it possible to reach carbon neutrality in 2050.

As can be observed in the graphic below, the current trend is rather the opposite: **global GHG emissions have increased since 2010. Both mitigation and adaptation** to climate change are technological, economic, social and institutional challenges that will become increasingly difficult to overcome without prompt action to reduce GHG emissions.

In France, these reduction objectives have been adapted since 2015 via the **"Stratégie Nationale Bas-carbone" [National Low Carbon Strategy] (SNBC)** which sets the objectives for reducing GHG emissions by 2050[2]: **between 1990 and 2030, a 40% reduction in emissions is expected** and by 2050 they will have to be divided by six. The SNBC also defines these objectives by sector of activity (building, industry, transport, energy, agriculture, waste).

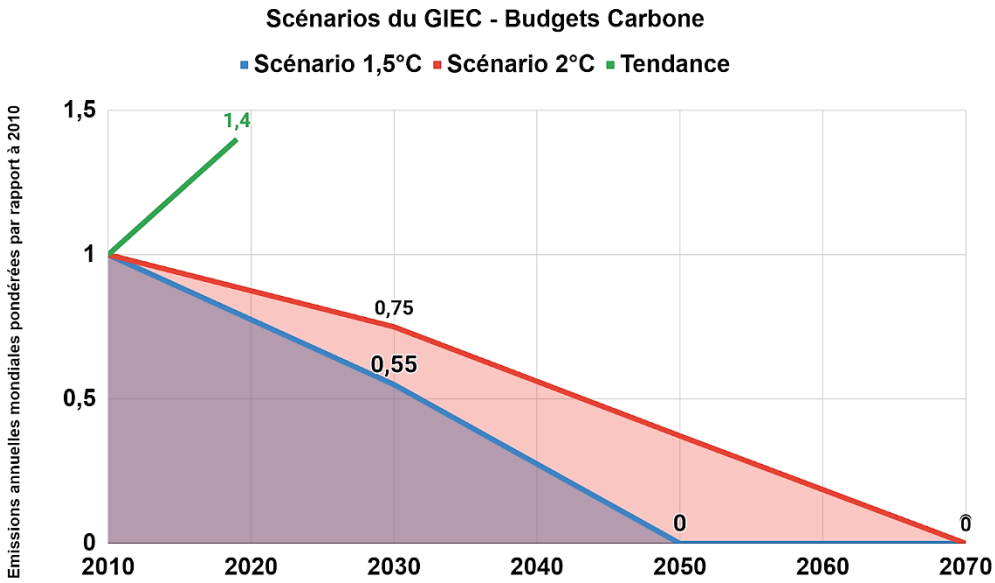

Figure 1 : IPCC mitigation scenarios
*[**vertical axis key**: world GHG emissions, base 1 for 2010 levels] ["Tendance" = actual trend]*

1.2 Principles of a "Bilan Carbone"

According to the ADEME (French Environment and Energy Management Agency) methodology, the carbon balance can be divided into three main areas (see picture below):

- Scope 1 includes direct emissions (biomass, cars belonging to the ECN…),
- Scope 2 covers indirect energy-related emissions (heating network, electricity).
- Scope 3 includes all the other indirect emissions (fixed assets, purchases of products and services, travel, food…).

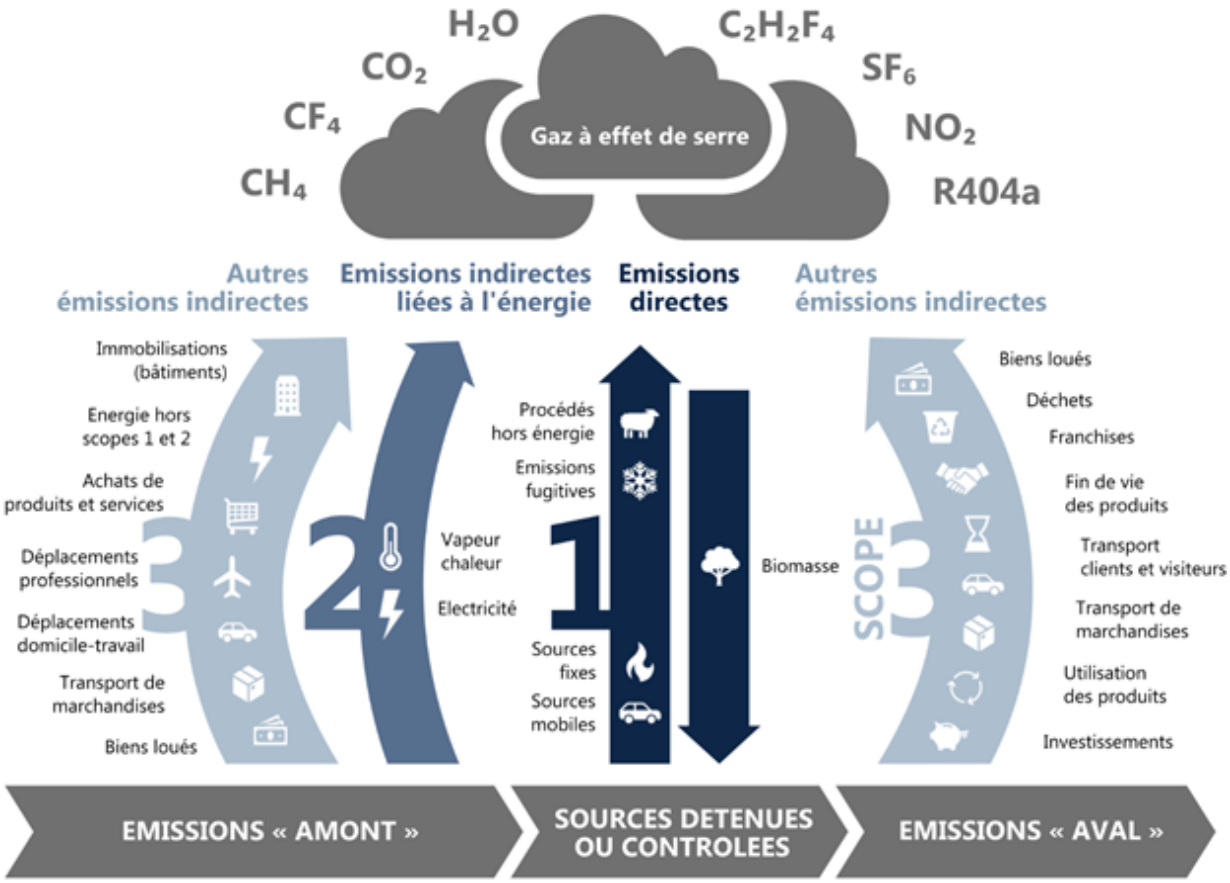

Figure 2 : Explanatory diagram of a "Bilan Carbone"
*[**left arrow, top to bottom** : other indirect emissions, buildings, energy outside scope 1-2, purchases and services, business trips, commuting, receiving goods, leased goods]*
*[**next arrow** : indirect emissions linked to energy, steam, heating, electricity]*
*[**middle left arrow** : processes (excluding energy), fugitive emissions, stationary and mobile sources]*
*[**right arrow, top to bottom** : rented property, waste, franchises, products end of life, clients and visitors trips, sending goods, products use, investments]*

The **Scope 3** of a "Bilan Carbone" is often neglected, because it concerns indirect emissions thus geographically far from the studied organisation, but it almost always weights **the most important part of the "Bilan Carbone".**

French law makes calculating a "Bilan Carbone" **mandatory** (only for scopes 1 and 2). Establishing a **transition plan for all public institutions** with more than 250 employees every 3 years is also required by law: the ECN is therefore concerned.

1.3 Individual action or collective action?

In 2017, the average French person was accountable for 10.8 teqCO_2/year, i.e. **5.4 times the required level** by the Paris Agreement : **2 teqCO_2 / year / person**

According to the report "Doing your fair share for the climate?", a person making **radical lifestyle changes** (without additional investments) could reduce his/her carbon footprint by 25 %.

Thanks to **strategic investments in households (mobility, housing…),** yearly individual emissions could be reduced by another 20 %, reaching a final 45 % in the end.

Figure 3 : Proportion of individual and collective actions to achieve the objectives of the Paris Agreement

How can we decrease our carbon footprint? First, there are the small everyday gestures to save electricity, water, decrease the use of plastic…

The "Doing your fair share for the climate?" report from Carbone 4 lists different ways to shrink the average French person footprint from 11 to **2 tCO_2eq* per year (as it is recommended by the Paris Agreement).**

The conclusion of the consulting company is blunt: "**It is therefore futile, and even dangerously counter-productive, to pretend that we can resolve climate issues by placing the full responsibility on individuals alone.**" (Figure 3)

* GHG emissions are counted in **tCO_2eq** (mass of **equivalent** carbon dioxide). This unit let us take into account all the other GHG, which have another **global warming potential** (GWP):

GWP (CO_2) = **1**
→ emission of 1 t CO_2 equals **1** tCO_2eq
GWP (CH_4 or methane) = **29**
→ emission of 1 t CH_4 equals **29** tCO_2eq

Put another way, 1 t of methane has an effect on the global warming 29 times stronger as carbon dioxide.

Organisations must therefore also take this ecological issue into account. **Preventing the worst climate scenarios from happening requires also collective rules and investments** made by governments, companies, local authorities or public institutions such as the ECN.

1.4 Low carbon approach within the ECN

The Carbon Neutrality specialization (opened in September 2019) follows the "Bilan Carbone" carried out in 2012. Its goal is **to initiate the reduction of GHG emissions induced by the ECN**. To that end, the 11 students involved **(1) made first of all another "Bilan Carbone"**, more thorough than the previous (including scope 3). The results were then **(2) presented to ECN users to raise awareness** through workshops and infographics. In the end, **(3) a custom plan of action for the ECN was designed** to find ways to reduce its carbon footprint.

This project is a valuable asset for the ECN: **it materialises the engineering school's commitment to sustainable development and social responsibility**. Future changes in law will also be more easily included in the school policies. Besides, it could lead the ECN to **be seen as a pioneer in ecological transition**, improving that way its reputation among other engineering schools.

2 "Bilan Carbone" of the ECN

2.1 Overall results

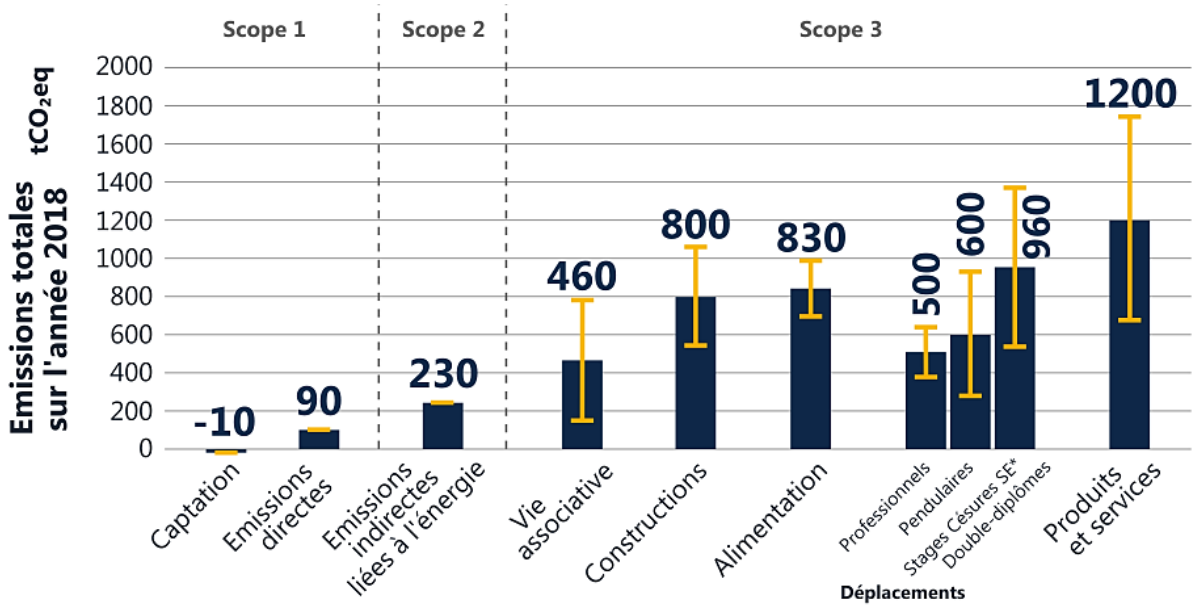

Figure 4 : Overall ECN's "Bilan Carbone" results (yellow bars represent uncertainty of measurement) [histogram bottom text, left to right : vegetation, direct sources, indirect ~ (energy), student life, buildings, food, trips (business, commuting, students), products and services]

The "Bilan Carbone" gave the following result: **5683 tCO2eq** for all 3 scopes in 2018. It is the same amount as if someone made **22 round trips between Paris and Moscow by plane every day, during a whole year** (252 working days in 2018).

Figure 4 shows that scope 1 and 2 emissions are very low (less than 6 % of the overall result). Moreover, scope 3 gathers three of the most carbon-intensive activities:

- **Student and staff trips** (2060 tCO2eq, 36 % of the overall result),
- **Products and services** (1200 tCO2eq, 21 %),
- **Students and staff lunches** (830 tCO2eq, 15 %).

Nevertheless, these results are non-exhaustive, thus most likely **underestimated**. Indeed, some activities remain **too complex to evaluate** (such as IT use, energy distribution networks), and others were only partially taken into account due to a **lack of raw data**.

2.2 Results by user profile

Evenly distributed among all its users, one ECN user is responsible for the emission of **2.25 tCO_2eq**. This figure exceeds the **total** amount of GHG one person can be accountable for: **2 tCO_2eq**, according to the **Paris Agreement**.

It has been chosen to split the overall result into 4 typical categories of users: students, PhD students, academic personnel and other staff (Figure 5).

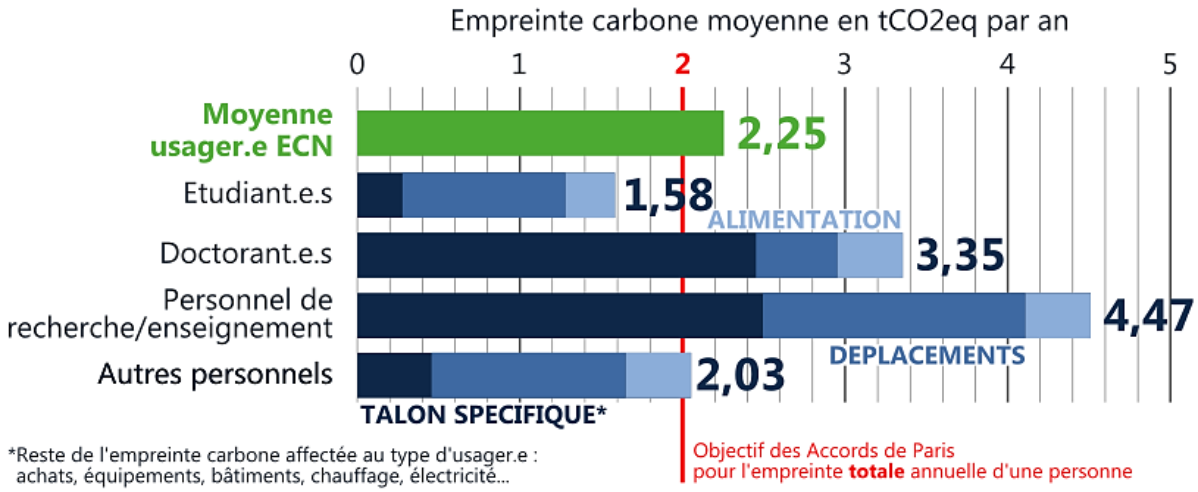

Figure 5 : Comparison of typical ECN user profiles:
average footprint per ECN user according to four profiles for the year 2018
[left, top to bottom: user average, students, PhD students, academic personnel, other staff]
*[*ALIMENTATION = *food,* DEPLACEMENT = *mobility,* TALON = *remainder]*
[bottom left text: ''remainder of the total footprint, specific to user types: purchases, equipment, buildings, heating, electricity...'']

These average profiles highlight an **uneven distribution of GHG emissions**. Students and academic personnel **travel a lot by airplane**, hence their trips carbon footprint; unlike PhD students and other staff. On the other hand, lunch-related emissions are similar regardless the profile.

The remainder gathers two categories. The first is common to all users, and includes GHG emissions linked to waste management, sheep and vegetation; the second varies depending on the profile. For instance, students only use buildings with classrooms (A, B, C and L) whereas academic personnel work in larger labs: the (buildings) carbon footprint of the latter is therefore greater.

It seems thus **essential to reduce the "professional part" of each user's carbon footprint**, in order to comply with the Paris Agreement requirements.

2.3 Focus on students and staff trips

Students and staff trips are the main source of GHG emissions for the ECN: **2060 tCO_2eq**. It is the same amount as if someone made **16 trips between Paris and Moscow by plane every day, during a whole year**.

This field gathers the following categories (Figure 6):

Work trips ["DEPLACEMENTS PROFESSIONNELS"]: journeys made by staff members in the context of their work, and trips made by visitors and clients (lecturers, doctoral juries...). The data needed to compute GHG emissions was given by the various transport service providers of the ECN and its labs;

Commuting ["DOMICILE ECOLE"]: the data needed was provided by the "Mobility" survey carried out in early 2020;

Student trips [*the whole left rectangle*] (internships, exchange programs...): several working periods are compulsory for students, and they often imply travelling. The anonymous data was given by the International Relations Department (DRI) and by the Academic Affairs Department. A single round trip was considered for each journey: the students were considered responsible for the additional trips.

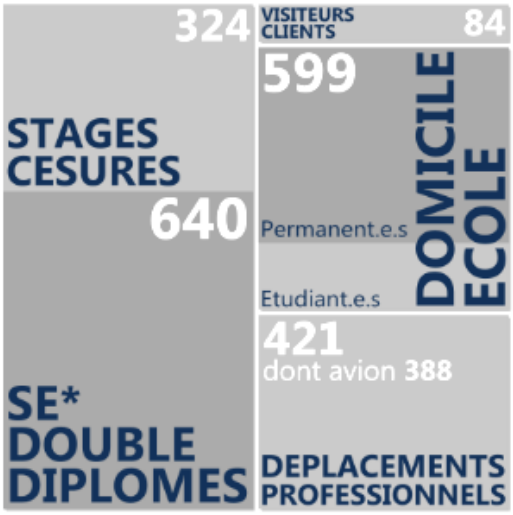

Figure 6 : GHG Emissions related to students and staff trips ["dont avion" = of which airplane] ["permanents" = staff "etudiants" = students]

Examples of levers for action

A **"Responsible Mobility" grant** to reduce the impact of student travel has been drafted. Depending on social criteria, it would fund the difference in price between train and plane for close destinations. A sum of 5,000 € for all selected could avoid the emission of **35 tCO_2eq,** thus reducing the **impact of student travel by 3 %**.

To reduce the carbon impact of commuting, one lever for action could be **to authorize and encourage staff and PhD students to work in Home Office more days,** up to three a week (according to French law). If half of the staff living more than 10 kilometers away from the ECN did one remote work day a week, **37 tCO_2eq** can be avoided, **i.e. a 6% reduction in emissions related to commuting.**

It is also possible to reduce the carbon impact of **staff business travel** by establishing a **maximum carbon budget** for travel, **for each laboratory and department**. It has indeed been noted that there are wide differences between individuals within these entities and across the ECN. The carbon budget thus allocated should be distributed democratically among the people within an entity. It could be then chosen to travel shorter distances (or choose better means of transport) to remain within the allocated budget. Under certain assumptions, the carbon gain of this lever for action would be **188 tCO2eq,** which corresponds to **a 49% reduction in the impact related to business travel**, i.e. a **3.2% reduction in the ECN's "Bilan Carbone"**.

2.4 Focus on products and services

"Products and services" (second most emissive activity: **1200 tCO_2eq**) includes all indirect GHG emissions generated by the **purchase of products and the use of services**. It generates the same amount of GHG as if someone made **9.5 trips between Paris and Moscow by plane every day, during a whole year**.

This field gathers the following categories (Figure 7):

- Machinery and equipment (529 tCO2eq),
- Repairs and installations (365 tCO_2eq),
- IT, electronics and optics (161 tCO_2eq),
- Services (83 tCO_2eq),
- Others: waste management, transport of goods… (64 tCO2eq)

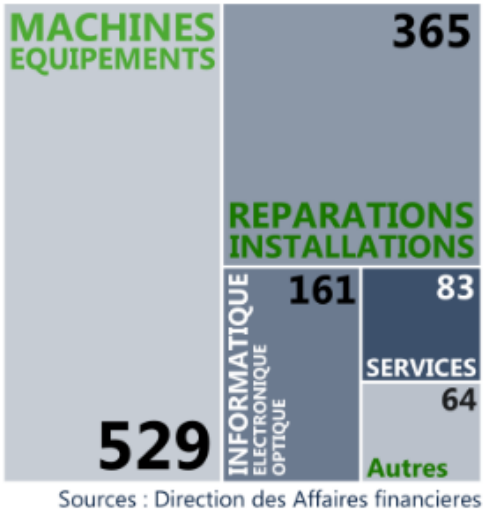

Figure 7 : GHG Emissions related to products and services

It is important to mention that the calculation method for this item is based on the use of the **ADEME's monetary ratios** (in $tCO_2eq/k€$ HT), which make it possible to associate an emission with an expenditure. Indeed, only monetary data on purchases from the ECN were available. The labels of these emission factors are very broad and do not take into account the diversity and specificities of the real products and services used. As a result, the **uncertainties in the calculations made are very large.**

Moreover, this calculation method does not allow for any improvements or the **decoupling investment/emission**. Indeed, if slightly more money is spent to choose a more environmentally friendly seller, or items with a lower carbon footprint, it will wrongly increase the carbon footprint[3].

The monetary factors allow a **good overall estimate**, but the final result is not detailed enough to precisely identify where GHG emissions are from.

Examples of levers for action

The above considerations lead however to possible improvements for the ECN. Counting the GHG emissions due to purchases of products and services could be done by the **creation of a Purchase Department,** which would centralise the ECN orders. Thus, a carbon balance of purchases could be carried out continuously, and it would be possible to draw a quantitative analysis of "Products and services". Furthermore, the people within this department could be trained on the environmental impacts of purchases in different sectors; hence, the implementation of a **general strategy for the improvement of ECN** purchases would be possible.

2.5 Focus on food

The third most emissive activity is lunches of ECN users: **830 tCO_2eq** (6.5 trips between Paris and Moscow by plane every day). It takes only into account lunches while at school: not during weekends, internships or while abroad (for students).

The previous figure has been computed thanks to a **survey** on lunch habits, and ADEME emissions factors. **14 % of meals** are with **red meat**, and induce **52 % of food-related GHG emissions**, while 43 % of meals are vegetarian, and induce only 13 % of food-related GHG emissions (Figure 9).

A vegetarian meal "produces" **more than 10 times less GHG** than a meal with red meat (beef, lamb…).

The average ECN user lunch amounts to 1.7 $kgCO_2eq$. This is **less than the national average** (2 $kgCO_2eq$). It is difficult to determine which parameters influence this result. Though, the declarative bias of the survey, a greater consideration of environmental issues or the high cost of meat products (especially for students) could explain the slight difference.

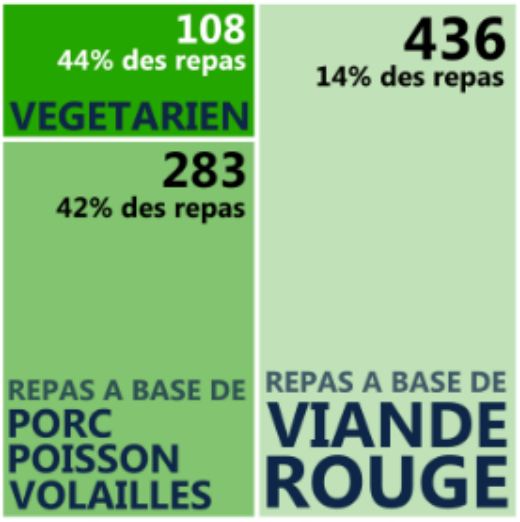

Figure 8 : GHG Emissions related to lunches of ECN users ["repas" = meals] ["PORC POISSON VOLAILLE" = pork fish poultry] ["VIANDE ROUGE" = red meat]

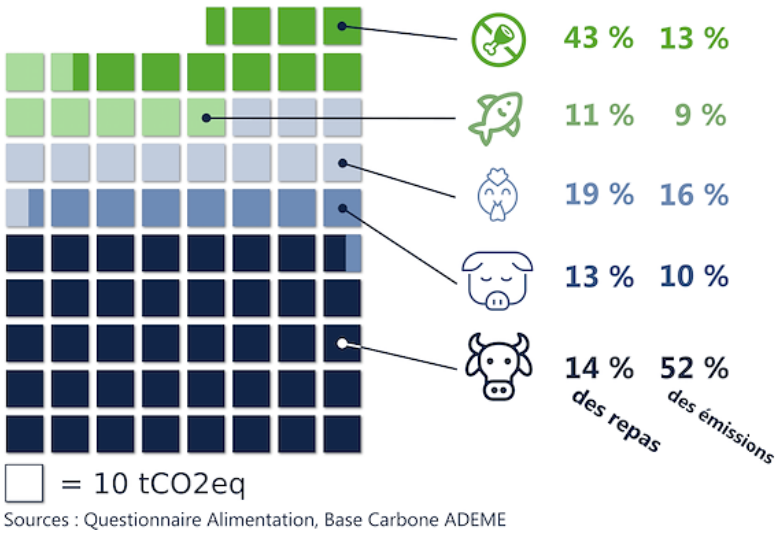

Figure 9 : Comparing GHG gases and the proportion of lunches (ECN users) containing different sources of proteins

Examples of levers for action

39 % of ECN users who eat at the main canteen (*Restaurant Universitaire (R.-U.) du Tertre*) state that they regularly don't eat all the food on their food tray. One of the ideas suggested would be to give the opportunity **to pay only for the chosen items** and not the usual price (common practice in Germany). This initiative would result in a reduction of **33 tCO_2eq**.

Another possibility would be to reduce the amount of red meat consumed in the canteen (19 % of meals served) by **dividing the amount of red meat on the plate by 3**. Meals would still contain meat, but would mainly contain proteins from plants. This would avoid the emission of **118 tCO2eq** (which corresponds to a reduction of 41% of the part of the carbon balance of the canteen related to the ECN activities, 15% of the food item and **2% of the "Bilan Carbone"**.

3 Discussion

3.1 Training and research

The two main missions of the ECN are student training and research. There is **no rigorous method** to assess the carbon emissions associated with these activities.

However, the impact of training can be seen in the **professional choices** made by graduates: **two experimental models** were designed to provide an order of magnitude of the average impact of **active engineers**. The first one draws a **link between wages and impact**, and the second takes into account the **company field, size and the hierarchical position** of engineers. In addition, a few ideas for estimating the impact of the research were outlined.

If the estimation was repeated every year, it would make observing **its evolution through time** possible. This would attest to the efforts made by the ECN, and to **the impact of training** on the awareness of young engineers, and the **impact of the work** of researchers on society.

The rough estimates calculated with these methods indicate that **efforts** to reduce the carbon and environmental impact of the ECN **should not focus only on the GHG emissions related to its main activities** (energy, trips, purchases…). What the ECN "produces" also needs to be rethought, since young engineers are likely to **make critical decisions in the future**, and because publishing research articles has an **influence on industrial practices** or mentalities.

Thus, the missions of the ECN should not be put aside when setting up a low-carbon strategy. **Designing courses that meet all the current challenges is a strong lever for action.**

3.2 Avoided emissions

The issue of **avoidance** can be seen as ambiguous. Indeed, in order to reduce the final value of an entity's carbon balance, one can be tempted to count certain "positive" actions as emissions to subtract to the overall "Bilan Carbone". The French ADEME explains that an emission avoided by an organisation **concerns an emission reduction achieved by its activities, products and/or services, when these reductions take place outside its scope of activity**.

However, it is also necessary to remain vigilant as to the alleged origin of the avoided emission. As pointed out by the ADEME, several stakeholders or organisations are often involved in an action that will lead to a reduction in emissions. Thus, it is preferable **not to attribute responsibility for it, but only to announce one's "contribution"** to the action. Finally, **increasing "avoidance" is not the priority**, unlike reducing one's own emissions. As the ADEME concludes, without questioning the environmental benefit of avoided emissions, an organisation's priority must be to **reduce its own direct and indirect emissions**.

Accounting avoided emissions is a delicate task that requires special attention. This is why in the ECN "Bilan Carbone", the "avoidance" of **average meals** (which users would take if they were not at the ECN) and the **energy production of the floating wind turbine** were not taken into account. It was however, for waste and recycling[a].

3.3 Carbon offsetting

Carbon offsetting consists of financing **projects to reduce or capture (in "sinks") GHG emissions** outside the scope of an organization's responsibility. This can be seen as a simple way of balancing the GHG emissions associated with an organization's activity.

The ADEME strongly insists on the conditions required for the implementation of an offset strategy: **voluntary offsetting only takes place after the implementation of effective actions to reduce GHG emissions within an organisation's scope of action**. As the risk of greenwashing is very high, any communication on offsetting actions has to be justified (emission reduction actions and their results)[4].

Offsetting is **not a miracle solution**, and can **sometimes even be counterproductive** by encouraging complacency[5] and therefore the terms "offsetting" or "carbon neutrality" must be used with caution. The purchase of a carbon credits by an organisation does not in any way means subtracting 1 tCO_2eq from its own overall carbon footprint. Offsetting should not be a way of relieving an organisation of its responsibility to reduce GHG emissions: **the illusion of a "neutralization" of GHG emissions that offsetting can create distorts the perception of an organization's environmental impact**, while its own emissions remain unchanged or continue to grow.

Offsetting has many other undesirable effects. Offsetting projects do not have the means to curb the growth of GHG emissions[6]; besides, offsetting is only a **promise** of future GHG reduction. Moreover, planting forests do not guarantee a definitive offsetting, it can even turn into a source of CO_2 under certain physical conditions. Finally, richer countries monopolise offsetting opportunities, while not reducing their own GHG emissions.

In order to reach carbon neutrality, **offsetting should not be rejected** despite its limitations, **but rethought**. A fairer accounting system has to be adopted, that gives more importance to emission reductions within the leading organisations.

[a] Because the data given by the company was based on a life cycle analysis, thus considered reliable.

Conclusion

The ECN's "Bilan Carbone" for 2018, although not exhaustive, highlights the main GHG emissive activities: **travels, products and services, and food** account for 72 % of the total carbon footprint.

Evenly distributed among all its users, **the Paris Agreement limit is far exceeded**. Indeed, this limit concerns the total footprint of each individual, not only their activity at the ECN.

Everyone has to do their "fair-share": small gestures do count. However, the outcome will not be sufficient without **a change in policy** of the ECN and the enforcement of a **strong low-carbon strategy.**

The work presented here needs therefore to be taken further, first by a **precise quantification of the different scenarios** that ECN could use to reduce its GHG emissions, then by the **introduction of concrete measures** and eventually, by **taking into account the responsibility of ECN as a trainer** of future engineers and as a research institute.

* * *

Sources

[1] https://www.ipcc.ch/sr15/chapter/spm/

[2] https://www.ecologique-solidaire.gouv.fr/strategie-nationale-bas-carbone-snbc (Document only available in French language)

3 Decoupling is further explored in the following article: Girod, B. and De Haan, P., More or Better? A Model for Changes in Household Greenhouse Gas Emissions due to Higher Income, Journal of Industrial Ecology, 2010. 14: 31-49 https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1530-9290.2009.00202.x

4 DUGAST C. et BETTIN R., Stop saying "carbon offset": Moving from "offsetting" to "contributing" Report 2019, Carbone 4. http://www.carbone4.com/stop-saying-carbon-offset-from-offsetting-to-contributing/?lang=en

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[6] ibid.