

Protocol for assessing the carbon footprint of the procurement of goods and services

Labos1point5, Procurement Footprint WG

Summary

The carbon footprint represents the volume of greenhouse gas emissions induced by human activities. This document aims to present a methodology for estimating this footprint for the purchases of goods and services by a French research unit. It is based on the use of monetary emission factors from three distinct sources: the ADEME carbon base, the American environmental data archive CEDA and the American EPA archive. The annual expenditure of a research unit is used in conjunction with these monetary emission factors to calculate the annual carbon footprint of purchases and an estimate of uncertainty. More specifically, each purchase of a unit is identified by a NACRES code (Nomenclature Achats Recherche Enseignement Supérieur) and is characterised by an amount spent. Each existing NACRES code in the nomenclature is associated with an average monetary emission factor calculated from the three ADEME, CEDA and EPA databases as well as a standard deviation. The product of the amount spent on the one hand and the average monetary emission factor of the corresponding NACRES code and its standard deviation on the other hand makes it possible to estimate the carbon footprint of this purchase and an uncertainty. All purchases of goods and services already accounted for elsewhere in GES1point5, i.e. tickets for business travel, fuel for vehicles and heating, and IT equipment, are excluded from the calculation scope. This methodology is currently only applicable to laboratories under the supervision of public institutions using NACRES codes (public universities, public scientific and technological institutions (EPST) and certain Grandes Ecoles).

The NACRES codes

The primary objective of the NACRES nomenclature ([Nomenclature Achats Recherche Enseignement Supérieur](#)) is to verify the value of the purchases made by the purchaser with regard to the thresholds provided for by the Public Order Code. It is a classification of purchasing segments covering all purchases, by nature. It was implemented in 2014 in all public higher education and research institutions. Requests for changes to this nomenclature are evaluated by a monitoring committee which is intended to meet twice a year.

1 - Thème	A	APPROVISIONNEMENTS GENERAUX
2 - Domaine	AA	ALIMENTATION - RESTAURATION - HOTELLERIE
3 - Sous-domaine	AA.0	PRODUITS ALIMENTAIRES CONGELES
4 - Famille = Groupe de marchandises	AA.01	PAINS, PATISSERIES, VIENNOISERIES CONGELES
	AA.02	PRODUITS CARNES CONGELES
	AA.03	PRODUITS DE LA MER OU D'EAU DOUCE CONGELES
	AA.04	FRUITS ET LEGUMES CONGELES
	AA.05	PREPARATIONS ALIMENTAIRES ET PLATS CUISINES CONGELES
Exemples	Exemples	Préparations alimentaires élaborées congelées Crèmes glacées, glaces et sorbets Autres préparations alimentaires congelées

Figure 1 General structure of NACRES codes

The NACRES purchasing nomenclature has four levels, of which only the fourth level is operational. This last level corresponds to the purchasing families known as commodity groups. It is organised into a Theme/Domain/Sub-domain/Family, which thus form a commodity group. The theme and the domain are each identified by a letter. The sub-domain and family are each identified by a number. A NACRES

code is therefore in the form of two letters followed by two numbers, separated or not by a dot. For example, AA.01 or AA01 refers to frozen bread, pastries and cakes (Fig. 1).

In practice, not all NACRES codes allowed by the codification are used. There are 24 themes used and about 1466 families defined.

A	APPROVISIONNEMENTS GENERAUX
B	BATIMENTS - INFRASTRUCTURES - ESPACES VERTS
C	COMMUNICATION - CULTURE - DOCUMENTATION
D	TRANSPORT ET HEBERGEMENT DES PERSONNES
E	ETUDES - CONSEILS - ASSURANCES - RESSOURCES HUMAINES
F	FRET / EXPEDITION / TRANSPORT / DEMENAGEMENT
G	GAZ DE LABORATOIRE OU D'ATELIER - CRYOGENIE
H	SANTE ET SECURITE AU TRAVAIL
I	INFORMATIQUE - TELECOMMUNICATIONS - AUDIOVISUEL
J	AMENAGEMENT ET MOBILIER DE LABORATOIRE
K	ELEVAGE ET EXPERIMENTATION ANIMALE
L	MEDICAL
M	MICROSCOPIE - PROFILOMETRIE
N	CHIMIE ET BIOLOGIE
O	OPTO - LASERS - MATERIEL D'OPTIQUE
P	PHYSIQUE NUCLEAIRE ET CORPUSCULAIRE - AUTRES EQUIPEMENTS DE PHYSIQUES
Q	EXPERIMENTATION VEGETALE
R	MECANIQUE (ATELIER ET BUREAU D'ETUDE) - AUTOMATIQUE
S	SPECTROMETRIE - SPECTROSCOPIE - RAYONS X
T	ELECTRONIQUE / TEST, ENERGIE, MESURES
U	SCIENCES DE LA TERRE - GEOPHYSIQUE - ASTROPHYSIQUE
V	VIDE ET ULTRA-VIDE : EQUIPEMENTS POUR LA GENERATION, LA MESURE ET LE CONTRÔLE DU VIDE ET DE L'ULTRA-VIDE
W	NANOTECHNOLOGIES - MICRO-ELECTRONIQUE
X	DEPENSES HORS ACHATS

Figure 2: The 24 themes of the NACRES nomenclature

Monetary Emission Factors

The method proposed here uses monetary Emission Factors (EFs) which are expressed in kgCO₂e/€. These factors are derived from Environmental-Extended Input-Output models (EEIO). These models use data on the inputs and outputs of industries, as well as their final consumption and value added, by means of input-output tables. These tables are combined with environmental data on resource use and releases of different pollutants in the form of satellite tables, using standard input-output analysis algorithms. They assign an emission factor to a broad or narrow economic sector.

This method has several advantages. First, it includes the possibility of accounting for non-physical flows such as services. Secondly, it offers a simple, standardised and time-efficient way of managing a wide variety of physical and non-physical flows. On the other hand, it has certain disadvantages, the main one being the lack of detail in the categories proposed by the existing databases, which sometimes group together very diverse objects in the same category with a single emission factor. Furthermore, this method is sensitive to price fluctuations.

In the methodology proposed here, we use three databases of monetary emission factors. The ADEME database offers factors separated into 36 categories (https://www.bilans-ges.ademe.fr/documentation/UPLOAD_DOC_FR/index.htm?ratio-monetaires.htm). The American databases CEDA (<https://www.vitalmetricsgroup.com/environmental->

databases) and EPA (<https://www.epa.gov/land-research/us-environmentally-extended-input-output-useio-technical-content>) contain approximately 385 categories common to both databases.

The CEDA base used is version 4.8 of 2014. We used EFs calculated using the *Life Cycle Inventory* method, expressed in kgCO₂e/\$2002 at purchaser prices. They were converted to 2019 \$ from detailed tables of inflation by sector between 2002 and 2011 and by taking the average inflation for the US economy between 2011 and 2019 (13.7%, <https://www.usinflationcalculator.com/>). For this year 2019, the \$ were then converted into € with the rate 1.12\$ for 1€ (<https://freecurrencyrates.com/en/exchange-rate-history/EUR-USD/2019/cbr>). The CEDA database expresses the EFs associated with six different GHGs (CO₂, CH₄, N₂O, HFCs, PFCs, SF₆) directly in kgCO₂e. We have therefore added these values together to obtain the total EF.

The EPA base is expressed in 2018 \$. These values were also converted to 2019 € using the same protocol. Given that research laboratories are retail purchasers, we have used *Supply Chain Emission Factors with Margins (purchaser price)*. In the EPA database, for each sector, the EFs are given for different greenhouse gases (CO₂, CH₄, NO₂ and others) directly in kgCO₂e. As in the CEDA database, we have therefore added these values to obtain the total EF.

The year of calculation of the EFs in the ADEME database is not specified. Thus we have taken these factors as they are, without making any correction for inflation.

Allocation of monetary EFs to NACRES codes

The allocation of monetary EFs to each NACRES code was done by matching the nature of the code to the categories proposed in the three databases, with the exception of the KA0 and KA3 codes. For each of the databases (CEDA, ADEME, EPA), at least one EF is assigned by this method. In case of ambiguity between several possible categories, several EFs can be allocated. For the CEDA and EPA databases, the NACRES codes can have up to 6 different EFs. For the ADEME database, there can be up to 2 EFs. In conclusion, each NACRES code can be allocated up to 6 monetary EFs from CEDA, the same number from EPA and up to 2 monetary EFs from ADEME.

In a second step, the monetary EFs from each base were averaged for each NACRES code where several existed. Finally, in a last step, the 3 average EFs were averaged so that each NACRES code had only one EF. Standard deviations are calculated in steps 2 and 3. The meaning and the principle of calculating these standard deviations are presented in the next section.

For codes KA0 and KA3, associated with purchases of rodents and other laboratory animals, we estimated the EF directly by dividing the carbon footprint by the turnover of a major laboratory animal supplier. The XF0 codes represent internal invoicing to organisations on certain themes, areas or sub-areas. They therefore correspond to purchases of highly aggregated goods and/or services. Therefore, we have attributed to them the mean value and standard deviation of the EFs of the corresponding domains or sub-domains.

Calculation of uncertainties

Two sources of uncertainty are taken into account when calculating the uncertainty of a EF: the uncertainty of attribution and the uncertainty due to the existence of several databases. As explained in the previous section, we have assigned up to 6 different EFs to each NACRES code for the CEDA and EPA databases, and up to 2 EFs for the ADEME database. For example, for the NACRES code NA.26, *BIOLOGY: PEPTIDES AND AMINE ACIDS*, we have associated 2 CEDA (and EPA) EFs, *In-vitro*

diagnostic substance manufacturing (0.24 kgCO₂e/€ in CEDA) and *All other chemical product and preparation manufacturing* (0.67 kgCO₂e/€ in CEDA), but only one ADEME EF, *Pharmaceuticals* (0.5 kgCO₂e/€).

We denote $x_{i,b,j}$ the j^{eme} EF (up to 6) associated with database b (up to 3, i.e. CEDA, EPA and ADEME) and NACRES code i (up to 1466). We first average over dimension j for each i and b . This calculates :

$$\begin{aligned} \langle x_{i,b} \rangle_j &= \frac{1}{N_{i,b}} \sum_{j=1}^{N_{i,b}} x_{i,b,j} \\ \sigma_j(x_{i,b}) &= \sqrt{\frac{1}{N_{i,b} - 1} \sum_{j=1}^{N_{i,b}} (x_{i,b,j} - \langle x_{i,b} \rangle_j)^2} \end{aligned}$$

where $N_{i,b}$ is the number of EFs associated with the base b and the NACRES code i . $\sigma_j(x_{i,b})$ is therefore the standard deviation that takes into account the allocation uncertainty between the base b and the NACRES code in question. We then calculate the average of the $\langle x_{i,b} \rangle_j$ along dimension b to obtain a single EF per NACRES code, as follows:

$$\langle x_i \rangle_{j,b} = \frac{1}{N_i} \sum_{b=1}^{N_i} \langle x_{i,b} \rangle_j$$

where N_i is the number of databases used for the NACRES code i (equal to 3 in our study). To estimate the uncertainty associated with the latter mean, we first calculate :

$$\sigma_b^{\text{typeI}}(x_i) = \sqrt{\frac{1}{N_i - 1} \sum_{b=1}^{N_i} (\langle x_{i,b} \rangle_j - \langle x_i \rangle_{j,b})^2}$$

$$\sigma_b^{\text{typeII}}(x_i) = \frac{1}{N_i} \sqrt{\sum_{b=1}^{N_i} (\sigma_j(x_{i,b}))^2}$$

$\sigma_b^{\text{typeI}}(x_i)$ being calculated as if the $\langle x_{i,b} \rangle_j$ were independent measures of EF free of uncertainty and $\sigma_b^{\text{typeII}}(x_i)$ as the average of independent standard deviations associated with an identical mean. From the definition of variance and assuming $N_{i,b} \gg 1$ (which is not exact but greatly facilitates the calculations by introducing a small error), we have :

$$\begin{aligned}
(\sigma(x_i))^2 &= \frac{1}{N_i - 1} \sum_{b=1}^{N_i} \frac{1}{N_{i,b} - 1} \sum_{j=1}^{N_{i,b}} (x_{i,b,j} - \bar{x}_{i,b})^2 \\
&\approx \left(\sigma_b^{type I}(x_i) \right)^2 + N_i \left(\sigma_b^{type II}(x_i) \right)^2
\end{aligned}$$

The uncertainty associated with the average EF of the NACRES code i is therefore expressed as :

$$\sigma(x_i) \approx \sqrt{\left(\sigma_b^{type I}(x_i) \right)^2 + N_i \left(\sigma_b^{type II}(x_i) \right)^2}$$

Perimeter

The method for estimating the footprint of purchases theoretically allows all purchases made by the laboratory to be taken into account. However, some of these purchases are already included in other modules of GES1point5. In order to avoid double counting, some NACRES codes are therefore not included in the final footprint of purchases of goods and services. These codes correspond to purchases of tickets for transporting people (part of the codes in the DA domain), purchases of fuel used for vehicles and heating (certain families in the AD and BA domains), and purchases of IT equipment taken into account in the corresponding module of GES1point5 (certain families in theme I). Finally, according to ADEME recommendations, taxes, salaries, contributions and charges should not be considered (part of the codes of theme X).

Eligible research units

The method presented in this document is based on the use of NACRES codes. Consequently, only research units that identify their purchases by means of these codes can use this method. This concerns French units under the supervision of Public Scientific and Technological Establishments (EPST such as CNRS, INRAE and IRD), Public Universities, and certain Grandes Écoles. This does not include, for example, Public Industrial and Commercial Establishments (EPIC, such as CEA and IFREMER) or private companies.

However, this method has the potential to be generalised to all units using a nomenclature to characterise their purchases. This could be done on a case-by-case basis in the future.