1 – Introduction

Today, the Carbon Footprint of the company and the Carbon Footprint of the kWh (the emission factor or carbon factor) are rigorously measured according to normalized approaches.

However, "avoided emissions", which depend on a baseline or reference situation as well as many other parameters and are often difficult to calculate. Indeed, there is no recognized single external reference method, and existing methods are generally complex and often subject to discussion.

The purpose of this note is to define basic principles to calculate emissions avoided **by an activity, action or project** within the EDF Group. We ask that all concerned parties respect these principles in the interests of consistency and exemplarity, unless otherwise justified and validated by the Impact Division. This document is validated annually by an external auditor as part of the verification process of the emissions avoided by the projects financed by Green Bond and updated regularly.

2 – EDF Group Principles for Calculating Avoided Emissions

The **fundamental principles** are as follows:

2.1 Calculating avoided emissions by an "action" typically involves comparing two situations:
- Emissions without considering the action: **the baseline or reference,**
- Emissions considering the action: **the assessment.**

2.2 The action can result in avoided emissions **within the EDF Group, or for third parties**[1] (for example, customers).

2.3 Emissions of the **whole life cycle** are accounted for, according to the Life Cycle Analysis approach (LCA).

2.4 The avoided emissions of the electrical system are calculated by taking as reference **the average emissions factor of the kWh of the network under consideration, inclusive of LCA**[2]. The latest known value of this network shall typically be used.

2.5 Avoided emissions are calculated **annually**.

2.6 Significant emissions linked to the **implementation of the action** (e.g. equipment, works, etc.) are accounted for by distributing them over the lifetime of the action[3].

2.7 If in doubt, the most conservative approach shall be chosen: i.e. the one that results in the lowest amounts of avoided emissions.

2.8 Relevant emission factors calculated based on widely acknowledged external sources are suggested and should be used by default (Annex 1).

In cases which justify a different or more complex approach, an auditable proposal for calculation shall be submitted to the Impact Division for approval. For information, examples of possible exceptions to the basic principles are presented in Annex 2.

[1] Some consider that "avoided" emissions are limited to emission reductions outside of a company's perimeter, while reductions within a company's perimeter are often qualified as "reduced" emissions. However, this distinction is difficult to apply to the electricity sector: for example, a new EDF wind farm in France will have an impact on the emissions of other EDF assets or assets of other producers, without it being possible to distinguish between the two
[2] Therefore any "marginal" reasoning will be avoided (Annex 2)
[3] It should be noted that the LCA Emission Factor of the kWh produced by a given generation pathway already includes the emissions associated with the construction of the facility. In the case where, for a given project, it would be possible to justify an LCA emission factor different from the one suggested by default, this new factor could be taken into account.

3 – <u>Validation of avoided emissions calculations used in external communication</u>

Group entities frequently use calculations of avoided emissions to highlight the CO2 benefits of their low-carbon projects and solutions. To this end, the avoided emissions data is presented in various external communication media (e.g. press releases, marketing documents, external reports, etc.). To guarantee the correct application of the calculation principles and the consistency of these communications, the entities submit their calculations of avoided emissions to the Impact Division for validation before publication.

4– <u>Illustrative Examples</u>

3.1 Energy efficiency of a commercial building in the United Kingdom

- Baseline: annual consumption of 10 MWh.
- Assessment: Implementation of insulation work that results in a 20% electricity saving.
- Numerical application:
  - Input Data:
    - Average emissions factor LCA in UK: 253 g eq CO_2 / kWh,
    - Emissions from the installation: considered negligible.
  - Calculation:

Annual avoided emissions = annual savings x average emissions factor = 2 x 253 = 0,506 Ton $eqCO_2$

3.2 Installation of a wind farm in France

- Baseline: electricity is generated by the existing means of production in the country.
- Assessment: a new wind farm is installed and operational.
- Numerical application:
  - Input data:
    - Average LCA emissions factor in France: 90 g eq CO_2 / kWh,
    - Annual production (real or anticipated): 30 GWh,
    - LCA emission factor in wind power kWh (including equipment and installation): 11 g eq CO_2 / kWh (default value).
  - Calculation:

Annual avoided emissions = annual production x (Average EF – Wind farm EF) = 30 x (90-11) = 2370 Tons $eqCO_2$

<u>Note</u>: this calculation does not consider emissions related to the energy production necessary to compensate for the intermittency of renewable energy generation.

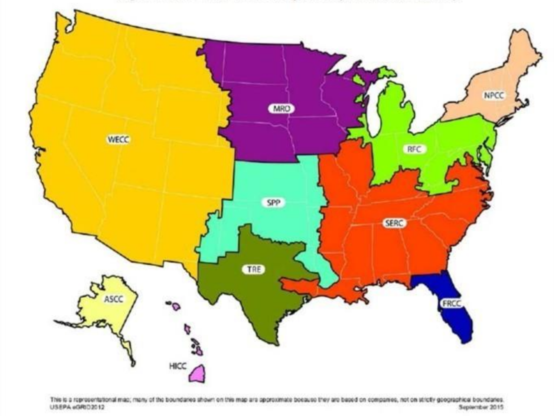
ANNEX 1: Average emission factors for electric kWh, LCA included, by production type and by region

- Sources: EDF R&D calculations based on data from the following sources:
  - Emission factors by production type, LCA included : global median values according to IPCC 2014 AR5 Chapter 7 page 539, and Annex III p 1335; except for oil: SRREN 2011 (most recent available values)
  - Production Mix by Country :
    - Europe and other countries: IEA 2022, specific mention to 2021 if 2022 is not available.
    - USA Network: EPA egrid 2021
    - Networks / Canadian Provinces: Statistics Canada 2022
    - Islands : Base Carbone de l'Ademe (update V23.1)

The following data is to be used by default. Data for other countries or production types can be added if needed. If more precise or relevant data is available and auditable, that data may be used instead (justification to be provided to the Impact Division).

Emission factor by production type, LCA included [g eqCO2/kWh]	Average emission factor [g eqCO2/kWh]
Nuclear	12
Coal	1040
Oil	840
Gas[5]	490
Hydro	24
Wind[6]	11
Solar PV	48
Solar CSP	27
Biomass (dedicated crops and waste)[7]	230
Biomass (Wood from forests)	148
Geothermal Energy	38

Figure B-2. eGRID NERC Region Representational Map



Regions	Average emission factor [g eqCO2/kWh]
COUNTRIES	
France contin.	90
UK	253
Belgium	169
Italy	409
China	683 (2020)
Switzerland	33
Germany	456
Poland	791
Greece	359
Chile	379
Brazil	116 (2020)
Mexico	473
Israel	575
ISLANDS	
French Guyana[4]	353
Martinique	840
Guadeloupe	702
Mayotte	780
Réunion	780
St Barthélémy	859
St Pierre et Miq	944
Corsica	595
USA/Canada Networks	
WECC	364
TRE	423
SPP	480
MRO	466
SERC	457
NPCC	272
FRCC	461
RFC	481
Quebec	30
Ontario	77

[4] Excluding fugitive emissions from Petit Saut

[5] Median data from IPCC AR5 Annex III table A.III.2 for CCGT, combined cycle being considered as the most significant gas technology in thermal gas production

[6] According to the IPCC report, onshore wind is at 11g, and offshore wind at 12g CO2 eq/kWh: it is therefore suggested to keep the same default value for both technologies, and to consider a more specific value for a given project if it can be justified

[7] The values indicated for biomass are default values indicated in the IPCC report; an R&D study to establish specific values by type of biomass is planned

ANNEX 2: Some examples of possible exceptions to the basic principles

The functioning of electrical systems is complex and, if some essential aspects are omitted, erroneous results are obtained:

- Energy policies and the market jointly contribute to making upstream and downstream (production and consumption) evolve in a coordinated way over time. It is therefore inappropriate to consider the impact in terms of emissions of a change in production while presupposing that consumption is fixed, and vice-versa.
- A variation in consumption or production on an electrical system can never be considered in isolation since many other variables simultaneously exert compensating effects. A single variation cannot, therefore, be considered independently of others.

As a result, any "marginal–type" calculation which seeks to assess the impact of a variation of production or consumption on emissions "all other things being equal" is to be avoided in the context of electrical systems.

It should be added that:

- Electrical systems are not controlled in such a way as to optimize emissions, but rather to optimize costs. This optimization of costs is itself disrupted by various regulatory and technical constraints (such as the priority given to renewables, availability, etc.).
- Hypotheses relating to the means of production which will develop in the future are inherently uncertain. Studies show that assumptions made in the past have proved to be inaccurate, as have the calculations which take them into account.

The basic principles held by the EDF Group in this procedural note avoid these pitfalls by using the latest known average emission factor of the kWh of the network as a reference. This approach is therefore the most satisfactory in most situations. [8]

However, **a certain number of exceptions can be considered (after validation by the Impact Division),** particularly concerning the choice of the baseline situation. Some examples are presented in the table below.

The spirit of these basic principles shall be respected, namely: a conservative approach, the preference for LCA, transparency on the chosen reference and rigour.

[8] It would be possible to take into account imports and exports relative to the network under consideration, but on the basis of net hourly balances in order to avoid distorting the calculations due to electricity in transit. In France, the impact would be limited, as the hours of the year when France is a net importer are few

	Specificity of the action under consideration	Calculation Reference	Examples
1	Specific time temporality	Average hourly contents (rather than annual) of the network considered, if available. However the gap with basic principles would be rather weak.	Variation in the efficiency of a hydroelectric turbine, running chiefly at the peak.
2	Accounting for impacts outside the electrical system and/or multiple impacts	Estimate real impacts in comparison to a specified relevant baseline scenario, integrating if possible the LCA. If needed, one can concurrently draw cumulative multiple impacts specifying the calculation method (ENR, electrical efficiency, etc.)	Emissions avoided by a heat network, or by a cogeneration plant: replacing an oil boiler with a gas boiler or a heat pump
3	Determination of emissions avoided over a number of years and/or to a term too remote for the last known average EF of the network to be a relevant reference	2 options: - Take as a reference the average prospective EF for the year (or years) considered, determined according to sources or assumptions to be specified (*e.g. RTE scenario in France).* - Other relevant conservative reference, preferably including LCA. The reference will be specified *(e.g. comparison with the emissions of a CCGT plant).* - Avoided emissions will be determined on the basis of the difference between this reference and the anticipated energy generated in a given year or over time	Impact on emissions of a new plant which will be connected to a network in five or ten year; or the cumulative impact during the lifetime of a plant; or renovation of a plant.
4	Substantial change in production likely to cause significant variation in the average content of the network under consideration, or inability to ascertain a reference.	Take the most pertinent reference possible, which must be explicitly specified *(e.g. average European content outside France).*	Benefit in terms of emissions of the existence of the French nuclear fleet.
5	Significant and very occasional variations in production	The impact depends on the period considered (level of demand), on the importance of the variation of production considered in comparison to the volume of production, whether carbon-based or not, available for replacement, and on other concomitant variations. The basic principles shall be normally used, as they avoid difficult estimates. Moreover, the CO_2 impact of a very occasional and exceptional variation in production or consumption has only a very small impact on CO_2 emissions, which become significant only over time. If, however, the conditions are such that, at the specific moment of production variation, there is a strong possibility: - that the action cannot be compensated by other variations of a comparable magnitude - that a certain type of production asset modulates as a result of the action, …then one could consider taking emissions of this type of asset as a reference, if a particular issue justifies it. The reference shall be specified explicitly, as well as the fact that the result is valid only under the specific conditions considered. *(e.g.: comparison with emissions from a CCGT plant).*	One day reduction of a nuclear power plant outage
6	Construction of a production asset in a country in which electric consumption is growing rapidly.	In this case, the comparison to the average mix makes little sense, as a new production asset will not replace active assets but will drive supplemental emissions of the electrical system. Two options: - Refer to an asset which could have been built in place of the project (and which emits more) - Evaluate emissions generated by other energies, usually non-electrical, displaced by the project. In both cases, the reference will be explicitly specified.	Construction of a photovoltaic park in India.
7	Change in downstream consumption.	Variations in consumption are almost never isolated and limited in time. The basic principles shall therefore generally apply.	Reduction of electrical heating.