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Research Letter

Corporate Ecological Footprint: New Conversion Factors

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The first ecological footprint calculation version, applied to companies, appeared in 2003. The said tool provides the possibility of calculating the total impact of a company or organisation in hectares or in equivalent emissions of CO_2. This paper updates carbon absorption rates and improves electricity consumption conversion factors, one of the major footprint generating consumptions in companies. The new rates prove that the footprint estimated to date will be notably increased as, among other aspects, the IPCC has downgraded the amount of carbon that forests are capable of absorbing. These data reveal that companies must make a great effort to adapt to the challenges triggered by climate change.

1. INTRODUCTION

The first version of the ecological footprint calculation method applied to companies (corporate ecological footprint or CEF) was developed between 2003 and 2007 [1–4]. Since then, it has been applied to an increasing number of organizations, such as ports, dealerships, fishing companies, the food and agriculture sector.

The CEF incorporates all types of consumptions, as well as waste products, discharges, and emissions. The different consumption categories are electricity, fuel, general materials, construction materials (building), services and contracts, farming and agricultural resources, forestry resources, and water.

Most of the data required for the calculation are taken from account books, meters (electricity, water), and the organization's annual report. The consumption of energy and materials is converted to gigajoules (KWh based on the equivalence of 1 KWh = 3.6 Mj; fuels based on their calorific value; and materials based on their energy intensity). Gigajoules, in turn, are converted into CO_2 emissions based on the emission factor of the fuel used. Finally, the said emissions are converted to hectares based on the forest absorption rate. The latter two steps can be simplified by dividing the Gigajoules consumed by "*energy productivity*," which is obtained by dividing the carbon absorption factor by the carbon emission factor of the fuel considered. Agricultural, forestry, or stockbreeding resources are directly converted to hectares based on their natural productivity levels. For further details on the calculation method, consult Doménech (2006) [3] and http://www.huellaecologica.com/.

However, several of the above-mentioned consumptions and their conversion factors are still under development, such as the validity of the system used for the conversion of electricity consumption, the incorporation of public infrastructures, the incorporation of dangerous waste products and discharges, the incorporation of fuel life cycles, or the incorporation of carbon absorption factors for ecosystems other than forests.

Some of the complications concerning the conversion of electricity consumption into hectares (ecological footprint) or into carbon emissions (carbon footprint) derive from the different emission and absorption factors used, according to the sources consulted. This paper describes the new conversion factors affecting companies' electricity footprints, which will become part of version 2 of the calculation method and that is still being prepared.

2. RESULTS: CHANGES TO THE ELECTRICITY FOOTPRINT CALCULATION METHOD

Substantial changes have been made to the method used to convert the electric energy consumed into CO_2 emissions or hectares—the CO_2 emission factors have been adjusted in

Table 1: New fuel conversion indices used to calculate corporate ecological footprints.

Fuel	Forest absorption rate (tCO_2/ha/year)	Emission factor with oxidation factor (tCO_2/Gj)	"Energy productivity" of forests (Gj/ha/year)
Solids			
Anthracite	3.6666	0.0973	37.7
Lignite	3.6666	0.1002	36.6
Coal for coke making	3.6666	0.0937	39.1
Other bitumen. coal	3.6666	0.0937	39.1
Tyres (cement factories)	3.6666	0.0820	44.7
Liquids			
Gas-oil	3.6666	0.0737	49.8
Gasoline	3.6666	0.0690	53.1
Fuel oil	3.6666	0.0760	48.2
General LPG	3.6666	0.0650	56.4
Kerosene (not for aircraft)	3.6666	0.0715	51.3
Oil coke	3.6666	0.0983	37.3
Oils & lubricants	3.6666	0.0729	50.3
Solvents (cement factories)	3.6666	0.0830	44.2
Used oil (cement factories)	3.6666	0.0730	50.2
Gas			
Natural gas (dry)	3.6666	0.0560	65.5
Butane	3.6666	0.0662	55.4
Methane	3.6666	0.0546	67.2
Propane	3.6666	0.0636	57.7
Carbon Monoxide	3.6666	0.1540	23.8
Hydrogen	3.6666	0.0000	0

Source: "España. Informe Inventarios" GEI 1990–2004 (May 2006).
http://portal.aragon.es/portal/page/portal/MEDIOAMBIENTE/CALIDAD_AMBIENTAL/CCLIMA/INFORMES/INVENTARIOEMISIONESGEI_1990–2004.PDF (last access: June/2008).

accordance with the document "España. Informe Inventarios GEI 1990–2004 (mayo 2006)" (http://portal.aragon.es/portal/page/portal/MEDIOAMBIENTE/CALIDAD_AMBIENTAL/CCLIMA/INFORMES/INVENTARIOEMISIONESGEI_1990–2004.PDF) "(Spain. GHG Inventory Report 1990–2004 (May 2006)," which is mainly based on IPCC data from 1996 and, especially, on changes made to the carbon absorption rate of forests, adopting the rate issued by the IPCC in 2001, which was 1 tC/ha/year.

The classic energy productivity of 71 Gj/ha/year generally applied to liquid fuels in previous versions is now of 51 Gj/ha/year (average of gas-oil, gasoline, and fuel oil). The 55 Gj/ha/year usually used for coal, is now 37 Gj/ha/year, and the 93 Gj/ha/year for gases is now 65.5 Gj/ha/year. This reduction in energy productivity results in higher footprints than in the previous version. In other words, the environmental impact of companies is greater than estimated to date.

Table 2 displays a company's electricity footprint calculation, obtained based on three different fuel sources: coal, liquid fuel, and gas. Three different data sources are also compared (1) those used to date in previous versions (CEF version 1); (2) those calculated directly based on KWh consumed, taken from Meier et al. (2005) [6], which include the entire life cycle in the emission factors (extraction, infrastructures, transport, waste, etc.); this variant is described by Álvarez et al. (2008) [5]; (3) those calculated in this paper based on national inventory data.

The "energy productivity" (emission factor/absorption factor) is also calculated based on two different carbon absorption factors: the most recent from the IPCC in 2001 (1 tC/ha/year or 3.66 tCO_2/ha/year) and the one we have been using to date (1.42 tC/ha/year or 5.2 tCO_2/ha/year).

Table 1 displays a list of fuels and updated emission factors and the new forest CO_2 absorption rate.

3. DISCUSSION AND CONCLUSIONS

Attention must be paid to the fact that variant 2 (Table 2) provides the lowest carbon footprint for the three types of fuel considered, even in spite of including the entire fuel life cycle from extraction to combustion and the treatment of waste products. On the other hand, the emission factors in cases 1 and 3 are very similar or slightly higher in case 3 (it seems advisable to choose the one that results in the highest footprint). Therefore, with a view to avoid the dispersion of data and to facilitate comparisons, subsequent corporate ecological footprint versions will use the official

Table 2: Method used to convert electricity consumption to CO_2 emission and hectares based on three different data sources and two different absorption factors.

	(1) Spread sheet for CEF version 1 (Doménech, 2006)	(2) Direct conversion with LCA (*) (Álvarez et al. 2008)	(3) GHG inventories 1990–2004
Electricity obtained from a coal fired power station			
Assumed electric consumption as an example	1 GWh (12,000 Gj)	1 GWh (12,000 Gj)	1 GWh (12,000 Gj)
Emission factor	0.026 tC/Gj (1)	1006 tCO$_2$/GWh (1)	0.0973 tCO$_2$/Gj (2)
t carbon emitted	312	274.4	318.4
tCO$_2$ emitted	1,144.0	1006	1,167.6
Conversion to hectares (5.20 tCO$_2$/ha/year) & "energy productivity"	220 ha/year 54.6 Gj/ha/year	193.5 ha/year —	224.5 ha/year 53.4 Gj/ha/year
Conversion to hectares (3.66 tCO$_2$/ha/year) & "energy productivity"	312.6 ha/year 38.5 Gj/ha/year	274.9 ha/year —	319.0 ha/year 37.6 Gj/ha/year
Electricity obtained from a power station fired by liquid fossil fuels			
Electricity consumption	1 GWh (12,000 Gj)	1 GWh (12,000 Gj)	1 GWh (12,000 Gj)
Emission factor	0.020 tC/Gj (3)	742 tCO$_2$/GWh (4)	0.076 tCO$_2$/Gj (4)
t carbon emitted	240	202.4	248.7
tCO$_2$ emitted	880	742	912
Conversion to hectares (5.20 tCO$_2$/ha/year) & "energy productivity"	169.2 ha/year 71 Gj/ha/year	142.7 ha/year —	175.4 ha/year 68.6 Gj/ha/year
Conversion to hectares (3.66 tCO$_2$/ha/year) & "energy productivity"	240.4 ha/year 50 Gj/ha/year	202.7 ha/year —	249.7 ha/year 48.3 Gj/ha/year
Electricity obtained from a gas fired power station			
Electricity consumption	1 GWh (12,000 Gj)	1 GWh (12,000 Gj)	1 GWh (12,000 Gj)
Emission factor	0.0153 tC/Gj	466 tCO$_2$/GWh	0.056 tCO$_2$/Gj
t carbon emitted	183.6	127.1	183.3
tCO$_2$ emitted	673.2	466	672
Conversion to hectares (5.20 tCO$_2$/ha/year) & "energy productivity"	129.5 ha/year 92.8 Gj/ha/year	89.6 ha/year —	129.2 ha/year 92.8 Gj/ha/year
Conversion to hectares (3.66 tCO$_2$/ha/year) & "energy productivity"	183.9 ha/year 65.4 Gj/ha/year	127.3 ha/year —	183.6 ha/year 65.4 Gj/ha/year

(*) Life cycle assessment.
(1) Referred to coal in general (includes several times); (2) anthracite; (3) fuel oil and gas-oil; (4) fuel oil.
Source: own preparation.

data provided by the national inventory. The new forest mass emission factor of (1 tC/ha/year), included in the IPCC 2001 report, will also be used as it is more recent than the one used in previous versions (1.42 tC/ha/year).

These new conversion factors, especially the new forest absorption rate, will substantially increase the ecological and carbon footprints attributed to companies to date. This will make it even more difficult for companies to face the challenges presented by climate change. The European Union carbon reduction objective for the year 2020 (20% less than in 1990) and the growing tendency toward a low-carbon economy leads us to suggest that companies should add

proactive carbon reduction policies to their main strategic targets.

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