Greenhouse Gas Emissions Balance 2016

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I. Context and purpose

This document is the CNIM Group's response to Article 75 of Law No 2010-788 of 12 July 2010 and its Implementing Decree No 2011-829 of 11 July 2011 concerning the greenhouse gas emissions balance:

- Article 75 of Law No 2010-788 of 12 July 2010 concerning the French national commitment to the environment (ENE) adds a new section to Book II, Title II, Chapter IX of the Environment Code, entitled 'Greenhouse gas emissions balance and regional climate-energy plan'.
- In compliance with Article 75, Implementing Decree No 2011-829 of 11 July 2011 concerning the greenhouse gas emissions balance and regional climate-energy plan introduces new regulatory provisions into Articles R229-45 to R229-56 of the Environment Code, defining the ways in which the new provision should be applied.

Since 2012, the CNIM Group has drawn up an annual greenhouse gas emissions balance each year.
These balances are available on the Group's website, http://www.cnim.com, from the Corporate Social Responsibility (CSR) page.

The main aims of the Greenhouse Gas Emissions Balance (BEGES) are to:

- estimate sources and quantities of greenhouse gas emissions associated with the Group's activities in order to assess the current situation and establish a carbon indicator;
- map the emissions associated with the Group's various activities so that effective, targeted action can be taken;
- measure activities' dependence on fossil fuels and anticipate the economic and social impact of a shortage of these fuels;
- raise awareness of good practice in the industry

II. Organizational scope

The CNIM Group's greenhouse gas balance for 2016 covers emissions produced by the following companies:

- CNIM SA
- Bertin IT
- Bertin Technologies
- CNIM Azerbaijan
- CNIM Babcock Maroc
- CNIM Centre France
- CNIM Energie Biomasse
- CNIM Insertion
- CNIM Ouest Armor
- CNIM Singapore
- CNIM Terre Atlantique
- CNIM Thiverval Grignon
- CNIM Transport Equipment
- Lab SA
- Lab WASHINGTON
- MES Environmental Ltd
- SUNCNIM
- Vecsys

Unless otherwise indicated, all the establishments and/or sites of each of these companies have been taken into account.

The chosen method of consolidation is the operational control approach, whereby the organization consolidates 100% of the emissions generated by plants over which it has operational control, i.e. which it runs and manages.

III. Methodology

- The Greenhouse Gas Emissions Balance (BEGES) is based on the Carbon Accounting method.
- All greenhouse gas emissions covered by the Kyoto Protocol are converted into CO_2 equivalents (CO_2 e).
  - The Global Warming Potential (GWP) factor makes it possible to express and quantify greenhouse gas emissions in CO_2 equivalents:

$$GWP_{100\,years} = \frac{\int_0^{100\,years} RadiativeForcing_{gas}(t)dt}{\int_0^{100\,years} RadiativeForcing_{CO_2}(t)dt}$$

Table of gases regulated* by the Kyoto Protocol and also covered by the decree of 24 August 2011:

Greenhouse gas	Formula	Source	GWP 100 years CO_2e
Carbon dioxide	CO_2	Combustion	1
Methane	CH_4	Decomposition	25
Nitrous oxide	N_2O	Fertilizer, industry	298
Sulfur hexafluoride	SF_6	Industry	22,800
Hydrofluorocarbon	HFC	Coolants, industry	124 to 14,800
Perfluorocarbon	PFC	Coolants, industry	7,390 to 12,200

** other gases may be included voluntarily.*

Emissions to be included as a minimum in a compulsory greenhouse gas emissions balance are as follows:

Category	Number	Heading
Direct greenhouse gas emissions	1	Direct stationary combustion emissions
	2	Direct mobile thermal engine emissions
	3	Direct emissions from non-energy processes
	4	Direct fugitive emissions
	5	Biomass emissions (soils and forests)
Indirect emissions associated with energy	6	Indirect emissions associated with electricity consumption
	7	Indirect emissions associated with vapor, heat or cold energy consumption

The following items can be included voluntarily to obtain a more far-reaching assessment:

Category	Number	Heading
Other indirect greenhouse gas emissions	8	Energy-related emissions not included in items 1-7
	9	Purchased goods and services
	10	Capital property
	11	Waste
	12	Upstream goods transport
	13	Business travel
	14	Upstream franchising
	15	Upstream leasing assets
	16	Investments
	17	Visitor and customer transport
	18	Downstream goods transport
	19	Use of products sold
	20	End-of-life of products sold
	21	Downstream franchising
	22	Downstream leasing
	23	Commuting
	24	Other indirect emissions

To calculate emissions for each item, the Carbon Accounting (Bilan Carbone©) tool uses a set of emissions factors.

- A few examples:

	Kg of CO_2e emitted by MWh LHV consumed	
Heading	**Upstream**	**Combustion**
Natural gas, France (including overseas departments and territories)	37	204
Domestic fuel, France (including overseas departments and territories)	57	272
Pure diesel, France (including overseas departments and territories)	57	273

Heading	**Kg of CO2e emitted per passenger for every 1,000 km traveled**
0-50 seater airplane, 0-1,000 km	373
180-250 seater airplane, 9,000-10,000 km	118
Average private petrol car, 1 passenger	259
Average private petrol car, 3 passengers	87
Complete train in France, TGV	4

These factors are calculated analytically, measured or estimated, with a value of uncertainty associated with each emission factor.

Specific features of the method used:

- The greenhouse gas emissions balance covers CNIM's consolidated activity for 2016 (see, in Chapter II, the list of companies included).
- The greenhouse gas emissions balance sheet 2016 covers scopes 1 and 2 (compulsory) but also takes account of emissions associated with the final waste of waste-treatment and waste-to-energy centers (scope 3).
- The fuel consumption of all of the Group's vehicles has been included.
- The tool used is the V7.2 spreadsheet program of the Association Bilan Carbone® (French Carbon Accounting Association), applying emission factors from the Carbon Database. The emission factors applied are 326 kg CO_2e/metric ton for household waste incineration, and 128 kg CO_2e/metric ton for landfill.
- Acetylene is a gas used by some CNIM Group companies. It is not referenced in the Carbon Database. We have added it to our balance with the following characteristics:
  - density 1.1 kg / m^3
  - emission factor: 3.38 kg CO_2 / kg(based on stoichiometric reaction ratios).

IV. Greenhouse gas emissions

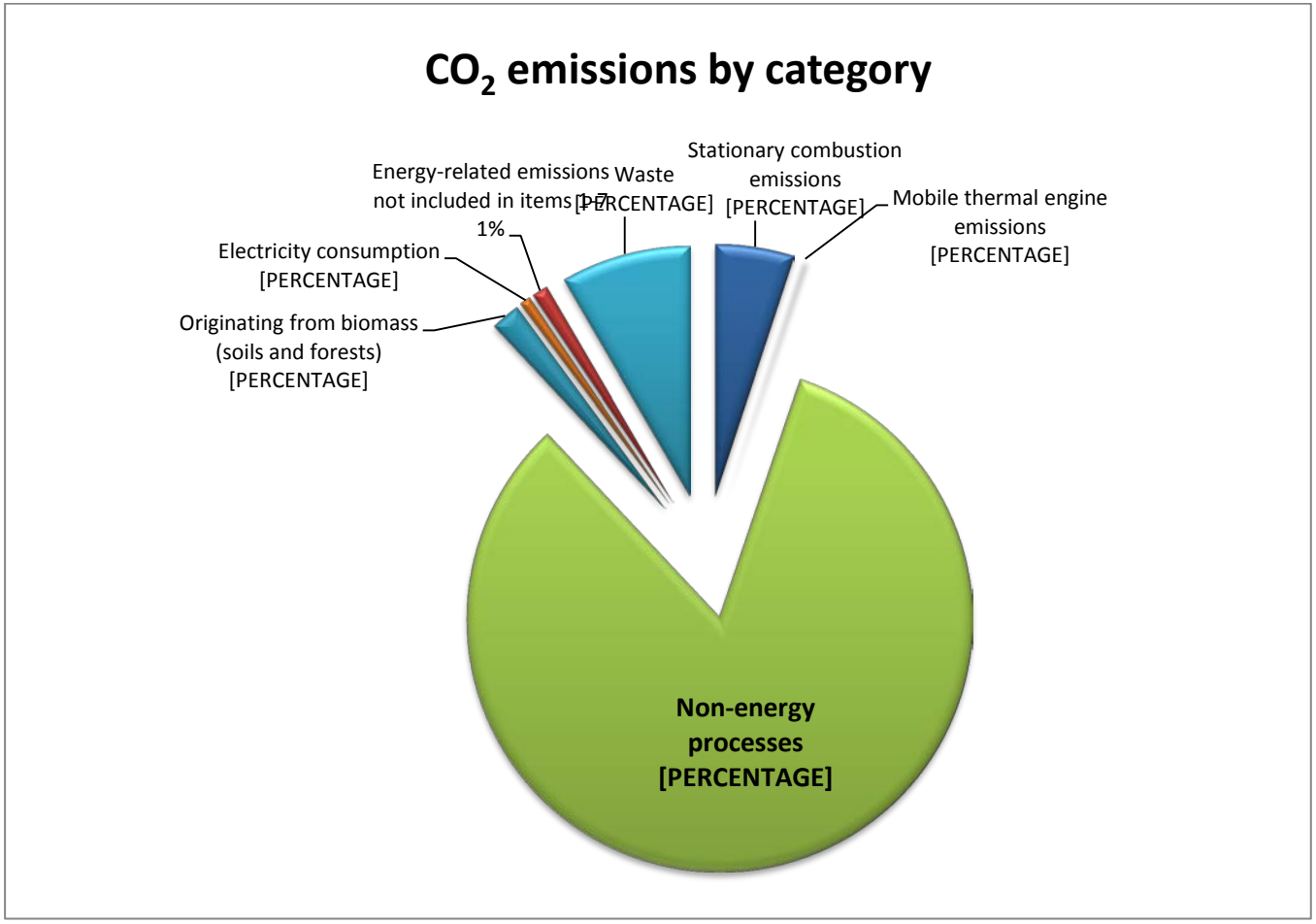
a) Emissions balance

In 2016, the consolidated greenhouse gas emissions were 523,815 tCO_2e, with a 36% uncertainty.

			Values calculated							
			Greenhouse gas emissions							Greenhouse gas emissions avoided
Emissions categories	**Numbers**	**Emissions headings**	CO_2 (metric tons)	CH_4 (metric tons)	N_2O (metric tons)	Other gases (metric tons)	**Total ($t CO_2e$)**	CO_2 b (metric tons)	Uncertainty (t CO2e)	**Total ($t CO_2e$)**
Direct greenhouse gas emissions	1	Direct stationary combustion emissions	25,688	2	1	0	26,064	443,961	1,281	0
	2	Direct mobile thermal engine emissions	1,274	0	0	0	1,284	36	76	0
	3	Direct emissions from non-energy processes	372,108	0	75	979	433,574	968,450	166,552	264,605
	4	Direct fugitive emissions	0	0	0	0	0	0	0	0
	5	Biomass emissions (soils and forests)	0	0	0	249	9,958	0	2,987	0
	Sub-total		**399,070**	**2**	**76**	**1,228**	**470,880**	**1,412,446**	**170,896**	**264,605**
Indirect emissions associated with energy	6	Indirect emissions associated with electricity consumption	0	0	0	0	3,726	0	320	0
	7	Indirect emissions associated with vapor, heat or cold energy consumption	0	0	0	0	0	0	0	0
	Sub-total		**0**	**0**	**0**	**0**	**3,726**	**0**	**320**	**0**
Other indirect greenhouse gas emissions	8	Energy-related emissions not included in items 1-7	3,530	54	0	0	5,411	-443,997	272	0
	9	Purchased goods and services	0	0	0	0	0	0	0	0
	10	Capital property	0	0	0	0	0	0	0	0
	11	Waste	42,423	55	0	0	43,798	0	19,667	0
	12	Upstream goods transport	0	0	0	0	0	0	0	0
	13	Business travel	0	0	0	0	0	0	0	0
	14	Upstream franchising	0	0	0	0	0	0	0	0
	15	Upstream leasing assets	0	0	0	0	0	0	0	0
	16	Investments	0	0	0	0	0	0	0	0
	17	Visitor and customer transport	0	0	0	0	0	0	0	0
	18	Downstream goods transport	0	0	0	0	0	0	0	0
	19	Use of products sold	0	0	0	0	0	0	0	0
	20	End-of-life of products sold	0	0	0	0	0	0	0	0
	21	Downstream franchising	0	0	0	0	0	0	0	0
	22	Downstream leasing	0	0	0	0	0	0	0	0
	23	Commuting	0	0	0	0	0	0	0	0
	24	Other indirect emissions	0	0	0	0	0	0	0	0
	Sub-total		**45,954**	**109**	**0**	**0**	**49,209**	**-443,997**	**19,939**	**0**

Note CO_2b: CO_2 of organic origin (biomass and organic waste), chemically identical to fossil-origin CO_2e but reported differently in the carbon account. It is classified as short-cycle carbon, unlike fossil-origin CO_2.

On a like-for-like basis, the increase in emissions from 2015 is associated with the activity of the waste-to-energy sites.



Note: the item 'Biomass emissions (soils and forests)' does not take into account the organic CO_2b emitted by the CNIM Energie Biomasse site.

- The item 'Direct emissions from non-energy processes' represents 83% of the CNIM Group's CO_2 emissions. These emissions are related to waste-to-energy operations, which also make a very important contribution to avoided emissions.
- The item 'Waste', which accounts for 8% of the Group's CO_2 emissions, is also linked to the sorting and processing of waste.

- The other greenhouse gas emissions, amounting to approximately 9%, are due to energy consumption (gas, electricity and diesel) by vehicles and in industrial and tertiary buildings belonging to Group companies.

V. Emissions avoided

The Carbon Accounting method makes it possible to estimate the emissions avoided by a certain activity. In the case of the CNIM Group, there are two sources of avoided emissions: the sorting and processing of waste.

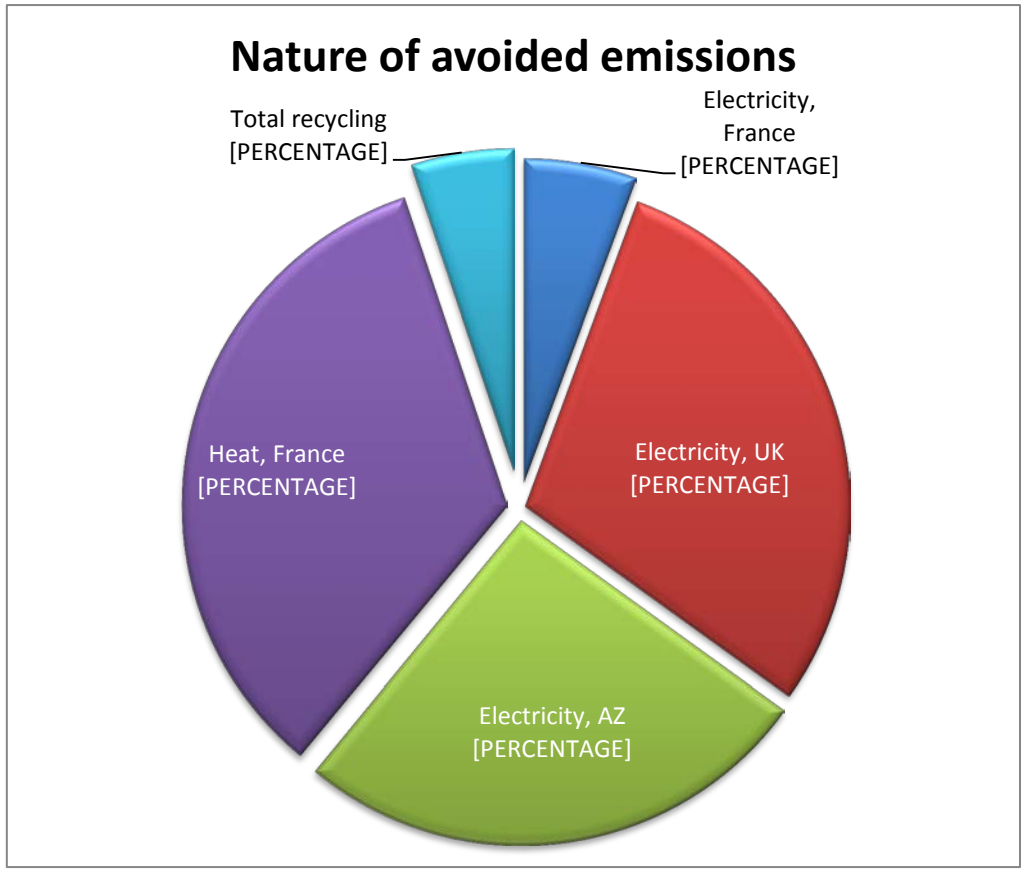
Thanks to waste-to-energy conversion and material waste processing at

- - Thiverval-Grignon, Pluzunet, Launay Lantic, Saint-Pantaléon de Larche, Nesles, Estrées Mons (France),
- - Wolverhampton, Stoke-on-Trent and Dudley (UK),
- - and Baku (Azerbaijan),

the CNIM Group avoided emissions of 264,605 tCO_2e in 2016.

Definition of avoided emissions: emissions that would have been generated in order to produce the same quantity of energy or raw material according to conventional production methods (national energy mix).

Item	Emission factor	MESE-Stoke-Dudley-Wolves		CTG		COA Lantic + Pluzunet		CTA		CCF		CEB E.Mons + Kogeban		BAKU		Total	
	$kgCO_2e$ / MWh	MWh	$t.CO_2e$	MWh	$t.CO_2e$	MWh	$t.CO_2e$			MWh	$t.CO_2e$	MWh	$t.CO_2e$	MWh	$t.CO_2e$	MWh	$t.CO_2e$
Electricity, France	56			27,041	1,514	8,229	461			5,086	285	224,823	12,590			265,179	14,850
Electricity, UK	505	153,649	77,593													153,649	77,593
Electricity, AZ	473													145,708	68,920	145,708	68,920
Heat, France	279			56,241	15,691	17,766	4,957			34,627	9,661	212,734	59,353			321,368	89,662
	Total Energy	153,649	77,593	83,282	17,206	25,995	5,418			39,713	9,946	437,557	71,943	145,708	68,920	885,904	251,024
	$kgCO_2/T$			t	$t.CO_2e$	t	$t.CO_2e$	t	$t.CO_2e$							t	$t.CO_2e$
Compost	36					8,979	323	0	0								
PET	3,061			1,370	4,194			0	0								
HDPE	1,705			492	839			0	0								
Steel	2,090			485	1,014			0	0								
Aluminum	9,314			27	251			0	0								
Glass	422			10,512	4,436			5,980	2,524								
	Total recycling	-	-	12,886	10,734	8,979	323	5,980	2,524	-	-	-	-	-	-	21,865	13,580
	Total per site		**77,593**		**27,939**		**5,741**		**2,524**		**9,946**		**71,943**		**68,920**	**264,605**	**$t.CO_2e$ avoided**
																Total of avoided emissions	



The transportation and distribution of electricity should not be included in the emission factor of electricity in France, which gives rise to a reduction from 72 to 56 kg.CO_2e */ MWh.*

Emission savings have increased by 3.2% by comparison with 2015.

Electricity sold in France has little effect on the Group's emissions both because of the part played by nuclear power in France's energy mix, which gives an emission factor per kWh that is ten times lower than in the UK or Azerbaijan, and because of the smaller capacity of French sites by comparison with those elsewhere.

VI. Uncertainties

Method of calculating total uncertainty: the ‘standard’ method of calculating the uncertainty of a figure is to make a quadratic sum of all errors. Using this method, we obtain a total uncertainty of approximately 17%. This method takes into account the fact that uncertainties may offset each other. However, it only works if the values being added together are independent. In this case, most of the emissions are due to the incineration of household waste (90% of the total). As each of these emissions depends directly on the emission factor of household waste incineration, the values are therefore not independent. As in previous years, the uncertainties have thus been added together in order to calculate the total uncertainty.

VII. Examples of action taken to reduce greenhouse gas emissions

a) Energy consumption reduction measures

- **La Seyne-sur-Mer: a multi-year plan for reducing consumption**

At the La Seyne-sur-Mer site, the Group's principal site, the multi-year campaign of works initiated with the objective of reducing energy consumption is continuing. The main measures undertaken in 2016 were:

- outside: initiative to replace the outdoor sodium spot lighting with LEDs, and fitting of solar protection films in order to reduce use of air conditioning in summer;
- inside: in 500 m² of offices, replacement of all lights with LEDs and removal of switches, these being replaced with individual detectors;
- acquisition of software enabling consumption of all fluids to be firstly monitored and then ultimately controlled for each building;
- acquisition of a first electric vehicle for on-site industrial maintenance, which has replaced a carbon-dioxide producing vehicle.

- **Two years of works for an energy-efficient head office**

Having been closed for works since 2014, CNIM's head office in Paris reopened its doors at the end of 2016. The building, a townhouse dating from the late 19th century, has undergone a complete renovation. The aims were firstly to bring together all of the Paris staff on one site, and secondly to comply with the applicable standards and regulations, in particular RT 2012 (the 2012 Heat Regulation). Specifically, the object of RT 2012, in accordance with Article 4 of the Law Grenelle 1, is to limit the amount of primary energy consumed by buildings.

The energy solution adopted is to connect to the city of Paris's urban network, which is itself powered by household-waste recovery. The whole of the building is now controlled by a programming system which enables the lighting and the temperature to be managed as a function of the days and hours of the week. Finally, there are no longer any light switches anywhere in the building, with the lighting being controlled by remote sensing. These measures, taken together, will mean that 50 kWh/m²/year will not be exceeded.

b) Development of services helping to reduce our customers' greenhouse gases

- **Energy efficiency in flue gas treatment**

As part of its projects, LAB includes in its projects a comprehensive offering of heat optimization and recovery by way of flue gas condensation systems, which may or may not be supplemented with heat pump systems and/or combustion air humidification systems. Examples: The projects AARHUS (commissioned in 2016), Nordforbanding (commissioned in 2016), Amager (commissioned in 2016), Hofor (order taken 2016) and Helsingor, all of which are in Denmark.

- **CNIM has been awarded a contract to modernize the waste-to-energy site at Thiverval-Grignon (France)**

At the end of 2016, CNIM was awarded a Design-Construction-Operation-Maintenance (CREM) contract for energy optimization of the Thiverval-Grignon waste-to-energy center. The center is able to process a yearly average of 200,000 metric tons of waste, as well as 20,000 metric tons of sludge from urban or rural cleaning stations. The project consists in optimizing the waste-to-energy center in order to respond to the following challenges:

- increasing the recovery of energy from waste incineration;
- improving energy performance in order to meet the European R1 (Recovery One) criterion;
- improving the treatment of the flue gas of the preserved existing line, with the current wet treatment system being replaced with a dry treatment system, and with elimination of stack plumes and reduction of Nox content.

- **Marine scrubbers supplied by LAB for three Brittany Ferries vessels**

On 1 January 2015, the European Directive on reducing the amount of sulfur emitted by marine vessels in ECA (Emission Control Area) regions took effect. The French ferry constructor STX has opted to fit LAB's flue-gas washing technology (marine scrubbers) to three Brittany Ferries vessels in order to bring them into line with the new standards. These are the very first scrubbers to be made of composite material, which makes them lighter, easier to repair and highly competitive. There is an overall global market of around 1,000 ships that will need to be equipped to comply with the Directive. These first new-generation scrubbers entered into operation during 2016, and performed as expected and even better.

- **District heating goes green in Paris**

CNIM Babcock Services and LAB Service have refurbished the Bercy steam generation plant operated by the Compagnie Parisienne de Chauffage Urbain (CPCU). The assignment, one of the largest environmental upgrades to be carried out in France in recent years, involves converting boilers that supply Paris's urban heating and hot water network to run on gas and biofuel. Ultimately, the works carried out have meant that CPCU is able to announce reductions in emissions values by 85% for nitrogen oxides, 98% for sulfur dioxide, 90% for particulates and 25% for carbon dioxide.