Highlights

Key figures on climate
France and worldwide

2016 Edition

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

I4CE
INSTITUTE FOR CLIMATE ECONOMICS
Une initiative de la Caisse des Dépôts et de l'Agence Française de Développement

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Ministère de l'Écologie, du Développement durable et de l'Énergie

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Key figures on climate France and worldwide

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Foreword

In line with previous years, but with a sharper focus that the issue deserves, the 2016 edition of "*Key figures on climate*" has been written in the context of the 21st Conference of the Parties on Climate Change (COP 21) to be held in Paris from 30 November to 11 December 2015.

This latest version has been updated and expanded relative to the 2015 edition. The sector-based analysis of GHG emissions has thus been supplemented by a double page on agriculture and emissions from Land Use, Land Use Change and Forestry (LULUCF). A page on carbon pricing around the world has been added. Some pages devoted to global data have also been spread across two to make them easier to read.
However, 2013 data for GHG emissions at the international level are not yet available. Unlike past years, this data will be made available by the European Environment Agency (EEA) later in the year.

This publication, through its structure and choice of topics, aims to inform as wide a readership as possible about climate change, its mechanisms, causes and effects, as well as the international schemes that have been established to limit them.

In addition to this paper edition, a smartphone application StatClimat was developed. It presents the main key figures on climate change in France and worldwide.

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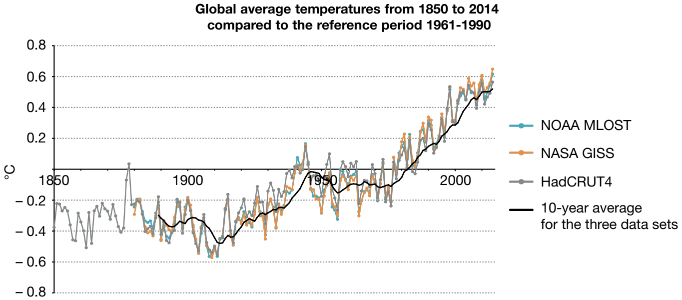
Global warming

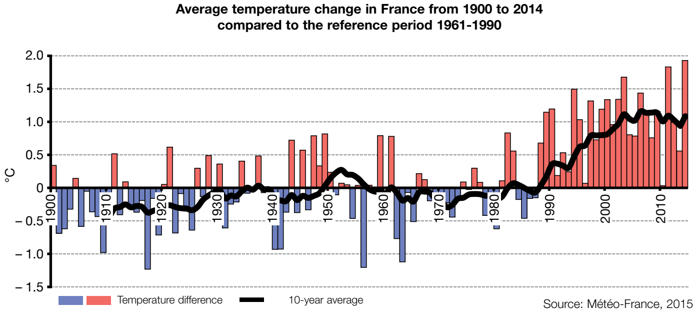
Global surface temperature change



Source: NOAA, NASA and Met Office, 2015

> In 2014, the average global surface temperature was 0.57 ± 0.09°C higher than the norm calculated for the period 1961–1990 (14°C). This was 0.08°C over the temperature average for the last ten years (2005–2014). It was the warmest year on record since 1880.

> Globally, the warmest years since 1880 have all occurred after 1998.

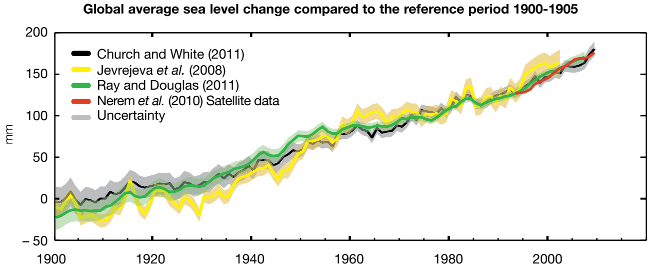


Source: Météo-France, 2015

> In metropolitan France, the average increase in air temperature has been around 0.7°C over the whole 20th century in north-eastern parts of the country. The increase is more pronounced in the south-west where it has reached over 1.1°C.

> As was the case worldwide, 2014 was the warmest year ever recorded in France, at + 1.9°C over the 1961-1990 average, thus beating the previous record from 2011 (+ 1.8°C).

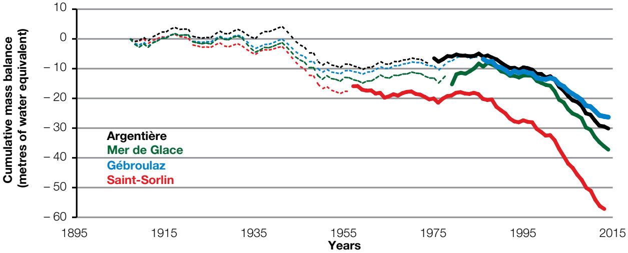
Rise in sea levels



Source: IPCC, Working Group I, 2013

> The global average sea level rose by **1.7 ± 0.3 mm/yr** over the period 1901-2010.
> The rise has been greater in recent decades, reaching 3.2 ± 0.4 mm/yr over the period 1993-2010 (satellite data).

Change in mass balance of temperate glaciers in the French Alps since 1904



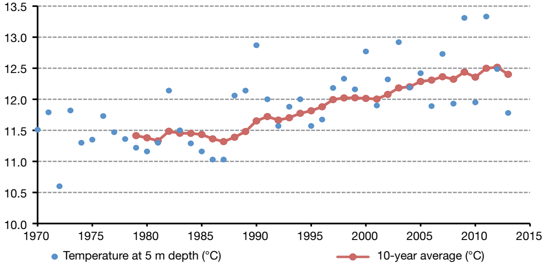
Note: Data for the 1st half of the 20th century (dotted line) were obtained from model simulations.
The solid lines are observations.

Source: GLACIOCLIM observation service, LGGE (CNRS-UJF), 2015

> Glacial reduction did not occur evenly throughout this period, with two phases of sharp decline: 1942-1953 and from 1985 onwards. The sharp decline in the forties was primarily due to low snowfall in the winter and very hot summers. The significant loss of glacier mass recorded since 1982 is the result of a very significant increase in summer melting. This mass loss has become more pronounced since 2003.

Consequences of climate change

Change in the temperature of Lake Geneva at a depth of 5 m

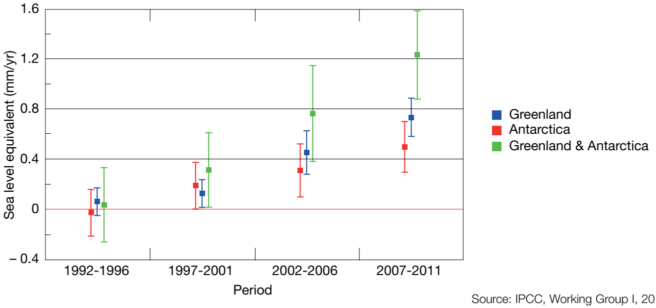


Source: Commission internationale pour la protection des eaux du Léman, 2015

> Lake Geneva's surface water temperature increased by 1.5°C between 1970 and 2013. In 2013, the average annual temperature was 11.8°C. 2009 and 2011 were by far the warmest years at the surface, with a water temperature measured at a depth of 5 m of 13.3°C in 2011.

Glacial melting

Snow cover loss in sea level equivalent per 5-year period between 1992 and 2011

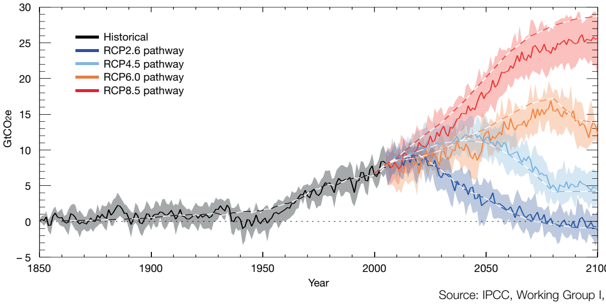


Source: IPCC, Working Group I, 2013

> In the Northern hemisphere, snow cover has declined throughout the 20th century. The rate of this decline has accelerated over the last few decades. The IPCC estimates that spring snow cover has decreased by 8% at the surface over the period 1970-2010 compared to the period 1922-1970. Reduced snow surface area decreases the earth's albedo – a measure of how much something reflects solar energy – and thus contributes to temperature rise.

Change in GHG emissions according to IPCC scenarios

Projection of emissions from fossil fuels according to the IPCC's four Representative Concentration Pathways (RCP)

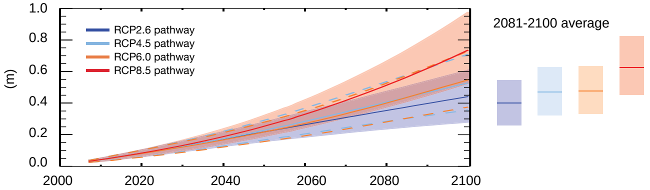


Source: IPCC, Working Group I, 2013

> The IPCC published its *First Assessment Report* (FAR) in 1990 and its fifth report (AR5) in late 2014. With each publication, the IPCC communicates climate projections based on different scenarios. For AR5, four pathways for GHG concentrations were chosen, referred to as *Representative Concentration Pathways* (RCP). Based on these pathways, climate simulations and socio-economic scenarios were produced.

Sea level change according to IPCC scenarios

Projection of the average rise in sea levels compared to the period 1986-2005



Source: IPCC, Working Group I, 2013

> The main factors in sea level rise are thermal expansion of the oceans and melting of land-based ice reserves (glaciers, polar ice caps, etc.).

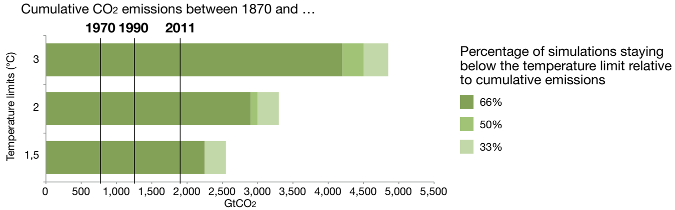
> The rise in sea levels will probably cause mass migrations of people, as over a billion people live in low-lying coastal areas.

> Despite numerous developments in recent years, ice melt forecast models still have wide margins of uncertainty.

Climate scenarios and carbon budgets

Carbon budgets in relation to temperature rises

Cumulative anthropogenic CO_2 emissions since 1870 ($GtCO_2$)



Note: The percentages cannot be interpreted as probabilities. The graph reads as follows: when looking at the 5,000 Gt of CO_2 cumulatively emitted since 1870, the simulations report only 33% of these involved a temperature rise of less than 3°C.

Sources: I4CE based on IPCC, Working Groups I and III, 2014

> A carbon budget is the maximum allowable amount of CO_2 emissions if an unreasonably rapid temperature rise is to be avoided. For example, the IPCC indicates that the scenario that would allow 66% of simulations to remain below the 2°C limit means emitting less than 1,000 $GtCO_2$ from 2011 onwards, a little less than thirty years' worth of emissions at the 2011 rate.

Results of scenarios regarding the likelihood of limiting temperature rise

Scenario	GHG concentrations in 2100 (in ppm CO_2e)	Cumulative CO_2 emissions ($GtCO_2$)		Change in emissions in CO_2e compared to 2010 (%)		Change in temperatures compared to 1850-1900				
						Projected temperature rise in 2100* (in °C)	Probability of not exceeding the temperature rise indicated in the 21st century			
		2011-2050	2011-2100	2050	2,100		1.5°C	2.0°C	3.0°C	4.0°C
RCP 2.6	450 (430-480)	550-1,300	630-1,180	Between – 72 and – 41	Between – 118 and – 78	1.5 - 1.7				
RCP 4.5	(580-650)	1,260-1,640	1,870-2,440	Between – 38 and + 24	Between – 134 and – 50	2.3 - 2.6				
	(650-720)	1,310-1,750	2,570-3,340	Between – 11 and + 17	Between – 54 and – 21	2.6 - 2.9				
RCP 6.0	(720-1,000)	1,570-1,940	3,620-4,990	Between + 18 and + 54	Between – 7 and + 72	3.1 - 3.7				
RCP 8.5	> 1,000	1,840-2,310	5,350-7,010	Between + 52 and + 95	Between + 74 and + 178	4.1 - 4.8	**	**		

* Ranges do not account for a number of uncertainties
** None of the simulations showed results below the temperature limit.

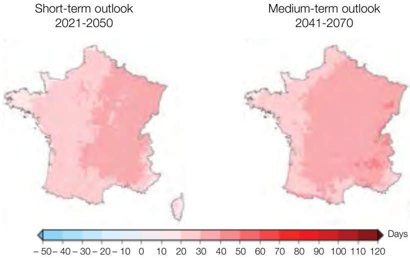
Probable | More probable than improbable | Improbable | More improbable than probable

Source: IPCC, Working Group III, 2014

> Out of the IPCC's four main scenarios, only the most ambitious – RCP 2.6 – gave a probability of over 50% for limiting the rise to 2°C. The business-as-usual scenario (RCP 8.5) shows a higher than 50% probability of an increase of over 4°C.

Consequences for France

Number of additional days temperatures will be abnormally high in the future (IPCC's RCP 4.5 scenario, 2014)



Source: Drias *les futurs du climat*, 2014

Schematic map of the potential impacts of climate change in metropolitan France by 2050 and beyond

ALL REGIONS:
Warming more pronounced in summer and in the south-east quarter:
- Sharp increase in the number of days of heat wave in summer
- Evaporation with reduced base flows and water resources for agriculture
- Effects on crop yields
- Shift in tourist attraction areas

LARGE CITIES:
- More intense heat waves with consequences on health and energy consumption
- Increased risk of urban flooding: overflow of sewerage systems, flooding of underground infrastructure

FORESTS:
- Risk of forest fires extended towards the north

MOUNTAINS:
- Reduced surface area of ski slopes
- Increased natural hazards: debris flows in some mountain ranges
- Biodiversity: changes in species distribution

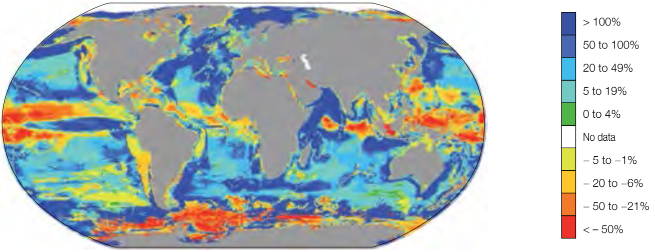
COASTLINES:
- Accentuated risk of erosion, submergence and salinisation of aquifers due to rising sea levels
- More frequent risk of partial flooding of polders and barrier beaches
- Ports and related industries at risk of coastal flooding
- Changes in the distribution of fisheries resources with northward movement

Sources: I4CE, 2015, according to IPCC (2014), MEDDE (2014 and 2015), ONERC (2010) and Météo-France

Climate forecasts

Changes in fisheries resources for the mid-21st century

Variation in potential maximum catches between the averages for 2001-2010 and 2051-2060 according to the scenario RCP 6.0

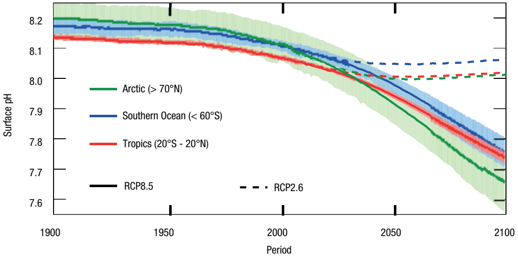


Source: IPCC, Working Group II, 2014

> According to climate forecasts for the mid-21st century, the redistribution of marine species and the reduction in biodiversity in some regions will both be obstacles to production in fisheries, as well as constraints on ecosystems.

Ocean acidification

Ocean acidification change according to the RCP 2.6 and RCP 8.5 scenarios



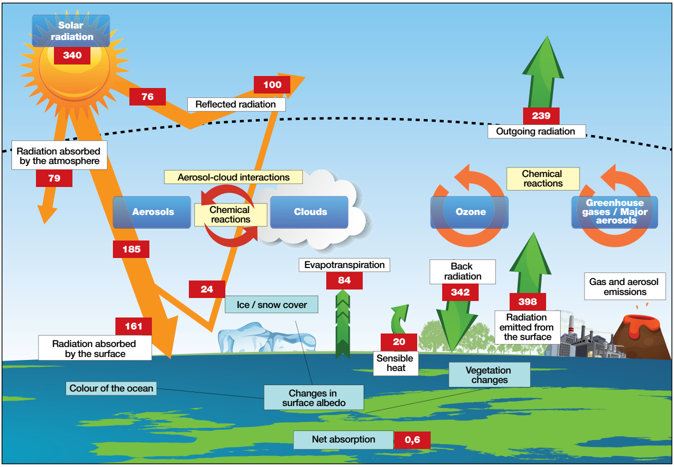
Source: IPCC, Working Group I, 2013

> Part of the CO_2 emitted into the atmosphere is dissolved in the oceans. This causes them to become more acidic by decreasing pH and carbonate ion concentration, which is very useful for shell growth.

> Additionally, climate change should have a number of effects on ocean composition, such as a reduction in dioxygen concentrations. These changes will have a significant impact on marine biodiversity.

Role of the atmosphere in the natural greenhouse effect

Actual energy flows in W/m²



Sunlight provides the earth with energy. Part of this energy is directly or indirectly reflected back towards space, while the majority is absorbed by the atmosphere or the earth's surface. The temperature at the earth's surface at any one time is due to the presence of GHGs that reradiate the majority of surface radiation to the earth.

Source: IPCC, Working Group I, 2013

Human activity and the greenhouse effect

> Higher anthropogenic GHG emissions in the atmosphere increase the amount of energy reradiated to the earth. This results in an imbalance in the system, which causes the land temperature to rise.

> A change in radiation caused by a substance, as compared to a reference year, is called radiative forcing. A positive radiative forcing value indicates a positive contribution to global warming.

> Some human activities such as aerosol emissions contribute to a reduction in the energy reradiated to the earth. In 2013, this negative radiative forcing was estimated to be - 0.45 ± 0.5 W/m² compared to 1750, while the radiative forcing from anthropogenic GHGs was + 2.90 ± 0.29 W/m². Overall anthropogenic radiative forcing was thus + 2.55 ± 1.1 W/m² in 2013 compared to 1750.

Greenhouse gases

Greenhouse gases

> Excluding water vapour, GHGs make up less than 0.1% of the volume of air. Water vapour fluctuates between 0.4 and 4%, is naturally occurring, and is the main greenhouse gas. Human activity has very little impact on the fluctuations of water vapour concentration.

Anthropogenic greenhouse gases

	CO_2	CH_4	N_2O	HFC	PFC	SF_6	NF_3
Atmospheric concentrations in 2013 (2005 figures in brackets)	395 ppm (379 ppm)	1,814 ppb (1,774 ppb)	326 ppb (319 ppb)	> 123 ppt (> 67 ppt)	> 83 ppt (> 79 ppt)	7.9 ppt (5.6 ppt)	< 1 ppt
Length of time in the atmosphere		~ 9 years	131 years	between 0.1 and 270 years	between 2,000 and 50,000 years	3,200 years	500 years
Global warming effect (cumulative over 100 years)	1	28-30	265	[1.4; 14,800]	[6,630; 11,100]	23,500	16,100
Source of anthropogenic emissions	Fossil fuel combustion and tropical deforestation	Landfill, agriculture, livestock farming and industrial processes	Agriculture, industrial processes, use of fertilisers	Sprays, refrigeration, industrial processes			Manufacture of electronic components
Modification of radiative forcing in 2013 since 1750 by anthropogenic emissions (W/m^2) (2005 figures in brackets)	+ 1.88 (+ 1.66)	+ 0.50 (+ 0.48)	+ 0.18 (+ 0.16)	+ 0.12 (+ 0.09)			

ppm = parts per million, ppb = parts per billion, ppt = parts per trillion.

Sources: IPCC, Working Group I, 2013, NOAA (2015), AGAGE (2015)

> **Global warming potential (GWP)** is the ratio between the amount of energy reradiated to the earth by 1 kg of a gas over 100 years and the amount that 1 kg of CO_2 would reradiate. It depends on the concentrations and lifetimes of the gases. For example, 1 kg of CH_4 and between 28 and 30 kg of CO_2 will warm up the atmosphere by the same amount over the century following their emission.

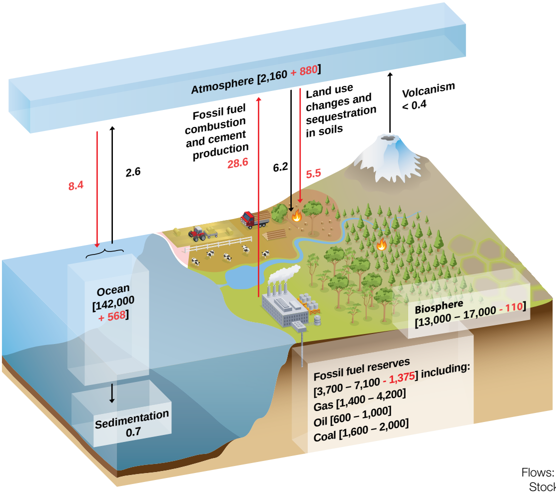
> **The ozone** – particularly in the troposphere – is also a GHG whose radiative forcing has increased by **+ 0.35 W/m^2** since 1750 due to its significantly higher concentrations.

> The gases covered by the Montreal Protocol on Substances that Deplete the Ozone Layer (including **CFCs** and **HCFCs**) are also GHGs. Their radiative forcing has increased by **+ 0.33 W/m^2** since 1750.

While CO_2 is the gas with the lowest global warming potential, it is also the one that has contributed the most to global warming since 1750.

Carbon stocks and GHG flows: the case of CO_2

Simplified CO_2 cycle in the 2000s



This graph shows: (i) in square brackets, the size of carbon stocks in pre-industrial times in billions of tonnes of CO_2 equivalent in black and their change over the period 1750-2011 in red; (ii) as arrows, carbon flows between the stocks in billions of tonnes of CO_2 equivalent per year. Pre-industrial flows are shown in black. Those from the development of anthropogenic activities between 2000 and 2009 are shown in red.

Source: according to IPCC, Working Group I, 2013

> Four large reservoirs allow carbon to be stored in various forms:

- **Atmosphere:** gaseous CO_2;
- **Biosphere:** organic matter from living things including forests;
- **Ocean:** limestone, dissolved CO_2;
- **Subsurface:** rocks, sediment, fossil fuels.

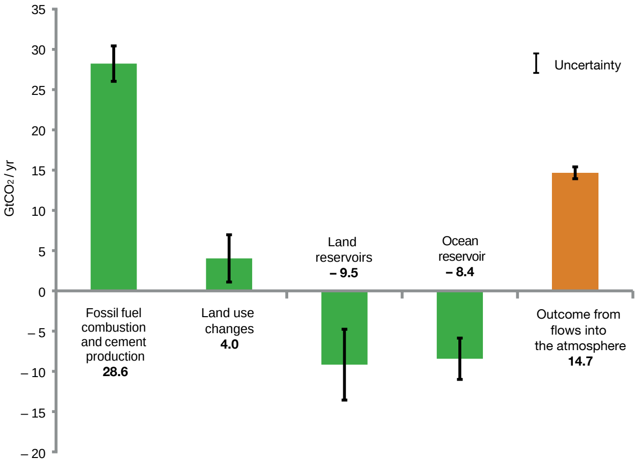
> Carbon flows between these reservoirs constitute the natural carbon cycle, which is disrupted by anthropogenic emissions of CO_2 that change the amounts exchanged or create new flows. E.g.: combustion of fossil organic carbon stocks.

> In the 2000s, of the 340 Gt of CO_2 released by human activities from the biosphere and lithosphere, the atmosphere absorbed 160 and the oceans 90. The atmosphere is the reservoir most affected by anthropogenic activities: the quantity of carbon stored has increased by nearly 40% compared to pre-industrial levels.

1.8 Increase in atmospheric GHG levels

Imbalance between emissions and CO2 storage capacity

Net annual flows of CO2 towards the atmosphere by source and reservoir over the period 2000-2009



Source: IPCC, Working Group I, 2013

> Since the development of industry, land and ocean reservoirs have absorbed half of anthropogenic emissions. The remaining emissions are still in the atmosphere, leading to **an increase in atmospheric concentrations of CO_2.**

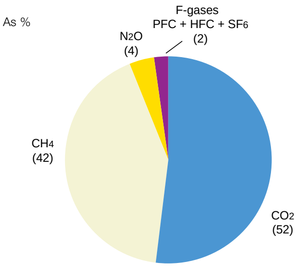
> Forests are the largest carbon reservoirs on land. They sequester a net 9.2 Gt of CO_2 emissions per year, the equivalent of 33% of global GHG emissions.

> In France, net carbon sequestration in forest biomass is estimated to be 57.3 $MtCO_2$, or 12% of national fossil carbon emissions (CITEPA, 2014).

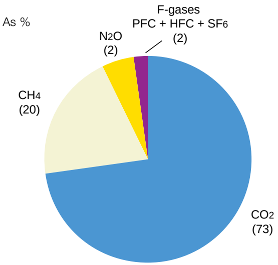
> Deforestation causes GHG emissions through the combustion and decomposition of organic matter. These gross emissions account for 11% of GHGs from anthropogenic sources (van der Werf et al., 2009, Nature Geoscience).

Global distribution of GHG[1] emissions by gas in 2010

Based on global warming potential[2] at **20 years**



Based on global warming potential[2] at **100 years**

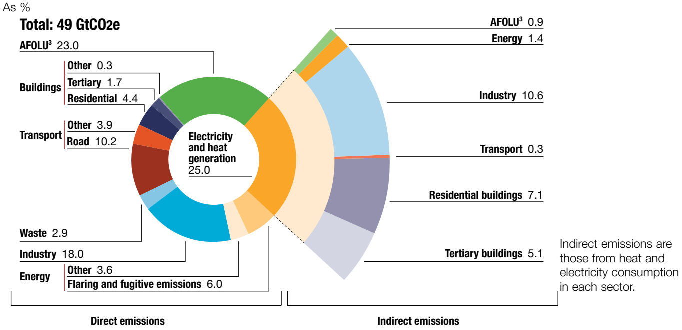


Source: IPCC, Working Group III, 2014

> Emissions of the six greenhouse gases covered by the Kyoto Protocol have increased by 80% since 1970 and by 45% since 1990, reaching **54 $GtCO_2e$ in 2013.**

CO_2: Carbon dioxide; N_2O: Nitrous oxide; CH_4: Methane; HFCs: Hydrofluorocarbons; PFCs: Perfluorocarbons; SF_6: Sulphur hexafluoride
1. Including emissions from Land Use, Land Use Change and Forestry (LULUCF).
2. Global warming potential allows a comparison to be made of the contributions of different greenhouse gases to global warming for a given period. The period chosen is often 100 years. However, this choice underestimates the short-term effect of some gases. It is for this reason that a period of 20 years is sometimes used.

Global distribution of GHG emissions by sector in 2010

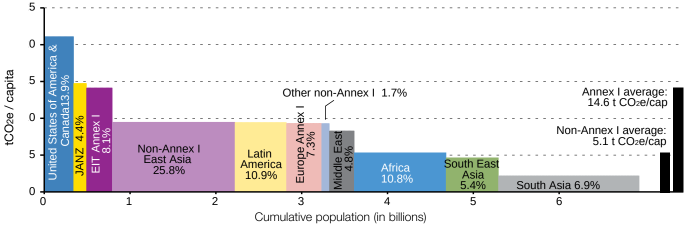


3. AFOLU: Agriculture, Forestry and Other Land Use

Source: IPCC, Working Group III, 2014

Overview of global GHG emissions

Regional distribution of GHG[1] emissions per capita in 2012

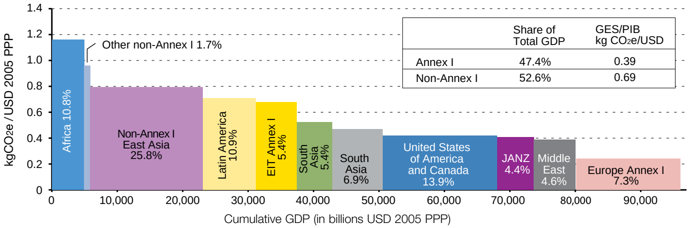


Country names given are based on the ISO 3166 standard.

Source: I4CE based on JRC EDGAR and World Bank, 2015

> In 2012, Annex I countries[2] represented **17% of the population,** 47% of GDP and accounted for **34% of global GHG** emissions. Their average for GHG emissions was 14.6 tCO_2e per capita, which is a little over twice that of non-Annex B countries. This differential has decreased since 2004 when it was four times greater.

Regional distribution of GHG[1] emissions per unit of GDP in 2012



Country names given are based on the ISO 3166 standard.

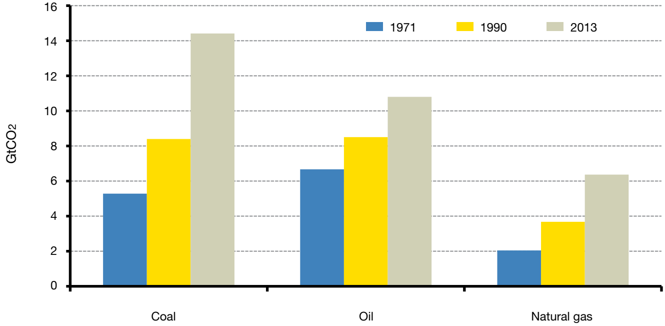
Source: I4CE based on JRC EDGAR and World Bank, 2015.

> On average in Annex I countries, generating one unit of GDP resulted in GHG emissions that amounted to half those of non-Annex I countries, as measured in 2005 dollars based on Purchasing Power Parity (PPP).

1. Including emissions from Land Use, Land Use Change and Forestry (LULUCF).
2. Annex I countries are developed countries and correspond almost exactly to Annex B countries of the Kyoto Protocol (see page 41).

Global CO_2 emissions from fuel combustion

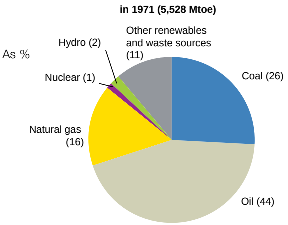
Global CO_2 emissions from fuel combustion by fuel

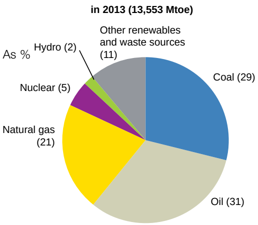


Source: International Energy Agency, September 2015

> Fossil fuels (coal, natural gas and crude oil) accounted for 81% of the world's energy mix in 2013 (five points less than in 1971), 74% of that of the EU-28 and only 49% of France's, owing to the extent of the country's nuclear generation. Globally, between 1971 and 2013, the share of crude oil in this mix fell by 13 points, in favour of gas (+ 5 points), nuclear power (+ 4 points) and coal (+ 3 points). At 29% of the energy mix, coal was the second largest energy source after crude oil in 2013, but was number one in terms of CO_2 emissions (45%). Its emission factor was considerably higher than those of gas and oil (see page 54). As renewable energy generation has increased at a rate close to total generation, its share in the world energy mix has not changed in 40 years.

Global primary energy mix





Source: International Energy Agency, September 2015

Global CO_2 emissions from fuel combustion

Global CO_2 emissions from fuel combustion[1]

In $MtCO_2$

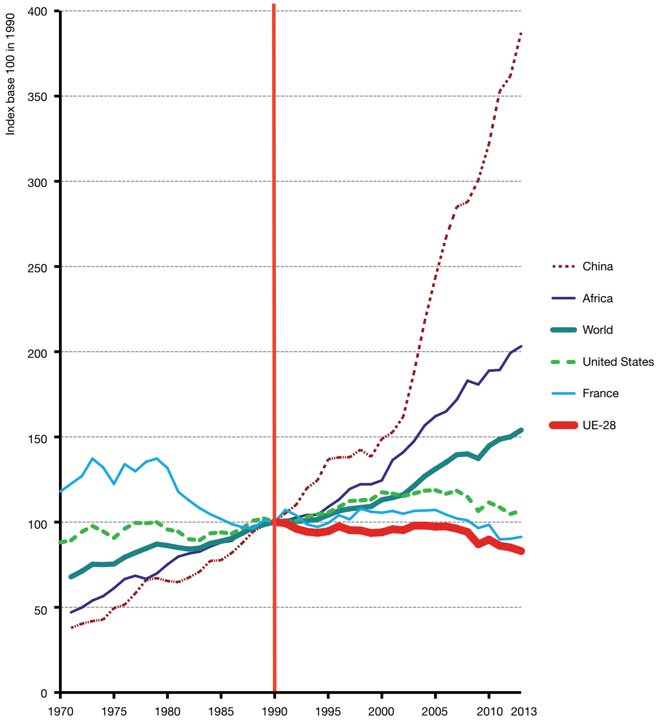
	1990	2012	2013	2013 share (%)	Change (%) 2013/2012	Change (%) 2013/1990
North America	**5,481**	**5,989**	**6,108**	**19.2**	**+ 2.0**	**+ 11.4**
including: Canada	419	524	536	1.7	+ 2.4	+ 28.0
United States	4,802	5,032	5,120	16.1	+ 1.7	+ 6.6
Latin America	**583**	**1,179**	**1,210**	**3.8**	**+ 2.6**	**+ 107.6**
including: Brazil	184	422	452	1.4	+ 7.2	+ 145.5
Europe and ex-USSR	**7,841**	**6,244**	**6,126**	**19.3**	**– 1.9**	**– 21.9**
including: EU-28	4,024	3,425	3,340	10.5	– 2.5	– 17.0
Ex-EU-15	3,038	2,751	2,692	8.5	– 2.1	– 11.4
including: Germany	940	745	760	2.4	+ 2.0	– 19.2
Spain	203	260	236	0.7	– 9.5	+16.3
France	**346**	**312**	**316**	**1.0**	**+ 1.2**	**– 8.7**
Italy	389	367	338	1.1	– 7.8	– 13.1
United Kingdom	548	462	449	1.4	– 2.8	– 18.1
13 new Member States	986	674	648	2.0	– 3.8	– 34.2
including: Russia	2,163	1,551	1,543	4.9	– 0.5	– 28.7
Africa	**529**	**1,054**	**1,075**	**3.4**	**+ 1.9**	**+ 103.2**
Middle East	**568**	**1,689**	**1,716**	**5.4**	**+ 1.6**	**+ 202.0**
Far East	**4,711**	**13,277**	**13,999**	**44.1**	**+ 5.4**	**+ 197.2**
including: China	2,217	8,021	8,585	27.0	+ 7.0	+ 287.3
South Korea	232	575	572	1.8	– 0.5	+ 147.0
India	534	1,780	1,869	5.9	+ 5.0	+ 249.9
Japan	1,049	1,217	1,235	3.9	+ 1.5	+ 17.7
Oceania	**281**	**418**	**419**	**1.3**	**+ 0.3**	**+ 49.1**
Annex I countries	**13,721**	**12,872**	**12,874**	**40.5**	**+ 0.0**	**– 6.2**
Non-Annex I countries	**6,272**	**16,979**	**17,778**	**56.0**	**+ 4.7**	**+ 183.5**
International aviation and shipping bunkers[2]	**630**	**1,096**	**1,103**	**3.5**	**+ 0.7**	**+ 75.1**
World	**20,623**	**30,947**	**31,755**	**100.0**	**+ 2.6**	**+ 54.0**

Source: International Energy Agency, September 2015

1. Emissions from fossil fuel combustion for final use (transport, heating, etc.) or not (power generation, oil refining, etc.). These data are estimated by the IEA based on energy balances. There are differences in scope and calculation method (including for emission factors) compared to the GHG emissions inventories submitted to the UNFCCC, which are used later in Chapters 3 and 4.
2. Emissions from international aviation and shipping bunkers have been excluded from national totals.

> In 2013, global CO_2 emissions from fuel combustion reached 31.8 billion tonnes of CO_2 ($GtCO_2$), up + 2.6% compared to 2012. With an emissions level of 8.6 $GtCO_2$, China is by far the world's largest emitter, ahead of the United States. In 2013, these two countries emitted 43% of global CO_2 emissions from fuel combustion.

Global CO_2 emissions from fuel combustion[1]



Source: International Energy Agency, September 2015

> Between 1990 and 2013, global emissions from fuel combustion increased by 50%. China showed the sharpest increase, with emissions almost quadrupling over the period. In the European Union, emissions showed a downward trend (– 15% since 1990). French emissions were also down overall, but they have remained stable over the last three years.

Global CO_2 emissions from fuel combustion

Global energy-related CO_2 emissions per capita

In tCO_2/capita

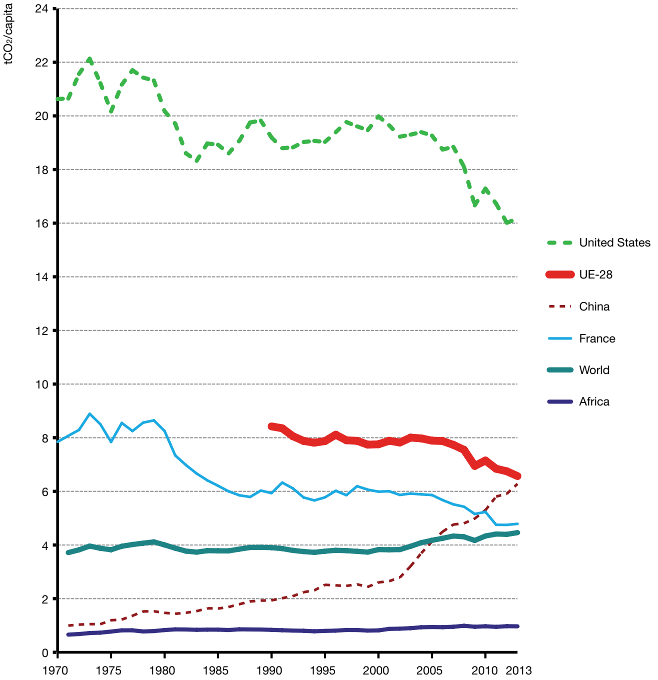
	1990	2012	2013	Change (%) 2013/2012	Change (%) 2013/1990
North America	**15.0**	**12.9**	**13.0**	**+ 1.1**	**– 13.5**
including: Canada	15.1	15.1	15.3	+ 1.2	+ 0.8
United States	19.2	16.0	16.2	+ 1.0	– 15.7
Latin America	**1.6**	**2.4**	**2.5**	**+ 1.6**	**+ 50.7**
including: Brazil	1.2	2.1	2.3	+ 6.6	+ 84.1
Europe and ex-USSR	**9.3**	**7.0**	**6.8**	**– 2.2**	**– 26.9**
including: EU-28	8.4	6.7	6.6	– 2.7	– 22.0
Ex-EU-15	8.3	6.8	6.7	– 2.4	– 19.5
including: Germany	11.8	9.1	9.3	+ 1.7	– 21.9
Spain	5.2	5.6	5.1	– 9.2	– 2.6
France	**5.9**	**4.8**	**4.8**	**+ 0.8**	**– 19.3**
Italy	6.9	6.1	5.6	– 8.3	– 18.7
United Kingdom	9.6	7.2	7.0	– 2.8	– 26.8
13 new Member States	8.8	6.4	6.1	– 4.7	– 30.9
including: Russia	14.6	10.8	10.8	–	– 26.0
Africa	**0.8**	**1.0**	**1.0**	**– 0.6**	**+ 15.7**
Middle East	**4.3**	**7.6**	**7.6**	**– 0.4**	**+ 76.0**
Far East	**1.6**	**3.4**	**3.6**	**+ 4.5**	**+ 124.3**
including: China	1.9	5.9	6.3	+ 6.2	+ 224.5
South Korea	5.4	11.5	11.4	– 1.0	+ 110.8
India	0.6	1.4	1.5	+ 4.1	+ 143.2
Japan	8.5	9.5	9.7	+ 1.6	+ 14.3
Oceania	**13.7**	**15.3**	**15.1**	**– 1.3**	**+ 10.4**
Annex I countries	**11.7**	**9.9**	**9.9**	**– 0.3**	**– 15.2**
Non-Annex I countries	**1.5**	**3.0**	**3.1**	**+ 3.2**	**+ 100.0**
World	**3.9**	**4.4**	**4.5**	**+ 2.5**	**+ 15.6**

Source: International Energy Agency, September 2015

> In 2013, CO_2 emissions from fuel combustion came to 4.5 tCO_2/capita. They were virtually stable in Annex I countries (– 0.3%), while they continue to increase everywhere else (+ 3.2%).

> Emissions per capita were highest in North America (over 15 tCO_2/cap in Canada and the United States) and in Oceania. In continental Europe, Russia reported emissions per capita of 10.8 tCO_2. This was considerably above the EU-28 average (6.9 tCO_2/cap), which in turn was higher than the French average (5.1 tCO_2/cap). In 2012, an inhabitant of France emitted three times less CO_2 than an inhabitant of the United States (16.1 tCO_2/cap).

Global energy-related CO_2 emissions per capita



Source: International Energy Agency, September 2015

> Since 1990, emissions per capita from fuel combustion has been on the decline in the European Union (– 22.0%), with France sitting just below the average (– 19.3%). In Latin America, and even more so in the Far East, emissions per capita have increased significantly in 20 years, more than tripling in China at 6.1 tCO_2/cap in 2013, and more than doubling in India and South Korea. These emissions have decreased in North America, under the impetus of the United States, while they remain stable in Canada.

Global CO_2 emissions from fuel combustion

Global energy-related CO_2 emissions in relation to GDP

In tCO_2/million $ 2005 PPP[1]

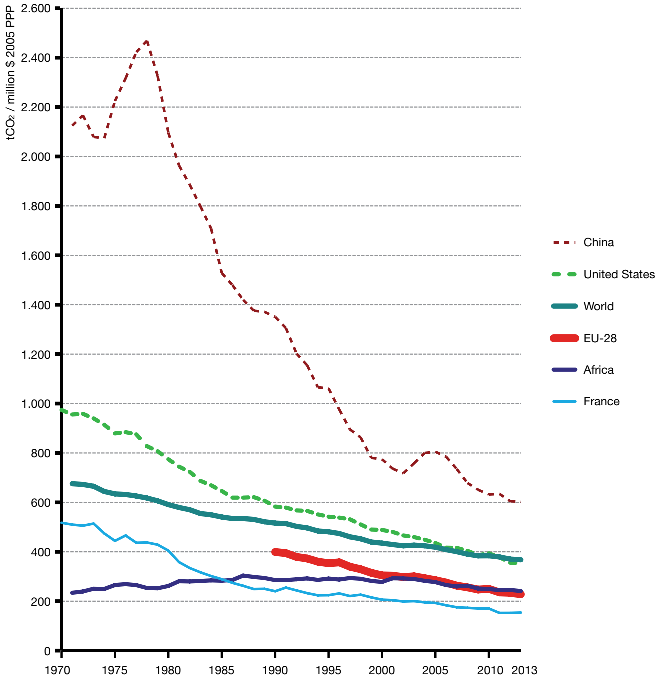
	1990	2012	2013	Change (%) 2013/2012	Change (%) 2013/1990
North America	**555**	**352**	**352**	**– 0.1**	**– 36.7**
including: Canada	542	403	405	+ 0.4	– 25.3
United States	583	356	354	– 0.5	– 39.2
Latin America	**216**	**209**	**207**	**– 0.7**	**– 4.0**
including: Brazil	138	167	174	+ 4.6	+ 26.0
Europe and ex-USSR	**565**	**316**	**307**	**– 2.6**	**– 45.6**
including: EU-28	399	234	228	– 2.6	– 42.9
Ex-EU-15	340	215	211	– 2.1	– 38.0
including: Germany	443	254	259	+ 1.9	– 41.6
Spain	259	209	191	– 8.4	– 26.2
France	**240**	**153**	**154**	**+ 1.0**	**– 35.9**
Italy	279	221	208	– 6.2	– 25.6
United Kingdom	385	211	201	– 4.4	– 47.6
13 new Member States	860	364	346	– 5.1	– 59.8
including: Russia	1,155	712	699	– 1.8	– 39.5
Africa	**285**	**246**	**241**	**– 1.9**	**– 15.6**
Middle East	**311**	**378**	**378**	**+ 0.1**	**+ 21.5**
Far East	**504**	**423**	**422**	**– 0.4**	**– 16.3**
including: China	1,351	605	602	– 0.5	– 55.4
South Korea	490	380	368	– 3.3	– 25.0
India	389	326	320	– 1.8	– 17.7
Japan	320	304	303	– 0.1	– 5.3
Oceania	**571**	**422**	**413**	**– 2.2**	**– 27.6**
Annex I countries	**526**	**327**	**323**	**– 1.3**	**– 38.5**
Non-Annex I countries	**453**	**384**	**382**	**– 0.4**	**– 15.5**
World	**516**	**370**	**368**	**– 0.5**	**– 28.7**

1. Purchasing Power Parity

Source: International Energy Agency, September 2015

> CO_2 emissions per unit of GDP were highest in the Far East, with significant disparities, at 320 gCO_2/$ in India, compared to over 600 gCO_2/$ in China. However they were even higher in Russia (699 gCO_2/$). While the European Union average was relatively low (228 gCO_2/$), France reported one of the lowest values: 154 gCO_2/$, behind Sweden (108 gCO_2/$).

Global energy-related CO_2 emissions in relation to GDP



Source: International Energy Agency, September 2015

> Since 1990, the quantity of CO_2 emitted per unit of GDP has been on a decline in all regions of the world (– 29%) except the Middle East (+ 21.5%). The decrease was particularly marked in the European Union (– 42.9%) and in North America (– 36.7%). China was the country that recorded the sharpest drop in 23 years, with emissions per unit of GDP down by almost half. They were however still very high in 2013.

Global CO_2 Emissions from Electricity Generation

Global CO_2 emissions from electricity generation[1]

In $MtCO_2$

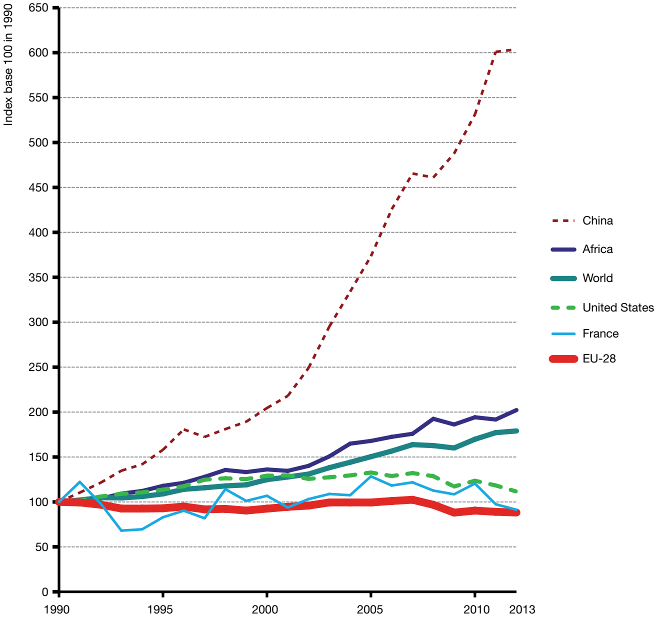
	1990	2012	2013	Share in energy-related emissions in 2013 (%) [2]	Change (%) 2013/2012	Change (%) 2013/1990
North America	**2,062**	**2,358**	**2,384**	**38.6**	**+ 1.1**	**+ 14.4**
including: Canada	97	103	105	19.3	+ 1.5	+ 6.4
United States	1,901	2,120	2,128	41.4	+ 0.4	+ 11.6
Latin America	**97**	**265**	**289**	**21.9**	**+ 9.3**	**+ 172.6**
including: Brazil	13	55	77	12.2	+ 39.1	+ 331.7
Europe and ex-USSR	**2,814**	**2,436**	**2,343**	**39.8**	**– 3.8**	**– 13.4**
including: EU-28	1,454	1,283	1,207	38.4	– 5.9	– 11.8
Ex-EU-15	1,026	966	907	35.9	– 6.1	– 5.9
including: Germany	382	330	332	43.4	+ 0.7	– 13.6
Spain	66	91	69	38.6	– 24.2	+ 37.8
France	**45**	**41**	**39**	**13.1**	**– 4.4**	**– 8.7**
Italy	124	128	111	37.9	– 13.4	+ 3.6
United Kingdom	218	176	163	39.2	– 7.2	– 19.2
13 new Member States	428	317	300	48.9	– 5.3	– 25.9
including: Russia	811	689	680	44.7	– 1.4	– 15.0
Africa	**215**	**435**	**435**	**40.5**	**– 0.1**	**+ 102.3**
Middle East	**183**	**668**	**680**	**38.9**	**+ 1.8**	**+ 264.2**
Far East	**1,418**	**6,019**	**6,322**	**43.0**	**+ 5.0**	**+ 324.5**
including: China	587	3,542	3,786	41.3	+ 6.9	+ 503.6
South Korea	57	308	300	53.7	– 2.4	+ 437.4
India	218	913	945	48.9	+3.5	+ 318.7
Japan	371	570	584	46.2	+2.4	+ 53.4
Oceania	**132**	**210**	**205**	**50.1**	**– 2.3**	**+ 58.9**
Annex I countries	**5,043**	**5,223**	**5,147**	**40.6**	**– 1.5**	**+ 3.6**
Non-Annex I countries	**1,879**	**7,169**	**7,511**	**40.3**	**+ 4.8**	**+ 281.6**
World	**6,922**	**12,392**	**12,658**	**39.0**	**+ 2.2**	**+ 79.0**

Source: International Energy Agency, September 2015

1. These include emissions from electricity generation (including cogeneration) as a main activity, but also emissions from self-producing facilities. Self-producers generate electricity in addition to another activity, often industrial. IPCC guidelines recommend accounting for emissions from self-producers in the final sector that produced them. This is one of the reasons for the discrepancy between these figures and those on page 28.
2. Ratio between emissions from electricity generation (including cogeneration) and emissions from fuel combustion (pages 16 and 17).

> In 2013, global CO_2 emissions from electricity generation (including CHP - combined heat power generation) came to 12.6 billion tonnes of CO_2 ($GtCO_2$). Germany, whose coal provided 46% of the electricity mix, was responsible for a quarter of the CO_2 emitted by EU-28 power stations; France only 3%, despite its electricity generation (including CHP) making up 17% of European generation.

Global CO_2 emissions from electricity generation[1]



Source: International Energy Agency, September 2015

1. These include emissions from electricity generation (including cogeneration) as a main activity, but also emissions from self-producing facilities. Self-producers generate electricity in addition to another activity, often industrial. IPCC guidelines recommend accounting for emissions from self-producers in the final sector that produced them. This is one of the reasons for the discrepancy between these figures and those on page 28.

> CO_2 emissions from electricity generation have been continuously rising since 1990, by + 2.7% per year on average, or + 79% over the whole period. They have multiplied sixfold in China, fivefold in South Korea and quadrupled in India and Brazil. However, at an EU-28 level, these emissions have decreased – 12% since 1990, reaching 1.1 $GtCO_2$ in 2011. Italy and more particularly Spain are the exception to this trend, with respective increases of 3.6% and 37.8% of these emissions between 1990 and 2013.

Overview of GHG emissions in Europe

EU-28 emissions in 2012

In $MtCO_2e$

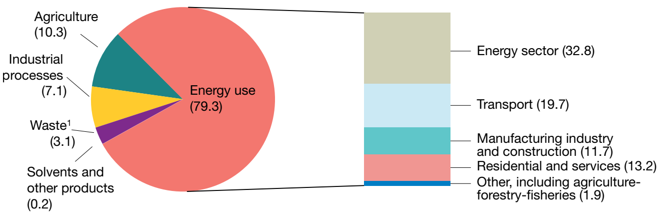
Source	Years	CO_2	CH_4	N_2O	F-gases	Total
Energy use	1990	4,136.1	155.5	33.5	0.0	4,325.1
	2012	3,495.5	76.4	32.4	0.0	3,604.3
Industrial processes	1990	284.3	1.4	116.1	60.3	462.1
	2012	212.3	1.1	12.1	95.2	320.7
Use of solvents and other products	1990	11.8	0.0	5.1	0.0	16.9
	2012	6.8	0.0	3.1	0.0	9.9
Agriculture	1990	0.0	257.6	360.3	0.0	617.9
	2012	0.0	198.8	271.9	0.0	470.6
Waste[1]	1990	4.9	191.7	13.5	0.0	210.1
	2012	2.9	125.5	14.4	0.0	142.8
Total excl. LULUCF[2]	**1990**	**4,437.1**	**606.1**	**528.6**	**60.3**	**5,632.1**
	2012	**3,717.5**	**401.8**	**333.8**	**95.2**	**4,548.4**
LULUCF[2]	1990	– 267.6	5.5	5.6	0.0	– 258.5
	2012	– 313.5	5.2	7.0	0.0	– 301.3
Total	**1990**	**4,169.5**	**611.7**	**534.2**	**60.3**	**5,375.7**
	2012	**3,404.0**	**406.9**	**340.8**	**95.2**	**4,247.1**

Source: European Environment Agency, June 2014

> **European GHG emissions excluding LULUCF[2] dropped by 19% over the period 1990-2012.**
> In the EU, energy use was the main GHG emission source (79%).
> The highest GHG emitting sector was the energy sector (33% of emissions), ahead of transport (20%).
> EU emissions decreased by 1.3% between 2011 and 2012. This can largely be explained by the economic slowdown, in the road transport and manufacturing sectors in particular.

Distribution of GHG emissions by source in the EU in 2012 ($4,548\ MtCO_2e$ excl. LULUCF[2])

As %



Source: European Environment Agency, June 2014

1. Excluding waste incineration with energy recovery (included in "energy sector"). Details page 32
2. Land Use, Land Use Change and Forestry (LULUCF)

France's emissions in 2013

In $MtCO_2e$

Source	Years	CO_2	CH_4	N_2O	F-gases	Total
Energy use	1990	369.4	12.3	3.5	0.6	385.8
	2013	344.6	3.1	4.1	15.6	367.3
Industrial processes	1990	24.9	0.1	23.6	11.2	59.8
	2013	17.6	0.1	0.9	5.2	23.7
Use of solvents and other products	1990	1.8	0.0	0.0	0.0	1.8
	2013	0.9	0.0	0.0	0.0	0.9
Agriculture	1990	1.8	42.1	42.6	0.0	86.4
	2013	1.9	39.0	38.5	0.2	79.5
Waste[1]	1990	2.1	14.3	0.9	0.0	17.3
	2013	1.5	17.1	1.0	0.0	19.6
Total excl. LULUCF[2]	**1990**	**399.9**	**68.7**	**70.6**	**11.8**	**551.1**
	2013	**366.5**	**59.2**	**44.4**	**21.0**	**491.1**
LULUCF[2]	1990	– 39.0	1.3	0.2	0.0	– 37.5
	2013	– 48.0	1.3	0.1	0.0	– 46.6
Total	**1990**	**360.9**	**70.1**	**70.8**	**11.8**	**513.6**
	2013	**318.5**	**60.5**	**44.5**	**21.0**	**444.5**

Source: CITEPA, June 2015

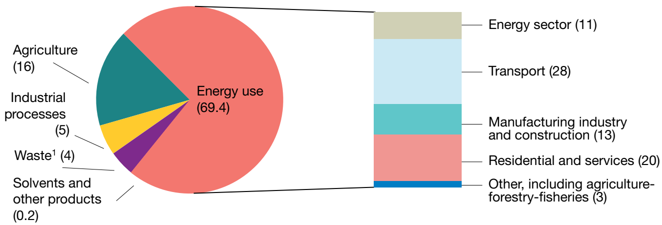
> **French GHG emissions decreased by 11% excluding LULUCF over the period 1990-2013.**

> As throughout the EU, energy use was the main GHG emission source in France (74%). However, in France, the highest emitting sector is transport (27.6%), while the energy sector has relatively low emissions (11.5%), owing to the extent of nuclear electricity generation.

> French emissions remained stable between 2012 and 2013.

Distribution of GHG emissions by source in France in 2013 (incl. overseas departments) (491.1 $MtCO_2e$ excl. LULUCF[2])

As %

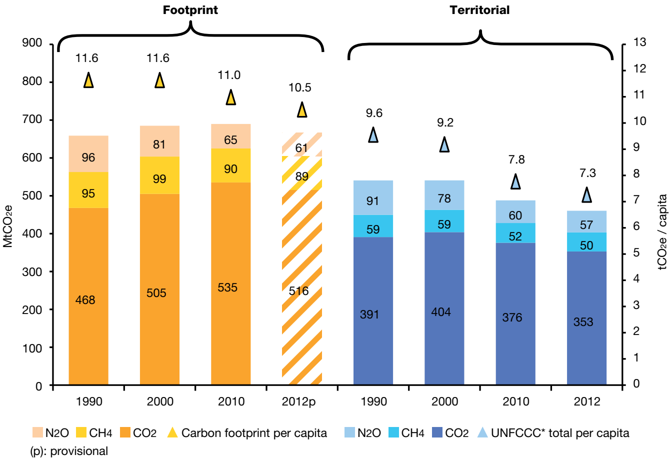


Source: CITEPA, inventory Climate Plan format (Kyoto scope), April 2015.

1. Excluding waste incineration with energy recovery (included in "energy sector"). Details page 32
2. Land Use, Land Use Change and Forestry (LULUCF)

Carbon footprint and emissions from imported goods

France's GHG emissions according to the territorial approach and the footprint approach



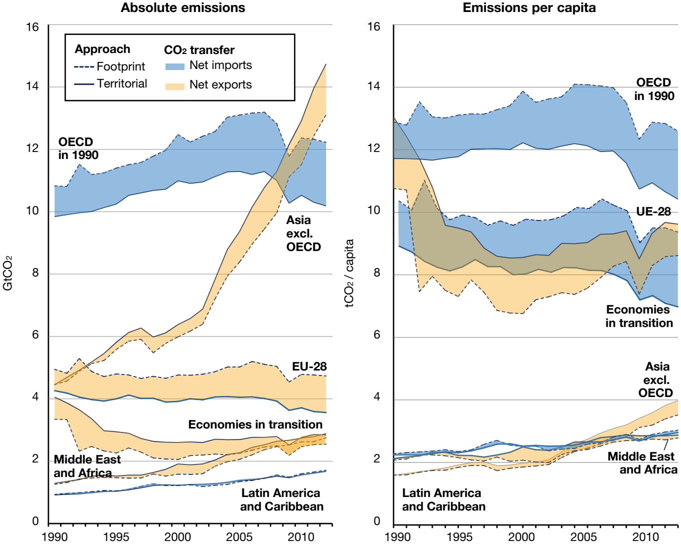
Sources: SOeS calculations based on data from IEA, CITEPA, Customs, Eurostat, INSEE

> The territorial approach counts GHG emissions at the place of emission. The footprint approach counts emissions from final domestic demand, adding emissions from imported products and subtracting those from products manufactured on French soil and then exported. France's carbon footprint from final demand thus represents all greenhouse gas emissions caused by French consumption both in France and abroad.

> In 2012, it was almost identical to that of 1990. However, if the increasing population is taken into account, calculated per capita the footprint decreased by 10% to 10.5 tonnes of CO_2 equivalent (tCO_2e). Over the same period, emissions on French territory decreased by 15% and the average per capita by 24%, reaching 7.3 tCO_2e in 2012.

> The maintained level of carbon footprint is a result of almost stable direct household emissions (heating and individual vehicles; or 19% of the footprint), which were 4% higher in 2012 than in 1990, a 51% increase in emissions from imports compared to 1990 (intermediate consumption by businesses and household final demand; 50% of the footprint), and the decrease in emissions from businesses in France (– 36%) in line with production for domestic demand.

International comparison of CO_2 emissions from fuel combustion according to the two approaches



Sources: I4CE based on Global Carbon Budget, 2015

> Between 1990 and 2012, CO_2 emissions from the OECD increased by 3% according to the territorial approach, and by 13% according to the footprint approach. In Asia excluding OECD countries, according to the territorial approach they more than tripled in 30 years, exceeding the emissions level of the OECD in 2008. According to the footprint approach, Asia excluding OECD countries exceeded OECD emissions in 2011. According to the footprint approach, Asian emissions excluding OECD have been increasing at an average annual rate of 7% since 2000.

> In terms of emissions per capita, the difference remains marked between the developed and developing country groups. In countries with transition economies – primarily countries in Central and Eastern Europe – emissions per capita converged with those of the OECD according to the territorial approach. According to the footprint approach, the difference between the two groups is still over 30%. In Asia excluding OECD countries, emissions were 2.6 to 3.6 times lower than in OECD countries, depending on the approach used.

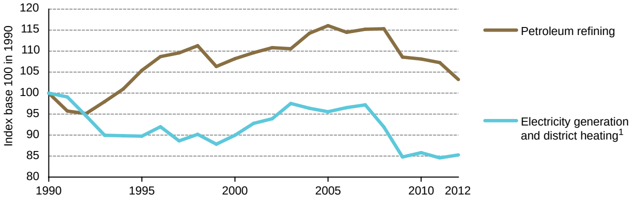
GHG emissions from the energy sector

GHG emissions from the energy sector in the EU

In $MtCO_2e$

	1990	2000	2005	2011	2012	2012/1990 (AAGR as %)[1]
Electricity generation and district heating[2]	1,437	1,293	1,373	1,215	1,225	– 0.7
Petroleum refining	123	133	143	132	127	0.1
Transformation of SMF[3] and others	116	82	78	66	56	– 3.2
Fugitive emissions from the energy sector	156	112	96	81	81	– 3.0
Total	**1,832**	**1,620**	**1,690**	**1,494**	**1,489**	**– 0.9**

At the time of writing this publication, data were not available for 2013.

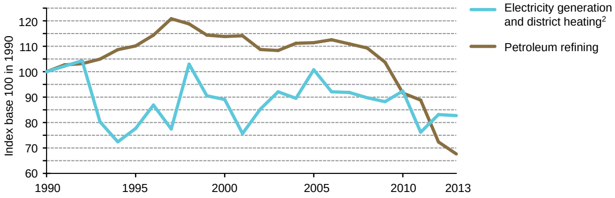


Source: European Environment Agency, June 2014

GHG Emissions from the energy sector in France
(incl. overseas departments)

In $MtCO_2e$

	1990	2000	2005	2012	2013	2012/1990 (AAGR as %)[1]
Electricity generation and district heating[2]	49.7	44.3	50.1	41.3	41.1	– 0.8
Petroleum refining	12.0	13.7	13.4	8.7	8.1	– 1.7
Transformation of SMF[3] and others	4.8	4.4	3.8	3.0	3.1	– 1.9
Fugitive emissions from the energy sector	10.6	8.3	5.5	4.4	4.2	– 4.0
Total	**77.2**	**70.6**	**72.8**	**57.5**	**56.6**	**– 1.3**



Source: CITEPA, June 2015

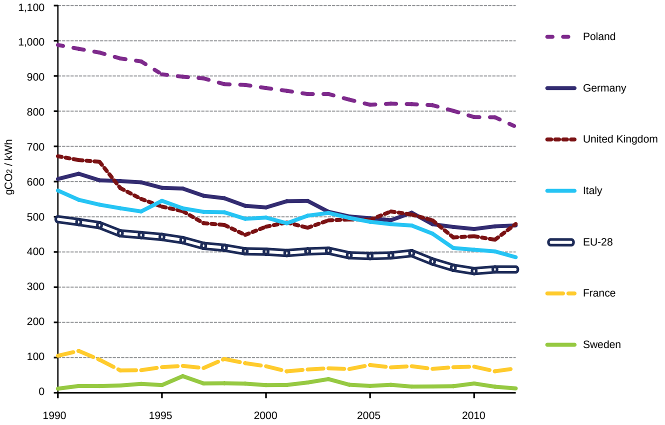
1. Average Annual Growth Rate.
2. Includes waste incineration with energy recovery.
3. Solid Mineral Fuels (coal and derivatives). Emissions mainly from coking plant activities.
4. Mainly from fossil fuel extraction activities (oil, gas, coal).

CO_2 emissions involved in generating 1 kWh of electricity in the EU

In gCO_2/kWh

	1990	2000	2010	2011	Change (%) 2011/2010	Change (%) 2011/1990
EU-28	**493**	**401**	**350**	**350**	**0.0**	**– 29.0**
EU-15	**442**	**363**	**309**	**314**	**1.8**	**– 28.9**
including: Germany	607	526	473	475	0.6	– 21.7
Austria	238	170	210	165	– 21.5	– 30.7
Belgium	347	291	196	212	8.2	– 38.9
Spain	427	432	292	305	4.4	– 28.5
Finland	188	173	191	134	– 29.6	– 28.8
France	**105**	**75**	**61**	**69**	**13.4**	**– 34.1**
Italy	575	498	402	385	-4.1	– 33.0
Netherlands	607	478	405	441	8.9	– 27.4
United Kingdom	672	472	435	479	10.3	– 28.7
Sweden	12	22	17	12	– 28.0	6.1
13 new Member States	**745**	**626**	**590**	**563**	**– 4.5**	**– 24.4**
including: Poland	988	866	783	756	– 3.4	– 23.5
Czech Republic	744	728	590	552	– 6.5	– 25.8

> CO_2 emissions per unit of electricity generated (including cogeneration) vary greatly from one country to another in the EU-28. They are very high (over 400 gCO_2/kWh) in countries where coal remains a major source, such as Germany and some countries in Central and Eastern Europe. They are low in countries where renewable energy and/or nuclear power have been developed, such as France (76% nuclear and 10% hydro) and Sweden (47% hydro and 38% nuclear).



Source: International Energy Agency, March 2014

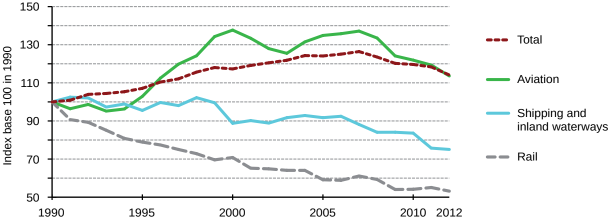
GHG Emissions from Transport

GHG Emissions from transport[1] in the EU

In MtCO2e

	1990	2000	2005	2011	2012	2012/1990 (AAGR as %)[2]
Aviation	14	20	19	17	16	0.6
Road	722	860	913	875	843	0.7
Rail	13	10	8	7	7	– 2.8
Shipping and inland waterways	23	20	21	17	17	– 1.3
Other transport	10	9	10	9	9	– 0.1
Total	**783**	**918**	**971**	**926**	**893**	**0.6**

At the time of writing this publication, data were not available for 2013.



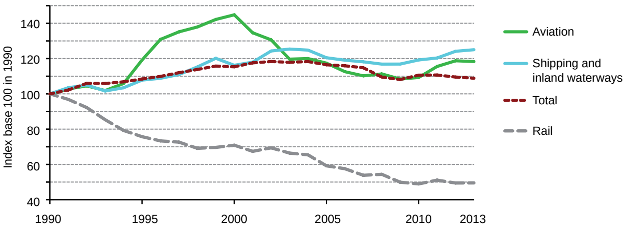
Note: In the interests of readability, the line for road transport is not shown, as it was easy to confuse with that of the total.

Source: European Environment Agency, June 2014

GHG Emissions from transport[3] in France (incl. overseas departments)

In MtCO2e

	1990	2000	2005	2012	2013	2012/1990 (AAGR as %)[2]
Aviation	4.3	6.2	5.0	5.1	5.1	0.7
Road	114.6	131.1	133.3	125.3	124.5	0.4
Rail	1.1	0.8	0.6	0.5	0.5	– 3.0
Shipping and inland waterways	1.1	1.3	1.3	1.4	1.4	1.0
Other transport	0.2	0.5	0.9	0.5	0.5	3.7
Total	**121.3**	**139.9**	**141.2**	**134.2**	**132.8**	**0.4**



1. Excludes international transport.
2. Average Annual Growth Rate.
3. Includes transport between metropolitan France and French overseas departments but not international transport.

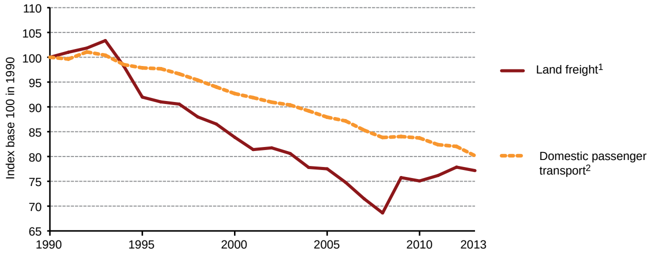
Source: CITEPA, June 2015

Intensity of GHG emissions in metropolitan France

Index base 100 in 1990

	1990	2000	2005	2010	2013
Domestic passenger transport[1]	100	92.7	87.9	82.4	82.0
Land freight[2]	100	83.9	77.5	76.2	77.9

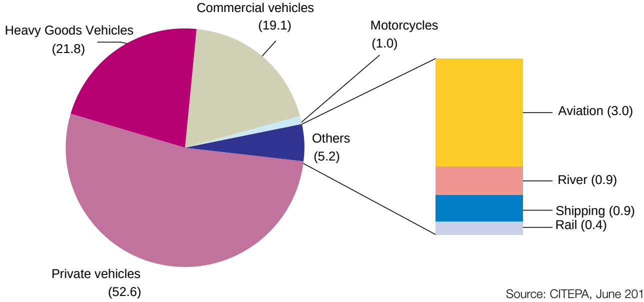
Unit GHG emissions



Source: CITEPA, June 2015 and SOeS

GHG emissions by transport mode[3] in metropolitan France (131.4 $MtCO_2e$ in 2013)

As %



Source: CITEPA, June 2015

1. GHG emissions per tonne-kilometre of freight.
2. GHG emissions per passenger-kilometre.
3. Only includes transport within metropolitan France.

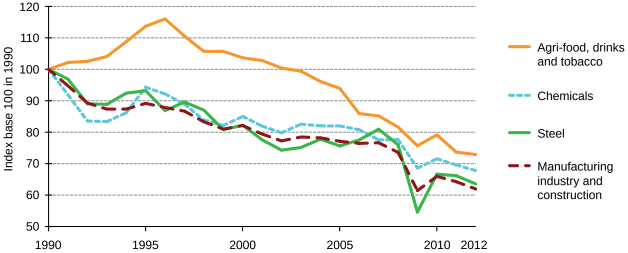
GHG Emissions from the Manufacturing Industry and Construction

Energy-related GHG Emissions from the manufacturing industry and construction in the EU

In $MtCO_2e$

	1990	2000	2005	2011	2012	2012/1990 (%)
Total	**861**	**707**	**663**	**553**	**533**	**– 38**
including: Steel	185	152	140	123	118	– 36
Chemicals	133	113	109	92	90	– 32
Agri-food, drinks and tobacco	54	56	51	40	39	– 27

At the time of writing this publication, data were not available for 2013.

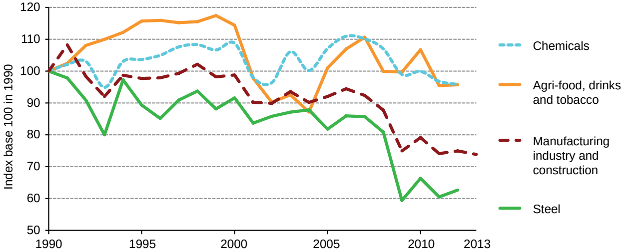


Source: European Environment Agency, June 2014

Energy-related GHG Emissions from the manufacturing industry and construction in France (incl. overseas departments)

In $MtCO_2e$

	1990	2000	2005	2012	2013	2013/1990 (%)
Total	**86.3**	**84.3**	**85.2**	**64.7**	**63.7**	**– 26**
including: Steel	21.5	19.7	17.6	13.0	n.a.	n.a.
Chemicals	19.8	21.6	21.2	19.2	n.a.	n.a.
Agri-food, drinks and tobacco	9.3	10.6	9.4	8.9	n.a.	n.a.



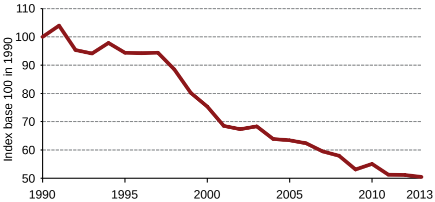
Source: CITEPA, June 2015

GHG emissions intensity from the manufacturing industry and construction in France

Index base 100 in 1990

	1990	2000	2005	2010	2013
GHG emissions / value added by volume	100	75.3	63.4	55.1	50.5

GHG emissions per unit of value added

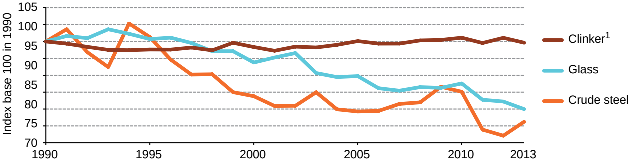


Source: INSEE (added value), CITEPA (GHG emissions), June 2015

CO_2 intensity for several energy-intensive products in France

		1990	2000	2005	2010	2013	2013/1990 (%)
Crude steel	Production (Mt)	19.0	21.0	19.5	15.4	15.7	– 17
	tCO_2/t steel produced	1.4	1.2	1.1	1.2	1.10	– 24
Glass	Production (Mt)	4.8	5.5	5.6	4.6	4.5	– 6
	tCO_2/t glass produced	0.80	0.75	0.72	0.70	0.64	– 20
Clinker[1]	Production (Mt)	20.9	16.3	17.3	14.9	13.8	– 34
	tCO_2/t clinker produced	0.86	0.85	0.86	0.87	0.9	0

Specific CO_2 emissions



1. Component of cement that results from heating a mixture of silica, iron oxide and lime.

Sources: French Steel Federation (FFA), Fédération des chambres syndicales de l'industrie du verre (FCSIV), Syndicat français de l'industrie cimentière (SFIC)

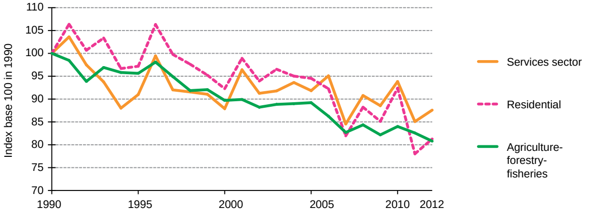
GHG emissions from other sectors

Energy-related GHG emissions from other sectors[1] in the EU

In $MtCO_2e$

	1990	2000	2005	2011	2012	2012/1990 (AAGR as %)[2]
Total	**849**	**759**	**778**	**669**	**688**	**– 1.0**
including: Residential	523	483	495	408	425	– 0.9
Services (excl. building and construction)	201	177	185	171	176	– 0.6
Agriculture-forestry-fisheries	97	87	86	80	78	– 1.0

At the time of writing this publication, data were not available for 2013.

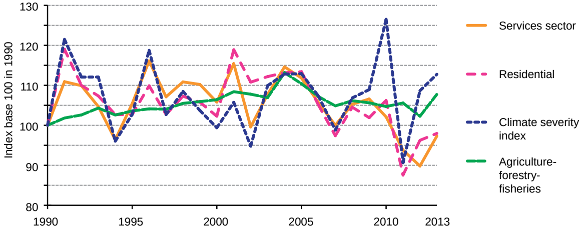


Source: European Environment Agency, June 2014

Energy-related GHG emissions from other sectors[1] in France (incl. overseas departments)

In $MtCO_2e$

	1990	2000	2005	2012	2013	2013/1990 (AAGR as %)[2]
Total	**100.6**	**104.4**	**113.3**	**95.7**	**99.5**	**0.0**
including: Residential	60.1	61.5	68.2	57.9	58.9	– 0.1
Services (excl. building and construction)	28.7	30.4	32.1	25.8	27.9	– 0.1
Agriculture-forestry-fisheries	11.7	12.5	13.0	12.0	12.6	0.3



Sources: CITEPA, June 2015 and SOeS, according to Météo-France

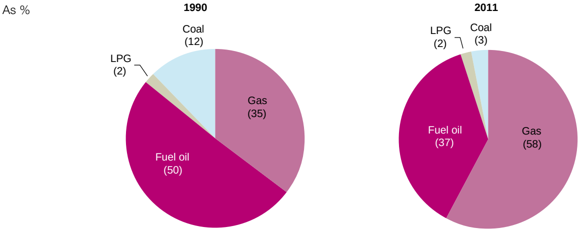
> Emissions from the residential and services sector vary depending on climate conditions. Temperatures were particularly mild in 1994, 2002, 2007 and 2011. This resulted in a reduction in heating consumption and thus in CO_2 emissions. In contrast, 1991, 1996 and 2010 were exceptionally cold.

1. Direct emissions from sectors other than energy, transport, manufacturing and construction.
2. Average Annual Growth Rate.

Contribution of each energy to CO_2 emissions from heating[1] in residential buildings in metropolitan France

As % - Data adjusted for climate variations

	1990	1995	2000	2005	2010	2011
Gas excl. LPG	35	42	45	52	59	58
Fuel oil	50	46	45	42	37	37
Liquefied Petroleum Gas (LPG)	2	3	3	3	2	2
Coal	12	9	6	3	3	3



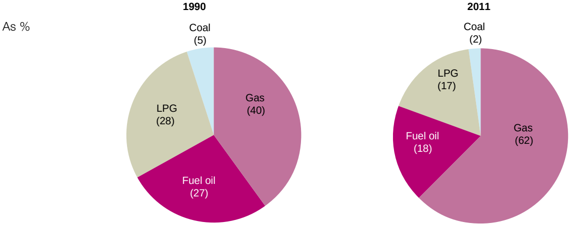
Source: SOeS according to CEREN

> During the period, natural gas was replaced by coal and fuel oil for heating in buildings, which accounts for the increase in its contribution to CO_2 emissions.

Contribution of each energy to CO_2 emissions from domestic hot water[1] and cooking[1] in metropolitan France

As %

	1990	1995	2000	2005	2010	2011
Gas excl. LPG	40	42	45	54	61	62
Fuel oil	27	28	28	23	19	18
Liquefied Petroleum Gas (LPG)	28	26	24	21	18	17
Coal	5	4	3	2	2	2



Source: SOeS according to CEREN

1. Only CO_2 emissions from fossil fuel combustion were taken into account. The carbon content of electricity was not measured.

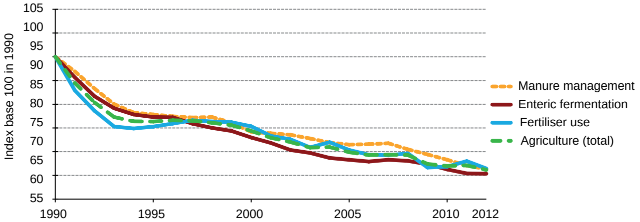
GHG emissions excluding energy use

GHG emissions from agriculture in the EU

In $MtCO_2e$

	1990	2000	2005	2010	2012	2012/1990 (%)
Total	**618**	**521**	**494**	**476**	**471**	**– 24**
including: Enteric fermentation	195	162	153	147	147	– 25
Manure management	103	87	84	80	79	– 24
Fertiliser use	316	269	254	246	241	– 24

At the time of writing this publication, data were not available for 2013.



Note: In the interests of readability, the line for emissions from meadows is not shown.

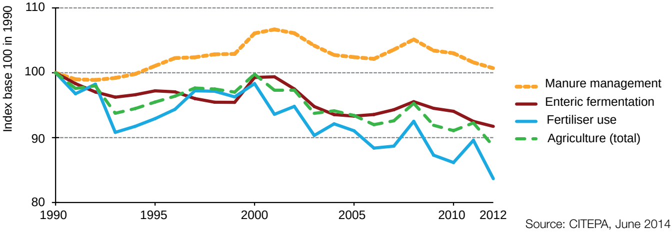
Source: European Environment Agency, June 2014

GHG emissions from agriculture in France (incl. overseas departments)

In $MtCO_2e$

	1990	2000	2005	2010	2012	2012/1990 (%)
Total	**86.4**	**86.9**	**81.3**	**80.8**	**79.5**	**– 8**
including: Enteric fermentation	36.6	36.2	33.7	34.0	33.2	– 9
Manure management	8.5	8.8	8.3	8.4	8.2	– 4
Fertiliser use	41.1	41.6	39.0	38.1	37.7	– 8

At the time of writing this publication, data were not available for 2013.



Source: CITEPA, June 2014

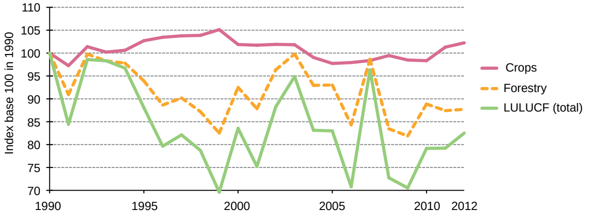
> Emissions from agriculture have been continuously falling in the European Union, at an average rate of – 0.8% per year. The trend in France is less regular from one category to another, but it is also a downward trend overall (– 0.6% per year on average since 2000).

GHG emissions from LULUCF[1] in the EU

In $MtCO_2e$

	1990	2000	2005	2010	2012	2012/1990 (%)
Total	**– 256**	**– 299**	**– 300**	**– 310**	**– 310**	**– 21**
including: Forestry	– 397	– 427	– 425	– 441	– 447	– 13
Crops	92	93	89	90	93	+ 1
Meadows	10	– 10	– 13	– 10	– 9	– 188

At the time of writing this publication, data were not available for 2013.



Note: In the interests of readability, the line for emissions from meadows is not shown.

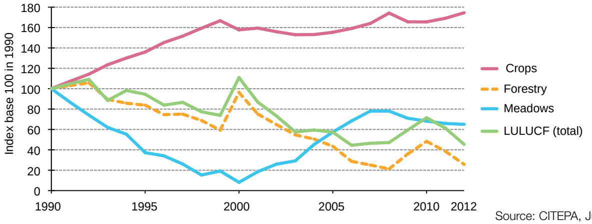
Source: European Environment Agency, June 2014

GHG emissions from LULUCF[1] in France (incl. overseas departments)

In $MtCO_2e$

	1990	2000	2005	2010	2012	2012/1990 (%)
Total	**– 28.6**	**– 25.5**	**– 40.8**	**– 36.8**	**– 44.3**	**– 55**

At the time of writing this publication, data were not available for 2013.



Source: CITEPA, June 2014

> Emissions from LULUCF are negative in both the European Union and France. This means that LULUCF activities sequester more GHGs than they emit. This is mainly due to the role of forests. These sequestrations have been on an upward trend since 1990.

1. Emissions from Land Use, Land Use Change and Forestry.

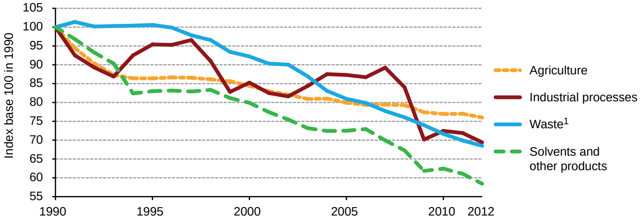
GHG emissions excluding energy use

GHG emissions excluding energy use in the EU

In MtCO2e

	1990	2000	2005	2011	2012	2012/1990 (AAGR as %)[2]
Total	**1,307**	**1,129**	**1,086**	**966**	**944**	**– 1.5**
Agriculture	618	521	494	476	471	– 1.2
Industrial processes	462	394	403	332	321	– 1.6
Waste[1]	210	200	176	147	143	– 1.7
Use of solvents and other products	17	14	12	10	10	– 2.4

At the time of writing this publication, data were not available for 2013.

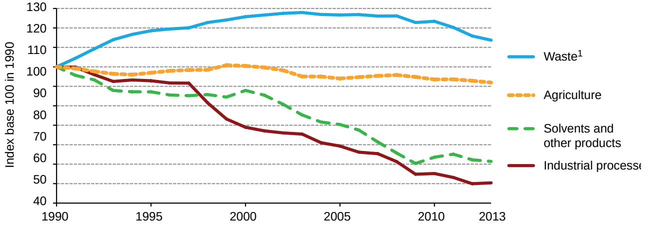


Source: European Environment Agency, June 2014

GHG Emissions excluding energy use in France (incl. overseas departments)

In MtCO2e

	1990	2000	2005	2010	2013	2013/1990 (AAGR as %)[2]
Total	**165.6**	**151.6**	**140.0**	**130.3**	**124.3**	**– 1.2**
Agriculture	86.4	86.9	81.3	80.8	79.5	– 0.4
Industrial processes	60.1	41.5	35.6	27.2	24.3	– 3.9
Waste[1]	17.3	21.7	21.9	21.3	19.6	0.6
Use of solvents and other products	1.8	1.6	1.3	1.0	0.9	– 2.9



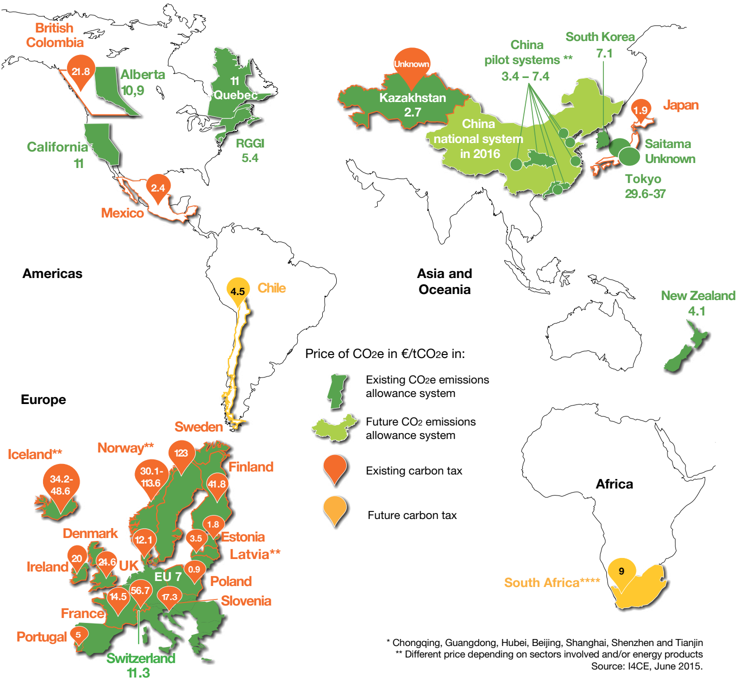
Source: CITEPA, June 2015

1. Excluding waste incineration with energy recovery (included in "energy sector").
2. Average Annual Growth Rate.

> To prompt economic operators to invest more in clean energy and low carbon technologies and less in technologies that promote GHG emissions, some governments have decided to give an economic value to the emission of one tCO_2e. Several economic instruments feature in the toolkit of public climate policy for creating carbon pricing, whether implicit or explicit. Some of these focus on prices (taxes), others on a level of carbon intensity (emission standards) and others still on emissions reduction volumes (*Emissions Trading Scheme*, or ETS).

> In 2015, 54 countries, 15 provinces or states and 7 cities established a carbon pricing mechanism. The global GHG emissions covered by carbon pricing instruments in 2015 are: **8.77%** by the ETS, **4.26%** by carbon taxes and **4.18%** by emission standards.

Overview of global carbon pricing on 30 June 2015



* Chongqing, Guangdong, Hubei, Beijing, Shanghai, Shenzhen and Tianjin
** Different price depending on sectors involved and/or energy products
Source: I4CE, June 2015.

5.2 International negotiations

United Nations Framework Convention on Climate Change (UNFCCC)[1]

> The first international treaty aiming to prevent dangerous anthropogenic interference with the climate system, the UNFCCC was adopted in 1992 in Rio de Janeiro. It recognises three principles:

- **Precautionary principle:** scientific uncertainty about the impacts of climate change does not justify postponing measures;
- **Principle of common but differentiated responsibility:** all emissions have an impact on climate change, but the more developed countries have a greater responsibility for the current concentration of GHGs;
- **Principle of the right to economic development:** measures taken to combat climate change should not negatively affect the priorities of developing countries, which are, inter alia, sustainable economic development and poverty eradication.

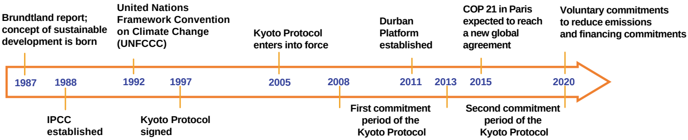
> Countries that are party to the UNFCCC meet at the end of each year for the "Conference of the Parties" (COP). It is during these conferences that the major UNFCCC decisions are made. The 21st COP will be held in Paris (France) at the Le Bourget site from 30 November to 11 December 2015.

The latest developments in international negotiations

> Since the conference in Cancun (2010), the ultimate aim of negotiations is to stabilise the average temperature rise at + 2°C by the end of the century. Since the conference in Durban (2011), negotiations have been striving to achieve an international post-2020 agreement by 2015.

> The form of this agreement marks a paradigm shift relative to the Kyoto Protocol, which was extended to 2020. The negotiation revolves around **four** key areas:

- Seeking an international agreement;
- Commitments of the countries especially through their national contributions;
- Financial commitments, particularly in line with the objective of developed countries raising 100 billion dollars per year by 2020 for developing countries;
- Commitments of non-governmental stakeholders like local authorities, private businesses and financial institutions.



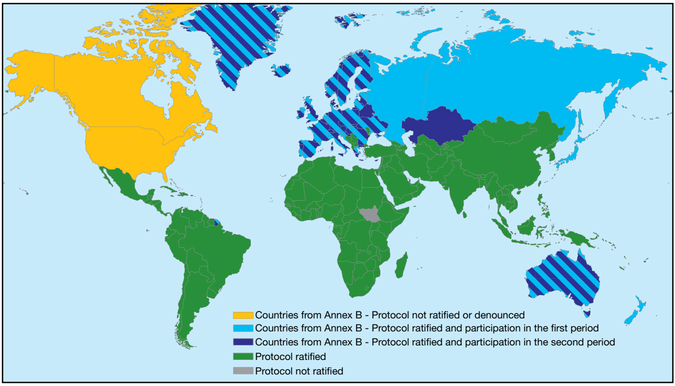
Source: I4CE

> **Signed in 1997, the Kyoto Protocol entered into force in 2005** after being ratified by Russia, which achieved the quorum of 55 States representing a minimum of 55% of Annex B emissions in 1990.
> At the time of adoption of the Kyoto Protocol, emissions from the 38 most developed countries (listed in Annex B of the Protocol) had to be reduced by at least **5% over the period 2008-2012 compared to 1990**. The specific targets differed from country to country. Countries not listed in Annex B had no emissions commitments.

> In Durban in 2011, participating countries agreed that the protocol should be continued beyond 2012. What followed is referred to as the **second commitment period of the Kyoto Protocol** (see page 43).
> To be compliant, Member States from Annex B needed to be in possession of as many allowances **(assigned amount units – AAUs)** and carbon credits as their actual emissions accumulated over a given period (between 2008 and 2012 for the first period).

> The emissions considered included **six GHGs from anthropogenic sources**: CO_2, CH_4, N_2O, HFC, PFC, SF_6. From 2013, NF_3 is also included.
> Only the United States has not ratified the convention out of the Annex B countries. It thus has no emissions commitments. In December 2011, Canada withdrew from the Kyoto Protocol. This withdrawal was effective in December 2012. Canada is thus no longer bound to honour its commitments for the first period of the Kyoto Protocol.

Signatory countries to the Kyoto Protocol on 30 September 2013.



Source: UNFCCC

5.4 First period of the Kyoto Protocol (2008-2012)

> The initial reduction target of 5% of GHG emissions for Annex B countries was redistributed among countries according to their economic circumstances and development potential.

> Countries in Central and Eastern Europe received more Assigned Amount Unit than their actual emissions to revive their economies. This surplus is called "*hot air*".

> Overall, even without accounting for the hot air effect, developed countries easily exceeded their targets. The extent of the excess (20 points) however can largely be explained by the hot air effect.

Country	Kyoto target for 2008-2012 (as %)[1]	Average AAUs received annually for the period 2008-2012 (in millions)	2008-2012 annual average including credits and debits under LULUCF		Distance to Kyoto target (in points)
			In $MtCO_2e$	Change (as %)[1]	
EU-15	**– 8**	**3,924**	**3,754**	**– 12**	4
Bulgaria	– 8	122	62	– 53	45
Croatia	– 5	30	28	– 11	6
Estonia	– 8	39	20	– 54	46
Hungary	– 6	108	65	– 44	38
Latvia	– 8	24	10	– 61	53
Lithuania	– 8	45	21	– 58	50
Poland	– 6	530	396	– 30	24
Czech Republic	– 8	179	135	– 31	23
Romania	– 8	256	120	– 57	49
Slovakia	– 8	66	45	– 37	29
Slovenia	– 8	19	18	– 10	2
Australia	8	592	571	4	4
Iceland	10	4	3	– 6	– 16
Japan	– 6	1,186	1,230	– 3	– 3
Liechtenstein	– 8	0	< 1	4	– 12
Monaco	– 8	0	< 1	– 12	4
Norway	1	50	52	5	– 4
New Zealand	0	62	60	– 2	2
Russia	0	3,323	2,117	– 36	36
Switzerland	– 8	49	51	– 4	– 4
Ukraine	0	921	395	– 57	57
Total	**– 4**	**11,528**	**9,153**	**– 24**	**20**
United States[2]	– 7	n.a.	6,759	10	– 17
Canada[3]	– 6	n.a.	704	19	– 25
Belarus[4]	– 8	n.a.	89	– 36	28
Kazakhstan[4]	0	n.a.	271	– 25	25

EU countries, Annex B non-EU countries, Annex B countries to which the Kyoto Protocol does not apply for the first commitment period.
1. Compared to the reference year, generally 1990. 2. Has not ratified the protocol. 3. Denounced the protocol in late 2011.
4. The amendments adding Belarus and Kazakhstan to Annex B have not been ratified and were thus not applied.

Source: I4CE based on UNFCCC, 2015

> Since 2008, Annex B countries have been able to trade their AAUs provided they always retain at least 90% of the amount received or five times the equivalent of their last GHG inventory.

> All Annex B countries had sufficient allowances and carbon credits in late 2013 to be compliant.

Second period of the Kyoto Protocol (2013-2020)

> The rules of the second period of the Kyoto Protocol (2013-2020) were finalised in Doha in 2012. Japan, Russia and New Zealand announced that they would not take part in the second commitment period of the Kyoto Protocol (CP2). Those countries that announced a commitment for CP2 represented 13% of global emissions in 2010.

> Some of the amendments decided on in Doha aim to limit the impact of hot air in the second period. One of these rules compels countries to adopt commitments that cannot involve an increase in emissions compared to the period 2008-2010. This rule calls into question the ultimate participation of Belarus, Kazakhstan and Ukraine in CP2, even though for the latter the surplus of allowances accumulated during the first period would allow the country to compensate for the impact of these new rules.

> A new initiative makes the procedures easier for countries wanting to strengthen their targets mid-period.

> To be implemented, these provisions must be ratified by at least 75% of the countries that ratified the Kyoto Protocol. As of 2 September 2015, 43 parties, a little over 20%, have finalised the CP2 ratification process.

As %

Country	Commitment period 1 (CP1; 2008-2012) compared to the reference year[1]	Commitment period 2 (CP2; 2013-2020) compared to the reference year[1]	CP2 target set by the countries (2013-2020) compared to 2008-2010 emissions	CP2 compared to the reference year[1] after application of the Doha amendments	CP2 compared to 2008-2012 emissions after application of the Doha amendments and transfer of surplus[2]
Australia	+ 8%	– 0.5%	+ 0.5%	– 1.0%	+ 2.3%
Belarus[3]	n.a.	– 12%	+ 37%	– 36%	0.4%
Croatia[4]	– 5%	– 20%	– 16.3%	– 20%	– 13.5%
Iceland[4]	+ 10%	– 20%	– 26%	– 20%	– 13.4%
Kazakhstan[3]	n.a.	– 5%	+ 30%	– 27%	– 2.6%
Liechtenstein	– 8%	– 16%	– 21%	– 16%	– 18.0%
Monaco	– 6%	– 22%	– 13%	– 22%	– 7.7%
Norway	+ 1%	– 16%	– 22%	– 16%	– 21.9%
Switzerland	– 8%	– 15.8%	– 17%	– 15.8%	– 15.1%
EU-27[5]	– 7.9%	– 20%	– 3%	– 20%	– 1.5%
Ukraine	0%	– 24%	+ 77%	– 57%	+ 81.1%[6]
Total	**– 5.6%**	**– 18.2%**	**+ 3.2%**	**– 23.5%**	**+ 3.4%**
Total excl. non-EU EITs[3]	**– 6.4%**	**– 18.3%**	**– 2.4%**	**– 18.8%**	**– 2.1%**

Source: I4CE based on UNFCCC, 2015

1. Generally 1990.
2. The surplus is calculated based on 2008-2012 emissions and does not account for allowance trading and carbon credits.
3. Economies in transition. Only non-European countries are included here. The participation of Belarus, Kazakhstan and Ukraine remains uncertain.
4. For CP2, Croatia and Iceland wish to fulfil their commitment jointly with the EU in application of Article 4 of the Kyoto Protocol.
5. EU-27 countries have differentiated commitments for CP1. The data provided thus include data from the countries involved. As part of the European Climate and Energy Package, the EU has committed to meeting its targets independently of any AAU surplus from the first period.
6. This percentage is only valid if Ukraine officially revises its CP2 commitment to ensure it matches its 2008-2010 emissions levels.

Commitments of the European Union

Kyoto targets of Member States for the first period of the Kyoto Protocol (2008-2012)

> The European Union (EU) managed **to redistribute its overall target of – 8% among its 15 Member States.** Since then, the EU has expanded to include 13 additional countries, all of which had made commitments under the Kyoto Protocol, except Cyprus and Malta.

Country	Kyoto target for 2008-2012 (as %)[1]	Average AAUs received annually for the period 2008-2012 (in millions)	2008-2012 annual average including credits and debits under LULUCF		Distance to Kyoto target (in points)
			In $MtCO_2e$	Change (as %)[1]	
Germany	– 21.0	974	932	– 24.4	3.4
Austria	– 13.0	69	81	+ 2.9	– 15.9
Belgium	– 7.5	135	126	– 13.9	6.4
Denmark	– 21.0	55	58	– 17.8	– 3.2
Spain	+ 15.0	333	346	+ 19.3	– 4.3
Finland	0.0	71	67	– 5.7	5.7
France	0.0	564	504	– 10.6	10.6
Greece	+ 25.0	134	119	+ 11.4	13.6
Ireland	+ 13.0	63	58	+ 3.9	9.1
Italy	– 6.5	483	478	– 7.5	1.0
Luxembourg	– 28.0	9	12	– 9.4	– 18.6
Netherlands	– 6.0	200	200	– 6.2	0.2
Portugal	+ 27.0	76	62	+ 2.5	24.5
United Kingdom	– 12.5	682	600	– 23.1	10.6
Sweden	+ 4.0	75	59	– 18.8	22.8

1. Compared to the reference year, generally 1990.

Source: I4CE based on European Commission and UNFCCC, 2015

Effort sharing

> Within the framework of the Kyoto Protocol, the European Union makes a commitment in its name for all its member countries at the time the commitments are adopted (15 countries for the first commitment period, 27 countries for the second). It then has to redistribute this commitment among its Member States. For the first period, this is what happened in the Effort Sharing Decision adopted in 2002.

> This flexibility granted to the EU is called *bubbling*. Within the EU, a country with a surplus of allowances and credits can compensate a country in deficit. In this case, the EU will be considered compliant as a whole.

The Climate and Energy Package (2020)

> The European Council of March 2007 announced three targets to achieve by 2020, known as "3 x 20":

- Increasing the **share of renewables** in energy consumption to 20%;
- Improving **energy efficiency by 20%;**
- Reducing **GHG emissions** by 20% compared to 1990. In the event a satisfactory international agreement is reached, this last target will become **– 30%**.

> The **Climate and Energy Package from March 2009** sets out more precise measures for meeting these targets and redistributes them among Member States. Member States are then free to adopt more restrictive national regulations.

> Over the course of 2014, European discussions were concerned with establishing a new Climate and Energy Package with an outlook to 2030 (see page 49). It is set to be the basis for European commitment to the new global agreement expected in Paris in December 2015.

	Change in GHG emissions in 2020 compared to 2005 for non EU-ETS sectors (as %)		Share of renewable energy in gross final energy consumption in 2020 (as %)		Annual change in primary energy consumption (as %/yr)		Annual change in final energy consumption (as %/yr)	
Country	**2020 target**	**Achieved in 2012**	**2020 target**	**Achieved in 2012**	**2020 target**	**Achieved in 2012**	**2020 target**	**Achieved in 2012**
Germany	– 14	– 4	18	12	– 0.91	– 0.91	– 0.78	– 0.36
Austria	– 16	– 11	34	32	– 0.24	– 0.37	– 0.46	– 0.42
Belgium	– 15	– 8	13	7	– 1.05	– 0.71	– 0.82	– 0.06
Bulgaria	20	5	16	16	– 1.19	– 0.88	– 0.68	– 1.33
Cyprus	– 5	– 21	13	8	1.14	0.02	1.25	– 0.53
Croatia	11	– 9	20	17	n/a	– 1.14	2.54	– 1.01
Denmark	– 20	– 15	30	26	– 0.53	– 1.09	– 0.31	– 1.33
Spain	– 10	– 18	20	14	– 0.83	– 1.61	– 1.32	– 2.29
Estonia	11	– 7	25	26	1.26	1.62	– 0.18	– 0.03
Finland	– 16	– 13	38	34	0.49	– 0.14	0.35	– 0.04
France	– 14	– 9	23	13	– 0.68	– 0.85	– 1.42	– 1.09
Greece	– 4	– 20	18	14	– 0.82	– 1.76	– 0.15	– 2.84
Hungary	10	– 21	13	10	0.30	– 2.26	– 0.01	– 2.91
Ireland	– 20	– 12	16	7	– 0.37	– 1.17	– 0.51	– 2.32
Italy	– 13	– 18	17	14	– 0.82	– 1.99	– 0.44	– 1.74
Latvia	17	1	40	36	1.19	– 0.18	0.71	0.03
Lithuania	15	– 4	23	22	– 1.31	– 4.20	– 0.48	0.71
Luxembourg	– 20	– 5	11	3	– 0.42	– 1.08	– 0.36	– 0.99
Malta	5	– 4	10	1	– 1.79	– 2.00	2.25	2.37
Netherlands	– 16	– 15	14	5	– 0.80	– 0.28	0.07	– 0.14
Poland	14	11	15	11	0.61	0.85	1.26	1.25
Portugal	1	– 12	31	25	– 0.67	– 2.48	– 0.59	– 2.30
Czech Rep.	9	– 2	13	11	– 0.42	– 0.73	– 0.43	– 1.12
Romania	19	– 7	24	23	1.05	– 1.25	1.37	– 1.21
United Kingdom	– 16	– 9	15	4	– 1.50	– 1.86	0.22	– 1.86
Slovakia	13	– 8	14	10	– 0.61	– 1.71	– 0.70	– 1.57
Slovenia	4	– 7	25	20	0.28	– 0.28	0.26	– 0.12
Sweden	– 17	– 20	49	51	– 0.77	– 0.22	– 0.70	– 0.55
EU-28	– 9	– 9	20	14	– 0.95	– 1.08	– 0.60	– 1.04

Note: Croatia has not communicated any commitments regarding primary energy consumption. The colours of the cells indicate countries' positions in relation to the intermediate targets according to the EEA: countries have fully (in green) or partially (in light orange) met their intermediate targets, or not at all (in dark orange).

Sources: European Commission, 2009 and European Environment Agency, 2015

5.7

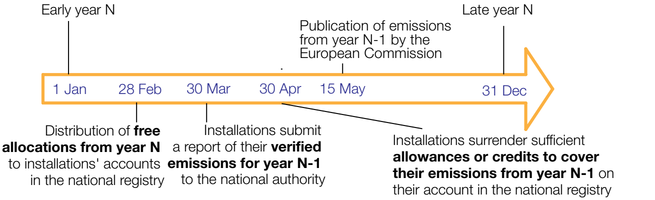
European Union Emissions Trading System (EU ETS)

How it works

> Since 2005, the EU ETS has imposed an emissions cap on around **11,400 installations in the energy and industrial sectors,** which are responsible for nearly **50% of the European Union's CO_2 emissions.** Since 2013, as the scope has been extended to include new sectors and greenhouse gases, some 16,400 installations and all intra-EU flights are now bound by this policy.

> Each year, these installations must surrender a number of allowances (1 allowance = 1 tonne of CO_2) equal to their verified emissions of the previous year. Since 2008, they are also entitled to use an amount of Kyoto credits (CERs or ERUs, see the glossary of terms), on average limited to 13.5% of their allowances between 2008 and 2012. This threshold has almost been reached.

EU ETS annual schedule



Source: I4CE

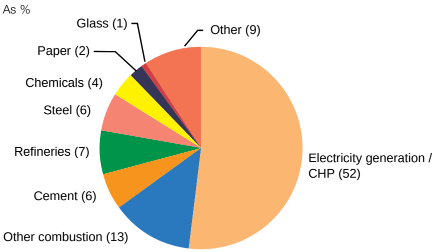
Emissions covered

> Initially, the EU ETS only covered CO_2 emissions. Since 2013, N_2O and SF_6 emissions from the chemical and aluminium production sectors are also covered.

> The energy sector (electricity and heat generation, refining, coking plants) is the main EU ETS sector. Electricity producers account for nearly half the emissions.

> In 2008, **Norway**, **Iceland** and **Liechtenstein** joined the 27 European Member States in the EU ETS. **Croatia** joined them in 2013.

Distribution of emissions by sector in 2014 (total: 1,865 $MtCO_2e$)



Sources: CITL, I4CE

Allowance allocation

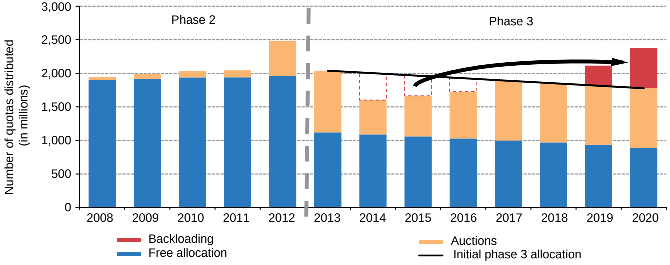
> Over the course of the first two phases of the EU ETS (2005-2007 test phase, and 2008-2012, Kyoto commitment period), the installations involved annually received mainly a free allowance allocation, the amount being set by the **national allocation plan (NAP) for emissions allowances** of each Member State established under the supervision of the European Commission.
> In the third phase (2013-2020), allocation of allowances is centralised in the European Commission. The emissions reduction target for EU ETS sectors has been set at – 21% between 2005 and 2020, or **– 1.74% per year.**

Allocations becoming less and less free

> The share of allowances auctioned was 0.13% in Phase 1 and 3.6% in Phase 2.
> From 2013, auctioning involves:
- 100% of the emissions cap for the electricity sector except where temporary exemptions have been granted (eight countries in Central and Eastern Europe);
- 20% of the emissions cap for other sectors in 2013, a share that will increase progressively to 70% in 2020, then 100% in 2027.

> Free allocations are established based on either sector-based or product-based carbon intensity benchmarks. Industrial sectors and subsectors that have been classified by the European Commission as being at risk of carbon leakage[1] will be granted 100% of the free allowance amount established by benchmarking until 2020.
> In the end, with the revision of the Phase 3 auction schedule voted in July 2012, at least 30% of allowances were auctioned in 2013 and up to 75% are expected in 2027.
> Auctions may be pooled but any income is managed by Member States.

Estimated change in allocations of allowances in Phases 2 and 3 (excl. aviation)



Source: I4CE based on data from the European Commission

1. Carbon leakage refers to "offshoring" for the purposes of avoiding carbon restrictions.

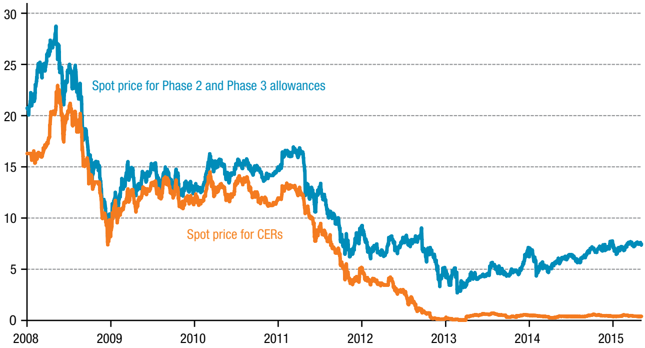
5.8 Carbon pricing in the EU ETS

Carbon emissions trading

> *European Union Allowances* (EUA) are tradable: installations that emit more than their allocation allows can purchase them on a market, while installations that reduce their emissions can sell any unused allowances. The decision to participate in trading largely depends on the price of the allowance on the market. Emissions reductions thus occur where they cost the least.

> Trading between suppliers and buyers of allowances is done **over-the-counter,** i.e. through bilateral contracts between manufacturers, **or in marketplaces,** electronic portals that release the prices and amounts traded to the public.

Price trends



Note: Any breaks in the line are due to temporary closures of the stock exchange and registry.

Source: BlueNext, ICE

> **Spot prices** are the price of a trade contract for allowances or credits for immediate delivery of those allowances or CERs; **futures prices** are the price of a trade contract for allowances or credits whose delivery will take place at a later date as specified in the contract.

> The allowance price is influenced by a number of factors such as economic conditions, 2020 policies on energy efficiency and renewable energy, changes in supply of allowances, but also lack of visibility on emissions reduction restrictions beyond 2020. The amounts of Kyoto credits (CERs and ERUs) surrendered by operators are close to reaching their maximum use limit (see page 46), which accounts for the decorrelation with the European allowance price from 2012 onwards.

Agreement targets for 2030

> The heads of state and government of the 28 Member States approved the framework for action on Climate and Energy policies for the period 2020-2030 at the European Summit on 23-24 October 2014. This framework forms the basis of the European contribution to global efforts to reduce greenhouse gas emissions (GHG). The framework for action proposes three targets:

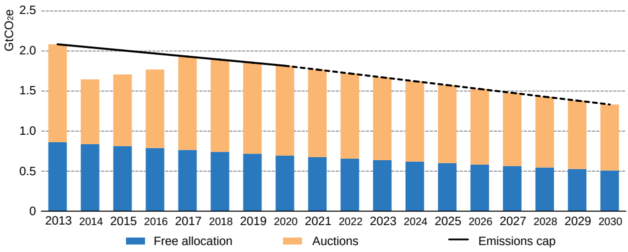
- A restrictive, collective reduction of at least 40% of GHG emissions compared to 1990;
- A European target of 27% share for renewable energy in the EU's final energy consumption;
- An indicative target of at least 27% improvement in energy efficiency by 2030.

Distribution of efforts across sectors

> In line with the 2020 framework for action, GHG emissions have been redistributed into two sector groups:

> Energy intensive sectors covered by the EU ETS, whose emissions reduction target is set at 43% compared to 2005 throughout the EU. The European Council provides guidelines on the rules governing EU ETS: the 2.2% annual reduction of the cap after 2020, the continuation of free allocation, a fixed share of auctioned allowances, implementation of an instrument aiming to stabilise the market price. A directive laying down detailed rules for the functioning of the EU ETS is expected in the second half of 2015.

Estimation of the trend in the EU ETS emissions cap post-2020

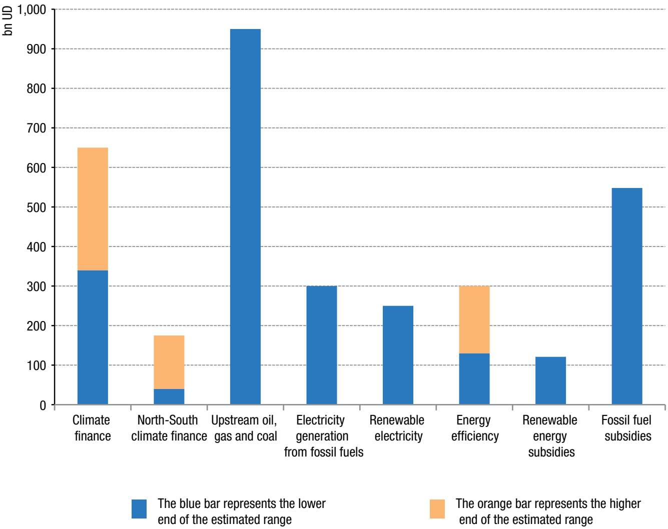


Source: I4CE based on data from the European Commission

> Sectors not covered by the EU ETS have an emissions reduction target set at 30% compared to 2005. This target will be redistributed among Member States in 2016 in order to reflect both the potential for cutting their emissions and their respective levels of development.

5.10 Financing the fight against climate change

Estimated annual investments and subsidies around the world



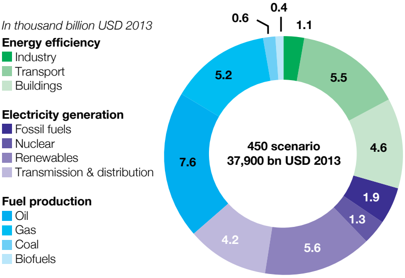
Sources: International Energy Agency, June 2014 and Permanent Finance Committee, 2014

> Climate finance encompasses all financial flows that enable the implementation of actions with a positive impact towards mitigation – reduction of GHG emissions – or adaptation to climate change. There are sometimes differences from one organisation and one definition to the next, depending on the level of impact and if a shared benefit or the main purpose of the financed action is involved.

> The accounting rules for the commitment made in Cancun to raise 100 billion dollars per year until 2020 by developed countries for developing countries (see page 40) have not yet been finalised. However, the UNFCCC's Permanent Finance Committee estimates climate finance from developed countries to assist developing countries to amount to somewhere between 40 and 175 billion dollars depending on the types of financing chosen.

Global energy investments required between 2015 and 2030 according to the IEA's 450 scenario

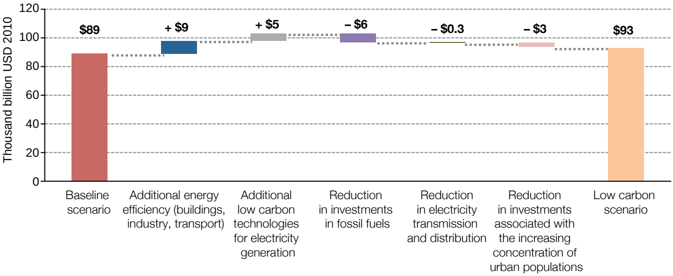
> Achieving the 2°C target would mean raising significant sums – in the region of one or several thousand billion dollars per year before 2030 – across all sectors. This involves both energy use and production. A scenario based on a continuation of current needs requires significant investments in view of the increase in energy demand, regardless of the level of climate restriction.



Source: International Energy Agency, June 2015

> The difference between a business-as-usual scenario and a 450 ppm scenario – i.e. one with a 50% chance of limiting the temperature rise to 2°C – mainly involves the distribution of investments. Whether you take the model simulations of the IEA or those of the Global Commission on the Economy and Climate – which is broader in scope – the additional investment costs of a 2°C scenario are estimated to be around 5%.

Global investments needed between 2015 and 2030



Source: Global Commission on the Economy and Climate, 2014

5.11

Member State climate policies: the case of France

Long-term targets

> France is one of the developed economies with the lowest GHG emissions in terms of emissions per capita and per unit of GDP, due to largely carbon-free electricity generation.
> Following the recommendations of the IPCC, France has set itself the target of reducing its GHG emissions fourfold by 2050 compared to 1990. The Law on Energy Transition for Green Growth sets an interim target of – 40% in 2030.
> In 2013, GHG emissions were 11% below their 1990 levels. The decline could reach 18% according to 2014 provisional results. This positive result must however be put into perspective, as 2014 was exceptionally mild across all French regions, with the number of frost days well below normal.

Reduce energy consumption in buildings and public spaces:

- Energy saving initiatives for individuals: replacing inefficient electric heaters, distributing very low-energy light bulbs, roof insulation, housing renovation passports, replacing old boilers;
- Deployment of services and networks for smart meters;
- Creation of a one-stop shop for information and advice on upgrading the energy efficiency of homes: energy transition tax credit, zero rate loans for energy-saving work, ANAH subsidies, recommendations for refurbishment;
- Modernisation of public lighting;
- Energy audit of one or more public buildings with a view to renovating them;
- Development of renewable energy.

Reduce greenhouse gas emissions and pollution from transport:

- Upgrading public vehicle fleets with cleaner vehicles;
- Development of public spaces to promote clean mobility: reserved parking spaces for electric vehicles, cycle paths and secure cycle parking, car sharing points;
- Support for businesses in establishing travel plans for their employees.

Develop the circular economy and sustainable waste management:

- Help with the planned abolition of single use plastic bags;
- Actions to combat food waste;
- Waste sorting at source and innovative processing and recovery equipment.

Produce local renewable energies:

- Programme to roll out renewable energies: biomass heat networks, agricultural and industrial biogas plants, solar thermal energy, wind and photovoltaic farms, CHP, residual and geothermal heat recovery;
- Zero pesticide approach based on the Healthy soil, pesticide-free municipalities project;
- Nature areas in schools and organic vegetable patches;
- Teaching apiaries and insect nest boxes (national pollinator plan).

Develop environmental education, green citizenship and community involvement:

- Civilian service programme on energy transition;
- Organisation of public competitions such as the Positive energy families challenge;
- Crowdfunding of projects.

Examples of emission factors

Transport

1,000 km (approximately one Paris-Amsterdam return trip) =
- > **0.21 tCO_2 by car (French average), or 213 gCO_2/km**[1]. Increasing the number of passengers proportionately reduces these emissions;
- > **0.31 tCO_2e by plane** (with a 75% load factor). The shorter the trip, the higher the emissions per kilometre, as take-off and landing use proportionately more fuel.
- > **0.07 tCO_2e by train**. Emissions vary depending on energy source. In France they are low (9 gCO_2/km), as electricity is mainly generated from nuclear power[1].

Electricity generation and consumption

A typical power station with a capacity of 250 MW operating off-peak (8,000 h/yr) emits:
- > **1.7 $MtCO_2$/yr** for a **coal-fired power station** (0.87 tCO_2/MWh, with a 40% thermal efficiency rate)[2];
- > **0.72 $MtCO_2$/yr** for a **gas-fired power station** (0.36 tCO_2/MWh, with a 55% thermal efficiency rate)[2];
- > **1.5 tCO_2/yr** are emitted per European household[2] through electricity consumption for lighting, heating and consumption for electrical appliances, the main emissions for buildings.

Industry

A **typical steelworks** producing 1 Mt of steel per year emits on average:
- > **1.8 $MtCO_2$/yr** for a **traditional steelworks** (1.8 tCO_2 per tonne of steel)[3];
- > **0.5 $MtCO_2$/yr** for an **electric steelworks** (scrap melting) (0.5 tCO_2 per tonne of steel corresponding to indirect emissions from electricity)[3];

Other CO_2 emitting industries:
- > **0.35 $MtCO_2$/yr** for a **typical cement works** producing 500,000 t/yr (0.7 tCO_2 per tonne of cement)[4];
- > **0.09 $MtCO_2$/yr** for a **typical glassworks** producing 150,000 t/yr (0.6 tCO_2 per tonne of glass)[5];

Forestry and agriculture

- > **580 tCO_2e** were emitted **per hectare of deforested tropical forest** (combustion and decomposition)[6].

Agriculture in France emits on average:
- > **3 tCO_2e/yr** from enteric fermentation and **2.2 tCO_2e/yr** from manure produced **per dairy cow**[7];
- > **0.5 tCO_2e/yr per pig** from manure produced[7].

1. Source: ADEME, Base carbone. 2. Source: IEA. 3. Source: European Commission. 4. Source: Cement Sustainability Initiative. 5. Source: Fédération des chambres syndicales de l'industrie du verre. 6. Source: IPCC. 7. Source: CITEPA.

CO_2 emission factors

In tCO_2/toe

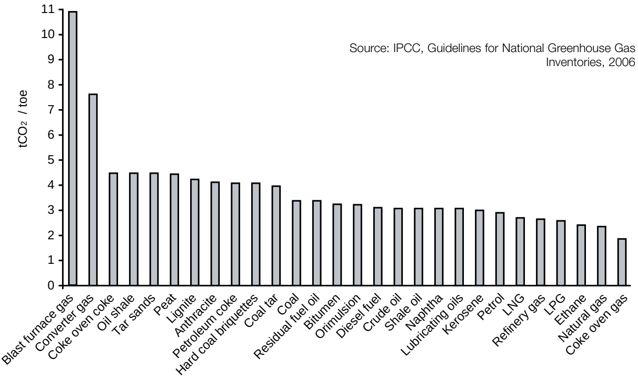
Blast furnace gas	10.9	Diesel fuel	3.1
Coke oven coke	4.5	Shale oil	3.1
Tar sands	4.5	Crude oil and other petroleum products	3.1
Peat	4.4	Kerosene	3.0
Lignite and lignite briquettes	4.2	Petrol	2.9
Hard coal briquettes	4.1	Liquefied Natural Gas (LNG)	2.7
Anthracite	4.1	Liquefied petroleum gas (LPG)	2.6
Petroleum coke	4.1	Refinery gas	2.4
Coal (coke, sub-bituminous or other bituminous)	4.0	Natural gas	2.3
Bitumen	3.4	Coke oven gas	1.9

Source: IPCC, Guidelines for National Greenhouse Gas Inventories, 2006

> CO_2 emission factors indicate the average amount of CO_2 emitted when a given fuel is combusted to produce one unit of energy (here, tonne of oil equivalent or toe). They are calculated by relating the CO_2 emissions measured to the amount of energy generated.

> These emission factors are standard values and can be broken down by country.

> The specific case of biomass is not covered here: CO_2 emissions from the combustion of biomass are considered to be compensated by the assimilation of CO_2 that will occur when the biomass is reconstituted. If this is not the case, any uncompensated emissions are recorded in the LULUCF sector (Land Use, Land Use Change and Forestry).



Anthropogenic:
Relating to human activities (industry, agriculture, etc.).

UNFCCC:
United Nations Framework Convention on Climate Change.

CO_2 equivalence:
Method of measuring greenhouse gases based on the warming effect of each gas relative to that of CO_2.

GHG:
Greenhouse gases: gaseous components of the atmosphere, both natural and anthropogenic, which absorb and re-emit infrared radiation.

IPCC:
Intergovernmental Panel on Climate Change Research group led by the World Meteorological Organization and the UNEP (United Nations Environment Programme), responsible for reviewing scientific research on climate change.

KP-CP1 / KP-CP2:
First and second commitment period of the Kyoto Protocol, respectively.

CDM:
Clean Development Mechanism.

JI:
Joint Implementation.

Annex I country and Annex B country:
Countries from the UNFCCC's Annex I are made up of developed countries and countries in transition to a market economy.
They make up the majority of the countries from Annex B of the Kyoto Protocol, which aims to establish binding quantified commitments. The only differences: the inclusion of Croatia, Monaco and Slovenia in Annex B countries; the absence of Belarus and Turkey.

GDP:
Gross Domestic Product. Measure of the wealth generated by country over a given period. Measured in purchasing power parity (PPP), it allows for meaningful comparisons between countries.

Emissions allowance:
Accounting unit of the trading system. Represents one tonne of CO_2.

International bunkers:
International aviation and maritime transport.

toe:
Tonne of oil equivalent. Unit of measure for energy.

AAU:
Assigned Amount Unit.

CER:
Certified Emission Reduction unit.

ERU:
Emission Reduction Unit.

LULUCF:
Land Use, Land Use Change and Forestry.

Units

1 T	**1 G**	**1 M**
1,000 billion	1 billion	1 million
1 ppm	**1 ppb**	**1 ppt**
1 part per million	1 part per billion	1 part per trillion

Units of measure for energy.

See: "Chiffres clés de l'énergie édition 2014 - Repères" (Key figures on energy, 2014 Edition - Highlights, in French) published by SOeS.

Useful websites

ADEME
(Agence de l'Environnement et de la Maîtrise d'Énergie – French Environmental and Energy Management Agency).. *www.ademe.fr*

EEA
European Environment Agency.. *www.eea.europa.eu*

IEA
International Energy Agency .... *www.iea.org*

UNFCCC
United Nations Framework Convention on Climate Change .... *http://unfccc.int*

I4CE - Institute for Climate Economics *www.i4ce.org*

Chaire Économie du Climat
CDC Climat & Université Paris-Dauphine................................ *www.chaireeconomieduclimat.org*

CITEPA
Interprofessional Technical Centre for Studies on Air Pollution .... *www.citepa.org*

European Commission... *http://ec.europa.eu*
CITL - Community International Transaction Log .... *http://ec.europa.eu/environment/ets*
Directorate-General for Climate Action .... *http://ec.europa.eu/clima*

Drias *les futurs du climat*
Météo-France, IPSL, CERFACS...*www.drias-climat.fr*

IPCC
Intergovernmental Panel on Climate Change .... *www.ipcc.ch*

MEDDE
French Ministry of Ecology, Sustainable Development and Energy..*www.developpement-durable.gouv.fr*
General Directorate for Sustainable Development – SOeS................................ *www.statistiques.developpement-durable.gouv.fr*
General Directorate for
Energy and Climate .... *www.developpement-durable.gouv.fr/energie*

NOAA
National Oceanic and Atmospheric Administration .... *www.noaa.gov*

UNEP DTU... *www.unepdtu.org*

Adaptation to global warming in France
Observatoire national sur les effets du réchauffement climatique .... *www.onerc.gouv.fr*

Université Paris-Dauphine - CGEMP
Centre of Geopolitics of Energy and Raw Materials .... *www.cgemp.dauphine.fr*

WRI
World Resources Institute... *www.wri.org*

The graphs and information cited as "IPCC, Working Group III, 2014" are from *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Specifically, these are Figure 1.3 (p.13 of the Highlights) and Tables SPM 1.1 (p.6) and 1.1 (p.13) of the report.

The graphs and information cited as "IPCC, Working Group I, 2013" are from *Climate Change 2013: The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Specifically, these are Figures SPM (1.3) (p.3 of the Highlights), 4.17 (p.4), TS.22 (p.5), 6.28 (p.8), 2.11 (p.9), 6.1 (p.11), and Tables SYR 2.2 (p.6), 2.1 (p.10) and 6.1 (p.12) of the report.

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ISSN: 2115-7634