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CLIMATE

Annual

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Key figures on climate
France and Worldwide

2017 EDITION

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

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

Ministère
de l'Environnement,
de l'Énergie
et de la Mer

summary

Key figures on climate
France and Worldwide

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Foreword

In line with previous years, the 2017 edition of "Key figures on climate" has been written in the context of the 22nd Conference of the Parties on Climate Change (COP 22) held in Marrakech from 7 to 18 November 2016.

This latest version, published as part of the new "datalab" collection of the General commission for sustainable development was updated and expanded relative to the 2016 edition. New data sources have been used for the part on global CO_2 emissions. The part on climate policies was further developed, and notably deals with the Paris agreement adopted in December 2015 at COP 21. Moreover, the analysis of climate finance (current climate investments and climate finance needs) has been expanded. About the form, and with a goal of simplification, some data previously displayed in both a graph and a table is now presented only in a graph. Data tables are still available on the web version.

—Sylvain Moreau
HEAD OF DEPARTMENT, SOES

part 1

What is climate change?

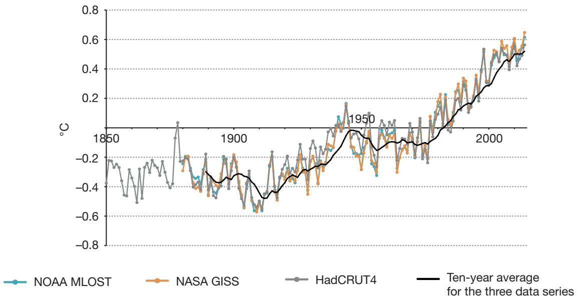
— The concept of global warming refers to a sustainable increase of the planet average temperature. Additionally to the average sea level which has increased by more than 15 cm since 1900, numerous other indicators illustrate this warming.

The conclusions of the scientific community and notably of the International Panel on Climate Change (IPCC) meet general consensus on the causes of climate change. The natural climate balance is disrupted by anthropogenic GHG emissions. The CO_2 atmospheric concentration – the main GHG – has increased by more than 40 % since 1750.

Projections show that global warming could have a severe impact on sea levels and crop yields in the future.

Climate change observations

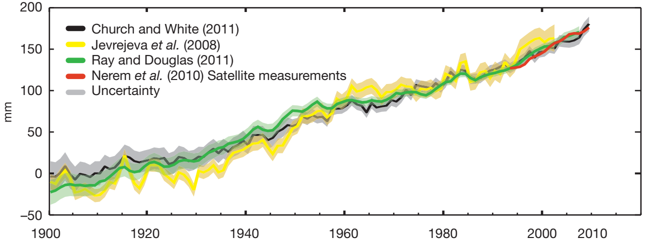
GLOBAL SURFACE TEMPERATURE CHANGE



Source: *NOAA , NASA, Hadley Center*

The increase in global average temperatures is very clear. The difference from the 1961-1990 reference period is far below zero until 1940, mostly negative until 1980, then the warming becomes more acute and the difference has almost always been positive since the early 1980's. The decade 2001-2010 was 0.21°C warmer than the decade 1991-2000 and was 0.48°C warmer than the 1961-1990 average. The year 2015, with an average temperature 0.74° over the 1961-1990 average, ranks first among the hottest years since 1850.

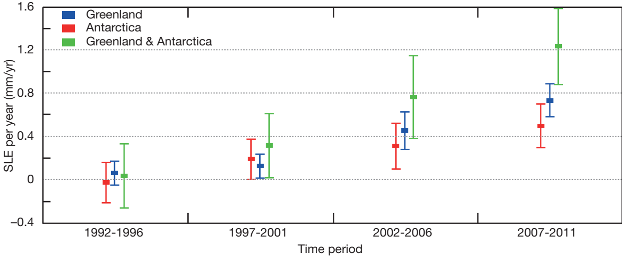
GLOBAL AVERAGE SEA LEVEL CHANGE COMPARED TO THE REFERENCE PERIOD 1900-1905



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).

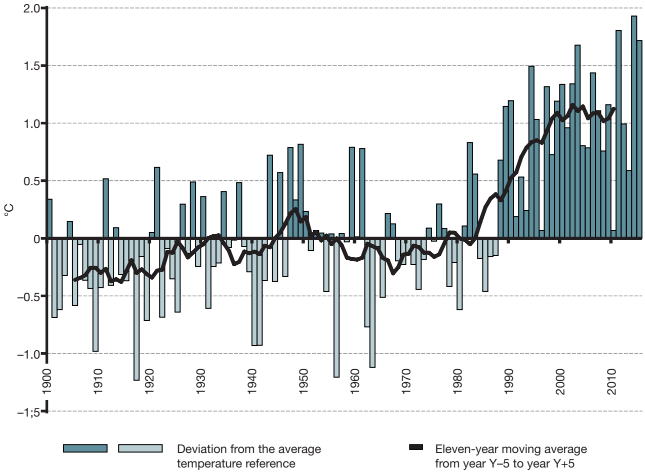
GLACIERS MELTING



Source: *IPCC, Working Group I, 2013*

Over the last two decades from 1992 to 2011, the total loss of continental polar ice is equivalent to a sea level rise of about 11.7 mm (8.4 to 15.1 mm). The most significant losses were observed over the last decade (2002-2012).

EVOLUTION OF THE AVERAGE ANNUAL TEMPERATURE IN FRANCE



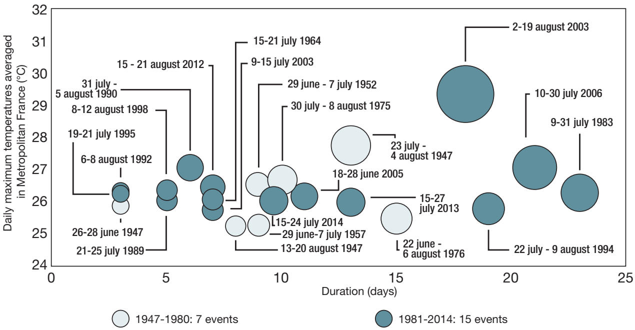
Source: *Météo-France*

As worldwide, the average temperature change in metropolitan France has shown a clear warming since 1900. The speed of this warming has been variable with a particularly pronounced increase since 1980. Over the period 1959-2009, the observed trend is roughly +0.3°C per decade. In France, 2004, 2011 and 2015 were the warmest years on record since 1990.

EXTREME WEATHER EVENTS

A weather event (tornadoes, hurricanes, heat waves, heavy rainfalls) is classified as extreme when it significantly exceeds reference levels. Climate change modifies the frequency, intensity, scale, duration and time of occurrence of extreme events. It can push the characteristics of these events to unprecedented levels.

Heat waves in France - 1947-2014 period

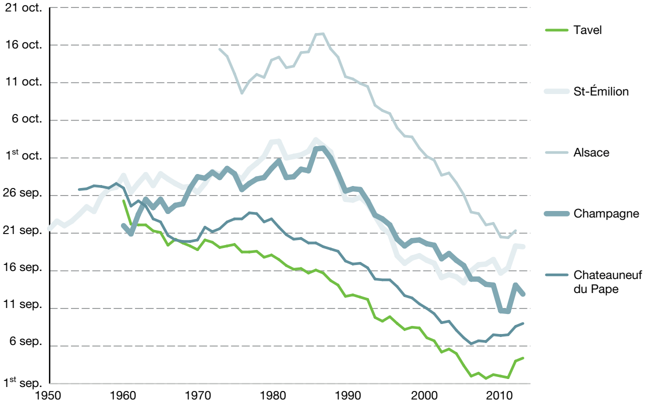


Note : The surface of each circle represents the intensity of the heat wave, which depends on its duration and its maximum temperature

***Source:** Météo-France*

At the French national level, the heat waves recorded since 1947 were twice as many over the last 34 years than over the previous period. This trend is also shaped by the occurrence of more severe events (duration, intensity overall) in recent years. Thus, the 4 longest heat waves and 3 among the 4 most intense waves occurred after 1981. The heat wave observed in France from 2 to 9 August 2003 is by far the most significant event over the observation period.

CHANGE IN GRAPE HARVEST DATES

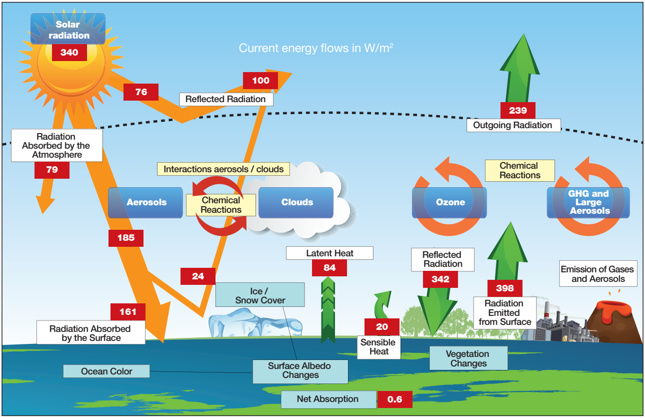


Sources: *Inter-Rhône, ENITA Bordeaux, Inra, CICV, Inter-Rhône*

Whatever the grape variety or the region, the wine harvest takes place at least two weeks earlier now than in 1988. If the overall decline in harvest dates is significant and fairly regular, inter-annual variations remain nevertheless important. Thus this indicator illustrates the two aspects of climate variability: Short-term climate fluctuation (on a yearly basis) and long-term climate change (on a decade basis).It should however be noted that even if the whole 2014 year was in France the warmest year since at least 1900, this year is not exceptional for the wine because July and August temperatures were not particularly high.

Climate change causes

NATURAL GREENHOUSE EFFECT AND ITS PERTURBATIONS BY HUMAN ACTIVITIES



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 by the earth's surface. The relatively warm temperatures at the earth's surface are due to GHGs that reradiate most of the surface radiation back to the earth.

***Source:** IPCC, Working group I, 2013*

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 rise of the global temperatures. A change in radiation caused by a substance, compared to a reference year, is called radiative forcing. A positive radiative forcing value indicates a positive contribution to global warming. The total anthropogenic radiative forcing was + 2.55 ± 1.1 W/m² in 2013 compared to 1750.

GREENHOUSE GASES (GHGs)

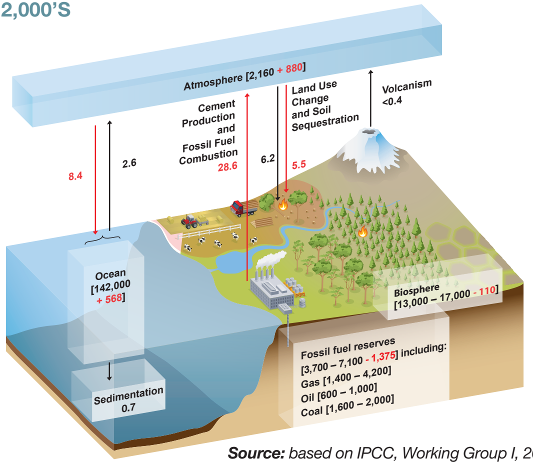
Water vapor excepted, GHGs make up less of 0.1% of the atmosphere. Water vapor, whose concentration in the atmosphere varies between 0.4% and 4% in volume, is the main GHG. Anthropogenic activities have little impact on the variations of its concentration but they have a strong impact on the concentration of other GHGs.

	CO_2	CH_4	N_2O	HFC	PFC	SF_6	NF_3
Atmospheric concentration 2014 (in 2005 between brackets)	397 ppm (379 ppm)	1,823 ppb (1,774 ppb)	327 ppb (319 ppb)	>157 ppt (>49 ppt)	>6.5 ppt (>4.1 ppt)	8.2 ppt (5.6 ppt)	<1 ppt
Global Warming potential (total over 100 years)	1	28-30	265	[1.4; 14,800]	[6,630; 11,100]	23,500	16,100
Anthropogenic sources	Fossil fuels combustion, industrial processes and tropical deforestation	Landfills, agriculture, livestock and industrial processes	Agriculture, industrial processes, use of fertilizer	Aerosols, refrigeration, aluminium smelting			Manufacture of electronic components
Change in radiative forcing due to anthropogenic emissions in 2014 since 1750 (W/m²) (in 2005 between brackets)	+1.91 (+1.66)	+0.50 (+0.48)	+0.19 (+0.16)	+0.12 (+0.09)			

ppm = parts per million, ppb = parts per billion, ppt = parts per trillion.
***Source:** IPCC, Working Group I, 2013, NOAA (2016), Agage (2016)*

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 gases' concentrations and lifetimes. 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.
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, because the significant amounts emitted.

CARBON STOCKS AND GHG FLOWS: SIMPLIFIED CO_2 CYCLE IN THE 2,000'S



Source: *based on IPCC, Working Group I, 2013*

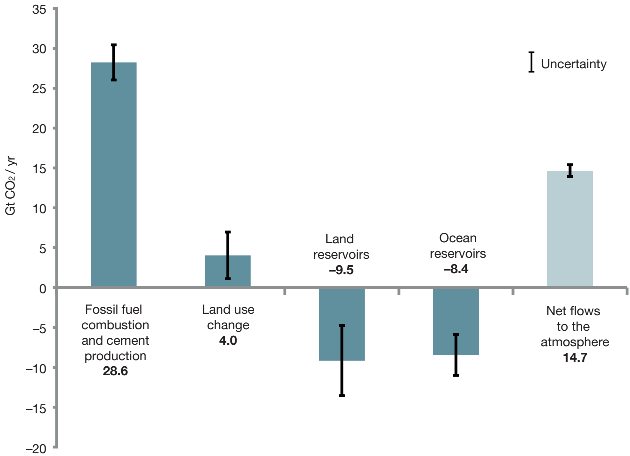
This graph shows: (i) in square brackets, the size of carbon stocks in pre-industrial times in billions of CO_2 tonnes equivalent in black and their change over the period 1750-2011 in red; (ii) as arrows, carbon flows between the stocks in billions of CO_2 tonnes equivalent per year. Pre-industrial flows are shown in black. Those from the development of anthropogenic activities between2000 and 2009 are shown in red.

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;
- **Subsoil:** rocks, sediment, fossil fuels.

Carbon flows between these reservoirs make up the natural carbon cycle, which has been disrupted by anthropogenic emissions of CO_2. The amounts exchanged have changed and new flows have been created, such as the combustion of fossil organic carbon stocks.

IMBALANCE BETWEEN EMISSIONS AND CO_2 STORAGE CAPACITY

Net annual CO_2 flows towards the atmosphere by source and reservoir over the period 2000-2009



***Source:** IPCC, Working Group I, 2013*

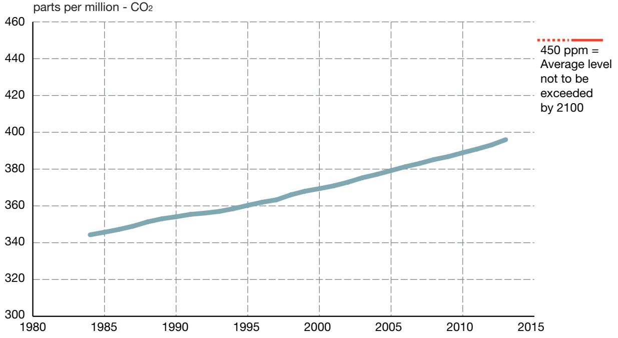
In the 2000s, of the 32.6 Gt of CO_2 annually released by human activities, the atmosphere absorbed 14.7, land reservoirs (biosphere and subsoil) 9.5 and the oceans 8.4. The atmosphere is the reservoir most affected by anthropogenic activities: the amount of carbon stored increased by nearly 40% compared to pre-industrial levels.

ROLE OF FORESTS IN THE CO_2 CYCLE

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

In France, the net carbon sequestration in forest biomass is estimated to be around 70 Mt CO_2, or 15% of national fossil carbon emissions (Citepa, 2016).

ATMOSPHERIC CO_2 CONCENTRATION

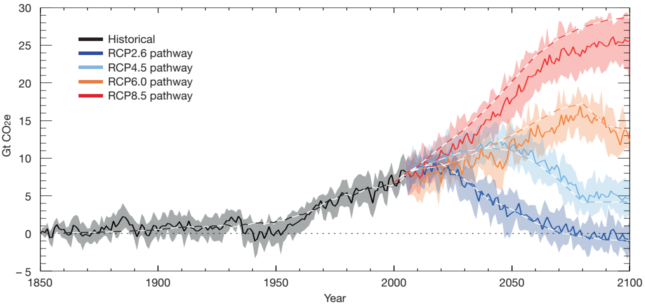


Source: *CMDGS under the authority of the OMM*

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 the atmospheric concentrations of GHGs.**

Scenarios and climate projections

PROJECTION OF EMISSIONS FROM FOSSIL FUELS ACCORDING TO THE IPCC'S FOUR REPRESENTATIVE CONCENTRATION PATHWAYS (RCP)



***Source:** IPCC, Working Group I, 2013*

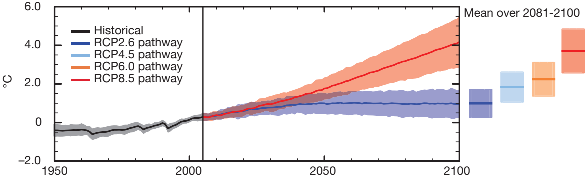
The IPCC published its First Assessment Report in 1990. Its fifth report (AR5) was published in its entirety end of 2014. For each publication, the IPCC communicates climate projections based on assumptions for the concentration of GHGs.

For the AR5, four Representative Concentration Pathways (RCP) were defined: **RCP2.6; RCP4.5; RCP6.0; RCP8.5**, from the most optimistic to the most pessimistic, named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial values (RCP8,5 corresponds to a situation with a radiative forcing of 8,5 W/m² in 2100.)

These pathways correspond to more or less drastic efforts to reduce global GHG emissions. Climate simulations and socio-economic scenarios are drawn up from these projections.

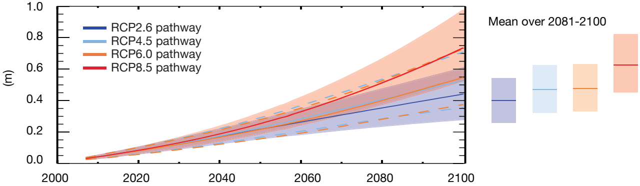
EVOLUTION OF TEMPERATURES AND SEA LEVELS IN THE IPCC'S CONCENTRATION PATHWAYS (RCPS)

Global average surface temperature change (relative to 1986–2005)



Source: *IPCC, Working Group I, 2013*

Global mean sea level rise (relative to 1986–2005)



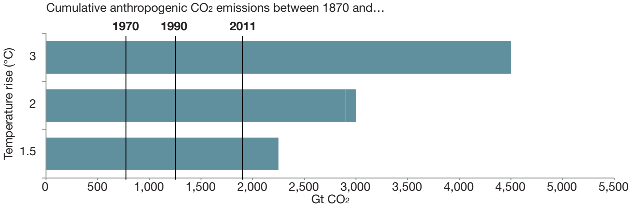
Source: *IPCC, Working Group I, 2013*

Sea level rise is mainly caused by ocean thermal expansion and the melting of land-based ice (glaciers, polar ice caps…).
Sea level rise will probably cause massive migration flows, as over one billion people live in low-lying coastal areas.
Despite progress in recent years, ice melting forecast models still have wide margins of uncertainty.

CARBON BUDGETS AND TEMPERATURE RISE

Among the four IPCC's concentration pathways, only the most ambitious, RCP2.6, has a probability higher than 50% to limit the temperature rise to 2°C in 2100. The most conservative pathway RCP 8.5 has more than 50% chance of leading to a temperature rise higher than 4°C.

Carbon budget for a 50% probability to limit temperature rise to a certain value



Note to read the graph: with a 50% probability, a 3°C temperature rise in 2100 implies the cumulative emission of less than 4,500 Gt CO_2. Among GHGs, only CO_2 is accounted for in the graph.

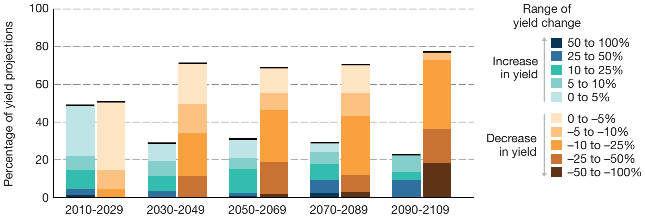
Source: *I4CE, based on IPCC, Working Groups, I and III, 2014*

A carbon budget is the maximum amount of GHGs which can be emitted to avoid a temperature rise too important.

For example, IPCC's simulations indicate that to have a probability higher than 50% to stay below a 2°C increase by 2100, cumulative anthropogenic emissions have to be lower than 3,000 Gt CO_2. As between 1870 and 2011, human activities already emitted 1,700 Gt CO_2, the carbon budget consistent with a 2°C limit is then 1,300 Gt CO_2 from 2011 until the end of the century. This carbon budget corresponds to around 30 years of 2014 emissions. The combustion of all current fossil fuel reserves would emit an amount of CO_2 much higher (4 to 7 times) than the carbon budget consistent with the 2°C limit.

CONSEQUENCES ON A GLOBAL SCALE

Summary of projected changes in crop yields due to climate change over the 21st century compared to the levels at the end of the 20th century

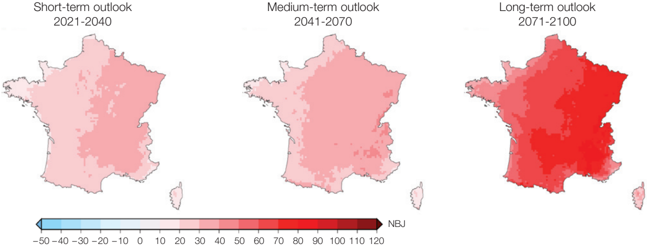


Source: *IPCC, Working Group II, 2014*

Climate change, without adaptation measures, is expected to have a negative impact on the main crop yields (wheat, rice, maize and soy) in tropical and temperate regions. The probability of a negative impact increases with time and the severity of the warming. After 2050, the decrease in the average crop yields is expected to go together with a gradual increase of the crop yields interannual variability in several regions.

CONSEQUENCES FOR FRANCE

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



Source: *Drias les futurs du climat, 2014*

In France, the number of additional days with abnormally high temperatures is expected to increase in the future, with possibly more than 100 additional days per year by 2100, according to the RCP4.5. The southern and eastern parts of France are expected to be the most exposed to these changes.

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 pertial 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

***Source:** I4CE, 2015, according to IPCC (2014), Meem (2014 et 2015), Onerc (2010) and Météo-France*

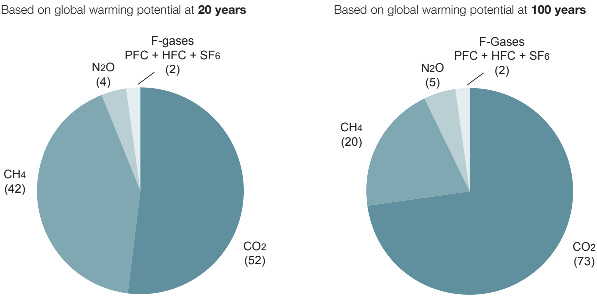
part 2

Which amounts of greenhouse gases are emitted globally?

— Anthropogenic GHG emissions reached 54 Gt CO_2eq in 2013, with CO_2 emissions accounting for around 73% of this total. Global CO_2 emissions (excluding LULUCF) increased by more than 58% between 1990 and 2014, with trajectories very different depending on the countries. China, the biggest world emitter in 2014, is an unusual case with its emissions having increased fourfold since 1990. When it comes to per capita CO_2 emissions, the situation is different. In countries such as the United States or Saudi Arabia, per capita emissions - more than 16 t CO_2 per year - are among the highest, while France is around the world average with emissions per capita around 5 t CO_2.

Global overview of GHG emissions

GLOBAL DISTRIBUTION OF GHG EMISSIONS (INCLUDING LULUCF) BY GAS IN 2010

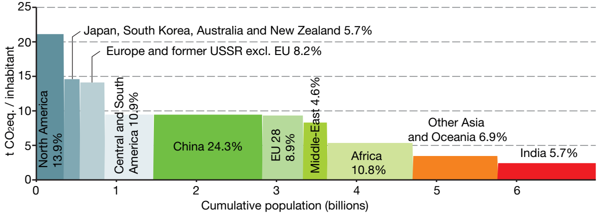


Source: *based on IPCC, Working Group III, 2014*

CO_2: Carbon dioxide;
N_2O: Nitrous oxide;
CH_4: Methane; HFC: Hydrofluorocarbons;
PFC: Perfluorocarbons;
SF_6: Sulphur hexafluoride

The emissions of the six GHGs initially covered by the Kyoto Protocol have increased by 80% since 1970 and by 45% since 1990, reaching **54 Gt CO_2e in 2013** and 49 Gt CO_2e in 2010.

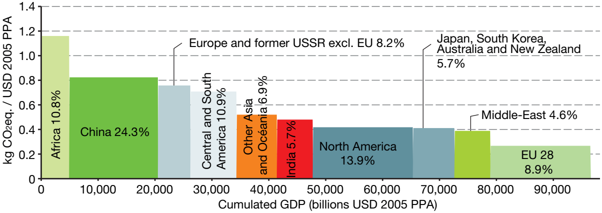
REGIONAL DISTRIBUTION OF GHG EMISSIONS PER CAPITA IN 2012 (INCLUDING LULUCF)



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

In 2012, average emissions per capita in North America are more than eight times higher than in India. Besides, these values does not reflect the disparity within a geographical area (for example, in Middle-East, emissions per capita are higher than 50 t CO_2eq./inhabitant in Qatar, and lower than 2 t CO_2eq./inhabitant in Yemen), and within a country.

REGIONAL DISTRIBUTION OF GHG EMISSIONS PER UNIT OF GDP IN 2012 (INCLUDING LULUCF)

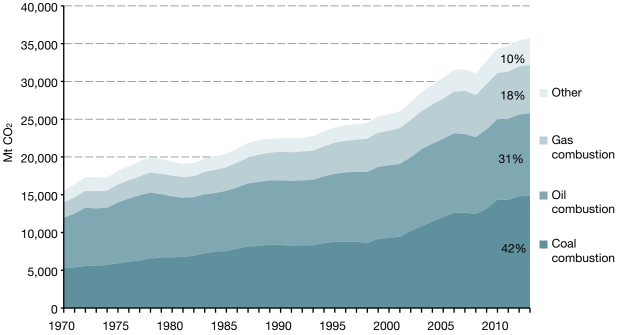


***Source:** I4CE based on JRC EDGAR and World Bank, 2015*

In 2012, the carbon intensity of GDP is more than four times higher in Africa than in the EU, meaning that four times more GHGs are emitted per unit of economic output.

Global CO_2 emissions excluding LULUCF

GLOBAL CO_2 EMISSIONS BY FUEL

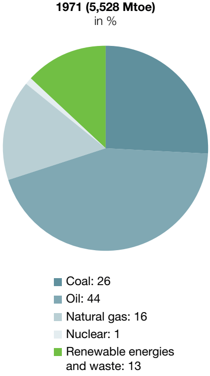


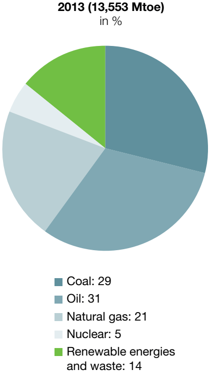
Note: Emissions listed here are CO_2 emissions from fossil fuel use and industrial processes. This corresponds to total CO_2 emissions excluding LULUCF. They account for 85% of all global CO_2 emissions and 65% of GHG emissions .

***Source:** EDGAR, 2015*

In 2014, global CO_2 emissions excluding LULUCF amount to 35.7 billion tonnes. Close to 42% of those emissions are caused by coal combustion, 31% by oil combustion and 18% by natural gas combustion. Emissions related to industrial processes, such as cement production, represent 10% of the total.

GLOBAL PRIMARY ENERGY MIX





Source: *IEA, september 2015*

The distribution of emissions by fuels can be linked to the global primary energy mix. In 2013, fossil fuels (coal, natural gas and oil) account for 81% of the global total primary energy supply. 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). Accounting for a 29% share of the energy mix, coal was the second largest energy source after crude oil in 2013. Yet, it ranked first in terms of CO_2 emissions as its emission factor is considerably higher than those of gas and oil (see page 74). As renewable energy generation has increased at a rate close to total generation, its share in the world energy mix has stayed stable in 40 years, around 14 %.

GEOGRAPHIC DISTRIBUTION OF GLOBAL CO_2 EMISSIONS (EXCL. LULUCF)

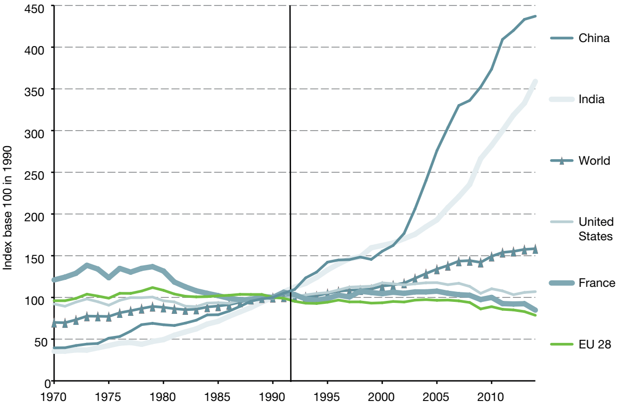
In Mt CO_2	1990	2013	2014	2014 share (%)	Change (%) 2014/2013	Change (%) 2014/1990
North America	**5,726**	**6,315**	**6,357**	**17.8**	**+0.7**	**+11.0**
of which: Canada	448	565	566	1.6	+0.2	+26.2
USA	4,988	5,286	5,335	15.0	+0.9	+6.9
Central and South America	**647**	**1,291**	**1,306**	**3.7**	**+1.1**	**+101.8**
of which: Brazil	217	485	501	1.4	+3.3	+130.5
Europe and former USSR	**8,353**	**6,403**	**6,142**	**17.2**	**–4.1**	**–26.5**
of which: Russia	2,379	1,792	1,766	5.0	–1.4	–25.7
EU-28	4,345	3,608	3,415	9.6	–5.4	–21.4
of which: EU-15	3,282	2,888	2,711	7.6	–6.1	–17.4
Germany	1,008	813	767	2.2	–5.6	–23.9
Spain	227	244	242	0.7	–1.0	+6.5
France	387	353	324	0.9	–8.3	–16.3
Italy	424	366	338	0.9	–7.6	–20.4
United Kingdom	579	456	415	1.2	–8.9	–28.3
13 new EU members	1,063	720	704	2.0	–2.3	–33.8
Africa	**667**	**1,162**	**1,188**	**3.3**	**+2.3**	**+78.1**
Middle East	**814**	**2,193**	**2,272**	**6.4**	**+3.6**	**+179.1**
of which Saudi Arabia	168	463	495	1.4	+7.0	+194.3
Asia	**5,378**	**16,543**	**16,833**	**47.2**	**+1.8**	**+213.0**
of which: China	2,411	10,448	10,541	29.6	+0.9	+337.1
South Korea	268	609	610	1.7	+0.2	+127.6
India	652	2,172	2,342	6.6	+7.8	+258.9
Japan	1,170	1,217	1,235	3.5	+1.5	+5.6
Oceania	**304**	**461**	**454**	**1.3**	**–1.6**	**+49.4**
Annex I countries	**14,894**	**13,937**	**13,666**	**38.3**	**–1.9**	**–8.2**
Non-Annex I countries	**6,995**	**20,431**	**20,886**	**58.6**	**+2.2**	**+198.6**
International bunkers	**626**	**1,109**	**1,117**	**3.1**	**+0.7**	**+78.2**
World	**22,516**	**35,477**	**35,669**	**100.0**	**+0.5**	**+58.4**

Note: International bunkers are emissions from international aviation and shipping. They have been excluded from national totals.

***Sources:** SOeS from EDGAR, World Bank, 2015*

In 2014, global CO_2 emissions (excluding LULUCF) slightly increased by 0.5%, well below the average yearly increase since 2000 (+2.5%). There is a clear difference between developing countries (here non-Annex I countries) where emissions grew by 2.2% and developed countries where emissions decreased by 1.9%. In 2014, for the first time, India is the country contributing the most to global emissions growth (+170 Mt CO_2).

EVOLUTION OF GLOBAL CO_2 EMISSIONS BETWEEN 1970 AND 2014



***Sources:** SOeS from EDGAR, World Bank, 2015*

In 2014, Chinese emissions accounted for almost 30% of global CO_2 emissions. China is the first emitting country, followed by the United States (15.0%), the EU-28 (9.6% of the global total when counted as a block) and India (6.6%). Between 1990 and 2014, global CO_2 emissions increased by 50%. Among the main emitters, China displays the highest growth rate: its emissions increased fourfold during the period. As for the United States, its emissions have increased by 7% since 1990. During the same period, EU-28 emissions decreased by 21% and French emissions by 16%.

GLOBAL CO_2 EMISSIONS PER CAPITA

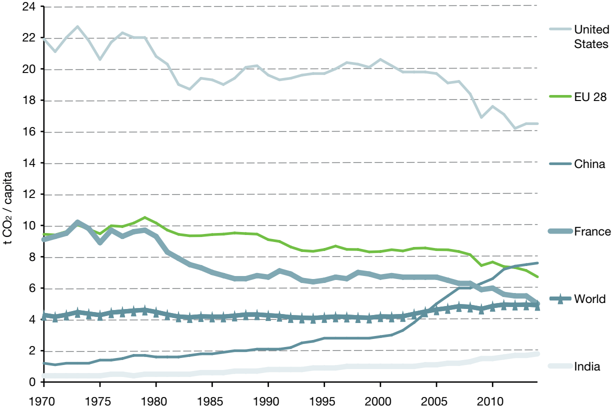
In t CO_2 / capita	1990	2013	2014	Change (%) 2014/2013	Change (%) 2014/1990
North America	**15.8**	**13.3**	**13.2**	**–0.3**	**–16.0**
of which: Canada	16.2	16.1	15.9	–1.2	–1.9
USA	19.6	16.5	16.5	–	–15.8
Central and South America	**1.8**	**2.6**	**2.6**	**+0.1**	**+45.2**
of which: Brazil	1.5	2.4	2.5	+2.5	+71.0
Europe and former USSR	**9.9**	**7.1**	**6.8**	**–4.5**	**–31.4**
of which: Russia	16.1	12.6	12.4	–1.2	–22.8
EU-28	9.1	7.1	6.7	–5.7	–26.1
of which: EU-15	9.0	7.2	6.7	–6.4	–25.1
Germany	12.5	9.8	9.3	–5.5	–25.9
Spain	5.8	5.2	5.1	–1.3	–12.0
France	6.7	5.5	5.0	–9.1	–25.4
Italy	7.5	6.0	5.5	–7.7	–26.0
United Kingdom	10.1	7.2	6.5	–9.5	–35.4
13 new EU members	9.4	6.7	6.5	–2.1	–30.8
Africa	**1.1**	**1.0**	**1.0**	**–0.3**	**–3.2**
Middle East	**7.6**	**12.6**	**12.8**	**+1.6**	**+67.3**
of which Saudi Arabia	10.4	16.1	16.9	+5.0	+62.3
Asia	**1.8**	**4.3**	**4.3**	**+0.8**	**+1 33.1**
of which: China	2.1	7.5	7.6	+1.3	+261.9
South Korea	6.2	12.4	12.3	–0.3	+97.4
India	0.8	1.7	1.8	+5.9	+125.0
Japan	9.6	10.3	10.1	–2.5	+5.2
Oceania	**13.6**	**15.5**	**15.0**	**–3.1**	**+9.9**
Annex I countries	**12.9**	**10.9**	**10.6**	**–2.4**	**–17.5**
Non-Annex I countries	**1.7**	**3.5**	**3.5**	**+0.9**	**+106.2**
World	**4.3**	**4.9**	**4.9**	**–0.7**	**+15.3**

Note: The figures here refer to the CO_2 emissions of a territory divided by its population. The average emissions due to the consumption of an inhabitant are calculated using a different approach (carbon footprint).

Sources: *SOeS from EDGAR, World Bank, 2015*

In 2014, global CO_2 emissions came to 4.5 t CO_2/capita on average, a decrease of 0.7% compared to 2013. It means that global CO_2 emissions growth in 2014 (+0.5%) was lower than demographic growth (+1.2%). Emissions per capita were highest in North America (over 16 t CO_2/capita in the United States), in the Middle East and in Oceania. Chinese emissions per capita are now 7,6 t CO_2/capita, above the French level of 5.0 t CO_2/capita and the average for the EU-28 (6.7 t CO_2/capita).

EVOLUTION OF GLOBAL CO_2 EMISSIONS PER CAPITA BETWEEN 1970 AND 2014



Sources: *SOeS from EDGAR, World Bank, 2015*

Since 1990, global average emissions per capita have increased by 15%. While emissions per capita in non-annex I countries are still three times lower than in annex I countries, there is an ongoing catching-up process between those two groups of countries. For instance, since 1990, emissions per capita have been multiplied by more than 3.5 in China and have more than doubled in India. Simultaneously, CO_2 emissions per capita have significantly decreased in the EU (–26%) and to a lesser extent in the United States (–16%).

GLOBAL CO_2 EMISSIONS IN RELATION TO GDP (EXCL. LULUCF)

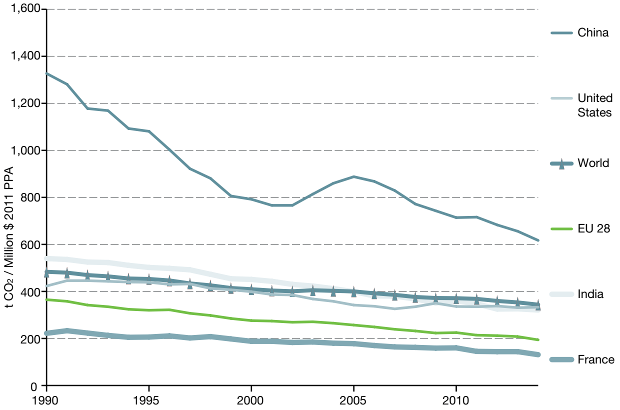
In t CO_2 / Million $ 2011 PPP	1990	2013	2014	Change (%) 2014/2013	Change (%) 2014/1990
North America	**512**	**320**	**315**	**–1.7**	**–38.4**
of which: Canada	519	384	375	–2.3	–27.7
USA	540	326	321	–1.5	–40.6
Central and South America	**194**	**179**	**179**	**+0.1**	**–7.7**
of which: Brazil	145	166	172	+3.6	+18.6
Europe and former USSR	**565**	**316**	**307**	**–2.6**	**–45.6**
of which: Russia	829	530	519	–2.1	–37.4
EU-28	365	208	194	–6.7	–46.8
of which: EU-15	312	192	178	–7.3	–42.9
Germany	403	209	191	–8.4	–52.6
Spain	242	165	161	–2.4	–33.5
France	222	144	131	–9.0	–41.0
Italy	243	179	166	–7.3	–31.7
United Kingdom	383	193	171	–11.4	–55.4
13 new EU members	780	306	291	–4.9	–62.7
Africa	**551**	**234**	**226**	**–3.4**	**–59.0**
Middle East	**388**	**421**	**424**	**+0.7**	**+9.1**
of which Saudi Arabia	294	308	318	+3.2	+8.2
Asia	**490**	**426**	**411**	**–3.5**	**–16.1**
of which: China	1,327	656	617	–5.9	–53.5
South Korea	517	371	359	–3.2	–30.6
India	423	331	333	+0.6	–21.3
Japan	321	290	282	–2.8	–12.1
Oceania	**528**	**401**	**385**	**–4.1**	**–27.2**
Annex I countries	**485**	**297**	**287**	**–3.5**	**–40.8**
Non-Annex I countries	**442**	**382**	**372**	**–2.5**	**–15.7**
World	**484**	**353**	**344**	**–2.7**	**–28.9**

Note: GDP at constant prices converted to US dollars on a Purchasing Power Parity (PPP) basis for 2011.

***Sources:** SOeS from EDGAR, World Bank, 2015*

The quantity of CO_2 emitted per unit of GDP keeps declining worldwide with a 2.7 % decrease in 2014. There are strong disparities between countries with the highest values in China (more than 600 t CO_2/ Million $) or in Russia. The United States (321 t CO_2/ Million $) or Japan are slightly below the global average, while the lowest values are in the EU (194 t CO_2/ Million $), in particular in France (131 t CO_2/ Million $).

EVOLUTION OF GLOBAL CO2 EMISSIONS IN RELATION TO GDP BETWEEN 1990 AND 2014

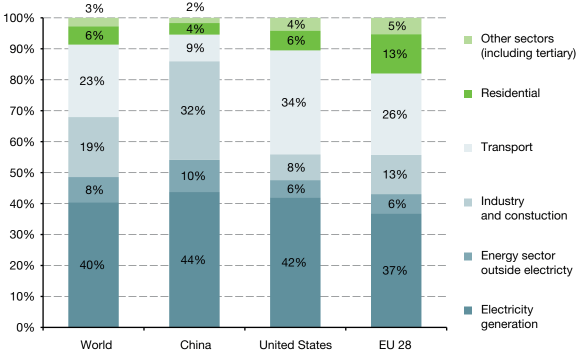


Sources: *SOeS from EDGAR, World Bank, 2015*

Since 1990, the quantity of CO_2 emitted per unit of GDP has dropped by 29% worldwide. It has decreased in most countries. The main exceptions are oil-producing countries such as Saudi Arabia (+8%) or raw materials exporting countries like Brazil (+18%). China was the country that recorded the sharpest drop in 24 years, with emissions per unit of GDP down by more than half. The decline in CO_2 intensity in relation to GDP is also significant in the EU (–47%) and in the United States (–41%).

Sectorial distribution of global CO_2 emissions from fuel combustion

DISTRIBUTION OF CO_2 EMISSIONS FROM FUEL COMBUSTION FOR THE MAIN EMITTERS IN 2013



Source: *IEA, 2015*

Accounting for 40% of global energy-related CO_2 emissions, electricity generation was the first emitting sector in 2013. Next are the transport sector and industry, respectively accounting for 23 % and 19 % of energy-related CO_2 emissions. In China, electricity generation (44%) and industry (32%) are responsible for a higher share of emissions than the global average. As for the transport sector, it is responsible of a higher share than the global average in the EU (26%) and even more in the United States (34%).

part 3

How much greenhouse gas is emitted in Europe and in France ?

— Within the UNFCCC framework, the European Union and France report the greenhouse gases emitted on their territory. In 2014, the EU emitted 4,282 Mt CO_2e excluding LULUCF, representing a drop of 24% compared to 1990. In France, emissions excluding LULUCF reached 459 Mt CO_2e in 2014 and have decreased by 16% since 1990. In the EU, the energy sector is the first emitting sector while the transport sector contributes the most to French emissions. The footprint approach, complementary to the territorial approach, gives an estimate of GHG emissions arising from the consumption of French residents. In 2010, French consumption-based emissions were over 50% higher than territory-based emissions.

Overview of GHG emissions in Europe

EU-28 GHG EMISSIONS IN 2014

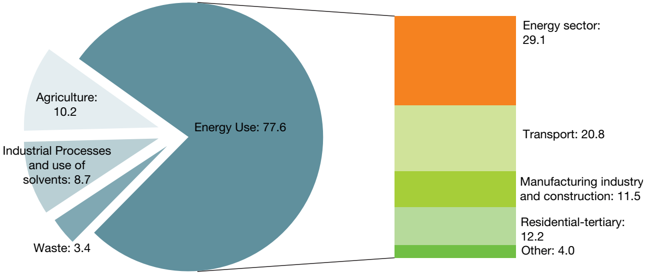
In Mt CO_2eq.	Years	CO_2	CH_4	N_2O	F-gases	Total
Energy use	1990	4,120.5	202.3	31.1	0.0	4,353.9
	2014	3,211.7	82.7	29.5	0.0	3,323.9
Industrial processes and use of solvents	1990	321.5	1.8	117.8	71.1	512.2
	2014	238.3	2.2	11.2	121.7	373.4
Agriculture (excluding energy use)	1990	13.9	304.1	229.8	0.0	547.8
	2014	10.2	236.9	187.9	0.0	434.9
Waste	1990	5.4	229.2	8.6	0.0	243.2
	2014	3.5	131.5	10.7	0.0	145.7
Total excl. LULUCF	**1990**	**4,469.6**	**737.3**	**387.4**	**71.1**	**5,665.5**
	2014	**3,467.9**	**453.3**	**239.2**	**121.7**	**4,282.1**
LULUCF	1990	–273.3	6.7	5.6	0.0	–255.2
	2014	–319.3	5.1	7.0	0.0	–302.6
Total	**1990**	**4,196.3**	**744.1**	**398.7**	**71.1**	**5,410.3**
	2014	**3,148.5**	**458.4**	**250.9**	**121.7**	**3,979.5**

Note: The waste sector excludes waste incineration with energy recovery (included in "energy use").
***Source:** EAA, july 2016*

In 2014, European GHG emissions excluding LULUCF reached 4,282 Mt CO_2e of which 81% are CO_2 emissions and 78% are energy-related. European GHG emissions dropped by 4.1% compared to 2013 and by 24% over the period 1990-2014.

DISTRIBUTION OF GHG EMISSIONS (EXCL. LULUCF) IN THE EU IN 2014

In %



***Source:** EAA, july 2016*

In the EU, energy use was the main source of GHG emissions (78%). The largest GHG emitting sector was the energy sector (29% of emissions), ahead of transport (21%).

Between 2013 and 2014, the decline of GHG emissions can largely be explained by significant decreases in the energy (–7%) and residential-tertiary (–15%) sectors.

Overview of GHG emissions in France

FRANCE'S EMISSIONS IN 2014

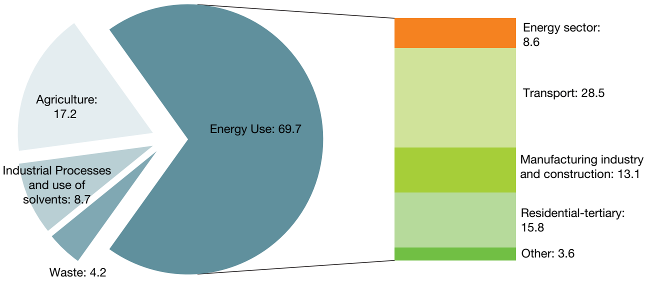
In Mt CO_2eq.	Years	CO_2	CH_4	N_2O	F-gases	Total
Energy use	1990	368.6	12.3	3.3	0.0	384.2
	2014	313.3	2.6	3.7	0.0	319.6
Industrial processes and use of solvents	1990	25.7	0.1	23.8	11.8	61.4
	2014	18.3	0.1	1.2	20.4	40.0
Agriculture (excluding energy use)	1990	1.7	41.8	39.6	0.0	83.2
	2014	1.9	39.9	37.0	0.0	78.9
Waste	1990	2.2	14.3	0.9	0.0	17.4
	2014	1.7	16.8	1.0	0.0	19.5
Total excl. LULUCF	**1990**	**400.2**	**68.5**	**67.5**	**11.8**	**548.1**
	2014	**336.3**	**59.3**	**42.9**	**20.4**	**458.9**
LULUCF	1990	–34.2	0.9	2.7	0.0	–30.6
	2014	–54.0	1.1	2.3	0.0	–50.6
Total	**1990**	**366.1**	**69.5**	**70.2**	**11.8**	**517.5**
	2014	**282.3**	**60.4**	**45.2**	**20.4**	**408.3**

Source: *Citepa, juin 2016*

In 2014, French GHG emissions, excluding LULUCF, reached 459 Mt CO_2e, of which 73% are CO_2 emissions and 70% are energy-related. French GHG emissions decreased by 5.7% compared to 2013 and by 16% over the period 1990-2014.

DISTRIBUTION OF GHG EMISSIONS (EXCL. LULUCF) IN FRANCE IN 2014

In %

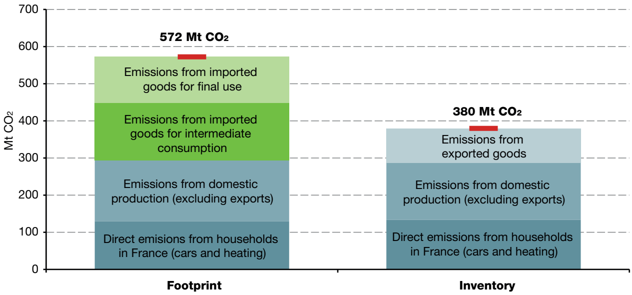


Source: *Citepa, juin 2016*

As throughout the EU, energy use was the main GHG emission source in France accounting for 70% of total emissions excluding LULUCF. However, unlike the EU average, the largest emitting sector in France is transport (29%), while the energy sector has relatively low emissions (9%), owing to the extent of nuclear electricity generation. Between 2013 and 2014, the sectors contributing the most to the reduction of French emissions were the energy (–25%) and residential-tertiary (–16%) sectors.

Carbon footprint and emissions from imported goods

COMPARISON BETWEEN THE FOOTPRINT APPROACH AND THE TERRITORIAL INVENTORY APPROACH FOR METROPOLITAN FRANCE - 2010 - CO_2 ONLY

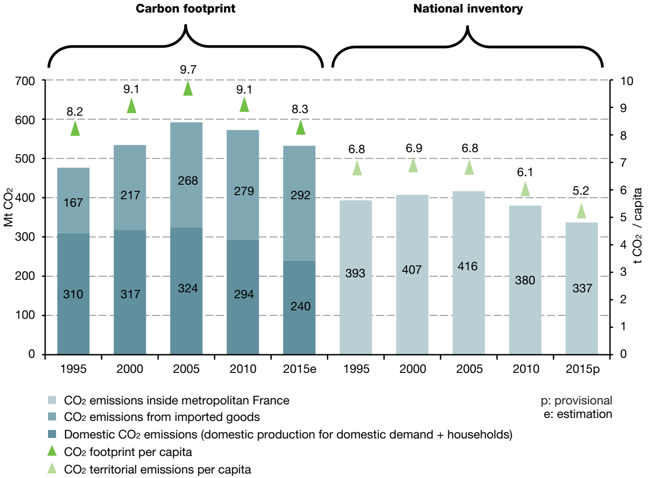


Source: *SOeS from Citepa, Eurostat, Insee, Customs, IEA, 2016*

Two complementary methods allow to estimate a country pressure on global climate:

- National inventories account for GHGs physically emitted inside a territory. These national inventories are carried out each year according to UNFCCC guidelines.
- The carbon footprint approach accounts for emissions from final domestic demand in the country. It includes direct emissions from households (housing and cars), emissions from domestic production (excluding exports) and emissions from imported goods.

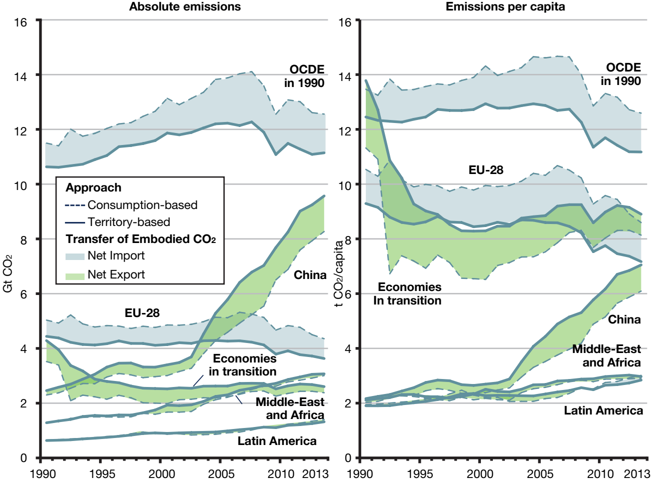
EVOLUTION OF FRANCE'S CO_2 EMISSIONS ACCORDING TO THE TERRITORIAL APPROACH AND THE FOOTPRINT APPROACH



***Source:** SOeS from Citepa, Eurostat, Insee, Customs, IEA, 2016*

In 2015, the French carbon footprint (CO_2 only) amounted to 532 Mt of CO_2, 11.7% higher than in 1995. Emissions from imported goods increased by 76% over the same period.
However, if the increased population is taken into account, the footprint calculated per capita in 2015 is almost the same as in 1995. Over this period, emissions inside metropolitan France decreased by 14.4% and the average emissions per capita by 23%. Both emissions from the territorial inventory and the carbon footprint have been declining since the middle of the 2000's.

INTERNATIONAL COMPARISON OF CO_2 EMISSIONS FROM FUEL COMBUSTION ACCORDING TO THE TWO APPROACHES



Source: *I4CE from Global Carbon Budget, 2015*

Between 1990 and 2012, CO_2 emissions in the OECD increased by 5% according to the territorial approach, and by 9% according to the footprint approach. In the EU, over the same period, they dropped by 18% according to the territorial approach but only by 14% with the footprint approach. In China, they have more than tripled according to both approaches.

According to the territorial approach, emissions per capita in China are now close to the EU average. However, according to the footprint approach, emissions per capita in China are still 30% lower than in the EU (and 50% lower than the OECD average).

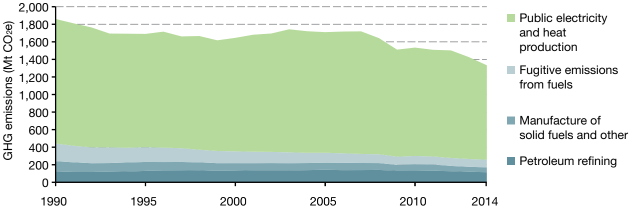
part 4

What is the sectoral distribution of GHG emissions in Europe and in France?

— European and French inventories enable a breakdown of GHG emissions by economic sectors and subsectors. In Europe and in France, the decline in emissions since 1990 has been the most significant in the manufacturing industry followed by the energy sector. Emissions in the residential and tertiary sectors have also been following a downward trend in the EU and to a lesser extent, in France. The transport sector is an exception as the level of emissions in 2014 was higher than in 1990, both in Europe and in France. However, since the mid 2000s, emissions have been decreasing in the transport sector at both levels. Emissions from LULUCF are negative, hence meaning that there is a net sequestration of CO_2 by biomass and soils.

GHG emissions from the energy sector

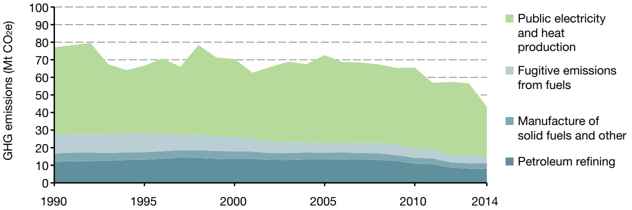
GHG EMISSIONS FROM THE ENERGY SECTOR IN THE EU



Note: Public electricity and heat production includes waste incineration with energy recovery. Heat refers here to traded heat only.

Source: *EEA,July 2016*

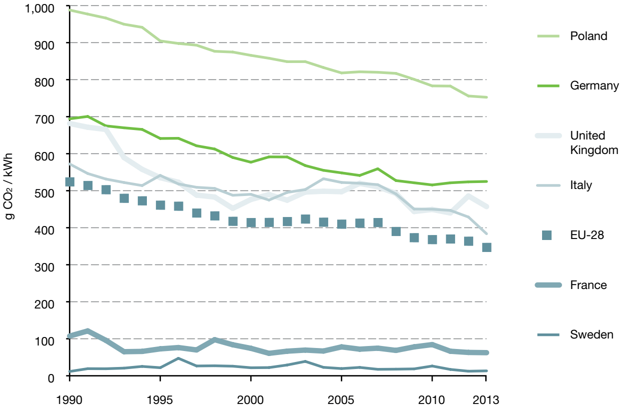
GHG EMISSIONS FROM THE ENERGY SECTOR IN FRANCE



Note: Public electricity and heat production includes waste incineration with energy recovery. Heat refers here to traded heat only.

Source: *Citepa,June 2016*

CO_2 EMISSIONS FROM THE GENERATION OF 1 KWH OF ELECTRICITY IN THE EU



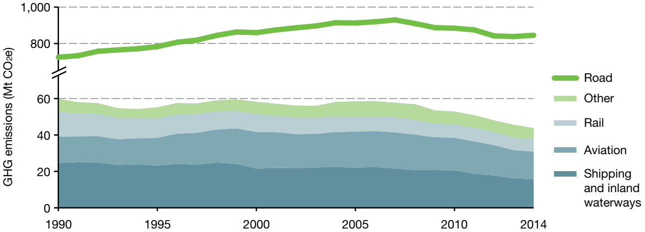
Note: cogeneration and autoproduction are included

***Source:** IEA, October 2015*

CO_2 emissions per unit of electricity generated vary greatly from one country to another in the EU-28. They are very high (over 400 g CO_2/kWh) in countries where coal remains a major source for electricity production, 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 significantly developed, such as France (78% nuclear and 12% hydro in 2014) and Sweden (42% hydro and 41% nuclear).

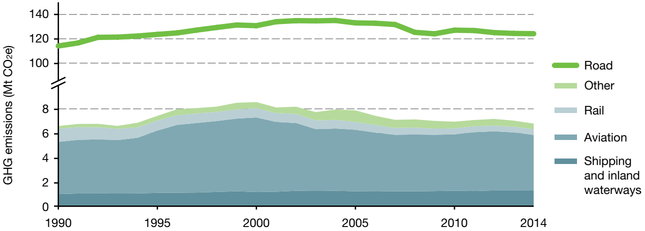
GHG emissions from transport

GHG EMISSIONS FROM TRANSPORT IN THE EU



Note: Emissions from international aviation and shipping are excluded.
***Source:** EEA,July 2016*

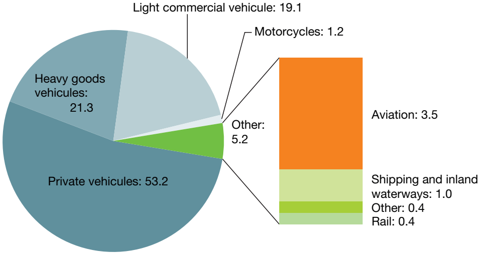
GHG EMISSIONS FROM TRANSPORT IN FRANCE (INCL. OVERSEAS TERRITORIES)



Note: Emissions from international aviation and shipping are excluded. Emissions from transport between metropolitan France and French overseas departments are included.
***Source:** Citepa,June 2015*

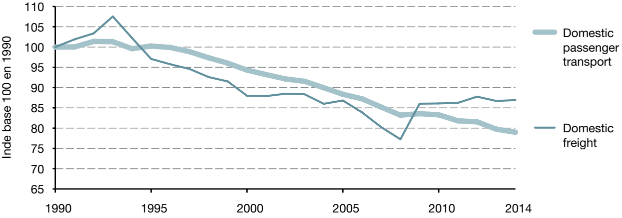
GHG EMISSIONS BY MODE OF TRANSPORT INSIDE METROPOLITAN FRANCE

In %



Source: *Citepa, June 2016*

INTENSITY OF GHG EMISSIONS IN METROPOLITAN FRANCE

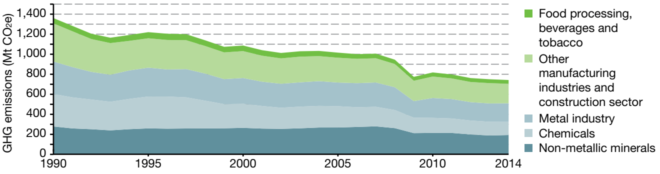


Note: The indicators used for freight and passenger transport are, respectively, GHG emissions per tonne-kilometre and GHG emissions per passenger-kilometre.

Source: *Citepa, June 2016 and SOeS*

GHG emissions from the manufacturing industry and the construction sector

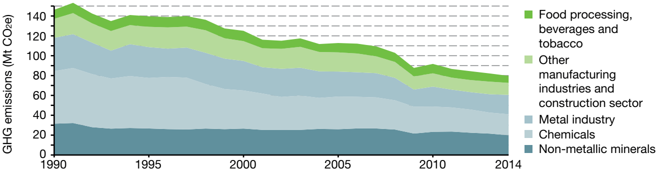
GHG EMISSIONS FROM THE MANUFACTURING INDUSTRY AND THE CONSTRUCTION SECTOR IN THE EU



Note: emissions from each sector include energy-related emissions and emissions from industrial processes.

Source: *EEA,July 2016*

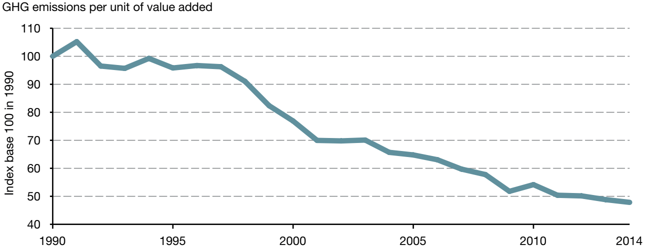
GHG EMISSIONS FROM THE MANUFACTURING INDUSTRY AND THE CONSTRUCTION SECTOR IN FRANCE (INCL. OVERSEAS TERRITORIES)



Note: emissions from each sector include energy-related emissions and emissions from industrial processes.

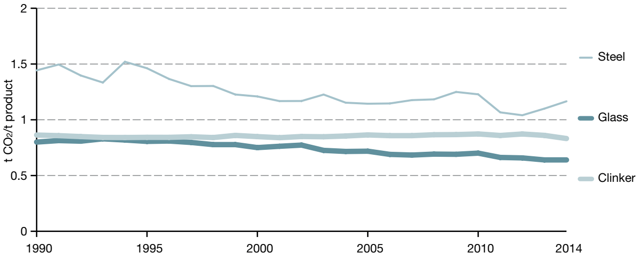
Source: *Citepa,June 2016*

GHG EMISSIONS INTENSITY OF THE MANUFACTURING INDUSTRY AND THE CONSTRUCTION SECTOR IN FRANCE



Source: *Insee (value added), Citepa (GHG emissions), June 2016*

CO_2 INTENSITY FOR SEVERAL CO_2-INTENSIVE PRODUCTS IN FRANCE

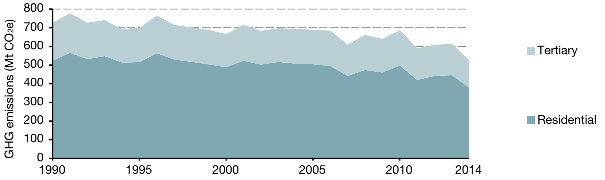


Note: Clinker is a component of cement that results from heating a mixture of silicia, iron oxide and limestone

Sources: *Fédération française de l'acier (FFA), Fédération des chambres syndicales de l'industrie du verre (FCSIV), Syndicat français de l'industrie cimentière (SFIC), Citepa*

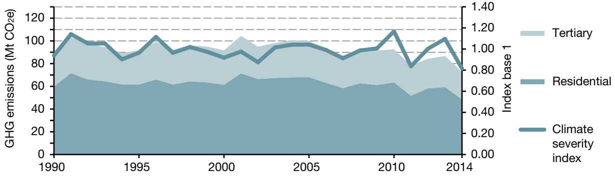
GHG emissions from the residential and tertiary sectors

GHG EMISSIONS FROM THE RESIDENTIAL AND TERTIARY SECTORS IN THE EU



Source: *EEA, July 2016*

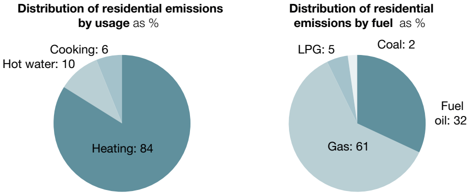
GHG EMISSIONS FROM THE RESIDENTIAL AND TERTIARY SECTORS IN FRANCE (INCL. OVERSEAS TERRITORIES)



Source: *Citepa, June 2016 and SOeS from Météo-France, 2016*

Emissions from the residential and tertiary sectors vary depending on climate conditions. Temperatures were particularly mild in 1994, 2002, 2007, 2011 and 2014. This resulted in a reduction in heating consumption and thus in CO_2 emissions. In contrast, 1991, 1996 and 2010 were exceptionally cold.

DISTRIBUTION OF CO_2 EMISSIONS FROM RESIDENTIAL BUILDINGS IN METROPOLITAN FRANCE

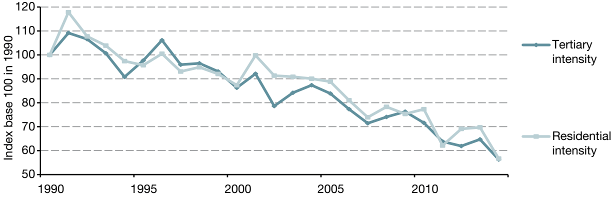


Note: only CO_2 emissions from fossil fuel combustion are taken into account. The carbon content of electricity is not measured.

***Source:** SOeS from Ceren, 2016*

Since 1990, natural gas has displaced coal and fuel oil for heating, cooking, and hot water production in buildings. Combustion of natural gas now accounts for 61 % of CO_2 emissions from residential buildings.

CO_2 INTENSITY FOR THE RESIDENTIAL AND TERTIARY SECTORS IN FRANCE

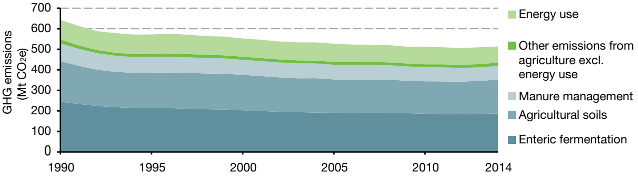


Note: emissions from the tertiary sector are divided by the value added of the tertiary sector (excluding transports) while emissions from residential buildings are divided by the total surface of occupied buildings.

***Source:** SOeS from Citepa and Insee, 2016*

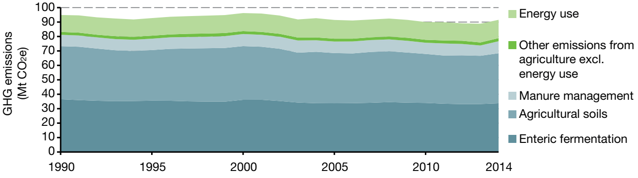
GHG emissions from agriculture, forestry and land use

GHG EMISSIONS FROM AGRICULTURE IN THE EU



Source: *EEA, July 2016*

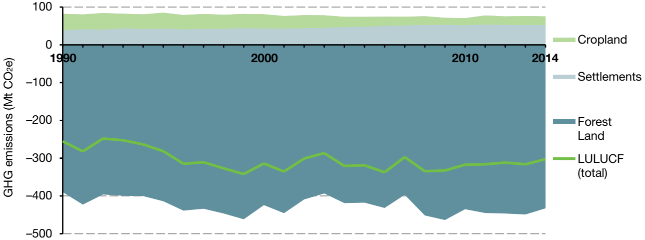
GHG EMISSIONS FROM AGRICULTURE IN FRANCE (INCL. OVERSEAS TERRITORIES)



Source: *Citepa, June 2016*

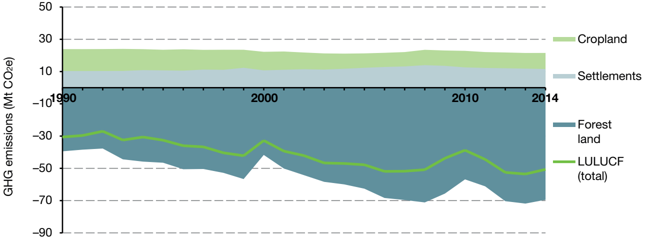
Agriculture differs from other economic sectors as most of the GHG emissions are not energy-related. The main GHGs sources are CH_4 emitted by livestock (enteric fermentation) and N_2O emitted by agriculture soils and linked to the nitrogen cycle.

GHG EMISSIONS FROM LULUCF IN THE EU



Source: *EEA, July 2016*

GHG EMISSIONS FROM LULUCF IN FRANCE (INCL. OVERSEAS TERRITORIES)

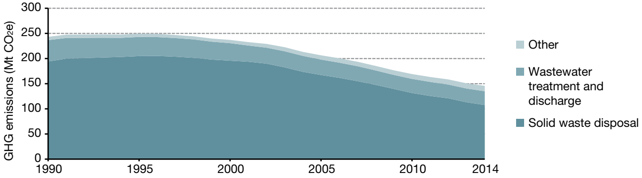


Source: *Citepa, June 2016*

Emissions from Land Use, Land Use Change and Forestery (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 growth of forests. In France, these sequestrations have been on an upward trend since 1990.

GHG emissions from waste management

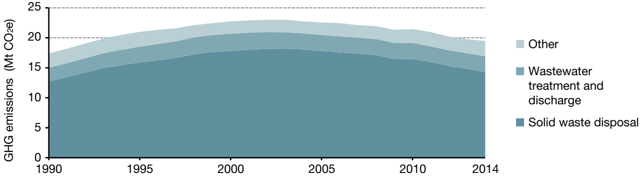
GHG EMISSIONS FROM WASTE MANAGEMENT IN THE EU



Note: emissions from waste incineration with energy recovery are not included (included in "energy sector").

Source: *EEA, July 2016*

GHG EMISSIONS FROM WASTE MANAGEMENT IN FRANCE (INCL. OVERSEAS TERRITORIES)



Note: emissions from waste incineration with energy recovery are not included (included in "energy sector").

Source: *Citepa, June 2016*

GHG emissions from waste management are mostly made of methane, emitted during the decomposition of waste in landfills. These emissions have been decreasing in Europe since the mid 90's and in France since the mid 2000's.

part 5

Which climate policies in the world, in Europe and in France?

— COP 21 led to the adoption of the Paris agreement in December 2015, which implies pledges to limit GHG emissions both for developped and developing countries. The European Union set a 40% emissions reduction target in 2030 compared to 1990 levels as well as climate policies based in particular on an emissions trading system. Carbon pricing mechanisms are set in the world, notably to reorient financial flows. France adopted a national low carbon strategy and carbon budgets to implement the transition to a low carbon economy.

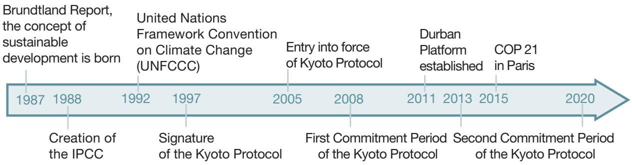
International negotiations

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

The UNFCCC, first international treaty aiming at preventing dangerous human interference with the climate system, was adopted in 1992 in Rio de Janeiro. It recognizes 3 principles:

- **a precautionary principle:** lack of full scientific certainty on the impacts of climate change shall not be used as a reason for delaying action;
- **the principle of common but differentiated responsibility:** all GHG emissions have an impact on global warming but the most industrialized countries carry a greater responsibility for the current concentration of GHGs;
- **the principle of the right to development:** climate actions shall not have a negative impact on the priorities of developing countries, including a sustainable economic growth and the fight against poverty.

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



KYOTO PROTOCOL

One of the first and most notable outcomes of a COP is the Kyoto Protocol which was agreed in 1997 and entered into force in 2005 after being ratified by Russia. It achieved the quorum of 55 States representing a minimum of 55% of Annex B emissions in 1990.

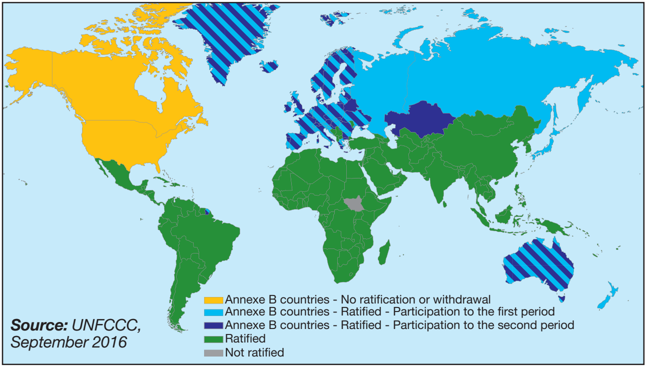
The Protocol is an agreement between 38 of the most developed countries (Annex B countries) which sets a goal to reduce GHG emissions by **roughly 5% between 2008 and 2012 relative to 1990 levels.**

Targets are binding and differentiated by country, with no emissions reduction objectives for Non-Annex B Parties.

Amongst Annex-B countries, only the United States have not ratified the Protocol, and Canada withdrew from the Protocol in December 2011.

In 2011, at COP17 in Durban (South Africa), Parties agreed to continue the Protocol for a second period of commitment from 2013 to 2020. Those countries that announced a commitment for the second period represented 13% of global emissions in 2010.

Status of ratification of the Kyoto protocol



***Source:** UNFCCC, September 2016*

Paris agreement

PARIS APPROACH

In contrast to the Kyoto Protocol approach, the Paris Agreement afforded Parties flexibility to determine and submit their own climate commitments based on their national circumstances, in the form of intended Nationally Determined Contributions (iNDCs). iNDCs describe national or regional emissions reduction targets to be achieved in the medium and long-term along with their climate mitigation and adaptation plans.

By adopting a bottom–up approach to determine and define Party ambition, the Agreement was able to engage both developed and developing parties, ensuring different climate priorities and issues were represented in the text and that consensus on the final text would be achievable.

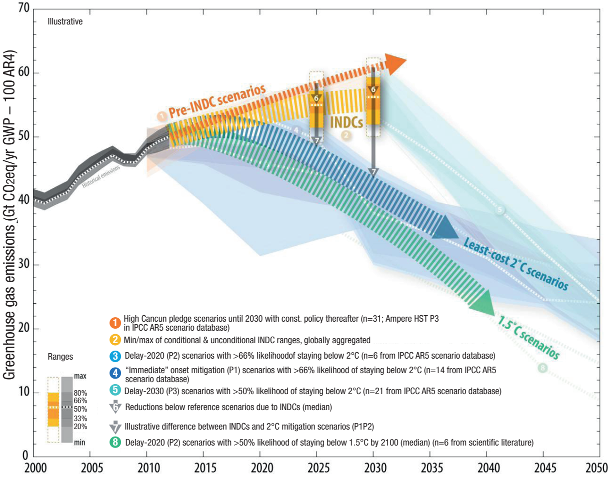
GHG emissions reduction goals in a selection of submitted iNDCs

UNFCCC party	iNDC
European Union	At least –40% in GHG emissions by 2030 compared to 1990 levels
China	A peaking of CO_2 emissions around 2030
United States	Between –26% and –28% in GHG emissions by 2025 compared to 2005 levels
Brazil	–37% in GHG emissions in 2025 compared to 2005 levels

Source: *UNFCCC*

IMPACT OF INDCS ON GLOBAL GHG EMISSIONS

Comparison of 2025 and 2030 global emissions levels resulting from iNDCs' implementation and other scenarios



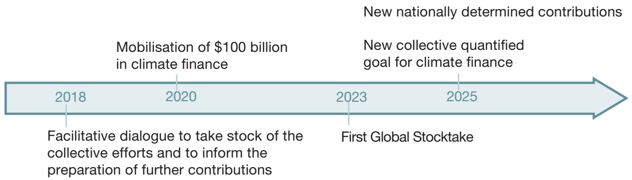
Source: *UNFCCC Synthesis report, 2016*

The UNFCCC has published a Synthesis Report that aggregates information from all iNDCs submitted by April 2016. This report concluded that, taking into account implementation of all iNDCs, GHG emissions are expected to increase between 34-53% by 2030 relative to 1990 levels. Per capita emissions are on the contrary expected to decrease by 10 % between 1990 and 2030.
Thus, iNDCs in their current form appear to be insufficient in meeting the 2°C-1.5°C objectives of the Paris Agreement.
Reaching these objectives is still possible but will require drastically increasing the ambition as soon as possible.

CONTENT OF THE PARIS AGREEMENT

On December 12th 2015 at COP21 in Paris, a text known as the Paris Agreement was adopted by the UNFCCC. For the first time, both developing and developed country Parties will (pending ratification) have binding commitments under the Convention.
The bottom-up iNDC process successfully received **162 submission**s representing 189 country pledges.
The key objectives of the Paris Agreement are threefold:
1. Mitigation
   - To contain the rise of global mean temperatures **"well below 2°C** above pre-industrial levels" by 2100 and to pursue efforts to **limit warming to 1.5°C.**
   - To reach global peaking of GHG emissions as soon as possible.
   - To achieve **net-zero emissions** before the end of the century.
2. Adaptation:
   - To enhance support and capacity building for adaptation and loss & damage.
3. Finance:
   - To make finance flows consistent with climate objectives.
   - To mobilise at least $100 billion in climate finance annually, from developed to developing countries between 2020 and 2025.

The Agreement introduces a Transparency Framework; it enhances cooperation at every level (between public and private stakeholders), and includes a **"ratcheting mechanism"** to ensure that Parties do not decrease climate ambition over time. To enter into force the **Agreement must be ratified by at least 55 Parties representing at least 55% of global emissions.**



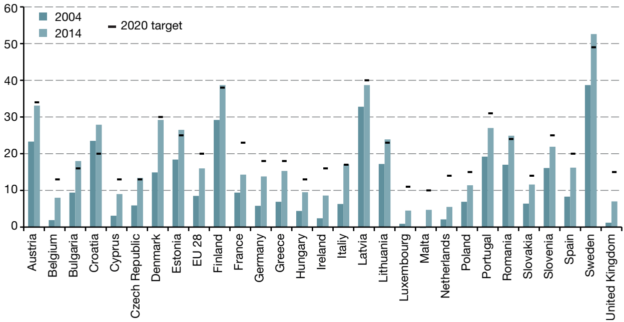
Commitments of the European Union

CLIMATE AND ENERGY PACKAGE 2020

The Climate and Energy Package sets three targets for 2020, known as "20-20-20":

- **A 20% cut in GHG emissions** from 1990 levels;
- **A 20% share of renewables in EU gross final consumption of energy**. This objective is translated into a national binding target for each Member State;
- **A 20% improvement in energy efficiency.** This objective corresponds to a 20% decrease in primary energy consumption compared to the Baseline scenario defined in 2007.

Share of renewables in the Member States' gross final energy consumption (%)



Source: *Eurostat*

CLIMATE AND ENERGY PACKAGE 2030

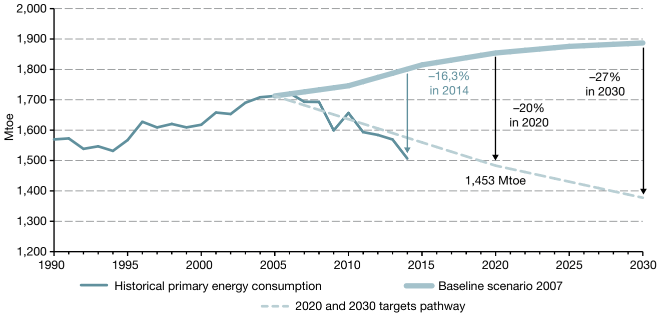
At a meeting on 23-24 October 2014, the European Council agreed on the 2030 climate and energy framework for the EU, which sets three targets for 2030:

- A **40% cut in GHG emissions from 1990 levels;**
- A **27% share of renewables in EU gross final consumption of energy;**
- A **27% improvement in energy efficiency,** which means a 27% decrease in primary energy consumption compared to the Baseline scenario defined in 2007.

The translation into regulation of the 2030 climate and energy package is currently under discussion.

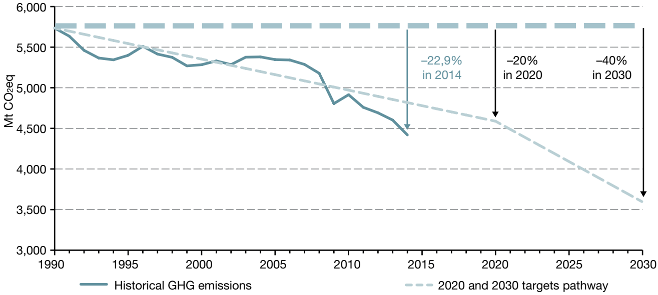
The European Parliament calls for a target of a 30% share of renewables in gross final energy consumption and a 40% target for energy efficiency.
The European Commission is expected to present proposals to revise the Renewable Energy and the Energy Efficiciency Directives by the end of 2016.

EU-28 primary energy consumption evolution and targets to 2020 and 2030



Source: *Eurostat et European Commission*

EU-28 GHG emissions evolution and targets to 2020 and 2030



Source: *Eurostat et European Commission*

EFFORT SHARING

The two main policy instruments to achieve the emissions reduction targets are the **European Union Emissions Trading System** (EU ETS, see p. 60) and the **Effort Sharing Decision** (ESD), which sets national emissions reduction targets for non-ETS sectors.
The 20% emissions reduction target by 2020 compared to 1990 translates into a **21% reduction from 2005 levels** for the EU ETS and a **10% reduction compared to 2005** for other sectors.
The 40% emissions reduction target by 2030 compared to 1990 translates into a **43% reduction from 2005 levels for the EU ETS** and a **30% reduction compared to 2005** for other sectors.
The Commission published in July 2016 a proposal to revise the Effort Sharing decision to divide the objective between Member States for the post-2020 period.

The EU ETS

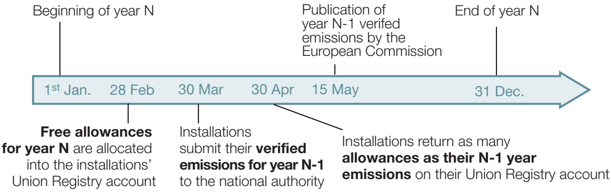
PRINCIPLE

The European Union Emissions Trading System (EU ETS) was created in 2005 with the aim of setting an annual cap on the emissions from heavy energy-using installations (power stations and industrial plants) and is now in its third phase (2013-2020).

Under the cap, installations receive or buy allowances which they can trade with each other. Every year, they have to surrender a number of allowances (1 allowance = 1 tonne of CO_2) equal to their verified emissions of the previous year.

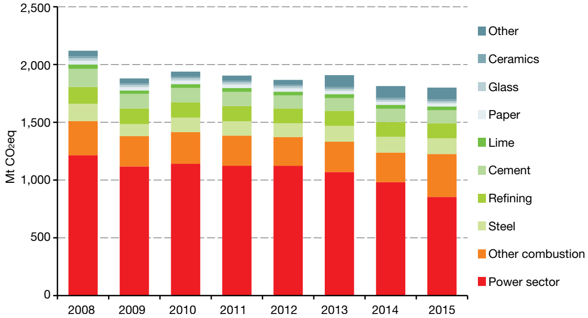
Since 2013, new sectors and new GHGs have been included in the EU ETS. It covers now 11,600 power stations and industrial plants installations in the EU and other countries of the European Economic Area (Norway, Liechtenstein and Iceland), as well as airlines operating between these countries, which represents about 45% of total GHG emissions.

EU ETS annual calendar



Source: *I4CE*

Sectoral GHG emissions in the EU ETS in phases II and III



***Source:** I4CE based on EU TL data*

ALLOCATION OF ALLOWANCES

During the first two phases of the EU ETS (2005-2007, the pilot phase, and 2008-2012, the first Kyoto commitment period), covered installations received every year the majority of their allowances for free, as set in the National Allocation Plans (NAP), established under the supervision of the European Commission.

In phase III (2013-2020), the allocation of allowances is centralised at the level of the European Commission.

EU ETS sectors (excluding aviation) have a **21% emissions reduction target by 2020 compared to 2005 levels,** which corresponds to an annual decrease of the cap by a linear reduction factor of 1.74% of the average total number of allowances issued annually in 2008-2012.

FEWER AND FEWER FREE ALLOCATIONS

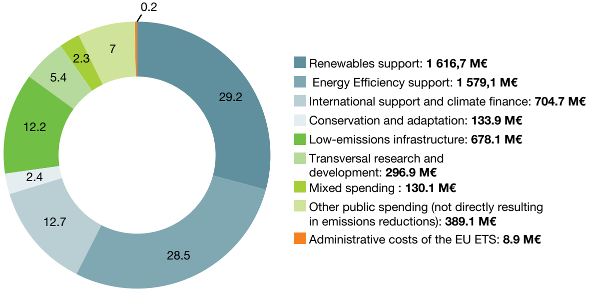
The share of allocations auctioned was 0.19% in phase 1 and 3.6% in phase 2.

Since 2013, auctioning has become the default allocation method. Have to be auctioned :

- 100 % of the allocation for power generators, with a temporary exception in eight countries in Eastern and Central Europe;
- 20 % of the allocation for manufacturing industry in 2013, a share progressively increasing to 70% in 2020.

Free allocations are set according to benchmarks of carbon intensity. Sectors and subsectors deemed to be exposed to a risk of carbon leakage (transfer of production to other countries with laxer emission constraints) receive 100% of the benchmark-based allocation until 2020.
Auctions may be pooled but the revenues are managed by Member States.

ETS revenue spending by EU Member States (2013-2015), in %



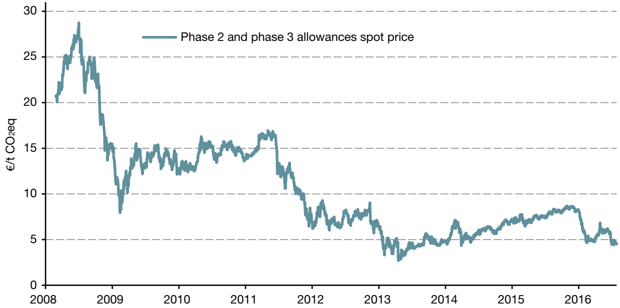
Source: *I4CE, May 2016*

TRADING CARBON ALLOWANCES

Allowances are tradable : an installation emitting more than its allocation may purchase allowances on the market, while installations which reduce their emissions can sell their unused allowances. Emissions are thus cut where it costs least to do so.

The trading of allowances is done **over-the-counter** *i.e* through bilateral contracts between industrials, or on **market platforms,** electronic portals which publicly list prices and amounts traded.

CARBON PRICE HISTORY



Source: *ICE Futures Europe*

The spot price is the price at which allowances can be sold for immmediate delivery; futures prices correspond to prices defined in contracts for a delivery at a later date specified in the contracts.

ALLOWANCES SURPLUS AND EU ETS REFORM FOR PHASE IV (2021-2030)

Low prices on the EU ETS (see previous page) are the consequence of the allowances surplus which has built up since 2009.

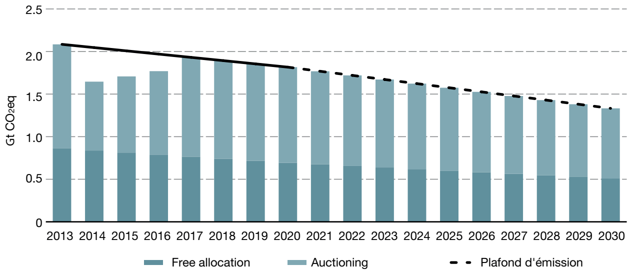
A first step of the reform was the backloading measure, which consisted in postponing the auctioning of 900 million allowances from 2014-2016 to 2019-2020.

A second step will be the implementation of the Market Stability Reserve (MSR) in 2019, whose objective is to regulate the long-term surplus by applying thresholds on the total amount of allowances circulating in the market.

The European Commission published in July 2015 a proposal for the reform of the EU ETS Directive. The trilogue negotiations between the Commission, the Parliament and the Council should start in March 2017.

The revision of the directive will notably set the linear reduction factor by which the emissions cap is reduced annually. The Commission recommended to change this linear factor from 1.74% to 2.2% after 2020.

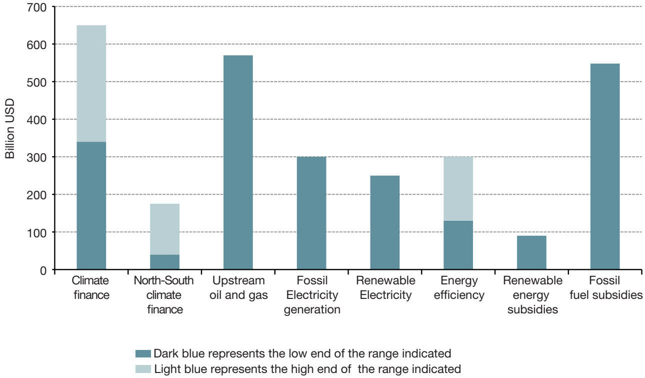
Estimation of the supply of allowances in phases III and IV (2013-2030)



Source: *I4CE based on data from the European Commission*

Climate finance

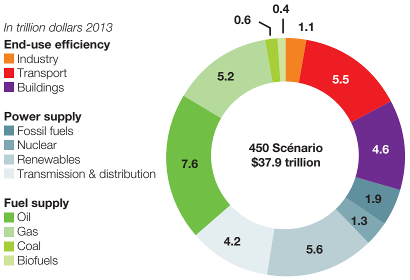
ESTIMATION OF ANNUAL GLOBAL INVESTMENTS AND SUBSIDIES (2011-2012)



Source: *Standing Committee on Finance, 2014*

Climate finance encompasses all the financial flows which enable the implementation of actions with a positive impact in terms of mitigation (GHG emissions reductions) or adaptation to climate change. Depending on the definition and the organization, distinctions can be made according to the level of impact and whether it is a shared benefit or the main purpose of the financed action.

CUMULATIVE GLOBAL ENERGY SECTOR INVESTMENTS BETWEEN 2015 AND 2030 IN THE IEA 450 SCENARIO

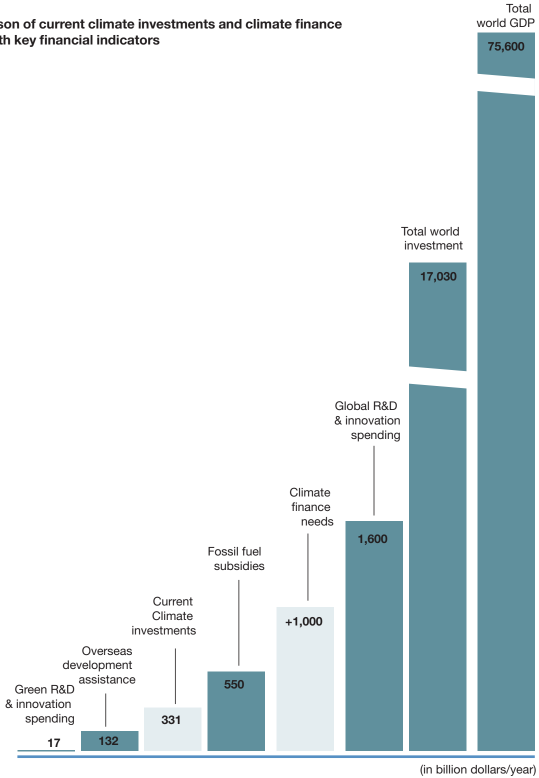


Source: *International Energy Agency, June 2015*

Achieving the 2°C target requires raising significant amounts – in the order of magnitude of one or several trillion dollars annually until 2030 – across all sectors, both for energy use and energy production. However, any scenario based on a continuation of current needs would require significant investments, regardless of the climate constraint.

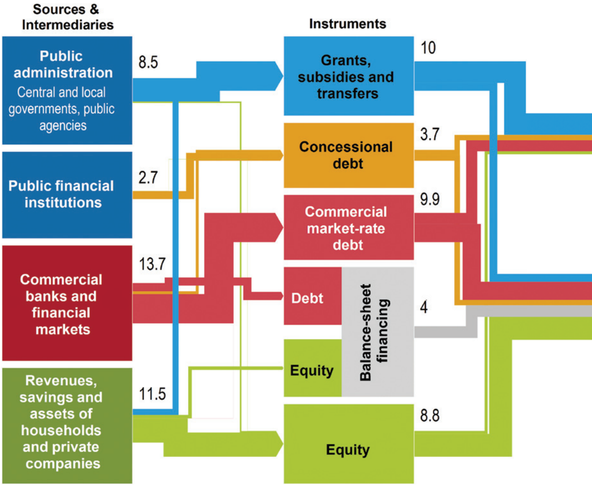
The difference between a business-as-usual scenario and a 450 ppm scenario – i.e. consistent with the goal of limiting the global increase in temperature to 2°C by limiting the concentration of GHGs in the atmosphere to around 450 ppm of CO_2 – is mainly about **the distribution of investments**. Indeed, higher investments are necessary in low carbon technologies and energy efficiency in a 450 ppm scenario, but lower investments are required in fossil fuels production for instance.

Comparison of current climate investments and climate finance needs with key financial indicators



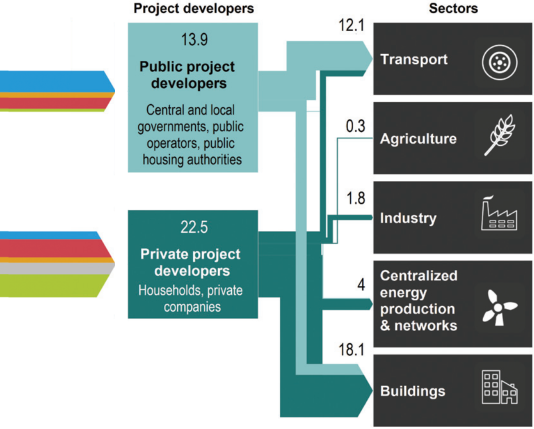
Sources: *I4CE, May 2015 from IEA, 2015, World Bank, 2013, UNFCCC, 2014, Climate Policy Initiative, 2014 and OECE, 2013*

LANDSCAPE OF CLIMATE FINANCE IN FRANCE (IN BILLION CURRENT EUROS)



Source: *I4CE, 2015*

In 2013 in France, investment contributing to GHG mitigation is estimated at up to €36.3bn across the five sectors displayed on the right side of the diagram. This investment was initiated by public and private project developers, who were most often considered to be the end-owners of the assets created. For example, households realized a majority of their investments in the residential (building) sector, whereas private companies invested primarily in transports and energy production.



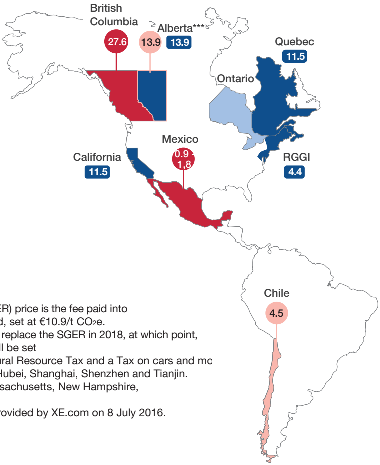
Note: This overview only represents financial flows which correspond to effective investments. Some public subsidies, such as VAT reduction for energy efficiency in buildings, or feed-in tariffs for renewable energy, are not represented in this diagram.

To finance these investments, project developers resorted to four principal types of instruments: 1) **grants, transfers and subsides**; 2) **concessional debt** at interest rates, tenure or volume preferential to typical market conditions; 3) **commercial market debt**; 4) and **equity** or own funds. **Balance-sheet financing**, which is used by private companies, is represented as a combination of commercial debt company-wide and equity.

Carbon pricing in the world

To prompt economic operators to invest more in clean energy and low carbon technologies and less in carbon-intensive technologies, some governments have decided to give an economic value to the emission of one t CO_2e. Several economic instruments exist in the policy toolkit to create a carbon price. Some of them target prices (taxes), others target the level of emissions (ETS).

Carbon pricing world map in July 2016



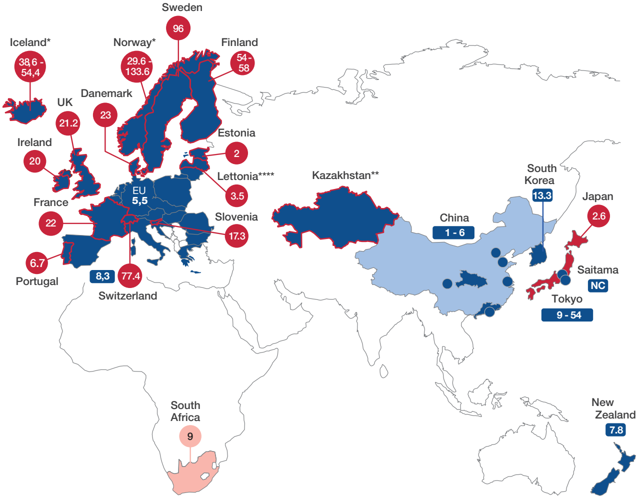
2016 prices given in €/t CO_2e

- Emissions Trading Scheme
- Scheduled Emissions Trading Scheme
- Carbon Tax
- Scheduled Carbon Tax

* Rate varies by sector/energy product
** ETS suspended until 2018
*** The 2015 Specified Gas Emitters Regulation (SGER) price is the fee paid into Climate Change and Emissions Management Fund, set at €10.9/t CO_2e.
The Carbon Competitiveness Regulation (CCR) will replace the SGER in 2018, at which point, an economy-wide carbon price of €21.8/t CO_2e will be set
**** Latvia has two taxes on carbon emissions: a Natural Resource Tax and a Tax on cars and mc
China ETS pilots: Beijing, Chongqing, Guangdong, Hubei, Shanghai, Shenzhen and Tianjin.
RGGI: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, Vermont.
Note: Prices were calculated using exchange rates provided by XE.com on 8 July 2016.

Some **40 countries** and **more than 20 cities, states and provinces** already use carbon pricing mechanisms. Amongst them are big emitters such as China, South Korea, the EU, South Africa, Japan and Mexico.

In 2016, 13% of global GHG emissions are covered by an explicit carbon pricing mechanism. These carbon pricing policies currently include 15 ETS and 16 carbon taxes.



Source: *I4CE, July 2016*

Member State Climate Policies: the case of France

By the energy transition for green growth Act published in August 2015, France has committed to reducing its greenhouse gas emissions by 40% between 1990 and 2030 and to dividing them by four between 1990 and 2050. To achieve these objectives, the law introduces new planning tools at the national level: the French national low-carbon strategy (SNBC), carbon budgets and a multi-annual energy programming.

The SNBC, published by the decree of the 19th of November 2015, includes cross-sectoral recommendations to implement the transition to a low-carbon economy and, beyond emissions reductions within the territory, calls for a reduction of the carbon footprint of France.

A carbon budget is the maximum amount of greenhouse gas emissions nationally released. It defines the trajectory of emission reductions for successive periods of 4 and 5 years.

Annual Average emissions (in Mt CO_2eq)	2013	1st carbon budget (2015-2018)	2nd carbon budget (2019-2023)	3rd carbon budget (2024-2028)
Sectors covered by the EU ETS (excluding international aviation)	119	110	n.d.	n.d.
Other sectors	373	332	n.d.	n.d.
All sectors	492	442	399	358

Source: *Decree No. 2015-1491 of 19 November 2015 concerning national carbon budgets and the national low-carbon strategy*

The multiannual energy programming, of which a draft has been put in consultation on the 1st of July 2016, sets out the objectives and priorities of public authorities in their management of various forms of energy, in line with the SNBC and the carbon budgets.

Examples of emission factors

Transport

1,000 km (approximately one Paris-Amsterdam return trip) =
> **0.21 t CO_2 by car (French average), or 213 g CO_2 / km**. Increasing the number of passengers proportionately reduces these emissions;
> **0.31 t CO_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 t CO_2e by train**. Emissions vary depending on energy source. In France they are low (9 g CO_2 / km), as electricity is mainly generated from nuclear power.

Electricity generation and consumption

A typical power station with a capacity of 250 MW operating off-peak (8,000 h / yr) emits:
> **1.7 Mt CO_2 / yr** for a **coal-fired power station** (0.87 t CO_2 / MWh, with a 40% thermal efficiency rate);
> **0.72 Mt CO_2 / yr** for a **gas-fired power station** (0.36 t CO_2 / MWh, with a 55% thermal efficiency rate);
> **1.5 t CO_2 / yr** are emitted per European household 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 Mt CO_2 / yr** for a **traditional steelworks** (1.8 t CO_2 per tonne of steel);
> **0.5 Mt CO_2 / yr** for an **electric steelworks** (scrap melting) (0.5 t CO_2 per tonne of steel corresponding to indirect emissions from electricity);

Other CO_2 emitting industries:
> **0.35 Mt CO_2 / yr** for a **typical cement works** producing 500,000 t / yr (0.7 t CO_2 per tonne of cement);
> **0.09 Mt CO_2 / yr** for a **typical glassworks producing** 150,000 t / yr (0.6 t CO_2 per tonne of glass);

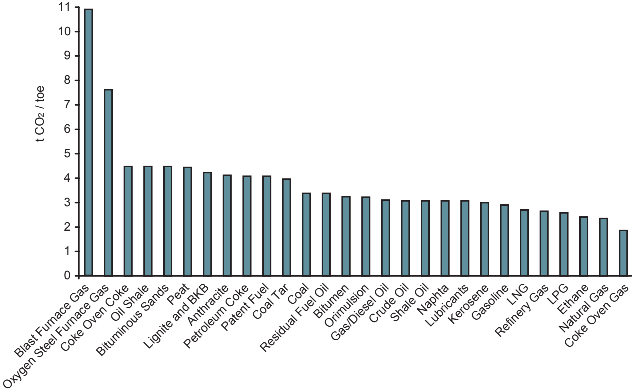
Forestry and agriculture

> **580 t CO_2e** were emitted **per hectare of deforested tropical forest** (combustion and decomposition).

Agriculture in France emits on average:
> **3 t CO_2e / yr** from enteric fermentation and 2.2 t CO_2e/yr from manure produced **per dairy cow**;
> **0.5 t CO_2e / yr per pig** from manure produced.

Source: *ADEME, AEE, Cement sustainability initiative, CITEPA, Commission européenne, Fédération des chambres syndicales de l'industrie du verre, GIEC*

CO_2 EMISSION FACTORS



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).

Glossary

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. With some minor differences, they are the countries from Annex B of the Kyoto Protocol, which aims to establish binding quantified commitments.

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

CO_2 equivalence (CO_2e) : Method of measuring greenhouse gases based on the warming effect of each gas relative to that of CO_2.

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

ETS : Emissions Trading System.

Fossil fuel reserves : Quantities of gas, oil and coal recoverable from known reservoirs with the existing technologies and economic conditions.

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.

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

GWP : Global warming potential. It allows a comparison to be made of the contributions of different greenhouse gases to global warming for a given period. The period chosen is usually 100 years but is sometimes taken at 20 years to better estimate the short-term effect of some gases.

iNDC : intended Nationally Determined Contributions. iNDCs describe national policies planned against climate change. It can include adaptation or attenuation objectives.

International bunkers: Emissions from international aviation and maritime transport.

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

LULUCF: Land Use, Land Use Change and Forestry.

Scenario Baseline 2007 : This scenario prepared by the Technical University of Athens proposes projections of the EU energy system until 2030. It takes into account policies implemented by members States until the end of 2006.

Solid fuels : Coal and its derivatives. Emissions from the transformation of solid fuels are mainly made of emissions from coke production

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

UNFCCC: United Nations Framework Convention on Climate Change.

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 ....*ttp://unfccc.int*

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

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

CITEPA - Interprofessional Technical Centre for Studies on Air Pollution ....*ww.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*

MEEM - French Ministry of Environment, Energy and the Sea...
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*

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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 measures that have been implemented to limit it, on an international, European and French scales. In particular, it gives detailed statistics on greenhouse gas emissions in the world, in Europe and in France.

Key figures on climate
France and Worldwide

commissariat général au développement durable

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Ministère de l'Environnement, de l'Énergie et de la Mer