

# 2012 CO<sub>2</sub> EMISSIONS OVERVIEW



# RECENT TRENDS IN CO<sub>2</sub> EMISSIONS FROM FUEL COMBUSTION

## The growing importance of energy-related emissions

Climate scientists have observed that carbon dioxide (CO<sub>2</sub>) concentrations in the atmosphere have been increasing significantly over the past century, compared to the rather steady level of the pre-industrial era (about 280 parts per million in volume, or ppmv). The 2013 concentration of CO<sub>2</sub> (396 ppmv) was about 40% higher than in the mid-1800s, with an average growth of 2 ppmv/year in the last ten years. Significant increases have also occurred in levels of methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O).

The *Fifth Assessment Report* from the Intergovernmental Panel on Climate Change (Working Group I) states that human influence on the climate system is clear (IPCC, 2013). Some impacts of the increased GHG concentrations may be slow to become apparent since stability is an inherent characteristic of the interacting climate, ecological and socio-economic systems. Even after stabilisation of the atmospheric concentration of CO<sub>2</sub>, anthropogenic warming and sea level rise would continue for centuries due to the time scales associated with climate processes and feedbacks. Some changes in the climate system would be irreversible in the course of a human lifespan.

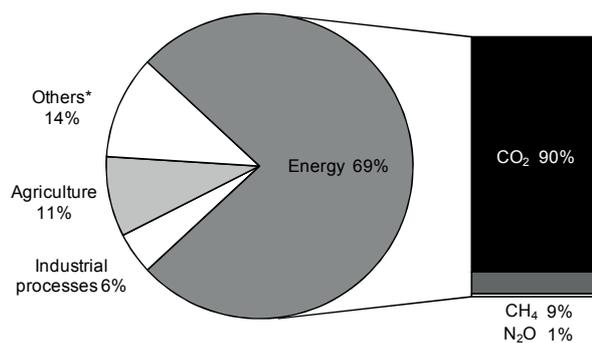
Given the long lifetime of CO<sub>2</sub> in the atmosphere, stabilising concentrations of greenhouse gases at any level would require large reductions of global CO<sub>2</sub> emissions from current levels. The lower the chosen level for stabilisation, the sooner the decline in global CO<sub>2</sub> emissions would need to begin, or the deeper the emission reduction would need to be over time. The United Nations Framework Convention on Climate Change (UNFCCC) provides a structure for inter-governmental efforts to tackle the challenge posed by

climate change. The Convention's ultimate objective is to stabilise GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The Conference of Parties (COP) further recognised that deep cuts in global GHG emissions are required, with a view to hold the increase in global average temperature below 2°C above preindustrial levels, and that Parties should take urgent action to meet this long-term goal, consistent with science and on the basis of equity.

## Energy use and greenhouse gases

Among the many human activities that produce greenhouse gases, the use of energy represents by far the largest source of emissions. Smaller shares correspond to agriculture, producing mainly CH<sub>4</sub> and N<sub>2</sub>O from domestic livestock and rice cultivation, and to industrial processes not related to energy, producing mainly fluorinated gases and N<sub>2</sub>O (Figure 1).

Figure 1. Shares of global anthropogenic GHG, 2010\*



\* Others include large-scale biomass burning, post-burn decay, peat decay, indirect N<sub>2</sub>O emissions from non-agricultural emissions of NO<sub>x</sub> and NH<sub>3</sub>, Waste, and Solvent Use.

Source: IEA estimates for CO<sub>2</sub> from fuel combustion and EDGAR 4.2 FT2010 estimates for all other sources.

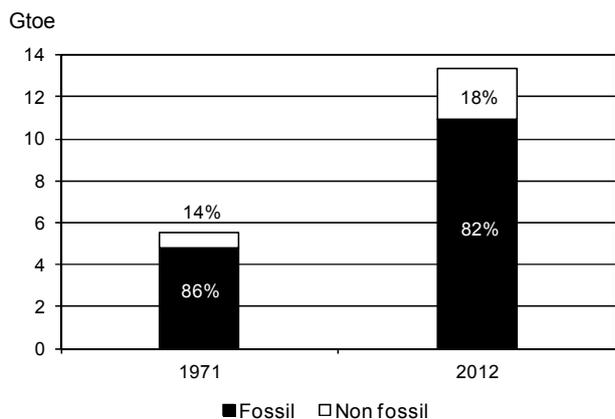
*Key point: Energy emissions, mostly CO<sub>2</sub>, account for the largest share of global GHG emissions.*

Within the energy sector<sup>1</sup>, CO<sub>2</sub> resulting from the oxidation of carbon in fuels during combustion dominates the total GHG emissions.

CO<sub>2</sub> from energy represents about three quarters of the anthropogenic GHG emissions for Annex I<sup>2</sup> countries, and almost 70% of global emissions. This percentage varies greatly by country, due to diverse national structures.

Increasing demand for energy comes from worldwide economic growth and development. Global total primary energy supply (TPES) more than doubled between 1971 and 2012, mainly relying on fossil fuels (Figure 2).

**Figure 2. World primary energy supply\***



\* World primary energy supply includes international bunkers.

*Key point: Fossil fuels still account for most – over 80% – of the world energy supply.*

Despite the growth of non-fossil energy (such as nuclear and hydropower), considered as non-emitting,<sup>3</sup>

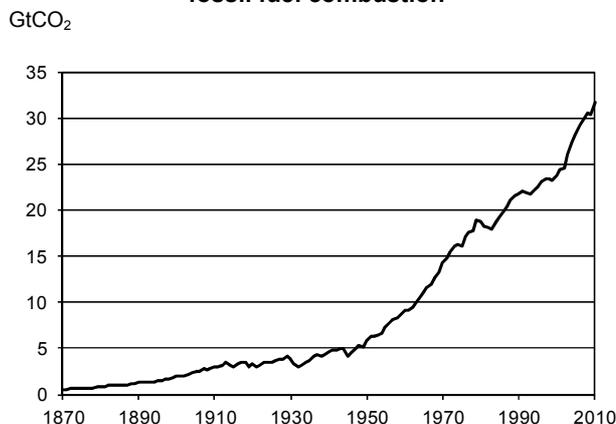
1. The energy sector includes emissions from “fuel combustion” (the large majority) and “fugitive emissions”, which are intentional or unintentional releases of gases resulting from production, processes, transmission, storage and use of fuels (e.g. CH<sub>4</sub> emissions from coal mining).

2. The Annex I Parties to the 1992 UN Framework Convention on Climate Change (UNFCCC) are: Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, the Czech Republic, Denmark, Estonia, European Economic Community, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom and United States. See [www.unfccc.int](http://www.unfccc.int). For country coverage of Annex I Economies in Transition (EIT) and Annex II, see [http://wds.iea.org/wds/pdf/CO2\\_Documentation.pdf](http://wds.iea.org/wds/pdf/CO2_Documentation.pdf).

3. Excluding the life cycle of all non-emitting sources and excluding combustion of biofuels (considered as non-emitting CO<sub>2</sub>, based on the assumption that the released carbon will be reabsorbed by biomass re-growth, under balanced conditions).

the share of fossil fuels within the world energy supply is relatively unchanged over the past 41 years. In 2012, fossil sources accounted for 82% of the global TPES.

**Figure 3. Trend in CO<sub>2</sub> emissions from fossil fuel combustion**



Source: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, US Department of Energy, Oak Ridge, Tenn., United States.

*Key point: Since 1870, CO<sub>2</sub> emissions from fuel combustion have risen exponentially.*

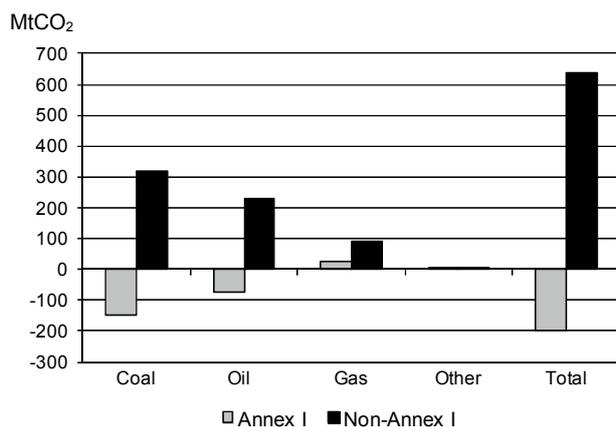
Growing world energy demand from fossil fuels plays a key role in the upward trend in CO<sub>2</sub> emissions (Figure 3). Since the Industrial Revolution, annual CO<sub>2</sub> emissions from fuel combustion dramatically increased from near zero to almost 32 GtCO<sub>2</sub> in 2012.

The next section provides a brief overview of recent trends in energy-related CO<sub>2</sub> emissions, as well as in some of the socio-economic drivers of emissions.

## Recent emissions trends

In 2012, global CO<sub>2</sub> emissions were 31.7 GtCO<sub>2</sub>. This represents a 1.2% year-on-year increase in emissions, about half the average annual growth rate since 2000, and four percentage points less than in 2010, year of initial recovery after the financial crisis.

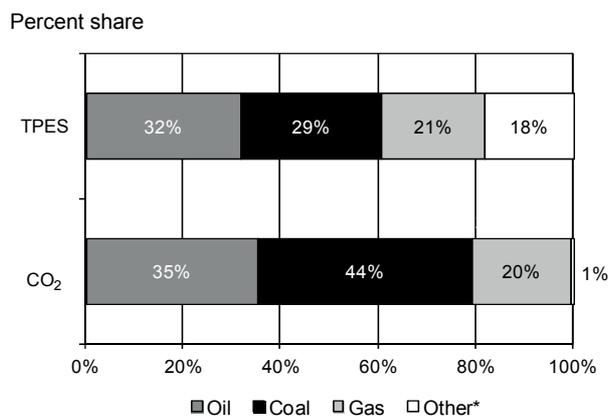
Emissions in non-Annex I countries continued to increase (3.8%), albeit at a lower rate than in 2011, while emissions in Annex I countries decreased by 1.5%. In absolute terms, global CO<sub>2</sub> emissions increased by 0.4 GtCO<sub>2</sub> in 2012, driven primarily by increased emissions from coal and oil in non-Annex I countries (Figure 4).

**Figure 4. Change in CO<sub>2</sub> emissions (2011-12)**

*Key point: In 2012, emissions from coal and oil increased in non-Annex I countries and decreased in Annex I countries.*

### Emissions by fuel

Although coal represented 29% of the world TPES in 2012, it accounted for 44% of the global CO<sub>2</sub> emissions due to its heavy carbon content per unit of energy released, and to the fact that 18% of the TPES derives from carbon-neutral fuels (Figure 5). As compared to gas, coal is nearly twice as emission intensive on average.<sup>4</sup>

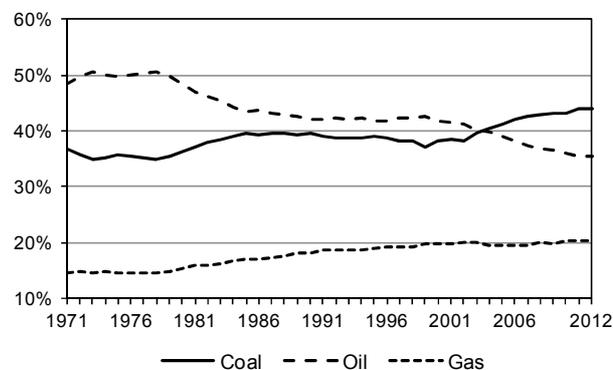
**Figure 5. World primary energy supply and CO<sub>2</sub> emissions: shares by fuel in 2012**

\* Other includes nuclear, hydro, geothermal, solar, tide, wind, biofuels and waste.

*Key point: Globally, coal combustion generates the largest share of CO<sub>2</sub> emissions, although oil still is the largest energy source.*

4. Default carbon emission factors from the *Revised 1996 IPCC Guidelines*: 15.3 tC/TJ for gas, 16.8 to 27.5 tC/TJ for oil products, 25.8 to 29.1 tC/TJ for primary coal products.

Those shares evolved significantly during the last decade, following ten years of rather stable relative contributions among fuels. In 2002 in fact, oil still held the largest share of emissions (41%), three percentage points ahead of coal (Figure 6).

**Figure 6. Fuel shares in global CO<sub>2</sub> emissions**

*Key point: The fossil fuel mix changed significantly in the last 10 years, with coal replacing oil as the largest source of CO<sub>2</sub> emissions.*

In 2012, CO<sub>2</sub> emissions from the combustion of coal increased by 1.3% to 13.9 GtCO<sub>2</sub>. Currently, coal fills much of the growing energy demand of those developing countries (such as China and India) where energy-intensive industrial production is growing rapidly and large coal reserves exist with limited reserves of other energy sources.

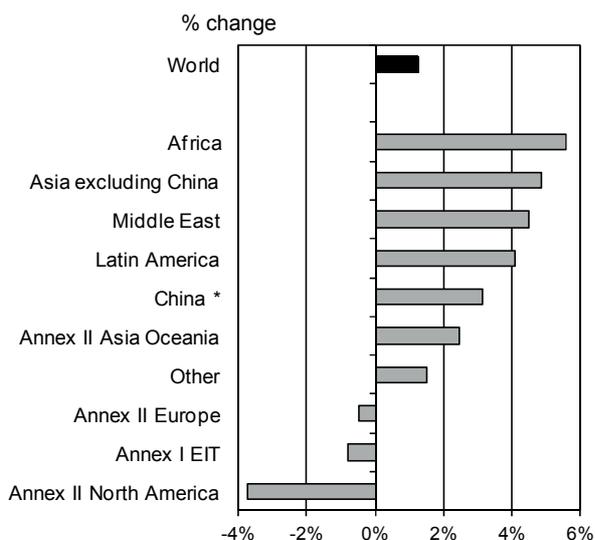
### Emissions by region

Non-Annex I countries, collectively, represented 55% of global CO<sub>2</sub> emissions in 2012. At the regional level, annual growth rates varied greatly: emissions growth in China (3.1%) was lower than in previous years, however, emissions grew strongly in Africa (5.6%), Asia excluding China (4.9%) and the Middle East (4.5%). Emissions in Latin America<sup>5</sup> (4.1%) and Annex II Asia Oceania (2.5%) grew at a more moderate rate, while emissions decreased in Annex II North America (-3.7%), Annex II Europe (-0.5%) and Annex I EIT (-0.8%) (Figure 7).

Regional differences in contributions to global emissions conceal even larger differences among individual countries. Nearly two-thirds of global emissions for 2012 originated from just ten countries, with the shares of China (26%) and the United States (16%) far surpassing those of all others. Combined, these two countries alone produced 13.3 GtCO<sub>2</sub>. The top-10 emitting countries include five Annex I countries and five non-Annex I countries (Figure 8).

5. For the purposes of this discussion, Latin America includes non-OECD Americas and Chile.

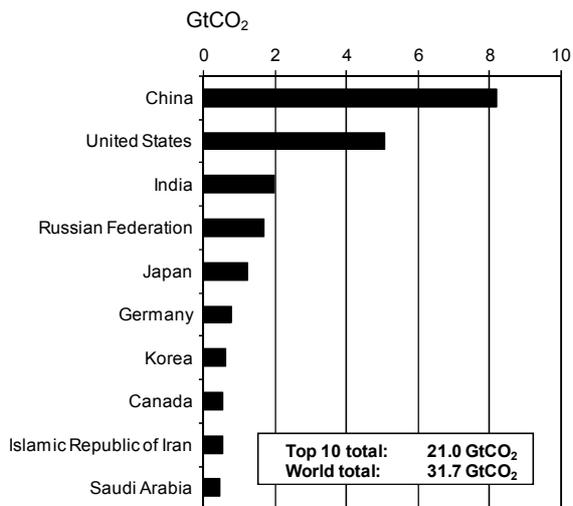
**Figure 7. Change in CO<sub>2</sub> emissions by region (2011-12)**



\* China includes Hong Kong, China.

*Key point: Emissions in Annex II North America fell in 2012; emissions in all non-Annex I regions grew, with Africa showing the largest relative increase.*

**Figure 8. Top 10 emitting countries in 2012**



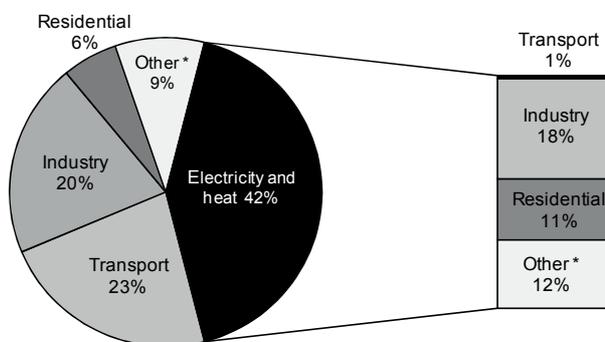
*Key point: The top 10 emitting countries account for two-thirds of global CO<sub>2</sub> emissions.*

As different regions and countries have contrasting economic and social structures, the picture would change significantly when moving from absolute emissions to indicators such as emissions per capita or per GDP. A more comprehensive analysis is given in the section *Coupling emissions with socio-economic indicators* later in this chapter.

### Emissions by sector

Two sectors produced nearly two-thirds of global CO<sub>2</sub> emissions in 2012: electricity and heat generation, by far the largest, accounted for 42%, while transport accounted for 23% (Figure 9).

**Figure 9. World CO<sub>2</sub> emissions by sector in 2012**



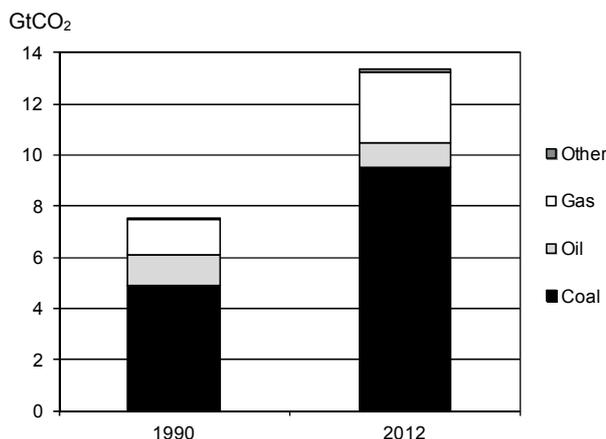
Note: Also shows allocation of electricity and heat to end-use sectors.

\* Other includes commercial/public services, agriculture/forestry, fishing, energy industries other than electricity and heat generation, and other emissions not specified elsewhere.

*Key point: Two sectors combined, generation of electricity and heat and transport, represented nearly two-thirds of global emissions in 2012.*

Generation of electricity and heat worldwide relies heavily on coal, the most carbon-intensive fossil fuel. Countries such as Australia, China, India, Poland and South Africa produce over two-thirds of their electricity and heat through the combustion of coal.

**Figure 10. CO<sub>2</sub> emissions from electricity and heat generation\***



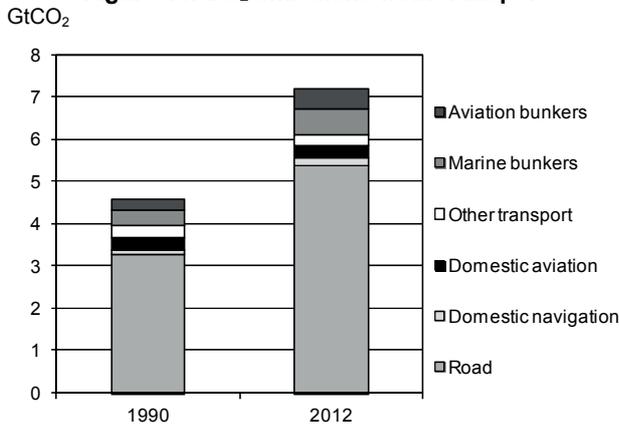
\* Refers to main activity producers and autoproducers of electricity and heat.

*Key point: CO<sub>2</sub> emissions from electricity and heat almost doubled between 1990 and 2012, driven by the large increase of generation from coal.*

Between 2011 and 2012, CO<sub>2</sub> emissions from electricity and heat increased by 1.8%, faster than total emissions. While the share of oil in electricity and heat emissions has declined steadily since 1990, the share of gas increased slightly, and the share of coal increased significantly, from 65% in 1990 to 72% in 2012 (Figure 10). Carbon intensity developments for this sector will strongly depend on the fuel mix used to generate electricity, including the share of non-emitting sources, such as renewables and nuclear, as well as on the potential penetration of CCS technologies.

As for transport, the fast emissions growth was driven by emissions from the road sector, which increased by 64% since 1990 and accounted for about three quarters of transport emissions in 2012 (Figure 11). It is interesting to note that despite efforts to limit emissions from international transport, emissions from marine and aviation bunkers, 66% and 80% higher in 2012 than in 1990 respectively, grew even faster than those from road.

**Figure 11. CO<sub>2</sub> emissions from transport**



*Key point: CO<sub>2</sub> emissions from road are driving the growth of transport emissions.*

### Coupling emissions with socio-economic indicators<sup>6</sup>

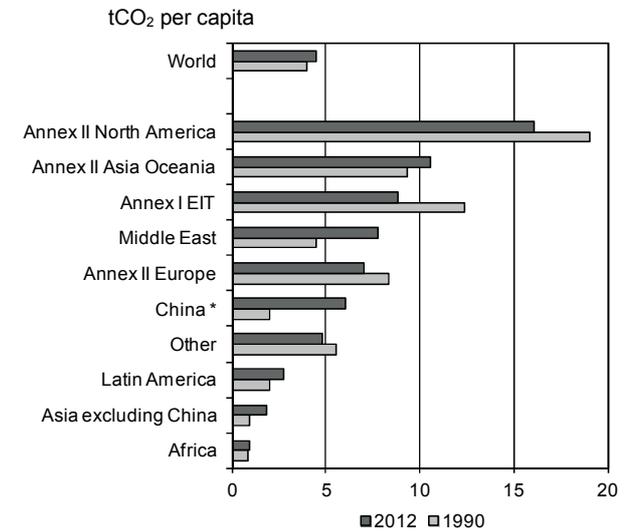
Indicators such as those briefly discussed in this section strongly reflect energy constraints and choices made to support the economic activities of each country. They also reflect sectors that predominate in different countries' economies.

The range of per-capita emission levels across the world is very large, highlighting wide divergences in the way different countries and regions use energy

6. No single indicator can provide a complete picture of a country's CO<sub>2</sub> emissions performance or its relative capacity to reduce emissions. The indicators discussed here are certainly incomplete and should only be used to provide a rough description of the situation in a country.

(Figure 12). For example, among the five largest emitters, the levels of per-capita emissions were very diverse, ranging from 1.6 tCO<sub>2</sub> for India and 6.1 tCO<sub>2</sub> for China to 16.1 tCO<sub>2</sub> for the United States. On average, industrialised countries emit far larger amounts of CO<sub>2</sub> per capita than developing countries. The lowest levels worldwide are in Asia excluding China and in Africa.

**Figure 12. CO<sub>2</sub> emissions per capita by major world regions**



\* China includes Hong Kong, China.

*Key point: Emissions per capita generally decreased in time across regions.*

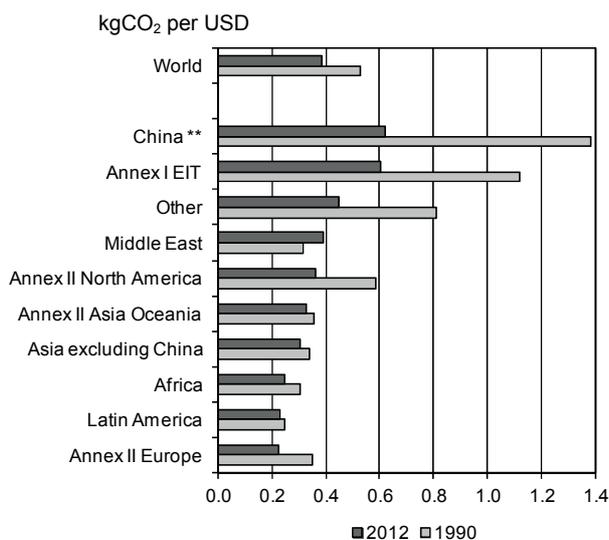
Emissions per unit of GDP<sup>7</sup> are also very variable across regions (Figure 13). Although climate, economic structure and other variables can affect energy use, relatively high values of emissions per GDP indicate a potential for decoupling CO<sub>2</sub> emissions from economic growth. Possible improvements can derive from fuel switching away from carbon-intensive sources or from energy efficiency at all stages of the energy value chain (from raw material extraction to energy end-use).<sup>8</sup>

All the five largest emitters have shown reductions of emissions per unit of GDP between 1990 and 2012, in line with the average reduction observed globally (28%). This decreasing trend was most pronounced

7. Throughout this analysis, GDP refers to GDP in 2005 USD, using purchasing power parities. A note of caution is necessary concerning the indicator of CO<sub>2</sub> emissions per GDP. It can be very useful to measure efforts over time for one country, but has limitations when comparing countries, as it is very sensitive to the base year used for the GDP purchasing power parity (PPP).

8. The IEA's Policies and Measures Databases offer access to information on energy-related policies and measures taken or planned to reduce GHG emissions, improve energy efficiency and support renewable energy development and deployment. The online databases can be consulted at: [www.iea.org/policiesandmeasures/](http://www.iea.org/policiesandmeasures/).

**Figure 13. CO<sub>2</sub> emissions per GDP\* by major world regions**



\* GDP in 2005 USD, using purchasing power parities.

\*\* China includes Hong Kong, China.

*Key point: Emission intensities in economic terms vary greatly around the world.*

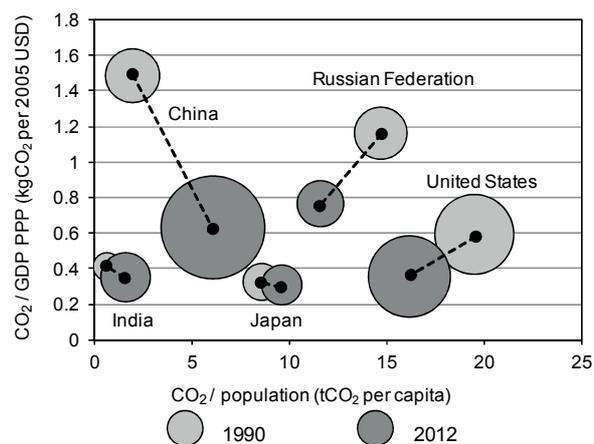
for China and the Russian Federation, whose 1990 levels were significantly higher than those of other countries (Figure 14), and for the United States.

Per-capita emissions, which increased by 13% globally between 1990 and 2012, showed instead contrasting trends among the top five emitting countries. For example, China tripled its per-capita emissions, while India more than doubled theirs, as did some other rapidly expanding economies. Conversely, per-capita emissions decreased significantly in both the Russian Federation (21%) and the United States (17%), although following very different patterns. Values for Russia dramatically dropped in the early nineties, and have progressively increased in recent years, while values for the United States started to decrease from 2008 onwards, having remained stable for many years.

On a global level, CO<sub>2</sub> emissions grew by 51% between 1990 and 2012. A simple decomposition<sup>9</sup> shows the main driving factors of the world CO<sub>2</sub> emissions trend. Globally, the economic growth partially decoupled from energy use, as energy intensity decreased by 27% over the period. However, with a practically unchanged carbon intensity of the energy

9. CO<sub>2</sub> emissions can be decomposed into the product of four factors: population, per capita GDP, TPES/GDP, CO<sub>2</sub>/TPES. For a more detailed description of the Kaya decomposition, see [http://wds.iaea.org/wds/pdf/CO2\\_Documentation.pdf](http://wds.iaea.org/wds/pdf/CO2_Documentation.pdf).

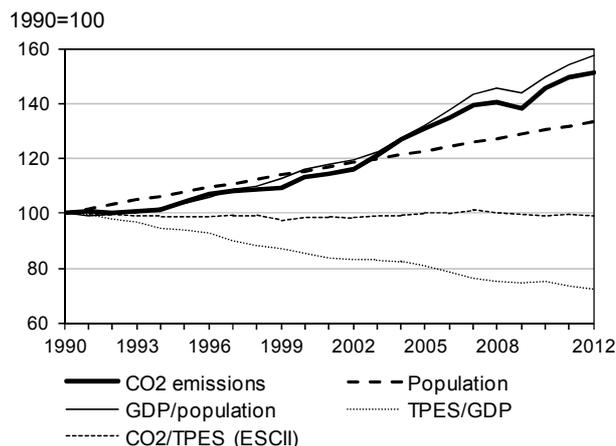
**Figure 14. Trends in CO<sub>2</sub> emission intensities for the top five emitting countries\***



\* The size of the circle represents the total CO<sub>2</sub> emissions from the country in that year.

*Key point: All top five emitters reduced their emissions per unit of GDP between 1990 and 2012, while emissions per capita showed contrasting trends.*

**Figure 15. Global CO<sub>2</sub> emissions and drivers (Kaya decomposition)**



*Key point: Despite some decoupling between economic growth and energy use, increasing wealth and population, with an unchanged carbon intensity of the mix, drove dramatic CO<sub>2</sub> emissions increases*

mix<sup>10</sup>, the combined growth in population (33%) and in per capita GDP (57%) led to a dramatic increase in global CO<sub>2</sub> emissions between 1990 and 2012.

Such behaviour varies greatly among countries and regions. Understanding the factors driving CO<sub>2</sub> emissions trends will be essential to designing sound and effective policies aiming at emissions reductions.

10. Also known, in its index form, as Energy Sector Carbon Intensity Index (ESCII), as in the IEA publication *Tracking Clean Energy Progress 2014*.

## Developing a low-carbon world

Traditionally, industrialised countries have emitted the large majority of anthropogenic greenhouse gases (GHGs). More recently, shares of developing country emissions surpassed those of industrialised countries, and have kept rising very rapidly. To shift towards a low-carbon world, mitigation efforts must occur across all countries: decarbonising the energy supplies of industrialised countries, and shifting developing countries onto a low-carbon development path.

The first binding commitments to reduce greenhouse gas emissions were set under the Kyoto Protocol's first commitment period (2008-12). Participating industrialised countries were required (as a group) to curb domestic emissions by about 5% relative to 1990 over this period. Thirty-eight countries have also agreed to take commitments under a second commitment period which will run from 2013 to 2020. The amendments to the Kyoto Protocol bringing the second commitment period into force require ratification by 144 countries (two-thirds of those participating); as of September 2014 only 18 have ratified.

Countries comply with their Kyoto Protocol targets by reducing emissions from fossil fuel combustion, reducing emission in other sectors (*i.e.* land-use or direct industrial emissions), or through use of the Kyoto Protocol's "flexible mechanisms" by which industrialised countries can earn emission credits from emissions reduction projects in participating developing countries and economies in transition (EITs).

Data on CO<sub>2</sub> emissions from fuel combustion are now available for the Kyoto Protocol's first commitment period (Table 1). According to IEA estimates, in 2012, CO<sub>2</sub> emissions from fuel combustion across all Parties with Kyoto Protocol targets were 14% below 1990 levels. Emissions in the EU-15 were 8% below 1990 levels, in line with their economy-wide goal of an 8% reduction. Some industrialised countries have seen significant increases, led by Australia (+48%), New Zealand (+44%)<sup>11</sup> and Spain (30%). To comply

with their Kyoto Protocol obligations, these countries will need to offset these increases by reductions in other sectors, or use the Kyoto Protocol's flexibility mechanisms<sup>12</sup>.

Despite its extensive participation (192 countries), the Kyoto Protocol is limited in its potential to address global emissions. The United States remains outside of the Protocol's jurisdiction, and developing countries do not face emissions targets. The Kyoto Protocol implies action on less than one-quarter of global CO<sub>2</sub> emissions, as measured in 2012.

Through its flexibility mechanisms and provisions for international trading, the Kyoto Protocol has made CO<sub>2</sub> a tradable commodity, and has been a key driver for the development of national emissions trading schemes.

### Building future international action

Recognising that the Kyoto Protocol framework is inadequate to deliver the global goal of limiting global temperature increase to less than 2°C above pre-industrial levels, countries are now negotiating a new climate agreement, to be finalised at COP21 in Paris in December 2015, and to apply from 2020. If agreement can be reached, this will be the first international climate agreement to extend mitigation obligations to all countries, both developed and developing.

This will build on the voluntary emissions reduction pledges for 2020 that were made at COP15 in Copenhagen. Developed and developing countries that submitted pledges under the Copenhagen Accord collectively account for over 80% of global emissions. Although the ambition of these pledges is currently insufficient to limit temperature rise to 2°C above pre-industrial levels, the breadth of participation in mitigation commitments marks a significant improvement on the coverage of the Kyoto Protocol.

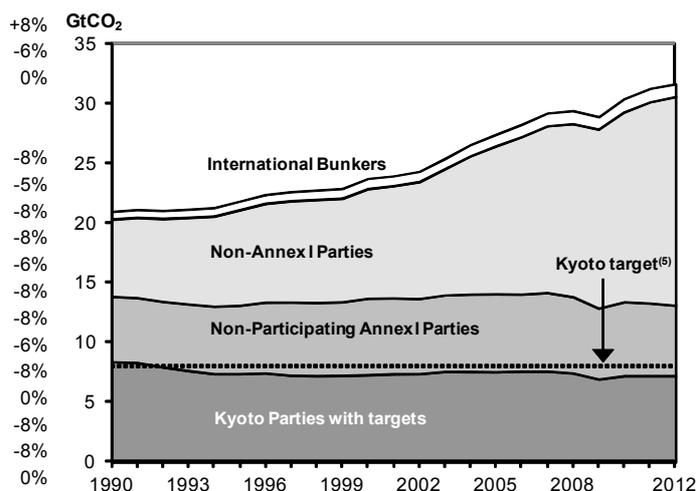
In order to respect countries' different responsibilities and capabilities, mitigation contributions in the 2015 climate agreement will be nationally determined. A key challenge in designing the new agreement will be how to, over time, bring these nationally-determined targets to levels consistent with the collective global goal of keeping temperature rise below 2°C.

11. Note that for some countries (e.g. Australia and New Zealand), the share of non-CO<sub>2</sub> emissions may be very significant. Therefore, the trend in CO<sub>2</sub> emissions from fuel combustion may differ substantially from the trend in total greenhouse gas emissions.

12. For Spain, a 15% increase is allowed under the EU effort-sharing arrangements.

**Table 1. World CO<sub>2</sub> emissions from fuel combustion and Kyoto Protocol targets<sup>(1)</sup>**

	1990 MtCO <sub>2</sub>	2012 MtCO <sub>2</sub>	% change 90-12	Kyoto Target		1990 MtCO <sub>2</sub>	2012 MtCO <sub>2</sub>	% change 90-12	Kyoto Target
<b>KYOTO PARTIES WITH TARGETS<sup>(1)</sup></b>	<b>8,339.6</b>	<b>7,157.0</b>	<b>-14.2%</b>	<b>-4.6%<sup>(2)</sup></b>	<b>OTHER COUNTRIES</b>	<b>12,014.7</b>	<b>23,497.4</b>	<b>95.6%</b>	
<i>Europe</i>	3,154.5	2,906.4	-7.9%		<i>Non-participating</i>				
Austria	56.4	64.7	14.8%	-13%	<i>Annex I Parties</i>	5,550.9	5,983.9	7.8%	
Belgium	107.9	104.6	-3.1%	-7.5%	Belarus	124.8	71.1	-43.0%	-8%
Denmark	50.6	37.1	-26.7%	-21%	Canada <sup>(1)</sup>	428.2	533.7	24.6%	-6%
Finland	54.4	49.4	-9.1%	0%	Malta	2.3	2.5	10.4%	none
France <sup>(3)</sup>	352.8	333.9	-5.4%	0%	Turkey	126.9	302.4	138.3%	none
Germany	949.7	755.3	-20.5%	-21%	United States	4,868.7	5,074.1	4.2%	-7%
Greece	70.1	77.5	10.5%	+25%	<i>Other Regions</i>	6,352.7	17,334.0	172.9%	none
Iceland	1.9	1.8	-2.5%	+10%	Africa	545.0	1,032.4	89.4%	none
Ireland	30.6	35.5	16.3%	+13%	Middle East	549.9	1,647.1	199.5%	none
Italy	397.4	374.8	-5.7%	-6.5%	N-OECD Eur. & Eurasia <sup>(4)</sup>	630.0	528.8	-16.1%	none
Luxembourg	10.4	10.2	-1.3%	-28%	Latin America <sup>(4)</sup>	842.5	1,583.3	87.9%	none
Netherlands	155.8	173.8	11.5%	-6%	Asia (excl. China) <sup>(4)</sup>	1,507.5	4,291.4	184.7%	none
Norway	28.3	36.2	27.9%	+1%	China	2,277.7	8,250.8	262.2%	none
Portugal	39.4	45.9	16.4%	+27%					
Spain	205.2	266.6	29.9%	+15%	<b>INTL. MARINE BUNKERS</b>	<b>363.2</b>	<b>602.2</b>	<b>65.8%</b>	
Sweden	52.8	40.4	-23.4%	+4%	<b>INTL. AVIATION BUNKERS</b>	<b>256.3</b>	<b>477.8</b>	<b>86.4%</b>	
Switzerland	41.6	41.3	-0.8%	-8%					
United Kingdom	549.3	457.5	-16.7%	-12.5%	<b>WORLD</b>	<b>20,973.9</b>	<b>31,734.3</b>	<b>51.3%</b>	
European Union - 15	3,082.7	2,827.1	-8.3%	-8%					
<i>Asia Oceania</i>	1,339.5	1,641.7	22.6%						
Australia	260.5	386.3	48.3%	+8%					
Japan	1,056.7	1,223.3	15.8%	-6%					
New Zealand	22.3	32.1	44.0%	0%					
<i>Economies in Transition</i>	3,845.6	2,608.8	-32.2%						
Bulgaria	74.9	44.3	-40.9%	-8%					
Croatia	21.5	17.2	-20.1%	-5%					
Czech Republic	148.8	107.8	-27.6%	-8%					
Estonia	35.8	16.3	-54.3%	-8%					
Hungary	66.4	43.6	-34.4%	-6%					
Latvia	18.6	7.0	-62.4%	-8%					
Lithuania	33.1	13.3	-59.8%	-8%					
Poland	342.1	293.8	-14.1%	-6%					
Romania	167.5	79.0	-52.9%	-8%					
Russian Federation	2,178.8	1,659.0	-23.9%	0%					
Slovak Republic	56.7	31.9	-43.8%	-8%					
Slovenia	13.3	14.6	9.6%	-8%					
Ukraine	687.9	281.1	-59.1%	0%					



(1) On 15 December 2011, Canada withdrew from the Kyoto Protocol. This action became effective for Canada on 15 December 2012.  
 (2) The actual country targets apply to a basket of six greenhouse gases and allow sinks and international credits to be used for compliance. The overall "Kyoto target" is estimated for this publication by applying the country targets to IEA data for CO<sub>2</sub> emissions from fuel combustion, and is only shown as an indication. The overall target for the combined EU-15 under the Protocol is -8%, but the member countries have agreed on a burden-sharing arrangement as listed.  
 (3) Emissions from Monaco are included with France.  
 (4) Composition of regions differs from elsewhere in this publication to take into account countries that are not Kyoto Parties.  
 (5) The Kyoto target is calculated as percentage of the 1990 CO<sub>2</sub> emissions from fuel combustion only, therefore it does not represent the total target for the six-gas basket. This assumes that the reduction targets are spread equally across all gases.

*Key point: The existing targets under the Kyoto Protocol are not sufficiently comprehensive to lead to reductions in global CO<sub>2</sub> emissions from fuel combustion.*

The nationally-determined targets will be complemented by an agreed framework for measuring, reporting and verifying emissions, and accounting for achievement of targets, and by enhanced actions on adaptation, technology development and on the provision of financial resources. While obligations are to start from 2020, emissions from the energy sector need to peak by 2020 if there is to be a reasonable chance of limiting temperature rise to below 2°C (IEA, 2012). This highlights the need for an ambitious start point in 2020, but also the importance of complementary initiatives outside the UNFCCC that can constrain emissions in the period up to 2020.

### Action beyond the UNFCCC

Alongside the UNFCCC process, progress toward a low-carbon future is being made in numerous other multilateral fora. The challenge of post-2012 discussions is the need to engage all countries with approaches, possibly including the carbon market, that suit their capacity and their legitimate aspiration for economic and social development. The G8 2005 Gleneagles Plan of Action, the G20 Clean Energy and Energy Efficiency (C3E) Working Group, and the Major Economies Forum on Energy and Climate (MEF) and Clean Energy Ministerial (CEM) processes have sought to involve developed and developing countries in common measures to address climate change. Other international fora gathering both developed and developing countries have emerged that can further mitigate efforts in specific areas, such as the International Renewable Energy Agency (IRENA), and the International Partnership for Energy Efficiency Co-operation (IPEEC).

In addition to international multilateral efforts, action on climate change is increasingly being taken unilaterally by individual countries, regions, and cities. A 2014 survey showed that 61 of the 66 countries surveyed now have climate change and clean energy legislation in place and that developing and emerging economies have been taking the lead in bringing forward new climate change laws and regulation. There was legislative progress in 2013 in Bolivia, El Salvador, Ecuador, Costa Rica, China, Indonesia, Kazakhstan, Micronesia, Poland, Switzerland, Jordan, United Arab Emirates, Kenya, Mozambique, Tanzania, and Nigeria (Nachmany et al., 2014).

The most significant development in 2013-14 has been the launch of pilot emissions trading systems in five Chinese cities (Shenzhen, Beijing, Tianjin, Chongqing, and Shanghai) and two provinces (Hubei

and Guangdong). Together these cover over 1.2Gt of greenhouse gas emissions, second only to the size of the EU emissions trading system (World Bank, 2014). China has also announced an intention to implement a nation-wide ETS after 2016, building on the experience gained in these pilots.

There has also been progress with other carbon pricing mechanisms in 2014, including the launch of the Kazakhstan ETS (after a one-year trial period in 2013), formal linking of the California and Quebec trading systems, and the announcement of proposals to reform the EU ETS, which covers the 29 member states of the European Union plus Norway, Liechtenstein and Iceland. The European Commission has proposed to establish a reserve mechanism that would withdraw allowances from auction when the system is oversupplied, with the intention of creating better balance between supply and demand. Looking ahead to 2015, trading will begin in Korea's emissions trading system. This system is designed to assist in delivering Korea's target of a 30% improvement on business-as-usual (BAU) emissions by 2020. Progress has not all been positive for carbon pricing however: despite early indications of its effectiveness, the Australian ETS legislation was repealed in 2014.

Action at the level of cities and regions is also accelerating. In addition to emissions trading systems in California and Quebec, the Regional Greenhouse Gas Initiative caps electricity sector emissions in nine north-eastern US states. A successful carbon tax is in place in the Canadian province of British Columbia, and there are emissions trading systems in Alberta, Canada and the city of Tokyo in Japan.

An important development in extending emissions trading to developing economies has been the World Bank's Partnership for Market Readiness, which provides funding and technical assistance to developing countries for capacity building toward the development and piloting of market-based instruments for GHG reduction. Brazil, Chile, China, Columbia, Costa Rica, India, Indonesia, Mexico, Morocco, Peru, South Africa, Thailand, Turkey, Ukraine and Viet Nam are currently participating as implementing countries.

In all these efforts, timely and accurate CO<sub>2</sub> and other GHG statistics will prove central to ascertaining compliance with international agreements and to informing policy makers and carbon market participants. The ability of countries to monitor and review emissions from their sources is essential in their engagement towards national and global GHG mitigation.

## References

IEA (2012), *World Energy Outlook 2012* (WEO 2012), OECD/IEA, Paris.

IPCC (2007), *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (1996 IPCC Guidelines)*, IPCC, Bracknell, UK.

IPCC (2013), *Working Group I Contribution to the IPCC Fifth Assessment Report, Climate Change 2013:*

*The Physical Science Basis, Summary for Policy Makers*, available at: [www.ipcc.ch/](http://www.ipcc.ch/).

Nachmany, M., S. Fankhauser, T. Townshend, M. Collins, T. Landesman, A. Matthews, C. Pavese, K. Rietig, P. Schleifer, and J. Setzer (2014) *The GLOBE Climate Legislation Study: A Review of Climate Change Legislation in 66 Countries. Fourth Edition*. London: GLOBE International and the Grantham Research Institute, London School of Economics.

World Bank (2014), *State and Trends of Carbon Pricing 2014*, World Bank, Washington D.C.