International Energy Agency
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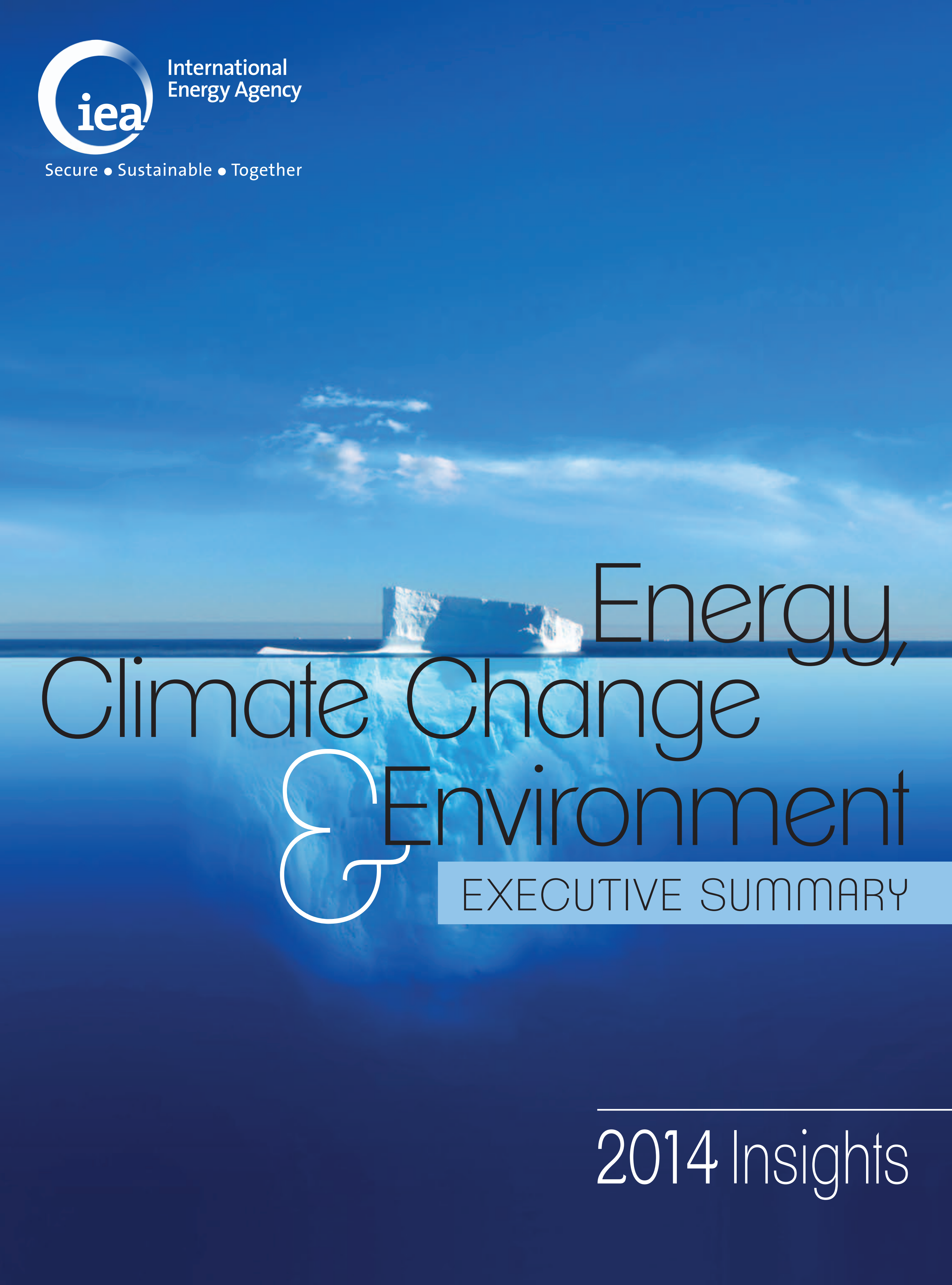

Energy, Climate Change & Environment

EXECUTIVE SUMMARY

2014 Insights

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INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 29 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

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The European Commission also participates in the work of the IEA.

International Energy Agency 1974–2014

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Executive Summary

The development of our energy systems has been and will continue to be markedly affected by a variety of environmental concerns, from air quality issues and acid rain, to more recent emphasis on climate change. Investments and other actions to provide for secure, affordable energy are influenced and modified to varying degrees by these diverse environmental considerations. In particular, the potential impact of climate change policies on the energy sector is increasing with the growing concern regarding climate change from greenhouse gas (GHG) emissions, 60% of which are generated by the energy sector. More than ever, the development of the energy sector and our planet's environment and climate are inextricably linked, creating the need for a fuller understanding of the opportunities to promote synergies between energy and environmental and climate policies.

This publication, *Energy, Climate Change and Environment: 2014 Insights* complements IEA modelling work such as the *World Energy Outlook* and *Energy Technology Perspectives* by providing a technical analysis of selected policy issues at the energy-climate interface, as well as providing updated key energy and emissions statistics. A summary of each chapter is provided below.

Policies and actions to "unlock" high-emissions assets

Meeting the challenge of climate change is not only about channelling new investments toward clean energy, but also addressing high-emissions assets that are already in place. Long-lived infrastructure can create path dependence in energy systems and the potential for lock-in. Staying on track to limit temperature rise to below two degrees Celsius requires a transition away from these assets at faster rates than natural infrastructure replacement would dictate (i.e. before the end of their economic lifetimes). Current assets could be seen as "locked in", but they can also be "unlocked" through policy intervention.

High and rising carbon prices could drive changes in infrastructure; however, given the low prices in most current carbon pricing systems today, alternative policy options need to be explored to unlock high-emissions infrastructure. The context of coal plants, one of the largest sources of energy sector GHG emissions, provides useful insights. There are a number of unlocking options available (Table ES.1), many of which are already in use.

In choosing policy options to unlock existing infrastructure, careful attention needs to be paid to not undermining

Table ES.1

Unlocking actions for existing coal plants and the range of policies that can drive them

Unlocking action	Policy options		
	Direct regulation of plants	Regulated change in supply/ demand balances	Influence markets via price
Retirement of coal plant	• ownership decision to shut down • regulated lifetime limits • regulated phase-out	• fleet-wide GHG emissions performance standard • regulated increase in renewable capacity • demand reductions	• fuel price changes • carbon pricing • preferential pricing for renewables
Change dispatch of the existing power generation fleet	• "clean-first" dispatch • priority dispatch of renewables	• fleet-wide GHG emissions performance standard	• fuel price changes • carbon pricing • removal of fossil fuel subsidies
Retrofit of coal plant to increase efficiency	• targets for plant retrofit rates	• fleet-wide GHG emissions performance standard	• carbon pricing • removal of fossil fuel subsidies
Retrofit of coal plant for carbon capture and storage (CCS)	• regulated lifetime limits • CCS retrofit mandates	• CCS trading schemes • fleet-wide GHG emissions performance standard	• carbon pricing • preferential pricing for CCS generation
Biomass co-firing or conversion	• ownership decision to convert	• renewable generation quota • fleet-wide GHG emissions performance standard	• carbon pricing • preferential pricing for renewables

long-term outcomes. For example, it is critical that any early retirements be replaced by clean generation. Equally, policies to drive deployment of clean generation need to be complemented by policies that address fossil fuel emissions, in order to avoid unintended consequences such as the mothballing of gas plants instead of coal in Europe. Moreover, energy security should always be a priority to produce sustainable actions from an energy perspective: early retirements need to be matched with new supply or energy efficiency gains to keep reserve margins at acceptable levels.

The new landscape of emissions trading systems

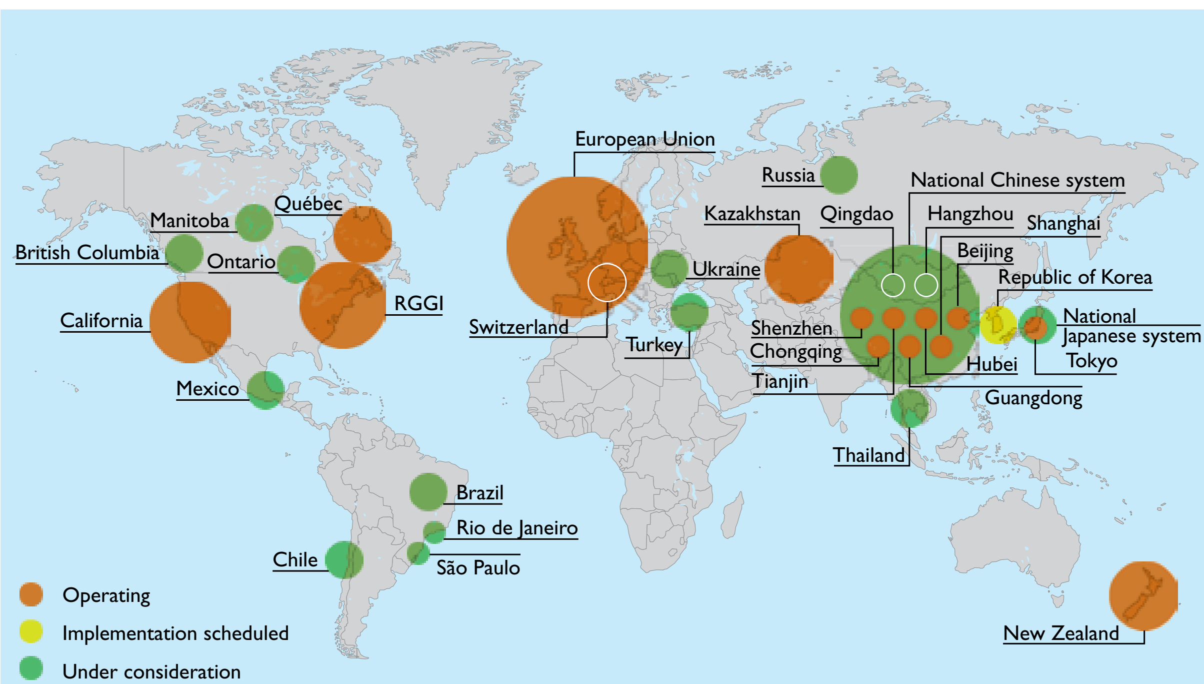
Emissions trading systems (ETSs) are enjoying somewhat of a resurgence around the world. As a form of carbon pricing, ETSs represent effective and low-cost policy responses to climate change. Beginning with the European Union Emissions Trading Scheme in 2005, which remains the largest system, current or planned systems now exist in all corners of the globe. Since 2013 the world has seen a rise in ETS implementation, with new or expanded systems in China, California, Québec, Kazakhstan and Switzerland. The Northeast United States, New Zealand, and Tokyo are other examples, and there are more under preparation: South Korea has passed legislation to begin emissions trading by 2015, and India, Chile, Brazil, Thailand and Mexico are in various stages of consideration and development of ETSs (Figure ES.1). While it is clear that support for carbon pricing and emissions trading is not universal, it is difficult to ignore the trend of expansion.

Key lessons can be drawn from recent ETS experiences:

- Improved integration of ETSs and complementary energy policies can ensure each set of policies meet its respective objectives.
- Measures can be taken to enhance ETS resilience and flexibility within changing economic conditions.
- ETS design must consider changing political contexts and public perceptions given that real as well as perceived impacts determine policy success.
- ETSs may be implemented in highly regulated electricity systems, though additional measures may be needed to ensure propagation of the carbon price signal.

Figure ES.1

Current status of ETSs worldwide



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

Note: The size of each circle is approximately proportional to GHG emissions covered.

Source: Adapted from country sources and ICAP (International Carbon Action Partnership) (2014), "ETS Map", https://icapcarbonaction.com/ets-map.

- Compensating those groups affected by rising electricity prices (driven by the carbon price) may achieve better outcomes than preventing the price rise.

Lastly, although the role of ETSs within an international climate change agreement remains uncertain despite their global expansion, the United Nations Framework Convention on Climate Change (UNFCCC) process has important potential functions to play. The UNFCCC process can help balance, on one hand, flexibility for countries to develop their own market-based approaches to GHG reductions with, on the other, the need to establish common international rules and standards to build trust and credibility.

Energy metrics: A useful tool for tracking decarbonisation progress

While GHG emissions reductions goals are an essential component of decarbonisation, specific energy sector metrics can provide deeper insight into the underlying drivers of change, and can track interventions with long-term as well as short-term impacts. Energy sector policies and actions that reduce GHG emissions may be motivated primarily by wider benefits such as energy security, building experience with new technologies, cutting air pollution, or reducing energy bills, with GHG emissions reductions as a secondary benefit.

There is a wide range of metrics that could be used to track energy sector decarbonisation: those expressed in GHG terms (Type I, e.g. the IEA Energy Sector Carbon Intensity Index [ESCII]); those that have an impact on shorter-term GHG emissions levels but are not themselves expressed in terms of GHG emissions (Type II, e.g. energy efficiency or renewable energy goals); and those that track actions with an impact on long-term emissions pathways (Type III) (Figure ES.2).

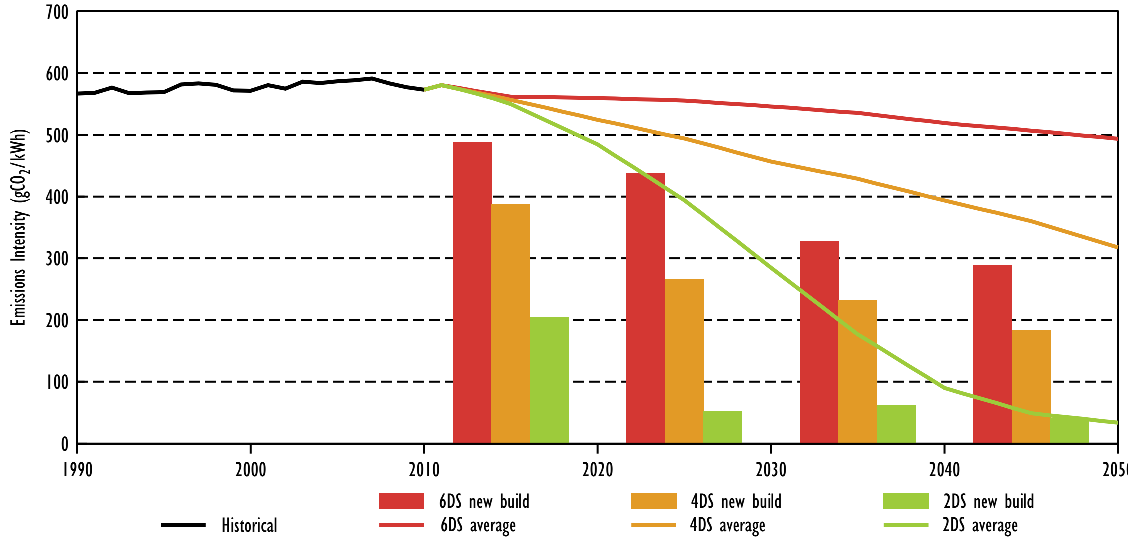
There are many reasons countries may be motivated to use energy sector goals and metrics to support GHG emissions reductions:

- Goals based on energy sector metrics can link more directly to policies under government control (e.g. renewable portfolio standards). They may consequently be easier to adopt, as outcomes are more easily influenced by policy and decision makers can have more confidence in delivery.
- Clean energy policies are implemented for a wide range of reasons and often have multiple benefits, of which emissions reductions are only one; accordingly, energy sector metrics may better reflect these objectives.
- Discussions toward the new 2015 agreement seek to frame climate action as an opportunity to be seized rather than a burden to be shared. Energy metrics can potentially help change the discourse around climate goals.
- Alternative metrics can help to target the long-term transformation that is needed to complement short-term goals (e.g. to prevent lock-in of high-emissions infrastructure or support the development of key clean technologies).

The use of energy sector metrics in addition to GHG goals could be helpful within and outside the UNFCCC process to help drive the energy sector actions needed for decarbonisation. The use of metrics that better reflect the various goals of parties could help them build support for climate policy.

Figure ES.2

Examples of Type I (fleet average emissions intensity [lines]) and Type III (new-build emissions intensity [bars]) metrics for power generation in the 6DS, 4DS and 2DS



The air pollution-GHG emissions nexus: Implications for the energy sector

The energy sector is the greatest contributor to heat-trapping GHG emissions through the combustion of fossil fuels. Fossil fuel combustion also causes air pollution, which poses increasingly pressing problems around the world as public health and economic damages continue to accrue in countries at all levels of development. This presents critical challenges for the production and use of energy, which is central to economic growth and development.

However, opportunities are available to "co-manage" these challenges at the air pollution-GHG emissions nexus in a variety of contexts. This is especially important since the interplay between air pollution control and GHG emissions abatement may not always be positive. Many countries are recognising the potential to address these dual priorities: China and the United States provide interesting illustrations of how this issue is playing out in very different contexts. With this in mind, a special focus in this year's publication is on the linkages between air pollution control and GHG emissions:

- **GHG co-benefits of air quality controls of large stationary sources.** Many countries have been tightening air quality regulations to force significant emissions reductions of air pollutants such as sulphur dioxide, particulate matter, and mercury. Compliance with these regulations can also produce co-benefits in terms of GHG reductions. These co-benefits and the channels through which they arise are examined, drawing on the experience of the European Union, the United States and Canada, as well as other regions. The results can be quite small or quite large, depending on factors that include the relative economics of coal- and gas-fired power generation and future expectations related to carbon control. The benefits of multi-pollutant strategies that take an integrated approach are underscored.

- **China's air quality constraints: Implications for GHG mitigation in power and key industry sectors.** China's "war on air pollution" agenda can drive ancillary reductions in carbon dioxide (CO_2) emissions and lead to the development of complementary air pollution and low-carbon policies. However, regional variation in pollution control measures and the design of industrial policies and measures in power and key industry sectors may limit GHG benefits (i.e. through geographic dislocation of emissions, methane or CO_2 leaks or increased CO_2 emissions intensity of pollution-reducing technologies). This is especially true if competing lower-carbon technology options do not provide for security of supply, or if air quality measures or monitoring and enforcement do not take a comprehensive accounting of environmental impacts. Overall, air pollution controls can lead to meaningful reductions in GHG emissions, provided they are structured to achieve these dual objectives.

- **The regulatory approach to climate policy in the United States.** To advance its climate change goals, the US government is targeting GHG emissions reductions through a sectoral approach, using a regulatory framework normally reserved for the control of conventional air pollutants. The cornerstone of this approach is the application of federal carbon pollution standards to the electric power sector. Though the use of regulatory standards is a notable expansion of the climate policy toolkit beyond the market mechanisms that dominated much of the previous policy debate, they have been designed with some degree of market flexibility in mind. These GHG-targeted regulations also have important implications for air quality and public health co-benefits.

Trends in energy and emissions data

Global energy-related CO_2 emissions reached their highest levels in 2012 (Figure ES.3). As the global economy recovered from the 2008-09 recession, emissions rose 5.4% in 2010, the highest growth rate in over three and a half decades. However, this rate of growth has since slowed to 2.8% in 2011 and 1.2% in 2012. Closer inspection of individual regions reveals substantial differences in regional trends. For instance, contrasting emissions trends were observed between OECD and non-OECD regions: OECD Europe and OECD Americas experienced declines in 2011 and 2012, while emissions grew in non-OECD regions over the same period, led by China and India.

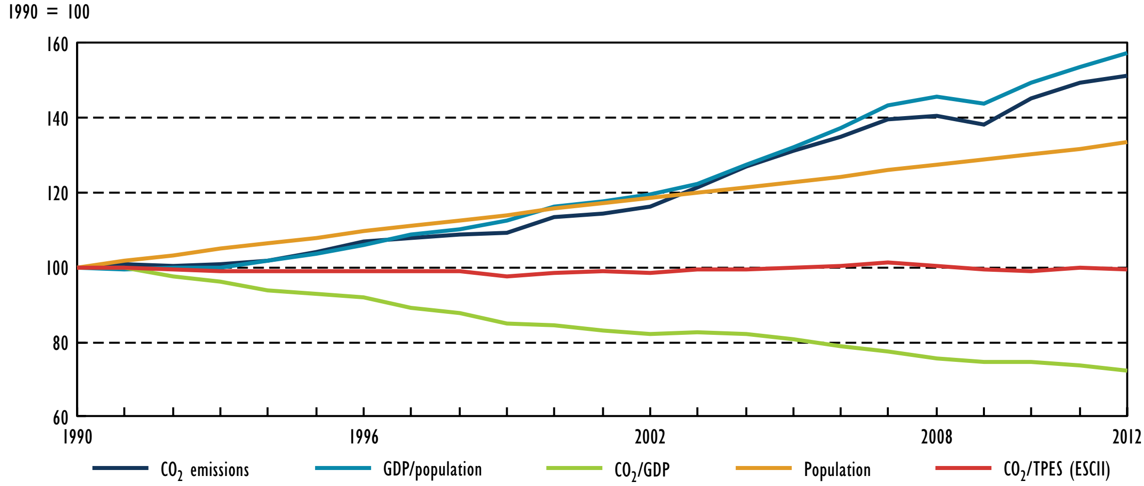
In 2011 and 2012, coal remained the largest contributor to emissions with its greatest shares (43.9% in both years) over the reporting period (1971-2012). Oil had the second largest share (35.3%), followed by gas (20.3%) in 2012. The rising demand for fossil fuels was also driven largely by consumption in fast-growing, non-OECD regions.

Economic growth continued to decouple from emissions growth, with 2012 having the lowest-ever emissions intensity (CO_2/GDP). Despite this, an increasing demand for energy due to rising population and wealth drove overall emissions upwards.

Among all sectors, the electricity and heat generation sector accounted for the greatest share of emissions in 2012 (42.1%), which also represented the largest contribution made by this sector over the reporting period. In 2011 the global electricity sector was the most fossil fuel-dependent it had been, with the share of non-fossil electricity reaching its lowest levels in over two decades (31.6%), driven in part by a decline in nuclear power generation. In other words, fossil fuels comprised over two-thirds (68.4%) of the

Figure ES.3

Selected indicators of global CO_2 emissions, per capita GDP (GDP/population), carbon intensity of economic activity (CO_2/GDP), population, and energy sector carbon intensity (ESCII): Change from 1990



electricity generation mix. In 2012, the share of non-fossil electricity increased slightly (to 31.8%).

Renewable sources of electricity such as wind, biomass and solar enjoyed the greatest rate of growth in 2011 and 2012 among all energy sources (including fossil fuels). In fact, in 2012 their share in the electricity mix rose to a level matching that of oil (to 5.0%) for the first time. This growth was driven by emerging economies, in particular that of China. However, the carbon intensity of energy supply (which measures the overall carbon intensity of the energy sector, namely our global energy mix) remained relatively unchanged, highlighting the very limited decarbonisation that has taken place in the energy sector over the past several decades.

Looking ahead

The world will need to significantly "bend the curve" away from current energy and emissions trends in order to tackle the challenge of global climate change. The analyses contained in *Energy, Climate Change and Environment: 2014 Insights* are intended to inform countries as they explore options to decarbonise their energy sectors. Better policies and data will be needed to support greater ambition and more effective action to reduce energy sector GHG emissions.

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2014 Insights

Policies that respond to climate change and other environmental issues will increasingly impact the development of the global energy sector. The transition to low-carbon economies will need to be carefully managed, as the provision of secure, affordable energy is critical for economic growth and social development. More than ever, there is a need for a fuller understanding of the opportunities to promote synergies between energy, environmental and climate policies. *Energy, Climate Change, and Environment: 2014 Insights* helps address this need with in-depth analysis of selected policy questions at the energy-climate interface, including:

- How can we accelerate the transition from (i.e., "unlock") existing high-emissions infrastructure?
- What are the best ways to design cost-effective emissions trading systems that fit with national circumstances?
- What are some alternative energy-specific metrics that support near-term emissions reductions and long-term decarbonisation of the energy sector?
- And, in the special focus of this report, can curbing local air pollution help reconcile energy priorities with environmental sustainability, including greenhouse gas mitigation?

Addressing these questions will help inform decisions that can boost decarbonisation of the energy sector while taking into account security and economic objectives.

This report also features an update of key energy and emissions statistics for ten world regions that should interest energy practitioners and climate policy makers alike.