



International
Energy Agency
Secure
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Energy and Climate Change

World Energy Outlook
Special Briefing for COP21

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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Climate pledges slow energy sector emissions growth dramatically

Actions in the energy sector can make or break efforts to achieve the world's agreed climate goal. Energy production and use account for around two-thirds of global greenhouse-gas (GHG) emissions, meaning that the energy sector must be at the heart of global action to tackle climate change. The 21st Conference of the Parties (COP21) – to be held in Paris in December 2015 – is a major milestone in efforts to combat climate change. As an exclusive release intended to inform decision-makers attending COP21, the International Energy Agency (IEA) presents here a summary assessment of the energy sector impacts of national climate pledges (so-called “Intended Nationally Determined Contributions” [INDCs]). The assessment updates the analysis and findings of the IEA’s *World Energy Outlook Special Report on Energy and Climate Change* (published in June 2015),¹ incorporating all climate pledges up to mid-October, together with the latest available energy data. It seeks to answer two key questions: what will the energy sector look like in 2030 if all INDCs are implemented fully, and will it be sufficient to put the energy sector on a pathway consistent with the world’s agreed global climate goal?²

Coverage of pledges is unprecedented, but energy sector focus is uneven

The coverage of climate change pledges is impressive. The more than 150 countries that have submitted pledges account for around 90% of global economic activity and almost 90% of global energy-related GHG emissions today (Figure 1). By world region, all of the countries in North America have submitted INDCs, almost all in Europe, around 90% in Africa, two-thirds in developing Asia, 60% of those in Latin America and one-third in the Middle East. These countries currently account for around 90% of global fossil fuel demand and almost 80% of global fossil fuel production.

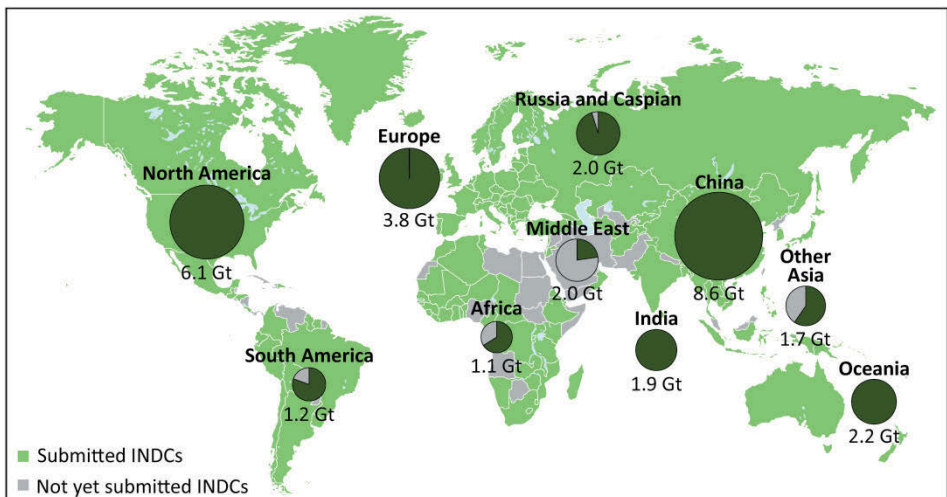
The content of climate pledges varies in many respects, making their interpretation and evaluation challenging. The forms of pledges put forward in the INDCs include absolute GHG emissions targets, deviation from “business-as-usual” emissions trajectories, emissions intensity targets (*i.e.* GHG emissions per unit of economic output), reductions or limitations in per-capita emissions, or statements regarding policies and measures to be implemented. A number of pledges are conditional, at least partially, on financial support or other factors. All of the 125 INDC submissions (which cover more than 150 countries) include coverage of energy sector emissions, and many include targets or actions to address them. Around half of all INDC submissions include explicit energy-focused targets, either alongside a GHG target or as a stand-alone goal. The most common energy-related measures are those that target increased renewables deployment (40% of submissions), or improved efficiency in energy use (one-third of submissions). Other energy sector measures that could help to cut energy-related GHG emissions in the short term, such as reducing the

¹ *Energy and Climate Change: World Energy Outlook Special Report* is available to download free at www.worldenergyoutlook.org/energyclimate.

² To limit the rise in average global temperatures to no more than two degrees Celsius (2 °C), relative to pre-industrial levels.

use of inefficient coal-fired power plants, lowering methane emissions from oil and gas production, fossil-fuel subsidy reform or carbon pricing, are reflected in the INDCs of just a handful of countries. Some of the energy sector technology or policy options that are required for a long term transformation of the energy sector, such as nuclear power, carbon capture and storage, and alternative vehicle fuels (advanced biofuels, electric vehicles etc.), are rarely mentioned. Finally, there are many cases in which an overall GHG target is specified within an INDC, but without making clear the expected contribution of the energy sector vis-à-vis non-energy sector sources of these emissions. One key instance is the contribution to GHG emissions expected from land-use, land-use change and forestry (LULUCF), which, for some countries, can be very significant.

Figure 1 ▶ National climate pledges submitted for COP21 and coverage in terms of energy-related CO₂ emissions in 2013



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 bubbles represent total energy-related carbon dioxide (CO₂) emissions. The share of these emissions covered by an INDC (as of mid-October) is shown in green and those that are not in grey.

Pledges break the link between power generation and power emissions

Growth in energy sector GHG emissions slows dramatically, if INDCs are implemented fully. A complete analysis of the INDCs submitted for COP21³ reveals that the global energy- and process-related emissions increase by 3.7 gigatonnes of carbon-dioxide

³ The IEA has analysed the INDCs submitted for COP21 as of mid-October, together with the latest available global energy data (including recent official revisions to China’s energy balance). The IEA’s World Energy Model was used to project the impact of INDCs on energy sector demand, supply, emissions and investment trends through to 2030, using the economic and energy price assumptions of *WEO-2015* (to be released on 10 November). Beyond the INDCs, the analysis takes into account all domestic energy sector policies that are currently in place or under discussion across all countries. The analysis is based upon the full implementation of unconditional INDC pledges. Some countries have also indicated that they might agree a more ambitious INDC under certain conditions, but such additional pledges are not included here.

equivalents (Gt CO₂-eq)⁴ from 2014 to 2030, one-third of the increase observed since 2000 (11.2 Gt CO₂-eq), as fossil-fuel demand growth slows down considerably and low-carbon fuels increase their share in the energy mix to around one-quarter in 2030 (from less than 20% today). Natural gas also increases its share in the energy mix, while that of coal and oil declines. The annual growth in global energy-related emissions slows to a relative crawl by 2030 (around 0.5% per year); but not yet come to a halt – a critical and urgent milestone to achieving the global climate goal. Total energy-related GHG emissions are projected to stand at 42 Gt CO₂-eq in 2030 (Table 1). Countries accounting for more than half of global economic activity are projected to either see their energy-related GHG emissions plateau or be in decline by 2030, including the likes of the European Union, the United States, China, Japan, Korea and South Africa. As such, climate pledges help to broaden the necessary decoupling between economic growth and energy-related GHG emissions – emissions per unit of economic output being 40% lower than today by 2030.

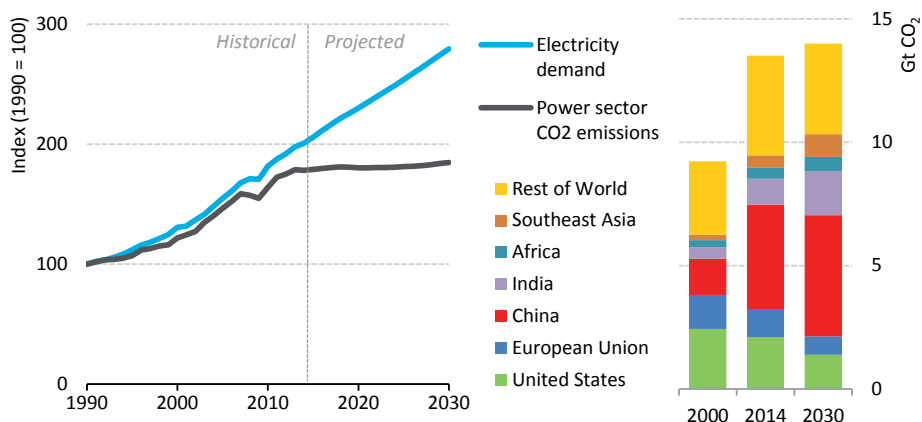
Table 1 ▶ **Global energy- and process-related greenhouse-gas emissions in the INDC Scenario (Gt CO₂-eq)**

	2014	2020	2025	2030
Energy-related GHG emissions	35.5	36.9	37.5	38.4
Process-related CO ₂ emissions	2.8	3.2	3.4	3.5
Total	38.2	40.1	40.9	41.9

World CO₂ emissions from power generation remain broadly flat through to 2030. The power sector is both the largest source of energy-related CO₂ emissions and the greatest focus (to date) of energy sector efforts to decarbonise. While global power sector emissions stay broadly flat, electricity demand increases by more than 40% to 2030. In essence, at the global level, the link between rising electricity demand and rising related CO₂ emissions is broken – an important step towards further decarbonisation (Figure 2). Across the OECD, electricity demand grows by around 10%, but total CO₂ emissions from the power sector drop by one-third. Across non-OECD countries, electricity demand grows by nearly 75%, but emissions go up by just one-quarter. Seven out of every ten units of additional electricity generation through to 2030 is projected to be low-carbon, bringing the share of total electricity generation from low-carbon sources from one-third today to nearly 45% in 2030.

⁴ Based on the global warming potentials (GWP) from the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), averaged over 100 years.

Figure 2 ▶ **Growth in world electricity demand and related CO₂ emissions since 1990 (left) and related CO₂ emissions by region (right)**



Low-carbon technologies move to the forefront of energy sector investment

The full implementation of climate pledges will require the energy sector to invest **\$13.5 trillion** in energy efficiency and low-carbon technologies from 2015 to 2030, representing almost 40% of total energy sector investment. Around \$8.3 trillion is needed to improve energy efficiency in the transport, buildings and industry sectors, while much of the remaining investment is to decarbonise the power sector. More than 60% of total investment in power generation capacity is projected to be for renewable capacity, at \$4.0 trillion, with one-third of this being for wind power, almost 30% for solar power (mainly solar photovoltaics) and around one-quarter for hydropower. While OECD countries absorb 60% of energy efficiency investment (\$5 trillion), non-OECD countries absorb a greater share of the investment in low-carbon technologies (\$2.7 trillion).

Pledges accelerate the energy transition, but it is not yet fast enough

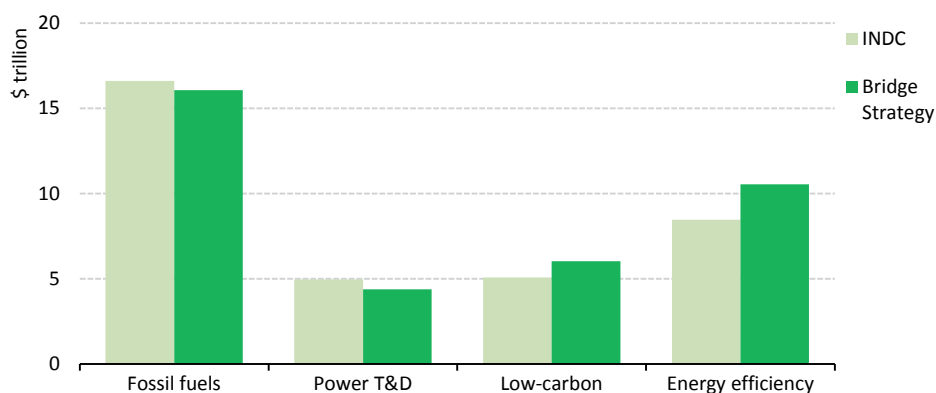
Pledges for COP21 will have a positive impact on future energy sector trends, but fall short of the major course correction required to achieve the agreed climate goal. If climate ambition is not raised progressively, it is estimated that the path set by the INDCs would be consistent with an average global temperature increase of around 2.7 degrees Celsius (°C) by 2100, falling short of limiting the increase to no more than 2 °C.⁵ The INDCs must therefore be viewed as an important base upon which to build ambition.

The energy sector can do more to restrain and reduce its GHG emissions; for all countries, there are many ways in which energy sector actions can still be accelerated. The IEA's

⁵ To assess the impact on global average temperature increase, we used MAGICC with an emissions pathway in between the representative concentration pathways (RCP) 4.5 and 6 from the IPCC's Fifth Assessment Report. This was judged as the long-term emissions trajectory most closely aligned with this INDC analysis.

Energy and Climate Change Special Report highlighted how just five energy sector measures (relying only on proven technologies and policies) could help achieve an early peak in total energy-related GHG emissions, at no net economic cost. These measures, which were presented as a “Bridge Strategy” and intended to be a bridge to further action, still hold true. The five measures are: improving energy efficiency in the industry, buildings and transport sectors; phasing out the use of the least-efficient coal-fired power plants; further boosting investment in renewables-based power generation technologies (to \$400 billion in 2030); gradually phasing out fossil fuel subsidies; and, reducing methane emissions from oil and gas production. Many of these measures are included within some of the submitted INDCs, but there is scope for their adoption to be broadened and their level of ambition to be raised. An additional \$3 trillion (around 20%) of cumulative investment in energy efficiency and low-carbon technologies would be required through to 2030 in order to bring the level of ambition reflected in the INDCs up to that of the IEA’s Bridge Strategy (Figure 3). Around 70% of the additional investments need to go towards improving energy efficiency and almost 30% towards supporting stronger deployment of renewables, delivering a major reduction in energy-related GHG emissions and improvements in a number of important sectoral energy indicators (Table 2).

Figure 3 ► Cumulative world energy sector investment by scenario, 2015-2030



Note: Fossil fuels includes investment in fossil-fuel supply and in fossil-fuel based power generation. T&D is transmission and distribution. Low-carbon includes power supply and transport fuels. Energy efficiency covers end-use energy sectors.

Clarity of vision and certainty of action can help the energy sector

Efforts to improve the clarity and consistency of climate pledges, as well as to identify ways to enhance their ambition, would bring major benefits. This includes more clearly defined and measurable targets, and more information on the underlying policies intended to enable achievement of these targets. Perhaps above all else, the energy sector needs clarity from INDCs and COP21 so that it can make a confident assessment of its role in

reducing GHG emissions, and then make the necessary investments in a timely and efficient way. There is also a need for greater consistency, both across INDCs, where the level of information provided varies (as does the ability to measure progress) and with countries own longer-term decarbonisation plans. For instance, how INDC targets and plans link through to the deployment of new and emerging energy sector technologies that have the potential to deliver the transformational change needed to achieve deep levels of decarbonisation in the decades to come.

Table 2 ▶ Selected indicators to track energy sector decarbonisation

	Metric	2030			Unit
		2014	INDC	Bridge	
Total energy sector	Energy- and process-related greenhouse gas emissions	38.2	41.9	35.8	Gt CO ₂ -eq
	Carbon intensity of primary energy supply	2.36	2.14	2.01	t CO ₂ /toe
	Energy intensity of GDP	0.176	0.127	0.120	toe / \$1000
Power	CO ₂ emissions per unit of electricity	518	382	306	g CO ₂ /kWh
Transport	New passenger cars: CO ₂ emissions per vehicle-kilometre	155	110	90	g CO ₂ /v-km
	Carbon intensity of total transport fuel demand	2.9	2.7	2.7	t CO ₂ /toe
Buildings	Residential: energy demand per dwelling*	8 265	7 850	7 400	kWh/dwelling

* Excludes traditional use of solid biomass.

Notes: toe = tonnes of oil equivalent, g CO₂/kWh = grammes of CO₂ per kilowatt-hour, g CO₂/v-km = grammes of CO₂ per vehicle-kilometre, t CO₂/toe = tonnes of CO₂ per tonnes of oil equivalent.

Advances in reducing energy-related GHG emissions must, ultimately, be permanent rather than temporary. As such, decision-makers must be wary that the projected gains envisaged by the implementation of INDCs will be at risk if achieved on the back of cyclical rather than structural change. The gains resulting from headwinds or tailwinds that come from prevailing price trends, broader economic trends or demographic trends may prove to be reversible. This speaks to ensuring that INDCs and their implementation are cast in the context of a national long-term decarbonisation pathway, to ensure that short and medium term plans are consistent with long term targets and strategies.

The reorientation of the global energy system to one that is consistent with global climate goals is one of the biggest challenges facing the energy sector today, and the IEA will continue to place a high priority on its work on climate change. The IEA will act as a centre of global expertise on the impact of the energy sector on the environment, and the technologies and policies available to mitigate them. It will also assess the impact of

national climate pledges as they are further developed, refined, revised and implemented, drawing on the wealth of energy data and indicators at its command.

On 10 November 2015, the IEA will publish the latest edition of its annual flagship publication, the *World Energy Outlook*⁶, putting the latest energy and climate developments into perspective, and exploring their implications for global energy security, economic development and the environment.

⁶ To pre-order a copy, go to www.iea.org/bookshop.

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World Outlook Energy 2015

The IEA *World Energy Outlook 2015*, to be released on 10 November, seeks to answer some of the big questions that abound in global energy in 2015:

- Could **oil prices** stay lower for longer? What would it take for this to happen and what would it mean for energy security and for the energy transition?
- **India** is set for a period of rapid, sustained growth in energy demand: how could this re-shape the energy scene?
- What do new **climate pledges** mean for the way that the world meets its rising needs for energy?
- What are the implications of the rising coverage of **energy efficiency** policies and the growing competitiveness of **renewables**?
- Is the **unconventional gas revolution** going to go global or to remain a North American phenomenon?

These issues – and many more – are discussed in *WEO-2015*, with a special focus on India accompanying the customary, in-depth analysis of the prospects for all fossil fuels, renewables, the power sector and energy efficiency around the world to 2040.

For more information, please visit: www.worldenergyoutlook.org