International Energy Agency

HOW THE ENERGY SECTOR CAN DELIVER ON A CLIMATE AGREEMENT IN COPENHAGEN

Special early excerpt of the World Energy Outlook 2009 for the Bangkok UNFCCC meeting

INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA) is an autonomous body which was established in November 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme.

It carries out a comprehensive programme of energy co-operation among twenty-eight of the thirty OECD member countries. The basic aims of the IEA are:

- To maintain and improve systems for coping with oil supply disruptions.
- To promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organisations.
- To operate a permanent information system on international oil markets.
- To provide data on other aspects of international energy markets.
- To improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use.
- To promote international collaboration on energy technology.
- To assist in the integration of environmental and energy policies, including relating to climate change.

IEA member countries:

Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Japan
Korea (Republic of)
Luxembourg
Netherlands
New Zealand
Norway
Poland
Portugal
Slovak Republic
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

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

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where the governments of thirty democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

International Energy Agency (IEA)
9 rue de la Fédération, 75739 Paris Cedex 15, France

HOW THE ENERGY SECTOR CAN DELIVER ON A CLIMATE AGREEMENT IN COPENHAGEN

Special early excerpt of the
World Energy Outlook 2009
for the Bangkok UNFCCC meeting

International Energy Agency

Foreword

by the Executive Director of the IEA

The *World Energy Outlook 2009* (*WEO-2009*) delivers a simple, stark message: if the world continues on the basis of today's energy policies, the climate change impacts will be severe. Energy, which accounts for two-thirds of today's greenhouse-gas emissions, is at the heart of the problem – and so must form the core of the solution. We need urgently to set in motion an energy and environmental revolution, to transform the way we use energy and to deliver a sustainable future. *WEO-2009* maps out this transformation, detailing the role of the energy sector in a scenario that leads to the long-term stabilisation of the concentration of greenhouse gases in the atmosphere at 450 parts per million of CO_2 equivalent – our 450 Scenario – and setting out the investments and financing needed to make it happen.

The financial and economic crisis of the past 18 months, analysed in depth in *WEO-2009*, has had a considerable impact on the energy sector. CO_2 emissions are expected to fall in 2009, which can help us to achieve this 450 trajectory – but only if the right policies are put in place promptly. The success of the UNFCCC process is crucial to this.

The task is extremely challenging, but it is achievable, and success is necessary to avoid the worst consequences of climate change. And the co-benefits are numerous. The 450 Scenario requires extra investment but most of this is in energy efficiency measures, which offer substantial energy cost savings, and in low-carbon power generation, which may have high up-front costs, but typically offers substantial cost savings compared to the technologies being replaced. The improved energy efficiency will help bring about more sustainable economic development, while lower energy imports in the 450 Scenario promise major energy security and economic benefits. And air quality improvements from curbing fossil fuel use are important both for the environment and for human health. Fossil fuels will still have a role to play but the 450 Scenario requires fossil-energy consumption to peak by around 2020 and then decline.

This special early excerpt of *WEO-2009* is a contribution from the energy sector to inform the negotiations leading into Copenhagen. It summarises the results of a fully-updated Reference Scenario, detailing by sector and by country/region the trends in energy use and emissions and the investments and funding needed to meet the 450 Scenario. It forms part of a much more detailed study, to be published in November in *WEO-2009*, which focuses on the impact of the financial crisis and recent policies on the energy sector, provides a comprehensive analysis of the results of the Reference Scenario and 450 Scenario, and analyses the international financial flows and mechanisms that might underpin a post-2012 agreement.

I am particularly grateful to Yvo de Boer and his team for helping us to put together this excerpt of *WEO-2009*. I believe and hope that it will play a useful role in delivering a strong agreement in Copenhagen.

Nobuo Tanaka
Executive Director
International Energy Agency

Foreword

by the Executive Secretary of the UNFCCC

I would like to express my appreciation to the International Energy Agency for making available this publication during the critical, final stretch of the negotiations ahead of the landmark climate change conference in Copenhagen this year. This is the first time that part of a *World Energy Outlook* has been released in advance of the full report. *World Energy Outlook 2009* is the first comprehensive analysis that includes the impact of the financial and economic crisis on the energy sector and the related CO_2 emissions. It represents a significant contribution by the energy sector to a positive outcome in Copenhagen.

The messages of *World Energy Outlook 2009* are clear and compelling:

- Continuing current energy policies would have catastrophic consequences for the climate.
- By reducing emissions, the financial and economic crisis has created a window of opportunity to transition the global energy system to a 450 ppm trajectory.
- This is a unique opportunity but we need to act now; delay increases the cost and drastically reduces the likelihood of stabilisation at 450 ppm ever being achieved, let alone anything below this concentration level.
- The transition is challenging and requires action in all countries, but it is doable.
- The cost of moving the global energy system to a 450 trajectory is manageable.
- Restructuring the energy system also yields economic development, energy security, human health and other environmental benefits.

An ambitious result is needed in Copenhagen to launch this transition and to advance it through a new level of international cooperation. The *WEO-2009* Climate Change Excerpt illustrates in a handy and clear way the scale of the energy-related emission reductions consistent with a 450 ppm trajectory, the measures that can achieve those reductions, the mitigation technologies required, the policies that can drive those measures, and the associated investments needed. The analysis also shows how financial resources for actions in developing countries can be provided through tradable credits and financial transfers.

The global economy does not suffer much from the costs incurred under a 450 scenario. Countries experiencing high rates of economic growth continue to do so. While the export revenues of oil producing countries are lower than for the Reference Scenario, they are four times higher than in the past.

I wish to thank Fatih Birol and his team for the extra effort they have made during a very busy period to prepare this material in time for the UNFCCC Bangkok sessions. This continues their efforts since 2007 to make *WEO* analyses more useful for climate negotiators. *WEO-2009* analyses a 450 scenario, including the investment and financing needed, just in time to be one of the important references for the Copenhagen negotiations.

These results should motivate us all to step up efforts to reach an agreement with the requisite ambition. The cost of addressing climate change is manageable. The cost of not doing so is unaffordable. We can not afford to fail.

Yvo de Boer
Executive Secretary
UNFCCC

Table of Contents

Background

Past editions of the IEA's *World Energy Outlook* (*WEO*) have highlighted the unsustainability of current energy trends– environmentally, economically and socially – and the urgent need for action to bring about a wholesale global shift to low-carbon technologies. The issue is particularly pertinent this year, as countries around the world negotiate a new global deal on action to address climate change. Energy is at the heart of the problem – accounting for about 65% of the world's greenhouse-gas emissions – and so must be at the heart of the solution.

This year's edition of *WEO* will include an in-depth analysis of climate policies. The core of the analysis is a climate scenario, one consistent with limiting the concentration of greenhouse gases in the atmosphere to 450 parts per million CO_2-equivalent. Key results of this analysis are being published early in this booklet to support the negotiation of a new climate change agreement under the UNFCCC. These results will be presented in early October during the negotiating session in Bangkok, before the final negotiating session in Copenhagen between December 7 and 18. The full report of the 2009 edition of *WEO* will be published on 10 November 2009.

Two scenarios have been modelled in detail for the purpose of this year's *WEO*: a Reference Scenario and a 450 Scenario. The Reference Scenario is a picture of how global energy markets would evolve if governments make no changes to their existing policies. It is not a forecast. By contrast, the 450 Scenario analyses measures in the energy sector which might be taken in order to fulfil a co-ordinated global commitment ultimately to stabilise the concentration of greenhouse-gas emissions in the atmosphere at 450 ppm CO_2-equivalent. The projections have been derived from the IEA's World Energy Model (WEM), which models 24 geographical regions.[1] This booklet provides the main statistical results of the climate scenario. For comparison purposes, some results from the Reference Scenario have been included.

WEO-2009 will provide a comprehensive review of global energy supply and demand, energy investment needs and energy-related[2] CO_2 emissions to 2030 and, besides the focus on climate, in-depth analyses of natural gas supply and energy supply and demand in the ASEAN region. It provides the first comprehensive analysis of the impact of the financial and economic crisis on energy and CO_2 trends. In our Reference Scenario this year, global emissions in 2020 are 1.9 Gt or 5% lower than in the Reference Scenario in *WEO-2008*. The impact of the economic crisis and lower growth account for three quarters of this improvement, while government stimulus spending to promote low-carbon investments and other new climate policies account for the remainder.

The Reference Scenario

The Reference Scenario takes account of government policies and measures enacted or adopted by mid-2009, although many of them have not yet been fully implemented. This includes a number of policies to limit greenhouse gas emissions, as well as various policies to enhance energy efficiency and promote renewable energy. Policies under consideration and "targets" not backed up by commensurate policy measures are not included. The Reference Scenario also assumes that energy subsidies are gradually removed in all countries where they currently exist.

In the absence of new initiatives to tackle climate change, rising global fossil fuel use in this scenario increases energy-related CO_2 emissions from 29 Gt in 2007 to over 40 Gt in 2030 and contributes to

[1] Complete documentation of WEM can be found at: www.worldenergyoutlook.org.
[2] This refers to emissions from fossil-fuel combustion only.

the deterioration of ambient air quality, with serious public health and environmental effects. The rise in emissions is due to increased fossil fuel use, especially in developing countries, where per-capita energy consumption still has far to go to approach that in OECD countries. OECD emissions are projected to dip slightly over the period, due to a slower increase in energy demand, large improvements in energy efficiency and the increased use of nuclear and renewables. These effects are, in large part, due to the policies already adopted to mitigate climate change and boost energy security. Our analysis indicates that the Reference Scenario – when projected out to 2050 and beyond and taking into account emissions of all greenhouse gases from all sources – would result in a concentration of greenhouse gases in the atmosphere of around 1 000 ppm over the long term.

The 450 Scenario

The 450 Scenario analyses measures to force energy-related CO_2 emissions down to a trajectory that, taking full account of the trends and mitigation potential for non-CO_2 greenhouse gases and CO_2 emissions outside the energy sector, would be consistent with ultimately stabilising the concentrations of all greenhouse gases in the atmosphere at 450 ppm. This level of concentration is expected to give rise to a global temperature increase of 2°C.

The long-term greenhouse gas concentration limit set – 450 ppm CO_2-equivalent – is less than half the concentration which occurs in the Reference Scenario. The trajectory is an overshoot trajectory, i.e. concentrations peak at 510 ppm in 2035, they stay steady for around 10 years and then decline to 450 ppm. Our analysis focuses on energy-related CO_2 emissions to 2030, which peak just before 2020 at 30.9 Gt and decline steadily thereafter, reaching 26.4 Gt in 2030.

The 450 Scenario also takes a close look at the period through to 2020 that is so crucial to the climate-negotiation process. Without attempting to prescribe an ideal outcome to the negotiations, it reflects a plausible set of commitments and policies which could emerge – a realistic combination of cap-and-trade, sectoral agreements and national policies tailored to each country's circumstances. The possible national and international implications of such a global climate deal for the energy mix, greenhouse-gas emissions, investment and costs are described, sector by sector and region by region. The aim is not to predict the commitments to which countries may sign up at Copenhagen or beyond, but rather to illustrate how emissions would evolve under a given set of assumptions consistent with the overall stabilisation goal.

The policy framework in the 450 Scenario

The emission reductions in the 450 Scenario can be achieved only by taking advantage of the mitigation potential in all regions. Thus, all countries are assumed to implement mitigation measures, while respecting the principle of common but differentiated responsibilities.

Three regional groups are considered:

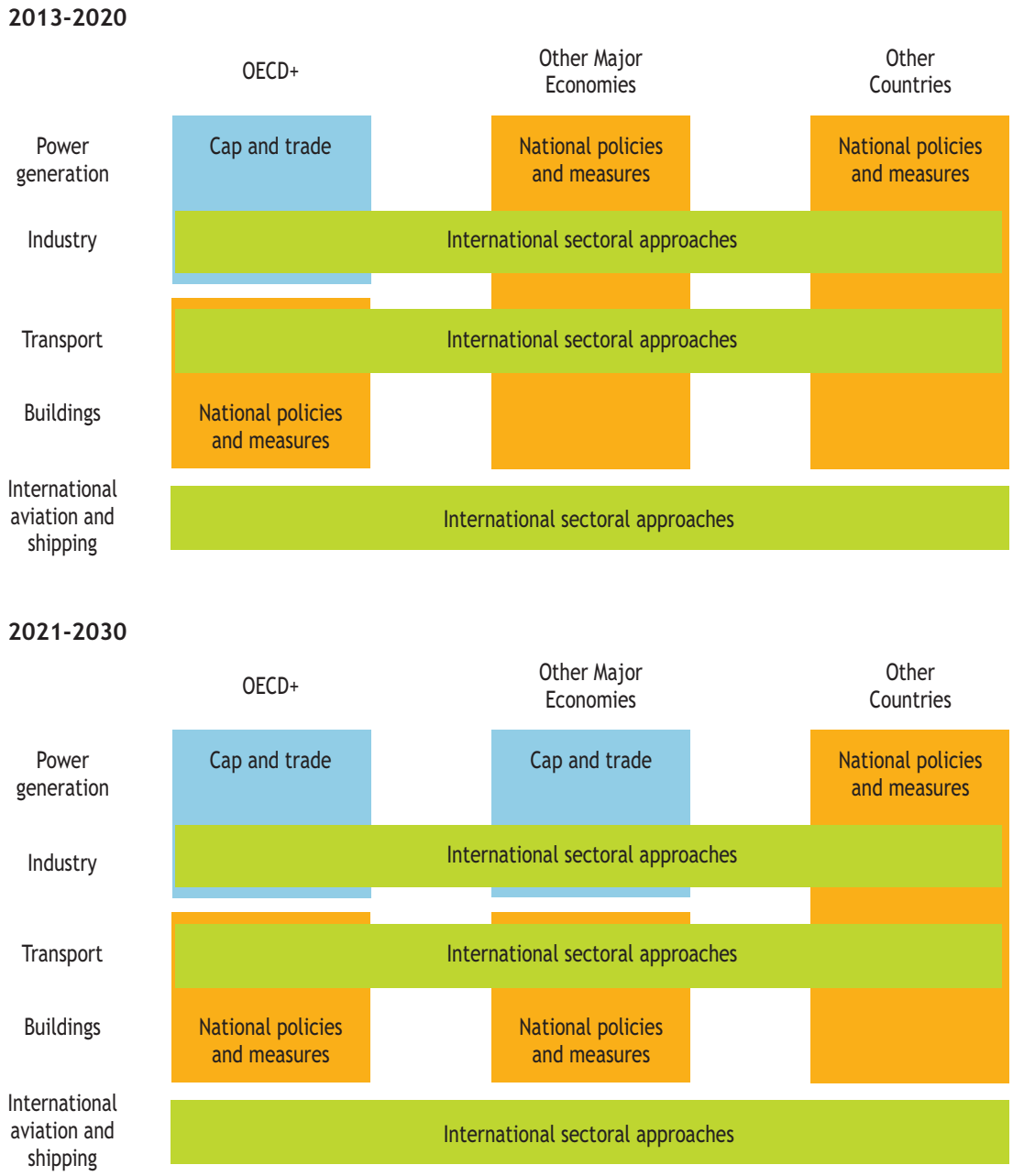
- "OECD+" countries – OECD countries and countries that are members of the European Union but not of the OECD.
- "Other Major Economies" (OME) - Brazil, China, the Middle East[3], Russia, and South Africa, that is the largest emitters outside OECD+ (based on their total emissions of energy-related CO_2 in 2007) with per capita GDP expected to exceed $13 000 in 2020.

[3] The region Middle East includes the following countries: Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, the United Arab Emirates and Yemen.

- "Other Countries" (OC) - all other countries.

Until 2020 OECD+ countries are assumed to have national commitments and to implement various mitigation policies, including a cap-and-trade system for power generation and industry. Other countries reduce their emissions through nationally appropriate mitigation actions (NAMAs), with international financial and technical support (Figure 1). All regions participate in sectoral agreements for cement, iron and steel, passenger vehicles, aviation and shipping that establish emissions intensity targets. After 2020, Other Major Economies are assumed to be part of the cap-and-trade system in power generation and industry.

Figure 1: Policy framework in the 450 Scenario



Key results of the 450 Scenario

All countries achieve substantial levels of abatement relative to the Reference Scenario. OECD+ emissions decline steadily, from 13.1 Gt in 2007 to 7.7 Gt in 2030. Emissions in Other Major Economies peak at 12.6 Gt in 2020 and then decline to 11.1 Gt in 2030, still 14% above 2007 levels. Emissions in Other Countries increase steadily. Most of the emission reductions from the Reference Scenario are achieved through energy efficiency measures. Significant reductions also come from changes to the mix of power generation technologies.

As noted above, cap-and-trade is assumed to apply to the power and industry sectors in OECD+ as of 2013 and to the Other Major Economies as of 2021. We assume that CO_2 is traded, initially, in two separate markets: the OECD+ and Other Major Economies. To contain emissions at the levels required, we estimate that the CO_2 price reaches $50 per tonne in OECD+ in 2020; it rises to $110 in OECD+ and $65 per tonne in the Other Major Economies in 2030. The prices are set by the most expensive abatement option (for example, CO_2 capture and storage in industry in the OECD+ in 2030).

WEO-2009 estimates that implementing the measures assumed in the 450 Scenario will increase cumulative energy-related investment[4] over the period 2010-2030 by $10.5 trillion. The largest increase is in transport, where most of the additional $4.7 trillion covers the additional cost of purchasing more efficient, but more expensive, vehicles. The additional investment in buildings, including appliances and equipment, amounts to $2.5 trillion. An extra $1.7 trillion is needed for the power sector. Investment in industry rises by $1.1 trillion, mainly for more efficient processes and electric motors. Facilities to produce biofuels require additional investment of $0.4 trillion. The energy efficiency investments in the buildings, industry and transport sectors are recovered through energy cost savings.

More than three quarters of the additional investment ($8.1 trillion) is needed in the last decade because most of the CO_2 emission reductions occur after 2020 (global CO_2 emissions are cut by 3.8 Gt in 2020 and by 13.8 Gt in 2030, relative to the Reference Scenario). About 48% of the additional investment is needed in OECD+ countries. Other Major Economies and Other Countries need 30% and 18% of the additional investment respectively. The rest is needed for international aviation.

In the 450 Scenario, the geographical and sectoral distribution of abatement expenditure and investment does not equate to how those actions will be funded. This is entirely a matter for negotiation. UNFCCC Parties have agreed that developed countries must provide financial support to developing countries, but the determination of the exact level of support is not a matter for the IEA. It is clear that there is a wide range of possible funding outcomes. Under the assumptions adopted in the 450 Scenario, $197 billion of additional investment is made in non-OECD countries in 2020 and an illustration is given of how OECD+ might contribute anywhere between $13 billion and $151 billion of this, in addition to supporting technology transfer and adaptation.

Although lower than in the Reference Scenario, OPEC revenues for oil exports in the 450 Scenario increase to $23 trillion between 2008 and 2030, a four-fold increase, compared with the period 1985-2007. The 450 Scenario also yields energy security benefits and substantially reduced import bills for most importing countries/regions. Human health and environmental benefits accrue due to reduced local pollution:[5] the pollution control costs for sulphur dioxide, nitrogen oxides and

[4] All monetary figures are expressed in 2008 US dollars.

[5] *WEO-2009* will include projections of SO_2, NO_x and PM2.5 (particulate matter with an aerodynamic diameter of less than 2.5 µm) for the Reference and 450 Scenarios. These are derived from IIASA's GAINS model.

particulate matter are reduced by $40 billion in 2020 and by over $100 billion in 2030, relative to the Reference Scenario. The largest savings are in China and the United States.

What is included in the profiles

Statistical results for the 450 Scenario are presented here in the form of profiles for ten major countries and regions: World, OECD+, United States, European Union, Japan, Other Major Economies (OME) as a group, Russia, China, Other Countries (OC) and India.[6] The profile for each country/region includes historical and projected CO_2 emissions and energy demand, key indicators (e.g., population, CO_2 intensity, per capita CO_2 emissions) and details of the emission reductions under the assumptions adopted about different measures and technologies (such as energy efficiency, renewables, biofuels, nuclear, and CO_2 capture and storage). The economic implications of the 450 Scenario are shown in the form of indicators, such as the increased investment required by sector or technology and the reductions in oil and gas import bills. These differ by country/region. The policy opportunities for the country/region in order to achieve the required energy-related CO_2 emissions reductions are listed.

The base year of the projections is 2007. The emission reductions shown in the profiles are achieved within the country/region shown and by the assumed measures; but this carries no implication that abatement measures and investments are funded wholly by the country in which they occur. These results therefore leave entirely open the negotiation of country commitments in the context of a post-2012 climate agreement.

The figures and tables which follow cover the world or various geographical sub-groupings (see above). The figures and tables are in the same format for each area. They fall into seven categories, as set out below. In each case, they are preceded by a set of Highlights, drawn from the figures, and conclude with three staccato points identifying the appropriate actions to realise the assumed savings in each region or country.

Energy-related CO_2 emissions

Figures 2, 7, 12, 17, 22, 27, 32, 37, 42, 47

These charts show historical CO_2 emissions from fossil fuel combustion for 1990 and 2007 (the base year of our projections) and projections for 2020 and 2030 for the Reference and the 450 Scenarios. Emissions are shown by sector, along with the relative shares. Historical CO_2 data come from IEA databases.

Key indicators

Tables 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

These tables show indicators related to energy and CO_2 emissions: per capita and intensity trends, cumulative emissions and sectoral efficiency. GDP is measured in purchasing power parity (PPP) terms and in 2008 US dollars. Per capita energy demand is measured in tonnes of oil equivalent of primary energy demand. Power CO_2 intensity is the average emissions (including new and existing power plants) per kWh of electricity output. Car fleet CO_2 intensity is the average on-road intensity of passenger cars (across the entire fleet) and is indexed to 2007. Historical cumulative CO_2 emissions are derived from Marland et al. (2006).

[6] The regional definitions are given in the section describing the policy framework in the 450 Scenario earlier in the booklet.

Energy-related CO_2 emissions abatement

Figures 3, 8, 13, 18, 23, 28, 33, 38, 43, 48

These charts show the CO_2 emissions savings achieved through the use of energy efficiency at end-use level and in power plants (including more efficient gas and coal plants, switching from coal to gas and early retirements) and from the use of renewables (for electricity generation and heat production), biofuels, nuclear power and CO_2 capture and storage (in power generation and industry). The table that accompanies the chart shows these savings in 2020 and 2030, as well as the corresponding cumulative incremental investment, relative to the Reference Scenario, in the periods 2010-2020 and 2021-2030. Investment in nuclear power in the 450 Scenario in Russia is lower than in the Reference Scenario in the period 2010-2030 because of lower electricity demand and because of the longer operational lifetimes assumed for its nuclear power plants, which reduce the need to build new capacity. Russia's incremental investment has been expressed as zero. The incremental investment in nuclear power in Other Major Economies as a whole for the period 2010-2020 takes account of the reduction in nuclear investment in Russia, with the net result that OME incremental investment is actually smaller than that of China.

Power generation capacity in the 450 Scenario

Figures 4, 9, 14, 19, 24, 29, 34, 39, 44, 49

These charts show power generation capacity for 2007, 2020 and 2030 by technology: coal-fired capacity without CO_2 capture and storage (CCS), gas-fired capacity without CCS, CCS capacity (coal and gas are shown together), nuclear power, hydropower (including small and large), wind power (including onshore and offshore) and other renewables (biomass, geothermal, solar and tide and wave power).

Share of passenger vehicle sales by technology and average new vehicle on-road CO_2 intensity in the 450 Scenario

Figures 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

These charts show the shares of conventional (internal combustion engine), hybrid, plug-in hybrid and electric vehicles in total sales in 2007 and in the 450 Scenario for 2020 and 2030. They also show the average on-road CO_2 intensity that corresponds to these sales (measured in grammes per kilometre and taking into account the use of biofuels).

Additional investment in the 450 Scenario relative to the Reference Scenario

Figures 6, 11, 16, 21, 26, 31, 36, 41, 46, 51

These charts show incremental annual investment needs in transport, biofuels production, buildings (including rooftop photovoltaics), power plants and industry (including industrial CCS), relative to the Reference Scenario.

Profiles: Regional Analysis

World

Highlights

- 6% global increase in energy-related CO_2 emissions by 2020, relative to 2007, to meet 450 Scenario
- Power generation CO_2 intensity decreasing by 21% and average car fleet CO_2 intensity decreasing by 37% by 2020 in 450 Scenario compared with 2007
- 3% increase in emissions from buildings and 9% increase in industry in 450 Scenario by 2020, relative to 2007
- Additional investment, relative to Reference Scenario, in low-carbon technologies and energy efficiency close to $430 billion in 2020 to meet 450 Scenario

Emissions

Figure 2: World energy-related CO_2 emissions

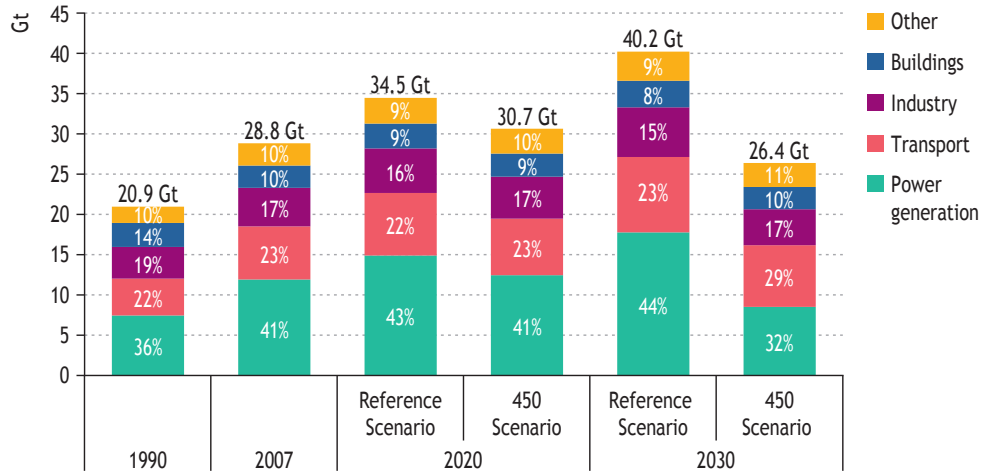
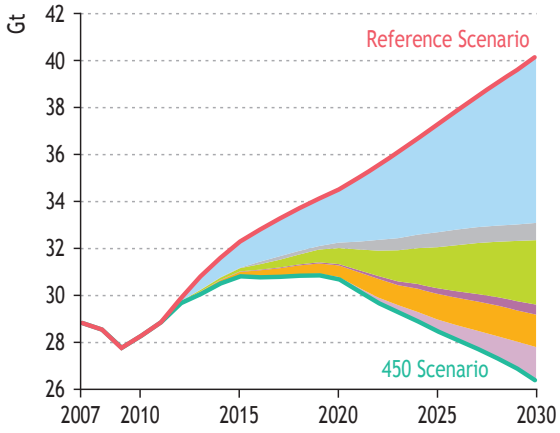


Table 1: World key indicators

	1990	2007	2020		2030	
			Reference Scenario	450 Scenario	Reference Scenario	450 Scenario
Population (million)	5 263	6 614	7 608		8 236	
Share of world population	100%	100%	100%		100%	
GDP ($2008 trillion, PPP)	38.6	67.2	102.1		137.0	
Share of world GDP	100%	100%	100%		100%	
Share of world CO_2 emissions	100%	100%	100%	100%	100%	100%
CO_2 emissions per capita (t)	4.0	4.4	4.5	4.0	4.9	3.2
Energy demand per capita (toe)	1.7	1.8	1.9	1.8	2.0	1.7
CO_2 intensity index (world 2007=100)	126	100	79	70	68	45
Cumulative CO_2 since 1890 (Gt)	778	1 201	1 608	1 589	1 984	1 871
Share of cumulative world CO_2	100%	100%	100%	100%	100%	100%
Power CO_2 intensity (g/kWh)	632	603	549	479	520	283
Car fleet CO_2 intensity (2007=100)	n.a.	100	78	63	75	47

Technology outlook

Figure 3: World energy-related CO_2 emissions abatement



	Abatement (Mt CO_2)		Investment ($2008 billion)	
	2020	2030	2010-2020	2021-2030
Efficiency	2 517	7 880	1 999	5 586
End-use	2 284	7 145	1 933	5 551
Power plants	233	735	66	35
Renewables	680	2 741	527	2 260
Biofuels	57	429	27	378
Nuclear	493	1 380	125	491
CCS	102	1 410	56	646

Figure 4: World power generation capacity in the 450 Scenario

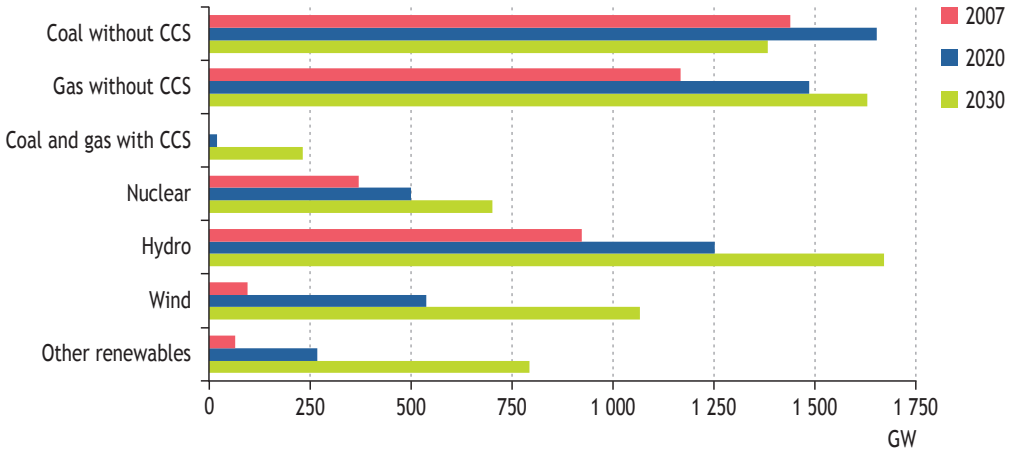
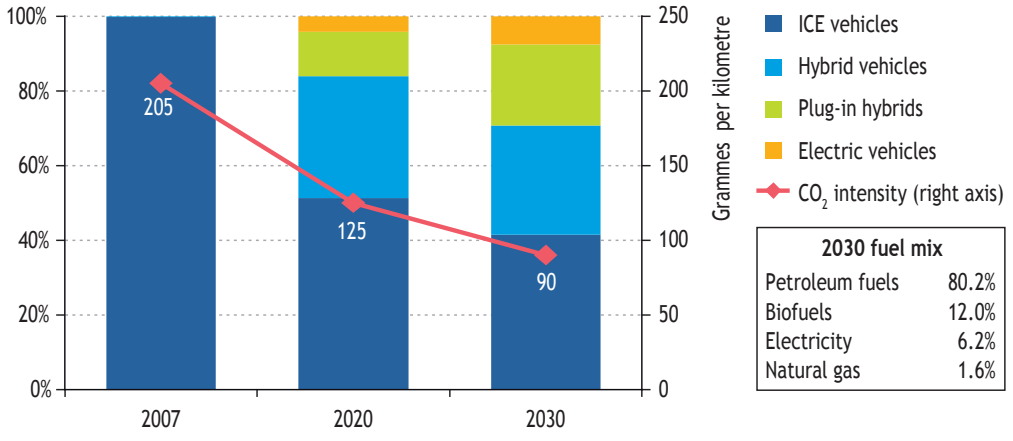


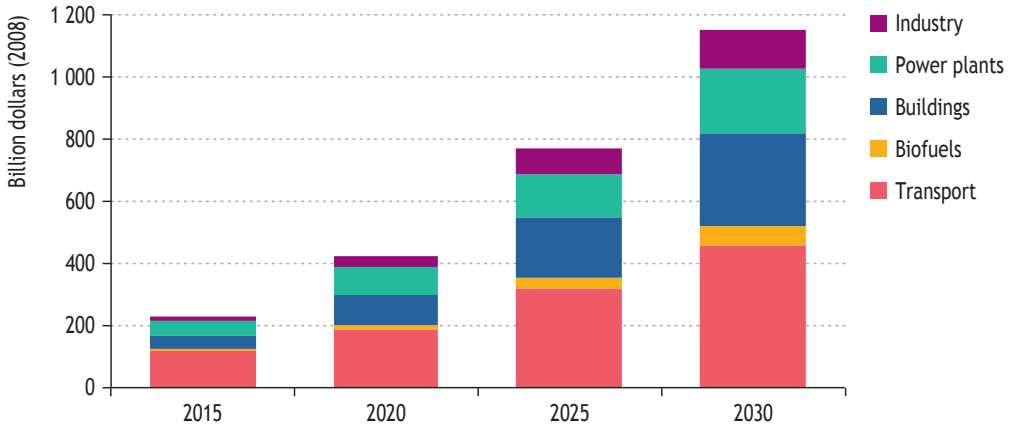
Figure 5: World share of passenger vehicle sales by technology and average new vehicle on-road CO_2 intensity in the 450 Scenario



2030 fuel mix	
Petroleum fuels	80.2%
Biofuels	12.0%
Electricity	6.2%
Natural gas	1.6%

Cost and benefits

Figure 6: World additional investment in the 450 Scenario relative to the Reference Scenario



- Additional cumulative investment cost: almost $2 400 billion over 2010-2020 and $8 100 billion over 2021-2030
- Total investment in the 450 Scenario of almost $6 600 billion in low-carbon power generation over 2010-2030 (72% renewables, 19% nuclear, 9% CCS)
- Incremental investment cost equal to 0.5% of GDP in 2020, rising to 1.1% of GDP in 2030
- Total fuel cost saving of $8 600 billion between 2010 and 2030, across industry, buildings and transport
- Local air pollution costs reduced by $40 billion in 2020 and $100 billion in 2030, relative to the Reference Scenario

Policy opportunities

- An ambitious, robust global agreement in Copenhagen, which will credibly deliver substantial emissions abatement relative to the Reference Scenario, with financial and technology support to ensure that all regions contribute and including an expanded, reformed CDM
- Faster deployment of low-carbon power technologies, which together account for over 5 Gt of abatement relative to the Reference Scenario by 2030. This includes much faster roll-out of renewables and nuclear - and urgent investment in and development of CO_2 capture and storage
- A transformation in end-use efficiency investment, to deliver over 7 Gt of abatement by 2030. Much of this will be carried out by households, who need strong incentives to purchase more efficient vehicles and appliances

OECD+

Highlights

- 17% reduction in energy-related CO_2 emissions by 2020, relative to 2007, to meet 450 Scenario
- Power generation CO_2 intensity decreasing by 29% and average car fleet CO_2 intensity decreasing by 39% by 2020, compared with 2007
- 10% reduction in emissions from buildings and 17% reduction in industry by 2020, relative to 2007
- Additional investment in low-carbon technologies and energy efficiency close to $220 billion in 2020 to meet the 450 Scenario

Emissions

Figure 7: OECD+ energy-related CO_2 emissions

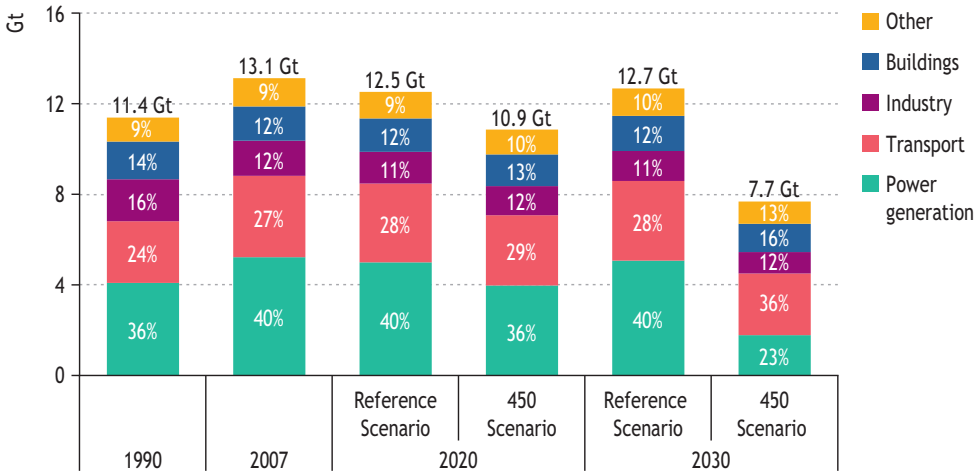
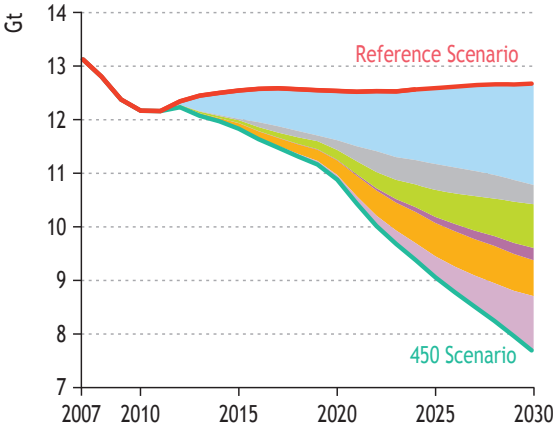


Table 2: OECD+ key indicators

	1990	2007	2020 Reference Scenario	2020 450 Scenario	2030 Reference Scenario	2030 450 Scenario
Population (million)	1 090	1 229	1 307		1 344	
Share of world population	21%	19%	17%		16%	
GDP ($2008 trillion, PPP)	26.2	40.1	49.7		60.0	
Share of world GDP	68%	60%	49%		44%	
Share of world CO_2 emissions	54%	46%	36%	35%	32%	29%
CO_2 emissions per capita (t)	10.4	10.7	9.6	8.3	9.4	5.7
Energy demand per capita (toe)	4.2	4.5	4.3	4.1	4.4	3.9
CO_2 intensity index (world 2007=100)	101	76	59	51	49	30
Cumulative CO_2 since 1890 (Gt)	498	700	863	854	989	944
Share of cumulative world CO_2	64%	58%	54%	54%	50%	50%
Power CO_2 intensity (g/kWh)	528	484	417	343	380	145
Car fleet CO_2 intensity (2007=100)	n.a.	100	74	61	69	43

Technology outlook

Figure 8: OECD+ energy-related CO_2 emissions abatement



	Abatement ($Mt CO_2$)		Investment ($2008 billion)	
	2020	2030	2010-2020	2021-2030
Efficiency	1 102	2 253	1 158	2 332
End-use	921	1 894	1 117	2 319
Power plants	181	359	42	13
Renewables	184	816	204	831
Biofuels	12	228	8	223
Nuclear	271	670	64	241
CCS	86	1 013	48	512

Figure 9: OECD+ power generation capacity in the 450 Scenario

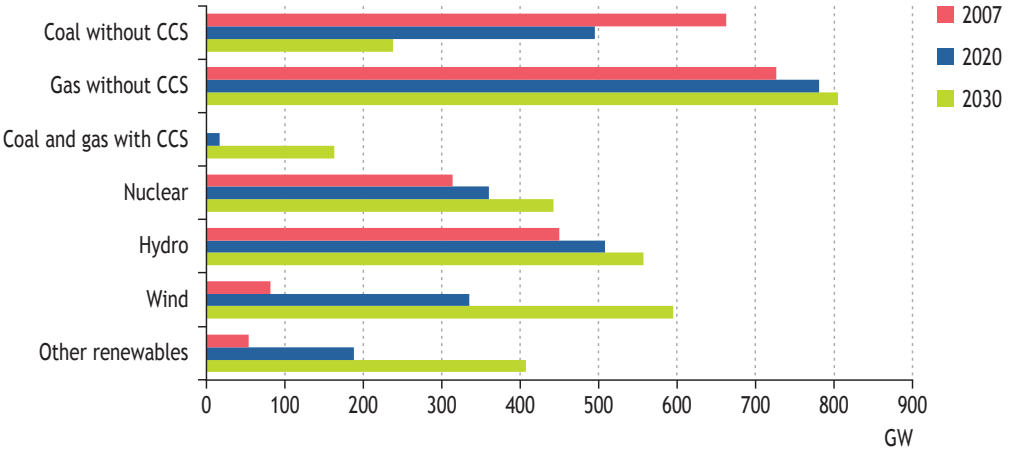
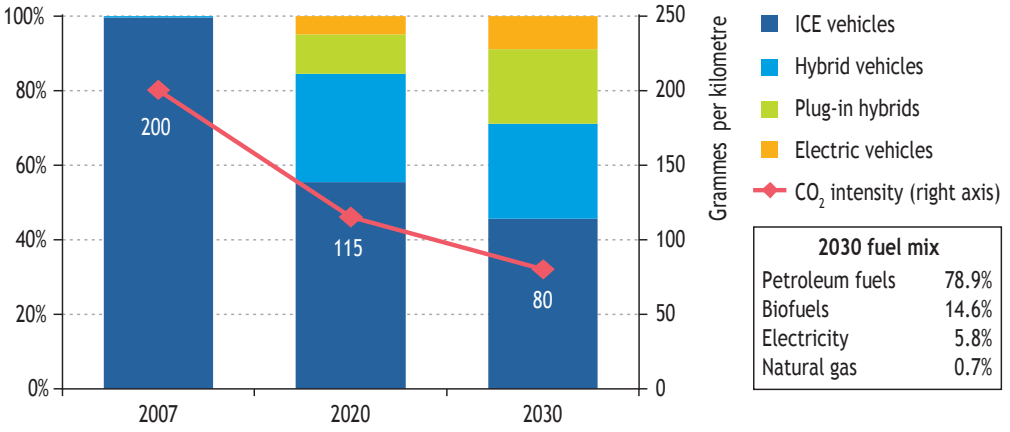


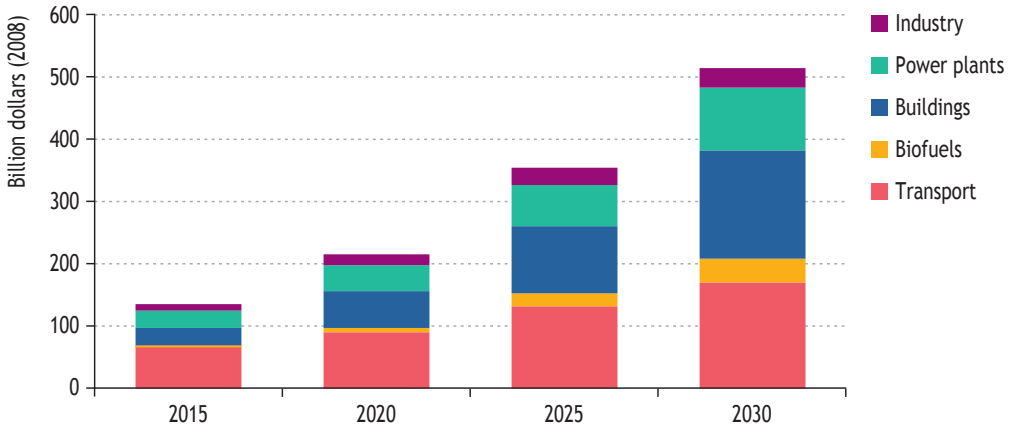
Figure 10: OECD+ share of passenger vehicle sales by technology and average new vehicle on-road CO_2 intensity in the 450 Scenario



2030 fuel mix	
Petroleum fuels	78.9%
Biofuels	14.6%
Electricity	5.8%
Natural gas	0.7%

Cost and benefits

Figure 11: OECD+ additional investment in the 450 Scenario relative to the Reference Scenario



- Additional cumulative investment cost: in excess of $1 300 billion over 2010-2020; nearly $3 700 billion over 2021-2030
- Total investment in the 450 Scenario of over $3 100 billion in low-carbon power generation over 2010-2030 (65% renewables, 20% nuclear, 15% CCS)
- Incremental investment cost equal to 0.4% of GDP in 2020, rising to 0.8% of GDP in 2030
- Oil savings of 7.3 mb/d in 2030 in the 450 Scenario, compared with the Reference Scenario - an amount close to China's 2008 oil demand
- Local air pollution costs reduced in excess of $20 billion in 2020 and $50 billion in 2030, relative to the Reference Scenario

Policy opportunities

- Implement an OECD-wide emissions trading scheme to deliver emission reductions in power generation and industry
- Expand support mechanisms for end-use sectors to encourage investment in energy efficiency in buildings and transport
- Facilitate the transfer of low-carbon technologies to non-OECD countries, through international sectoral agreements, the purchase of carbon credits and other measures

United States

Highlights

- 18% reduction in energy related CO_2 emissions by 2020 (relative to 2007) to meet 450 Scenario
- Power generation CO_2 intensity decreasing by 25% and average car fleet CO_2 intensity decreasing by 41% by 2020, compared with 2007
- 16% reduction in CO_2 emissions from buildings and 25% reduction in industry by 2020, relative to 2007
- Additional investment in low-carbon technologies and energy efficiency of close to $90 billion in 2020 to meet 450 Scenario

Emissions

Figure 12: United States energy-related CO_2 emissions

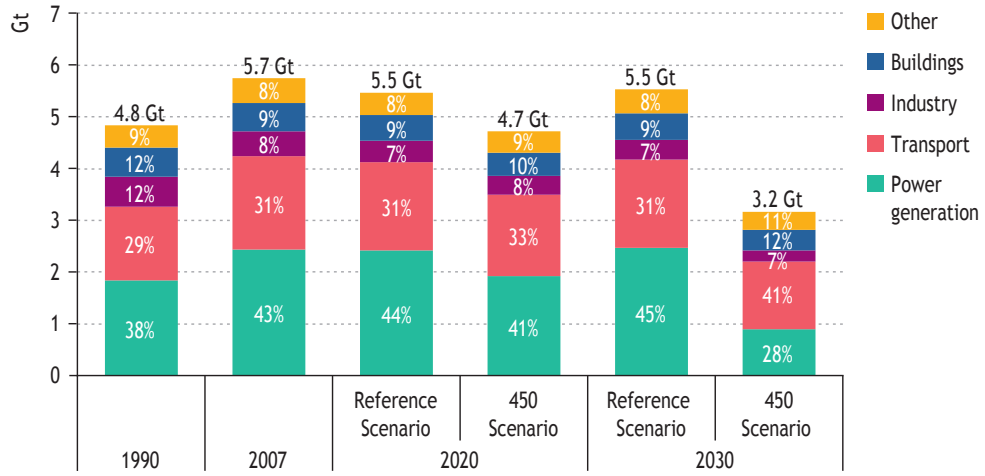
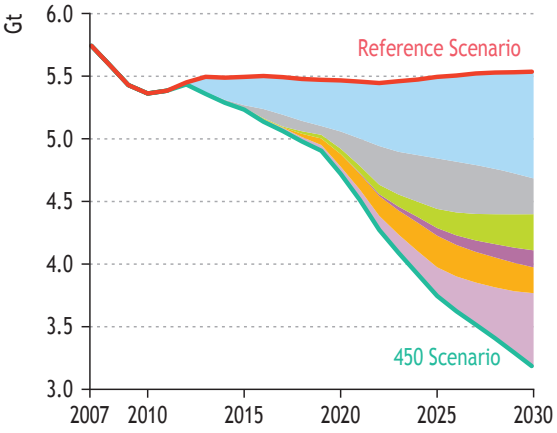


Table 3: United States key indicators

	1990	2007	2020 Reference Scenario	2020 450 Scenario	2030 Reference Scenario	2030 450 Scenario
Population (million)	254	306	343		367	
Share of world population	5%	5%	5%		4%	
GDP ($2008 trillion, PPP)	8.7	14.1	18.1		22.4	
Share of world GDP	23%	21%	18%		16%	
Share of world CO_2 emissions	23%	20%	16%	15%	14%	12%
CO_2 emissions per capita (t)	19.1	18.7	15.9	13.7	15.1	8.6
Energy demand per capita (toe)	7.5	7.6	6.7	6.3	6.5	5.7
CO_2 intensity index (world 2007=100)	130	95	70	61	58	33
Cumulative CO_2 since 1890 (Gt)	239	333	404	400	459	437
Share of cumulative world CO_2	31%	28%	25%	25%	23%	23%
Power CO_2 intensity (g/kWh)	577	565	509	423	468	185
Car fleet CO_2 intensity (2007=100)	n.a.	100	80	59	72	39

Technology outlook

Figure 13: United States energy-related CO_2 emissions abatement



	Abatement (Mt CO_2)		Investment ($2008 billion)	
	2020	2030	2010-2020	2021-2030
Efficiency	548	1 141	475	955
End-use	411	855	443	949
Power plants	137	286	32	5
Renewables	43	288	36	330
Biofuels	0	136	0	127
Nuclear	101	206	62	77
CCS	57	593	33	300

Figure 14: United States power generation capacity in the 450 Scenario

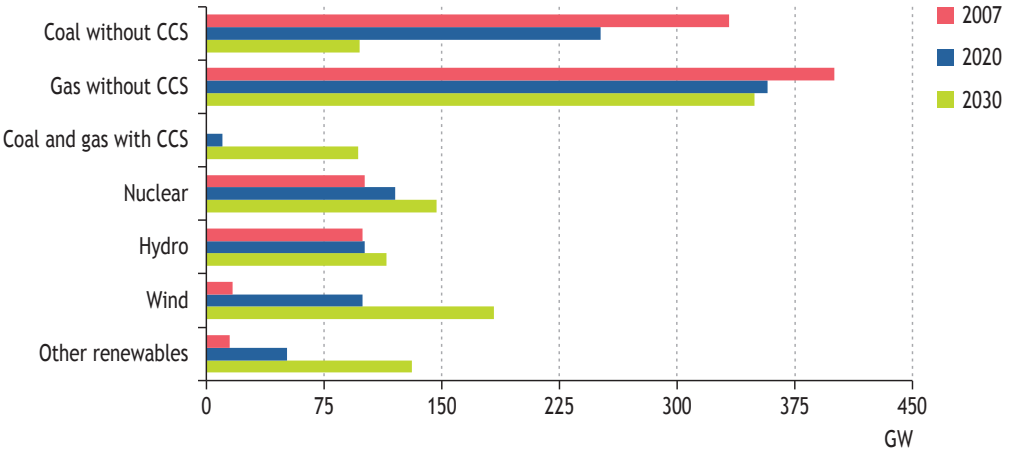
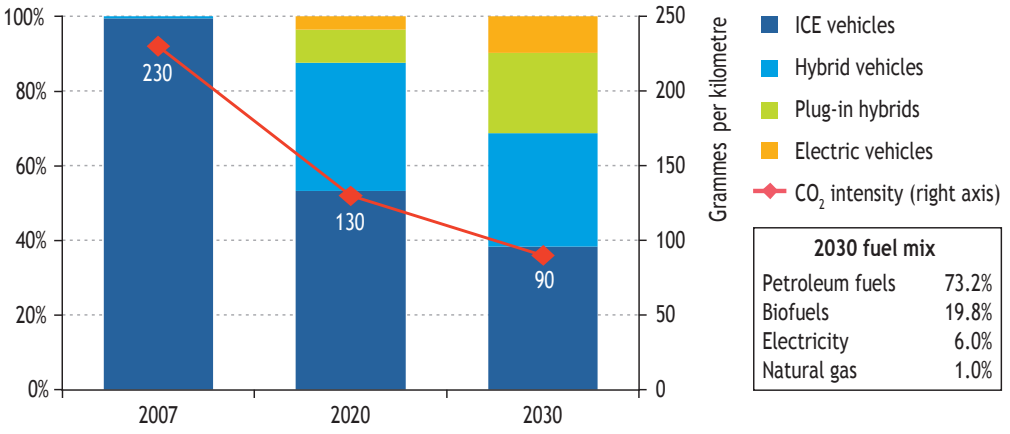


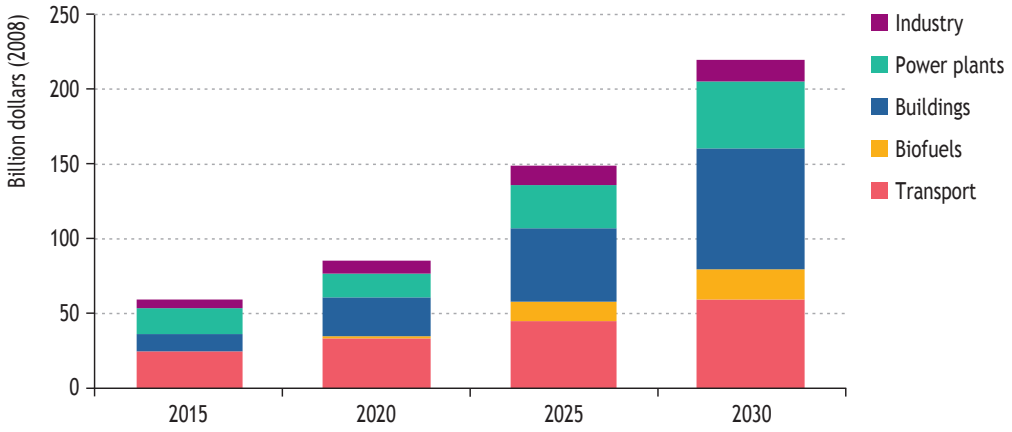
Figure 15: United States share of passenger vehicle sales by technology and average new vehicle on-road CO_2 intensity in the 450 Scenario



2030 fuel mix	
Petroleum fuels	73.2%
Biofuels	19.8%
Electricity	6.0%
Natural gas	1.0%

Cost and benefits

Figure 16: United States additional investment in the 450 Scenario relative to the Reference Scenario



- Additional cumulative investment cost: in excess of $520 billion over 2010-2020; $1 500 billion over 2021-2030
- Total investment in the 450 Scenario of over $1 100 billion in low-carbon power generation over 2010-2030 (53% renewables, 27% CCS, 19% nuclear)
- Incremental investment cost equal to 0.5% of GDP in 2020, rising to 1.0% of GDP in 2030
- Oil and gas import bill reduced by $80 billion in 2020 and nearly $155 billion in 2030, compared with the Reference Scenario
- Local air pollution costs reduced by close to $10 billion in 2020 and in excess of $20 billion in 2030, relative to the Reference Scenario

Policy opportunities

- Establish a cap-and-trade scheme that promotes domestic reductions and allows the purchase of credits to support emissions reductions in other countries and sectors
- Provide funding for CCS to achieve commercialisation by 2020; and encourage investment in renewables and nuclear power
- Strengthen policies and standards for new and refurbished buildings and reduce the CO_2 intensity of new passenger vehicles to 110 grammes per km by 2020

European Union

Highlights

- 20% reduction in energy-related CO_2 emissions by 2020 (relative to 2007) to meet 450 Scenario
- Power generation CO_2 intensity decreasing by 37% and average car fleet CO_2 intensity decreasing by 37% by 2020, compared with 2007
- 7% reduction in emissions from buildings and 17% reduction in industry by 2020, relative to 2007
- Additional investment in low-carbon technologies and energy efficiency of $70 billion in 2020 to meet 450 Scenario

Emissions

Figure 17: European Union energy-related CO_2 emissions

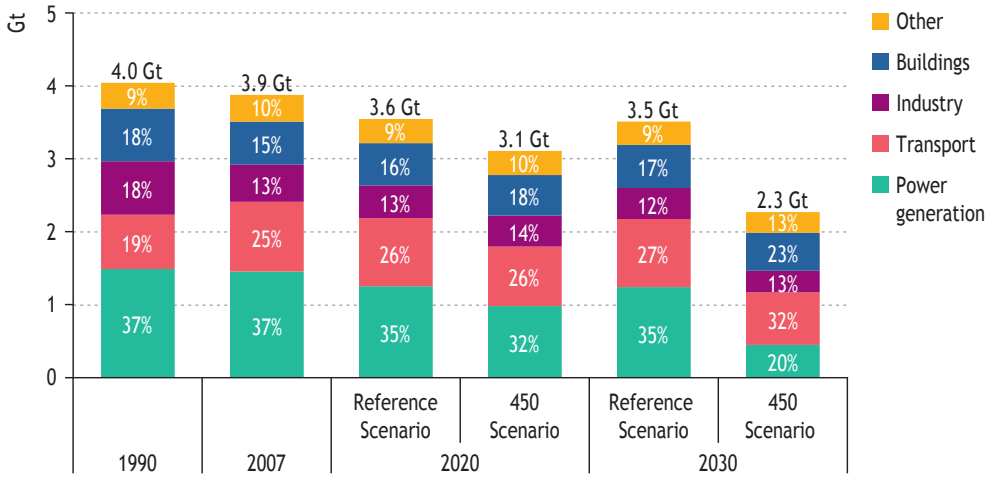
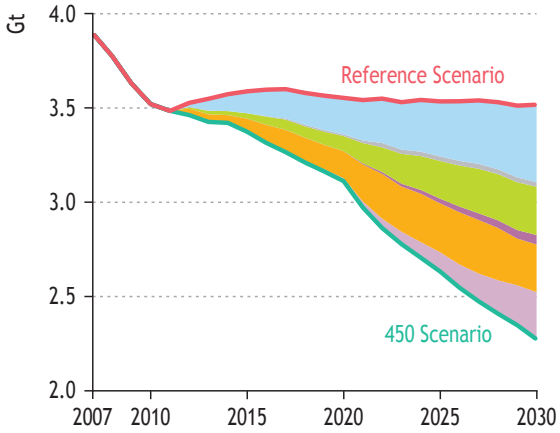


Table 4: European Union key indicators

	1990	2007	2020 Reference Scenario	2020 450 Scenario	2030 Reference Scenario	2030 450 Scenario
Population (million)	473	496	508		508	
Share of world population	9%	7%	7%		6%	
GDP ($2008 trillion, PPP)	10.4	15.1	17.9		21.3	
Share of world GDP	27%	22%	18%		16%	
Share of world CO_2 emissions	19%	13%	10%	10%	9%	9%
CO_2 emissions per capita (t)	8.5	7.8	7.0	6.1	6.9	4.5
Energy demand per capita (toe)	3.5	3.5	3.4	3.3	3.5	3.3
CO_2 intensity index (world 2007=100)	90	60	46	40	39	25
Cumulative CO_2 since 1890 (Gt)	211	276	322	320	358	346
Share of cumulative world CO_2	27%	23%	20%	20%	18%	18%
Power CO_2 intensity (g/kWh)	581	436	348	275	312	118
Car fleet CO_2 intensity (2007=100)	n.a.	100	74	63	65	46

Technology outlook

Figure 18: European Union energy-related CO_2 emissions abatement



	Abatement (Mt CO_2) 2020	2030	Investment ($2008 billion) 2010-2020	2021-2030
Efficiency	206	438	392	709
End-use	197	414	387	709
Power plants	9	24	5	0
Renewables	80	256	113	268
Biofuels	1	50	4	60
Nuclear	143	253	0	88
CCS	16	250	9	126

Figure 19: European Union power generation capacity in the 450 Scenario

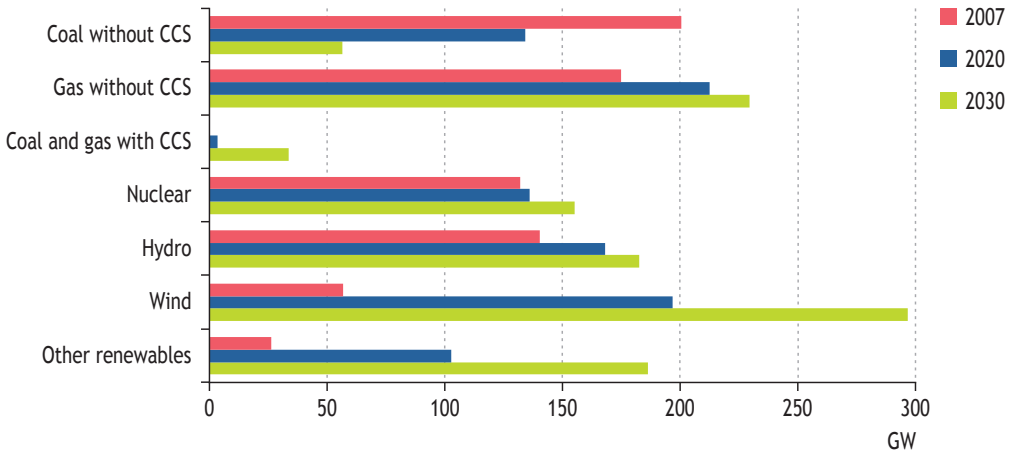
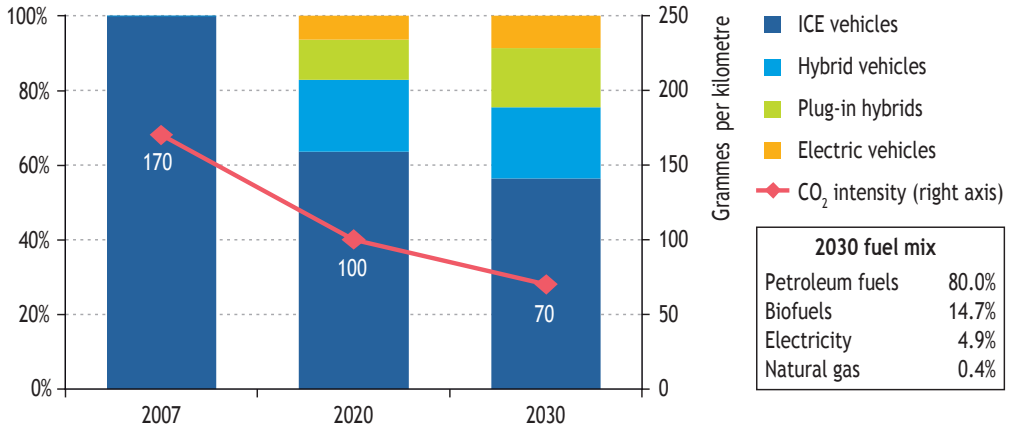


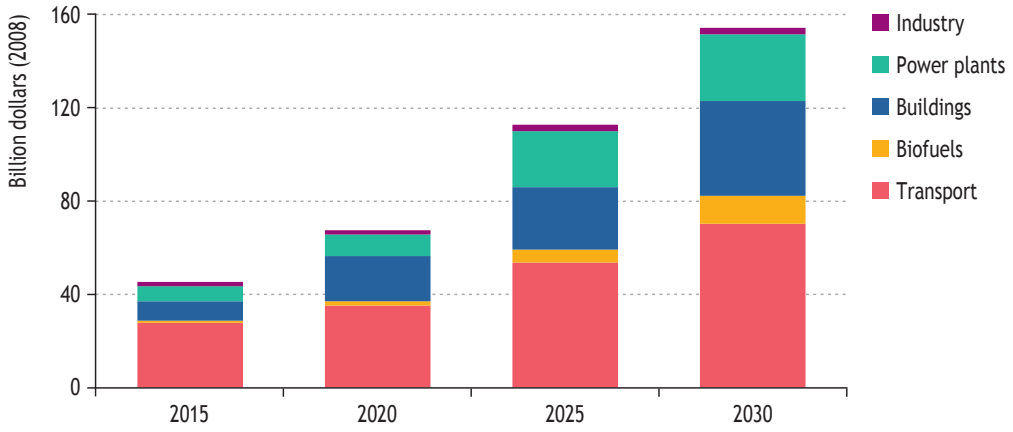
Figure 20: European Union share of passenger vehicle sales by technology and average new vehicle on-road CO_2 intensity in the 450 Scenario



2030 fuel mix	
Petroleum fuels	80.0%
Biofuels	14.7%
Electricity	4.9%
Natural gas	0.4%

Cost and benefits

Figure 21: European Union additional investment in the 450 Scenario relative to the Reference Scenario



- Additional cumulative investment cost: nearly $500 billion over 2010-2020; in excess of $1 100 billion over 2021-2030
- Total investment in the 450 Scenario of nearly $1 300 billion in low-carbon power generation over 2010-2030 (77% renewables, 16% nuclear, 7% CCS)
- Incremental investment cost equal to 0.3% of GDP in 2020, rising to 0.6% of GDP in 2030
- Oil and gas import bill reduced in excess of $90 billion in 2020 and nearly $240 billion in 2030, compared with the Reference Scenario
- Local air pollution costs reduced by $9 billion in 2020 and $15 billion in 2030, relative to the Reference Scenario

Policy opportunities

- Continue the policy support to increase the use of renewables in electricity, heat and biofuels production to reach the 20% target in 2020; strengthen the framework to support renewables for heat
- Support the commercialisation of CCS through a carbon price via the emissions trading scheme and through additional funding, such as the revenues from 300 million allowances for early demonstration projects
- Enhance policies to achieve greater efficiency in buildings; and meet the target of 95 g CO_2 per km for new passenger cars by 2020

Japan

Highlights

- 22% reduction in energy related CO_2 emissions by 2020 (relative to 2007) to meet 450 Scenario
- Power generation CO_2 intensity decreasing by 28% and average car fleet CO_2 intensity decreasing by 39% by 2020, compared with 2007
- 9% reduction in CO_2 emissions from buildings and 16% reduction in industry by 2020, relative to 2007
- Additional investment in low-carbon technologies and energy efficiency of $17 billion in 2020 to meet 450 Scenario

Emissions

Figure 22: Japan energy-related CO_2 emissions

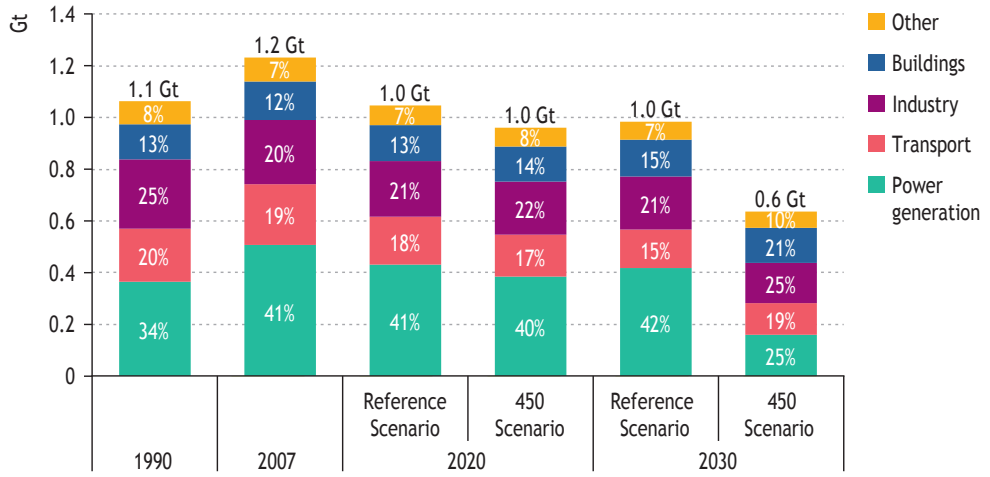
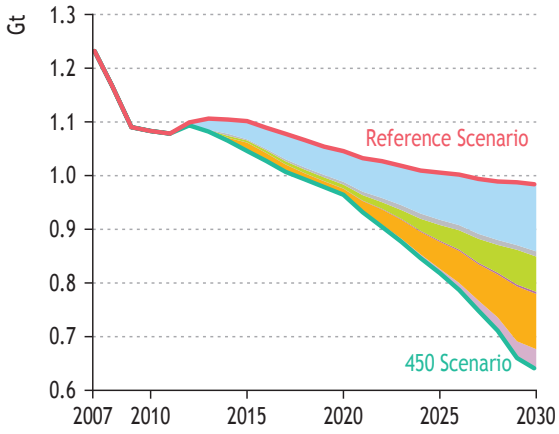


Table 5: Japan key indicators

	1990	2007	2020 Reference Scenario	2020 450 Scenario	2030 Reference Scenario	2030 450 Scenario
Population (million)	123	128	124		118	
Share of world population	2%	2%	2%		1%	
GDP ($2008 trillion, PPP)	3.5	4.4	4.9		5.5	
Share of world GDP	9%	7%	5%		4%	
Share of world CO_2 emissions	5%	4%	3%	3%	2%	2%
CO_2 emissions per capita (t)	8.6	9.6	8.4	7.8	8.4	5.4
Energy demand per capita (toe)	3.5	4.0	3.9	3.7	4.1	3.8
CO_2 intensity index (world 2007=100)	71	65	50	46	42	27
Cumulative CO_2 since 1890 (Gt)	29	48	63	62	73	70
Share of cumulative world CO_2	4%	4%	4%	4%	4%	4%
Power CO_2 intensity (g/kWh)	435	450	354	326	321	134
Car fleet CO_2 intensity (2007=100)	n.a.	100	79	61	72	48

Technology outlook

Figure 23: Japan energy-related CO_2 emissions abatement



	Abatement ($Mt CO_2$)		Investment ($2008 billion)	
	2020	2030	2010-2020	2021-2030
Efficiency	65	138	77	164
End-use	60	128	74	161
Power plants	5	10	3	3
Renewables	7	66	21	71
Biofuels	1	4	1	7
Nuclear	10	103	0	36
CCS	1	38	1	21

Figure 24: Japan power generation capacity in the 450 Scenario

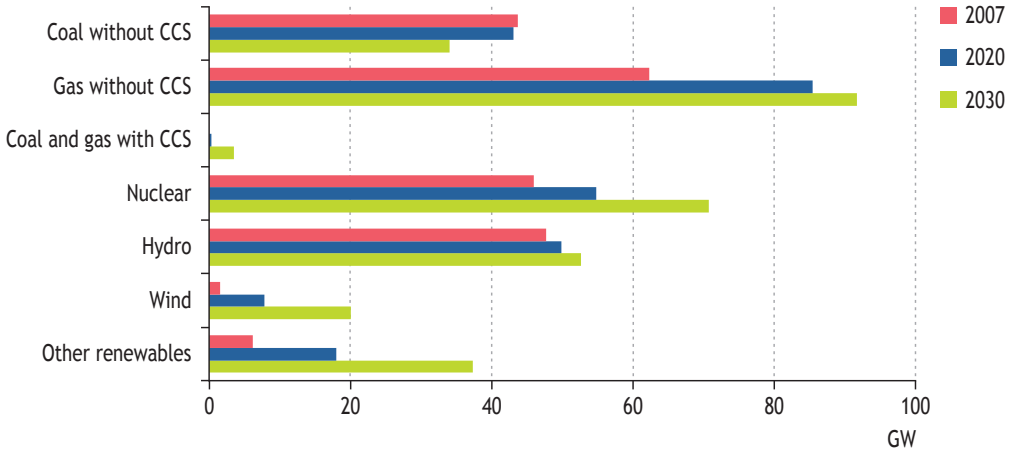
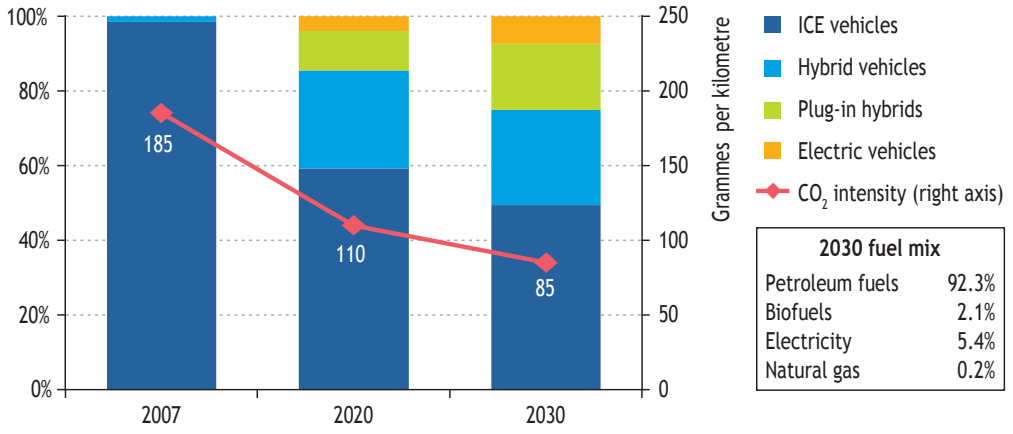


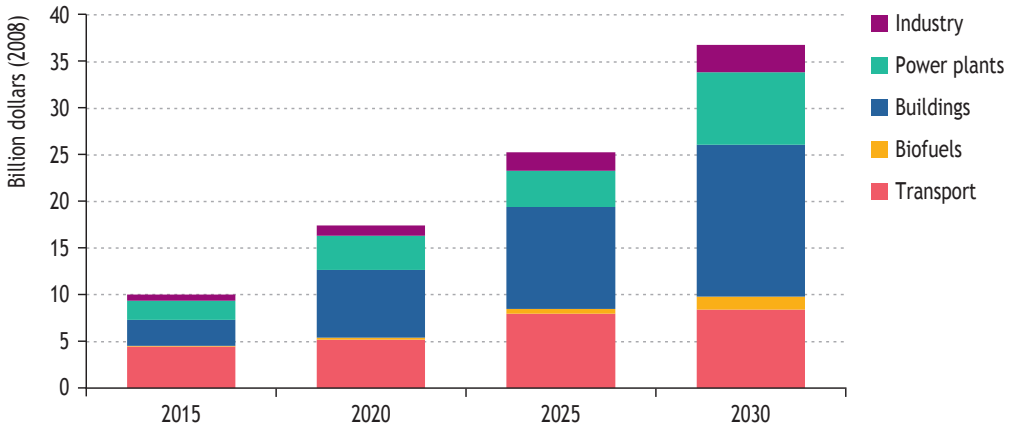
Figure 25: Japan share of passenger vehicle sales by technology and average new vehicle on-road CO_2 intensity in the 450 Scenario



2030 fuel mix	
Petroleum fuels	92.3%
Biofuels	2.1%
Electricity	5.4%
Natural gas	0.2%

Cost and benefits

Figure 26: Japan additional investment in the 450 Scenario relative to the Reference Scenario



- Additional cumulative investment cost: close to $90 billion over 2010-2020; $280 billion over 2021-2030
- Total investment in the 450 Scenario in excess of $200 billion in low-carbon power generation over 2010-2030 (50% renewables, 46% nuclear, 4% CCS)
- Incremental investment cost equal to 0.3% of GDP in 2020, rising to 0.6% by 2030
- Oil and gas import bill reduced in excess of $30 billion in 2020 and $60 billion in 2030, compared with the Reference Scenario
- Local air pollution costs reduced by $2 billion in 2020 and $5 billion in 2030, relative to the Reference Scenario

Policy opportunities

- Promote the use of cleaner energy and efficiency in buildings – efficient though they are, there is scope for more - through greater use of photovoltaics, advanced water heaters and more heat insulation
- Accelerate the construction of nuclear power plants and raise the average load factor to achieve a greater than 40% share of nuclear power in total electricity generation by 2030
- Substantially increase the share of next generation vehicles (including electric and hybrid cars)

Other Major Economies

Highlights

- 30% increase in energy-related CO_2 emissions by 2020 (relative to 2007) to meet 450 Scenario
- Power generation CO_2 intensity decreasing by 21% and average car fleet CO_2 intensity decreasing by 38% by 2020, compared with 2007
- 22% increase in emissions from buildings and 19% increase in industry by 2020, relative to 2007
- Additional investment in low-carbon technologies and energy efficiency in excess of $120 billion in 2020 to meet 450 Scenario

Emissions

Figure 27: Other Major Economies energy-related CO_2 emissions

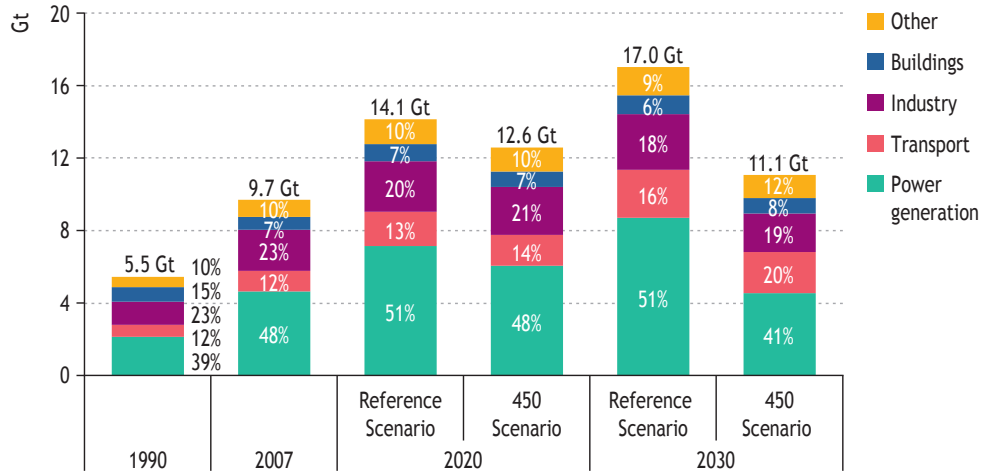
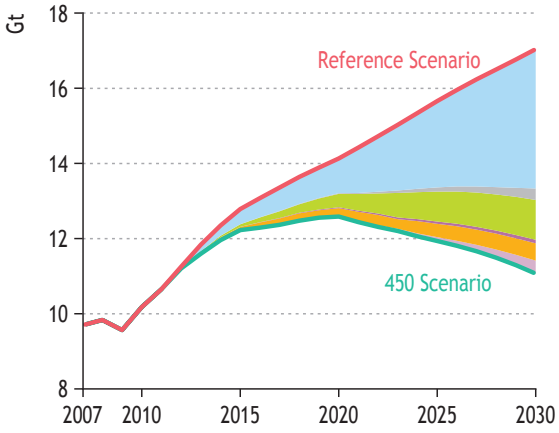


Table 6: Other Major Economies key indicators

	1990	2007	2020 Reference Scenario	2020 450 Scenario	2030 Reference Scenario	2030 450 Scenario
Population (million)	1 605	1 901	2 069		2 140	
Share of world population	31%	29%	27%		26%	
GDP ($2008 trillion, PPP)	6.2	14.4	29.8		43.5	
Share of world GDP	16%	21%	29%		32%	
Share of world CO_2 emissions	26%	34%	41%	41%	42%	42%
CO_2 emissions per capita (t)	3.4	5.1	6.8	6.1	8.0	5.2
Energy demand per capita (toe)	1.4	1.9	2.5	2.3	2.9	2.3
CO_2 intensity index (world 2007=100)	205	157	111	99	91	59
Cumulative CO_2 since 1890 (Gt)	187	319	476	468	633	586
Share of cumulative world CO_2	24%	27%	30%	29%	32%	31%
Power CO_2 intensity (g/kWh)	906	814	715	641	664	421
Car fleet CO_2 intensity (2007=100)	n.a.	100	80	62	74	44

Technology outlook

Figure 28: Other Major Economies energy-related CO_2 emissions abatement



	Abatement (Mt CO_2)		Investment ($2008 billion)	
	2020	2030	2010-2020	2021-2030
Efficiency	944	4 018	491	1 889
End-use	927	3 713	477	1 883
Power plants	17	305	14	6
Renewables	357	1 059	231	685
Biofuels	23	94	11	56
Nuclear	209	459	57	134
CCS	12	345	5	109

Figure 29: Other Major Economies power generation capacity in the 450 Scenario

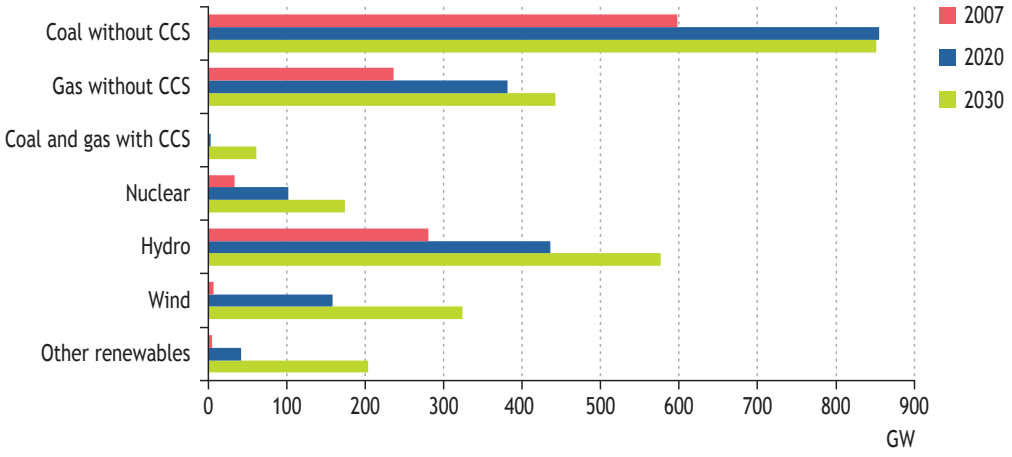
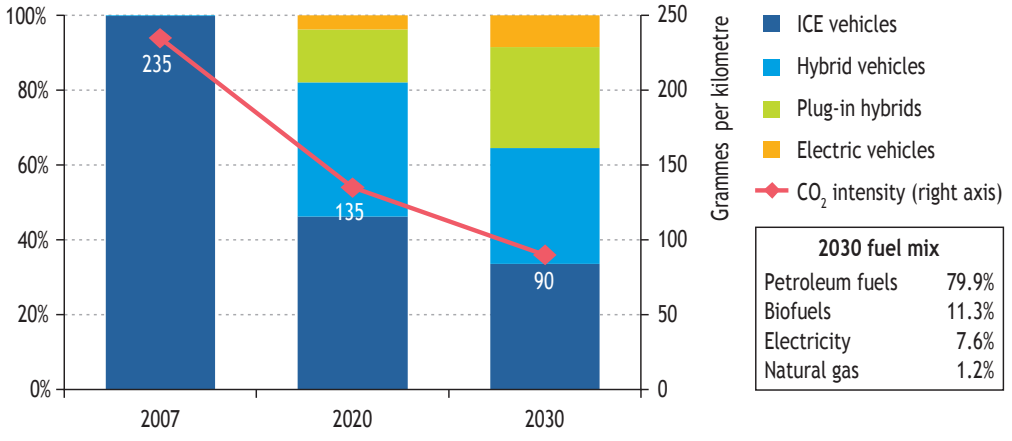
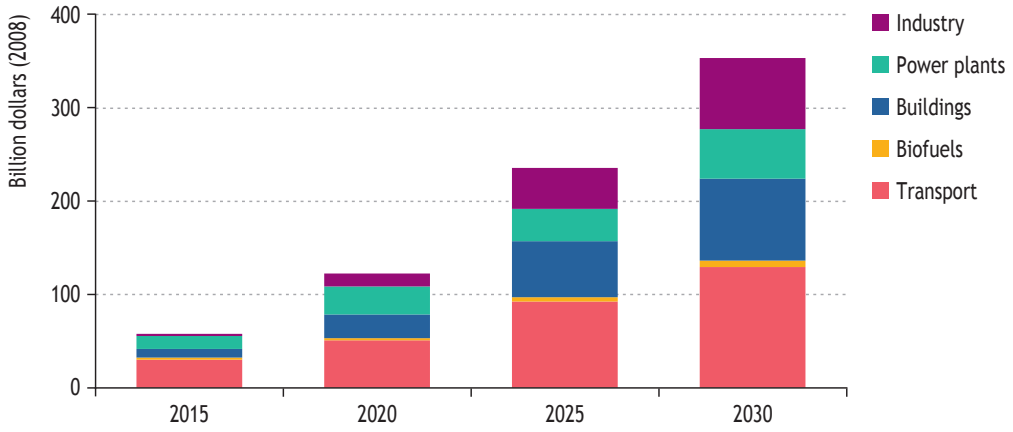


Figure 30: Other Major Economies share of passenger vehicle sales by technology and average new vehicle on-road CO_2 intensity in the 450 Scenario



Cost and benefits

Figure 31: Other Major Economies additional investment in the 450 Scenario relative to the Reference Scenario



- Additional cumulative investment cost: in excess of $620 billion over 2010-2020; nearly $2 500 billion over 2021-2030
- Total investment in the 450 Scenario of close to $2 000 billion in low-carbon power generation over 2010-2030 (72% renewables, 22% nuclear, 6% CCS)
- Incremental investment cost equal to 0.7% of GDP in 2020, rising to 1.3% by 2030
- Oil savings of 4.7 mb/d in 2030 in the 450 Scenario, compared with the Reference Scenario, an amount close to Japan's 2008 oil demand
- Local air pollution costs reduced in excess of $10 billion in 2020 and $40 billion in 2030, relative to the Reference Scenario

Policy opportunities

- Reduce the environmental footprint of fossil-fuels, especially through price subsidy reform, and diversify energy supply to obtain greater reliance on renewables and nuclear power
- Promote energy efficiency measures, such as setting building codes, and participate in international sectoral agreements in order to ensure adoption of less polluting technologies in industry and passenger cars
- Further develop carbon credit markets through the implementation of CDM projects and capitalise on this experience to participate in an emissions trading scheme soon after 2020

Russia

Highlights

- 1% increase in energy-related CO_2 emissions by 2020 (relative to 2007) to meet 450 Scenario
- Power generation CO_2 intensity decreasing by 17% and average car fleet CO_2 intensity decreasing by 36% by 2020, compared with 2007
- 2% increase in emissions from buildings and 3% decrease in industry by 2020, relative to 2007
- Additional investment in low-carbon technologies and energy efficiency of close to $8 billion in 2020 to meet 450 Scenario

Emissions

Figure 32: Russia energy-related CO_2 emissions

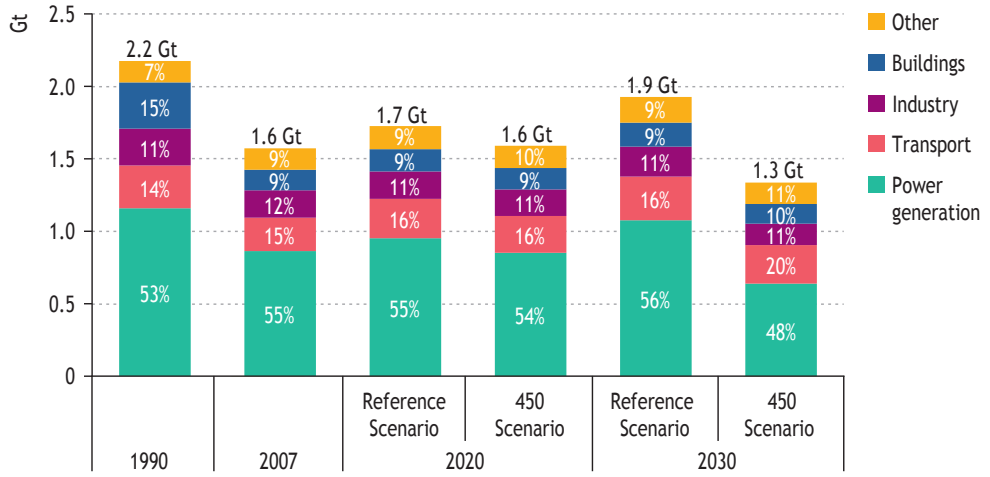
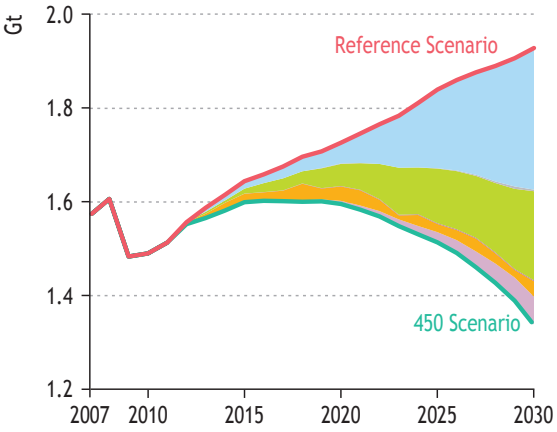


Table 7: Russia key indicators

	1990	2007	2020 Reference Scenario	2020 450 Scenario	2030 Reference Scenario	2030 450 Scenario
Population (million)	148	142	135		129	
Share of world population	3%	2%	2%		2%	
GDP ($2008 trillion, PPP)	2.0	2.1	3.4		4.6	
Share of world GDP	5%	3%	3%		3%	
Share of world CO_2 emissions	10%	5%	5%	5%	5%	5%
CO_2 emissions per capita (t)	14.7	11.1	12.8	11.8	15.0	10.4
Energy demand per capita (toe)	5.9	4.7	5.4	5.2	6.3	5.3
CO_2 intensity index (world 2007=100)	250	171	120	111	98	68
Cumulative CO_2 since 1890 (Gt)	107	135	156	156	175	170
Share of cumulative world CO_2	14%	11%	10%	10%	9%	9%
Power CO_2 intensity (g/kWh)	1 074	854	781	711	756	501
Car fleet CO_2 intensity (2007=100)	n.a.	100	91	64	86	51

Technology outlook

Figure 33: Russia energy-related CO_2 emissions abatement



	Abatement (Mt CO_2)		Investment ($2008 billion)	
	2020	2030	2010-2020	2021-2030
Efficiency	48	308	51	153
End-use	47	305	48	153
Power plants	1	3	3	0
Renewables	47	190	7	89
Biofuels	1	2	0	1
Nuclear	31	33	0	0
CCS	7	59	3	25

Figure 34: Russia power generation capacity in the 450 Scenario

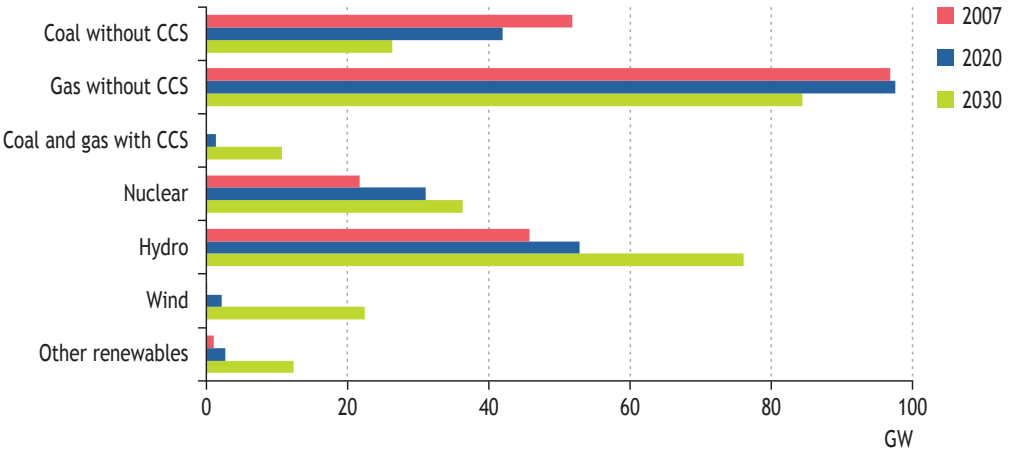
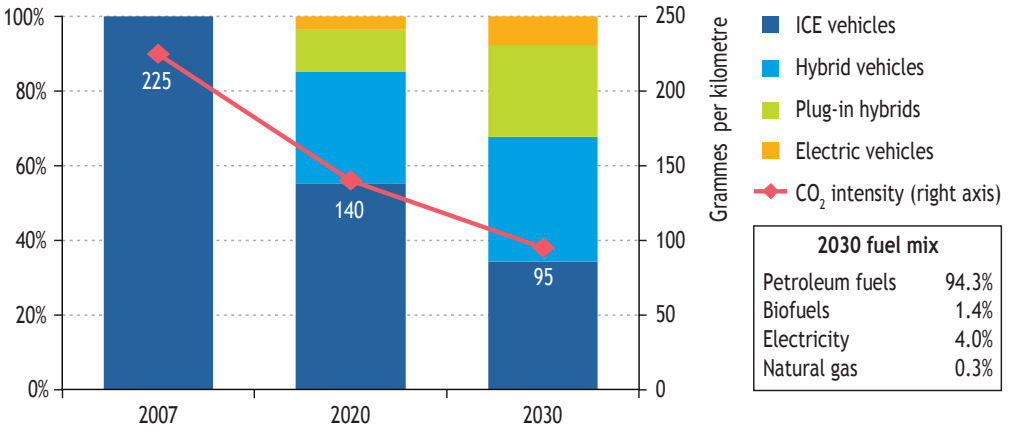
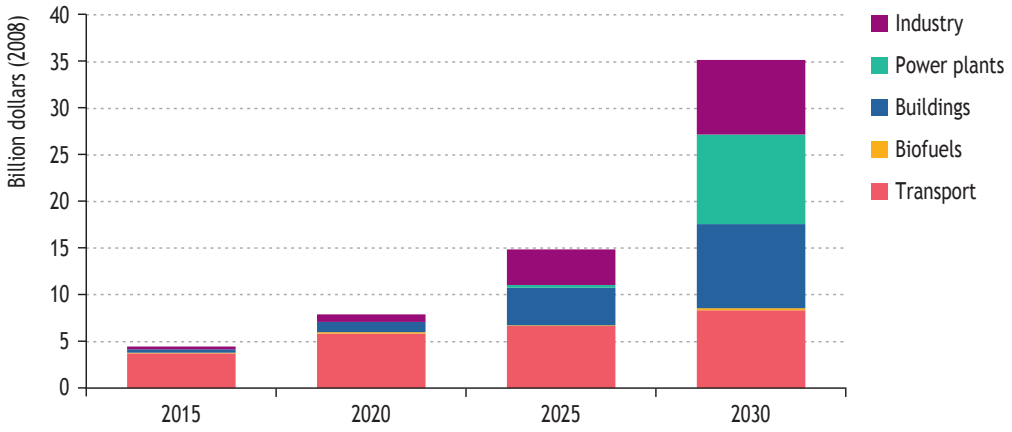


Figure 35: Russia share of passenger vehicle sales by technology and average new vehicle on-road CO_2 intensity in the 450 Scenario



Cost and benefits

Figure 36: Russia additional investment in the 450 Scenario relative to the Reference Scenario



- Additional cumulative investment cost: $18 billion over 2010-2020 and $180 billion over 2021-2030
- Total investment in the 450 Scenario of in excess of $220 billion in low-carbon power generation over 2010-2030 (58% renewables, 30% nuclear, 12% CCS)
- Incremental investment cost equal to 0.3% of GDP in 2020, rising to 1.0% by 2030
- Oil savings of 0.3 mb/d in 2030 in the 450 Scenario compared with the Reference Scenario
- Local air pollution costs reduced by $1 billion in 2020 and $3 billion in 2030, relative to the Reference Scenario

Policy opportunities

- Adopt the Law on Energy Efficiency and ensure its effective implementation to reduce energy losses in industry, the residential sector and transport
- Create the conditions for greater use of renewable energy in electricity generation by deciding on support measures and engaging the private sector
- Continue to implement price subsidy reform by following through on the government plans to raise domestic energy prices

China

Highlights

- 38% increase in energy related CO_2 emissions by 2020 (relative to 2007) to meet 450 Scenario
- Power generation CO_2 intensity decreasing by 24% and average car fleet CO_2 intensity decreasing by 42% by 2020, compared with 2007
- 37% increase in CO_2 emissions from buildings and 19% increase in industry by 2020, relative to 2007
- Additional investment in low-carbon technologies and energy efficiency of $80 billion in 2020 to meet 450 Scenario

Emissions

Figure 37: China energy-related CO_2 emissions

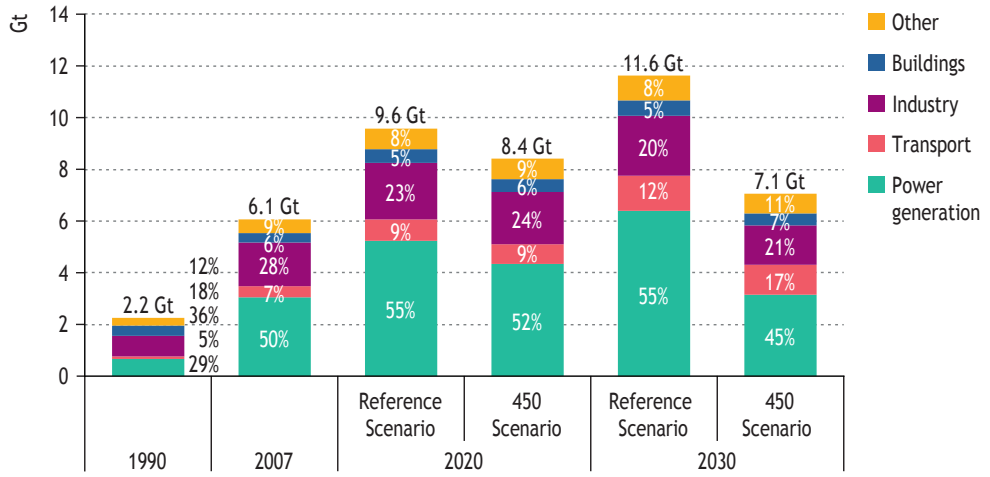
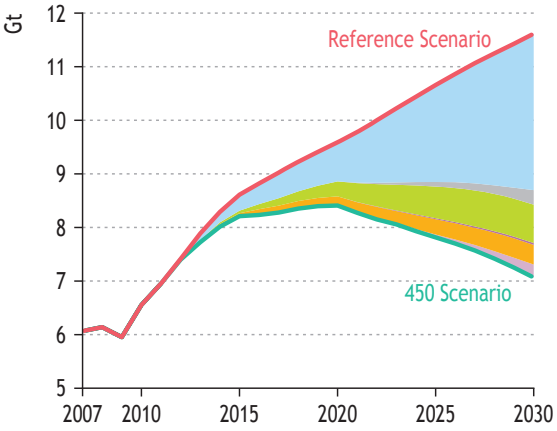


Table 8: China key indicators

	1990	2007	2020 Reference Scenario	2020 450 Scenario	2030 Reference Scenario	2030 450 Scenario
Population (million)	1 141	1 327	1 429		1 461	
Share of world population	22%	20%	19%		18%	
GDP ($2008 trillion, PPP)	1.5	7.6	18.8		28.5	
Share of world GDP	4%	11%	18%		21%	
Share of world CO_2 emissions	11%	21%	28%	27%	29%	27%
CO_2 emissions per capita (t)	2.0	4.6	6.7	5.9	8.0	4.8
Energy demand per capita (toe)	0.8	1.5	2.2	2.0	2.6	2.0
CO_2 intensity index (world 2007=100)	349	187	119	104	95	58
Cumulative CO_2 since 1890 (Gt)	42	104	208	202	315	280
Share of cumulative world CO_2	5%	9%	13%	13%	16%	15%
Power CO_2 intensity (g/kWh)	1 003	922	782	698	722	448
Car fleet CO_2 intensity (2007=100)	n.a.	100	76	58	72	43

Technology outlook

Figure 38: China energy-related CO_2 emissions abatement



	Abatement (Mt CO_2)		Investment ($2008 billion)	
	2020	2030	2010-2020	2021-2030
Efficiency	728	3 195	266	1 210
End-use	728	2 923	257	1 205
Power plants	0	272	8	5
Renewables	279	715	208	485
Biofuels	0	35	1	28
Nuclear	168	366	63	107
CCS	3	243	1	68

Figure 39: China power generation capacity in the 450 Scenario

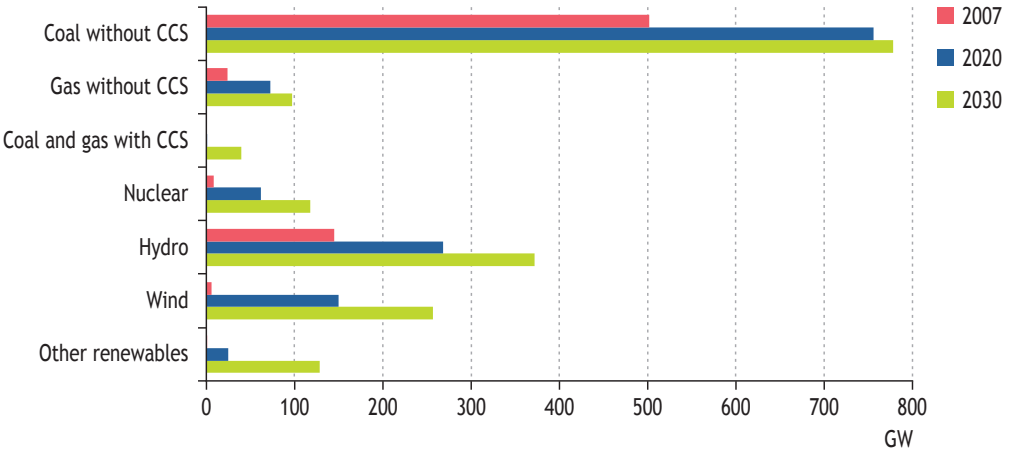
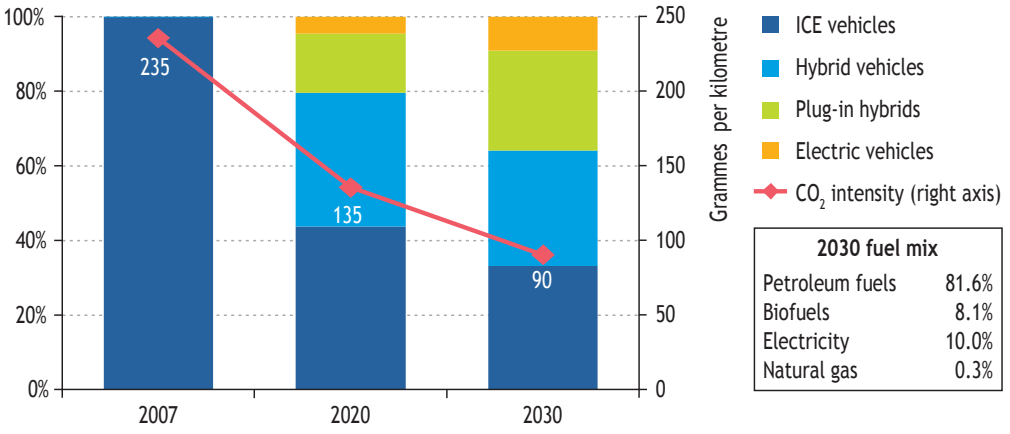
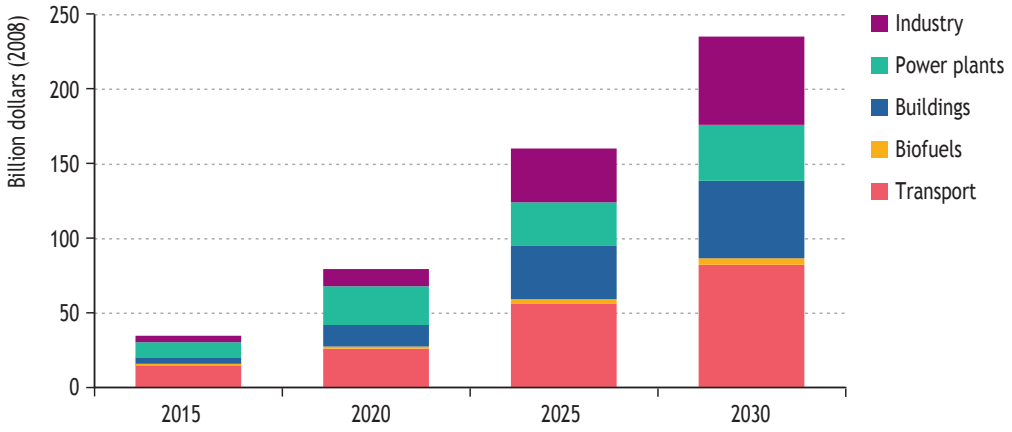


Figure 40: China share of passenger vehicle sales by technology and average new vehicle on-road CO_2 intensity in the 450 Scenario



Cost and benefits

Figure 41: China additional investment in the 450 Scenario relative to the Reference Scenario



- Additional cumulative investment cost: nearly $400 billion over 2010-2020 and $1 700 billion over 2021-2030
- Total investment in the 450 Scenario of nearly $1 500 billion in low-carbon power generation over 2010-2030 (73% renewables, 22% nuclear, 5% CCS)
- Incremental investment cost equal to 0.8% of GDP in 2020, rising to 1.5% by 2030
- Oil and gas import bill reduced by nearly $40 billion in 2020 and $170 billion in 2030, compared with the Reference Scenario
- Local air pollution costs reduced by around $10 billion in 2020 and in excess of $30 billion in 2030, relative to the Reference Scenario

Policy opportunities

- Continue recent ambitious policies to raise the share of nuclear, wind and solar power (16% of installed capacity by 2020) in power generation and raise hydropower capacity to 300 GW by 2020
- Intensify efforts to rebalance the economy towards services, which would moderate growth in industrial emissions
- Establish standards for the efficiency of new buildings, appliances and lighting and promote efforts to save energy in buildings, as prescribed in China's Medium and Long Term Energy Conservation Plan

Other Countries

Highlights

- 22% increase in energy-related CO_2 emissions by 2020 (relative to 2007) to meet 450 Scenario
- Power generation CO_2 intensity decreasing by 22% and average car fleet CO_2 intensity decreasing by 26% by 2020, compared with 2007
- 14% increase in emissions from buildings and 28% increase in industry by 2020, relative to 2007
- Additional investment in low-carbon technologies and energy efficiency in excess of $70 billion in 2020 to meet 450 Scenario

Emissions

Figure 42: Other Countries energy-related CO_2 emissions

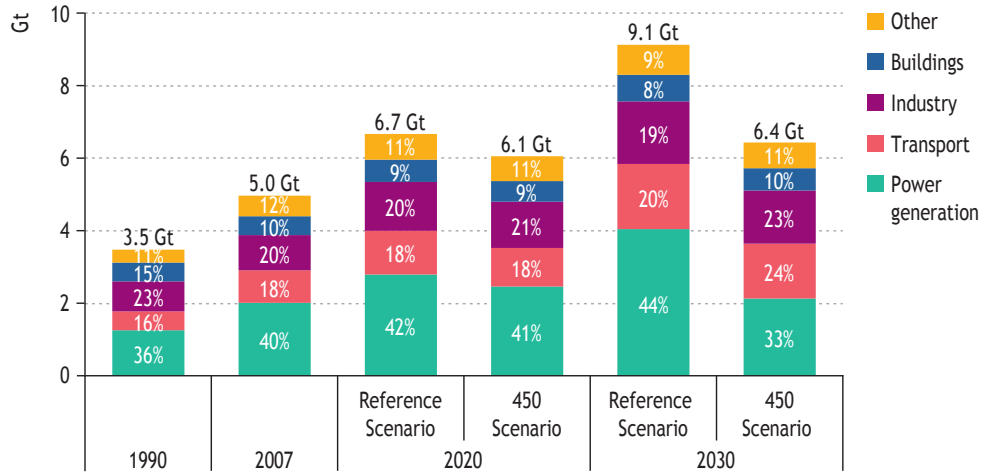
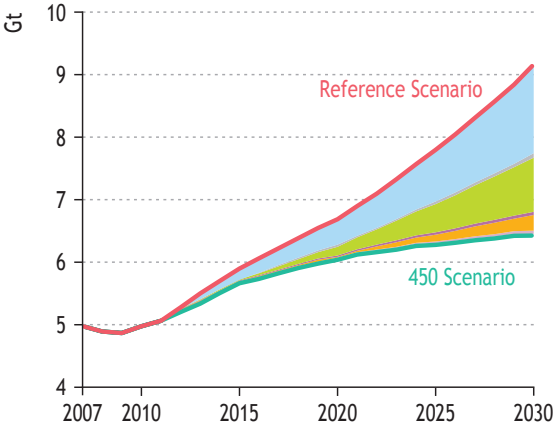


Table 9: Other Countries key indicators

	1990	2007	2020 Reference Scenario	2020 450 Scenario	2030 Reference Scenario	2030 450 Scenario
Population (million)	2 568	3 484	4 232		4 753	
Share of world population	49%	53%	56%		58%	
GDP ($2008 trillion, PPP)	6.2	12.7	22.6		33.5	
Share of world GDP	16%	19%	22%		24%	
Share of world CO_2 emissions	17%	17%	19%	20%	23%	24%
CO_2 emissions per capita (t)	1.4	1.4	1.6	1.4	1.9	1.4
Energy demand per capita (toe)	0.7	0.7	0.8	0.7	0.9	0.8
CO_2 intensity index (world 2007=100)	132	91	69	62	64	45
Cumulative CO_2 since 1890 (Gt)	92	178	252	249	331	312
Share of cumulative world CO_2	12%	15%	16%	16%	17%	17%
Power CO_2 intensity (g/kWh)	727	627	535	489	518	314
Car fleet CO_2 intensity (2007=100)	n.a.	100	95	74	88	59

Technology outlook

Figure 43: Other Countries energy-related CO_2 emissions abatement



	Abatement (Mt CO_2)		Investment ($2008 billion)	
	2020	2030	2010-2020	2021-2030
Efficiency	443	1 469	308	982
End-use	408	1 398	297	965
Power plants	35	71	11	16
Renewables	139	865	92	745
Biofuels	22	50	9	32
Nuclear	12	250	4	117
CCS	4	53	2	25

Figure 44: Other Countries power generation capacity in the 450 Scenario

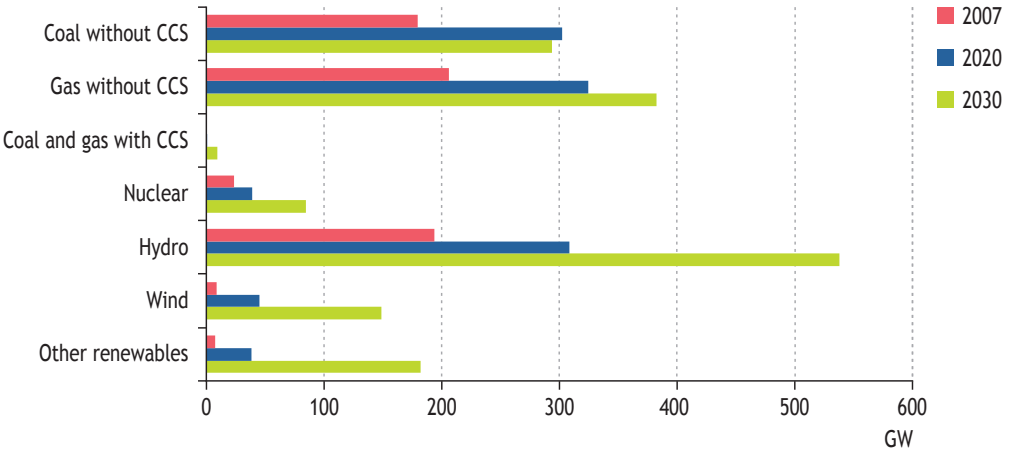
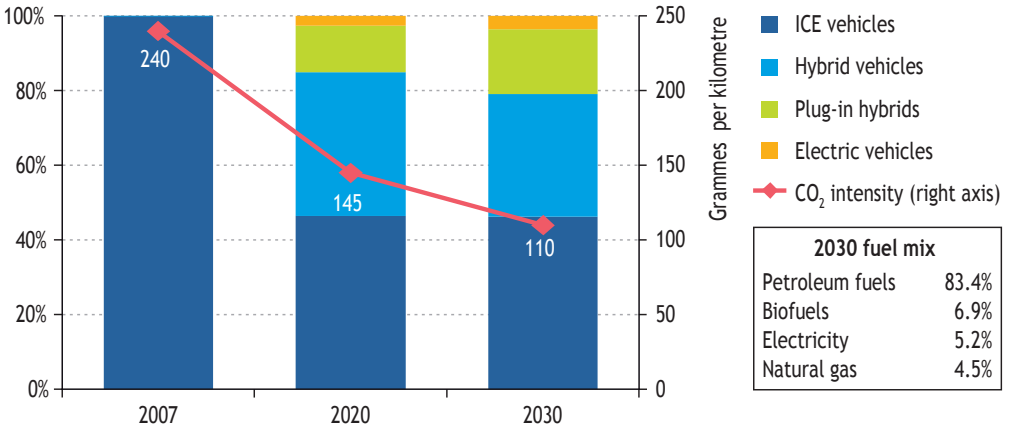


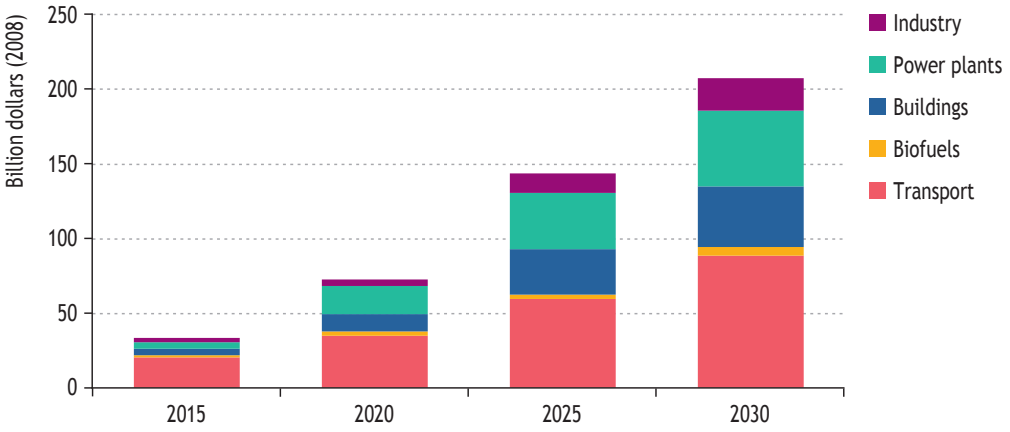
Figure 45: Other Countries share of passenger vehicle sales by technology and average new vehicle on-road CO_2 intensity in the 450 Scenario



2030 fuel mix	
Petroleum fuels	83.4%
Biofuels	6.9%
Electricity	5.2%
Natural gas	4.5%

Cost and benefits

Figure 46: Other Countries additional investment in the 450 Scenario relative to the Reference Scenario



- Additional cumulative investment cost: nearly $400 billion over 2010-2020; close to $1 500 billion over 2021-2030
- Total investment in the 450 Scenario of over $1 450 billion in low-carbon power generation over 2010-2030 (85% renewables, 13% nuclear, 1% CCS)
- Incremental investment cost equal to 0.6% of GDP in 2020, rising to 1.2% by 2030
- Oil savings of 3.3 mb/d in 2030 in the 450 Scenario, compared with the Reference Scenario, an amount close to India's 2008 oil demand
- Local air pollution costs reduced by $4 billion in 2020 and in excess of $10 billion in 2030, relative to the Reference Scenario

Policy opportunities

- Reduce the environmental footprint of fossil-fuels, especially through price subsidy reform, and diversify energy supply through greater reliance on renewables and nuclear power
- Define national potentials for energy efficiency, set building codes and participate in international sectoral agreements to adopt less polluting technologies in industry and passenger cars
- Expand the role of CDM to attract much needed investment, to achieve economic development and cleaner energy technologies at the same time

India

Highlights

- 44% increase in energy-related CO_2 emissions by 2020 (relative to 2007) to meet 450 Scenario
- Power generation CO_2 intensity decreasing by 33% and average car fleet CO_2 intensity decreasing by 34% by 2020, compared with 2007
- 25% increase in emissions from buildings and 66% increase in industry by 2020, relative to 2007
- Additional investment in low-carbon technologies and energy efficiency of nearly $25 billion in 2020 to meet 450 Scenario

Emissions

Figure 47: India energy-related CO_2 emissions

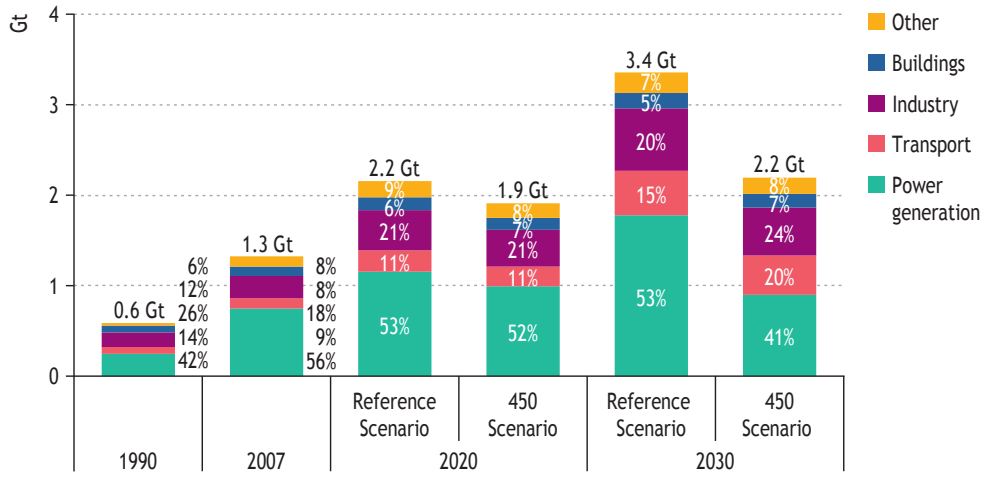
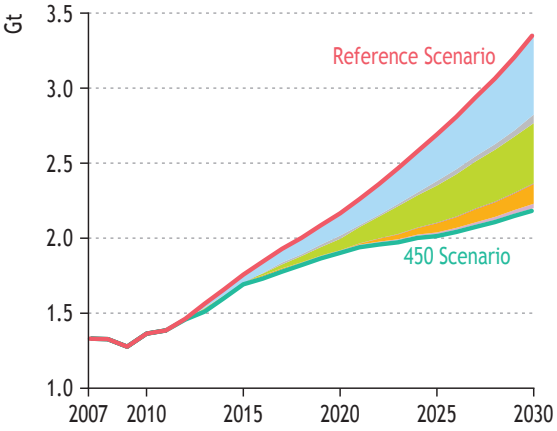


Table 10: India key indicators

	1990	2007	2020 Reference Scenario	2020 450 Scenario	2030 Reference Scenario	2030 450 Scenario
Population (million)	850	1 123	1 319		1 432	
Share of world population	16%	17%	17%		17%	
GDP ($2008 trillion, PPP)	1.1	3.1	7.1		12.5	
Share of world GDP	3%	5%	7%		9%	
Share of world CO_2 emissions	3%	5%	6%	6%	8%	8%
CO_2 emissions per capita (t)	0.7	1.2	1.6	1.4	2.3	1.5
Energy demand per capita (toe)	0.4	0.5	0.7	0.6	0.9	0.8
CO_2 intensity index (world 2007=100)	126	101	71	63	63	41
Cumulative CO_2 since 1890 (Gt)	13	31	52	51	80	72
Share of cumulative world CO_2	2%	3%	3%	3%	4%	4%
Power CO_2 intensity (g/kWh)	848	942	698	628	650	376
Car fleet CO_2 intensity (2007=100)	n.a.	100	89	66	83	53

Technology outlook

Figure 48: India energy-related CO_2 emissions abatement



	Abatement (Mt CO_2)		Investment ($2008 billion)	
	2020	2030	2010-2020	2021-2030
Efficiency	170	601	74	301
End-use	148	544	66	290
Power plants	22	57	8	11
Renewables	76	400	48	312
Biofuels	1	5	1	11
Nuclear	0	131	0	59
CCS	2	30	1	11

Figure 49: India power generation capacity in the 450 Scenario

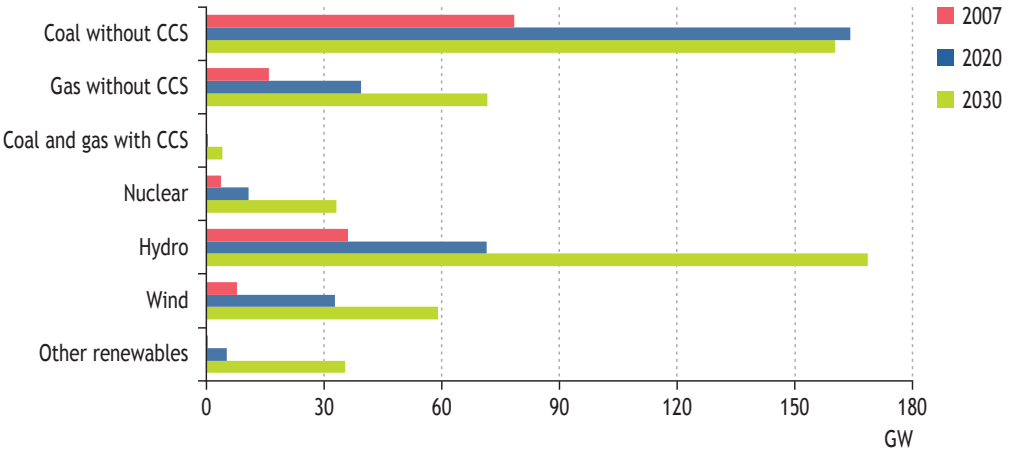
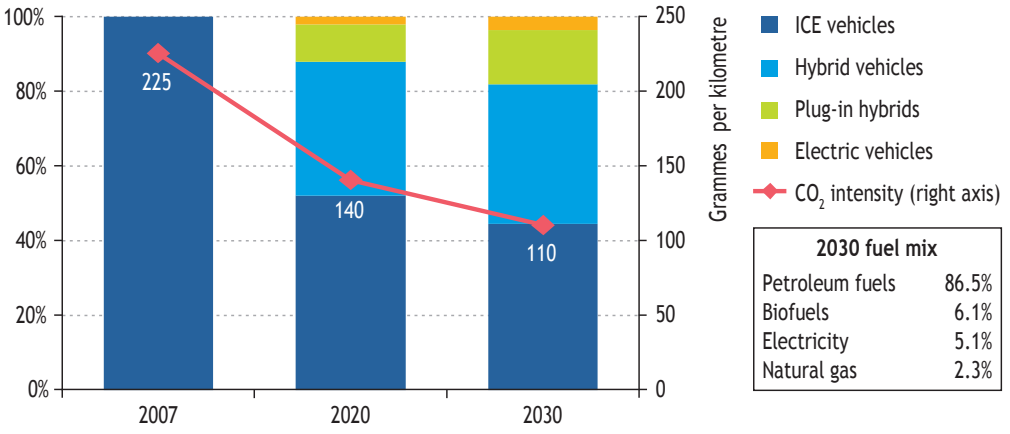
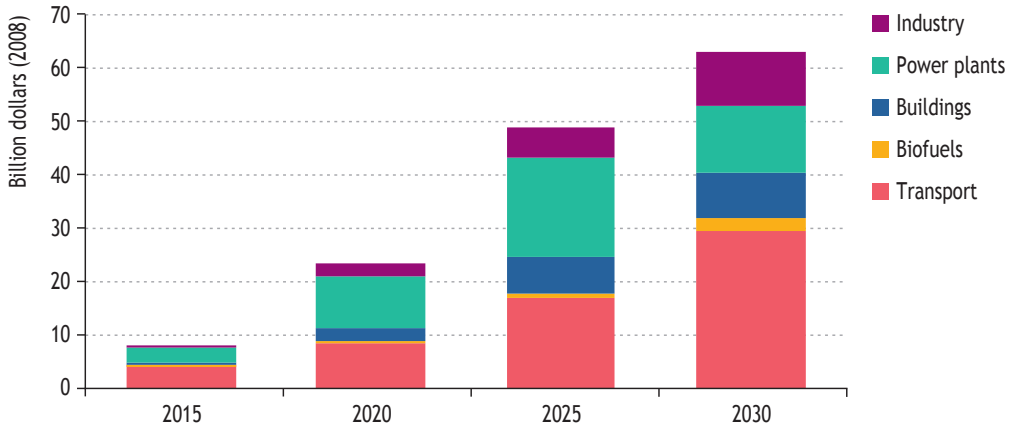


Figure 50: India share of passenger vehicle sales by technology and average new vehicle on-road CO_2 intensity in the 450 Scenario



Cost and benefits

Figure 51: India additional investment in the 450 Scenario relative to the Reference Scenario



- Additional cumulative investment cost: in excess of $100 billion over 2010-2020; nearly $500 billion over 2021-2030
- Total investment in the 450 Scenario in excess of $550 billion in low-carbon power generation over 2010-2030 (83% renewables, 16% nuclear, 2% CCS)
- Incremental investment cost equal to 0.9% of GDP in 2020, rising to 1.4% by 2030
- Oil and gas import bill reduced in excess of $30 billion in 2020 and $90 billion in 2030, compared with the Reference Scenario
- Local air pollution costs reduced by $1 billion in 2020 and $3 billion in 2030, relative to the Reference Scenario

Policy opportunities

- Accelerate investment in nuclear power plants and strengthen policies to promote renewables in power generation, a sector that provides major opportunities to reduce CO_2 emissions and local pollutants
- Further define and strengthen policies to promote cleaner transport, including the use of mass transport and more efficient cars
- Continue the implementation of CDM projects and expand CDM to more sectors

World Energy Outlook

2009

RELEASE
10 November 2009

International Energy Agency

World Energy Outlook 2009

Since ***WEO-2008***, the economic downturn has led to a drop in energy use, CO_2 emissions and energy investment. Is this an opportunity to arrest climate change or a threat that any economic upturn might be stifled at birth?

What package of commitments and measures should the climate negotiators at Copenhagen put together if they really want to stop global temperatures rising? How much would it cost? And how much might the developed world have to pay to finance action elsewhere?

How big is the gas resource base and what is the typical pattern of production from a gas field? What does the unconventional gas boom in the United States mean for the rest of the world? Are we headed for a global gas glut? What role will gas play in the future energy mix? And how might the way gas is priced change?

All these questions and many others are answered in ***WEO-2009***. The data are extensive, the projections more detailed than ever and the analyses compelling.

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

Order from our website: www.iea.org/books

or e-mail: books@iea.org

International Energy Agency

9, rue de la Fédération - 75739 Paris Cedex 15 - France

Tel +33 1 40 57 66 90

The Paris-based International Energy Agency is an intergovernmental body committed to advancing security of energy supply, economic growth and environmental sustainability through energy policy and technology co-operation. It was founded after the oil supply disruptions in 1973-1974 and consists of 28 industrialised countries, all members of the Organisation for Economic Co-operation and Development.

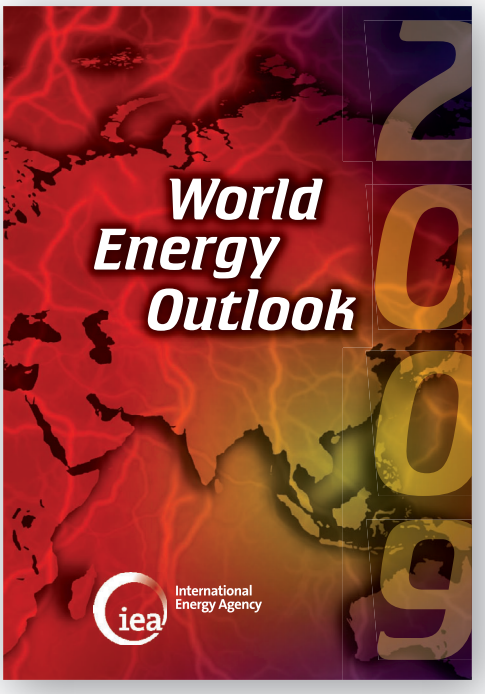


TABLE OF CONTENTS

International Energy Agency

Online bookshop

Buy IEA publications online:

www.iea.org/books

PDF versions available at 20% discount

Books published before January 2008 - except statistics publications - are freely available in pdf

International Energy Agency • 9 rue de la Fédération • 75739 Paris Cedex 15, France

iea

Tel: +33 (0)1 40 57 66 90

E-mail:
books@iea.org