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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

# Climate Change: Meeting the Challenge to 2050



## Introduction

Climate change is already with us. Scientific evidence shows that past emissions of greenhouse gases (GHG) are already affecting the Earth's climate. If current trends and policies continue, the result will be a rapidly warming world. Action is needed now to significantly reduce global greenhouse gas (GHG) emissions in the coming decades.

If governments fail to act, or delay adopting the necessary policies, the likely consequences and costs of this policy inaction will be significant. Without further policies to combat climate change, the OECD projects GHG emissions will grow by about 52% by 2050. This would raise the global temperature by between 1.7 °C and 2.4 °C compared to pre-industrial levels – at least twice the temperature increase seen between 1899 and 2005.

In contrast, starting today to implement policies could deliver by 2050 a reduction of almost 40% in GHG emissions compared to 2000 levels, and could move emissions onto a pathway that would stabilise atmospheric concentrations at low levels and significantly limit the risk of the worst of climate change impacts in the long-term.

Over the past decade, governments have developed an international framework for action on climate change, and many countries have implemented policies to address it. While this experience will be invaluable as a base for developing future climate policies and a post-2012 framework for tackling climate change internationally, the current actions are insufficient to significantly slow the progress of climate change.

This *Policy Brief* highlights the OECD's work on the likely impact of various courses of action to mitigate climate change, and the costs of inaction. ■

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## Why worry about climate change?

Scientific evidence shows unequivocal warming of the climate system, and the rate of change is accelerating. Melting glaciers and ice caps, and more extreme weather in many areas – worse droughts, bigger tropical cyclones, heavier rainfall, more wildfires – have been recorded since the 1970s. Changes in ocean acidity due to increases in carbon dioxide emissions, reported for the first time in 2004, are meanwhile altering ocean chemistry and may threaten marine organisms.

Most of the observed warming in the past 50 years has been caused by human activities, particularly producing and consuming fossil fuels, increasing agriculture and changing land use. These human activities have increased greenhouse gas (GHG) emissions leading to changes in the Earth's atmosphere. Carbon dioxide ($CO_2$) and methane levels in the atmosphere are higher than at any time in the last 650 000 years. Over the past century, increased $CO_2$ emissions have boosted their level in the atmosphere from 280 to 379 parts per million (ppm), while methane levels rose even faster, from 715 to 1 774 parts per billion (ppb).

Future projections suggest we are likely, and in some cases certain, to see all these trends continue unless action is taken to reduce emissions significantly below current levels. And since the effects of GHGs take some time to affect the Earth's systems, particularly the oceans, it is estimated that even if GHGs stabilised at today's levels, we would still see an additional increase in global surface temperature of 0.8 °C-1.4 °C (compared to pre-industrial levels) by the end of the 21st century. ■

## What are the trends in greenhouse gas emissions?

The principal gases associated with increased GHGs are carbon dioxide ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$). Carbon dioxide is the dominant GHG, accounting for 76% of global emissions and about 83% of emissions from OECD countries in 2005. Burning fossil fuels (coal, oil, natural gas) is by far the largest global source of $CO_2$ emissions, accounting for 66% of global GHG emissions in 2005. Power generation accounted for about one-quarter of all global GHG emissions in 2005. Global $CO_2$ emissions from road transport are also significant, accounting for 11% of total GHG emissions worldwide in 2005.

Global human-caused GHG emissions grew 28% between 1990 and 2005. But the increase was far larger in major developing countries – 70% in Brazil, India and China – than in OECD countries, where emissions grew 14%. Despite this, the per capita GHG emissions in BRIC countries were only about one-third of those in OECD countries in 2005 (the equivalent of 5.1 tonnes of $CO_2$ [5.1 T $CO_2$-eq] per person in BRIC countries compared with 15.0 T $CO_2$-eq per person for OECD countries) and this pattern continues. ■

**Table 1.**

**KEY INDICATORS, OECD ENVIRONMENTAL OUTLOOK, ALL GHG EMISSIONS**

| | 2005 | 2030 | 2050 | 2005 | 2030 | 2050 | 2005 | 2030 | 2050 |
|---|---|---|---|---|---|---|---|---|---|
| | Gt $CO_2$-eq – % change from 2005 | | | $CO_2$-eq per capita (t/person) | | | $CO_2$-eq per GDP (kg/USD real) | | |
| OECD | 18.7 | 23% | 26% | 15.0 | 16.8 | 17.0 | 0.7 | 0.5 | 0.3 |
| BRIC | 16.1 | 46% | 63% | 5.1 | 6.1 | 6.4 | 4.6 | 2.2 | 1.3 |
| ROW | 12.1 | 45% | 79% | 5.8 | 5.9 | 6.0 | 2.9 | 1.6 | 1.0 |
| **World** | **46.9** | **37%** | **52%** | **7.2** | **7.8** | **7.8** | **1.3** | **0.9** | **0.6** |

Source: *OECD Environmental Outlook*, 2008.

## How fast will they grow in the future?

If no new action is taken, global greenhouse gas emissions are expected to grow by about 52% by 2050, according to simulations prepared by the OECD. But the increase will be faster outside the OECD area; the OECD share of global GHG emissions will fall to 33% in 2050 from 40%.

Energy-related $CO_2$ emissions are forecast to grow even more rapidly, increasing by 78% between 2005 and 2050 if no new action is taken to curb them, largely as a result of increased coal and natural gas use to support growing demand for electricity. Global emissions of $CO_2$ from the transport sector are meanwhile expected to double by 2050 as the demand for cars increases, particularly in developing countries.

Methane emissions from sources such as solid waste disposal on land, animal digestive processes, natural gas pipelines and rice production are projected to increase in line with expanding production of animal products and rice, increasing 47% from 2005 to 2050. Global $N_2O$ emissions from agriculture, industry and other sources will meanwhile increase by about 26% by 2050.

HFCs and PFCs were introduced to replace chlorofluorocarbons (CFCs), which were depleting the ozone layer, but they themselves have a high global warming potential and will nearly quadruple by 2050, contributing roughly 4% of the total change in GHG emissions from 2005.

Though these projections may seem dramatic, they are on the low side of the range of emission scenarios produced by various experts. ■

## How can policies help?

To slow and then limit climate change will require an international effort over the long term. The main international means to address climate change is the UN Framework Convention on Climate Change (UNFCCC), which has been ratified by 189 countries.

The declared objective of the UN Convention is: "*… stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system… within a time-frame sufficient to allow ecosystems to adapt naturally to climate change to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.*" By signing the Convention, OECD countries and other industrialised nations agreed to take the lead to achieve this objective, as well as to provide financial and technical assistance to other countries to help them address climate change.

The Kyoto Protocol, which entered into force in 2005, helps governments to put the Convention into practice. In it, a number of industrialised countries (the "Annex I Parties") make commitments to individual, legally binding targets to limit or reduce their greenhouse gas emissions by 2008-2012. But these are just the first steps towards tackling climate change. Governments knew this when they adopted the Convention and the Protocol and this has become even clearer today, as several large developing countries, such as China and India, have seen their economies and energy demand grow rapidly in the intervening years, with large increases in emissions as a result.

The current internationally-agreed mitigation targets apply only to industrialised countries and do not extend beyond 2012. Successfully limiting emissions in order to stabilise atmospheric GHG concentrations at a level acceptable to achieve the objectives of the Convention will require the participation of all major emitting countries. The Convention and the Protocol leave it up to individual countries to decide how to achieve their current emission targets.

Industrialised countries have made some progress, albeit limited, in curbing GHG emissions since 1990. This period has seen the emergence of policies specifically designed to tackle climate change and reduce GHGs, including emission trading schemes, $CO_2$ and green energy taxes, voluntary measures with industry to address GHG emissions, targeted regulation (*e.g.* for $CH_4$ emissions), and collaborative research and development programmes.

Many countries have also made progress in developing "whole of government" efforts to integrate climate change into existing policy frameworks. These include using energy policy to accelerate investment in energy efficiency, and reinforcing policies on waste minimisation, landfill gas recovery and agriculture fertiliser management. All of these low-cost measures have multiple environmental and economic benefits, including reducing GHG emissions.

Less progress has been made on policies and actions to respond to the socio-economic effects of climate change ("adaptation policies"), including those from rising sea levels threatening coastal zones, or more frequent flooding, drought, heat waves or fire, depending on the region.

Along with a number of individual countries (*e.g.* Denmark, Canada, the Netherlands and the UK), the EU is now also treating the issue of adapting to climate change as a priority. In 2007, the European Commission adopted its first policy document on adaptation. The OECD also recently agreed a declaration calling for greater co-operation and attention to integrating adaptation to climate change into development assistance and national planning for development. ■

## What would policies achieve?

Simulations comparing the likely effects of different policies to mitigate climate change suggest two key messages: doing nothing is not an option as the consequence of inaction are high; and achieving ambitious climate stabilisation goals could be affordable – costing roughly a half a per cent of GDP by 2030 – but only if we start today and implement the least-cost solutions already available

If nothing is done, global GHG emissions are projected to increase by 52% by 2050 (see Figure 1). This would raise global mean temperature by 1.7 °C-2.4 °C (at equilibrium, compared to pre-industrial levels) in 2050. Beyond 2050, following the Baseline of the OECD Environmental Outlook would lead to temperature rise in the long-term of 4 °C-6 °C (compared to pre-industrial levels).

And there is a risk of a "snowball" effect. Factors like reduced sea ice cover, which would change the regional albedo (reflectivity of the Earth's surface), and increased methane emissions from melting permafrost soil, could accelerate climate change even more.

But if the international community were to take action now, these trends could be slowed and limited overall. If all the major GHG emitters phased-in over several years a tax of USD 25 (escalating at roughly 2% a year) on every tonne of GHG produced, global emissions would be stabilised at 2000 levels by 2050. Putting in place instead an immediate tax of USD 25 per tonne of $CO_2$-eq imposed by all nations today would see global emissions fall to about 21% below 2000 levels by 2050.

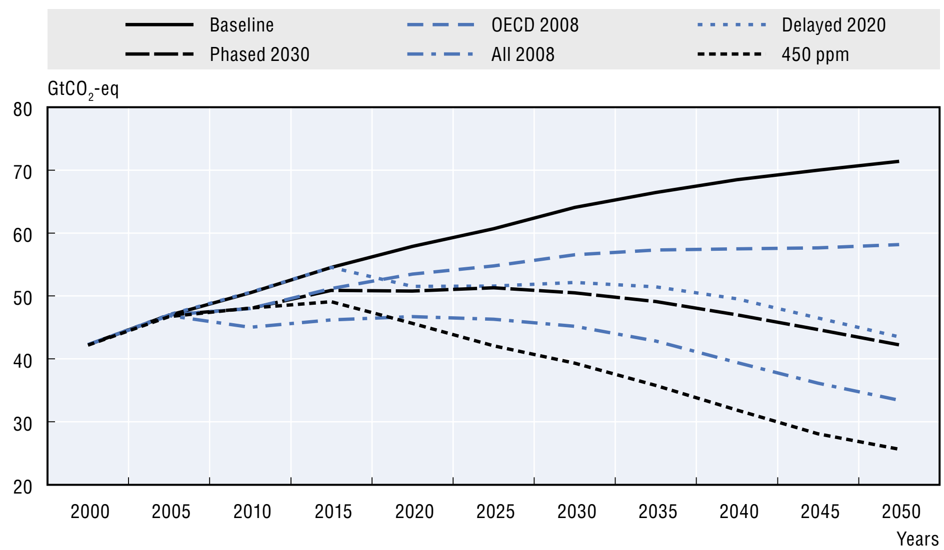
A more ambitious scenario was also simulated, reflecting a phased-in tax set at the level necessary to limit atmospheric concentrations to 450 ppm of $CO_2$-eq in the atmosphere in the long term. This would lead to a reduction in global emissions by about 40% in 2050 compared to 2000 levels.

There is a difference of roughly 0.6 °C in the predicted temperature rise by 2050 between the Baseline and the "most challenging" mitigation case examined that would stabilise atmospheric concentrations of $CO_2$-eq at 450 ppm. This is significant because avoiding substantial temperature change by mid-century is a starting point for achieving more aggressive long-term targets and makes it possible to limit long-term global mean temperature increases, *i.e.* to 2 °C-3 °C (at equilibrium above pre-industrial levels), and to avoid some of the most severe risks of climate change.

Reducing GHG emissions can create a "virtuous circle" that has significant co-benefits in other areas as well. Measures taken to significantly reduce GHG emissions would likely also reduce air pollution and improve human health. For example, moving emissions onto the pathway to stabilise concentrations at 450 ppm $CO_2$-eq would also reduce sulphur oxides ($SO_x$) by 20%-30% by 2030 and nitrogen oxides ($NO_x$) by 30%-40% compared to Baseline levels. These pollutants cause acid rain, and act as precursors to ozone formation, which affects respiratory systems and aggravates asthma. They result from fossil fuel combustion, which would be reduced under the 450 ppm $CO_2$-eq scenario. The largest air pollution benefits would be found in some of the most rapidly developing and urbanising areas of South Asia, including India, as well as in China, Russia and North America. ■

**Figure 1.**

**IMPACTS OF POLICY SIMULATIONS ON GHG EMISSIONS TO 2050**




*Note:* OECD 2008 = all OECD countries apply a GHG tax of USD 25 per tonne of $CO_2$-eq; Delayed 2020 = all countries apply the tax, starting only in 2020; Phased 2030 = OECD countries apply the tax in 2008, BRIC in 2020 and ROW in 2030; All 2008 = all countries apply the tax, starting in 2008; 450 ppm = scenario to stabilise GHG concentrations in the atmosphere at 450 ppm $CO_2$-eq; For all USD 25 tax cases, the tax is escalating by about 2% per year after the initial year of introduction.

*Source: OECD Environmental Outlook*, 2008.

## How much will it cost and who will pay?

The global economic costs of limiting climate change are not insignificant but they are manageable, even for the most ambitious case, which stabilises concentrations at 450 ppm $CO_2$-eq in the long-term. Total loss of GDP worldwide, compared to a "no action" scenario, would be equivalent to losing less than 0.1 percentage points of global GDP growth per year through to 2050, with an aggregate loss of 0.5% of GDP in 2030, and just under 2.5% in 2050.

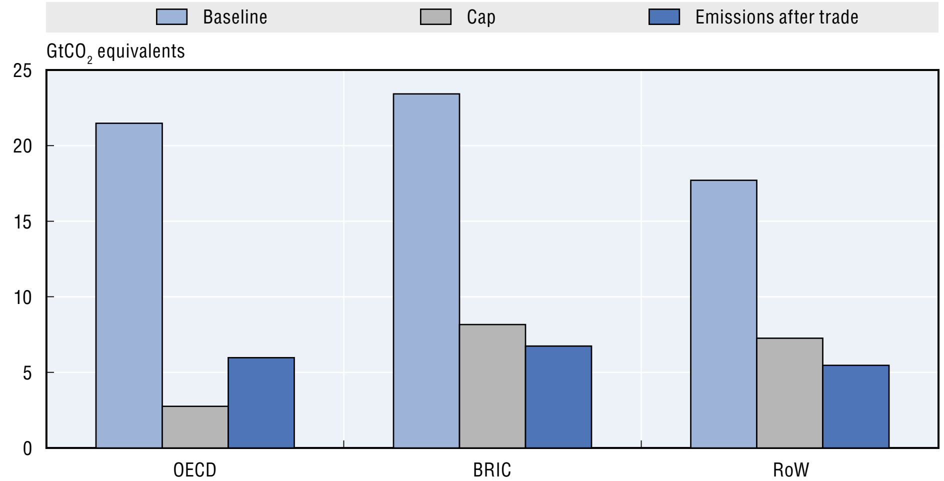
The real problem is not the total cost of action, but how it would be distributed around the world, since many developing countries may face far bigger GDP losses than the industrial world if a straightforward global tax policy was used. For example, in the 450 ppm case, the OECD would lose 0.2% of GDP in 2030, and 1.1% in 2050, but Brazil, Russia, India and China (BRIC) would lose five times as much – a loss of 1.4% of GDP in 2030, and 5.5% in 2050 (see Figure 2). For BRIC, for example, this would mean that the economy would increase by a factor of 4.5 from 2005 to 2050 rather than the projected 4.8 under the Baseline.

It is expected that oil- and gas-producing countries (including Russia) would suffer the biggest GDP loss from efforts to curb climate change, whichever model is used, because of their economic vulnerability to taxing the carbon content of fossil fuels and their products. The losses would be particularly large in oil-exporting countries which subsidise national energy consumption. In the 450 ppm case, where all countries immediately adopt a tax that is phased in over time, in 2050 aggregate GDP in the oil-producing countries is estimated to be about 11% lower than the no-action scenario. Delaying the tax would roughly halve the economic loss, but would also significantly reduce the reduction in global GHG emissions. Oil-producing countries could limit their losses instead by diversifying their economies and raising the price of domestic energy to the world price.

Less developed countries would also be expected to face a reduction in economic growth over the period as a result of such a global GHG emissions tax. In part, this would reflect the fact that they have larger pools of low-cost mitigation potential, and as such the tax applied would result in relatively

**Figure 2.**

**GREENHOUSE GAS EMISSIONS, BASELINE AND 450 PPM $CO_2$-EQ CASE WITH A CAP AND TRADE BURDEN-SHARING ARRANGEMENT**




*Source: OECD Environmental Outlook*, 2008.

larger emission reductions in these regions. While this makes sense from an economic efficiency perspective, it is unlikely to be acceptable as it stands from the perspective of equity and fairness.

Instead, these policy simulations suggest a need for a mechanism for sharing the burden of the costs of global GHG emissions reduction action. This could be done in a number of ways, but one that seems to be acceptable to many governments is an emission trading permit system. Through differential target setting and allocation of emission permits, this would make it possible for OECD countries to carry a relatively greater financial responsibility for emission reduction than non-OECD regions, while still allowing mitigation action to take place where it is least cost, thereby keeping the global costs of mitigation low.

Under a simulation in the *OECD Environmental Outlook* of applying a cap and trade scheme to the scenario to achieve the 450 ppm stabilisation, the direct costs of mitigation in the BRIC region would be expected to fall by more than half, and those in the ROW region by four-fifths, compared to the global tax scheme, given the increased share of emission reductions taken up by industrialised OECD countries (Figure 2). The overall global costs of the mitigation effort would remain the same, but these costs would be re-distributed amongst countries.

One of the unique aspects of tackling climate change is the time lag between cause and effect. This generation pollutes but the next generation will suffer the consequences. A similar imbalance occurs geographically – the regions and countries worst-hit by the effects of climate change are expected to be those where emissions are lowest.

International efforts to deal with climate change will have to deal with all these issues when discussing how much action to take to mitigate climate change, how fast, and how to ensure that the burden and rewards are shared equitably. One thing is clear – if no action is taken, governments will be faced with an even greater challenge in the years to come. ■

## For further information

For more information about the OECD's work on climate change and the *OECD Environmental Outlook*, please contact:
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Note: This analysis was developed using the OECD ENV-Linkages model (a computable general equilibrium model used to study factors that impact on the economy) and the IMAGE suite of models (to make the connection to physical processes so that impacts on the environment can be estimated) from the Netherlands Environmental Assessment Agency.

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## For further reading

For more information on OECD climate change work, see: *www.oecd.org/env/cc*.


OECD (2008, forthcoming), **OECD Environmental Outlook to 2030**, ISBN 978-92-64-04048-9, € 90, 461 pages.

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