UNIVERSITY OF CAMBRIDGE

Briefing Paper series from the Cambridge Centre for Climate Change Mitigation Research

4CMR

How much could decarbonisation improve air quality in Mexico?

Research Background

There are important co-benefits from climate control through the reduction in air pollution. The switch from burning coal and oil to gas in industry and the switch from petrol to electric vehicles in transport both bring about reduction in other pollutants given out by combustion, such as SO_2, NOx and soot and dust (particulates) as well as greenhouse gases. Some of these emissions give rise to the creation of low-level ozone in the atmosphere, depending on sunlight, the presence of volatile compounds in the atmosphere and special weather and geographical conditions. The ensuing mixture of gases and particles leads to damages to human and animal health and to crops and buildings.

The Study

We have studied the effects of a substantial reduction in emissions of CO_2 unilaterally in Mexico as well as globally on some aspects of air quality in Mexico and North America. We chose Mexico for the study because the metropolitan area of Mexico City is an air pollution hot spot. The megacity is surrounded by mountains, so that bad air can accumulate. It is home to some 20 million people, and it is the centre of economic activity in Mexico. The pollution has long been a problem, and the government has resorted to various costly measures to reduce emissions, including moving polluting factories out of the area, regulating traffic and production when the air quality gets particularly bad, and constructing an urban transport system to help reduce congestion and pollution.

Mexico City's air is much less polluted than it was, but more can be done to improve it.

Modelling both the emissions of the pollutants and their mixing in the atmosphere is complicated because we had to bring together understanding from economics, energy systems and atmospheric chemistry. We have linked our global model, E3MG, with an atmospheric chemistry model used by colleagues in the Department of Chemistry (called pTOMCAT). The coupling is at present one way, from the emissions to the consequences for concentrations of atmospheric pollution. The research considers three illustrative scenarios, a trend reference case and the two decarbonisation scenarios to show the effects of a very substantial reduction of CO_2 emissions, some 75 to 80% reduction by 2050 below trend levels both for Mexico alone and globally.

The Results

We have calculated the GDP and other macroeconomic results in the scenarios and compared them to show the effects of decarbonisation on the path of GDP in the projections to 2050. Unilateral Mexican mitigation leads to GDP being slightly higher.

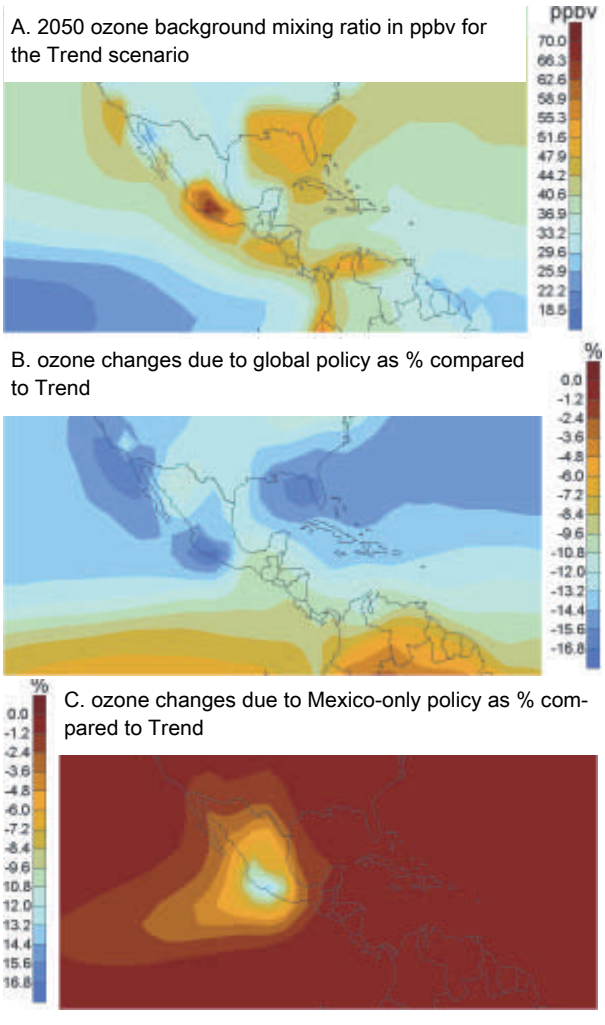
The Briefing Papers series by 4CMR provides policy makers, organisations, communities and citizens with advanced research on the roles of economic, energy and environmental strategies for reducing the risk of climate change.

The series is made possible through a generous award from the Three Guineas Trust supporting both the research described and public outreach and engagement.

GDP reaches 1.1% above the trend projection by 2050 with negligible effects on the US and rest of the world GDP. Multilateral mitigation action leads to an increase of 1.6% above the trend projection by 2050. These effects are very small – the 1.1% extra GDP by 2050 can be expressed as the annual growth rate changing from 3.61% a year for the trend to 3.64% a year for the mitigation scenario 2005 to 2050. This result contrasts with many, but not all, of the results from other models for the effects of mitigation on GDP reported by the IPCC and the Stern Review in 2007. The consensus is that stringent mitigation will lead to reductions in GDP below baseline, but this result is largely based on modelling in which the economy is assumed to be at full employment, so that there is little room for expansion of supply and in which technological change does not respond to climate policy. We have allowed in E3MG for under-employed resources to be available for investment in low-carbon sources of energy and for the investment to fall in cost as the scale increases, so we find that GDP can increase.

Conclusion on Air Quality

The effects on the emissions of other atmospheric pollutants from the unilateral 77% CO_2 reduction for Mexico are substantial, confirming other studies of co-benefits of GHG mitigation. SO_2 is about 17% below trend by 2050, NO_x about 49%, carbon monoxide about 30% and volatile organic compounds about 49%. With global decarbonisation, the necessary CO_2 reduction in Mexico is smaller because Mexico has higher cost mitigation options compared to the rest of the world, so the co-benefits are also somewhat smaller.



The modelling of the atmospheric mixing of the pollutants allows us to give an indication of the effects of the reduction in fossil-fuel burning on the concentrations of some pollutants over Mexico. The figures show the results for low-level ozone by 2050. Figure A shows the trend concentrations, B the change for global mitigation and C the change for Mexico-only mitigation. The ozone is some 11-13% less than would be anticipated, enough to bring the concentrations close to the WHO guideline limit.

The Cambridge Centre for Climate Change Mitigation Research (4CMR) studies the interconnected economic, energy and environmental policies at the heart of climate change policy.

This Briefing Paper was developed by Terry Barker of 4CMR.

The research is reported in: Barker, T., A. Anger, O. Dessens, H. Pollitt, H. Rogers, S. Scrieciu, R. Jones and J. Pyle, "Integrated modelling of climate control and air pollution: methodology and results from one-way coupling of an energy-environment-economy (E3MG) and atmospheric chemistry model (p-TOMCAT) in decarbonising scenarios for Mexico to 2050" in *Environmental Science and Policy. DOI:* 10.1016/j.envsci.2010.09.008

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