European Consortium for Modelling of Air Pollution and Climate Strategies (EC4MACS)

Cost effective approaches for reducing air pollution while minimizing climate change

A project funded by the EU Life programme to develop cost effective, practical options for improving air quality in Europe while helping to protect the global climate.

THE EC4MACS project aims to provide policy makers with the best available science to inform their clean air and climate protection policies.

What is the link between air pollution and climate change?

The effects of air pollution are diverse and costly. These effects range from the immediate impact on human health (e.g. respiratory disease), reduced agricultural productivity, and at a global scale, interference with the climate, resulting from pollutants known as greenhouse gases. Increasing levels of greenhouse gases in the atmosphere are causing the planet to warm, global warming is the major component of climate change. While seemingly insignificant, this subtle warming is likely to result in more extreme weather and associated floods and droughts, affecting food supplies and water quality and availability. Infectious disease and insect borne diseases are also likely to increase, while higher temperatures can also worsen air pollution.

Much of this air pollution is caused by the burning of fossil fuels (primarily coal and oil) to produce energy for homes, industry and transport. The burning of fossil fuels accounts for about 60 percent of all greenhouse gas emissions, while agriculture, food production and industry account for about 30 percent of emissions. Scientists reporting to the Intergovernmental Panel on Climate Change (IPCC) believe there is a greater than 90 percent chance that most of the global warming that has occurred since the 1950s is due to the increase in greenhouse gas emissions from human activities.

Air pollution and climate change are strongly linked, both are caused by the same types of activities. Reducing air pollution will also help fight climate change.

There are six key greenhouse gases, while some of these occur naturally, like CO2 and water, it is the rapid increase in the amount of CO2 and other greenhouse gases in the atmosphere today that is causing global warming, and associated climate change. This increase is due to human activities.

Air quality and climate change in the European Union

Clean air and climate change are key areas of concern for policy makers globally and many countries have set targets for reducing their greenhouse gas emissions. The European Commission, in March 2011, agreed to reduce emissions across the EU by as much as 95% by 2050 (compared to 1990 levels). This reduction will be gradual - 20% by 2020, 40% by 2030 and 60% by 2040.

As the major producers of greenhouse gases, the reductions will come from the key sectors of energy, transport, agriculture and industry. How to meet these targets in the most cost-effective and sustained way is a challenge for EU policy makers, who must ensure productivity remains high, jobs are not compromised, and that the economy continues to grow.

How science helps guide EU environmental policy

Air quality legislation, developed by the European Commission is in place in the EU and it is reviewed and amended as needed. To guide decision making and policy development the EU relies on the best available science. To this end, in 2006, the EU Life Programme established the European Consortium for Modelling of Air Pollution and Climate Strategies, the EC4MACS project.

What is EC4MACS

EC4MACS involves leading research agencies from across Europe who joined forces to analyse every aspect of climate change and air pollution in Europe and provide options to help resolve both issues.

The researchers have shown that there are "…significant interactions and potentially large economic synergies between air pollution control and greenhouse gas mitigation". This means that by adopting policies and management strategies that tackle air pollution, significant benefits will also be gained in other areas such as climate change mitigation but also human and environmental health.

Each member of the project brings sophisticated and well established economic and environmental modelling tools for different sectors to the project. The GAINS model integrates the information across all sectors, models and regions to estimate environmental and economic impact of alternative policy scenarios.

Connecting all the pieces of the air pollution and climate change puzzle

Scientists have long understood the connections between air pollution, climate change and human and environmental health. What has been missing however, is a systematic way of linking all aspects of the environment and society together to anticipate what impact policies in one area may have on another region or sector.

Using innovative scientific models the researchers involved in the EC4MACS project are able to unravel this complex puzzle.
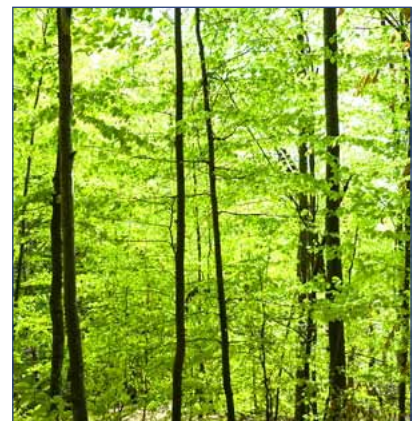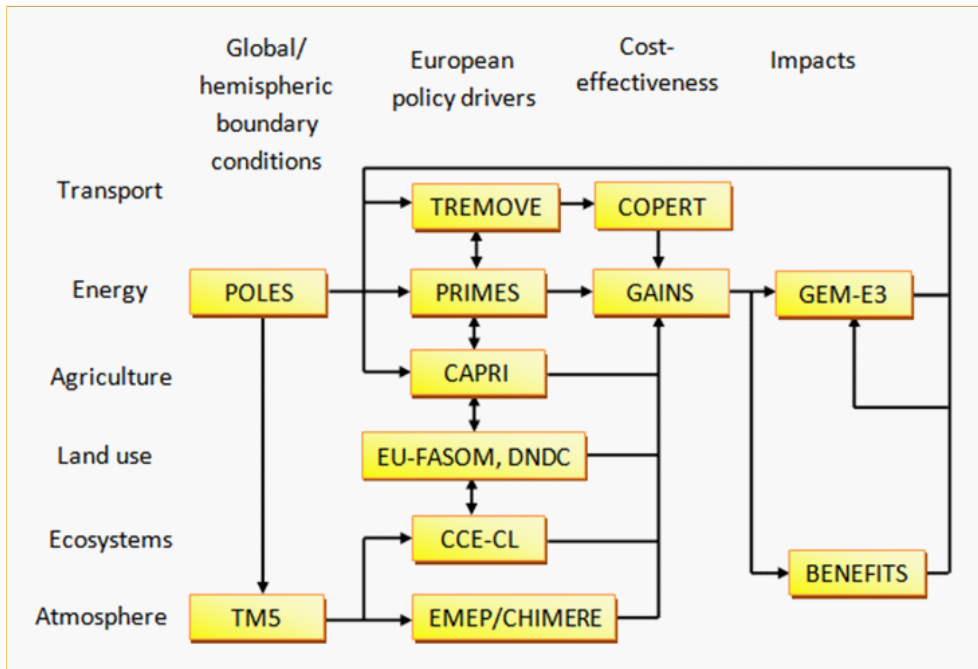
Everything is connected – changes in one area of the environment or society can have profound effects elsewhere. EC4MACS enables scientists to anticipate these changes and the costs (economic, social and environmental) and benefits of resolving or preventing them. Cleaning up air pollution can, for example, avoid millions of lives lost globally each year to due 'dirty air', while also reducing climate impacts and at no extra cost.

The project draws on a diverse and extensive amount of information to evaluate the effectiveness of current EU policies, and to guide modifications of these policies to ensure clean air and climate change mitigation targets are achieved.

The project utilizes twelve major models, each model is tailored to analyze specific components of air pollution and climate change. Each model is reliant on, or provides information to, other models, the result is a fully integrated model of all the factors connected with air pollution and climate change in Europe.

For example, using world energy data, the POLES model, developed by Joint Research Centre of the European Union, IPTS, is able to simulate the entire global energy system and produce long-term forecasts of energy demand, supply and price by regions. Information from this models feeds into the PRIMES model, which in turn is able to simulate the response of energy users and energy supply systems to different pathways of economic development.

The IIASA developed GAINS model is an integrated assessment model that brings together information on the sources and impacts of air pollution. These include: for energy-PRIMES, agriculture- CAPRI, the transport sector-TREMOVE, atmospheric pollution- EMEP, and the sensitivity of ecosystems to acidifying and nitrogen compounds- CCE IMPACT. It explores cost-effective emission control strategies that meet clean air and climate change objective. GAINS has assessed the effectiveness and costs of more than 1000 emission control measures employed across all 43 European countries. The results from the GAINS models feed directly into the GEM-E3 model for calculation the cost of emission control strategies, and to BENEFIT – a model that assesses the impacts of pollution on human health.

Climate change refers to significant changes in measures of climate (such as precipitation, temperature, or wind) lasting for an extended period (decades or longer), these changes can be caused by natural process (changes in ocean currents, or changes in the sun's intensity), or by human activities that change the atmosphere, (e.g. the burning of fossil fuels) or the land (e.g. deforestation, urbanization, or desertification).

Since 1750, atmospheric concentrations of some greenhouse gases – CO2, CH4 and N2O have increased by over 36 percent, 148 percent and 18 percent, respectively, these increases are believed to be caused by human activities, primarily the burning of fossil fuels, and changes to the way land is managed.
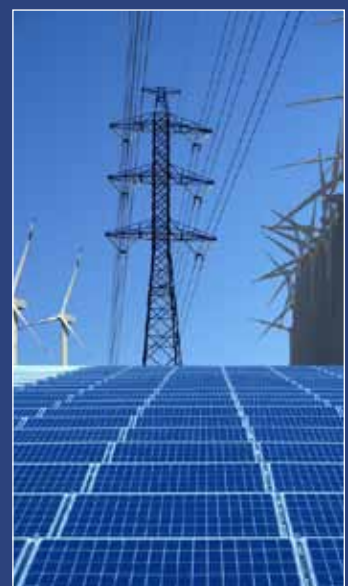
Outcomes of the EC4MACS project

The EC4MACS project is the first ever very fully integrated study that can assess and define the actions governments can take to reduce air pollution and greenhouse gas emissions across Europe. This innovative approach incorporates all of the major contributors to this problem (by sector), provides a full economic balance – that is the costs and co-benefits (savings) of resolving the problem, and identifies the 'synergies' and 'trade-offs' resulting from policy responses in different sectors and regions. In 2010 EC4MACS delivered some preliminary findings:

1. that despite some improvements in pollution levels serious threats remain to human and environmental health
2. Due to stringent policies, projections suggest emissions will decline, however they may not be sufficient to achieve a sustainable environment in Europe, and
3. Other cost-effective options exist to improve air quality and their benefits will outweigh their cost.

On completion (2012) and after review the project will:

- produce a toolbox of relevant models that incorporate latest scientific findings,
- analyze the impacts of uncertainties on policy conclusions,
- incorporate the latest data on energy, agriculture, transport, industry and economic assumptions, for all EU Member States,
- validate this data with national experts, and
- conduct a final comprehensive assessment on future air quality and climate in Europe.

Lessons from Europe have global application

Climate change and air pollution do not respect regional, national, international boundaries, or, as climate science is suggestion, planetary boundaries. The work undertaken in EC4MACS will be relevant to all regions of the world, as the modelling toolkit can be adapted to national and regional conditions.

Improvements in air quality in the EU will also be felt beyond the EU.

Partner Organizations

The EC4MACS consortium involves the major European institutions that work on the modelling of air pollution and climate strategies, including:

- The International Institute for Applied Systems Analysis (IIASA), Austria
- The Coordination Centre for Effects (CCE) at RIVM, Bilthoven, Netherlands
- The E3M-Lab of the National Technical University (NTUA), Athens, Greece
- The Laboratory for Thermodynamics of the Aristotle University of Thessaloniki (LAT/AuTh), Greece
- The Institute for Agricultural Policy, Market research and Economic Sociology of the University of Bonn (IAP), Germany
- EuroCARE GmbH Bonn, Germany
- Ecometrics Research and Consulting (EMRC), AEA Technology, MetroEconomica, UK
- L'Institut National de l'Environnement Industriel et des Risques INERIS, France

Two EU Joint Research Centre's also participate in EC4MACS

- The Institute for Environment and Sustainability (IES) of the Joint Research Centre in Ispra
- The Institute for Prospective Technological Studies (IPTS) of the Joint Research Centre in Sevilla

The EC4MACS project employs the following models:

The GAINS (Greenhouse gas-Air pollution Interactions and Synergies) model --IIASA

The PRIMES model – National Technical University of Athens Economics-Energy-Environment Modelling Laboratory E3MLab –
The TREMOVE EU transport model – The European Commission
The CAPRI Common Agricultural Policy Regionalised Impact Modelling System – coordinated by Bonn University
The CCE IMPACT database - Coordination Centre for Effects – Netherlands Environmental Assessment Agency
The Chimere chemistry-transport model - Ecole Polytechnique, France
The European Forest and Agricultural Sector Optimization Model (EUFASOM)- University Hamburg and International Institute for Applied Systems Analysis (IIASA)
The BENEFITS assessment - AEA is a global sustainability consultancy
GEM-E3 is an applied general equilibrium model - National Technical University of Athens (NTUA
The EMEP Eulerian model - The Norwegian Meteorological Institute
The TM5 model - University of Utrecht, Netherlands and maintained by Joint Research Centre (JRC) of the EU, Institute for Environment and Sustainability (IES)
The POLES model - Joint Research Centre (JRC) of the European Union, Institute for Prospective Technological Studies

The EC4MACS project commenced in 2007 and is coordinated by the International Institute for Applied Systems Analysis, Austria. Funding for the project was provided by the EU Life Programme. More about the project can be found at: http://www.ec4macs.eu/home/index.html

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