

# EU action against climate change



## Research and development to fight climate change



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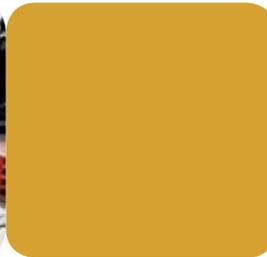
## Research and development to fight climate change



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## The crucial role of research and development in addressing climate change



Climate change is a subject of enormous complexity and magnitude. Thanks to a focused research effort, we are continuously improving our understanding of the drivers of climate change and the options we have to reduce its impacts. Research has helped us to find out about the causes, manifestations and effects of climate change. Our knowledge is advancing rapidly, thereby reducing uncertainty.

Research combined with economic analysis has enabled us to identify the most cost-effective measures to mitigate climate change. Research focusing on technological development plays an important role in preparing the low-carbon society of the future by improving existing climate-friendly technologies and devising those of tomorrow.

We also need research in order to predict climate-related changes, at global, regional and local levels, so that we can take measures to adapt to them.

The European Union (EU) has financed research into climate change and technological development (R&D) since the 1980s, facilitating the formulation of realistic policy objectives. The EU's main instrument for R&D funding in Europe is the multi-annual Framework Programme. It brings together scientists from all 27 Member States and is open to those from third countries.

As most projects are only partially financed by the EU, EU R&D programmes mobilise additional national funding. The programmes also signal European research priorities to national research communities and the private sector, triggering further research activity.

## EU R&D priorities

*In broad terms, EU-funded research supports the following climate change-related priorities:*

- *Understanding, monitoring and predicting climate change and its impacts*
- *Providing tools to analyse the effectiveness, costs and benefits of different policy options for mitigating climate change and adapting to its impacts*
- *Improving, demonstrating and deploying existing climate-friendly technologies and developing the technologies of the future.*



The EU's Sixth Framework R&D programme, covering 2002-2006, allocated more than €2 billion to research that directly or indirectly addressed climate change. Another €1.2 billion was spent on nuclear research.

Reflecting the increasing urgency of the climate challenge as the manifestations of climate change multiply, funding for climate-relevant research has been substantially increased to €9 billion in the Seventh Framework Programme (FP7) covering 2007-2013. FP7 has a total budget of €51.5 billion.

This research will support not only European policy action but also international processes in the framework of the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol.

Climate-relevant research under FP7 is focused on four main thematic areas:

**Environment** (total budget €1.89 billion)

The objective of relevant activities under the Environment theme is to strengthen understanding of climate change and our capacities to manage and adapt to it. This involves in particular:

- Improving our capacity to predict the future evolution of the climate-Earth system
- Improving the accuracy of climate information at regional and local levels through the 'downscaling' of modelling techniques and their application to smaller areas
- Integrating the physical and socio-economic aspects of climate change in order to quantify better its impacts and thus design more effective response strategies for Europe and beyond
- Assessing climate-induced changes in the water cycle, extreme events, and human health.

- Providing efficient adaptation strategies especially for the most vulnerable countries and regions of the world. This will support the objectives of the European Commission's June 2007 Green Paper on adaptation to climate change<sup>1</sup> by helping to fill knowledge gaps.

### **Energy** (total budget €2.35 billion)

Relevant activities under this theme focus on supporting the development of a more



environmentally sustainable energy system to address the pressing challenges of security of supply and climate change. This involves in particular:

- Improving energy efficiency throughout the energy system
- Accelerating the increase in renewable energy sources' share of the energy mix
- Decarbonising power generation and, in the longer term, substantially decarbonising the transport sector
- Reducing greenhouse gas emissions

### **Transport** (total budget €4.16 billion)

The objective of climate change-relevant activities under the transport theme is to promote the development of integrated, "greener" and "smarter" European transport systems in order to reduce greenhouse gas emissions. The main activities include:

- 'Greening' air transport: Developing technologies to reduce the environmental impact of aviation with the aim of halving carbon dioxide (CO<sub>2</sub>) emissions and cutting specific emissions of nitrogen oxides (NO<sub>x</sub>) by 80 %. This encompasses work on engines and alternative fuels, new aircraft structures and designs, airport operations and traffic management.

<sup>1</sup>) *Adapting to climate change in Europe - options for EU action*. Green Paper. COM(2007) 354 final

- 'Greening' surface transport: Developing technologies and knowledge to reduce pollution of the air (including emissions of greenhouse gases), water and soil. This includes:
  - Developing clean and efficient engines and power-trains including hybrid technologies
  - Use of alternative fuels for transport applications, in particular hydrogen and fuel cells
  - Developing end-of-life strategies for vehicles and vessels.
  - Taking account of cost-efficiency and energy-efficiency considerations



**Space and Global Monitoring for Environment and Security (GMES) (total budget €1.43 billion)**

Relevant activities under this theme focus on monitoring climate change through Earth observation from satellites. This involves in particular:

- Developing appropriate satellite-based monitoring and early warning systems, including for public safety
- Providing support to the development of operational GMES services that will enable decision-makers to better anticipate or mitigate crisis situations and manage environmental issues, security and natural disasters
- Improving knowledge about the state and evolution of sustainable use of renewable resources, wetlands, desertification, land cover, land use, food supply, agriculture and fisheries, carbon sinks and stocks, atmospheric processes and chemistry, and the condition of the seas.

A further €2.7 billion under FP7 is earmarked for research into nuclear fusion and fission and radiation protection between 2007 and 2011.

Additional funding will come from other activities and specific programmes. For example, the European Commission's Joint Research Centre will increasingly support EU climate change policies, while a Competitiveness and Innovation Framework Programme, with funding of €3.6 billion between 2007-2013, is promoting innovation in industry.



## International cooperation

International cooperation is an integral part of the EU's R&D framework programmes. Under the 6th Framework Programme, €600 million was allocated to funding scientists from third countries, so they could participate in EU-supported research projects, and to projects aimed



at establishing international cooperation in specific fields. This is expected to rise under the 7th programme.

International climate change research activities are explicitly encouraged by the UNFCCC and the Kyoto Protocol. The two agreements call on their signatories to promote, and to cooperate in, scientific, technological, technical, socio-economic and other research, systematic observation and development of data archives.

European researchers in the field of climate change are therefore actively cooperating with their counterparts in third countries and disseminating the results of European research projects.

The results also feed into the work of the United Nations' Intergovernmental Panel on Climate Change (IPCC), which brings together more than 1 000 scientists from across the world to assess and synthesise existing knowledge on climate change, its causes, its impacts and response measures. Many European researchers directly contribute to the work of the IPCC by making available their research, providing expert knowledge and peer-reviewing studies. In recognition of the value of its work, and of the threat to world security that climate change poses, the IPCC was joint winner of the Nobel Peace Prize in 2007, the year it published its Fourth Assessment Report.

## Ensuring the take-up of new technologies

On its own, the development of climate-friendly technologies will not bring about the changes in our energy systems and economies that are necessary to limit climate change. The technologies must also be put to use. Studies indicate that the successful development and take-up of low-carbon technologies requires a dual approach combining 'technology push' through R&D with 'market pull' through incentives and an appropriate regulatory framework.



Market-based instruments can play an important role in assisting 'market pull.' For example, the EU Emissions Trading System encourages the use of emission-saving technologies by capping CO<sub>2</sub> emissions from some 10,500 energy intensive installations in the EU. Other examples of market-based instruments used by Member States are green certificate schemes and fiscal incentives for renewable energy sources.

As a result of focused research and policies 'pulling' wind power onto the market, particularly in Germany, Spain and Denmark, wind turbine power has increased by a factor of 100 in the last 20 years, while wind power generation costs have declined by some 80%.

When all cost elements (including investment, operation and maintenance costs) are considered together, the cost of wind power generation in the EU has come down to around 4-6 €cents/kWh at sites with very good wind speeds, and to 6-8.5 €cents/kWh at sites with low wind speeds. These figures were calculated for 2006 when the wholesale cost of electricity produced by conventional power plants was around 3 €cents/kWh.

Due to recent increases in electricity prices, wind power is now approaching competitiveness in locations with high average wind speeds. European companies dominate the global market for wind turbines, a market worth around € 18 billion and growing at over 30% per year.

Other renewable energy sources and low-carbon technologies are ready to be used more widely if the right mix of policies is put in place. Renewables, carbon capture and storage techniques and nuclear fission can decarbonise electricity production and reduce the use of

fossil fuels to produce energy. Other existing technologies can improve the energy efficiency of buildings, power plants and vehicles. There are also techniques to manage forests and agricultural soil that can enhance the function of natural sinks.

At the same time, research remains crucial to devising further technologies to cut emissions in the medium to long-term. Hydrogen & fuel cell technology are particularly promising options.

## Clean, clever, competitive: the Environmental Technologies Action Plan

The EU's Environmental Technologies Action Plan (ETAP)<sup>2</sup>, launched in 2004, is helping to improve the development and promote the wider use of eco-technologies in the EU, including climate-friendly technologies. EU eco-industries include sectors such as climate-friendly low-carbon technologies, air pollution control, wastewater management and recycling industries.

ETAP reflects a recognition that promoting greater take-up of environmental technologies which already exist or are just entering the market can bring substantial environmental gains and, at the same time, boost Europe's competitiveness and economic growth.

Eco-industries have grown in recent years to become a prominent force in the EU's economy. Today they represent about 2.1% of EU Gross Domestic Product and account for some 3.5 million jobs. About three-quarters of these jobs are in the water and waste management sectors and the remainder in other areas such as air pollution control, soil remediation, renewable energy and recycling. The European sector is strong internationally, accounting for about one-third of the world market in eco-industries.

The wind power sector, for example, owes much of its success to research and development projects funded by the EU. This success needs to be emulated in other areas. By 2013, ETAP will have been instrumental in channelling over €12 billion towards eco-innovation projects through FP6, FP7 and other EU funding programmes.

ETAP has identified 25 actions to overcome barriers that slow down the development and introduction of eco-technologies. These barriers include economic obstacles, unfavourable regulations and standards, lack of targeted research, inadequate availability of risk capital, and lack of market demand. EU member states are addressing these barriers through eco-innovation 'roadmaps'. These roadmaps also provide a basis for sharing promising practices that can have a powerful multiplier effect across the EU.

Measures such as green procurement and performance-driven standardisation can stimulate demand for environmental technologies. In the short term these policies need to focus on the sectors which can yield large environmental benefits quickly and easily. These include construction, food and drink and private transport, which together are estimated to account for 70 to 80% of all environmental impacts.

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2) <http://ec.europa.eu/environment/etap>

## EU-funded research projects

The following are examples of research projects funded by the EU under the 6th Framework Programme (2002-2006) and which are still under way.

### *Connecting models to policy needs*

*In recent years, the focus has moved from developing large-scale climate models to linking these models to policy needs. EU-funded projects are now facilitating decision-making by providing a sound scientific base, including estimates of uncertainties.*

### **Future climate projections - ENSEMBLES (2004-2009)**

This UK-led project brings together 70 partners from the EU, Switzerland, Australia and the US, with EU funding of €15 million. The project aims to develop and test a prediction system for climate change, simultaneously using several models, and to quantify and reduce uncertainty in the representation of feedbacks in the Earth system. (Feedbacks describe the interlinkages between different components of the Earth system.)

[www.ensembles-eu.org](http://www.ensembles-eu.org)

### **Carbon sources and sinks - CARBOEUROPE (2004-2009)**

This project is aiming to understand and quantify the terrestrial carbon balance between the uptake and return of CO<sub>2</sub> to the atmosphere in Europe and the associated uncertainties at local, regional and continental levels. Funded with €16.3 million from the EU and another €16 million from national governments, CARBOEUROPE involves 61 partners from 17 European countries.

[www.carboeurope.org](http://www.carboeurope.org)



### *Evaluating the impacts and costs of climate change*

*Theoretical knowledge, observations, experimental results and newly developed tools are being brought together under the EU umbrella. This is generating better understanding of the environmental and socio-economic impacts of climate change as well as the impacts and costs of mitigation and adaptation policies.*

#### **Water and global change – WATCH (2007-2011)**

The WATCH project aims to analyse, quantify and predict the components of the current and future global water cycles and the state of related water resources. It will also clarify the overall vulnerability of global water resources related to the main societal and economic sectors. With EU funding of €10 million, WATCH brings together the hydrological, water resources and climate communities and involves 25 partners from 14 European countries as well as from India, China, South Africa, Brazil and Israel.

#### **Transport emissions and climate impacts - QUANTIFY (2005-2010)**

This project, in which 15 European countries and the USA are participating, is seeking to quantify the contribution of transport emissions to climate change, ozone depletion and changes in atmospheric composition. It is assessing the climate impact of various transport modes (land-based, shipping, aviation) and their emissions of long-lived greenhouse gases, such as carbon dioxide and nitrous oxide, ozone precursors and particles. QUANTIFY is also assessing the impact of linear clouds caused by ship emissions, known as ship tracks. The EU is providing funding of € 8 million.

<http://www.pa.op.dlr.de/quantify/>

#### **Adaptation and mitigation strategies - ADAM (2006-2009)**

ADAM aims to assess the costs and effectiveness of impact mitigation and adaptation policies to achieve a tolerable transition to a world that is no more than 2°C warmer than in the pre-industrial era. With EU funding of €12.9 million, the project is also drawing up a portfolio of longer term strategy options to adapt to and mitigate climate change. Some 26 partners from 12 European countries, China and India are participating.

<http://www.adamproject.eu/>

#### **Earth Observation - DAMOCLES (2005-2009)**

This project's goal is to carry out an observation and assessment of Arctic sea ice cover and its reduction due to global warming. In studying key interactions between the Arctic's ocean, atmosphere and ice cover, DAMOCLES is making an important contribution to the International Polar Year 2007-2008. The EU is providing funding of €16.5 million for the project, in which 12 EU Member States plus Russia and Belarus are participating.

<http://www.damocles-eu.org/>

### **Carbon sources and sinks - CARBOOCEAN (2005-2009)**

The ocean is a major sink of CO<sub>2</sub> and any changes in its capacity - due to climate change or other factors - could have serious consequences and feedbacks. CARBOOCEAN aims to make an accurate assessment of marine carbon sources and sinks. The project involves 35 partners from 16 countries and is receiving EU funding of €14.5 million.

<http://www.carboocean.org>

### **Lessons from the ice: EPICA**

The polar ice sheets are unique and precious archives of past changes in the climate and the atmosphere's composition. Tiny air bubbles trapped in the ice provide clues to the composition of the atmosphere thousands of years ago, while the relationship between the levels of atmospheric CO<sub>2</sub> found in the bubbles and the temperature at which the ice formed reflects the extent of the greenhouse effect at that time.

EPICA, which ran from 1996 to 2005, was an ambitious multinational European initiative to drill deep ice cores in Antarctica. A joint project of the European Commission and the European Science Foundation, it received EU funding of € 8.5 million.

EPICA's aim was to help predict more accurately how the global climate is likely to respond to increased emissions of greenhouse gases as a result of human activities. It succeeded in recovering the longest record of past climatic changes (going back 800 000 years), established a record of CO<sub>2</sub> levels in the atmosphere for the past 650 000 years, and documented the uniqueness of present levels.



## *Achieving more sustainable energy systems*

*The path towards more sustainable energy systems requires significantly greater production of clean and renewable energy, as well as further improvements in energy efficiency, from production to end use. A more sustainable energy system will result in reduced greenhouse gas emissions, cleaner air, greater security of energy supply and lower vulnerability to oil price fluctuations.*

### **Photovoltaics - CRYSTAL CLEAR (2004-2008)**

The main objective of this project involving 16 partners is to allow crystalline silicon photovoltaic modules to be produced at lower cost (towards €1 per watt) while further improving their environmental profile. CRYSTAL CLEAR is receiving EU funding of €16 million.  
[www.ipcrystalclear.info](http://www.ipcrystalclear.info)

### **Biofuels - RENEW (2004-2008)**

With 31 partners and EU funding of €10 million, this project is developing and evaluating processing technologies for the synthesis of liquid fuels from biomass. The goal is to produce cost-effective premium fuels for current and future combustion engines.

[www.renew-fuel.com](http://www.renew-fuel.com)

### **Geological storage of carbon dioxide - CO2SINK (2004-2008)**

Aided by EU funding of €8.7 million, CO2SINK is exploring the geological storage of CO<sub>2</sub> in a deep saline aquifer under a former natural gas storage site. If the location is found to be safe, 60,000 tonnes of CO<sub>2</sub> will be injected. The effects of the injection and the behaviour of the CO<sub>2</sub> will be monitored using special techniques.

[www.co2sink.org](http://www.co2sink.org)

### **Storage of hydrogen – NESSHY (2006-2010)**

This project, with EU funding of €7.5 million, is developing novel materials and methods for storing hydrogen as an energy carrier for mobile and stationary applications. Twenty-two partners from 12 European countries and the USA are participating.

[www.nesshy.net](http://www.nesshy.net)

### **Fuel cells - FURIM (2004-2008)**

Involving 12 European institutes and companies, FURIM is focused on the further development of fuel cell technologies, particularly polymer membranes for operation above 150°C. This will support the commercialisation of fuel cell technology for stationary applications. The EU is providing funding of €4 million.

[www.furim.com](http://www.furim.com)

### **Analytical tools, models and databases developed with EU support**

PRIMES - a large-scale model of the energy systems of EU Member States that allows for forecasting, scenario construction and policy impact analysis covering a wide range of energy, environmental and technological policies;

POLES - a world simulation model for the energy sector that allows for regional long-term projections of demand, supply and prices, analyses of the impacts of emission trading systems and the costs of CO<sub>2</sub> abatement policies, and technology improvement scenarios;

GEM-E3 - a model providing details on the macro-economy of EU countries or world regions and their interaction with the environment and energy systems. It allows for a consistent evaluation of climate change policy measures;

NEMESIS - an econometric macro-sectoral model for EU countries to assess the impacts of economic, environmental and R&D policies in the short to medium term;

MURE - a database on policies and measures for the rational use of energy and renewables in the EU as well as their ex-ante evaluation;

GREEN-X - a tool box with a database calculating potential and costs of climate-friendly energy sources and technologies and the corresponding reductions in greenhouse gases.

### **Coordinating and harmonising Earth observation systems**

*Through space, meteorological, atmospheric, oceanic and terrestrial observation centres, European scientists are constantly monitoring the effects of human activities on the global atmosphere and water, as well as land use and ecosystems changes. This is providing the necessary scientific background for solid policies. The EU has built up considerable experience in the design, production and operation of Earth observing tools.*

### **Global Earth Observation System of Systems - GEOSS (2005-2015)**

As part of the Group on Earth Observations, the EU is working on the ground-breaking Global Earth Observation System of Systems (GEOSS) project, which was launched by 50 countries and 40 international and scientific organisations in February 2005. GEOSS will bring together and make available information on the state of the global environment.

[http://europa.eu.int/comm/research/environment/geo/article\\_2450\\_en.htm#4](http://europa.eu.int/comm/research/environment/geo/article_2450_en.htm#4)



### **Global Monitoring for Environment and Security - GMES (2002-2008)**

Global Monitoring for Environment and Security (GMES) is a joint EU and European Space Agency programme to collate environmental and security-related data and to link information providers with users.

[www.gmes.info](http://www.gmes.info)

### **Oceanic observation - MERSEA (2004-2008)**

This project aims to develop a European system for operational monitoring and forecasting of ocean physics, biogeochemistry and ecosystems at both global and regional scales. The system will be the ocean component of the future GMES system.

[www.mersea.eu.org](http://www.mersea.eu.org)

### **Space-based observation**

The EU has provided operational space missions with permanent and continuous capacity for observing Earth system functions, including climate change and its impacts. The European Commission's Joint Research Centre is developing data analysis methods to extract the information from these space observations and assist space agencies in meeting the needs of climate science.

### **Atmospheric observation - World Data Centre for Aerosols**

The European Commission's Joint Research Centre operates the World Data Centre for Aerosols. This is one of six World Data Centres set up in the framework of Global Atmosphere Watch, a programme of the World Meteorological Organisation.

<http://rea.ei.jrc.it/netshare/wilson/WDCA/> 17



## International cooperation

*Climate change is a global issue, and international cooperation has been an integral part of the priority thematic areas of all EU framework research programmes.*

### **Climate change & African monsoons - AMMA (2005-2009)**

Supported by €13 million of funding from the EU, AMMA aims to reinforce regional environmental monitoring systems in Africa and improve the ability to predict the impact of climate change on West African Monsoon variability.

[www.amma-eu.org](http://www.amma-eu.org)

### **Europe/South America cooperation on climate change - CLARIS (2004-2007)**

This project provides for the transfer of knowledge and expertise in Earth System models between Europe and South America and the creation of a high-quality climate database for South America. The EU is supporting the project with €500,000.

[www.claris-eu.org](http://www.claris-eu.org)

### **The Amazon ecosystem - PAN-AMAZONIA (2004-2007)**

With €400,000 in funding from the EU, this project is strengthening European cooperation with Latin American partners in building up a critical mass of human resources and techniques for monitoring and understanding the role of the Amazon ecosystem in climate change and biodiversity.

[www.geog.ox.ac.uk/research/projects/panamazonia](http://www.geog.ox.ac.uk/research/projects/panamazonia)

### **Atmospheric composition changes - EUCAARI (2007-2010)**

Uncertainties over the effects of natural and man-made aerosols in the atmosphere and on cloudiness and cloud properties are a major complicating factor in predicting future climate change. The EUCAARI project, with EU funding of €10 million, is trying to reduce these uncertainties significantly. Some 48 partners from 17 European countries, as well as India, China, South Africa, Brazil and Israel, are taking part.

[www.atm.helsinki.fi/eucaari](http://www.atm.helsinki.fi/eucaari)



