



European
Commission

LOW-CARBON RESEARCH AND INNOVATION

Building
a low-carbon,
climate-resilient
future



Research and
Innovation

LOW-CARBON RESEARCH AND INNOVATION - Building a low-carbon, climate-resilient future

European Commission
Directorate-General for Research and Innovation
Directorate A – Policy Development and Coordination
Unit A1 - Communication

Contact Rossella PAINO
E-mail Rossella.PAINO@ec.europa.eu
RTD-PUBLICATIONS@ec.europa.eu

European Commission
B-1049 Brussels

Manuscript completed in August 2017

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Luxembourg: Publications Office of the European Union, 2017

Print	ISBN 978-92-79-68893-5	doi:10.2777/914531	KI-02-17-573-EN-C
PDF	ISBN 978-92-79-68892-8	doi:10.2777/828317	KI-02-17-573-EN-N

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CONTENTS

Foreword.....	2
Introduction.....	4
Secure, clean and efficient energy	6
Climate change science and innovation	8
Nanotechnologies, advanced materials, advanced manufacturing and processing	10
Pathway to avoiding a 2 °C warming.....	12
Space and Earth observation	14
Sustainable agriculture, forestry, fishery and food transformation.....	16
Smart, green and integrated transport.....	18

FOREWORD



Maroš Šefčovič



Carlos Moedas

Climate change is undoubtedly one of the greatest challenges of our time. We have a collective duty to rapidly decrease our greenhouse gas emissions towards reaching climate neutrality in the next decades, and to prepare and adapt to the changes which are already taking place.

The European Union is a world leader in climate action. It is also striving to become a world leader in promoting open science and open innovation in order to help achieve the ambitious mitigation and adaptation targets outlined in the COP21 Paris Agreement.

Making energy more secure, affordable and sustainable is therefore one of the top priorities of this Commission. The EU's Energy Union strategy recognises that wiser energy use, while fighting climate change, is both a spur for new jobs and growth and an investment in Europe's clean and sustainable future.

This is clearly reflected in the focus of our clean energy research and innovation efforts in 4 inter-linked areas: renewables; energy storage; electro-mobility and decarbonising Europe's building stock.

However, beyond the energy sector, much more needs to be done in all aspects of the economy and society in order to mitigate and adapt to climate change. It is not only a matter of technological innovation; it requires ambitious new ideas, services and business models that help change our way of life.

‘Business as usual’ is clearly not an option. We need to boost investment in research and innovation in order to create breakthroughs in low-carbon solutions. Such breakthroughs drive the transition to a cleaner, greener society and improve our competitiveness. The challenge is huge, cross-sectoral and multidisciplinary by nature. But we will take action.

The focus area ‘Building a low-carbon, climate-resilient future’ brings together and coordinates the activities of several thematic areas of Horizon 2020 — the European Union’s research and innovation funding programme. It will include research and innovation activities on climate change science, energy, transport, industry, agriculture, the built environment and Earth observation. It mobilises strong investments that will underpin our leadership in delivering solutions that help to achieve the objectives of the Paris agreement.

Europe needs to be open to the world in order to derive greater value from its position as a ‘climate champion’ but also to consolidate its position as a ‘research and innovation champion’. Therefore, international scientific cooperation is a key component of this focus area.

On climate change, we need to be clever, bold, ambitious and fast. Focusing on ‘Building a low-carbon, climate-resilient future’ gives Europe the impetus to make a positive impact.

Maroš Šefčovič,
*European Commission Vice-President
for Energy Union*

Carlos Moedas,
Commissioner for Research, Science and Innovation

INTRODUCTION

ACTIONS TO ACHIEVE A LOW-CARBON SOCIETY

The adoption of the COP21 Paris Agreement in 2015 marked the beginning of a new era in the fight against climate change. The historic agreement set out the challenging long-term goals to put the world on track to limiting global warming to “well below 2 °C above pre-industrial levels” and “pursuing efforts” to limit warming to 1.5 °C. At the same time, it called for greater resilience and ability of societies to adapt to the adverse impacts of climate change.

Research and innovation within the Horizon 2020 focus area ‘Building a low-carbon, climate-resilient future’ helps to implement the Paris Agreement. This includes designing cost-effective pathways for mitigation and adaptation goals. It also includes actions to produce relevant data to support scientific assessments by the United Nations’ Intergovernmental Panel on Climate Change (IPCC). The work done within this focus area also helps to prepare the next steps in international climate negotiations.

Moreover, the development of ground-breaking technological and non-technological solutions, especially for the energy system, and technology transfers are recognised as key tools to achieve the Paris objectives. This creates great opportunities for business development and for reinforcing European competitiveness.

Actions within this focus area support a broad range of relevant EU policies and objectives, including the EU’s energy and climate policies, Arctic policy, Adaptation Strategy and climate diplomacy efforts. It also helps to boost international cooperation with strategic partner countries and key regions of the world, in particular with major emitters and with less developed countries.

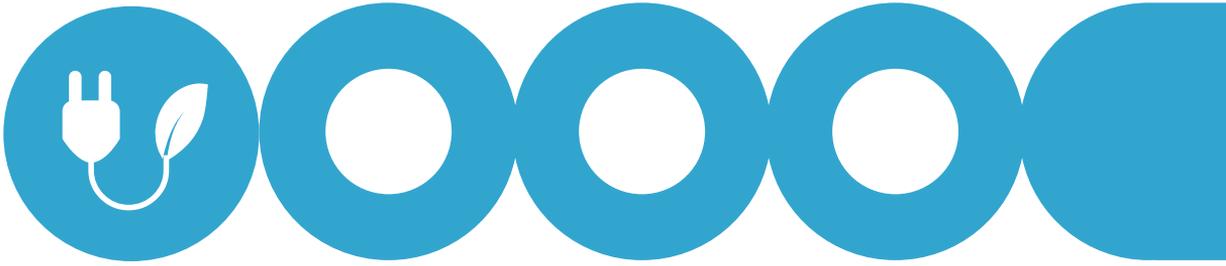
This focus area has significant financial resources to deliver concrete results that can have a major impact. With a total budget of about EUR 3.4 billion between now and 2020 that means more than EUR 1.1 billion annually for the next three years.

The focus area takes the form of 'virtual calls', linking topics across specific programmes of Horizon 2020, thereby unlocking new types of impact and producing better added value.

Only projects with very high relevance for climate action are supported under this funding stream. Many other projects financed from other calls under Horizon 2020 are also contributing to the climate action agenda. Overall, 35 % of Horizon 2020 is earmarked to fund climate-related research and innovation projects.

This focus area builds on the results of previously funded projects, including those mentioned in this booklet.

The EU confirmed in 2016 its commitment to the Paris Agreement by adopting the 'Clean Energy for all Europeans' legislative package which includes a European Commission Communication on Accelerating Clean Energy Innovation (COM(2016)763). It proposes 20 actions in four key areas that have the potential to fast track the development and market-introduction of breakthrough technologies: decarbonising Europe's building stock, strengthening the EU's leadership in renewable energy, developing integrated and affordable energy storage solutions, and electro-mobility. In order to achieve these goals, over EUR 2 billion have been earmarked in support of four priority areas during the last three years of Horizon 2020.



Achieving carbon neutrality in the energy sector, while ensuring more efficient energy use, secure supply, affordable prices and low environmental impact, requires research and innovation activities on multiple fronts. Within this focus area, very large investments are foreseen in a broad range of activities that should deliver:

- ▶ On the supply side, cheaper and better-performing renewable energy generation technologies which are better integrated across the energy system;
- ▶ On the demand side, increased overall energy efficiency and tools for consumers to play a more active role in the energy transition;
- ▶ In general, a smarter, more flexible and resilient energy system;
- ▶ Better understanding of the specific socio-economic contexts in which energy transition takes place, to address obstacles more effectively;
- ▶ Increased market uptake of innovations, including implementing energy policy, rolling out investments, and supporting capacity-building.

“Within this focus area, very large investments are foreseen in a broad range of activities.”

Budget

A budget of some **EUR 2 billion** has been earmarked for investment secure, clean and efficient energy under this focus area.

SECURE, CLEAN AND EFFICIENT ENERGY



EUROSUNMED

The EUROSUNMED project's scientific goal is to develop new technologies in three energy fields — photovoltaics (PV), concentrated solar power (CSP) and grid integration (GI). It also aims to boost collaboration with research institutes, universities and SMEs around the Mediterranean. The project further aims to produce and trial components in hot, dry and other testing conditions. The research is complemented by PV, CSP and GI studies in Morocco and Egypt.

COORDINATOR: Centre national de la recherche scientifique, France

TOTAL COST: EUR 6301821

EC CONTRIBUTION: EUR 5261726

START/END: September 2013 to August 2017

OTHER COUNTRIES: Morocco, Norway, Spain, Belgium, Egypt, Italy

WEB: www.eurosunmed.eu

NOBEL GRID

The NOBEL GRID project is developing tools and ICT software for the electricity market, including cooperatives and local communities, to ensure lower energy prices, more secure and stable electrical grids, and clean electricity. It has designed three grid management tools, including two smart meters being tested in Belgium, Greece, Italy, Spain and the UK. These tools have potential to reduce energy consumption by 20 %, thus lowering energy bills.

COORDINATOR: ETRA Investigación y Desarrollo, Spain

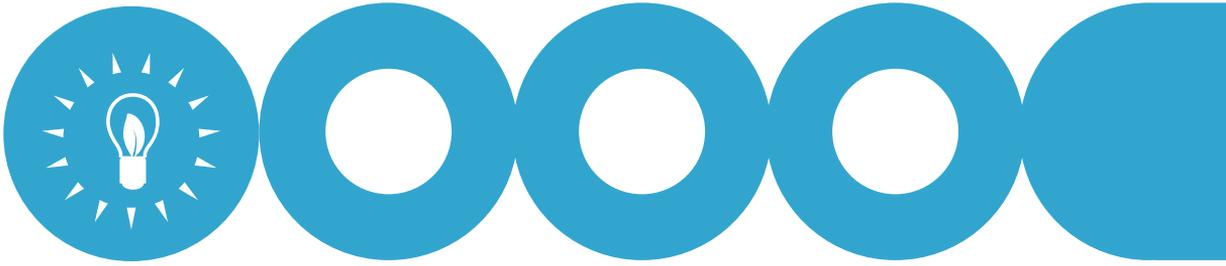
TOTAL COST: EUR 14034360

EC CONTRIBUTION: EUR 11725973

START/END: January 2015 to June 2018

OTHER COUNTRIES: Germany, Austria, Belgium, Sweden, Greece, Romania, United Kingdom, Netherlands, Portugal.

WEB: <http://nobelgrid.eu>



Actions in this field aim to contribute to reviews by the Inter-governmental Panel on Climate Change (IPCC) and the Paris Agreement Global Stocktake. These reviews every five years take stock of the impact of countries' climate change actions. Actions will address areas of relevance for the 6th IPCC Assessment Report. These areas include key knowledge gaps in climate processes, tipping points and Earth observation needs for improving predictability. The deep societal and technological transformation required to achieve the goals set out in the 2015 Paris Agreement on climate change is also part of this focus area. In-depth assessments of impacts, vulnerabilities, risks and solutions for disaster risk reduction also come under this remit. Research will also focus on ways to help humanity and nature (including ecosystems) build resilience to the worst impacts of climate change. This could include approaches to climate-proof assets and critical infrastructure. It also includes developing, testing and deploying more nature-based solutions and services. Special consideration is given to cooperation with strategic partner countries/regions. Targeted partners will be key carbon emitters and those most vulnerable to climate change, such as small island states.

“Special consideration is given to cooperation with strategic partner countries/regions.”

Budget

A budget of some **EUR 410 million** has been earmarked for investment in this focus area.

CLIMATE CHANGE SCIENCE AND INNOVATION



CD-LINKS

The CD-LINKS project addresses an important question for policymakers in the G20 and beyond, which is how to bring climate action into the broader sustainable development agenda. Objectives such as eradicating energy poverty and increasing air quality, food and water are critical to boosting overall well-being. Through better understanding of the links between climate change policies (past and present) and multiple sustainable development objectives, this research network seeks to develop globally consistent national low-carbon development policies and pathways.

COORDINATOR: Internationales Institut für angewandte Systemanalyse, Austria

TOTAL COST: EUR 5 212 962

EC CONTRIBUTION: EUR 5 037 962

START/END: September 2015 to August 2019

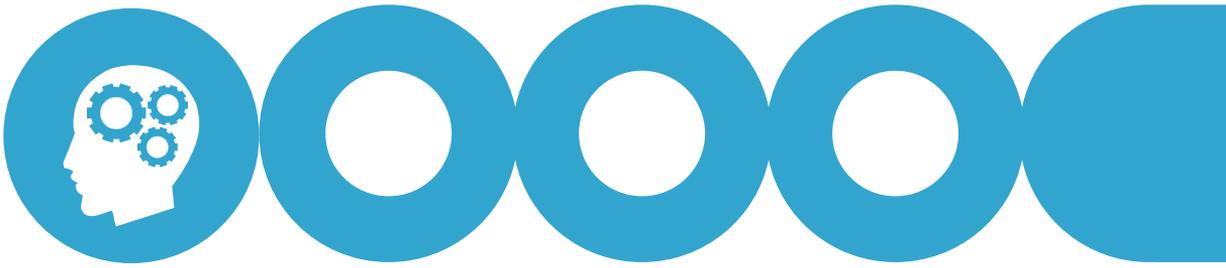
OTHER COUNTRIES: Germany, Italy, Netherlands, Greece, United Kingdom, France, Brazil, China, India, Russia, Japan

WEB: www.cd-links.org

UNALAB, CONNECTING, GREEN GROWTH, URBAN GREEN UP

The four large-scale demonstration projects UNALAB, CONNECTING, GREEN GROWTH and URBAN GREEN UP aim to develop, pilot and document the contribution of nature-based solutions to climate and water resilience in around 13 cities or 'living labs' engaging all relevant stakeholders in a co-creation process. To ensure effective uptake and eventual scale-up of the solutions developed, 26 additional cities have been recruited as potential 'replicators' to help leverage and amplify the findings across Europe and the rest of the world.

WEB: www.openlivinglabs.eu



Key enabling technologies provide the basis for innovation in most crucial sectors for decarbonisation. Innovative advanced materials and nanotechnologies enable reliable, efficient and affordable energy production and storage solutions, which are indispensable for e-mobility and for better integrating sustainable energy production sources in the electricity grid. Actions address research and innovation on materials for stationary and mobile storage solutions and for advanced sustainable energy production.

Decarbonisation in the construction sector — one of the main emitters in Europe — requires further development, demonstration and validation of breakthrough technologies for buildings and districts. The public-private partnership on ‘Energy-efficient Buildings’ addresses these needs. It also targets ‘plus-energy houses’, which generate more renewable electricity than they draw from outside sources, as well as smart materials in buildings, integrated storage systems, and the industrialisation and digitalisation of construction processes.

“Actions address research and innovation on materials for stationary and mobile storage solutions and for advanced sustainable energy production.”

Budget

Targeting energy-efficient buildings and materials for energy applications, this focus area of Horizon 2020 has been allocated some **EUR 270 million**.

NANOTECHNOLOGIES, ADVANCED MATERIALS, ADVANCED MANUFACTURING AND PROCESSING



ISOBIO

The ISOBIO project is developing a new approach to insulating buildings. It combines existing bio-derived sources with innovative binding agents to produce durable composite construction materials, which contain 50 % less carbon and perform 20 % better than oil-based insulation panels. ISOBIO materials take advantage of the natural moisture sorption/desorption characteristics of bio-based materials, which is known to passively manage the indoor environment and improve air quality, whilst at the same time reducing the demand for air conditioning.

COORDINATOR: TWI Ltd., United Kingdom

TOTAL COST: EUR 6286320

EC CONTRIBUTION: EUR 5470127

START/END: February 2015 to January 2019

OTHER COUNTRIES: France, Germany, Norway, Spain, Belgium

WEB: <http://isobioproject.com>

ALISE

ALISE is a pan-European project to better understand, develop and then commercially scale up new materials for lithium-sulphur batteries — a potential technology for emerging mobile applications. The goal is to produce and test the safety and performance of a competitively priced, stable 500 Wh/kg lithium-sulphur cell. New materials need to be developed and the cell properties (anode, cathode, electrolyte and separator) optimised for integrating into breakthrough components and associated architecture. The lithium-sulphur technology will be demonstrated and validated under real-live conditions.

COORDINATOR: Acondicionamiento Tarrasense Asociacion, Spain

TOTAL COST: EUR 6899233

EC CONTRIBUTION: EUR 6899233

START/END: June 2015 to May 2019

OTHER COUNTRIES: France, Germany, United Kingdom, Italy

WEB: www.aliseproject.com

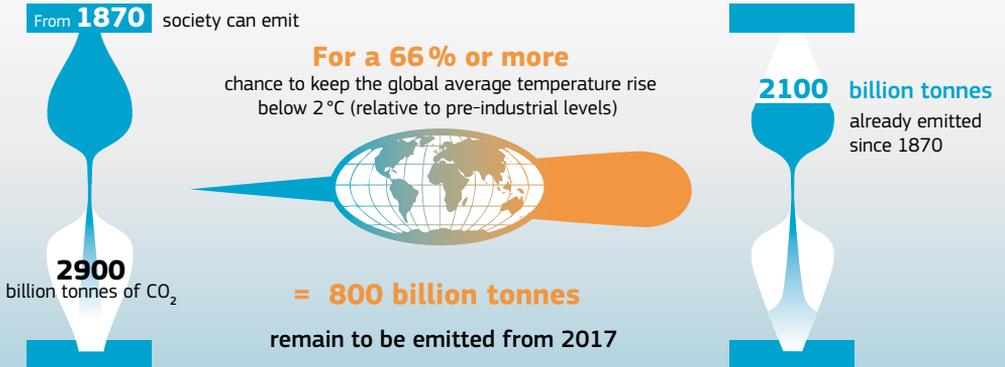
PATHWAY TO AVOIDING A 2°C WARMING

THE GLOBAL CARBON QUOTA

TO KEEP GLOBAL WARMING BELOW A 2°C RISE (RELATIVE TO PRE-INDUSTRIAL LEVELS)

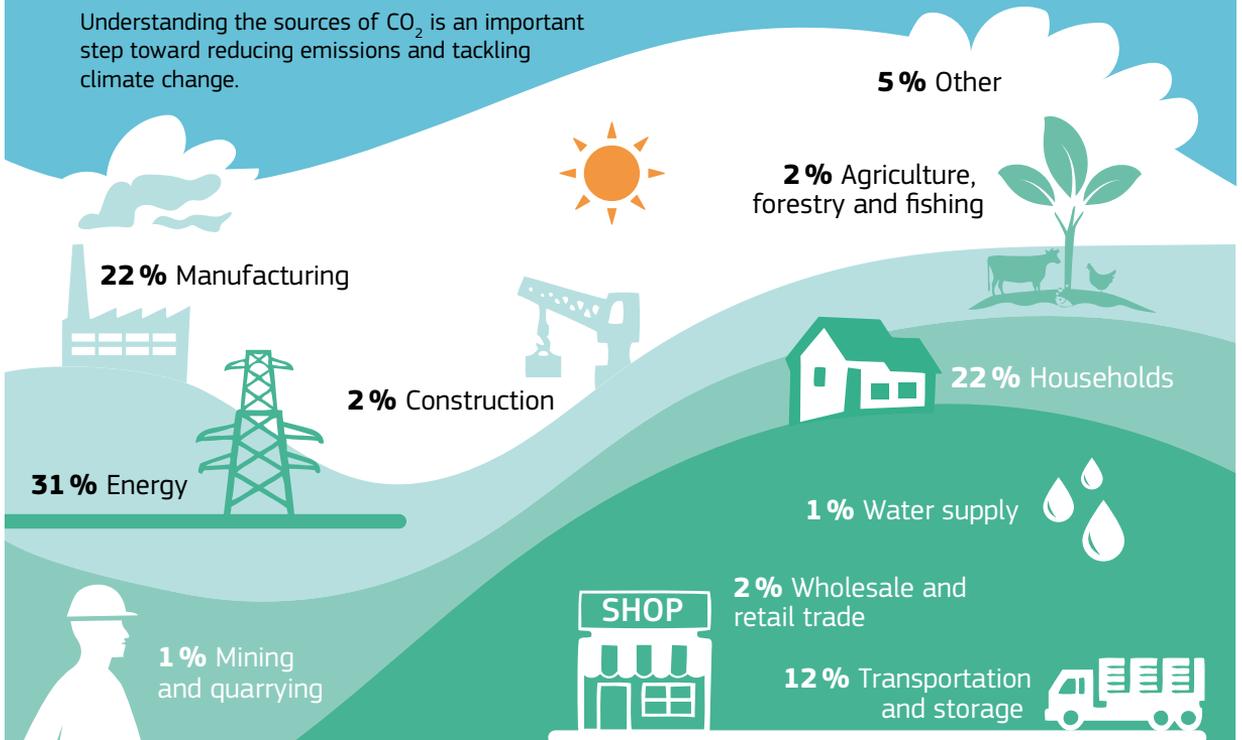
40-70% reduction in global anthropogenic greenhouse gas emissions by 2050 (compared to 2010 levels)

Reduce emissions to near zero or below in 2100



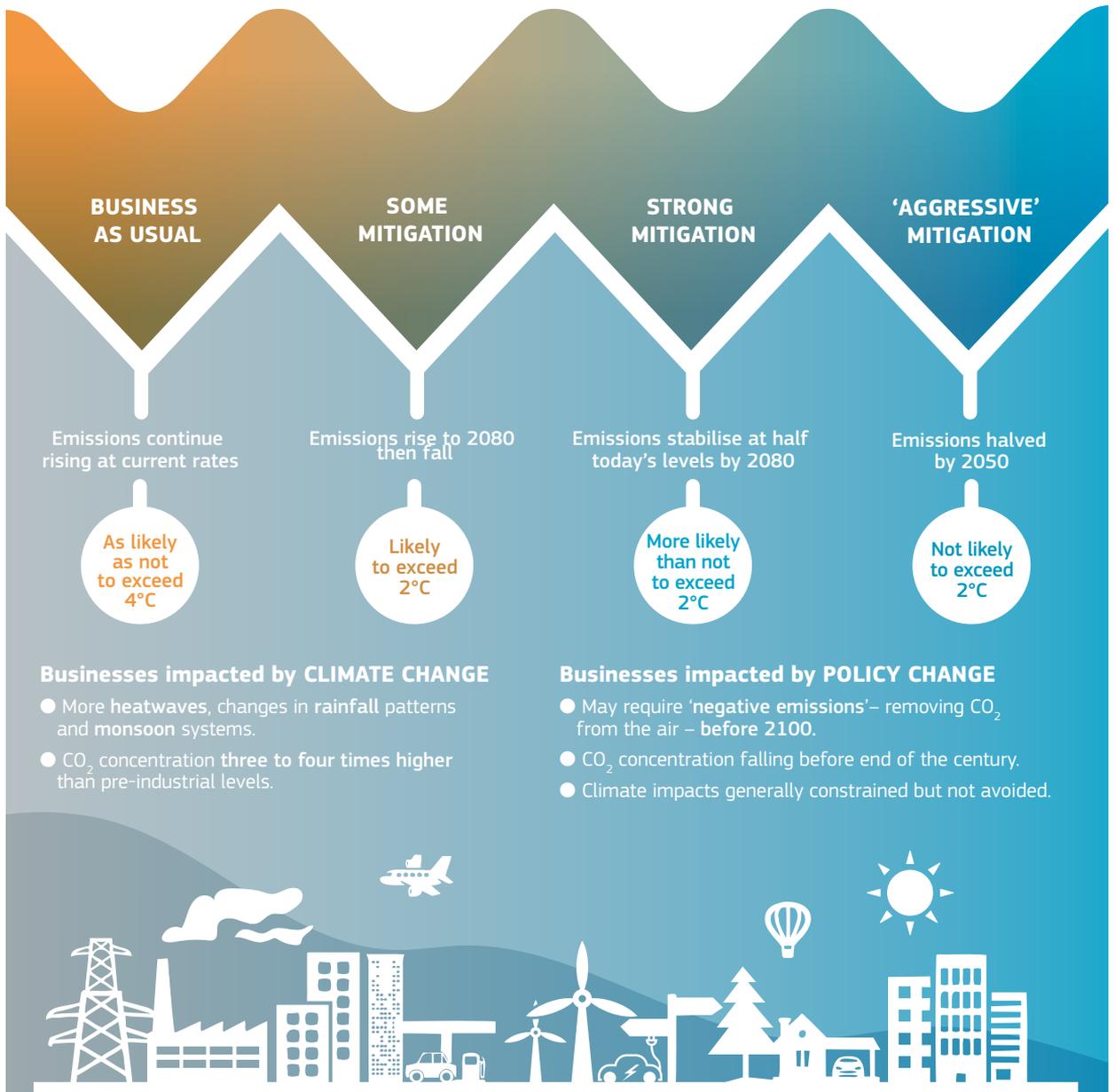
EU CO₂ EMISSIONS BY SECTOR

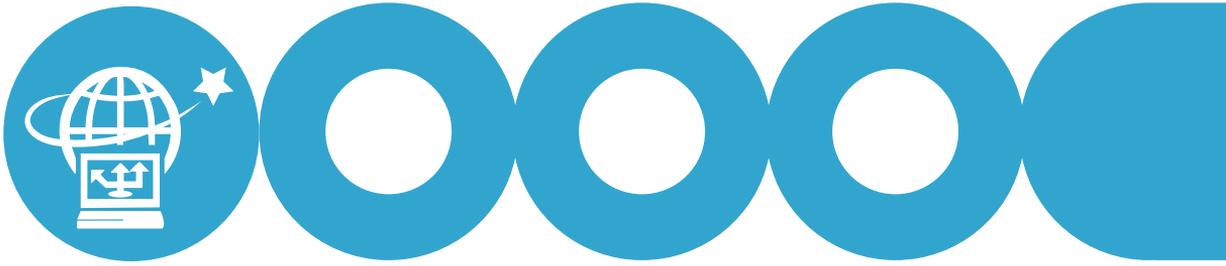
Understanding the sources of CO₂ is an important step toward reducing emissions and tackling climate change.





CHOICES AND CONSEQUENCES





Investment in this area ultimately aims to help countries support and evaluate the effectiveness of their CO₂ emission-reduction strategies by carrying out novel space-based research and missions. The aim is to produce reliable and comprehensive datasets and integrate these in advanced modelling systems for monitoring man-made CO₂ emissions.

Suitable findings from these missions — those demonstrating sufficient technological maturity, for example — can then be fed into ongoing developments with Copernicus, the EU's Earth observation and monitoring programme, and harvested for a diverse climate services.

The use of Earth observation data and information, delivered by Copernicus and GEOSS, feeds into a better understanding climate change processes and the monitoring of greenhouse gases. Satellite navigation (GALILEO) enabled services can also bolster society's defences against climate change and facilitate smart technologies and services for various applications that reduce emissions, including green, safe and smart mobility.

“The use of Earth observation data and information, delivered by Copernicus and GEOSS, is key to better understanding climate change processes and monitoring greenhouse gases.”

Budget

A budget of some **EUR 110 million** is earmarked for Copernicus and Global Earth Observation System of Systems (GEOSS) actions.

SPACE AND EARTH OBSERVATION



ERA-CLIM2

The ERA-CLIM2 project set out to improve methods for (re)analysing historical climate data back to the early 20th century, and generate valuable datasets for scientists and other users. Programmes include rescuing and preparing observation data, and optimising systems so the resulting datasets can be assimilated into the Copernicus Climate Change Service (C3S). ERA-CLIM2 is at the heart of a concerted effort in Europe to build the information infrastructure needed to support climate monitoring, research and services, based on the best available science and observations.

COORDINATOR: European Centre for Medium-Range Weather Forecasts, United Kingdom

TOTAL COST: EUR 15 893 496

EC CONTRIBUTION: EUR 6 996 159

START/END: January 2014 to December 2017

OTHER COUNTRIES: Germany, Switzerland, Austria, Portugal, Russia, France, Italy, Finland

WEB: www.era-clim.eu



ATLANTOS

AtlantOS (Atlantic Ocean Observation System) aims to deliver an advanced framework for an integrated system for observing climate-related changes in the Atlantic Ocean. Countries and organisations around the Atlantic are helping to evaluate the 'readiness' of observing networks and their datasets, in order to define the requirements and architecture of the new integrated system. Outputs from AtlantOS ultimately feed into wider climate-monitoring programmes; namely the Global Ocean Observing System (GOOS) and Global Earth Observation System of Systems (GEOSS).

COORDINATOR: Helmholtz-Zentrum für Ozeanforschung Kiel, Germany

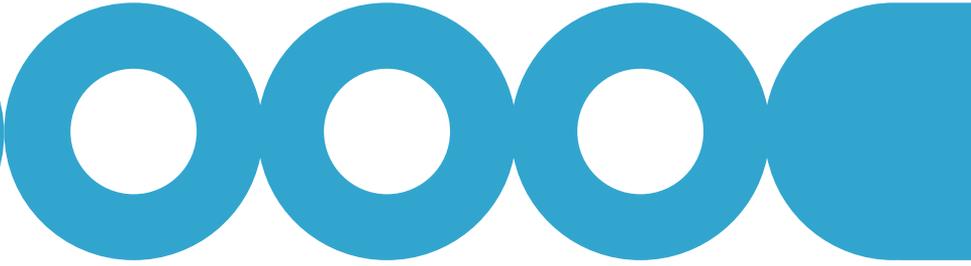
TOTAL COST: EUR 20 652 921

EC CONTRIBUTION: EUR 20 652 921

START/END: April 2015 to June 2019

OTHER COUNTRIES: United Kingdom, Ireland, Denmark, France, Poland, Norway, Spain, Portugal, Netherlands, Faeroe Islands, Belgium, Italy, Croatia, Canada, Brazil, United States, South Africa.

WEB: www.atlantos-h2020.eu



Agriculture, forestry and the natural resources they rely on are increasingly vulnerable to climate change. In the agri-food sectors, research and innovation addresses the need to increase resilience to climate change by adapting farming and food systems, strengthening ecosystems, tackling emerging threats to food safety, while ensuring long-term food and nutrition security.

Weaning ourselves off fossil fuels, while responding to demand for bio-based products and renewable energy sources, is the key to a sustainable future. Innovation in the bio-economy will boost EU efforts to achieve a low- or no-carbon economy. Innovation also includes contributions from various land and resource users, a better understanding of how soil and vegetation store emissions (carbon sink), and the development of bio-refineries and bio-material value chains. Investment in R&I boosts understanding of the synergies and trade-offs between adaptation and mitigation measures in primary production. In the marine and aquatic sector, it helps to assess the effects of climate change, ocean acidification and de-oxygenation on marine ecosystems and biological resources, fisheries and aquaculture, as well as wider impacts on migration. Actions also focus on further developing observations of physical, bio-geochemical and biological variables.

“Weaning ourselves off fossil fuels, while responding to demand for bio-based products and renewable energy sources, is the key to a sustainable future.”

Budget

A total of some **EUR 200 million** has been assigned to research in this domain of the focus area.

SUSTAINABLE AGRICULTURE, FORESTRY, FISHERY AND FOOD TRANSFORMATION



LANDMARK

The LANDMARK project is focusing on ways that Europe can sustainably manage its land and soil. How can we make the most of our land while ensuring that the soil continues to deliver the many services expected of it? This the key question and concerns a variety of issues, from carbon sequestration, nutrient cycles and water regulation issues to primary production and other factors. The overall scientific aim is to comprehensively quantify current and future soil functions across the EU, as determined by soil properties, land use, and soil management practices.

COORDINATOR: Wageningen University, Netherlands

TOTAL COST: EUR 5 307 551

EC CONTRIBUTION: EUR 4 999 663

START/END: May 2015 to October 2019

OTHER COUNTRIES: Denmark, Belgium, Ireland, Hungary, United Kingdom, France, Germany, Austria, China, Brazil, Switzerland, Romania, Sweden, Slovenia, Spain

WEB: <http://landmark2020.eu>

CERES

The CERES project is building a cause-and-effect case to understand how future climate changes will influence Europe's most important fish and shellfish populations, their habitats, and the economic activities dependent on these species. To do this, it is providing regional projections of key environmental variables for European marine and freshwater ecosystems, checking for changes (productivity, biology, ecology) of wild and cultivated stocks, developing mitigation and adaptation scenarios for mitigation, and considering market impacts, industry needs and policy decisions.

COORDINATOR: L'Iniziativa Centro Europea, Italy

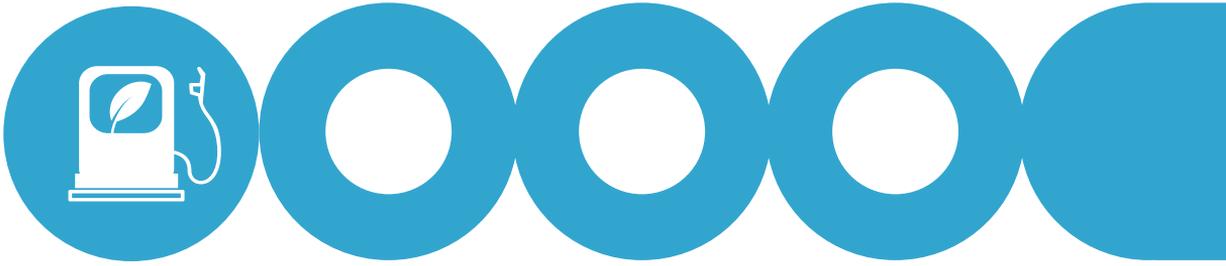
TOTAL COST: EUR 1 008 000

EC CONTRIBUTION: EUR 403 200

START/END: April 2009 to March 2014

OTHER COUNTRIES: France

WEB: <https://ceresproject.eu>



Research and innovation in this domain aims to boost decarbonisation efforts in the transport system as a whole, by advancing electro-mobility solutions and battery technologies.

The work supports a fundamental shift towards environmentally friendly mobility solutions, driving digitisation for more efficient (and safe) transport, developing game-changing low-carbon solutions, and helping new business models and innovation-friendly standards and regulations to emerge, in particular in urban areas.

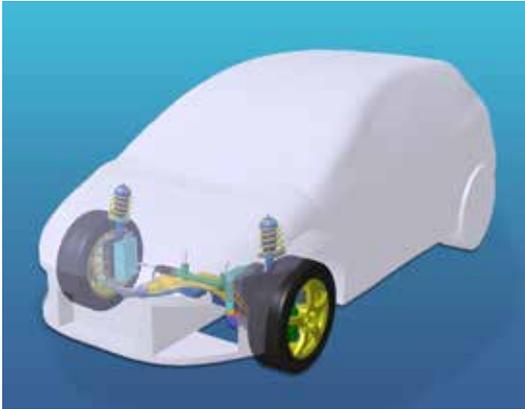
Decarbonisation of the transport system also requires continuous advances in the energy efficiency of both vehicles and the way people and goods move. This calls for innovative approaches to design and manufacturing, development and use of alternative fuels, 'intelligent' transport systems, and behavioural change across the whole value chain.

“Decarbonisation of the transport system also requires continuous advances in the energy efficiency of both vehicles and the way people and goods move.”

Budget

Some **EUR 400 million** has been set aside in this focus area for investments in next-generation transport solutions.

SMART, GREEN AND INTEGRATED TRANSPORT



EUNICE

Imagine putting the whole powertrain of an electric car, except for the battery, in its wheels. The whole space on board would be available for carrying passengers, freight, baggage or pets, thus making Electric Vehicles more attractive for customers. That's the achievement of EUNICE: EU-funded researchers have demonstrated a prototype high-power integrated in-wheel electric motor that could revolutionise green road transport.

In the process, EUNICE has also developed software that allows the vehicle to have tighter and safer cornering performance by spinning each wheel to the optimum speed. All in all, a huge innovation and decarbonisation potential!

COORDINATOR: FUNDACION TECNALIA RESEARCH & INNOVATION, Spain

TOTAL COST: EUR 4 845 811

EC CONTRIBUTION: EUR 2 907 097

START/END: September 2012 to August 2015

OTHER COUNTRIES: Italy, Germany, Austria, United Kingdom, Belgium, Sweden

WEB: <http://www.eunice-project.eu>

VIAJEO PLUS

The Viajeo PLUS project is working to benchmark outstanding solutions for innovative and green urban mobility in Europe, Latin America, China and Singapore. The goal is to promote uptake of these solutions across different cities in these regions, as well as Mediterranean Partner Countries (MPCs). Innovation leaders in academia and industry are providing their insights and know-how as the project seeks to establish good practices, demonstrate their effectiveness, and share the results of these innovative 'green' solutions widely.

COORDINATOR: European Road Transport Telematics Implementation Coordination Organisation-Intelligent Transport Systems & Services Europe, Belgium

TOTAL COST: EUR 2 107 152

EC CONTRIBUTION: EUR 1 971 921

START/END: May 2013 to April 2016

OTHER COUNTRIES: France, United Kingdom, Italy, Sweden, Netherlands, Germany, Turkey, Brazil, China

WEB: <http://viajeoplus.eu>

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Climate change is undoubtedly one of the greatest challenges of our time. The European Union is a world leader in climate action. The EU's Energy Union strategy recognises that wiser energy use, while fighting climate change, is both a spur for new jobs and growth and an investment in Europe's clean and sustainable future. 'Business as usual' is clearly not an option. We need to boost investment in research and innovation in order to create breakthroughs in low-carbon solutions. Such breakthroughs drive the transition to a cleaner, greener society and improve our competitiveness. The challenge is huge, cross-sectoral and multidisciplinary by nature. For this reason about €3.4 billion will be invested in the focus area 'Building a low-carbon, climate-resilient future' from the final Work Programme (2018-2020) of Horizon 2020 — the European Union's research and innovation funding programme.

Research and Innovation policy

