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Ex-Post Evaluation of FP7 Cooperation Programme Theme: "Environment (including Climate Change)"

Report to the European Commission

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Ex-Post Evaluation of FP7 Cooperation Programme Theme: "Environment (including Climate Change)"

Report to the European Commission

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EXECUTIVE SUMMARY

«*Environment, including climate change*» was one of the 10 Themes within the specific «Cooperation» programme of the *Seventh Framework Programme of the European Community for research, technological development and demonstration activities* (FP7 2007-2013). FP7-Environment was primarily designed to support and coordinate cooperation in environmental and climate change research, in line with the principles of the European Research Area, and to support policies and European commitments in the field.

Innovation and technological development was a secondary objective of FP7-Environment, until the global economic crisis. As with the entire FP7, the Environment theme underwent a re-orientation of its priorities in response to the economic crisis. The European Commission responded by launching new actions and strategic documents [e.g. Economic Recovery Plan (2008); Europe 2020 (2010); Innovation Union (2010)]. The re-orientation of research towards innovation and impact became a major tool in addressing the crisis and to tackle societal challenges. This is indeed at the core of the rationale of Horizon 2020, the successor to FP7.

This report assesses the rationale, objectives, participation, outputs, outcomes and impacts of the FP7-Environment programme. The analysis of outputs and impacts is subdivided into the areas of: scientific excellence, innovation, cross-cutting issues, support to policy and European added-value. When this *ex-post evaluation* started, the majority of FP7-Environment research projects were on-going; only 35% of the funded projects were completed. Thus, the long-term impacts of FP7 research were considered in projected terms.

The *ex-post evaluation* of FP7-Environment presented here has been carried out by a group of five independent experts (Group of Experts: GoE), who collected and analysed written and oral evidence, including from internal databases of the Commission (Corda and Respir). The GoE conducted a review of a sample of finalised projects (with the support of reviewers), an innovation survey, and interviews and discussions with European Commission officials. The GoE was supported by 25 reviewers and by Commission officers.

Participation in FP7-Environment

FP7-Environment issued 29 calls for proposals, eliciting a response of 2,589 proposals, of which 19% were retained for negotiations[1]. Thus, FP7-Environment funded 493 projects, involving 7,102 participations (averaging 14 participants per project).

Participation was dominated by the major research organisations, universities and environmental agencies that operate in the field, including the Joint Research Centre, the French *CNRS,* the Italian *CNR*, the *Consejo Superior de Investigaciones Científicas* (CSIC, Spain), the *Max Planck Institute* and the *Fraunhofer Society* (Germany), TNO (the Netherlands), the UK's Natural Environment Research Council (NERC) and Germany's Ecologic.

The FP7-Environment programme was characterised by a low participation rate from industry (19.5%), which was below the average of the Cooperation specific programme (33.6%). Most "private for profit" beneficiaries were SMEs (74.6% of "private for profit"). Involvement of Non Governmental Organisations (NGOs) and Civil Society Organisations (CSOs), such as the World Wildlife Fund (WWF) or the Club of Rome was also low (3%), considering the importance of citizen involvement in the field.

[1] As of November 2014.

Industry representation had a secondary profile in FP7-Environment participation rates. There are a few major industrial participants, such as *Acciona S.A.* (Spain)[2] and *Veolia Environnement S.A.* (France)[3], but most of the private-for-profit beneficiaries were consultants or private research organisations. Engineering firms and producers of specific technological components that were involved in projects were mainly SMEs. This low rate of industrial participation presented a challenge for innovation, as projects and programmes with an active involvement of researchers, large companies (with the capacity to integrate technologies at large scale), innovative SMEs and final users, are more likely to obtain innovation results and impacts.

Participation by country correlated with national GDP and national R&D expenditure. Generally, the more a country invested in R&D, the more likely it was that its research community would benefit from FP7-Environment. However, to fully benefit from the FP7-Environment programme, required that countries would invest a minimum amount in R&D. Notable examples are Greece, Italy or Spain, where, despite the decrease in national R&D expenditure they performed well in securing FP7-Environment funding. Their researchers found opportunities in FP7 funding in times of financial austerity in their home R&D systems (perhaps founded on the legacy of previous funding). These countries could be good examples for Member States that joined the EU from 2004, and were not highly successful in accessing FP7 funding; an increase of their national funding would support a critical mass that would then be capable of accessing EU funding.

Scientific results and impacts

Projects funded through the FP7-Environment programme produced 2,876 papers, of which 44% were in high ranked journals. On average, each project produced 13.6 publications, which is above the Cooperation programme average (12.5). The percentage of papers published in high ranked journals was positioned third among the FP7 themes, behind "Health" and "Nanosciences, Nanotechnologies, Materials and new Production Technologies" (NMP).

Factors that lead to better scientific performance (i.e. high ranked publications) included:

– Large project instruments were more efficient than small project instruments in terms of publication outcome.

– The combination in projects of early stage-researchers with internationally top-performing researchers is likely to have a pull-effect that increases the number of high ranked publications (quantity *and* quality).

– The level of maturity of international scientific self-organisation is a key factor of success in scientific excellence. The maturity of international scientific communities, with their own fora and journals, is characterised by an integration of scientific excellence with societal relevance. Mature scientific communities (e.g. marine, climate change) performed better than less developed ones (e.g. assessment tools for sustainable development).

- At the time of completion of this report, 30% of the projects had not produced any scientific publications[4].

With regard to excellent publications, 35 papers were published in *Nature, Science Nanotechnology,* and *Science*, with SJR indexes of 14.5, 12 and 11.2 respectively. Few projects reached a top level of scientific excellence, as measured by the

[2] Acciona S.A. specialises in the development and management of infrastructure, renewable energy, water and services.

[3] Veolia Environnement S.A. specialises in water supply and management, waste management, energy and transport services.

[4]The GoE notes that this percentage is high and may be unrealistic. A large part of it may be attributed to reporting constraints.

ranking of their journal. Six percent of all papers are in the top 450 journals (SJR index of 3 or more) and only 1.3% were published in journals with an SJR index greater than 9. Thus, it is evident that the FP7-Environment programme was successful in supporting a critical mass of good research rather than on creating the domain leader in worldwide excellence.

Innovation results and impacts

FP7-Environment was particularly affected by the re-orientation of its priority-setting towards innovation. The response to this re-orientation was successful in part. The budget allocated to innovation projects increased after 2009, but the programme management was confronted with the difficult task of adapting its research agenda from promoting excellent science to also supporting industrial and social innovation, without changing its total budget or its management structures, and this issue could not be fully addressed.

The main policy tool to implement this change was the Work Programme. However, moving towards innovation requires a new methodology for allocating resources, different players (e.g. industrial commitment), as well as innovation-oriented specific tools and expertise.

For example, the European Commission could have adapted methodologies from the well-developed R&I portfolio management used in industry and translate them to the needs of FP7-Environment. Different concepts and methods were necessary to decide how much money would be awarded to each area of potential innovation, and which (combinations of) actors and which phases of technology would be targeted. The same rationale would also supply the information to quantify financial instruments for the follow-up at the end of the projects.

While some measures to monitor innovation were foreseen by the Commission, not all of them could be implemented. Under FP7-Environment, there was still a wide gap between managing public research and industrial innovation research. The new management culture and tools required to support innovation were lacking. However, FP7-Environment did achieve some relevant results in the context of innovation.

Intellectual Property Rights (IPR)

According to reports generated from specific projects (Respir database), the 212 finalised projects produced 21 IPR applications: 17 patents, 2 utility models and 2 "others". The figure (0.1 IPR per project) is below the Cooperation programme average (0.5). The late orientation of the FP7-Environment programme towards innovation may have contributed to this low score. The innovation survey carried-out in the context of this ex post evaluation predicts a higher figure (0.2 applications per project), but still below the average for the Cooperation programme.

Beyond IPR: Products, services, methods

The innovation survey showed a significant percentage of actual and expected innovations in those projects that were surveyed; the results from this limited set of projects were extrapolated to FP7-Enviroment as a whole. New processes and products (around 40%) are likely to be the most widespread. Approximately 57% of surveyed projects that deal with innovations (i.e. 23% of all projects) stated that there were already commitments to ensure continuity of funding, but only 29% of such commitments come from industry – in principle the main market player. This figure rises to 71% for projects that were started in the early years of the programme and are now close to market.

Successful innovation projects included partnerships between SMES, Large Enterprises (LEs), and universities or research institutes (research performing organisations, RPOs). They shared their innovation budget (typically more than

50% of the total budget) in the following proportions: 30% SMEs[5]: 20% LEs: 50% RPOs (this proportion is known as the "Golden Funding Ratio"). All those successful projects involved end-users, though not necessarily as partners.

Most of the innovation budget was spent on medium-high risk ideas, which require a medium to long term period to be mature (4.6 years on average). The survey data allowed the Group of Experts to make some estimates of the economic and societal impact of the programme. The projects surveyed can generate around **€1.5 billion of sales** and **€7.5 billion of energy and raw materials savings** over their innovation lifetime (typically, 20 years). By extrapolation, FP7-Environment as a whole could generate 20-60 successful innovations with large economic impacts, creating around **€7-20 billion of sales** and **€30-100 billion in terms of resource savings**.

While these numbers are estimated in broad orders of magnitude, they show that the programme gave value for money in terms of innovation. Nevertheless, in terms of economic and societal impact, they remain below the potential of such a programme and investment.

Research in support of policies

Supporting other EU policies and international commitments was amongst the main priorities of FP7-Environment when the programme was designed. There is a huge number of such policies, going from environmental directives to international fora like the Intergovernmental Panel for Climate Change (IPCC). The output from research supported through FP7-Environment was expected to play a pivotal role in supporting EU institutions by providing high quality, science-based insight to inform the policy cycle, including anticipating and understanding emerging challenges. However the direct link with decision-making was not always evident; the main policy role of FP7-Environment was more in creating knowledge that would subsequently be used, through intermediaries (e.g. the Joint Research Centre, the European Environment Agency, think-tanks and consultancies). The Commission – specifically DG RTD in this case – lacked a system of monitoring policy impact of funded projects; it is therefore difficult to determine the actual influence of FP7-Environment projects on policy.

Most policy-oriented projects were structured via the Coordination and Support Action (CSA) instrument; however, several of these projects did not necessarily deliver effectively in accordance with the expectations of their call. In contrast, several of the more research intensive projects funded as Collaborative Projects (CPs) delivered excellent research output and in tandem took responsibility to develop extensive policy-relevant output, being influential in the science-policy interface. Thus, the separation of excellence-oriented research from research in support of policy through different instruments was not deemed to be successful. Furthermore, several of the CPs that generated output of relevance to policy were constituted by mature consortia, which would be more likely to maintain the legacy of the initiative long term. In contrast, the configuration of consortia in the CSAs tended not to be maintained beyond the duration of funding. The review of finalised projects showed that, with some exceptions, there was an evident absence of strategies for exploitation of research results, such as targeted dissemination strategy towards key groups of relevant stakeholders and policy-makers. There was also an absence of procedures for the Commission DGs themselves to follow up and use output from the projects.

[5] FP7-Environment allocated a target of 15% share of funding going to SMEs, in line with all Cooperation Programme funding.

Cross-cutting issues

Gender issues were generally taken into account in terms of pursuing a gender balance in the composition of the workforce. Most of the projects reviewed managed to achieve a gender balance of around 35-50% in the total workforce of the project. Yet, this share dropped to around 25-35% when talking about women in leading positions such as work-package leaders or scientific managers. Female shares overcame male shares usually in the cases of PhD students or other staff that hold less demanding positions. These disappointing figures are however better than the Cooperation programme averages. The figures concerning more specific gender aspects, such as developing gender equality action plans, implementing an equal opportunity policy or carrying-out specific actions for improved work-life balance, are even lower.

FP7-Environment gave relevant career opportunities to *young researchers*. Most of the projects reviewed stated that a number of PhD students were involved. A number of 1,720 additional researchers were recruited, of which 793 were women (46%).

Mobility was not among the main aims of the projects per se. However, there were examples of study visits, trainings and summer schools and even exchange programmes across participant institutions.

FP7-Environment supported a good balance between new projects and beneficiaries and *continuity of research*. Such continuity was often a factor for scientific excellence (knowledge creation is a cumulative process; working in stable teams helps to refine findings and improve the quality of publications) and for implementing innovation. It supports the consolidation of mature research communities.

Society engagement is still at the level of raising awareness and training. Even though the field of environmental research offers opportunities for more active engagement this has not been taken up to the degree possible. The majority of projects followed *open access* principles in relation to publications. The main obstacles for open access were publishers' licensing agreements, high costs of open access publishing or commercialisation purposes. Open access to data was much less widespread. Open access principles were often seen as a challenge for any future exploitation of results.

Internationalisation of networks was considered by FP7-Environment participants as a major impact, including beyond EU borders (e.g. USA, Canada, Asia, Africa). Sometimes international cooperation actions are linked with larger EU policies, like the Union for the Mediterranean and specific projects to address water issues.

European added-value

The review of finalised projects and the innovation survey documented European added value of environmental research projects from different perspectives, including in relation to the need for international collaboration in dealing with environmental challenges, for capacity building and development of the critical mass as well as for harmonising databases, procedures, measurements, models, etc. However, it has to be noted that the added value of a project heavily depends on the uptake of research results, including adoption of harmonised measurement procedures or tools, or integration of recommendations into relevant policies. In several cases it was noted that the potential of added value would be high provided that the results were followed up. Yet, in many cases such evidence was lacking or very limited, partly attributable to the fact that the projects were completed recently. Nevertheless, some notable examples of projects with high European added value were identified.

Some intervention areas of FP7-Environment are exemplary of European added value, because research would be inefficient if not coordinated at European and/or international level. This is clearly the case of Earth Observation. The FP7-Environment programme played an active role in implementing the Global Earth

Observation System of Systems (GEOSS); while the European Commission is one of the four co-chairs of the Group on Earth Observation (GEO). GEO is an intergovernmental organisation of 89 governments and around 80 international organisations, which develop together projects and coordinate their strategies on earth observation. GEOSS is critical to tackle global challenges such as climate change, energy and food security, or health.

FP7-Environment also played a key role in the development and aggregation of climate change models, with a strong impact at the International Panel on Climate Change (IPCC). Models could be developed at national level, but FP7-Environment is unique because of its coordination role. It collated and ran models, ensuring the completeness of the systems. FP7-Environment allows an international co-development of climate change models, creating a process of mutual learning and an efficient knowledge creation. With its funding activities in this field, the Commission contributes to the creation of international standards that avoid fragmentation of research and funding. Something similar happens in other areas, like greenhouse gases (GHG) measurement or carbon in the sea, where the EU is leader thanks to its coordination and standardisation role – not to mention the impact of research in these field on policy (e.g. Directives).

General recommendations

- The Commission should develop an **enhanced monitoring and follow-up system** to assess and increase the impact of projects. The Commission should develop methodologies and reporting tools allowing a close follow-up of the content of projects, in order to play a **more pro-active role** towards ensuring societal impact. This would represent a cultural change in the way of managing projects and the programme; moving from procedures to results and impacts.
- Development of such monitoring systems would enable the Commission to identify innovative projects with a potential societal impact, as well as their strengths and weaknesses, to provide further support (if needed) and facilitate dissemination. For innovation issues, such a system should rely on a set of smart indicators (based for example on the questionnaire implemented in this ex post evaluation, and on the conclusions about which factors lead to implementation) and on Project Officers. The experience with the sample of projects with an innovation potential, preselected by Project Officers, has proven that their views are in most cases accurate.
- The follow-up of projects' impacts should continue after a project is completed. Otherwise, the actual impact of the programme is not adequately assessed.
- The monitoring system should also cover policy impacts. There is currently no evidence about how projects have influenced policy (e.g. Directives, international agreements, national or sub-national legislation).
- The Commission should collect reliable data and methodologies to measure the environmental and resource-efficiency impact. The Commission is committed to allocate to 35% of its research and innovation budget to climate and 60% to sustainability, and a monitoring of funding is already in place (the "Rio Markers"); attention should be afforded to the results of this financial effort.
- More efforts should be done to improve the coordination between research and innovation funding and regional funding, so that there would be a dual focus on supporting existing excellence in science and building excellence in regions where performance is less strong, usually as a result of a disadvantaged economic and political history. FP7-Environment developed technologies and other innovations in areas like water, recycling or waste, which could be applied at large scale through EU's regional funds. This would increase the societal impact of output from different funding programmes.

- The Commission should collect reliable data on the R&D performance of national research programmes, including from third countries (e.g. US, Japan BRIC). This would allow benchmarking of the efficiency and effectiveness of the Framework Programmes.

Specific recommendations

Research excellence

- An indicator and monitoring system should be set up to evaluate the impact of financed projects on improving scientific excellence at the level of individual researchers, and at the level of scientific communities. For instance, comparing the publications record of beneficiaries in a dynamic way, during/after and before funding.
- To exploit its particular strength as the leading transnational, very large-scale research funding programme, the Commission, through Horizon 2020, should emphasise its role of creating and consolidating large integrated research communities ("European schools of thought") that focus on grand societal challenges and that are capable of establishing durable interdisciplinary research networks.
- The Commission should target the integration of scientific excellence (publication in high ranked journals) with procedures for high-level support to policy. Separating research activities that support policy (via CSA instrument) from excellence oriented research (via CP instrument) risks low quality support to policy. Requirements for policy based projects to provide commitment to maintain their legacy should be inherent in future Horizon 2020 funding.

Innovation

- The Commission should be equipped with reliable sectoral data on (potential) markets, in order to develop its innovation priorities. This information would allow a detailed analysis of economic and societal impacts of technologies and other innovations promoted by the calls.
- To increase its impact in terms of innovation, Horizon 2020's Societal Challenge 5 (SC5) should strength the links with industrial organisations that are very active in R&D. Such organisations have the capacity to better exploit results from research and innovation actions. The Commission should support a participation balance between innovative SMEs that are capable of developing advanced technologies, and large companies which have the capacity to integrate such innovations and exploit them at large scale.
- In order to attract more relevant industry participants into innovation projects within the future environment themes of Horizon 2020, the evaluation process needs to be critically revisited, putting more emphasis on specific and targeted objectives, commitment of partners for follow-up investments and project legacy, with clear procedures for the protection of sensitive information.
- A further involvement of NGOs and CSOs would be important to strength the links between the R&I community and society, thus increasing the impact of projects that require public entrepreneurship. Involving CSOs and NGOs could also enhance the innovation potential of projects, anticipating societal reactions to technologies and increasing the understanding of citizens (final users) needs and wishes.
- Involvement of financial organisations is essential to exploit innovation. The Commission should facilitate and strengthen the links between research performers and industrial partners with such organisations, to understand their wishes and expectation and facilitate access to further private funding to good projects.

Research in support of policy

- The Commission should develop processes to support the extraction and synthesis of knowledge and outputs from EU and national funded research activities, and make them widely accessible (per descriptor, criteria, indicator, pressures and impacts).
- The Commission should develop mechanisms to involve potential beneficiaries, including other DGs in a project's "policy profile" aspect. Projects should include strategies to monitor the evolving policy environment and adapt accordingly.
- To safeguard against the risk that a project might be weak with regard to informing policy, Horizon 2020 should provide for increased monitoring of projects. This would include enhancing opportunities for interaction with the Commission officers from both DG RTD and other relevant DGs such as MARE, Environment, CLIMA, Transport, etc.
- The Commission should pay specific attention in Horizon 2020 to the elaboration of how projects are structured to support the development of science-policy interfaces. More direct involvement of Commission officers with policy projects would support enhanced focus on the objectives of the call. (There is a natural tendency for consortia to become more focused towards the call concept in the knowledge that Commission officers will attend their meetings and provide their feedback.)

Cross-cutting issues

- The section in the proposals' template that addressed gender issues was a good step towards enhanced gender balance in organisation of the projects. However, there was little evidence that any more than that has been achieved. Gender equality actions and other relevant activities were taken up by a minority of projects. It would be useful if the proposers would be informed about what type of horizontal activities promoting gender and better work-life balance could be organised as side actions in their projects.
- Engaging society has to go beyond the end-user perspective. In the field of environment where society's behaviour and concerns are crucial for the success of mitigation actions, it is important that society is actively engaged and empowered through inclusion from the early stages of the research. Relevant NGOs, societal organisations and movements such as "citizens' scientists" should be considered more seriously in this respect.
- Open access to knowledge requires a well-thought out strategy addressing existing challenges. Such a strategy should allow for a differentiated approach in open access depending on the research areas at stake. In parallel, changes in the academic reward systems as well as open access policies of publishing houses need to be promoted if a real boost in this principle is aimed at.
- Internationalisation may have to take a more focused approach in the future in view of the global challenges-driven approach taken up in Horizon 2020, which calls for the appropriate partnerships with relevant countries and regions depending on the specific challenge area in question.
- Following-up on the research results is not only important in the cases where there is high potential for commercialisation; it is also important in cases where for example harmonised measurement procedures need to be adopted at the national / regional level, or where recommendations need to be integrated in relevant policies. This would help to establish and/or strengthen European added value of EU funded research, which in the framework of public accountability and in view of the challenge-orientation in Horizon 2020 emerges as even more important.

1. INTRODUCTION

1.1. Context of the Evaluation

Europe is facing two fundamental challenges, manifest at the global level, which at the surface may seem separate, but are in reality intertwined. Firstly, there is a deep global economic crisis causing almost unforeseen stagnation of the system. Secondly, there is the challenge of mounting environmental pressures. At the heart of the economic troubles lie inefficiencies in production and distribution systems, which when combined with the present patterns of use of natural resources and raw materials, result in unsustainable costs.

These challenges are compounded by a massive dependency on imported energy in the form of fossil fuels. With the exception of some individual Member States, the European Union (EU) as a whole continues to address the challenge of building common approaches to take advantage of the potential solutions, based on innovation and common action, in these areas.

This is all the more important as Europe moves from one socio-economic era – dominated by the expansion and proliferation of ICT – into the next era. The emerging era – projected to last until 2050 – will be dominated by the type of intelligent technologies that bring material resource productivity into new levels, saving materials and energy, replacing unrenewable and fossil energy resources[6].

As reflected in the *ex-post evaluation* presented here, a common awareness is developing of the need for a more concerted action to derive intelligent and ecologically sound solutions that could build competitive advantage for Europe[7]. The European Union is in a position to take on the progressive role of pioneering the international sustainability agenda. This can only be done if sufficient resources are allocated to building the required knowledge-base, technological solutions and political agendas to counteract the deep crisis into which Europe has been drawn.

Thus, it is natural that allocation of research funding to address environmental challenges is at the heart of the EU's economic strategy. The EU's Framework Programmes (FPs) have, since the 1980s, supported trans-national collaborative research, with increasing attention towards addressing environmental issues.

The *Seventh Framework Programme of the European Community for research, technological development and demonstration activities* (known as FP7: 2007-2013) was designed to support the "*…development of a knowledge-based economy and society in Europe which will meet the goals of the Lisbon Strategy…*" (Article 8 of the Decision 1982/2006/EC),[8] while fostering sustainable growth in a globalised economy.

The legislative basis for FP7[9] is summarised in Appendix I, and includes the over-riding aim towards: "*…becoming the **world's leading research area**…strongly focused on promoting and **investing in world-class state-of-the-art research**, based primarily upon the principle of **excellence in research**…towards the **creation of the European Research Area** and … the development of **a knowledge-based economy and society** in Europe…"*

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[6] Willenius, M. and Kurki, S (2012) *Surfing the Sixth Wave. Exploring the next 40 years of global change*. FFRC E-books 10/2012.

[7] See the recent Communication from the Commission (2014) *Towards a circular economy: A zero waste programme for Europe*. COM(2014)398 final.

[8] The Lisbon Strategy (2000-2010) was aimed at making the EU "*the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion*". Lisbon European Council, 23-24 March 2000, Presidency conclusions. Available at: http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/00100-r1.en0.htm

[9] Decision No 1982/2006/EC of the European Parliament and of the Council of 18 December 2006 concerning the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007-2013), OJ L412, 30.12.2006

FP7 was structured around four Specific Programmes (pillars), namely: Cooperation, Ideas, People and Capacities. Each Specific Programme was further subdivided into Thematic Areas; the Cooperation Programme was subdivided into 10 priority Thematic Areas. One of these priority areas, the Thematic Area known as *Environment (including Climate Change)* (generally referred to as **FP7-Environment**), was **designed to fund collaborative, trans-national research to promote the sustainable management of both the man-made and natural environments and associated resources.**

During its lifetime, the FP7 work programme had to adapt and align its priorities in keeping with the **Europe 2020 Strategy** (launched in 2010; it is the EU's ten-year strategy for growth and jobs, and as such replaced the Lisbon Strategy[10]). Europe 2020 aims, through seven flagship initiatives, to create conditions for smart, sustainable and inclusive growth through: more effective investments in education, research and innovation; move towards a low-carbon economy, and a strong emphasis on job creation and poverty reduction. The seven flagship initiatives of Europe 2020 are:

"Smart growth":

(i) Digital agenda for Europe

(ii) Innovation Union

(iii) Youth on the move

"Sustainable growth":

(iv) Resource efficient Europe

(v) An industrial policy for the globalisation era

"Inclusive growth":

(vi) An agenda for new skills and jobs

(vii) European platform against poverty

The specific objective of this *ex-post* assessment of FP7-Environment research is to provide an independent assessment of the rationale, implementation, achievements and impacts of the programme, and in so doing, contribute to the overall *ex-post* assessment of FP7.

The report **focuses on the impacts that research funded by FP7-Environment has on: scientific excellence, environmental innovation, evidence-based policy making, cross-cutting issues of relevance to the European Research Area (ERA), and on European added value (EAV)**. The seven flagship initiatives of Europe 2020 were implicitly considered when framing this assessment.

The report presented here summarises the evaluation undertaken by the Group of Experts (GoE), and is structured as follows: Chapter 1: the background and context to this *ex-post* evaluation of a selection of FP7-Environment funded projects; Chapter 2: the approach and methodology developed and adopted; Chapter 3: the results found and a profile of their impacts; Chapter 4: concluding findings and recommendations.

1.2. FP7: Background and goals

In its function as the cornerstone of the EU's strategy towards realising the knowledge economy, FP7 was tasked to: (i) promote transnational cooperation; (ii) promote investigator-driven basic research based on excellence; and (iii) develop the human potential in research and technology, thereby "…*encouraging researchers' mobility and career development…*". FP7 was also designed to support

[10] Communication from the Commission (2010) *Europe 2020: A strategy for smart, sustainable and inclusive growth*, COM (2010)2020 final.

the creation of the **European Research Area** (ERA; launched 2000)[11]. FP7 was further expected to support the "Ljubljana process"[12] (launched 2008) in the development of a continuous research landscape in the EU. By 2012, the European Research Area Communication[13] defined the ERA as a unified research area open to the world in which researchers, scientific knowledge and technology circulate freely and through which the Union and its Member States strengthen their scientific and technological bases, their competitiveness and their capacity to collectively address grand challenges. The 2012 Communication on the ERA defined the following five priorities, which provided the context for the assessment presented in this report:

1. More effective national research systems – including research competition within national borders and sustained or greater investment in research;
2. Optimal transnational co-operation and competition – defining and implementing common research agendas on grand challenges, raising quality through Europe-wide open competition, and constructing and running effectively key research infrastructures on a pan-European basis;
3. An open labour market for researchers – to ensure the removal of barriers to researcher mobility, training and attractive careers;
4. Gender equality and gender mainstreaming in research – to end the waste of talent and to diversify views and approaches in research and foster excellence;
5. Optimal circulation, access to and transfer of, scientific knowledge including via digital ERA – to guarantee access to, and uptake of, knowledge by all.

The FP7 work programme was also influenced by the **Lund Declaration (2009)**[14], which is the major pan-European statement on research policy issued during the lifetime of FP7. The Lund Declaration provided a high-level statement on the requirements to address the European research system. It called for research processes to be based on an understanding of the interaction between "bottom-up" and "top-down" initiated research. It called for attention to: more systematic division of labour between European, national and regional research programmes; enhanced links between research and policy; and a risk-tolerant and trust-based approach in research funding.

While FP7's Cooperation specific programme focused on supporting research excellence with an emphasis on transnational and interdisciplinary collaboration, the European Research Council (ERC) funding focused on supporting an individual's research excellence (rather than on a team of researchers). The relevant benefit and impact of this dual approach by the EU to research funding is exemplified by the pattern whereby recent Nobel Prize winners, namely K. Novoselov (2010) and M.B. Moser and E.I. Moser (2014), were previously successful ERC grantees, and had also been funded by EU Framework Programme collaborative projects[15].

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[11] The ERA concept combines: an internal market for research within Europe, where researchers, technology and knowledge freely circulate; the effective European level coordination of national and regional research activities, programmes and policies; and the initiatives implemented and funded at European level.

[12] December 2008, EU Member States adopted their joint vision of the ERA in 2020. Through the "Ljubljana process" Member States committed to a process towards realising this vision, in mutual partnership with the Commission.

[13] Communication from the Commission (2012) *A Reinforced European Research Area Partnership for Excellence and Growth***.** COM(2012) 392 final.

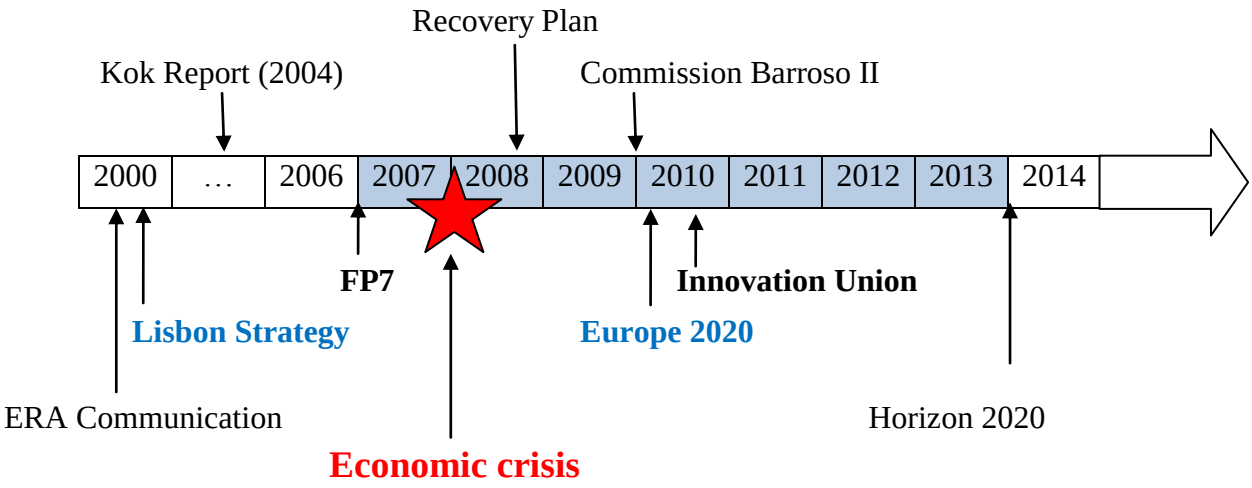
[14] Swedish Presidency of the European Council. 2009. The Lund Declaration "*Europe must focus on the grand challenges of our time"*.

[15] The role of the ERC in FP7 was to fund groundbreaking research at the pinnacle of excellence, both by established star researchers and their most promising younger colleagues. During FP7, the ERC redoubled its efforts to attract top research talent from outside Europe, reversing the "brain drain". Novoselov received on of the first ERC grants (2007) to investigate the "Physics and Applications of Graphene".

While FP7 focused primarily on scientific research, other EU funding schemes concentrated on innovation and competitiveness, the premier scheme being the Competitiveness and Innovation Programme (CIP)[16].

The global economic crisis of 2007 required that FP7 had to adapt and evolve within a changing global context[17]. In November 2008, the European Commission launched its **Economic Recovery Plan**[18], which re-oriented its strategic priorities. The then EU President M. Barroso, in the introductory note to the Communication on the Economic Recovery Plan, emphasised the necessity for smart investments, including towards clean technology, stating: "*Smart investment means investing in the right skills for tomorrow's needs; investing in energy efficiency to create jobs and save energy; investing in clean technologies to boost sectors like construction and automobiles in the low-carbon markets of the future; and investing in infrastructure and inter-connection to promote efficiency and innovation*".

Figure 1: FP7 timeframe: political and economic framework.



The "*smart, sustainable and inclusive growth*" concept of the Europe 2020 Strategy (see above) explicitly identifies the "*smart*" component as referring to "*knowledge and innovation as drivers of future growth*". The strategy identifies research as crucial for success, and states that a platform is necessary to facilitate interfacing between societal challenges, research excellence, and industrial leadership. The **Innovation Union** flagship initiative, announced in Europe 2020, highlights the need for action at the EU level to enhance and secure the European Research Area and to develop a strategic approach to research and innovation. The European Commission states that innovation is "*…our best means of successfully tackling*

[16] The CIP (2007-2013, €3.6 billion) aim was to support all forms of innovation and growth, especially helping enterprises and industry to innovate. It covered fields including energy efficiency and renewable energy sources, environmental technologies and a better use of information and communication technology (ICT). Eco-innovation was supported with a budget of €430 million. The CIP was integrated into Horizon 2020 (see Decision 1639/2006/EC of the European Parliament and of the Council of 24 October 2006 establishing a Competitiveness and Innovation Framework Programme (2007 to 2013) - OJ L 310/15, 09.11.2006). In addition, the European Commission created new financial instruments focused on innovation, for example the Risk Sharing Finance Facility (RSFF). While the Framework Programmes always had innovation-related results, innovation was not their main focus until recently.

[17] By comparison with when the original decision was taken in 2006 when "*the Union is experiencing its best macro-economic outlook for a generation*", as stated in Article 3 of the Presidency conclusions establishing the Lisbon Strategy.

[18] Communication from the Commission (2008) *A European Economic Recovery Plan*, COM (2008)800 final.

major societal challenges, such as climate change, energy and resource scarcity, health and ageing, which are becoming more urgent by the day."[19]

The broad directions of socio-economic development, in combination with challenges such as the ageing population, new economic and knowledge competitors, climate change, food security and the imperative of shifting to a low carbon paradigm, *inter alia,* are collectively referred to as "Global Challenges". While Europe is emerging from the most severe global economic crisis in decades, the EU is also shaping its long-term growth agenda in a manner consistent with confronting these major societal challenges, including particularly: the long-term implications of climate change and energy shortages; how to address job losses as traditional sector decline and activities relocate outside Europe, how to increase innovation and productivity to maintain international competitiveness in Europe's areas of potential strength. Newly derived knowledge generated from research is fundamental to facilitate society in adapting to such challenges and to support innovation. The ERA and FP7 were designed to meet these challenges; this requires coherence in policy approaches, including reduction of fragmentation and duplication, and alignment with national funding programmes, one of the five priorities of the ERA (as detailed above).

Throughout the world, universities are the source of a large group of researchers with the freedom to address the global challenges. Access to world-class infrastructures that support interdisciplinary collaboration is a *sine que non* for research excellence. Europe's competitiveness is dependent on the competitiveness of its research performing organisations (universities and institutes), which involves *inter alia* the education of future leaders and the generation of intellectual property and innovation, enhancing the EU's competitive edge.

To develop a fresh approach to the EU's economy and how it should be run requires an understanding of the economy as a system that has normal systems requirements: materials and energy need to flow into and within that system, as in any organic entity. As the EU starts to embrace the ideas of circular economy, concrete cases will be needed to show it is indeed possible socially, profitable economically and sustainable environmentally. This requires strategic and progressive decision-making to pave the way for more sound economies.

1.3. Scales of research investment

Building on the experience and success of preceding Framework Programmes, FP7 represented the single largest research funding programme in the world and the largest ever investment made by the EU (at that time) towards securing Europe's future as a knowledge-based economy and society. FP7 represented a budget of approximately **€**50 billion awarded over the period 2007-2013 (projects awarded in 2013 will run through subsequent years). This is a significant growth in the scale of investment from that of preceding FPs, and paved the way toward the establishment of an even greater research investment in Horizon 2020[20].

FP7-Environment represented a budget allocation of **€1.89 billion** for research and development (R&D) activities within the strategic priorities of Environment, Climate and Natural Resources. It also represented the single largest funding source for environment relevant research in Europe, representing 17% of the total Cooperation programme budget, and 3.7% of the total FP7 budget. Aspects of environmental research were also supported via other thematic priorities of FP7 like Energy or Food, Agriculture, Fisheries and Biotechnology.

By comparison, in the global context, it has been estimated that the US spends 2.7% GDP on R&D; the UK spends 1.8%, while the average amongst EU Member

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[19] European Commission (2010) *Europe 2020 Flagship Initiative Innovation Union*, COM (2010) 546 final.

[20] Horizon 2020, launched 2014, represents a research funding budget of €70.2bn, which is the largest ever research budget globally.

States is just over 2%[21]. Austria, Belgium, Germany, Estonia, France, the Netherlands, Slovenia and the Nordic Countries, Japan and South Korea all invest a greater percentage of GDP in research than the EU average[22] (e.g. Germany spends 3%). China currently spends less than the 2% average of EU Member States; China is increasing its spending on R&D at a rate of 19% year on year, and is expected to soon overtake the EU average[23].

While it is evident that considerable benefits flowed to Europe's economy from the sustained investment in excellent research via FP7, the quantification of this evidence is beyond the scope of this report.

Private sector investment in R&D

Business-financed investment in R&D is a vital driver of innovation and growth. Businesses gain competitive advantage through research collaboration with research performing organisations. The OECD average of business-financed R&D as a percentage of GDP is estimated at 1.5%[24]. The EU average is 1.3%, below that of Japan (2.5%) and the US (1.8%)[25].

There is evidence that companies in Europe are not investing in R&D for the long-term. Only Denmark, Finland, Germany, Slovenia and Sweden have levels of business investments in R&D (represented as percentage of GDP) above the US average.

Levels of investment in Europe remain far from the R&D investment target stated in the Europe 2020 strategy (3%). This may indeed be attributable to the relatively low level of enterprise investment in R&D.

1.4. Objectives of FP7-Environment within the Cooperation Specific Programme

The thematic objective of FP7-Environment is defined in the Council Decision 2006/971/EC (see Appendix I), and includes reference to:

"Sustainable management of the environment … through advancing our knowledge of the interactions between the climate, biosphere, ecosystems and human activities, and developing new technologies, tools and service…. Emphasis … on prediction of climate, ecological, earth and ocean systems changes, on tools and on technologies for monitoring, prevention, mitigation of and adaptation to environmental pressures and risks including on health, as well as for the sustainability of the natural and man-made environment."

This Council Decision 2006/971/EC underlines the European added-value of cooperation in the field of environmental research, and defines the main orientations or functions of future actions as:

- *Coordination and integration of research outputs*: Developing common methodologies, databases and large-scale observation and forecasting systems.

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[21] While absolute R&D spending levels are one metric used in describing investments in research, the level of research spending relative to GDP, commonly known as the research intensity ratio, is an internationally relevant method of putting the scale of investment in context. The Europe 2020 Strategy fixed 3% of GDP as target.

[22] The range of approaches to research investment varies across EU Member States; for example, Britain is home to 1% of the world's population, holds 3% of the global funding for research, and produces 15.9% of the most highly regarded scientific work. See: BIS-Department of Business, Innovation and Skills (2014) *UK Share of highly cited academic articles*. At: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/310544/bis-performance-indicators-uk-share-highly-cited-academic-articles-april-2014.pdf

[23] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/R_%26_D_expenditure

[24] OECD (2009) *OECD Science, Technology and Industry Scoreboard 2009*. Paris.

[25] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/R_%26_D_expenditure

- *Policy support* to the Union and Member States.
- *Contribute to global and EU commitments*.
- *Technology development*: Support innovative environmental technologies for a more sustainable use of resources, contributing to improve the competitive position of European enterprises.

The legal text of the Council Decision 2006/971/EC stressed the need for *dissemination of research outcomes*, as well as the need to exploit *synergies* with other funding mechanisms for a better *uptake* by end-users and policy-makers. It also specified the areas where FP7-Environment activities had to be conducted (see Box 1).

Box 1: Areas of action of FP7-Environment programme

- *Climate change, pollution and risks:*

– Pressures on environment and climate;

– Environment and health; (FP7 saw this become more integrated into environmental research as one of the main sub-activities)

– Natural hazards.

- *Sustainable management of resources:*

– Conservation and sustainable management of natural and man-made resources and biodiversity;

– Management of marine environments. "sustainable management of marine environments" sub-activity focuses on improving understanding of the impact of human activities on the oceans and seas and on marine resources.

- *Environmental technologies:*

– Environmental technologies for observation, simulation, prevention, mitigation, adaptation, remediation and restoration of the natural and man-made environment;

– Protection, conservation and enhancement of cultural heritage, including human habitat;

– Technology assessment, verification and testing.

- *Earth observation and assessment tools for sustainable development:*

– Earth and ocean observation systems and monitoring methods for the environment and sustainable development[26];

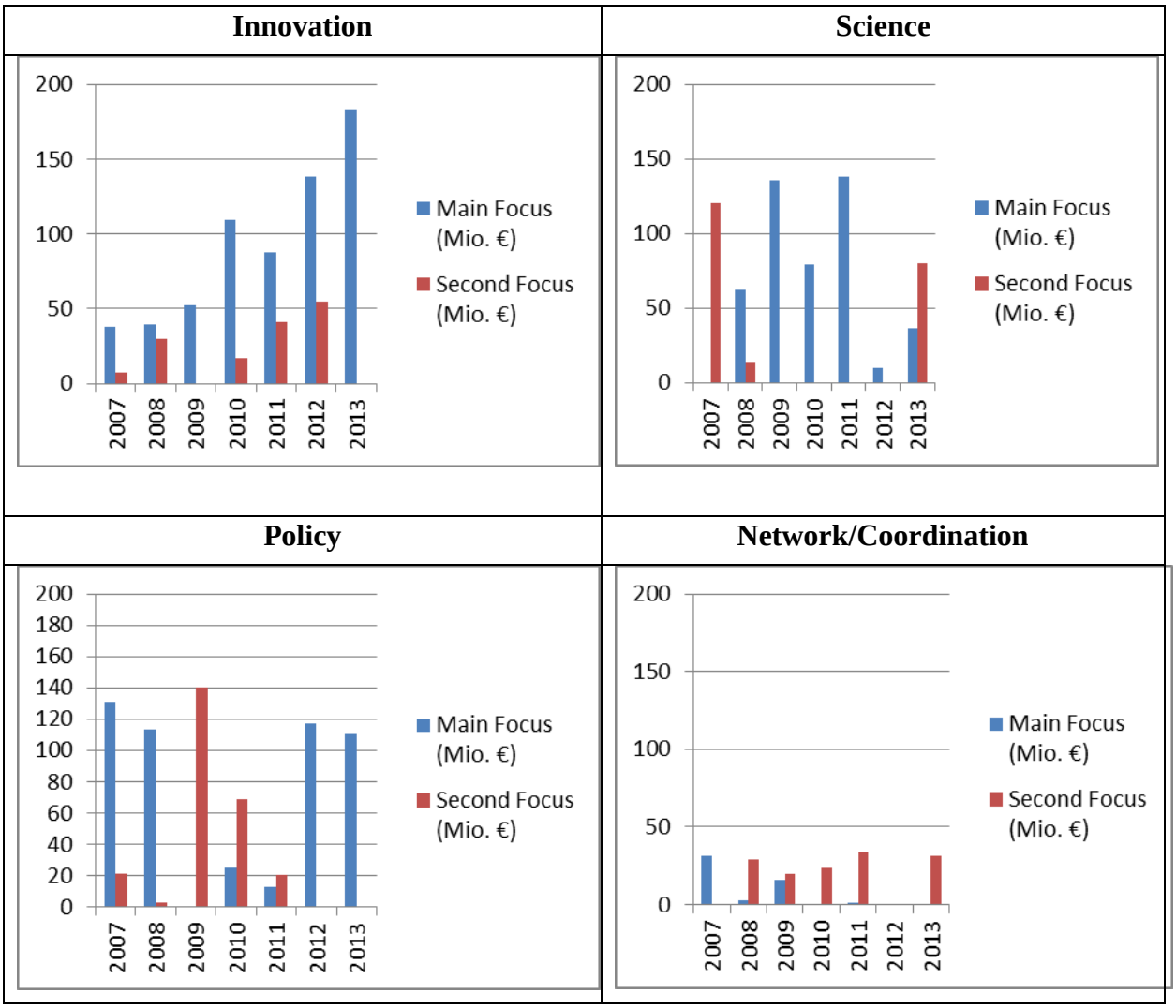
– Forecasting methods and assessment tools for sustainable development taking into account differing scales of observation.

The overall objective of FP7-Environment calls was the pursuit of long-term research goals in the interest of the EU and society, with a view to preserving and improving human life and lifestyle, addressed through the design of strategically oriented research programmes in the different fields within the theme. The FP7-Environment work programme was specifically designed to support the refinement of the EU's environment policies, thus further contributing to the development of said policies in a research-informed manner. The FP7-Environment calls for proposals were also designed to provide impetus to enhance the coordination of European research efforts, both trans-boundary and trans-disciplinary.

[26] This refers to "the development and integration of the Global Earth Observation System of Systems (GEOSS) for environment and sustainable development issues in the framework of the GEO initiative to which Global Monitoring for Environment and Security (GMES) is complementary". It addresses "Interoperability between observation systems, information management and data sharing, and optimisation of information for understanding, modelling and predicting environment phenomena and related human activities" (see Council Decision 2006/971/EC). The Earth Observation theme is addressed in a separate report to the European Commission: Connolly, N. et al. (2014) *Assessment of the Achievements of the Group on Earth Observations (GEO): A European Union Perspective.*

During its lifetime (2007-2013) the FP7-Environment theme (as evidenced across all FP7) was marked by a strong re-orientation in terms of priorities in response to changing external conditions. Figure 2 shows how innovation became increasingly relevant in terms of funding allocated in Work Programmes since 2009-2010. This evolution of priority setting impacted on the results expected from projects, with associated methodological issues (see Box 2 in section 2.2).

Figure 2: Historical evolution of the main and second focus of Work Programme calls, in € Mio.[27]



The majority of projects funded via FP7-Environment were collaborative research projects ("Collaborative Projects": CPs), involving large consortia (some over 30 partners) and large-scale EU funding investment (several over €10 million). FP7-Environment funding configured a relatively large number of Coordination Support Actions (CSAs). This was due to the emphasis on the policy support function of FP7-Environment; CSAs were used to support the science-policy interface and the

[27] Figure 2 presents the evolution of the objectives of FP7-Environment calls, according to the following categories: Policy, Science, Innovation and Network/Coordination. This breakdown is subjective. For instance, several calls on climate change were considered policy-relevant, because they aimed at providing feedback to develop Directives or to contribute to the IPCC. However, the beneficiaries focused their efforts in knowledge creation or, in other words, in science – i.e. building the evidence-base to develop policy. The frontiers between the different categories are not always clear, and there can even be primary objectives and secondary objectives (e.g. science and policy).

associated development of informed policies. See section 3.2.4, and Table 6 in Appendix VII.

2. METHODOLOGY

2.1. *Ex-post* evaluation of FP7- Environment (including Climate Change)

This *ex-post* evaluation of the outputs, outcomes and impacts from FP7–Cooperation Theme: "Environment (including Climate Change)" is one element of the continuing work to assess and improve the quality, relevance and impact of research funded by the EU Framework Programmes.

The overall aim of this *ex-post* evaluation (see definitions in Appendix II) was to assess the impact of outputs derived from a subset of FP7-Environment funded projects, and to provide evidence as to the level of success achieved, both in fostering development of research and in transnational research collaboration (in keeping with the FP7 objectives). The evaluation also considered how the results would inform the ongoing development of the Horizon 2020 research and innovation programme.

This exercise was carried out by a group of five independent experts (referred to as the Group of Experts [GoE] identified from the European Commission's database of experts), appointed by the European Commission (EC) Directorate on Climate Action and Resource Efficiency of the Directorate General for Research and Innovation (DG RTD). The GoE was supported by European Commission officers via a Steering Committee, and by a dedicated Project Officer.

2.2. Objectives and approach of this *ex-post* assessment

The Group of Experts (Appendix III) was first convened by DG RTD in January 2014, and worked in accordance with a Terms of Reference (Appendix IV). The overall objectives were addressed via a set of evaluation questions (section 2.2. of the Terms of Reference).

The mandate of the GoE was twofold. The GoE had to conduct an assessment at project level (micro level) and on that basis develop an evaluation at strategic level (macro level). More specifically the GoE was requested to:

- Design the general methodological framework of the whole *ex-post* evaluation (Box 2 presents methodological details).
- Analyse available information about FP7-Environment, including policy documents, data from project reports, studies, etc.
- Examine a subset (90) of the projects and activities funded via FP7-Environment (only completed projects were considered).
- Provide recommendations towards the future development and implementation of Horizon 2020, as the successor to FP7.

The GoE collected and analysed written and oral evidence. Specific tasks were allocated to individual members. A supporting panel of 25 topic-specific experts (referred to as monitors/reviewers) was also convened; each monitor was tasked to review a selection of projects in more detail, primarily by consulting each project's final report, and by interacting with the project coordinator to address specific questions, which were developed by the GoE (see Appendix V). Members of the GoE also held discussions with individual EC Project Officers. The GoE met collectively on four occasions, while individual members maintained regular exchanges by phone, Skype and email.

Box 2: Methodological framework and implementation

The analytical framework of this *ex-post* evaluation was based on the rationale and objectives of FP7-Environment. It distinguishes between inputs, outputs, outcomes and impacts of the programme, with a particular focus on impacts. The analysis of outputs and impacts is subdivided into the areas of: *scientific excellence; support to policy; innovation; cross-cutting issues; and European added-value.*

Sources of information

The GoE used and analysed the following sources of information:

- Commission's statistics on funding and participation to FP7 (e-Corda).
- Commission's statistics on projects' outputs and outcomes (Respir), including publications, patents and intellectual property rights, foreground IP, workforce statistics and dissemination activities.
- A review (with the assistance of 25 monitors) of 90 finalised projects, based on common guidelines according to the analytical framework. The list and selection of projects is explained in Appendix V.
- An innovation survey, conducted amongst a sample of FP7-Environment project coordinators (section 3.4.2, Box 7).
- Discussions with Project Officers and other EC officials involved in FP7-Environment activities.

Methodological caveats

The objectives established by the FP7-Environment legal base and work programmes and by the projects themselves should be the first reference to assess their success or failure; it would be unfair to evaluate a project on the basis of goals or rationales established *a posteriori*.

The review is limited to a subset of 90 projects selected from finalised FP7 projects (175 finalised projects when the review process started, out of a total number of 493 [35.5%]). The priorities of FP7-Environment radically evolved over time. Projects that started during later stages were more likely to focus on innovation than those funded during the initial stages of FP7; the majority of the projects analysed in this report began in the first years of the programme. Consequently, the sample of 90 projects reviewed by monitors is not representative of the whole programme. Proposals submitted to the last FP7 calls were evaluated in April 2013. In May 2014, there were still 285 projects ongoing.

Data on the outputs from projects (such as publications, patents etc) are likely to be under-estimates, as, for example, there is generally a time lapse between submission of a scientific paper and its publication. Final reports of projects (the main source of data on publications or patents) do not cover outputs and outcomes that are delivered beyond the dates of finalising the project.

Assessment of innovation is not addressed within the reporting procedures for FP7-Environment projects, with the exception of information on patents. To address this, the GoE launched a survey in July 2014 to collect information on innovation results, patterns and potentials, details of which are provided below, in section 3.4.2.

2.3. Assessment of Research Impacts: Pathways from Ideas to Impacts

For the purposes of this report, the GoE distinguishes between *outputs*, *outcomes* and *impacts* of research. Publications, discoveries, and patents are seen as outputs. These outputs become outcomes when, for example, they inform policy guidelines, are used to build competencies, or add to the knowledge-base for a particular discipline. Impacts are considered as the development of these outcomes into enhanced environmental and economic status, balanced with sustainable development, improved health and/or wellbeing, enhanced state of knowledge within a field, reduced waste etc. Examples of types of outputs relevant to FP7-Environment are provided in Appendix VI.

The impact of research can be described as "*the demonstrable contribution that*

excellent research makes to society and the economy"[28]. The diverse ways in which FP7-Environment derived research-related knowledge and skills provide benefits to Member States and the EU include by: enhancing quality of life and health; supporting an innovative and enterprising economy, including creation of new products, services and technology; increasing the effectiveness of public policies; developing and retaining Europe's international reputation for research excellence; and providing solutions to address major global challenges.

The GoE acknowledges that it is the nature of research that some projects deliver early-stage impacts, while other projects take longer to deliver impacts. For example, there may be a time lag before an output such as a filed patent would create an impact; the adoption of a project output such as a new standard or protocol that would improve the performance of an existing procedure also involves a time lag.

The GoE further acknowledges that impacts from research do not necessarily follow a linear process (portrayed as basic research adapting into applied research which then translates into technological development of devices and systems). In conceptualising and articulating the potential impacts of research, the GoE has taken a broad view of where a project fits into the overall objectives of FP7-Environment. While the GoE distinguished between outputs, outcomes and impacts conceptually, using this as the framework, in practice it was not always possible to make this distinction *sensu strictu* (as FP7-Environment did not adopt such monitoring systems). The GoE considered participation as an output; publications, discoveries, patents as outcomes, and the remainder as impacts[29].

The GoE endeavoured to evaluate the potential impacts as appropriate to specific research fields. Research with potentially high impacts is often high-risk research; in competitive and rapidly evolving fields there may be limited opportunities for the development of such research. In other fields the benefits of research is only realised over long time scales. Thus, the GoE adapted expectations to the context of the research field being examined. Detailed analysis of each of the 10 priority themes of FP7-Environment, while beyond the scope of the evaluation presented here, requires more in-depth assessment (as has already been provided in the review of FP7-Environment GEO projects)[30]

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[28] UK Research Council, at: http://www.rcuk.ac.uk/RCUK-prod/assets/documents/impacts/RCUKImpactFAQ.pdf

[29] European Commission (2004) *Evaluating EU activities – A practical guide for the Commission Services*. Luxembourg, Office for Official Publications of the European Communities, p.72.

[30] N. Connolly et al. (2014) *op.cit*.

3. RESULTS: ANALYSIS OF FP7-ENVIRONMENT PROJECTS - OUTCOMES AND IMPACTS

"Science is built up with facts, as a house is with stones. But a collection of facts is no more a science than a heap of stones is a house."

Jules Henri Poincaré (1854-1912) French mathematician

3.1. Implementation: participation in FP7-Environment

During the period 2007-2013, FP7-Environment issued 29 calls for proposals across its research areas, eliciting a response of 2,589 proposal submissions, of which 19% were retained for negotiation. FP7-Environment funded 493 projects, involving 7,102 project partner participants, with an average consortium size of 14 partner organisations per project. The average budget of projects funded in FP7-Environment is in accordance with the scale of project funding throughout FP7's Cooperation specific programme.

The FP7-Environment programme was characterised by a low rate of participation of representatives from industry (19.5%), which was below the average rate for the Cooperation specific programme (33.6%). The rate of participation of non-profit research organisations and public bodies in FP7-Environment was above the average for the Cooperation programme.

SME participation

One thousand and thirty three (1,033) Small and Medium Enterprises (74.6% of "private for profit", representing 14.5% of all participations) participated in FP7-Environment. This proportion of SME participation is comparable with that in programmes including: Health (79.8%); Food, Agriculture and Fisheries (74.3%); Socio-economy and Humanities (75.4%). The proportion of SME participation in FP7-Environment is above that for other FP7 programmes, namely: Transport, Energy, Security, ICT, Industrial Technologies, and Space (with a range of SME participation of between 35% and 55%).

The scope for participation of SMEs in FP7 funded environmental research was limited. Over the lifetime of FP7, calls in the later years required SME participation, in keeping with meeting the required target of allocation of 15% funding to SMEs. The type of SME represented within FP7-Environment consortia tended more often to be a knowledge-based consultancy service (providing for example websites, dissemination, facilitation etc), rather than a technology or industrial-based SME; this may be an unintentional consequence of the requirement to include SME partners in proposals. The findings presented here are in keeping with an evaluation of SME participation throughout FP7 programmes[31] which concluded that SME participation was generally not focussed on the generation of commercial impact from results.

Only 3% of FP7-Environment participants were categorised as "Other", which includes Non-Governmental Organisations (NGOs) and Civil Society Organisations (CSOs)[32]. A detailed analysis of participation in FP7-Environment by type of organisation is provided in Appendix VII.

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[31] Panteia et al. (2014) *Performance of SMEs within FP7 An Interim evaluation of FP7 components*, at:, http://ec.europa.eu/research/sme-techweb/pdf/volume_i_smes_in_fp7-may2014.pdf

[32] Examples of CSOs involved in FP7-Environment include : the Club of Rome, the Paul Getty Trust, the World Wildlife Fund (WWF); European networks such as the European Science Foundation, "fair trade " organisations such as Max Havelaar, think-tanks, expert groups etc.

Beneficiaries of FP7-Environment, by organisation type

The designated legal entity that represented each FP7-Environment beneficiary (partner in a project consortium) was on average involved in 2.4 projects; however, the level of dispersion in participation rates is extensive (see Figure 1 in Appendix VII). The majority of organisations (68%) were involved in one single FP7-Environment project; 122 organisations (4%) were involved in 10 projects or more.

The fact that beneficiaries engage in repeated project participation may be indicative of the attractiveness of the FP7-Environment funding programme, and its relevance to the research communities within Member States. Repeat participation may also indicate that organisations that had a positive experience with their first FP7-Environment project, subsequently submitted further successful proposals. The existence of several different disciplinary teams within one legal entity (for example a university or large research institute), also accounts in part for the multiple participation of some legal entities.

FP7-Environment supported continuity of research capacity in many organisations, with evidence of research teams being maintained and built up over several successive FP projects. Funded consortia achieved a balance between new participants and experienced ones (if project participation was dominated by traditional players, access to funding would risk being dominated by a closed club, which is contrary to the key principles of FP7 and the European Research Area).

The main beneficiaries of FP7-Environment (in terms of number of participations and volume of funds received) include major EU research institutes, such as the EU's Joint Research Centre (JRC of the EU), the *Centre National de la Recherche Scientifique* (CNRS, France), the *Consiglio Nazionale delle Ricerche* (CNR, Italy), the *Consejo Superior de Investigaciones Científicas* (CSIC, Spain), the *Max Planck Institute* and the *Fraunhofer Society* (both Germany) and the *Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek* (TNO, Netherlands). Other repeatedly successful organisations include universities and institutes from the Netherlands (Wageningen, Utrecht and Amsterdam universities), Denmark (Aarhus university and the Danish Technological Institute), UK (Exeter university) and Switzerland (ETH Zürich), together with environmental agencies (for example the UK's Natural Environment Research Council), private entities (Ecologic, Germany) and research centres focused on environment and related domains[33].

The 21 organisations with the highest rates of participation in FP7-Environment projects do not include any industry-based representative. In terms of the scale of funding received, the main private-for-profit organisations represented are *KWR Water B.V*. ("Watercycle Research Institute", a Dutch private research institute), *Norwegian Geotechnical Institute* (NGI; consultant on offshore energy, construction and transportation, natural hazards and environmental engineering, Norway) and *Acciona Infraestructuras S.A.* (Spain)[34], ranked respectively 83rd, 102nd and 116th.

When considering the number of projects participated in, the three main private-for-profit partners were *Acciona S.A*. (Spain; 11 projects), the *Sustainable Europe Research Institute* (SERI, a Pan-European think-tank based in Austria; eight projects) *and KWR Water B.V.* (the Netherlands; eight projects).

Most of the private-for-profit organisations represented are consultants, engineering firms and/or private research organisations. Nonetheless, sectors such as producers of specific technology components (e.g. *Idonaut srl*., specialised in the design and manufacturing of high-performance oceanographic sensors) and even publishers (e.g. *Pensoft Publishers Ltd,* Bulgaria) are also represented as participants.

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[33] An example of the assessment by the UK Russell Group of Universities of the benefits of participation in FP7 is included in Appendix XIV.

[34]Specialised in the development and management of infrastructure, renewable energy, water and services; turnover: €7,056 billion in 2012. Acciona's Annual Report 2012, at: http://annualreport2012.acciona.com/

These data indicate that industry (Large Enterprises: LEs) had a minor involvement in the research activities funded through FP7-Environment[35]. There are however some major industrial participants, such as *Acciona S.A*. and *Veolia Environnement S.A.* (France[36]). Some of the leading European-based companies in terms of R&D investment[37], such as *Daimler*, *Nokia*, *Bayer*, participated as project partners in FP7-Environment on one or two occasions.

Box 3: Example of added value of FP7 to a Member State: UK*:

The UK won 14.5% of all FP7 funding (the second highest share, Germany being first). This is higher than the proportional UK contribution to the EU budget (c. 11.9%) or the proportion of overall EU spending allocated to the UK (c. 5.0%). Funding for competitiveness and innovation accounts for 18.3% of the UK's receipts from the EU. This is almost the same as the receipts from cohesion funding (18.5%), even though overall EU spending on cohesion is nearly four times larger than that for competitiveness. FP7 alone represents 14% of the UK's receipts from the EU; this is higher than in any Member State except the Netherlands. The UK's, Russell Group of Universities (24 research intensive universities) conclude that there is a great deal of added-value from participation in the EU's Framework Programmes for research funding. The Russell Group universities make up 14 of the top 50 higher education participants in FP7.

*See: http://www.russellgroup.ac.uk

The low rate of industrial participation is a challenge to addressing the core FP7 objective of moving towards increased innovation. This low rate of industrial participation may be partly accounted for by the fact that FP7-Environment research focused on research relevant to the early stages of innovation, and that the traditional FP7 participants are the scientific research and environment policy communities. To increase its impact in terms of innovation, the Societal Challenge 5 (SC5) of Horizon 2020 ("Climate Action, Environment, Resource Efficiency and Raw Materials"), as the successor of FP7-Environment, should strengthen the links with industrial partners who are active in R&D, involving both large companies – with the capacity to integrate technologies at a large scale – and innovative SMEs. A further involvement of NGOs and CSOs would also strengthen the links between the research and innovation communities and society, contributing to the potential increase in impacts of projects.

Participation rates by country

While all EU Member States are well represented in FP7-Environment projects, there are differences in the frequency of involvement. The main beneficiaries in terms of FP7-Environment **volume of funding** awarded were Germany (14.5% of total funding), the UK (13.8%), the Netherlands (10.5%), followed by Spain, France and Italy (less than 6% each). The share of funding received by those Member States that acceded to the EU since 2004[38] is below 1%. Third Countries received 4.1% of the total funding, which is comparable to the rates for associated countries such as Norway.

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[35] One possible reason, apart of the fact that innovation was not the main priority in early stages of FP7-Environment, is the existence of other funding programmes, such as the CIP, which targeted innovation. Similarly, the relatively low participation of CSOs and NGOs may be attributable to the fact that the LIFE + programme had special grants for NGOs.

[36] Water supply and management, waste management, energy and transport services; revenue in 2013: €22.3 billion http://www.finance.veolia.com/key-key-figures.html

[37] According to: European Commission-Joint Research Centre (2013) *2013 EU Industrial R&D Investment Scoreboard*. Luxembourg: Publications Office of the European Union. At: http://iri.jrc.ec.europa.eu/scoreboard13.html

[38] Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia in 2004, plus Bulgaria and Romania in 2007.

Examining FP7 funding awarded per country shows strong correlations with the scale of national GDP[39] and R&D investments[40] (see Appendix VII). This indicates that the higher the GDP of a country (and by implication its R&D investment), the more likely the country was to acquire FP7 grants[41].

Figure 3 shows the correlation between individual Member States' expenditure on R&D and the FP7-Environment contribution secured per Member State. It is evident that Member States that have attained a certain critical mass in terms of national R&D investment were in a position to benefit from FP7-Environment funding. The countries that secured the most funding, when compared with their national R&D funding, were the UK, the Netherlands, Spain and Italy[42]. In contrast, despite being amongst the main FP7-Environment beneficiaries, Germany and France received a smaller volume of funding than expected. There are positive exceptions, such as Greece, which, despite a low level of national R&D investment, nonetheless secured a significant level FP7-Environment funding.

While other countries are close to the expected level of FP7-Environment funding, most of them (especially the Member States that joined the EU after 2004) did not secure high levels of funding. It is worth noting that this Figure includes only FP7-Environment funding and not Structural and Cohesion Funds allocated to R&D. The pattern for Member States that have joined the EU since 2004 would be different if Structural and Cohesion Funds were included.

Access to EU Framework Programme funding is often crucial in countries where national R&D funding has declined. For example, while the UK contributes 11.5% to the overall EU budget, it won 14.5% of the FP7 research funding. Other relevant examples include Greece, Italy and Spain, where despite decreases in national expenditure on R&D, researchers successfully secured FP7 funding. Participation rates from those Member States that joined the EU since 2004 are below average. This may be attributable to the need for a minimum level of national funding, to develop a core critical mass and capacity which can then leverage EU programme funding.

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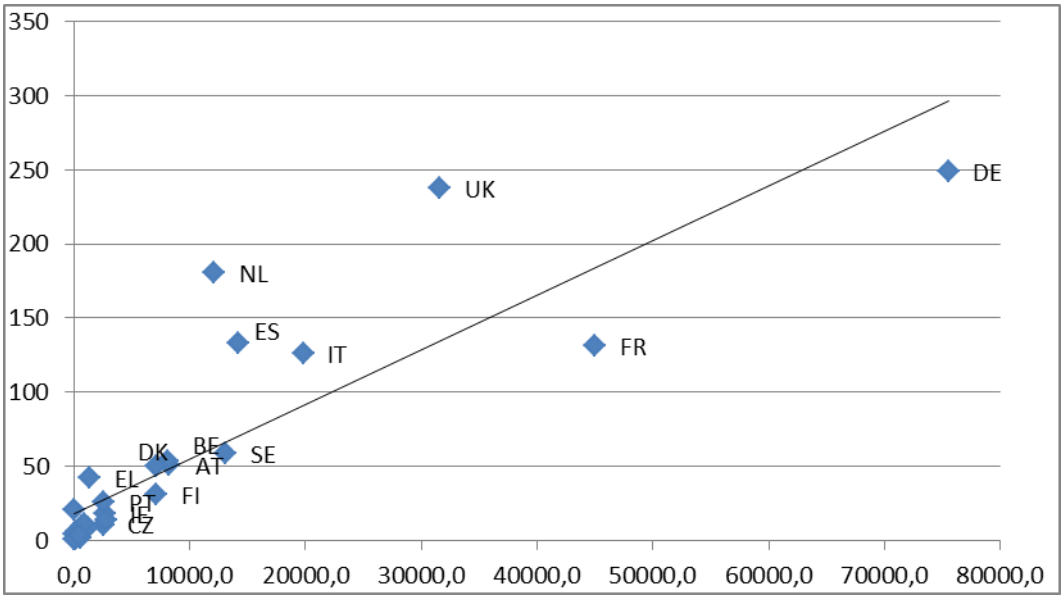
[39] R-square = 81.8%

[40] R-square = 72.7%. Both based on Eurostat statistics. Reference year for GDP: 2013. Reference year for R&D investments: 2011.

[41] The relationship is nevertheless inelastic: 0.6.

[42] Those situated below the regression line («likely EU contribution») can be considered as relatively low, and vice-versa. An analysis of the regression's residuals allows a more detailed view.

Figure 3: Correlation between national R&D investment and FP7-Environment contribution (EU Member States only)



X-axis: R&D investment Y-axis: EU contribution (FP7-Environment)

It is important to ensure that EC research funding is complementary to national research funding – supporting transnational projects and research excellence – rather than as a substitute for national funding. During the lifetime of FP7-Environment, the smaller EU Member State had a tendency to cut their R&D budgets as a result of the economic downturn. Some newer Member States do not have the scale of research infrastructure within their universities and institutes that are extant in older Member States, which limits their access to competitive funding. The national funding programmes in many countries are under-resourced, which impacts directly on the capacity for researchers to access Framework Programme funding. It is necessary that merit-based and competitive national funding systems lay the foundations for successfully competing at the European level; this would be further supported via enhanced coordination between national funding programmes, regional programmes and Horizon 2020.

Researchers need access to infrastructure and to colleagues; researchers from smaller EU Member States (in particular those that joined post 2004), need to be supported in networking and to access involvement in larger projects. Indirect effects of FP7-Environment on national funding systems included impacts on raising research standards, facilitating networking and mobility of researchers, and access to infrastructures. This trans-national interaction between researchers within consortia heightens awareness of best practice. Free movement of researchers between partners is of particular benefit to early-stage researchers, with effects on raising standards across the EU. Such collaboration supports the development of critical mass, particularly in areas of importance to technology and policy. There is evidence that such collaboration, where successful, is maintained from one FP funding programme to the next. It will be interesting to examine which collaborations are maintained from FP7-Environment into Horizon 2020's Societal Challenge 5 (SC5).

The ERA-NET instrument, first introduced in FP6, continues to impact directly on the European research landscape by enhancing collaboration between national research programmes, while developing calls that are complementary to the FP calls. The successful alignment of national and regional funding programmes with FP7-Environment, reducing fragmentation and duplication, and increasing the

knowledge-base, is particularly evident in BONUS[43] (Joint Baltic Sea Research Programme), an exemplar in the evolution and success of the ERA-NET instrument (from its initial implementation in FP6), providing cohesion between marine environmental funding programmes for the Baltic states. BONUS itself is supported through FP7, both as a dedicated Article 185 (ex Article 169) and through a CSA, and has successfully implemented its own funding calls (supported by national funding agencies) that support research throughout the Baltic region. Other examples included the FP7 ERA-NET SEAS-ERA (evolved from FP6 ERA-NET MarinERA), which worked very closely with FP7-Environment theme "Marine environment" in the alignment of their respective work programmes and calls, including access to infrastructure (research vessels being crucial for marine research), and addressing policy. Assessment of the ERA-NET funded activities and how they interacted with FP7-Environment research was beyond the scope of this report, and would yield worthwhile information for the design and implementation of Horizon 2020 SC5.

Participation and success rates

As stated, FP7-Environment calls received 2,589 eligible proposals, with a success rate of 18.9% (in keeping with the average for the Cooperation programme of 19%). The success rate was lower for proposals submitted as Collaborative Projects (CPs), with a rate of 17.3%, by comparison with proposals submitted as Coordination Support Actions (CSAs) with a 27.4% success rate (see Appendix VII, Table 4).

An overall success rate of less than 20% is considered by the majority of proposal submitters to be low. There are two associated aspects, from the perspective of the research performing community: (i) the success rate may be an indicator of the attractiveness of the funding programme, and thus of the intensity of the competition; (ii) considerable effort is expended in the preparation of unsuccessful proposals. In principle, the lower the success rate, the higher the expected degree of excellence of projects, but this is an *a priori* analysis to be validated by outputs and outcomes and impacts of projects.

While post-2004 Member States achieved lower success rates than the average, countries such as Finland, Greece, Italy, Luxembourg, Portugal and Spain were also below the average[44]. By comparison, Belgium, Denmark, Ireland, the Netherlands, and the United Kingdom represent the highest success rates.

The cases of France and Germany are notable. While their participation was relatively low when compared with their respective national R&D investments, their success rates in acquiring FP7-Environment funding are high, and above the average. This paradox may be explained by: (i) the availability of, and on occasion the status associated with, national R&D programmes, which reduces the pressure to apply for international funding; (ii) a higher interest in other Cooperation thematic programmes (by comparison with FP7-Environment), which are more relevant to the national strategic areas and capacities in research and innovation. Other reasons – for example as in Finland – could be the recent internationalisation of their R&D funding systems[45].

The level of participation and success rates by Member States demonstrate that FP7-Environment was focused on scientific excellence. The main beneficiaries, when considered by Member State, were those that invest the most in R&D. This is indicative of the trend whereby a certain critical mass of R&D investment is deemed necessary to benefit from the programme. FP7-Environment gave relevant opportunities to countries such as Greece, Italy and Spain, with good levels of

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[43] http://www.bonusportal.org/

[44] Both as participants and as coordinators.

[45] Ahonen, P.P. et al. (2009) *Internationalisation of Finnish Scientific Research*. Helsinki, Academy of Finland.

participation and funding even through their success rates (measured as percentage of submitted proposals that were successful) were below the EU28 average.

Collaborative links by country and by organisation

One of the notable impacts of FP7-Environment is its successful support for transnational collaboration and the development of the ERA. It is estimated that FP7-Environment supported 96,362 inter-institutional collaborations, of which 91,557 (94.8%) were trans-national. The majority of links were established between Member States (80,775), while Norway and Switzerland (associated countries) were highly represented (more than 3,000 links each). These collaborations are of a scale that would not be possible through funding programmes other than the EU's FP.

From Figure 4 of Appendix VII, presenting transnational collaborations, it is evident that a group of countries have created axes for international networking, namely: France, Germany, Italy, the Netherlands, Spain and the UK, and to a lesser extent, Norway and Switzerland. Amongst the post-2004 Member States, Poland is the country with the most links with other countries, in particular with Germany and the UK.

Beneficiaries by funding instruments

Compared with the entire FP7, FP7-Environment funding resulted in a greater number of CSA structured projects (as predetermined by the calls). The higher number of CSAs is linked with the policy support function of FP7-Environment, and is a function of the design of the calls. Only one Network of Excellence (NoE) was funded through FP7-Environment, namely the project LIAISE (Table 6 in Appendix VII). The CSAs funded included those specifically targeting policy, and others in support of networking interdisciplinary communities in emerging research areas; others supported the establishment and development of trans-national research programmes, as for example the CSAs that supported BONUS, as well as the Joint Programming Initiative (JPI) Oceans[46], and climate change initiatives.

In terms of funding, the breakdown of FP7-Environment by funding instrument is similar to the breakdown of the entire FP7 Cooperation programme. The average cost of projects by instrument is also similar within FP-Environment to that throughout the FP7 Cooperation programme.

3.2. Assessment of projects: outcomes and impacts

It is widely acknowledged that FP7 funding supported the development of a critical mass of knowledge, expertise and capability across Europe, providing the basis for addressing global challenges, while also having a significant economic impact. The long-term impact to Europe of FP7 has been estimated as an increase of 0.96% GDP, an increase of 1.57% in exports, reduction of 0.88% in imports, along with 900,000 new jobs, of which 300,000 were in research[47]. Specific aspects of the impacts are detailed below.

The driver to assess research performance data is multifaceted. The European Parliament commissioned an analysis of current approaches to research performance assessment in Europe, including the concepts, methods and tools

[46] JPI Oceans: The Joint Programming Initiative Healthy and Productive Seas and Oceans (JPI Oceans) is established in 2011 as a coordinating and integrating strategic platform, open to all EU Member States and Associated Countries who invest in marine and maritime research. See: http://www.jpi-oceans.eu/

[47] Russell Group of Universities (2013) *Inquiry into the Effectiveness of EU Research and Innovation Proposals*. At: http://www.russellgroup.ac.uk/uploads/HoL-EU-Select-inquiry-into-EU-research-and-innovation-evidence-from-the-Russell-Group-11-February.pdf

used, as well as benefits and challenges[48]. That report provides an analysis of the desirability and feasibility of creating a transnational system for collecting and monitoring research performance data (on inputs, outputs and productivity) and to identify relevant research policy options.

3.2.1. Scientific excellence

Enhancing scientific excellence throughout the European Research Area was one of the core objectives of FP7-Environment. The underlying rationale included the need to build a strong evidence-base for sustainable management of the environment, and the development of associated policies. FP7-Environment funding calls supported scientists and engineers to create both research excellence and impact.

This analysis distinguishes between scientific excellence at the level of outcomes (first section) and at the level of impacts (second section). At the level of outcomes, the most frequently used indicators for scientific excellence are the number, quality and citations of scientific publications. The European Commission maintains a database of publications (Respir), that made it possible to conduct a quantitative, bibliometric analysis. At the level of impacts, the analysis of scientific excellence is not yet supported by quantitative indicators. Thus, the review of the 90 projects was specifically used for the analysis of impact[49].

Scientific excellence at the level of outcomes

Publication outcome of FP7-Environment compared with other Cooperation themes

The FP7-Environment programme produced **2,876 papers** (as of November 2014**)**, of which **44%** were published in high ranked journals[50]. On average, each project produced **13.6 publications.** The total number of publications produced per project is just above the average for the Cooperation programme (12.5%), while the percentage of papers published in high ranked journals is below the average (49%). The Cooperation programme average is strongly influenced by the Health theme, which presents the highest number of finalised and processed projects and a very high rate of papers published in high ranked journals; the NMP theme also influenced the average.

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[48] Technopolis (2014) *Measuring scientific performance for improved policy making*. Report for the European Parliamentary Research Service – Science and Technology Options Assessment (STOA) project. At: http://wiki.lib.sun.ac.za/images/3/3e/Stoa-performance.pdf

[49] This combination of quantitative and qualitative methods is the commonest trend to assess research. See: Thwaites, T. (2014) "Calling science into account", in *Nature*, Vol. 511, July, pp. S57-S60.

[50] High impact journals are defined to be the top 10% (in terms of SJR index) of all journals within a given scientific category. For a complete list of scientific categories please visit: http://www.scimagojr.com/journalrank.php

The SJR - Journal Rank Indicator, it is a measure of journal's impact, influence or prestige. It expresses the average number of weighted citations received in the selected year by the documents published in the journal in the three previous years.

Table 1: Publications by FP7 Cooperation Programme Theme

Theme	No. of processed projects	Percentage without reported publications	Number of publications	Publications by project	Pub. in High-Impact Journals	%
Health - HEALTH	384	14%	11193	29.1	6323	56%
Food, Agriculture and Fisheries, and Biotechnology - KBBE	174	20%	2631	15.1	1117	42%
Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP	345	28%	4050	11.7	1973	49%
Energy - ENERGY	102	33%	715	7	304	43%
Environment (including Climate Change) - ENV	212	30%	2876	13.6	1265	44%
Transport (including Aeronautics) - TPT	274	61%	545	2	162	30%
Socio-economic sciences and Humanities - SSH	127	35%	655	5.2	154	24%
Space - SPA	102	46%	575	5.6	204	35%
Security - SEC	70	57%	229	3.2	36	16%
General Activities - GA	11	91%	252	22.9	57	23%
Joint Technology Initiatives (Annex IV-SP1) - SP1-JTI	108	86%	49	0.5	22	45%
TOTAL COOPERATION	**1909**	**36%**	**23770**	**12.5**	**11617**	**49%**

Source: EC's Respir database. Extraction: 06/11/2014

Comparison of publication outcome for different priority areas within the FP7-Environment theme.

Within the FP7-Environment theme, two main categories can be distinguished: at the forefront, the first group includes the areas "Climate change, pollution and risks" (ENV.1), and "Sustainable Management of Natural Resources" (ENV.2). The average number of publications per project in this group is above 15, representing in excess of 50 publications per €10 million FP7-Environment funding. Scientific communities covering these areas are seen as mature, with an established tradition of international cooperation and a solid infrastructure of international scientific organisations, including conference series and domain specific scientific journals. Projects within these areas are embedded in the mature, internationally operating infrastructure; as a consequence, the project setup time is kept to a minimum and facilitates the relatively rapid production of scientific outcome. Examples of such projects include: Carbo-Extreme, COMBINE, EPOCA, ICE2SEA, REDD-Alter (ENV.1), FUME, MICORE, MOTIVE, WISER (ENV.2).

Box 4: EPOCA: an example of excellent publication results

EPOCA (*European Project on OCean Acidification*) has a whole welter of key scientific

findings to its credit. The project highlighted the fact that ocean acidification in the Arctic Sea close to Iceland was proceeding 50% faster than in sub-tropical regions such as the North Atlantic and the Pacific Oceans.

A total of 200 peer-reviewed publications emerged as a result of the EPOCA project, with the vast majority of these being published in leading scientific journals such as *Global Change Biology* (IF = 6.91), *PloS One* (IF = 3.73), *Nature Geosciences* (IF = 12.367) and *Biogeosciences* (IF = 3.859). At least one paper featuring EPOCA project results was published in each of the prestigious *Science* and *Nature* journals.

The majority of the 160 scientists participating in the project are acclaimed in their respective fields of expertise, with a solid publication background. In addition, some of the EPOCA partners had contributed extensively to IPCC third and fourth assessment reports, to OSPAR, WWF and other key working groups on ocean acidification. The chapter on ocean observations within the IPCC's 5th assessment makes reference to the book on Ocean Acidification released through the EPOCA project.

The second category of projects includes the areas "Environmental technologies" (ENV.3) and "Earth observation and assessment tools for sustainable development" (ENV.4). The average number of publications per project is seven for ENV.3 and six for ENV.4, representing approximately 30 publications per €10 million of FP7-Environment funding.

While these rates of publications are lower than those of the first category of projects, they are influenced by the orientation of the domains (more technological than scientific, for ENV.3) and, in the case of the "assessment tools" domain, the stage of maturity of the scientific community, which is still at the early-stages of development and not yet fully consolidated. The Earth observation domain is far more mature and stronger in terms of scientific excellence[51]. Both areas are characterised by a strong degree of inter- and trans-disciplinary cooperation. Although high ranked journals featuring inter- and trans-disciplinary research have evolved over the past decade, securing high ranking scientific publication for such research is still less straightforward than in other scientific fields with a longer, disciplinary history. Furthermore, setup time for research is longer, as it first requires the joint elaboration of a common analytical framework that is acceptable from multiple disciplinary standpoints.

When considering all priority areas within FP7-Environment, the average number of publications per €10 million of FP7 funding is 51, which is higher than the numbers for the FP6 Environment programme, which were: 25 for STREPs and 52 for IPs and NoEs[52].

[51] Connolly, N. et al. (2014) *op.cit.*

[52] Amanatidou et al. (2011) *Stocktaking of results and Impacts of EU-funded environmental research*. Report for the European Commission, at: http://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/horizon2020_env_stocktaking_goe_final_2011.pdf

Table 2: Publications by FP7-Environment priority area[53]

	Projects with a Processed Final Report	No. of projects with at least one publication	Total No. of pubs.	No. of pubs. in High Impact Peer Reviewed Journals	%	Average No. of pubs. per project	No. of pubs. by €10 M	No. of pubs. in High Impact Peer Reviewed Journals by € 10M
Climate change, pollution, and risks - ENV.1	62	54	1632	807	49%	26.3	79	39
Sustainable management of resources - ENV.2.	32	24	542	225	42%	16.9	55	23
Environmental technologies - ENV.3.	59	39	436	127	29%	7.4	28	8
Earth observation and assessment tools for sustainable development - ENV.4.	46	27	258	104	4%	5.6	31	12
Horizontal activities - ENV.5.	13	4	8	2	25%	0.6	6	2
TOTAL ENV	**212**	**148**	**2876**	**1265**	**44%**	**13.6**	**51**	**23**

Source: EC's Respir database. Extraction 06/11/2014

Analysis of journal rankings

At the top of the list, 35 papers were published in *Nature, Science Nanotechnology,* and *Science*, with SJR indexes of 14.5, 12 and 11.2 respectively. Those papers were produced by the following projects (some of them within the 90 projects reviewed for this report): HERMIONE, RECONCILE, CARBO-EXTREME, THOR, EELIAD, MEECE, COMBINE, EUROSITES, MEGALOPOLI, COCOS, EPOCA, DEER, PROSUITE, ICE2SEA (with eight such publications), QWECI, THESEUS and HIGHNOON. This information indicates that relatively few projects reached a top level of scientific excellence, measured in terms of the ranking of the journal in which they published. Only 6% of all papers published are in the top 450 journals (SJR index 3 or more) and 1.3% reached an SJR higher than 9 (Appendix VIII). This indicates that FP7-Environment funding was more successful in supporting the creation of critical mass of good research, rather than in creating a worldwide lead for Europe in excellence in particular domains[54].

Statistical analysis: variables for the publication outcomes

[53] The GoE notes that the percentage of projects designated as without publications is unexpectedly high (35%). This may be attributable to shortcomings in reporting procedures.

[54] Recent Nobel Prizes Professor Novoselov (Physics Laureate for work on grapheme, 2010) and the 2014 winners in Physiology and Medicine, MB Moser and E.I. Moser, were FP6 and FP7 beneficiaries before receiving ERC grants, and subsequent Nobel Prizes. FP collaborative projects create high level career opportunities for early-stage researchers, supporting knowledge creation and sharing, international networking, etc.

The data presented under-estimate the real scientific record of FP7-Environment projects, given the lag effect with regard to timing of publications versus completion of projects. However, even within the limits of the data available, a statistical analysis is possible to understand which factors influence the publication results of projects. The EC's Respir database was used to carry out a multivariate regression, presented in Appendix IX.

The dependent variable (Y) was the number of high ranked publications. Six variables significantly (F-test, t-student test) affected the number of high ranked publications of a project: (i) the instrument; (ii) the scale of EC contribution; (iii) the total number of participants in the consortium; (iv) the total workforce; (v) the number of additional researchers hired by the project; and (vi) the total number of publications[55].

It is likely that these new researchers include early stage scientists, very motivated to publish, either alone or in collaboration with more experienced colleagues. They benefit from the opportunity given by their participation in FP7 projects to prepare a career pathway, in particular enhancing their publication record[56]. It is worth noting that variables such as the number of companies involved, the number of SMEs, the duration of the project, the starting year of the project, and the number of patents are not statistically significant (t-Student test, see Appendix IX).

The role of the instrument in the publication outcome can be seen in Table 3. The largest instrument CP-IP clearly ranked best in terms of the number of high ranked publications per project. As calls for CSAs were designed to support the development of policies, and in some instances to provide a forum for networking of expertise in yet-to-be mature domains, the low level of publications by CSAs is not surprising, as their purpose was not the extension of scientific frontiers *per se.* This reinforces the results of the FP6 *ex-post* analysis, in which IPs and NoEs were found to be twice as efficient with regards to the number of publications per unit amount of funding than the smaller STREP instruments[57].

The main factor influencing the number of publications in high calibre journals is the total number of publications, which had a greater correlation than the project budget. This indicates that the more papers that a project generates for publication, the more likely it is that one of its publication will appear in high impact journal. Does quantity lead to quality? – This paradox is probably explained by the fact that excellent papers are the result of years of work, building on a foundation of previous publications in journals, conference proceedings, etc. This is another indication of the importance of the maturity of the scientific community behind a certain research field, before the attainment of excellent scientific outcomes.

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[55] The statistical model is not optimal because some of the explanatory variables correlate (e.g. total workforce and number of additional researchers).

[56] This is also supported by other international evidence. See: McGilvray, A. (2014) "The limits of excellence", in *Nature*, vol. 511, July, pp. S64-S66.

[57] Amanatidou et al. (2011) *Stocktaking of results and Impacts of EU-funded environmental research*. Report for the European Commission, at: http://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/horizon2020_env_stocktaking_goe_final_2011.pdf

Table 3: Average publications per project, by instrument

Instrument	Publications by project	No. of projects
CSA	1.8	67
CP	19.5	139
CP-FP	13.9	97
CP-FP-SICA	11.1	9
CP-IP	50.9	22
CP-IP-SICA	11.0	2
CP-SICA	14.4	9
BSG-CSO	0.0	4
Total	**13.5**	**210**

Source: EC's Respir database. Extraction: 05/11/2014

Scientific excellence at the level of impacts

The pathway to impacts of FP7-Environment research on improving the scientific excellence of its contributors is more difficult to measure. The pathway to impact was assessed through the question of how far FP7-Environment research actually improved scientific capacity in fostering excellence and its long-term maintenance. To date, there are neither commonly accepted indicators nor a monitoring system nor databases available to answer this question. A qualitative analysis of the reviews of the 90 project selected was conducted to address this shortcoming. The impacts on scientific excellence were analysed at two levels: the individual participants and the scientific community within a certain research area.

Impact on scientific excellence of individual participants

From the perspective of scientific excellence, a research project was considered to be successful when it had the largest number of excellent participants in its consortium, and when the excellence of individual researchers was enhanced through the collaboration in the project. Scientific excellence at individual level is usually measured by the h-factor and/or by the impact factor of the journal chosen for publication. However, average h-factors and journal impact factors vary between scientific disciplines. The typical range of h-factors and journal impact factors for the particular research areas therefore need to be considered when undertaking comparisons.

Among the 90 projects reviewed, approximately 20% reported an increase both in the number of publications and in the journal impact factor achieved through project collaboration. In the majority of cases this was due to the pull effect of excellent key partners towards the other partners in the consortium. Examples of such projects are ATP[58] and COMBINE[59], two projects of the priority area ENV.1

[58] ATP analysed time series data and experiments to investigate the existence of climate driven tipping points for key species and ecosystem process in the Arctic Ocean. ATP provided input to the IPCC, amongst other policy making fora. http://eu-atp.org/

[59] COMBINE successfully brought together research groups to advance the capabilities of Earth system models (ESMs) for more accurate climate projection and climate prediction. COMBINE improved ESMs and directly contributed to IPCC AR5: http://www.combine-project.eu/

(Climate change, pollution and risk). The pull effect was made possible through the recruitment of early career researchers combined with a system of staff exchanges and joint training efforts. This finding substantiates the statistical analysis of the factors affecting publication outcomes of the projects, which identified the number of additional researchers hired by the project as a significant independent variable. Clearly, this impact is a valuable example for the implementation of the European Research Area, improving excellence through European cooperation.

Box 5: HERMIONE: example of improving partners' excellence through participation

HERMIONE (*Hotspot Ecosystem Research and Man's Impact On European Seas*) has involved a multi-disciplinary team of biologists, ecologists, microbiologists, biogeochemists, sedimentologists, physical oceanographers, modellers and socio-economists to make the nexus between the deep-sea assemblages and ecosystem services provided to humankind. The majority of the core scientists participating within the project are authorities in their respective academic fields, eminently established within the field of deep-sea research.

HERMIONE has certainly caused a stir within the scientific community through its pro-active approach, with a remarkable total of 761 conference participations and numerous other workshop ones. The project provided a lot of fodder for thought for policy-makers who must contend with the designation of revised policy instruments to address newly-discovered human impacts on deep-sea assemblages, such as the fact that cold-water coral communities are already under stress due to bottom trawling in many areas.

Impact on scientific excellence and maturity of the scientific community of a particular research area

There is a tendency for scientific communities to self-organise at international levels. Means of self-organisation include the constitution of international scientific organisations, scientific conferences and conference series, editing of scientific journals, and the elaboration of strategic research agendas and cooperation plans. While traditionally this self-organisation took place within disciplines, it is now happening at interdisciplinary levels. Often, global societal challenges (climate change, food security, energy scarcity) serve as catalysts for such movements. The most prominent examples in the environment area include the IPCC (Intergovernmental Panel for Climate Change) programme, the Future Earth Programme of ICSU (International Council of Scientific Unions), the IPBES (Intergovernmental Platform for Biodiversity and Ecosystem Services), the ESP (Ecosystem Service Partnership), and the GLP (Global Land Project).

Active interaction within these platforms can be seen as one measure of the impact of FP7-Environment research on excellence and leadership at international level. Indeed, it is about implementing "*European schools of thought*" to address societal challenges. Thereby, the key element of maturity lies in the integration of scientific excellence with societal relevance in lasting interdisciplinary networks of global relevance.

Approximately 20% of the 90 projects that were reviewed reported active interaction with and impact on international communities. Among those, interaction with the IPCC was the most frequently reported. As noted above, climate change is the priority area with the best performance in scientific outcome. The maturity of this community in terms of international scientific self-organisation is a factor of success in scientific excellence; European researchers play a dominant role in this.

Box 6: Carbo-EXTREME, example of excellent impact on international research agenda

Carbo-EXTREME (*The terrestrial Carbon cycle under Climate Variability and Extremes – a Pan-European synthesis*) had the objective to obtain a better and more predictive understanding of the European terrestrial carbon cycle responses to climate variability and extreme weather events. The consortium consisted of 82 researchers from 26 organisations. The most excellent researchers have h-factor of 55. Many of the other researchers' h-factor varies around 40. The consortium contributed to the IPCC and IGBP activities. CARBO-Extreme researchers in many high-level policy relevant boards and contribution to the IPCC reports as lead authors. Significant interactions were developed between the CARBO-Extreme EME sites and the infrastructure Project EXPEER (FP7).

Projects such as CLIMSAVE and KNOWSEAS, managed to interact with numerous international research organisations; CLIMSAVE developed a web-based knowledge tool, with the involvement of stakeholders. A few projects reported active interaction with international organisations acting at the science-policy interface such as UNEP (United Nations Environment Programme), UNDP (United Nations Development Programme) or FAO (Food and Agriculture Organisation). In those cases, influence on the international environmental policy debate and a combined impact of the research cooperation on scientific excellence and policy support is likely to be expected (see also section 3.2.4.)

Structuring scientific impacts, creating critical mass

The successful acquisition of FP7-Environment funding was characterised by competitiveness; as the work programme was not designed to fund excellent science alone, excellence *per se* was not a determinant in project evaluation and selection for funding. Thus, FP7-Environment was more successful in supporting the creation of critical mass of good research than in creating the singular leading worldwide focus of excellence in a particular field. This was evidenced by the publication output.

Recommendations on research excellence

- An indicator and monitoring system should be established to evaluate the impact of financed projects on improving scientific excellence at the level of individual researchers, and at the level of scientific communities (see below), including, for instance, comparing the publications record of beneficiaries in a dynamic way, during/after and before funding.
- To exploit its particular strength as the leading transnational, large-scale research funding programme, the European Commission, through Horizon 2020, should emphasise its role in creating and consolidating large integrated research communities (*European Schools of Thought*) that focus on grand societal challenges with high level research.
- The European Commission should target the integration of scientific excellence (publication in high ranked journals) with procedures for high-level support to policy. Separating research activities that support policy from excellence oriented of poor support to policy. Requirements for policy based projects to provide commitment to maintain their legacy should be inherent in future Horizon 2020 funding.
- The Commission should collect reliable data on the R&D performance of national research programmes, including from third countries (e.g. US, Japan, BRIC). This would allow the cost-efficiency of the Framework Programmes to be benchmarked.

It was evident from the above assessment that FP7-Environment funding was a key support to the continued growth of research excellence throughout the EU. FP7-

Environment played a critical role in structuring research communities, at European and international level, supporting the attainment of excellence and maturity. The participation in international fora helped to structure research communities, sharing knowledge, overcoming fragmentation and avoiding duplication of funding. The funding for research was most effective when distributed on the basis of domain-specific excellence to teams of international standing, with a clear recognition of the need to develop critical mass. FP7-Environment provided an irreplaceable source of funding for Member State universities, in particular research-intensive universities, and provided a unique and highly competitive platform for international collaboration.

3.2.2 Innovation[60]

In the re-orientation of FP7-Environment's main priorities (in the context of the global economic crisis), the programme had to adapt its research agenda and management systems from its original approach (promoting excellent research), to also supporting industrial and social innovation. This had to be achieved without change to the FP7-Environment budget, structure, systems or processes. The focus on innovation and societal impact is continuing in Horizon 2020[61].

Within the FP7-Environment Work Programme, innovation became predominant in calls and topics from 2010 (see Figure 2). However, moving towards innovation also necessitates new methodology for allocating resources, different players (e.g. industrial participation and commitment), as well as innovation-oriented specific tools and expertise. Such rationale would help to decide how much money would be awarded to each area of potential innovation, and which (combinations of) actors and which phases of technology would be targeted. The same rationale would also supply the information to quantify financial instruments for the follow-up (e.g. nurturing fast-growing SMEs) at the end of the projects. Options for adoption of research and innovation (R&I) portfolio management models as used in industry are provided in Appendix X.

Under FP7-Environment, there was still a wide gap between managing public research and managing industry-based innovation research. The required new management culture and tools to support innovation were still weak. Despite these structural constraints, FP7-Environment obtained some relevant results related to innovation.

As innovation was not well covered by the FP7 project reporting systems, a survey was designed to estimate the present and future impact of the FP7-Environment programme on innovation. However, assessing innovation through the (present) results of FP7-Environment underestimates the actual outcomes and impacts. The projects that emerged from calls after their "reorientation" are mostly still ongoing and as such, their final reports are not yet available[62].

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[60] A detailed analysis of innovation under FP7-Environment, including other policy options, is provided in Appendix X.

[61] By comparison with its successor, Horizon 2020, FP7 initially concentrated more on science than on innovation. The official title of FP7 details activities *from research to demonstration*, while Horizon 2020 is "*the framework programme for research and innovation*". Innovation is a step beyond demonstration activities mentioned in FP7's title, and is in this context much closer to the market.

[62] A non-exhaustive, indicative list of some topics from FP7 Environment calls which emphasised innovation, and which projects were still running at the start of this ex post evaluation, shows the relevance of this observation:

- ENV.2011.3.1.9-1 Eco-innovation (part of the Eco-innovation Call)
- ENV.2012.6.3-1 Innovative resource efficient technologies, processes and services
- ENV.2012.6.5-2 Demonstration and exploitation of most promising prototypes and tools derived from European research activities
- ENV.2013.6.3-1 Turning waste into a resource through innovative technologies, processes and services
- ENV.2013.6.3-2 Eco-innovative demonstration projects

Innovation results: The "Innovation Survey"

The content of the European Commission databases (Respir) related to innovation are limited, probably because innovation was not a key priority of FP7 when the programme was defined. Reporting data do not allow the investigation of new products, services or methods introduced in the market or internal to the firm, or even the pre-commercial stages of innovations (e.g. pilots, demonstrations). It is therefore not possible to assess the actual and potential economic impact of innovations derived from FP7-Environment funding based on reporting data.

The GoE carried out an innovation survey among FP7-Environment project coordinators. The objectives of the survey were to:

(i) Collect basic information about the innovation output of FP7-Environment projects, both for typical (randomly selected) projects and for a sub-sample of 41 projects pre-selected by Project Officers (POs) based on excellence in innovation. The survey covered the following topics: Technology Readiness Level (TRL) achieved, type and nature of innovations, budget allocated, commercialisation data, factors of success, further investments obtained.

(ii) Assess the economic and resource efficiency impacts of such innovations.

(iii) To create an understanding of innovation in FP7-Environment for the benefit of innovation management in Horizon 2020.

The survey was conceived as a first step towards these objectives, with the understanding that an accurate assessment of the innovation output and impact was not possible at this early stage, as many projects were still running or project results were too immature to estimate their impact on innovation, but also because successful innovations need a considerable lifetime (e.g. patents have a lifetime of up to 20 years). The innovation survey methodology is presented in Box 7 and the questionnaire in Appendix XI.

Box 7: Innovation survey methodology

The survey sample was twofold:

– A sample "A" focused on 41 projects selected by Project Officers for their innovation potential. Most of these projects were already finalised or at an advanced stage.

– A sample "B", which size was 70 finalised or ongoing projects, selected randomly. Six of them were already included in sample "A"; their coordinator had to answer just once.

The sample "B" is statistically representative, with a theoretical margin of error of +/- 10.8% (confidence level: 95%). Its objective was to identify innovative projects outside the ones pre-selected by Project Officers.

The questionnaire was the same for both samples.

The surveys were implemented online by the European Commission between the 15/07/2014 and the 15/09/2014. Despite two reminders sent to coordinators, the answer rates were low:

– 15 responses to sample A (answer rate: 36.6%)

– 21 responses to sample B (answer rate: 29.7%,; confidence level: +/- 20.95 %)

Therefore inferences have to be considered with care. Estimates just provide an order of magnitude. Another caveat is the fact that, while the respondents of survey A refer to actual innovations (implemented or not yet), those interviewed in survey B are both ongoing and finalised projects – therefore the data include actual <u>and</u> expected innovations.

- ENV.2013.WATER INNO&DEMO-1 Water innovation demonstration projects

Intellectual Property Rights

According to project reports (Respir database, on 6/11/2014), the 212 finalised projects produced 21 Intellectual Property Rights (IPR) applications (including patents, trademarks, registered designs), including: 17 patents, two utility models and two "others". This represents 0.3 patent applications per €10 million of FP7-Environment investment, which while a crude measure, allows for comparison with other FP7 programmes (e.g. 2.8 patent applications per €10 million invested in the Energy programme, or 2.4 in the Nanotechnologies, Materials and new Production technologies one).

The figure of 0.1 IPR applications per project is below the Cooperation programme average (0.5). It is likely that the late orientation of the FP7-Environment programme towards innovation influenced this score. Most IPR applications (13) came from projects funded by the sub-programme ENV.3 ("Environmental technologies"), for example from projects: W2PLASTICS, MUSECORR, MIDTAL, MODELPROBE, SOILCAM, AQUAFIT4USE, FIRESENSE, CLEARWATER, UPSOIL, TYGRE, ZEROWIN, 3ENCULT, AQUAREHAB and NAMETEC. The three other IPR applications were produced by a single Earth observation project, EUROSITES. The multivariate regression presented in Appendix IX shows that the instrument and the number of private-for-profit organisations involved are the most significant explanatory variables; however, the model is not optimal.

In the innovation survey, projects were also asked about their IPR, in order to update the data provided in their final reports. The results[63] showed an average of 0.2 IPR applications per project, which is greater than the figure given in Respir, but below the Cooperation programme average (0.5).

Beyond IPR: Products, services, methods

Traditionally, IPR have been considered a proxy of innovation[64]. This vision is nowadays challenged. For instance, not all inventions are patented, while patents terms and legislation are sometimes commercially counter-productive[65]. In addition, there is currently a global explosion of patents, most of them without clear market value[66]. It is therefore necessary to go beyond IPR and collect data on new products, services and methods, implemented or not yet. The following table shows data about projects reporting actual or expected innovations.

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[63] Extrapolations from sample A. Data from the random sample B shown 0.5 IPR applications per project on average, but all applications come from a single project ("outlier"). It is therefore better not to consider this data.

[64] See Griliches, Z. (1990). "Patent statistics as economic indicators: A survey". *Journal of Economic Literature* 28, 1661–1707, at: http://www.nber.org/chapters/c8351.pdf

[65] Budish, E.; Roin, B.N. and Williams, H. (2013) "Do fixed patent terms distort innovation? Evidence from cancer clinical trials", National Bureau of Economic Research (NBER) Working Paper No. 19430. Cambridge, Massachussets, in: http://www.nber.org/papers/w19430.pdf

[66] See World Intellectual Property Organization (WIPO) statistics at: http://ipstatsdb.wipo.org/ipstatv2/ipstats/patentsSearch

Literature talks about a "patents paradox". Applications are constantly growing "despite the weakness of patents as an instrument for protecting innovation, documented in various surveys of innovators in a number of different industries and countries". (Hall, B.; Thoma, G. and Torrisi, S. (2007) "The market value of patents and R&D: Evidence from European firms". *NBER Working Paper* No. 13426, p.2. At: http://www.rady.ucsd.edu/faculty/seminars/2010/papers/hall.pdf)

Table 4: Innovation results

Survey	Percentage of reported innovations	Exploited innovations (%):			Total exploited (%)
		Commercialised	Internal to the firm	Other (e.g. public domain)	
A	80%	40%*	6.7%	6.7%	53.3%
B	40.5%	3.4%*	0.6%	10.2%	14.2%

(*) Includes an innovation commercialised and internal to the firm.

Principal conclusions from this table include:

– The percentage of actual and expected innovations is rather high, considering that innovation was not the priority at the beginning of FP7 and that most ongoing projects are still unable to report on this sort of outcomes.

– Two-thirds of respondents from sample A have already exploited at least one innovation, mainly commercially.

– Non-commercial innovation, like methods, processes or databases in public domain are rather widespread within FP7-Environment.

– The results from sample A show that Project Officers are key players in identifying potential innovators; their selection proved to be very insightful. The Commission should further use the skills of POs to identify in real-time those projects that display an innovative character, in order to provide further specific support towards exploitation (e.g. to find further private financing, to help with IPR issues).

On average, projects from sample A had a TRL 6.8, close to TRL 7 (i.e. system demonstration in operational environment, such as prototypes). However, TRLs varied between 3 (experimental proof of concept) and 9 (competitive manufacturing). Unsurprisingly, the average TRL attained in sample B is lower, 4.8 (almost 5, concept validated in relevant environment; e.g. industrially relevant environment in the case of key enabling technologies). It can be expected that, by the end of the ongoing projects which were funded in more innovation-oriented calls, TRLs reached on average will be essentially higher.

Types of innovations developed via FP7-Environment: Taking the 19 innovations declared in both samples A and B, 42.1% are processes, 36.8% are products, 10.5% are services, 5.3% cover all three, and an additional 5.3% are organisational methods. Some examples of innovations (exploited or not yet) are presented in Box 8.

Respondents were asked to define if the innovations on which they spent most of their budget belong to one of the following categories:

- *Core innovation*: low-risk, short-term, not creating new social behaviour, new markets or using new technology.
- *Adjacent innovation*: medium-risk, medium term, new market, largely applying existing technology base or based on existing behaviour of citizens.
- *Transformational innovation*: game-changing, breakthrough, disruptive: high-risk, long-term, creating entirely new products or services, based on new technology or new social behaviour.

Half of the respondents involved in innovations considered that they worked on an adjacent innovation, while 33.3% said they dealt with transformational innovations. Similar proportions apply amongst exploited (commercially, internal to the firm or other) innovations.

Assuming that respondents made the correct estimate, the majority of the innovation budget was spent on medium-high risk ideas, which requires a medium to long term period to be mature, but is potentially disruptive. This has implications

with regard to obtaining further funding, especially from private sources, to continue the research.

Box 8: Examples of innovations resultant from FP7-Environment funding:

Among the innovations supported by FP7-Environment, we find new process that improve recycling capacities in different areas:

– Sorting systems that improve the recovery of paper for recycling.

– Processes and technologies to recover high-purity polyolefins from complex wastes at low cost.

– Recovering of fines from a moist waste flow, in particular from crushed end-of-life concrete.

– Technology to eliminate persistent pharmaceutical pollutants in wastewaters.

There are also products, like:

– Capacitative deionisation systems for treatment of cooling water.

– Devices and algorithms for on-line and at the site water quality monitoring.

– Ultra-low noise "poro-elastic" pavement that reduces noise reduction like screens.

Other projects developed validation and assessment methods for technologies, including through standards, as well as (environmental) decision-support systems.

The survey also provides data on actual turnovers resultant from exploited innovations, sizes of the market, the possible market share and the number of years needed to reach it. This information is also relevant for obtaining further funding.

Projects that had already commercialised their innovation stated that they have obtained a turnover of between €50,000 and €90 million, with a median between €1 million and €3.5 million. Actual cost-savings in energy and raw materials are between €0.3 million and €20 million. There are however very few projects that were able to provide such data, but these examples show that FP7-Environment projects can implement commercial innovations even during their lifetime or a short time after the end of the project, obtaining a significant turnover.

All projects that had innovations in the market were already exporting beyond the EU. Exports represent between 40% and 100% of revenues coming from implemented innovations supported by the programme, indicating that those new products, services or methods are competitive in global markets.

However, projects dealing with innovations consider that they will need 4.6 years on average to reach a relevant market share, which varies between 1% and 50% depending on the project[67], with most of them under 10%. These market development estimates are realistic; they correspond with typical innovation deployment evidence[68].

The data collected allows a rough estimation of the economic and societal impact of the innovations supported by FP7-Environment (details of the calculations and assumptions are provided in Appendix X):

- The *potential* total market size (sales) and the *potential* total resources savings of the surveyed projects are about **€8 billion** and **€37 billion** respectively.
- These projects can generate around **€1.5 billion of sales** and **€7.5 billion of energy and raw materials savings** over their innovation lifetime (typically 20 years).

[67] Non-commercial (i.e. open domain) innovations are not taken into account here.

[68] See: Rogers, E.M (2003) *Diffusion of Innovations*. New York: Simon and Schuster. 5th edition.

- FP7- Environment as a whole could generate around **€7-20 billion of sales** and **€30-100 billion in terms of resource savings**.

(Note: these numbers are orders of magnitude, based on specific assumptions.)

All projects that exploited an innovation carried-out a technical assessment from the environmental point of view (e.g. a life-cycle assessment)[69]. This sort of analysis is very common in projects that are in advanced stages of implementing a commercial innovation: 83% of such projects did it. It represents a commercial asset, because resource efficiency can be demonstrated.

Continuity of funding is a key element to fully implement the innovation on which projects were working. Around 57% of surveyed projects dealing with innovation said that they had already secured commitments to ensure such continuity. However, only 29% of such commitments come from industry – in principle the main player to go to the market. The figure rises to 71% in sample A, which innovations are closer to market or already under exploitation.

Understanding innovation

A more detailed analysis of the survey results allows an improved understanding of those factors that lead to successful innovation, and what information at various stages of a project (i.e. proposal, execution, final reports) allow its anticipation.

The survey data show that IPR applications market implementation of the innovation (commercially or internal to the firm) do not correlate significantly. IPR applications are not a condition *sine qua non* to successfully innovate.

The most successful innovation projects in FP7–Environment generally allocated more than 50% of their budget to innovation. They always involved academic partners with SMEs and large enterprises. The innovation-related funding was distributed over the parties as 50% going to universities, 30% to SMEs and 20% to large enterprises (known as the "Golden Funding Ratio"). This confirms the preliminary conclusions on innovation and participation presented in section 3.1.

CSOs received a share of the innovation funding more rarely. However, all projects surveyed with successful market innovations collaborated with end users, who were in most cases included in the consortium. End users provide added-value as consortium partners if the call (or the proposal) looks for commercial innovation at the end of the project, and if the nature of the innovation is such that there is a clear advantage in integrating end users and partners, instead of as part of the external network of the project. If the project focuses on early stage research, or if end users do not need to contribute beyond being a testing ground, the presence of end users within the consortium should not be a requirement; this caveat should be kept in mind in the design of Horizon 2020 calls.

The main sectors that delivered successful innovations were waste and water management, including recycling technologies. Other areas covered included materials.

As stated, EC Project Officers were highly perceptive in their pre-selection of potentially innovative projects. The Commission and all actors involved in future funded projects would benefit form the establishment of effective communication channels to ensure a close follow-up of projects in an innovation character, in order to increase their economic and societal impact. Reference in the proposals to the reputation of participants in the field of innovation did not correlate significantly with successful implementation of results.

Innovation - outputs and impacts on growth and jobs

[69] A life-cycle assessment or similar constitutes a commercial asset, since it demonstrates the benefits of the new technology or method, especially in terms of energy or resource efficiency.

While technology development was initially a secondary goal of FP7-Environment, the programme nonetheless has produced relevant innovation results. Projects dealing with innovations typically present TRLs between 5 and 7. The majority of innovations developed were transformational ones, with medium-high risk.

While the estimates of **€1.5 billion of sales** and **€7.5 billion of energy and raw materials savings** (and others above) are in broad orders of magnitude, they indicate that the programme gave value for money in terms of innovation. These impact data can be considered as impressive but, in terms of economic and societal impact, they remain below the potential of such a programme and investment. The shift of the FP7-Environment priority-setting towards innovation was not accompanied by new budgets, implementation tools, capacities or procedures. For example, the information on innovation collected through reporting and indicators to follow-up projects within the programme was weak. The low rate of industrial participation is also a challenge to obtaining insights on results and impacts.

In 2009-2010, the Commission was not equipped with an adapted methodology for allocating resources and expertise or for developing specific tools. There was a low participation rate of industrial players and innovative SMEs. The radical re-orientation of priorities towards innovation would have benefitted from a new system for managing projects and the programme, for example through the adaptation of concepts from the proven R&I portfolio management models used in industry. Exploitation of innovation activities was almost completely delegated to projects, with little attention to follow-up and support from the Commission, except at micro level, by individual Project Officers.

Recommendations on innovation

- To increase its impact in terms of innovation, Horizon 2020's SC5 should strengthen the links with industrial organisations that are very active in R&D. Such organisations have the capacity to better exploit results from research and innovation actions. The Commission should support a participation balance between innovative SMEs that are capable of developing advanced technologies, and large enterprises that have the capacity to integrate such innovations and exploit them at large scale.
- In order to attract more relevant industry participants into innovation projects within the future environment themes of Horizon 2020, the evaluation process needs to be critically revisited, putting more emphasis on targeted objectives and a clear allocation of resources, commitment of partners for follow-up investments and project legacy, with clear procedures for the protection of sensitive information.
- A further involvement of NGOs and CSOs would be important to strength the links between the R&I community and society, thus increasing the impact of projects. Involving CSOs and NGOs (as partners or in external networks) could also enhance the innovation potential of projects, anticipating societal reactions to technologies and increasing the understanding of citizens (final users) needs and wishes.
- Involvement of financial organisations is essential to exploit innovation. The Commission should strength the links with such organisations, to understand their wishes and expectation and facilitate access to further private funding to good projects.
- The Commission should be equipped with reliable sectoral data on (potential) markets, in order to develop its innovation priorities. This information would allow a detailed analysis of economic and societal impacts of technologies and other innovations promoted by the calls.
- Increased efforts should be afforded to improving the coordination between funding of research and innovation and regional funding, so that there would be a dual focus on supporting existing excellence in science and building excellence in regions where performance is less strong, usually as a result of

a disadvantaged economic and political history. FP7-Environment developed technologies and other innovations in areas like water, recycling or waste, which could be applied at large scale through EU's regional funds. This would increase the societal impact of the programme.

The Horizon 2020 Impact Assessment report calculates that, across all Member States, every euro of funding from the programme will lead to an increase in industry added value of €13[70]. This return of investment should be confirmed ex post, starting with the economic impact of FP7.

FP7-Environment has paved the way for the Societal Challenge 5 (SC5) of Horizon 2020 as its successor, adapting the programme orientation towards innovation and the creation of sustainable economic value.

3.2.3. Cross-cutting themes

This section addresses the broader impacts and contribution of FP7-Environment projects in aspects related to the European Research Area (ERA) including: gender issues, mobility, international cooperation, open access, issues related to early stage or senior researchers and issues associated with the concept of "science with and for society".

Gender issues

Gender equality and gender mainstreaming in research are among the priorities of the ERA, as stated in the Communication "*A Reinforced European Research Area Partnership for Excellence and Growth*"[71]. For the purpose of this review, gender issues were examined at three levels:

- At the proposal writing stage, where there is usually a section in the template asking if and what gender issues the proposal raises/addresses;
- At the proposal organisation level, where attention is paid so that the composition of the research team is balanced in relation to gender;
- During the execution of the project, where the research and associated activities may have been oriented to address gender issues or impacts on gender.

Based on the information available in the documentation associated with each of the 90 projects reviewed, the monitors identified the extent to which, and how, the projects addressed gender issues in any of the above levels, in a direct or indirect way.

In the majority of projects[72] the research itself did not have any implications on gender issues. However, gender issues were generally taken into account by projects in terms of pursuing a gender balance in the composition of the workforce. Most of the projects reviewed managed to achieve a gender balance of 35-50% in the total workforce of the project, indicating an overall, balanced participation between men and women. This proportion dropped to around 25-35% when considering women in leading posts such as work-package leaders or scientific managers. This indicates a clear shift in balance in relation to leadership roles; the

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[70] Commission Staff Working Paper Impact Assessment accompanying the Communication from the Commission "Horizon 2020 – The Framework Programme for Research and Innovation", COM(2011) 808 final, in: http://ec.europa.eu/research/horizon2020/pdf/proposals/horizon_2020_impact_assessment_report.pdf

[71] COM(2012) 392 final, at: http://ec.europa.eu/research/era/gender-equality-and-gender-mainstreaming_en.htm

[72] It is not possible to specify actual percentages here because data on gender statistics was not provided in a uniform and comparable way in the project review reports. However, this is covered by the workforce statistics that were provided by the Commission about the total of the FP7-Environment projects with a processed final report (and not only the projects reviewed by the monitors). This data is presented and discussed in the tables that follow.

ratio of males to females increases with seniority and as the management roles increase; males held the majority of leadership roles. The proportion of female PhD students was usually greater than the proportion of male PhD students; similarly for staff categories in less demanding posts. This dominance of females in the more junior levels in the professional pipeline may support the increase in women in leadership roles in the future.

However, there were some notable exceptions, as in the case of IMPRINTS and CLIMATEWATER (Box 8).

Box 8: IMPRINTS and CLIMATEWATER, examples of gender balance

IMPRINTS (*IMproving Preparedness and RIsk maNagemenT for flash floods and debriS flow events*) employed 74% females. This share exceeded 75% with regards to experienced researchers. At the organisational/leadership level, the team was very well balanced with five out of the 10 work package leaders being female.

CLIMATEWATER (*Bridging the gap between adaptation strategies of climate change impacts and European water policies*) achieved a balanced composition of the consortium at all levels: 50% of work package leaders, 44% of experienced researchers, 66% of PhD students and 60% of "other staff" were female, yielding an average of 53% of female employment.

Overall, the trend whereby the proportion of females was usually greater than males only in relation to more junior posts is confirmed by the workforce statistics for the total FP7-Environment theme. As the following table shows, while the overall female staffing level reached 40% of the total workforce, the proportions of female scientific managers, work package leaders and experienced researchers dropped to around 35%, while increasing to 50% or more in the case of PhD and other staff. In comparison with the average percentages for the total of the Cooperation programme, the FP7-Environment theme presents slightly increased proportions of female staff, in the range of 3-6 percentage points greater, across all staff categories.

Table 5: Selected workforce statistics for the FP7-Environment Theme

	Environment (and Climate Change) theme*	Total Cooperation Programme*
Female reported workforce	40%	38%
Female scientific managers	34%	29%
Female experienced researchers	35%	35%
Female PhD students	50%	46%
Female work package leaders	33%	29%
Female other staff	49%	44%
Female add. researchers recruited	46%	45%

(*) Shares of total Source: EC's Respir database. Extraction: 6/11/2014

In relation to specific gender aspects, such as developing gender equality action plans or implementing an equal opportunity policy, percentages drop significantly (Table 6). Further efforts to implement specific actions for improved work-life balance, or cases where gender dimension was associated with the research

content, were even fewer. This raises some concerns about the degree to which the gender dimension in the research content itself receives the attention it deserves.

While the majority of the projects achieved the 40% target for overall minority gender representation, only 17% of the projects set explicit targets to achieve a gender balance. In some cases the partners had intentions to do so, but did not deliver as envisaged. For example, the ICE2SEA consortium aspired to elaborate a gender action plan, and provided advice to project partners on gender mainstreaming issues, with particular emphasis on equal opportunities in new research positions, avoidance of using inappropriate language/stereotypes, etc. However, the ICE2SEA project did not achieve the Helsinki Group target of 40% for participation of females in senior roles (24%) and the overall workforce (28%).

The section about gender issues in the proposals template represented a good step towards enhancing gender balance in project consortia. However, not much more than that has been achieved. Gender equality actions and other relevant activities are taken up only in the minority of projects.

Table 6: Gender aspects reported for the FP7 Environment Theme

	Environment (incl. Climate Change) theme*	Total Cooperation Programme*
No. of projects with specific Gender Equality Actions	28%	26%
Design and implement an equal opportunity policy	17%	20%
Set targets to achieve a gender balance in the workforce	16%	17%
Organise conferences and workshops on gender	2%	4%
Actions to improve work-life balance	15%	15%
No. of projects where gender dimension was associated with the research content	16%	15%

(*)Shares of total number of projects with a gender aspects report. N=212 for Environment; N=1909 for the Cooperation Programme)
Source: EC's Respir database. Extraction: 6/11/2014

Early stage and senior researchers

Projects were also examined in terms of benefits to early-stage researchers. Benefits to early-stage researchers may have been gained in a number of direct or indirect ways. For example, a project may have provided for the execution of PhD or post-doc research, or the resources available from the project may have led participating organisations to hire early-stage researchers.

Most of the projects reviewed stated that a number of PhD students were involved. Projects recruited more than 1,700 new researchers, including PhD students, and promoted the assignment of thesis topics. This number ranged from five PhD theses and two BSc theses delivered in the case of IMPRINTS, to more than 20 PhD researchers in the case of HITEA and CONGRESS, and around 30 PhD students (SECOA, WISER or AQUAFIT4USE).

Early-stage researchers represented most of the staff newly recruited to a project; as stated above, females constituted the higher proportion of newly recruited staff. Based on the overall workforce statistics for FP7-Environment, the additional

researchers recruited formed 11.8% of the total reported workforce, which does not differ greatly from the total average for the Cooperation programme (12.6%). Out of the 1,284 additional researchers recruited to FP7-Environment, 603 were female (47%).

The inclusion of senior researchers was also considered by the Group of Experts. In the absence of any relevant data[73] however, this was judged mainly based on the expertise level and age. In many cases seniority of expertise was predominant, while there were some projects where the number of senior researchers was around the same as that of junior researchers. However, given the scarcity of cases for which this information was available, no sound conclusions can be drawn.

Researcher mobility

Impacts on mobility were examined in terms of enabling mobility of researchers between institutions (such as academic institutions or research organisations) or even between sectors, i.e. from an academic organisation to industry.

Researcher mobility was not among the main aims of the projects *per se*. However, there were cases where projects organised study visits and exchange programmes between the different participating institutions (COPHES, LIVEDIVERSE, W2PLASTICS, ENNAH). In addition, training events or summer schools were organised (ORCHESTRA, ICE2SEA); there were also cases where researchers moved between consortium partners (CCTAME, MOTIVE) with relevant benefits in their careers.

Continuity of research

Continuity of research may be achieved in a number of ways. The networks of individuals or organisations formed through collaboration in specific projects may continue to collaborate beyond the project duration. Several projects actually resulted as a continuation of prior collaboration. This was the case for the KNOWSEAS project, a successor to a series of Framework research projects that began with the ELOISE programme (established in 1994; first supported through the Framework Programme by FP4 MAST and Environment and Climate). Other projects were the initiators of fruitful collaborations that took the form of future research projects or more tangible forms of exploitation of research results produced.

EPOCA paved the way for a lasting legacy on ocean acidification research, through the successive and ongoing related projects MedSeA, BIOACID and UKOA. These projects included several EPOCA partners and built on the EPOCA project.

Seven of the partners of the ICE2SEA consortium continued collaboration in the Ice-Arc project (Ice, Climate, Economics – Arctic Research on Change), funded under the FP7 2013 Environment call continuing research in the thematic area of impacts of climate change in the cryosphere, and particularly the Arctic region.

MOTIVE was built on a long lasting collaboration of some of the partners as they had been previously involved in FP6 projects (EFORWOOD, ECOCHANGE, NoE EVOLTREE). MOTIVE partners continue to actively collaborate in publications and in preparing a number of research proposals for Horizon 2020 based on MOTIVE results. In addition, the framework of the Adaptive Forest Management toolbox produced by MOTIVE is being used in a follow-up project within FP7 (ARANGE), while the MOTIVE case study in the Netherlands continues in the FP7 project INTEGRAL. FUNDIVEUROPE, another FP7 project that is still ongoing also uses the toolbox developed under MOTIVE as a framework.

Continuity of research teams very often led to excellent results. Projects such as EPOCA, HERMIONE, WISER and ICE2SEA obtained impressive publication records, in

[73] The workforce reports do not include any data on senior researchers.

high ranked journals. Knowledge creation is a cumulative process; working in stable teams helps to refine findings and improve the quality of publications. Continuation of collaboration in research may go beyond preparing papers for publications or funding applications under research funding programmes such as Horizon 2020. Exploitation of the results, although not usually with concrete outcomes within the lifetime of the project, has also been the object of continued collaboration. Noteworthy examples include W2PLASTICS and SAFELAND.

Box 9: W2PLASTICS and SAFELAND: Continuity of research towards innovation

In W2PLASTICS (*Magnetic Sorting and Ultrasound Sensor Technologies for Production of High Purity Secondary Polyolefins from Waste*) the private partner UMD in collaboration with TU Delft will continue research with own funds or Horizon 2020 to add additional innovations and technologies to the basic MDS technology developed. The company has employed two of the PhD graduates who completed their doctoral studies within W2PLASTICS. This ensures that research on this topic will continue further for industrialisation of the results.

In SAFELAND (*Living with landslide risk in Europe: Assessment, effects of global change, and risk management strategies*), the regional landslide hazard and risk zonation methodology developed has been used in several national case studies (Indonesia and El Salvador) for UNISDR. In addition, the Norwegian Water Resources and Energy Directorate, a SAFELAND end-user, provided supplementary funding and went further to build an early warning system for rainfall-induced debris flows in Norway based on the models developed in SAFELAND.

Supporting continuity also contributes to the maturity of research communities (see section 3.4.1). The counterbalance is the risk is that it would make the FP7-Environment programme a closed club, unable to open to new partners (e.g. other researchers, other countries, other R&D traditions, other types of participants such as industry or CSOs). Both the participation data presented in section 3.3 and the review of projects suggest that this was not the case within FP7-Environment.

Science with and for society

Interaction with society can take many different forms, ranging from raising awareness actions to training and even empowerment of societal stakeholders. Actions towards raising awareness include for example science fairs and exhibitions, articles and interviews in the popular media, and summaries of project results presented in plain language available on websites and widely distributed. Widespread training activities may be of relevance in certain projects, such as those focusing on guidelines on what to do in emergency situations (e.g. fires or floods). Such training activities may include visits and presentations to schools and other education institutions, and / or development of curricula.

For example, ICE2SEA engaged with society through the popular press, non-specialist magazines, television coverage and video production. IMPRINTS raised awareness through workshops, webinars and training courses, with particular care to reach a wider audience through the production of dedicated audiovisual material on different aspects of flash flood risks and management, and the contribution of EU FP7 research in enhanced disaster preparedness and risk management. HERMIONE, in collaboration with European Environment Agency (EEA), produced a collection of Eye on Earth-based Map Books with case studies that are highly appealing to a lay audience and are freely available on the internet (beyond lifetime). Furthermore, HERMIONE organised student training workshops and produced the "Message in a Bottle" book, targeting children, three interactive learning modules in the form of tutorials, and also a large number of short video clips about pelagic and deep-sea assemblages.

Certain projects might also be oriented towards empowering societal organisations by for example engaging them as core partners with a primary role, rather than that of an end-user. However, the participation of "other" organisations (including

NGOs, foundations, etc.) as mentioned in Section 3.1 was limited to 3% of total participants. For a research theme of high social interest and relevance (as FP7-Environment), and considering that changing social attitudes and recent concepts such as co-creation and co-delivery of solutions play a crucial role in dealing with this grand challenge, this figure should be considerably higher. "End-users" are usually involved at the later stages of a project, being among other groups in the target audience of the project's wider dissemination activities.

An outstanding project worth noting is CSOCONTRIBUTION2SCP.

Box 10: Science for modifying behaviours: CSOCONTRIBUTION2SCP

CSOCONTRIBUTION2SCP (*Partnering to Enhance Civil Society Organisations' Contribution to Research in Sustainable Consumption & Production*) was in essence a capacity building and support tool to assist civil society organisation (CSOs) link with the scientific organisations in promotion of sustainable consumption and production traditions. As a result of the project the "SMART CSO platform" was created representing the community of practice of civil society organisations, academics and funders united by the idea of promoting synergies between CSO and research activities. The SMART CSO platform is still operating after the end of the project based on donations and support from Greenpeace and Charles Leopols Mayer Foundation. The project enjoyed strong representation of SCO networks while engaging SCOs/NGOs, changing consumption and production patterns, and introducing new more sustainable behavioural traditions have been at the core focus of the project.

Open access and transfer of scientific knowledge

Open access and transfer of scientific knowledge is gaining increasing importance in the discussions about the European Research Area. It is explicitly mentioned in the ERA principle in relation to "Optimal circulation, access to and transfer of scientific knowledge"[74]. Open access may refer to scientific knowledge, data as well as infrastructures. At the output level the projects may explicitly mention a primary focus on open access principles for the dissemination of produced knowledge and data, or project activities may have been based on the pre-condition of open access to existing infrastructures (facilities, data-bases, etc.) or project activities may have aimed at creating (new) open-access infrastructures. At the impact level, the content of the research might have been directed to facilitate or enable adoption of open access principles in various settings, including harmonisation and opening up of databases, definition of criteria for sharing infrastructures, etc.

The projects reviewed provided examples mainly of the first group (output level). The majority of projects followed open access principles in relation to publication of papers, reports, etc. However, not all the papers were published in open access journals, the main reasons being prohibitive publishers' licensing agreements, high costs of open access publishing, or commercialisation purposes. Open access to publications is compulsory under Horizon 2020 and the support provided to cover extra costs is considered a positive step in the direction of further promoting open access.

There have been fewer cases for open access to data, databases, tools, etc. For instance, the Adaptive Forest Management toolbox produced by the MOTIVE project is open source, while they also chose to publish some of its medium impact research in open access journals such as PLoS ONE and Ecology & Society. In the COMBINE project, the lead partner established institutional repositories whereby all COMBINE publications were open access within six months from their publications. A large proportion of the model-data produced by COMBINE simulations are also available on the public CMIP5 archive, and are thus available to the international scientific community for analysis. MarineTT (CSA) provided open access to all deliverables including information contained in the project's database and knowledge transfer methodologies.

[74] http://ec.europa.eu/research/era/optimal-circulation_en.htm

EUCHIC contributed to open access and transfer of scientific knowledge by producing the EUCHIC guidelines in 13 languages, which can be utilised to apply the CHICEBERG protocol on a wider scale. In addition the project developed a standardised documentation methodology for Cultural Heritage monitoring and preservation which is openly accessible.

There is no precise information about the actual impact of open access actions. However the review of 90 projects showed that some preferred not to follow an open access policy, in order to not challenge the possibility of commercially exploiting their results[75].

In contrast, at least one project (WASHTEC) opened public domain innovative processes to validate water and sanitation technologies, which are currently used in Europe and Africa. This is an interesting case of non-commercial innovation.

Internationalisation

As with the entire FP7, the FP7-Environment work programme was explicitly designed to enhance Europe's competitiveness and global research lead, through international cooperation. The prioritisation of international cooperation increased during the lifetime of FP7-Environment, supporting enhanced efficiency in research and the development of a strategic approach[76].

The FP7 objectives for international activity included to[77]:

1. Support European competitiveness through strategic partnerships with third countries in selected fields of science and by engaging the best third country scientists to work in and with Europe;
2. Enhance the production of knowledge and scientific excellence by enabling European universities, research institutions and firms to establish contact with their partners in third countries, thereby facilitating access to research environments outside Europe and promoting synergies on a global scale;
3. Address specific problems that third countries face or that have a global character, on the basis of mutual interest and mutual benefit.

Benefits from international collaboration were particularly pronounced in the review reports of the 90 projects. In the vast majority of cases, reviewers agreed that participation in the projects enlarged the international networks of the participants. There were also several cases where this collaboration extended beyond the EU borders.

The international European and Asian cooperation has been fundamental in ISSOWAMA connecting European partners with counterparts from Bangladesh, India, Cambodia, Thailand, China, Vietnam, Indonesia and the Philippines. In ORCHESTRA the cooperation across European countries was important as they face the same legislation (REACH). Nevertheless, the project has collected the experience of countries such as the US and Canada as they have a broad experience in using in silicone methods to evaluate the toxicity of chemicals. In addition, developing countries have shown interest in the research conducted and contacts were made with scientists in India, Thailand, Korea, Brazil and Argentina. The international collaboration under ICE2SEA enabled the conduct of research in Antarctica, the Arctic and Greenland, and in Chile. The CLUVA project facilitated collaboration between EU and African Universities, while POEM reached out to Chinese and Indian institutions. LIVEDIVERSE worked with societal organisations,

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[75] The review shows that some projects see open access and (commercial) innovation as contradictory concepts. Indeed sometimes open access is considered as a major objective of the project, and (commercial) exploitation is not even seen as an option.

[76] Communication from the Commission (2012) *Enhancing and focussing EU international cooperation in research and innovation; a strategic approach*. COM(2012) 497, at: http://ec.europa.eu/research/iscp/pdf/policy/com_2012_497_communication_from_commission_to_inst_en.pdf

[77] http://cordis.europa.eu/fp7/public_en.html

NGOs and local residents in target communities in India, South Africa, Vietnam and Costa Rica. SAFELAND included international collaborators and advisers from China, India, USA, Japan and Hong Kong.

In some instances, international cooperation actions are linked with larger EU policies. For example, during the 10th Anniversary Summit of the Barcelona Process in 2005, the Euro-Mediterranean Partners committed to increasing efforts to substantially reduce the pollution of the Mediterranean by 2020 in what became known as the "Horizon 2020 Initiative" (H2020). This H2020 Initiative was endorsed during the Environment Ministerial Conference held in Cairo in November 2006 and is now one of the key initiatives endorsed by the Union for the Mediterranean (UfM) at its launch in Paris in 2008.

FP7-Environment contributed directly and indirectly to the H2020 Initiative. FP7-Environment's 2010 Work Programme included a topic which addressed Mediterranean Partner Countries (MPCs)[78] aimed at preparing the ground for the implementation of Best Available Techniques (BAT), with the overall objective of reducing the "pollution leakage" due to the displacement of polluting industries. A number of other projects supported activities relevant to the depollution of water, including monitoring and assessing the quality of water and marine ecosystems. Some of them were centred on the Mediterranean region, while others are partially or indirectly relevant to the specific region under consideration. The following FP7-Environment projects were explicitly relevant to the Mediterranean region: BAT4MED, MARSOL, demEAUmed, PERSEUS MEDSEA, PEGASO and MEDINA. These projects included technical assistance (e.g. BAT4MED) and technological development and demonstration; MARSOL (on water management) is also a good example of continuity of research and innovation actions.

Internationalisation of research, including beyond the EU-EEA boundaries, and ensuring continuity of R&D activities, were two major impacts. Such continuity was, in fact, a key contributory factor to scientific excellence and innovation results. It is evident from the above that the architectures of international collaboration in FP7-Environment are complex, variable and context specific. A thorough assessment of the impact of internationalisation on European based research merits further investigation.

Conclusions on cross-cutting issues

Although gender issues are usually considered in achieving a balance in the research teams, there is still scope for improvement in relation to several aspects of gender issues in research. The FP7-Environment research projects enabled different types of mobility ranging from conference visits and networking to exchanges across academic partners enhancing the researchers' careers. Continuity of research is common and highly relevant mainly in terms of furthering research in the same or related areas, rather than in exploiting the research results. Society engagement is still at the level of raising awareness and training, even though the field of environmental research offers opportunities for more active engagement. Following open access principles in conducting and publishing research seems to face several challenges in practice, ranging from high publishing costs to commercialisation purposes, to hindrances in accessing existing research results, or to conflicting requirements in researchers' reward systems. Internationalisation of research is a highly relevant impact from FP7-Environment projects. The dimensions of European added value usually documented in FP7-Environment projects'refer to the need for international collaboration in dealing with environmental challenges, which are cross-national by default, as well as the need for capacity building and development of critical mass, and for harmonising databases, procedures, measurements, models, etc.

[78] ENV.2010.3.1.4-1 Integrated Pollution Prevention and Control of industrial emissions in the Mediterranean region.

Recommendations on cross-cutting issues

- As gender issues are important whatever the research area, it would be useful that the proposers are informed about what kind of horizontal activities promoting gender and better work-life balance can be organised as side actions in their projects. This could be incorporated as part of their dissemination strategy.
- Engaging society has to go beyond the "end-user" perspective. In the field of environment where society's behaviour and concerns are crucial for the success of mitigation actions, it is important that society is actively engaged and empowered through inclusion from the early stages of the research. Relevant NGOs, societal organisations and movements like 'citizens' scientists' need to be considered more seriously in this respect.
- Open access to knowledge needs a well-thought out strategy addressing existing challenges. This strategy needs to allow for a differentiated approach in open access depending on the research areas at stake. At the same time however changes in the academic reward systems as well as open access policies of publishing houses need to be promoted if a real boost in this principle is aimed at.
- Internationalisation may have to take a more focused approach in the future in view of the global challenges-driven approach taken up in Horizon 2020, which calls for the appropriate partnerships with relevant countries and regions depending on the specific challenge area in question.
- Following-up on the research results is not only important in the cases where there is high potential for commercialisation. It is also important in other cases where for example harmonised measurement procedures need to be adopted at the national / regional level or where recommendations need to be integrated in relevant policies. This will help establish and/or strengthen European added value of FP research, which in the framework of public accountability and in view of the challenge-orientation in Horizon 2020 emerges as even more important.

3.2.4. Support to EU policies

Context

Civil society increasingly seeks access to output from publicly funded research; demands from domain-specific stakeholders for results from relevant areas (e.g. climate change) are also increasing. The development of informed policies to address global environmental challenges requires investment in policy-based research, whose outputs then contribute to the policy cycle. Monitoring and analysis of policy-oriented research provides qualitative and quantitative information, which in turn supports the further design, implementation, evaluation and transnational coordination of globally relevant, public, evidence-informed policies.

It is widely agreed that European and international policies that address long-term issues such as energy, climate change, and environmental sustainability, are most effective when they are informed by proven scientific knowledge and expertise. While outputs from EU policy-relevant research may impact on the policy cycle, there is no guarantee of such impact. Extending the impact of EU funded research requires effective transfer of knowledge, which is built on external engagement, beyond the specific research domain involved. As a consequence, there are increasing pressures on European research funding programmes to implement more integrated methods to measure not only research performance *per se*, but also the contributions, effects and impacts of research output on policies.

To secure the influence of research output requires engagement with a diverse mix of stakeholders (e.g. industry, NGOs, scientists and policy makers) in flexible modes of interaction and dialogue, essential to maximise the impact of research and its translation for benefit to society. Research discussions continue to self-organise into "knowledge communities", on global (in the case of climate change,

Earth observation, etc.) or regional (in the case of biodiversity) scales. The EC has an important role in engaging and contributing to this evolving landscape and where possible providing a platform for this debate to happen, addressing issues of global importance. This includes facilitating the engagement with business, government and policy makers towards supporting them to develop sustainable scientific solutions for both private and public good.

One of the main objectives of FP7-Environment ("*To promote the sustainable management of both the man-made and the natural environment and resources*") was to increase knowledge of the interaction between the climate, the biosphere, ecosystems and human activities. The FP7-Environment calls were specifically designed with the expectation that the insights and knowledge derived from the resultant research output would inform the enhanced development of new policies and solutions to address global environmental challenges. The intention was that these policies would then become more effective, efficient and equitable, as well as sustainable from an economic, environmental and societal perspective.

FP7-Environment research output was expected to provide high quality, science-based insight to inform the EU's policy cycle, including anticipating and understanding emerging challenges, supporting EU institutions at the science-policy interface. The output would inform debate and decision-making in government agencies and influential bodies nationally and throughout the EU Ideally, such research output would provide a worldwide reference for the use of scientific evidence to support the policy making cycle, thus assisting in defining future policy agenda priorities. The insights and knowledge derived from the research findings would then inform the development of new, more effective, efficient and equitable policies, which would be sustainable from an economic, environmental and ethical perspective.

Scientific output to inform effective EU policies

Measuring scientific performance for improved policy making is an inexact exercise; in the context of the report presented here, it involves the evaluation of collaborative initiatives between policymakers and researchers in developing strategies to support evidence-informed policy addressed through the FP7-Environment calls.

While the relationships between science, technology, government and society continue to evolve, there are fundamental differences between the objectives of researchers and those of policy makers. The obligations, incentives and institutional structures that characterise research performing organisations (universities and institutes) differ from those of the policy landscape (governments, agencies, NGOs). Policy makers operate within short timeframes by comparison with those of researchers; they frequently want brief synopses that can provide insight into their immediate policy problems. In contrast, research activities are constrained by the need to secure grants and publish in high quality journals. The time frame in which researchers operate – from preparing a proposal to submitting a final report – may take five years (or more when waiting for the development of a relevant call). Thus, the timing of policy makers requests rarely coincides with the timing of research outputs. In adapting from their training, which emphasises careful consideration of the identified problems, scientific researchers often find that responding to the more immediate demands of policymakers are unrealistic. Furthermore, the needs of policy makers are primarily inter- and trans-disciplinary by nature; interdisciplinary research is often considered to be high-risk by the research performing communities; academic frameworks that assess research excellence (and thus impact on career progression) are often discipline specific, which curtails the incentive for researchers to undertake interdisciplinary research.

Ideally, research output would produce tools to support the development and implementation of policy. In reality, the impact of research on policy is often

indirect; it generates original knowledge and/or facilitates knowledge exchange and mobilisation[79]. To counterbalance this, policymakers such as the EC's DG Environment often make use of other sources of evidence, so-called "knowledge brokers", by commissioning studies from specialist consultancies, and/or working with EC's bodies like the Joint Research Centre (JRC) and the European Environment Agency (EEA).

FP7-Environment funding calls were developed with specific policy-related objectives. The resultant large increase in research output in itself presents challenges with regard to how the output can be harnessed to support policy, including how to:

- **Support decision-makers to get an overview of the existing evidence** in a particular field when it is scattered amongst different databases, journals, websites etc.
- **Develop syntheses of output** so that it is in a format which is useful and accessible for a non-technical audience
- **Identify evidence gaps**, which are then **prioritised for future research** funding.

Thus, the research community can extend their sphere of influence not only by ensuring that research output is accessible in a format that is useful for policy decision-making, they can also support an efficient and strategic approach to the prioritisation of future funding for new research that is identified from gaps in the existing evidence base.

Specific policies addressed in FP7-Environment

The Council Decision 2006/971/EC on the Specific Programme "Cooperation"[80] defined that one of the functions of the Theme Environment (including Climate Change) was *"policy support to the Union and Member States".*

There are several EU policies, strategies and global obligations with direct implications for the areas of research that were funded by FP7-Environment (see Appendix XII). As stated FP7-Environment represented a regular investment in policy supporting actions, totalling between €100 million and €140 million per annum (with the exception of 2010 and 2011, see Figure 2), with an increase (from FP6) in the number of CSAs supported.

Outputs from FP7-Environment research were expected to contribute to informing the EU's approach and adherence to international commitments, including: the United Nations Framework Convention on Climate Change; post-Kyoto and Montreal protocols and initiatives on greenhouse gas emissions; UN Conventions (e.g. on Biodiversity, Desertification); the Intergovernmental Panel on Climate Change (IPCC); the Group on Earth Observation (GEO) initiative, as well as the EU's own environmental initiatives, and the EU Health Policy. Sustainable development (a core policy of the EU, as stated in article 11 of the Treaty on the Functioning of the European Union[81]) was also expected to be enhanced by research output from FP7-Environment; the EU's Sustainable Development Strategy reaffirms the importance of assessing the impact of a policy, where social, environmental and economic dimensions are evaluated in a balanced way.

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[79] A good example of this is the recent European Commission's public consultation on policy options to optimise water reuse in the EU, managed by DG Environment. The background document is based on two reports drafted by a consultancy (TYPSA), which makes extensive use of the information and analysis done by the FP5 project AQUAREC, finalised in 2006.

[80] Council Decision of 19 November 2006 concerning the Specific Programme "Cooperation" implementing the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007 to 2013). No. 2006/971/EC.

[81] Article 11 of the TFEU: "*Environmental protection requirements must be integrated into the definition and implementation of the Union's policies and activities, in particular with a view to promoting sustainable development*."

In the case of Earth observation (EO) research, FP7-Environment calls for EO proposals were specifically addressed towards the establishment and development of the Global Earth Observation System of Systems (GEOSS), with funded EO projects increasingly integrated into the GEOSS. GEOSS is a programme of GEO (the Group on Earth Observation: an intergovernmental organisation of 89 member countries [including governments of USA, China and South Africa] and the European Commission [one of the four co-chairs of GEO], which together develop projects and strategies on Earth observation research priorities and infrastructure investment). This aspect of FP7-Environment, with its global range of potential impacts, is the subject of a separate dedicated review[82] (see also 3.2.5 below re EAV).

Conservation and enhancement of cultural heritage was also an integral part of FP7-Environment. Support to research on environmental and cultural heritage preservation technologies adopted a systems approach aiming to integrate all components of the process while taking into account external factors, thus helping to decouple growth from resource depletion.

Policy implications of the projects reviewed

This *ex-post* evaluation considered how FP7-Environment projects influenced the policy cycle (such as how environmental policy decisions or changes to legislation, regulations or guidelines may have been stimulated or informed by research output and evidence). The review of 90 projects provided evidence of varying levels of adherence to (and awareness of) the policy objectives behind the specific calls (and their expected impacts in the context of the core objectives of the FP7-Environment).

The role of research in informing evidenced-based policy, and the responsibility of project consortia to deliver information in a policy-relevant manner (in accordance with the call's objectives), were not always easily incorporated within the focus and delivery of domain-specific research. Principal tangible outputs that would meet with the needs of policymakers, such as syntheses or policy briefs, were not widely produced (or widely disseminated). There was little evidence of the use of tools such as evidence gap maps, which would make evidence more readily available to users.[83]

Appendix XIII provides summaries of those projects considered by the GoE to be exemplars in providing policy outputs and impacts of direct relevance to the programme calls. With the exception of some exemplar projects, including projects run by mature consortia (with evidence of evolution from pervious FP projects), few projects addressed efforts to organise national policy dialogues within partner countries or at EU level.

Research output feeds not only into environmental policy cycles, but also into those policy cycles that establish research priorities in structuring future research funding programmes, at both national and EU levels, as well as for infrastructure investments. This in turn supports the long-term sustainability of research domains and maintains critical mass of teams, enhancing capacity and continuity of specific competencies. With the exception of the more mature consortia (for example in domains such as climate change and marine environment), the potential for the research community to adopt this influential role of advising on research priorities to inform future funding priorities was not widely realised.

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[82] Connolly, N. et al. (2014) *op.cit.*

[83] Evidence gap maps make existing research available to users and ensure new research is informed by the existing evidence. They inform policy by making evidence more readily available to users in ready packaged collections. They can also inform future research, and allow for a systematic and strategic approach to closing the evidence gap. They enable users to explore and compare the quality, characteristics, distribution and findings of available evidence on the effectiveness of interventions in a particular sector.

The GoE considered it an inherent weakness that a limit was placed on the number of project meetings that EC Project Officers could attend. Direct and regular engagement with the Commission officers would provide opportunities to further strengthen the policy perspective and targeted dissemination of output. The potential to conduct mid-term reviews of projects was also limited; such reviews, with the benefit of input from external experts, would be a constructive tool to assist both the research performers (or project partners in the case of networking CSAs) and the EC in aligning objectives, expectations and outputs towards heightened impact.

Output in support of specific policy obligations of the EU

When considering the impacts of research in support of policy, it is relevant to consider the 10 research areas (domains) prioritised within the FP7-Environment work programme, namely: Climate change; Natural hazards; Environment and health; Natural resources management; Biodiversity; Marine environment; Land and urban management; Environmental technologies including cultural heritage; Earth observation; Assessment tools for sustainable development.

From the review of 90 projects, it was evident that activities funded through FP7-Environment contributed strongly to addressing increasingly global-scale environmental challenges, supporting the improvement of the policy making process through the provision and improvement of scientific evidence for policy assessment.

Examples of such contributions include:

– Strong contribution to the EU's Climate Action and Renewable Energy Package, the Floods Directive, the Droughts and Water Scarcity Communication, the Communication and Action Plan on Disaster Prevention and Early Warning, the Environmental and Health Action Plan, the Environmental Technologies Action Plan, the Sustainable Consumption and Production, and Sustainable Industrial Action Plan.
– Strong support to international initiatives, including:
  - the International Panel on Climate Change (IPCC). Enhanced links with the UN IPCC to foster EU contribution to future Assessment Reports, including strong advocacy for timely publication of results of FP7 projects.
  - Promotion of European excellence in key domains to foster the implementation the Global Earth Observation System of Systems (GEOSS)[84].
  - The Biological Diversity Convention (BDC). Multi-scale analysis of biological diversity and development of economic activities from ecosystem services.

Other successes include:

– Support to the development of environmental technologies in the area of water treatment and water and soil rehabilitation and protection with clear economic, environmental and social potential impacts

From the above, it is apparent that FP7-Environment projects – in particular research projects – successfully addressed a wide range of policies. It is particularly noteworthy that FP7-Environment funding played a valuable role as activator and facilitator of collecting, harmonising and integrating regional, EU and global data sets related to: greenhouse gas emissions, conventional air pollution (e.g. aerosols) and biodiversity (the latter submitted to the intergovernmental organisation GBIF: Global Biodiversity Information Forum). The resultant research output has a high potential relevance to future policies in these areas.

In-depth assessment to compare the level of impacts of projects in FP7-Environment's 10 research areas is beyond the scope of this report. The GoE notes that an *ex-post* evaluation of projects that address Earth observation has been conducted[85], and agrees that there is valuable merit in conducting individual dedicated assessments for each of the 10 priority areas (this could be considered in combination with reviewing ERA-NETs in those domains). Below, by way of a summary example, is a brief overview encapsulating some of the trends noted in two research areas, namely Climate change and the Marine environment (note, as throughout the report, only a subset of projects completed by July 2014 has been considered). Further analysis of each of FP7-Environment's 10 priority research areas, including an assessment of the triangular articulation and complementarity between domain specific projects supported via CP, CSA and ERA-NET would be highly informative, not least in the context of prioritising topics and processes for Horizon 2020 SC5.

Examples of support to policy in two research areas of FP7-Environment

(i) Climate Change

Climate change research supported through FP7-Environment was intrinsically multi- and interdisciplinary, bringing together researchers from earth sciences, ecology, engineering, physics, economics, mathematical modelling, health etc. The FP7-Environment calls supported the first stages of the development of climate services for Europe, within the global climates services context. The research was supported to enhance fundamental understanding of the science of climate change, including developing mitigation and adaptation responses to it. Collaboration in modelling was particularly relevant to ensure reliable output, supporting a scale of development that would not have been possible via national funding activities working in isolation.

The CSAs that addressed climate change were particularly influential in providing a platform for networking. CSAs supported integration, connecting international communities, and linking back with the EC in developing the work programmes of national and EU funding, identifying research priorities and establishing projects.

Exemplar projects from the 2010 calls included CLIMRUN[86], which produced extensive policy relevant output (including novel visualisation material), and EUCLIPSE[87] (which addressed impact of shortlived gases e.g. black carbon on climate change); both projects addressed the development of climate services for Europe. EUCLIPSE produced an important policy briefing document[88] which directly addressed one of the most important new international climate science initiatives, the World Climate Research Programme's grand science challenge on clouds, circulation and climate sensitivity. EUCLIPSE, as well as producing 69 refereed publications (from 2011-2014; including in *Nature*) also produced a short film, and published in *International Innovation*[89]. ECLISE[90] successfully involved a range of stakeholders consultations which were tailored to the requirements of specific sectors and regions, and produced a report on lessons learned. IMPACT2C project also resulted in a high level of impact on policy.

Other highly successful policy related projects included the cluster of projects that

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[85] Connolly, N. et al. (2014) *op.cit.*

[86] http://www.climrun.eu/

[87] http://www.euclipse.eu/

[88] Siebesma, A.P., Bony, S., and Stevens, B. (2014) *EUCLIPSE Policy Brief*: July 17, at: http://www.euclipse.eu/downloads/D0.15_Policy_Brief_on_implications_of_the_project_results_on_the_climate_decision_making_process.pdf. It made major scientific contributions which underpinned and in some cases have already eclipsed the fifth assessment report of the IPCC.

[89] *International Innovation* is a leading global dissemination resource for the wider scientific, technology and research communities, disseminating the latest science, research and technological innovations on a global level.

[90] http://www.eclise-project.eu/

contributed to the development of next generation climate services in Europe. This cluster included: SPECS, which researched seasonal predictions and developed regional specific tools; NACLIM, which developed climate modelling for the North Atlantic and Arctic Ocean; and EUPORIA, which developed climate prediction services tailored to the needs of specific users. COMBINE (which has been highlighted throughout this report) has been highly successful, enabling the European climate community to participate in the international Coupled Model Intercomparison Project Phase 5 (CMIP5) of the World Climate Research Programme (WCRP). The COMBINE project findings support international climate research well into the future, including assessments carried out under the Intergovernmental Panel on Climate Change (IPCC). Other projects of note include those with specific relevance to the Arctic, namely IceArc and ATP.

A further exemplar project – PACHELBEL[91] which addressed climate change and consumer behaviour – identified a gap in the resources available to support policy-making for sustainability, and set out to address this. The project identified a mismatch between the responses that people typically give to surveys and what they actually do as consumer behaviour. PACHELBEL developed a policymaking support tool (STAVE) which links the sphere of policy making and the sphere of citizens' everyday consumption practices; STAVE trials were successfully implemented across six European countries working with public administration.

(ii) Marine environment

The Commission Communication on *A European Strategy for Marine and Maritime Research* (2008)[92] highlights the importance of integration between established marine and maritime research disciplines in order to reinforce excellence in science and to boost our knowledge of the oceans and our ability to manage sea-related activities in a sustainable manner. As a key pillar of the European Maritime Policy, this strategy was welcomed by the Competitiveness Council (2 December 2008) and recognised as a significant progress towards the development of the ERA. The Strategy for Marine and Maritime Research recognised that RTD efforts are necessary to increase their eco-efficiency and offer solutions to overcome the unsustainable use of resources. The strategy identified a list of research topics requiring cross-thematic approach to reap the full benefit. In tandem with this, the Marine Strategy Framework Directive (MSFD) was adopted in June 2008. It emphasised that science and technology are required to support the balance between the promotion of sustainable growth of the marine economy with environmental conservation ("Blue Growth")[93].

The 2009 FP7-Environment Work Programme, with 11 marine and maritime topics under "Sustainable use of seas and oceans" represented a major step towards a more integrated approach to marine and maritime research within FP7. Support to implement the strategy was embedded in the FP7 initiative "The Oceans of Tomorrow", with a total FP7 contribution of 196 million in 2010-2013 (cross-thematic FP7 funding). The impact of marine projects funded under FP7-Environmnet on the policy dimension is high, and is relevant across the different fields according to the different topics addressed, including the Common Fisheries Policy (CFP), Ecosystem Approach to Fisheries Management (EAFM), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD), and the

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[91] PACHELBEL,"*Policy addressing climate change and learning about consumer behaviour and everyday life*", at: http://www.pachelbel.eu

[92] Communication from the Commission (2008) *A European strategy for marine and maritime research. A coherent European Research Area Framework in support of a sustainable use of oceans and seas*. COM(2008) 534 final.

[93] EU Marine and Maritime policies on economic and environmental sustainability: Blue Growth policy, http://ec.europa.eu/maritimeaffairs/policy/blue_growth/index_en.htm

Habitats Directive. Exemplar projects included CLAMER, ECO2, EuroMarine (evolved from three FP6 NoEs[94]), HERMIONE, ICE2SEA, MarineTT and MEECE[95].

EuroMarine is a highly successful example of how FP7-Environment funding sustained the critical mass built up via three large-scale FP6 NoEs to a stage where the legacy continues to be maintained beyond the lifetime even of FP7-Environment funding. EuroMarine has been maintained (by the consortium) as the EuroMarine Network (now funded by the partner organisations). EuroMarine Network launched its own first calls for proposals (July 2014), and is preparing its second call.[96] Other examples of projects that delivered long-lasting impacts include MEECE, which developed both decision support and management strategy evaluation tools (DSS and MSE tools) that are on the boundary between research and operational domains; many of the tools continue to be exploited by organisations directly involved in the implementation of the MSFD at national levels. Another project that has maintained a legacy is PROTOOL, which developed automated tools to measure primary productivity in European seas. The next phase is for these tools to be deployed on ships-of-opportunity, which is in progress. The new equipment which PROTOOL developed is expected to yield annual sales of 40-50 units per year.[97]

In both the "Climate change" and "Marine environment" thematic areas, FP7-Environment funding to research performing organisations was complemented by the ERA-NET funding instrument, which through FP6 ERA-NETs (CIRCLE [climate change], MARINERA [marine]) and FP7 ERA-NETS (CIRCLE-2; SEASERA) provided platforms and processes which supported enhanced cohesion between national funding agencies (research funding organisations), working together to identify and address priorities in research funding, as well as facilitating access to infrastructures, training and mobility, etc. Assessment of the linkages between FP7-Environment projects (both CPs and CSAs) and ERA-NETs requires further evaluation, and is beyond the scope of this study.

CSAs as an instrument to support policy

Several FP7-Environment calls used the CSA instrument to address coordination of output from existing research to support the science-policy interface (including generating networks, workshops and briefings). Specific themes successfully addressed using CSAs included climate change, Earth observation, biodiversity and urban development, and marine and maritime environment. The calls for these CSAs were developed in the context of their relevance to the impacts of economic growth, balanced with good environmental status, within the EU's current ecosystem management and sustainable development approach. The intention was for the CSA instrument to incentivise activities that would contribute to the knowledge-base and the development of methods and tools in support of environmental related policy. Several of these domain specific CSAs (e.g. in Climate change: CLAMER) were very successful, including in networking research communities that were at early stages of cohesion, and which would be likely to progress to partnerships in research activities.

However some of the policy-specific CSAs delivered less than was expected by their calls; there was sometimes an absence of evidence of easily identifiable and accessible knowledge and findings which would be used to advance environmental policy agendas and/or support the implementation specific EU Directives and policies. There was on occasion a lack of evidence that consortia (either as individual partner organisations or collectively) would commit to maintaining a legacy of activities, beyond the duration of FP7-Environment funding (despite in some instances being led by trans-national organisations with relevant capacities).

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[94] EUROMARINE was set up to integrate the networks and activities associated with three marine FP6 NoEs: EUR-OCEANS, MarBef and Marine Genomics Europe, which ran from 2004-2009.

[95] http://www.MEECE.uk/

[96] http://euromarineconsortium.eu/

[97] http://www.prottol-project.eu/

Some projects showed little evidence of a commitment to hosting training events to address the best ways to increase the impact of research output through policy engagement (e.g. with parliamentarians and policy makers as a way of raising awareness of research output amongst decision makers).

Some FP7-Environment calls were specifically designed to improve the manner in which the output generated from FP6 and FP7 research projects, would be managed, disseminated and transferred (supported by CSAs as a policy pull to leverage on research output). One such exemplar project is MarineTT[98], which, despite having only two partners and a relatively small budget of €0.75 million, successfully developed an efficient tool based on an existing portal, which focused on syntheses and dissemination of knowledge outputs rather than a simple listing of research projects. This knowledge portal has already been leveraged on in proposals submitted to some of the earliest calls in Horizon 2020.

It is noteworthy that several projects were repeatedly denoted as being highly successful across a range of the assessment areas (excellence, policy, innovation, cross-cutting) of this evaluation. Examples include: AQUAFIT4USE, COMBINE, ENRIECO, MEECE, HERMIONE, W2PLASTICS. Appendix XV summarises a set of 13 projects specifically prioritised from the innovation perspective, which were also identified as repeatedly successful in their approach and outcomes across the range of assessments. They include: LoRe-LCA[99], Vision RD4SD[100] and MarineTT, each of which show how influential a CSA project can be in terms of support for networking, policy support prioritising research agendas, and developing tools for policy makers.

CPs as an instrument to support policy

There was a clear tendency for several of the more research-intensive CP structured projects (that delivered excellence in their scientific output, including papers in *Nature* and *Science*), to also synthesise and deliver highly relevant outputs that were influential in the science-policy interface (research push to inform policy). Such CPs tended to be constituted by mature consortia with a provenance of FP funding (for example HERMES in FP6, evolved into HERMIONE in FP7; some of this community had first collaborated in FP3), emphasising the importance of FP funding in supporting the retention of critical mass in specific domains.

Such consortia are also more likely to maintain the legacy of the initiative long term, thus increasing the potential impact on future policy development, emphasising the effectiveness of interfaces that originated from mature research consortia. Exemplar research projects that delivered highly effective policy-relevant syntheses include: HERMIONE, KNOWSEAS, ICE2SEA (all in the marine domain), and WISER, ENRIECO, ESCAPE, ComEnVir. These projects also developed dialogue platforms to facilitate the science-policy interface. For example, ComEnVir published a book, films, Best Practice Manual, website and Science Information Packages.[101]

While such CPs were exemplary, there was, with some exceptions, often an absence of dedicated strategies for exploitation of research results towards policy, such as dissemination strategies targeted at key groups of relevant stakeholders and policy-maker (including processes for interacting directly with Commission officers). The capacity for a project's findings to be harnessed in support of the policy making cycle was not always maximised. There was a general absence of detail in project documentation addressing the management of communication of complex research output to policy makers (or to the public), with the exception of projects that specifically had partners that specialised in this area embedded in the consortium. Furthermore, there was little evidence that any communication strategies that were developed would be maintained beyond the lifetime of the project, which lessened

[98] http://marinett.eu/

[99] http://cordis.europa.eu/

[100] http://www.visionrd4sd.eu/

[101] http://www.comenvire.eu/

likely impact; this was particularly evident with regard to websites and portals. The majority of dissemination activities were transient (newsletters, websites, workshops, social media), exhibiting a range of standards and styles in their development. There is a need for enhanced understanding of the needs and expectations around policy development, including assessing good practices in support of research output with regard to transferability and methods of implementation towards solutions to global challenges. While policy briefs must be based on good research, a project's policy-relevant findings must be presented in convincing terms.

The assessment of impact on policy correlates well with the assessment of excellence, as discussed above (section 3.2.1 above) and with European Added Value (section 3.2.5 below).

Partnerships in CSAs vs. IP

There is a notable difference between the configuration of partnerships in CPs versus those in CSAs. CPs tended to be populated by partners representing individuals from research performing organisations (e.g. universities and/or institutes). CSAs were often developed to support interfacing of disparate communities, and as such tended to be populated by trans-national associations of research performing organisations. Precaution must be taken against any risk of duplication of funding as such trans-national organisations are mandated and funded by their constituent Member Organisations to carry-out some aspects of that for which they received EU funding.

Direct links with mandated policy makers was not always evident in consortia, either at the national or EU level. While some consortia included partners such as the JRC, there is scope for enhanced interaction not only with officers from DG RTD, but also with other DGs in accordance with the call topic (e.g. MARE, ENVIRONMENT, CLIMA, TRANSPORT, etc.)

Effectiveness of FP7-Environment research in policy support

While the demand for policy-relevant evidence is greater than ever, the existence of potentially valuable key tangible outputs from FP7-Environment research is often unknown, and lies unused in inaccessible or non-user-friendly contexts, which limits the exploitation/uptake by potential stakeholders, including other scientists and policy makers. Throughout the timeline of FP7 the EU made increasing efforts to monitor and facilitate open access to information and results emanating from policy specific projects; however, such processes were not always widely adopted. Furthermore, while it was evident that many organisations were committed to open access, the implementation of open access policy itself presents a number of challenges, in particular to universities.

On reviewing the subset of 90 projects, several lacked attention to strategies for refined synthesis and exploitation of research output, such as a targeted dissemination strategy towards key groups of relevant stakeholders, as well as policy makers, and towards maintaining the legacy of the projects' outputs. Few projects produced specific syntheses in a format (e.g. policy briefs, position papers) tailored to inform the policy-making sectors (often, emphasis was paced on hosting workshops), though those that did were highly successful (as detailed above). The tendency for a project's findings to be harnessed in support of the policy making cycle increased through the lifetime of FP7-Environment; as a result, several projects embedded in the research community resulted in transfer of information and knowledge to the policy community, through the development of very effective science-policy interfaces.

Recommendations on policy

- Identify the needs for further research (the evidence gaps) to improve the scientific underpinning for the implementation of existing and future EU Directives and policies and global obligations.
- Develop processes and increase support mechanisms to extract the knowledge and outputs from research activities, analyse and synthesise them, and make them widely accessible (per descriptor, criteria, indicator, pressures and impacts). This support to the production of relevant, reliable, accessible and timely syntheses of research into policy briefs, targeted towards policy makers will involve:
    - Support to the establishment of clearing houses for research syntheses and policy relevant research;
    - Horizon 2020 funded projects to be obliged to support a substantially improved EU research synthesis and dissemination strategy, encompassing easy and open access to the results of publicly funded European research, including commitment to supporting the legacy of the project.
- Specific attention in Horizon 2020 to the elaboration of how policy relevant instruments will be used to support the development of science-policy interfaces.
    - Engage with policy makers from the earliest stages of the project, so that the two-way dialogue can inform the researchers of the needs and expectations of the policy maker; such deliberative fora would involve civil society and the general public, supporting access to and use of research evidence.
    - Establish domain specific science-policy interface platforms, (with involvement of several projects) to share and validate good practices, bringing together the relevant stakeholders, towards supporting the implementation of environmental Directives and policies.
    - Develop rapid response mechanisms to meet policymakers' needs for research evidence within short time frames. Projects should include strategies to monitor the evolving policy environment and adapt accordingly.
    - Mechanisms for more direct involvement of Project Officers in policy projects, as well as potential beneficiaries, including other DGs, in a project's "policy profile" aspect.
    - Conduct regular interim reviews to support fine-tuning of call expectations with reality of limitations of research activities, thus enhancing impact.

3.2.5. European Added Value

The attainment of European Added Value (EAV), is defined as[102]:*"the value resulting from an EU intervention which is additional to the value that would have been otherwise created by Member State action alone."*

The concept of European Added Value is at the core of European policy. Attempts to realise European added value have underpinned the Framework Programme for many years and are associated with developing and strengthening the ERA. EAV addresses research performance and impact arising from a pan-European approach, beyond that of national funding.

Typically, European Added Value is analysed through establishing: (i) the need for public intervention, and (ii) the need of intervention at European level.

[102] Commission Staff Working Document (2011) *The added value of the EU budget*, accompanying the document *Commission Communication A budget for Europe 2020*. SEC(2011) 867 final

In the field of research and innovation, some typical characteristics of the European Added Value are:

– *Dealing with pan-European challenges*, such as environmental issues or climate change.

– *Coordination of national/international policies*, such as Earth observation or climate change forecasts (e.g. contribution to the IPCC reports).

– *EU scale dissemination of results*, including commercialised innovations supported by FP7 as an indicator of competitiveness.

– *Critical mass*, such as building pan-European research capacities (e.g. skills and research communities).

– *Reduction of research risks*, very high in fields such as marine or Arctic research, characterised by high costs of fieldwork.

– *Reduction of commercial risks*, very evident in the type of innovations that are typically supported by FP7-Environment; i.e. early stages or medium-high risk, transformational, innovations.

– *Increased competition in research*, this can in part be exemplified by the low success rates (see section 3.1.)

EU funded research supports the kind of pan-European research collaboration required to speedily produce industrial standards that can set the tone and be adopted at the global level. For instance, without the EU Framework Programmes, Europe would not have been at the origin of the global standard for 2G and 3G mobile phone communications.

A significant part of EU research investment supports projects for the collective public good; these projects would not necessarily be done by the private sector alone and can be done more coherently and economically by collaboration between several countries rather than by one. FP7-Environment funding represented a significant funding source for this type of public research in Europe, For example, the FP7-Environment SAFER project received €3.5 million to develop earthquake early warning systems which were developed and tested in several seismic areas across Europe.

European added value of environmental research projects can be documented in a number of different ways, e.g. in relation to:

- *Infrastructures*: Access to infrastructures and databases is important in environmental research. However, this is sometimes hampered by different national rules and settings, or incompatibility and lack of interoperability of systems. Projects may lead to harmonising or enabling inter-connectedness of national infrastructures or contribute to creating (new) joint European infrastructures.
- *Dealing with environmental challenges*: Environmental problems are not confined to national borders. This, coupled with shrinking public research budgets at the national levels, makes international collaboration imperative. Increasing access to resources and coordinating research policies and funding programmes across Member States is necessary to reduce duplication. Some projects may have been explicitly organised in partnerships including actors from several regions or countries facing similar environmental problems and jointly looking for possible solutions.
- *Capacity building and development of critical mass*: Projects may target geographical regions or research areas that need gathering of input data from a variety of (geographical) settings, or require a combination of various fields of expertise under a multidisciplinary research approach. This dimension of European added value also relates to building research capacity in specific countries in certain fields and by pooling of resources to attain the critical mass needed to deal with environmental issues.
- *The potential for leveraging additional resources*: Publicly funded research projects can leverage additional funds from the private sector. This is

possible especially in the cases where exploitation of the research results can lead to market developments.

On a 1-5 Likert scale, around 40% of the projects that were eventually graded for European added value (32/81) scored 4 or above, while the majority (61/81) scored 3 or above.[103] The projects that scored 4 or above presented high added value in more than one of the dimensions listed above. The dimensions of added value usually documented in a project's justifications and results referred to the need for international collaboration in dealing with environmental challenges, for capacity building and development of the critical mass as well as for harmonising databases, procedures, measurements, models, etc.

However, it has to be noted that the added value of a project heavily depends on the uptake of research results, including adoption of harmonised measurement procedures or tools, or integration of recommendations into relevant policies. In several cases it was noted that the potential of added value would be high provided that the results were followed up. However, in many cases such evidence was lacking or very limited given also the fact that the projects were completed recently. Nevertheless, some notable examples of projects with high European added value are indicated below.

Several themes of FP7-Environment resulted in excellent examples of European added value, in the sense that the research efficiency was enhanced by coordinated at European level. One such is the case of Earth observation. The FP7-Environment programme played an active role in implementing the Global Earth Observation System of Systems (GEOSS), including the role of the European Commission (via DG RTD) as one of the four co-chairs of the intergovernmental Group on Earth Observation (GEO) – see section 3.2.4. The important contribution of FP7-Environment research to GEO is evaluated in a separate report[104] that demonstrates the relevance to the EU of these actions: opening up of access to essential global, regional and national datasets; adoption of compatible data policies in EU Member States and pan-European organisations; direct and indirect contribution to the Europe 2020 Strategy and related policies (including capacity building in developing countries); mobilisation of the research community; potential to foster and stimulate growth and innovation for industry (especially SMEs). The report concludes that the EC's research contribution to GEOSS is critical in addressing global challenges such as climate change, energy and food security, and health.

FP7-Environment also played a key role in the development and aggregation of climate change models, with a strong contribution to the International Panel on Climate Change (IPCC). While models could be developed at national level, FP7-Environment provided a unique coordination role, allowing models to be run together, ensuring the completeness of the systems. FP7-Environment thus facilitated the international co-development of climate change models, creating a process of mutual learning and efficient knowledge creation. With its funding activities in this field, the Commission contributes to the creation of international standards that avoid fragmentation of research and funding. Similar progress is apparent in areas such as greenhouse gases (GHG) measurement and ocean acidification and carbon sequestration, where the EU is a leader thanks to its coordination and standardisation role – not to mention the impact of research in these fields on policy and Directives.

[103] Scorings made by the GoE based on projects' review reports.

[104] Connolly, N. et al. (2014) *op.cit.*

Box 11: Notable examples of European added value.

LIVEDIVERSE: The project provided an important added value in strengthening the capacities of international partners (in India, Viet Nam, South Africa and Costa Rica) by enabling them to access the state-of-the-art knowledge in the field. At the same time the EU funding allowed to push the knowledge boundaries in the field for the European partners and afford doing field research in developing countries. The project was implemented at such a big scale that it enabled the conduct of comparative parallel studies in four countries and three continents. Such research, while being important, cannot always acquire funding from national governments (European and developing countries).

FUME presents a great potential of European added value as it can lead to significantly greater harmonisation, provided that the database created continues to be expanded and data format/type is harmonised. The environmental challenge that the project was designed to investigate is very much a pan-European one, as well as being relevant in many areas throughout Europe. FUME could lead to greater coordination of national policies, as relevant countries will have access to harmonised information upon which to base their policies. The project is also likely to have enhanced research capacity by benefiting less well-funded areas, and it was successful in achieving a critical mass, as it was successful as a large-scale integrating project.

W2PLASTICS also reflects several dimensions of the European added value including dealing with cross border environmental challenges, pooling resources to attain a critical mass and leveraging additional resources from the private sector. W2PLASTICS deals with environmental burden from complex industrial and household waste which is a serious problem common for many if not all European countries. Joint efforts to develop a breakthrough recycling technology are imperative in this case. The project demonstrates successful pooling of resources for research, innovations and exploitation especially investments from the private sector to establish spin-offs.

MESMA is a good example of all the different dimensions of European added value. This project provided access to a new open access database that is available through the MESMA Geoportal. The database has been built in harmony with existing and emerging EU and international standards for interoperability, data delivery, data visualisation, and data integration (the INSPIRE directive). Second, the environmental challenges tackled in the project relate to the continuous nature of the marine environment and the variability in marine habitats, which may shift and change over time and be influenced by external factors that originate in one jurisdiction and have an effect on another. In this regard international co-operation was essential for developing a generic and not case-specific framework for marine Spatially Managed Areas. Third, MESMA may have an impact on developing policies such as the proposed EC Directive on Maritime Spatial Planning and Integrated Coastal Zone Management. Fourth, because of the potential commercial exploitation of the MESMA framework, associated web-based application and developed or modified tools the project also has the potential to leveraging some funds from the private sector, either to support the development of a more mature application or through expert consulting services provided by the academic partners.

Appendix XIV presents an example of European added-value derived from FP7 in the case of a single EU Member State, the UK, with a focus on growth and jobs.

4. CONCLUSIONS AND RECOMMENDATIONS

Overview

Challenges to the implementation of this *ex-post* evaluation exercise, and the interpretation of the derived information, included that: (i) the strategic priorities of FP7-Environment were revised midway during the lifetime of the programme (in response to the global economic crisis), with a shift in emphasis from scientific excellence to innovation, technology and societal impacts; (ii) project monitoring systems that would have informed the questions posed by this evaluation had not been developed during the lifetime of the programme (this necessitated the development of surveys, questionnaires and dialogues within this exercise to address these gaps); and (iii) a substantial number of the FP7-Environment projects were not completed at the time of evaluation. The resultant conclusions presented here have to be viewed through the perspective of these caveats.

The *ex-post* evaluation of projects indicates substantial differences in terms of their scientific and innovation performances. While some of these differences are attributable to the varying nature and scope of the activities funded, nonetheless wide ranging divergence in quality was evident between some projects. This observation calls for the design of more aligned assessment procedures for future monitoring of projects, which would safeguard against extensive divergence in future funding programmes.

With regard to the European Commission's current emphasis on innovation, enhanced efforts will be required in Horizon 2020 to support the type of consortia best suited to address such objectives. The evidence gathered in this evaluation indicates that a triumvirate collaboration between innovative SMEs, industrial partners (LEs) and research organisations has the greatest potential to provide tangible outputs, outcomes and impacts in terms of innovation.

An observed weakness in the delivery of the funding programme was that, in several cases, too few resources were allocated within projects towards effective knowledge transfer, including dissemination and targeted communication of results. With specific reference to the impact on policies and decision-making, outputs and impacts often lag behind those expected when calls were developed. Addressing this in Horizon 2020 will require the development of a revised approach towards enhancing the use of the research, development and innovation activities in the realm of EU policy making.

The increasing emphasis on the requirement for impact (from research funding) may be compromised by the widespread calls for simplification of administrative procedures. Increased involvement with the EC Project Officer risks being misconstrued as an administrative burden, rather than that such involvement informs both policy and the prioritisation of future research agendas, while also facilitating networking with complementary research consortia, to the benefit of both the research and policy communities. The separation in Horizon 2020 of the EC's administration of projects from the EC policy activities should be designed to facilitate interfacing between the researchers and DG RTD officers towards supporting enhanced impact of project outputs. Increased involvement of DG RTD officers at project meetings (beyond the restriction of one visit per project lifetime in FP7-Environment) would support this, as would the increased use of interim reviews.

Key findings

Evolution of priorities

As the FP7-Environment (including Climate Change) work programme was characterised by a re-orientation of priorities (from 2009) during its timeline, it would be artificially biased to assess all FP7-Environment project outputs on the basis of recent and current priorities, when several of the projects reviewed were

developed prior to this shift. A large proportion of the projects funded under the more recent innovation-oriented calls are on-going, and thus beyond the scope of this evaluation.

Participation dominated by major research organisations and countries

In line with the initial focus on scientific excellence (i.e. "*contribute to the Union becoming the world's leading research area*") and transnational cooperation (in support of the European Research Area), participation in FP7-Environment was dominated by large-scale European research institutes, including the *JRC* (EU), *CNRS* (France), *CNR* (Italy), the *CSIC* (Spain), the *Max Planck Institute* and *Fraunhofer Society* (both Germany), and *TNO* (the Netherlands).

In general, participation rates by country correlated well with national levels of R&D expenditures. It appears that to fully benefit from FP7-Environment, a minimum national R&D investment was necessary, which generated critical mass. Countries with very small R&D expenditures (e.g. post-2004 Member States) were generally less successful in acquiring FP7-Environment funding, while others such as Greece, Italy and Spain are examples of how FP7-Environment funding was used to supplement shrinking national R&D investments (as a result of the economic crisis).

FP7-Environment supported more than 91,000 trans-national cooperation links, in support of the ERA objectives. Such cooperation is dominated by an axis of activity between Germany, Spain, France, Italy, the Netherlands, the UK and, to a lesser extent, with Switzerland and Norway. Of the post-2004 Member States, Poland has the greatest number of bilateral linkages, predominantly with Germany and the UK.

Industrial participation

The rate of participation of industrial partners in FP7-Environment was low; industrial participation included a large number of consultancies and engineering firms. The key industry players from the environmental sector (e.g. representing water treatment, recycling, waste management) had a low rate of participation in FP7-Environment, with exceptions being *Veolia Environnement S.A.* (France) and *Acciona S.A.* (Spain). The number of SMEs participating was comparatively high (14.9%), mainly involving knowledge-based consultants and private research organisations. Involvement of end-users representing NGOs and CSOs was low, despite their relevance to the environment field and their potential role in increased exploitation and enhanced societal impacts.

Consolidating European schools of thought

FP7-Environment played a crucial role in structuring research communities, at European and international level, including supporting the attainment of excellence and maturity. Since excellence *per se* was not the only determinant in selecting a proposal for funding, FP7-Environment was more successful in supporting the creation of critical mass of good research in key domains, rather than in creating the singular leading global focus of excellence in a particular domain. Funding was a critical support to the continued growth of research capacity and competence, and for self-organisation of interdisciplinary scientific communities, including successfully integrating scientific excellence with societal relevance.

Nurturing innovation

With the evolution of innovation as a priority in FP7-Environment, the European Commission was not equipped with an adapted methodology for allocating resources and expertise, or for developing specific tools. Participation rate of industrial players and innovative SMEs was low. Reporting procedures for FP7-Environment projects did not include the collection of innovation indicators. The radical mid-term re-orientation of the FP7 work programme priorities towards

innovation would have benefitted from an enhanced system for managing projects and the programme, for example through the adaptation of concepts from the proven R&I portfolio management models used in industry. Exploitation of innovation activities was almost completely delegated to projects, with little attention to follow-up and support from the Commission, except at the micro level by individual Project Officers.

Cross cutting issues

Although gender issues were always considered with regard to achieving a balance in the research workforce, nonetheless, the majority of female researchers occupied junior posts rather than posts of responsibility. While support to mobility as such was not among the core aims of the FP7-Environment theme, several projects enabled inter-organisational mobility that benefited the careers of researchers. Continuity of research was frequently evident and highly relevant in terms of furthering research in the same or related areas. This did not happen to the extent of creating a closed club, as new-comers outweighed those with repeated FP7 participation. Civil society was mainly the beneficial recipient of training or raising awareness activities. Active engagement of societal stakeholders was not taken up in projects to the degree possible. Following open access principles in carrying out and publishing research faced several challenges in practice, ranging from high open access publishing costs to commercialisation purposes, to hindrances in accessing existing research results, or to opposite requirements in researchers' reward systems.

Enhanced internationalisation of research activities is a very significant impact from FP7-Environment projects, which provided unique and highly competitive platforms for international collaboration. In view of a more challenge-driven approach in Horizon 2020, it will be crucial to establish the appropriate partnerships and cover the appropriate regions in dealing with certain challenges. The dimensions of European added value usually documented in FP7-Environment projects refer to the need for international collaboration in dealing with environmental challenges, which are by their nature trans-national, as well as the need for capacity building and development of critical mass and for harmonising databases, procedures, measurements, models, etc. National funding streams within Member States are key to the continued growth of research excellence, to innovation and to the creation of economic value. Member States acknowledge that EU research funding programmes generate an excellent return to their national economies, while it is essential that national funding schemes be retained to nurture opportunities to leverage for EU funding.[105]

Informing policy

The scale and pan-European scope of FP7-Environment research enabled the pooling of Member States' resources to address global environmental challenges (including as climate change, natural hazards, Earth observation, etc.), which would be prohibitive at the level of individual Member States. Projects made a strong contribution to the EU's advancements in international and intergovernmental initiatives, including the International Panel on Climate Change (IPCC), the Group on Earth Observation (GEO and the Global Earth Observation System of Systems (GEOSS), and the Biological Diversity Convention (BDC).

With the notable exception of some exemplary projects (particularly in Climate change, and Earth observation), several policy-oriented projects did not habitually establish science-policy interface platforms from the earliest stages. Concrete strategies for the synthesis, exploitation and dissemination of project results were

[105] Russell Group Response to the Government Review of the Balance of Competences between the UK and EU: EU Budget. January 2014. At: http://www.russellgroup.ac.uk/uploads/45-Russell-Group-response-to-Balance-of-Competences-EU-Budget.pdf

often absent. This was particularly evident in some policy-oriented projects, where tangible impacts (e.g. informing the design and implementation of environmental Directives and policies) were not always accessible. Through enhanced dialogue between the relevant stakeholders, science-policy interfaces would have supported sharing and validation of good practices. Opportunities to adapt project outputs towards needs of decision-makers were sometimes missed, either because such needs were not investigated, or because there was a disconnect between policy makers and researchers, or for reasons of lack of awareness of design and structuring of professional documentation (e.g. scientific journal publications vs. policy briefs). To further enhance capacity and improve access to and use of research evidence in policy development, projects (and the associated academic systems) would benefit from recognising that policy briefs and academic publications are designed as different forms of publications, having different functions, though equally important; thus, publication styles should be tailored to develop user-friendly formats for research syntheses.

Recommendations

The specific recommendations from this *ex-post* evaluation have been clustered within four key areas, and include to:

1. Develop a project monitoring system for assessing impacts of outputs on research excellence, policy, innovation and cross-cutting issues

Despite an evident improvement in recent years, the Commission's project monitoring processes would benefit from enhancement, especially in the areas of innovation and policy impacts. With regard to scientific excellence, while some outputs and outcomes are monitored, there is an absence of an indicator system for the follow-up of long-term impacts on the structuring and development of excellence in European research. A structured system for monitoring, aggregating and synthesising contents and outputs of projects should be developed, based on indicators appropriate to manage the programmes and identify outcomes and impacts.

The GoE recommends:

- The Commission should **enhance its monitoring and follow-up system** to assess the impact of projects in Horizon 2020. This would represent a cultural change in the way of managing projects and their funding programmes, shifting emphasis from procedures to results and impacts. The Commission should develop methodologies and reporting tools allowing a close follow-up of the content of projects, with a more **pro-active role** towards ensuring societal impact.
- An indicator and monitoring system should be established to evaluate the impact of projects on improving scientific excellence at the level of individual researchers, and at the level of scientific communities, including for example, comparing the publications record of beneficiaries in a dynamic way, before, during and after funding.
- The development of such a monitoring system would enable the Commission to **identify innovative projects** with potential societal impacts, as well as their strengths and weaknesses, to provide further support (if needed) and facilitate networking with complementary projects, and dissemination. For innovation issues, the monitoring system should rely on a set of smart indicators (based for example on the questionnaire implemented in this *ex-post* evaluation, and on the conclusions regarding which factors lead to implementation) and on insights from Project Officers.
- Regular interaction between projects and EC Project Officers should be supported, as should interim reviews, allowing fine-tuning of project delivery. Both would safeguard against any risk of substantial deviations from the core expectations of the funding call, while informing the

Commission of the reality of any limitations within project implementation, and would ultimately be beneficial to both project delivery and outcomes. This would be particularly relevant in the case of early-stage consortia.

- The follow-up of projects' impacts should continue after a project has been completed, beyond the funding lifetime. Otherwise, the actual impact of the work programme is not adequately monitored and measured, and a project's legacy risks being under-estimated.
- Incentivising data provision beyond the lifetime of the project: a mechanism should be developed which would create advantage for coordinators to take time to report on outputs and outcomes after the lifetime of a project.
- The monitoring system should also cover policy impacts. The Commission should systematically collect evidence about how projects influence policy (e.g. informing Directives, international agreements, national legislation, etc.).
- The Commission should collect reliable data and methodologies to measure the environmental and resource-efficiency impact of projects. The Commission is committed to allocating 35% of its research and innovation budget to climate research and 60% to sustainability-related research, and a monitoring of funding is already in place (referred to as the "Rio Markers"); attention should be afforded to the results of this financial effort.

2. Focus on exploitation and applicability of project output, including beyond the project's lifetime

Innovation:

- To increase its impact in terms of innovation, Horizon 2020's SC5 should strengthen the links with industrial organisations that are very active in R&D. Such organisations have the capacity to increase the exploitation of results from research and innovation actions. The Commission should support a participation balance between innovative SMEs that are capable of developing advanced technologies, and large companies that have the capacity to integrate such innovations and exploit them at large scale.
- In order to attract more relevant industry participants into innovation projects within the future environment themes of Horizon 2020, the evaluation process should place more emphasis on targeted objectives and a clear allocation of resources, commitment of partners for follow-up investments and project legacy, with clear procedures for the protection of sensitive information.
- A further involvement of NGOs and CSOs would be important to strengthen the links between the R&I community and society, thus increasing the impact of projects. Involving CSOs and NGOs (as partners or in external networks) would also enhance the innovation potential of projects, anticipating societal reactions to technologies and increasing the understanding of the requirements and expectations of citizens.
- Involvement of financial investors is essential to exploit innovation. The Commission should strengthen the links with such organisations, to understand their requirements and expectations, and to facilitate access to further private funding for relevant projects.

Policy:

- Specific attention should be paid in Horizon 2020 to the elaboration of how policy relevant instruments will be used to support the development of science-policy interfaces, including to:
    - Engage with policy makers from the earliest stages of the project, so that the two-way dialogue can inform the researchers of the needs

and expectations of the policy maker; such deliberative fora would involve civil society and the general public, supporting access to and use of research evidence.

  - Establish domain specific science-policy interface platforms (with involvement of several projects) to share and validate good practices, bringing together the relevant stakeholders, towards supporting the implementation of environmental Directives and policies.
  - Develop rapid response mechanisms to meet policymakers' needs for research evidence within short time frames. Projects should include strategies to monitor the evolving policy environment and adapt accordingly.
  - Mechanisms for more direct involvement of Project Officers in policy projects, as well as potential beneficiaries, including other DGs, in a project's "policy profile" aspect.

- Engaging society has to go beyond the end-user perspective. In the environment domain, where society's behaviour and concerns are crucial for the success of mitigation actions, it is important that society is actively engaged and empowered through inclusion from the early stages of the research. The involvement of relevant NGOs, societal organisations and movements such as "citizen scientists" should be considered more extensively in this respect.
- Following-up on research results is important in cases where for example harmonised measurement procedures need to be adopted at the national and/or regional level, or where recommendations need to be integrated into relevant policies. This would help to establish and/or strengthen European added value of FP research, which in the framework of public accountability and in view of the challenge-orientation in Horizon 2020 emerges as increasingly important.

3. Integrate research excellence and innovation with policy support

- To exploit its particular strength as the leading transnational, interdisciplinary, very large-scale research funding programme, the European Commission, through Horizon 2020, should emphasise its role in creating and consolidating large integrated research communities (*"European schools of thought"*) that focus on addressing grand societal challenges with high level research.
- The European Commission should target the integration of scientific excellence (as measured by publication in high ranked journals) with procedures for high-level support to policy. Separating research activities that support policy from excellence oriented research, risks overlooking some excellent research output which is relevant to support policy. Enhanced engagement with Project Officers would also address this. Requirements for policy-based projects to provide commitment to maintain their legacy beyond their funding lifetime should be inherent in Horizon 2020 funding.
- Regular interaction between projects and the European Commission would enhance engagement with pan-European research prioritisation exercises, both within Member States (e.g. via ERA-NETs, JPIs) and in Horizon 2020 SC5, which in turn will direct funding to address specific global challenges, while enhancing the development of critical mass of expertise in key domains.
- The Commission should collect reliable data on the R&D performance of national research programmes, including from third countries (e.g. US, Japan, BRIC countries). This would address the reduction in duplication and fragmentation of research investments and efforts, and allow cost-efficiency to be compared.

- To support enhanced innovation and policy outputs, it is crucial to take both into account from the earliest stages of projects, from creating the consortium and designing the proposal ("co-design - co-production - co-delivery"). The collaboration with stakeholders and end-users is critical in this regard, from the earliest stages of project concept.

4. Identify evidence gaps to prioritise research and to inform the solution based approach to policies

- Identify the needs for further research (the evidence gaps) which is necessary to improve the scientific underpinning for implementation of existing and future EU Directives and policies and global obligations; this identification of evidence gaps should be coupled with research prioritisation exercises.
- Develop processes and increase support mechanisms to extract the knowledge and outputs from research activities, analyse and synthesise them, and make them widely accessible (per descriptor, criteria, indicator, pressures and impacts). Such support to the production of relevant, reliable, accessible, targeted and timely syntheses of research into policy briefs, targeted towards policy makers would include:
    - Development of an EU research synthesis and dissemination strategy, encompassing easy and open access to the results of publicly funded European research, including commitment to supporting the legacy of the project;
    - Support to the establishment of clearing houses for research syntheses and policy relevant research.

Concluding remarks

FP7-Environment played a pivotal role in creating a critical mass in Europe of highly relevant research, in providing opportunities to early-stage researchers and in structuring research communities. FP7-Environment was designed to support EU institutions and Member States by generating high quality science-based advice throughout the entire policy cycle, and to anticipate and understand emerging global challenges. In that sense, FP7-Environment projects made a strong contribution to the EU's role in advancements of international and intergovernmental initiatives.

As the original objectives of FP7-Environment did not address innovation *per se*, when the change in the global economic and political context led to a re-orientation of priority-setting, the Commission was not adequately equipped with the relevant systems (methodologies) to support and assess innovation. Nonetheless, several projects accomplished highly relevant innovation results, reaching the exploitation stage with success. The overall economic and societal impact, however, was considered to be below the potential of the programme.

There is a need for enhanced understanding of the needs and expectations around policy development, including assessing good practices in support of research output with regard to transferability and methods of implementation towards solutions to global challenges. Furthermore, monitoring of policy impacts resultant from research actions will embed awareness of the relevance of research funding in the wider community.

Overall, projects funded via the FP7-Environment programme achieved considerable results and impacts. FP7-Environment created the foundations for the development of a successful Societal Challenge 5 (SC5) under Horizon 2020, especially towards improving innovation actions and societal impact.

Europe has a pivotal role to play in establishing intelligent resource-efficient solutions to address sustainability. Concepts such as "green growth" and "circular economy" should be placed high in international political agendas, not only for

environmental reasons, but also for their capacity to build a competitive advantage for the EU. Horizon 2020 activities can support the development of these concepts and their transition into practice, including providing examples of successful implementation. The EU is well placed to adopt a progressive and pioneering role in leading the international sustainability agenda. This will require that sufficient resources and efforts are devoted to build the knowledge-base, and technological solutions, through Horizon 2020.

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ANNEXES

Appendix I: Legislative basis of FP7 and the Cooperation Theme "Environment, including Climate Change"

The legislative basis for FP7[106] states:

"…the overriding aim of the Seventh Framework Programme is to contribute to the Union becoming the world's leading research area. This requires the Framework Programme to be strongly focused on promoting and investing in world-class state-of-the-art research, based primarily upon the principle of excellence in research […]. The objectives […] should be chosen with a view to building upon the achievements of the Sixth Framework Programme towards the creation of the European Research Area and carrying them further towards the development of a knowledge-based economy and society in Europe which will meet the goals of the Lisbon strategy and Community policies."

The thematic objective of the Cooperation Theme "Environment, including Climate Change" is defined in the Council Decision 2006/971/EC:

"Sustainable management of the environment and its resources through advancing our knowledge of the interactions between the climate, biosphere, ecosystems and human activities, and developing new technologies, tools and services, in order to address in an integrated way global environmental issues. Emphasis will be put on prediction of climate, ecological, earth and ocean systems changes, on tools and on technologies for monitoring, prevention, mitigation of and adaptation to environmental pressures and risks including on health, as well as for the sustainability of the natural and man-made environment."

[106] Decision No 1982/2006/EC of the European Parliament and of the Council of 18 December 2006 concerning the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007-2013), OJ L412, 30.12.2006

Appendix II: Ex Post Evaluation of R&D activities. Definitions.

Evaluation is defined as a "*judgement of interventions according to their results, impacts and needs they aim to satisfy*"[107]. The key point is that any evaluation leads to a judgment or assessment of an intervention or action. Evaluation focuses on the needs, results and impacts of any intervention.

Ex-post assessment is a specialised area of evaluation designed to identify and measure the consequences resulting from a programme or project's earlier interventions. The defining characteristic of *ex-post* reviews is their timing, as they take place after a programme has generated the intervention being assessed and sufficient time has elapsed and experience accumulated to assess the interventions performance in terms of longer-term economic, social, and environmental consequences. *Ex-post* assessments contribute primarily to accountability by demonstrating impact to stakeholders, and secondarily to learning about the effectively of environmental research. The impacts of an intervention may be positive or negative, primary or secondary, direct or indirect and intended or unintended.

Measurement of Research and Development

Research and Experimental Development (R&D), as defined by the Organisation for Economic Co-operation and Development (OECD) in the Frascati Manual[108], is:

"creative work undertaken on a systematic basis in order to increase the stock of knowledge. It is characterized by originality, where investigation is a primary objective.

There is a need to appreciate that the impact of research is not necessarily evident within the lifetime of a particular funded project. It is necessary to review performance over the longer term to assist in the identification of trends and impacts. Assessing areas of success also assists in the identification of areas for improvement.

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[107] Communication on Evaluation (SEC(2000) 1051), as quoted by European Commission (2004) *Evaluating EU activities – A practical guide for the Commission Services*. Luxembourg, Office for Official Publications of the European Communities.

[108] OECD (2002) *Frascati Manual: Proposed standard practice for surveys on research and experimental development*. Paris, OECD, p. 30.

Appendix III: Group of Experts

Name	Surname	Institution	Title	Gender	Nationality
Katharina	Helming	ZALF – Leibniz-Zentrum für Agrarlandscaftsforschung	Senior Researcher	F	DE
Rem	Peter	Technical University Delft	Professor	M	NL
Connolly	Niamh	Innovation Advisory Partners and Nanyang Technological University	Associated	F	IE
Wilenius	Markku	Finland Futures Research Centre	Senior Advisor	M	FI
Amanatidou	Effie	University of Manchester/Institute of Innovation Research	Research Associate	F	EL

Appendix IV: Terms of Reference

1. OVERALL OBJECTIVE

A Group of Experts (GoE) is set up by the Directorate General for Research and Innovation (Environment Directorate) of the European Commission to analyze and evaluate the appropriateness, effectiveness and impacts of environmental research and innovation supported by the thematic area "Environment (including Climate Change)" within the Seventh Framework Programme of the European Community for Research, Technological Development and Demonstration activities (2007-2013, FP7), in the context of the overall policy objectives of Europe 2020, the Innovation Union, the European Research Area (ERA) and EU and global environmental commitments. The analysis, based on a thorough analysis of available documents, data and possibly some field research, will provide two complementary outcomes:

–An ex-post evaluation of the Environment Theme at Project Level, and

– An ex-post evaluation of the Environment Theme at Strategic Level.

The ex post evaluation of the Environment Theme contributes to the overall FP7 evaluation required by Article 27.4 of the Financial Regulation: "*In order to improve decision-making, institutions shall undertake both ex ante and ex post evaluations in line with guidance provided by the Commission. Such evaluations shall be applied to all programmes and activities which entail significant spending and evaluation results disseminated to spending, legislative and budgetary authorities*". Evaluation activities are part of the evidence-based policy making of the Commission and are an important tool to improve the design and implementation of policies. Therefore, the core objective of the evaluation is to provide recommendations for future research and innovation programming and implementation at EU level.

2. MANDATE, DELIVERABLES AND TIMETABLE

2.1. Policy Context

The policy context of EU environmental research is constantly evolving. Currently, research and innovation are amongst the forefront priorities of the Europe 2020 strategy launched in 2010. Europe 2020 aims at turning Europe into a smart, sustainable and inclusive economy. One of the flagship initiatives launched by Europe 2020 is "Innovation Union", which aim is to improve "*framework conditions and access to finance for research and innovation so as to ensure that innovative ideas can be turned into products and services that create growth and jobs*". In particular, Innovation Union states that efforts must focus on "*innovations that address the major societal challenges identified in Europe 2020*", amongst which climate change.

Research and innovation activities in the field of climate change and environment are closely linked with policy development and implementation. Scientific findings are increasingly becoming a driver for policy, and vice-versa.

"Environment (including climate change)" – from now on referred to as FP7-Environment – is one of the Themes under the FP7 "Cooperation" specific programme, which overarching aim is to contribute to sustainable development by promoting research, the primary purpose of which is to increase knowledge, at the highest level of excellence[109].

With a EUR 1.9 billion budget between 2007 and 2013, the FP7-Environment has the following objectives[110]:

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[109] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:400:0086:0242:en:PDF

[110] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:412:0001:0041:EN:PDF

– "*Sustainable management of the environment and its resources through the advancement of knowledge on the interaction between the climate, biosphere, ecosystems and human activities, and*

– *the development of new technologies, tools and services, in order to address global environmental issues in an integrated way.*

Emphasis will be placed on prediction of climate, ecological, earth and ocean systems changes, on tools and technologies for monitoring, prevention, mitigation and adaptation of environmental pressures and risks, including risks to health, and on tools and technologies for the sustainability of the natural and man-made environment".

FP7-Environment covers specific 10 topics structured in four main activities or challenges:

- **Climate change, pollution and risks**

– Pressures on environment and climate

– Environment and health

– Natural hazards

- **Sustainable management of resources**

– Conservation and sustainable management of natural and man-made resources and biodiversity

– Management of marine environments

- **Environmental technologies**

– Environmental technologies for observation, simulation, prevention, mitigation, adaptation, remediation and restoration of the natural and man-made environment

– Protection, conservation and enhancement of cultural heritage, including human habitat

– Technology assessment, verification and testing

- **Earth observation and assessment tools for sustainable development**

– Earth and ocean observation systems and monitoring methods for the environment and sustainable development

– Forecasting methods and assessment tools for sustainable development taking into account differing scales of observation

2.2. Issues and questions to be addressed

The objective of the GoE is to assess the impact and achievements of the Environment Theme in FP7 against the strategic objectives set out in the FP7 decisions as implemented through the Work Programmes 2007 to 2013, and the funded activities. In this context, the rationale and implementation of FP7-Environment shall be assessed.

The work of the GoE shall focus on the core objectives of the FP7-Environment Theme: (i) Enhancing knowledge for a sustainable management of environment and its resources, and (ii) developing new technologies to address global environmental issues.

<u>The GoE has the following tasks:</u>

- Design the general methodological framework of the evaluation. This includes preparing the guidelines to review and analyse a sample of projects funded under FP7-Environment.
- Perform the evaluation of FP7-Environment, responding to the questions mentioned below.
- Present the findings of the Evaluation in different fora.

To perform the assessment, the GoE must respond two different kinds of evaluation questions:

Strategic evaluation questions:

- *On policy rationale:*

1. To what extent have the objectives of the FP7 Environment Theme appropriately addressed the needs and the problems of the European society and economy, in particular the European Research Area (ERA), Innovation Union and EU and global environmental commitments?

2. Has the FP7-Environment Theme evolved taking into account state-of-the-art of research and policy priorities worldwide during the duration of FP? Has the Commission managed to translate the needs into appropriate topics within the Environment Work Programmes and funded projects?

3. To what extent has the programme addressed societal challenges over time?

- *On implementation:*

4. Has the Environment Theme attracted excellent participants (e.g. researchers, institutions, industry, SMEs, NGOs)? Has it contributed to improve European and international cooperation in the field of environmental research and innovation?

5. How well has the funding been coordinated with other FP7 Cooperation Themes (e.g. Energy, Transport, Industrial Technologies) or other programmes (e.g. Specific FP7 programmes – Ideas, People, Capacities – or Structural Funds) with similar or complementary objectives?

6. Has FP7-Environement been able to address relevant cross-cutting issues like international cooperation, gender or science in society?

7. How appropriate were the different funding schemes within the Environment Theme achieving the objectives? How well have they been implemented and executed? Could other tools help to achieve the objectives and increase impacts?

- *On outcomes and impacts:*

8. To what extent the Theme has influenced research agendas in Europe and beyond, as well as environmental policy debates and orientations in international fora?

9. Has the FP7-Environment led to innovation in technologies, tools and services that address global environmental issues?

10 How well has the funding been converted into results and impacts? Were the effects obtained cost-effective? What was the EU added-value compared with other programmes or actions (e.g. at national or regional levels)?

11. To what extent has the Commission been successful in disseminating the results of the Environment Theme? Has the Theme influenced the development of social knowledge, behaviours and practices related to environment?

12. What are the lessons learnt and recommendations for future research and innovation funding activities at European level? In particular, with reference to the implementation of Horizon 2020.

13. What are the lessons learnt and recommendations for Horizon 2020 on how to structure future evaluation, monitoring and impact assessment activities?

In order to answer such strategic questions, the GoE will be supported, amongst other sources, by an analysis of a sample of projects made by reviewers. On that basis, the GoE will prepare an overview responding to the following questions:

Project-level evaluation questions:

1. What kind of results have projects funded by FP7-Environment generated?

2. To what extent the projects funded by the Environment Theme have

produced excellent outcomes, from the points of view of science, innovation, market uptake and policy consolidation? Did FP7-Environment produce frontier research, going beyond the state-of-the-art?

3. Have the projects funded by the Environment Theme created opportunities to young and prospective researchers?

4. Has the Environment Theme created leverage effects to projects funded (e.g. attraction of other sources of funding, like venture capital ones)?

5. Have projects funded by the Environment Theme been well managed from the administrative point of view (e.g. time to contract, time to pay, support and follow-up from the Commission)?

6. Have projects been able to address relevant cross-cutting issues like gender, international cooperation or science in society?

7. Which factors influence the success or failure of a project?

Project reviewers will provide evidence at micro level (from projects funded and assessed) useful to the preparation of the evaluation prepared by the GoE.

The analysis carried-out the GoE must be supported by reliable evidence. In addition to existent statistics and databases, the Commission services can support other fieldwork required to conduct the tasks required to the GoE.

2.3 Deliverables and Timetable

The analysis involves both collective and individual work punctuated by several meetings. The GoE summarizes conclusions and recommendations in a written report.

The report – addressed to the Commission services – will be in English and of maximum 30 pages plus Annexes. They must include an analysis of findings and a set of conclusions and recommendations on the basis of evidence. The report should be prefaced by a self-contained executive summary, not exceeding 3 pages. The report is to be made publicly available on http://ec.europa.eu/research/environment.

The "Strategic Evaluation" GoE start its work in December 2013. During the kick-off meeting the Commission will present its needs. Participants will discuss them and how to achieve the GoEs' objectives.

A first interim report will be addressed to the Commission in January 2014, containing a methodology to assess projects, which will be used by the project reviewers, as well as the structure of the final report. A second meeting will be organized in January 2014, to present the methodological guidelines for reviewers and discuss the first findings of the GoE.

A third meeting will be organized in April 2041, to discuss preliminary conclusions based on a first set of projects reviews, as well as other sources. The draft final report will be provided to the Commission services in June 2014. It will be discussed in a validation meeting (fourth meeting). The final report that will take into account possible modifications that may arise during the process has to be delivered by September 2014.

The GoE meets up to a maximum of four times throughout the duration of the contract. The duration of each meeting will be of up to 2 days. At least some reviewers will be invited to two of the meetings: The one to be organized in January 2014 and the validation one to share conclusions and agree on the final report.

All meetings will be held in Brussels.

Members of the GoE may be asked to present their findings in different fora (i.e. workshops, conferences, meetings, etc.).

A table that summarizes the timing of both the GoE and Reviewers is presented at the end of this document.

3. OPERATION OF THE GROUP OF EXPERTS

3.1. Number, identification and selection of experts

The GoE is composed of up to five independent experts, who are nominated by the Commission in their personal capacity. Their expertise covers the different areas of environmental research, innovation, socio-economic analysis, foresight and tools for evaluation and impact assessment especially in the area of environment. At least part of the GoE members must have a proved knowledge and involvement in the Framework Programme, either in projects funded by the Framework Programme or as evaluators of proposals or of programmes. Staff from Commission services and from external organisations may also be invited to contribute, where appropriate, by providing specific inputs.

The Commission nominates the Chairperson and the Reporter of the GoE.

3.2. Working method

The Chairperson of the GoE decides on its working methods; (s)he is however requested to ensure that the GoE members expertise are best exploited to allow for the identification of the most adequate methodologies for carrying out the assessment of past research for the environment. The GoE works on the basis of consensus, based on both individual and collective contributions.

The Reporter prepares the final report of the GoE, on the basis of all members' written contributions and of relevant material identified by the GoE members and/or the Commission. (S)he highlights and exploits main points of reports presented by experts, creates PowerPoint presentations and draft summaries of the discussions held at meetings.

The Commission staff responsible for the GoE is in regular contact with its members and notably the Chairpersons and the Reporters to ensure the smooth running of the GoEs, and they will attend the meetings to provide appropriate support, information and guidance. The assessment will be designed and carried out in line with the relevant Commission standards for evaluation and subject to the Commission's quality assessment criteria.

3.3. Expert support and evidence-base

The GoE will carry out their activities and draft its reports in an evidence-based manner.

The Commission provides the GoE with relevant available information, in particular:

– Legal texts:

- Communication Europe 2020: A strategy for smart, sustainable and inclusive growth[111]
- Europe 2020 Flagship Initiative Innovation Union Communication[112]
- Decision No 1982/2006/EC of the European Parliament and of the Council of 18 December 2006 concerning the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007-2013)[113]
- Council Decision of 19 December 2006 concerning the Specific Programme "Cooperation" implementing the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007 to 2013)[114]
- FP7-Environment Work Programmes, 2007-1013.

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[111] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF

[112] http://ec.europa.eu/research/innovation-union/pdf/innovation-union-communication_en.pdf#view=fit&pagemode=none

[113] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:412:0001:0041:EN:PDF

[114] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:400:0086:0242:en:PDF

– Reports and studies:

- Interim Evaluation of FP7[115]
- Interim evaluation of EU FP7 research for the environment
- Report of the Expert Group on the Horizon 2020 Ex Ante Impact Assessment for Horizon 2020.
- Ex-post Impact assessment – FP6 Sub-priority "Global Change and Ecosystems"[116]
- Gearing European research towards sustainability[117].
- The impact of European Policy on the development of the ERA in the environment area
- Different foresight commissioned b Commission services.

Other sources of information are:

- Datasets extracted from CORDA (with data on participation and proposals) and RESPIR (which include socio-economic data, including on projects' outcomes and workforce).
- Eurostat and other international databases.

However, one of the main tasks of the experts is the identification of **additional sources** (e.g. academic studies, internationally comparative analysis of private, national and international organizations), in order to diversify sources of information and provide a more complete analysis.
If the identification of the additional sources requires consultation of other Commission services or entities, such as Technology Platforms, Joint Technology Initiatives or Joint Programming Initiatives, these consultations have to be agreed and coordinated with the Commission services.

3.4. Credits

The physical and intellectual products generated by the experts' assignment will remain the property of the Commission. The experts of the GoE undertake not to use these products outside this assignment without the previous written agreement of the Directorate-General for Research and Innovation. The published reports will acknowledge the contributions of the members of the GoE.

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115 http://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/fp7_interim_evaluation_expert_group_report.pdf

116 http://ec.europa.eu/research/environment/index_en.cfm?pg=impact

117 http://ec.europa.eu/research/sd/index_en.cfm?pg=publications

Appendix V: Monitors in charge of the projects' review, projects reviewed and guidelines

Monitors:

Family Name	First name	Gender	First Nationality
AIZPURUA	Nerea	F	ES
ANDERSDOTTER	Charlotte	F	SE
ASSIMACOPOULOS	Dionysis	M	EL
AUTRUP	Herman	M	DK
BASILE	Elisabetta	F	IT
BLAHA	Ludek	M	CZ
CARIAS	Catia	F	PT
DEIDUN	Alan	M	MT
DICKS	Lynn	F	UK
DORANOVA	Asel	F	KG
FRIEDLINGSTEIN	Pierre	M	BE
KUSIAK	Monika Agnieszka	F	PL
LAGE	Olga	F	PT
MAZZANTI	Massimiliano	M	IT
MELZER	Georg	M	AT
MIEDZINSKI	Michal	M	PL
NEOCLEOUS	Kyriacos	M	CY
NUSSBAUM	Roland	M	FR
POTSCHIN	Marion	F	DE
RASHID	Amir	M	SE
RYDIN	Stefan	M	SE
SHAW	Kenneth	M	UK
SOBIECKA	Elzbieta	F	PL
URGELES	Roger	M	ES
WAGNER	Zsofia	F	HU

Projects reviewed:

Project Call Identifier	Project Number	Main sector	Project Acronym	Project Title
FP7-ENV-2007-1	211384	Climate Change	EPOCA	European Project on Ocean Acidification
FP7-ENV-2007-1	211894	Climate Change	CLIMATEWATER	Bridging the gap between adaptation strategies of climate change impacts and European water policies
FP7-ENV-2007-1	212535	Climate Change	CCTAME	Climate Change - Terrestrial Adaption and Mitigation in Europe
FP7-ENV-2007-1	211488	Environment and Health	HITEA	Health Effects of Indoor Pollutants: Integrating microbial, toxicological and epidemiological approaches
FP7-ENV-2007-1	212502	Environment and Health	CONTAMED	Contaminant mixtures and human reproductive health - novel strategies for health impact and risk assessment of endocrine disrupters
FP7-ENV-2007-1	212885	Environment and Health	REEF	Reproductive effects of environmental chemicals in females
FP7-ENV-2007-1	211250	Environment & Health	ESCAPE	European Study of Cohorts for Air Pollution Effects
FP7-ENV-2007-1	212854	Environment and Health	HEREPLUS	HEalth Risk from Environmental Pollution Levels in Urban Systems
FP7-ENV-2007-1	202798	Natural Hazards	MICORE	Morphological Impacts and COastal Risks induced by Extreme storm events
FP7-ENV-2007-1	211732	Natural Resources Management	MIRAGE	Mediterranean Intermittent River Management
FP7-ENV-2007-1	211779	Biodiversity	SOILSERVICE	Conflicting demands of land use, soil biodiversity and the sustainable delivery of ecosystem goods and services in Europe
FP7-ENV-2007-1	211392	Biodiversity	LIVEDIVERSE	Sustainable Livelihoods and Biodiversity in Riparian Areas in Developing Countries
FP7-ENV-2007-1	211345	Land and Urban Management	BRIDGE	sustainaBle uRban plannIng Decision support accountinG for urban mEtabolism
FP7-ENV-2007-1	212085	Marine Environment	MEECE	Marine Ecosystem Evolution in a Changing Environment
FP7-ENV-2007-1	211534	Environmental Technologies	AQUAFIT4USE	Water in Industry, Fit-for-Use Sustainable Water Use in Chemical, Paper, textile and Food Industry
FP7-ENV-2007-1	211523	Environmental Technologies	DIGISOIL	Integrated system of data collection technologies for mapping soil properties
FP7-ENV-2007-1	211386	Natural Resources Management	ISOIL	Interactions between soil related sciences - Linking geophysics, soil science and digital soil mapping

FP7-ENV-2007-1	212781	Natural Resources Management	ISOSOIL	Contaminant-specific isotope analyses as sharp environmental-forensics tools for site characterisation, monitoring and source apportionment of pollutants in soil
FP7-ENV-2007-1	213161	Natural Resources Management	MODELPROBE	Model driven Soil Probing, Site Assessment and Evaluation
FP7-ENV-2007-1	212782	Environmental Technologies	W2PLASTICS	Magnetic Sorting and Ultrasound Sensor Technologies for Production of High Purity Secondary Polyolefins from Waste
FP7-ENV-2007-1	211873	Environmental Technologies	ISSOWAMA	Integrated Sustainable Solid Waste Management in Asia
FP7-ENV-2007-1	212531	Environmental Technologies	LORE-LCA	Low Resource consumption buildings and constructions by use of LCA in design and decision making
FP7-ENV-2007-1	212998	Environmental Technologies	PERFECTION	PERFORMANCE INDICATORS FOR HEALTH, COMFORT AND SAFETY OF THE INDOOR ENVIRONMENT
FP7-ENV-2007-1	212304	Tools for Sustainable Development	TESS	Transactional Environmental Support System
FP7-ENV-2007-1	213091	Tools for Sustainable Development	SUST-RUS	Spatial-economic-ecological model for the assessment of sustainability policies of Russia
FP7-ENV-2007-1	211759	Tools for Sustainable Development	IN-STREAM	INtegrating MainSTREAM Economic Indicators with those of Sustainable Development
FP7-ENV-2007-1	212457	Tools for Sustainable Development	CSOCONTRIBUTION2SCP	Partnering to Enhance Civil Society Organisations' Contribution to Research in Sustainable Consumption & Production
FP7-ENV-2007-1	213106	Tools for Sustainable Development	ENCI-LOWCARB	European Network engaging CIvil society in Low Carbon scenarios
FP7-ENV-2007-1	211662	Tools for Sustainable Development	SUSTAINERGYNET	Integrating civil, scientific and stakeholder knowledge towards African sustainable energy policy
FP7-ENV-2007-1	212237	Tools for Sustainable Development	ESDINDS	The Development of Indicators & Assessment Tools for CSO Values-based projects in Education for Sustainable Development (ESD)
FP7-ENV-2008-1	226375	Climate Change	ICE2SEA	Ice2sea - estimating the future contribution of continental ice to sea-level rise
FP7-ENV-2008-1	226701	Climate Change	CARBO-EXTREME	The terrestrial Carbon cycle under Climate Variability and Extremes – a Pan-European synthesis

FP7-ENV-2008-1	226520	Climate Change	COMBINE	Comprehensive Modelling of the Earth system for better climate prediction and projection
FP7-ENV-2008-1	226310	Climate Change	REDD-ALERT	Reducing Emissions from Deforestation and Degradation through Alternative Landuses in Rainforests of the Tropics
FP7-ENV-2008-1	226248	Climate Change	ATP	Arctic Tipping Points
FP7-ENV-2008-1	226282	Climate Change	POEM	Policy Options to engage Emerging Asian economies in a post-Kyoto regime
FP7-ENV-2008-1	226442	Environment and Health	ENNAH	European Network on Noise And Health
FP7-ENV-2008-1	226285	Environment and Health	ENRIECO	ENVIRONMENTAL HEALTH RISKS IN EUROPEAN BIRTH COHORTS
FP7-ENV-2008-1	227073	Natural Hazards	CAPHAZ-NET	Social Capacity Building for Natural Hazards: Toward More Resilient Societies
FP7-ENV-2008-1	226479	Natural Hazards	SAFELAND	Living with landslide risk in Europe: Assessment, effects of global change, and risk management strategies
FP7-ENV-2008-1	226555	Natural Hazards	IMPRINTS	IMproving Preparedness and RIsk maNagemenT for flash floods and debriS flow events
FP7-ENV-2008-1	226571	Natural Resources Management	TWIN2GO	Coordinating Twinning partnerships towards more adaptive Governance in river basins
FP7-ENV-2008-1	226273	Natural Resources Management	WISER	Water bodies in Europe: Integrative Systems to assess Ecological status and Recovery
FP7-ENV-2008-1	226544	Natural Resources Management	MOTIVE	Models for Adaptive Forest Management
FP7-ENV-2008-1	226661	Marine Environment	MESMA	Monitoring and Evaluation of Spatially Managed Areas (MESMA)
FP7-ENV-2008-1	226354	Marine Environment	HERMIONE	Hotspot Ecosystem Research and Man's Impact on European seas
FP7-ENV-2008-1	226675	Marine Environment	KNOWSEAS	Knowledge-based Sustainable Management for Europe's Seas
FP7-ENV-NMP-2008-2	226791	Environmental Technologies	NAMETECH	Development of intensified water treatment concepts by integrating nano- and membrane technologies
FP7-ENV-2008-1	226870	Environmental Technologies	UMBRELLA	Using MicroBes for the REgulation of heavy metaL mobiLity at ecosystem and landscape scAle: an integrative approach for soil remediation by geobiological processes
FP7-ENV-2008-1	226995	Environmental Technologies	EU CHIC	European Cultural Heritage Identity Card

FP7-ENV-2008-1	226225	Environmental Technologies	WRECKPROTECT	Strategies for the protection of shipwrecks in the Baltic Sea against forthcoming attack by wood degrading marine borers. A synthesis and information project based on the effects of climatic changes.
FP7-ENV-2008-1	226898	Environmental Technologies	ROCARE	Roman Cements for Architectural Restoration to New High Standards
FP7-ENV-2008-1	226824	Environmental Technologies	ADVANCEETV	Coordination action on Environmental Technology Verification ETV - Building a framework for international cooperation
FP7-ENV-2008-1	226589	Tools for Sustainable Development	PASSO	Participatory Assessment of Sustainable Development indicators on good governance from the Civil Society perspective
FP7-ENV-2008-1	227030	Tools for Sustainable Development	CONVERGE	Rethinking Globalisation in the light of Contraction and CONVERGEnce
FP7-ENV-2008-1	227042	Climate Change	SUSTAINABLERIO	Sustainable development reflexive inputs to world organisation
FP7-ENV-2008-1	226814	Tools for Sustainable Development	PRIMUS	Policies and Research for an Integrated Management of Urban Sustainability
FP7-ENV-2008-1	226521	Dissemination and Communication	ORCHESTRA	Organising dissemination on Results of projects on Chemical Evaluation, Spreading Techniques for Risk Assessment
FP7-ENV-2009-1	244031	Climate Change	CLIMSAVE	Climate change integrated assessment methodology for cross-sectoral adaptation and vulnerability in Europe
FP7-ENV-2009-1	244237	Environment and Health	COPHES	European coordination action on human biomonitoring
FP7-ENV-2009-1	243888	Natural Hazards	FUME	Forest fires under climate, social and economic changes in Europe, the Mediterranean and other fire-affected areas of the world
FP7-ENV-2009-1	244061	Natural Hazards	SYNER-G	Systemic Seismic Vulnerability and Risk Analysis for Buildings, Lifeline Networks and Infrastructures Safety Gain
FP7-ENV-2009-1	244251	Land and Urban Management	SECOA	SOLUTIONS for ENVIRONMENTAL CONTRASTS in COASTAL AREAS
FP7-ENV-2009-1	243840	Natural Resources Management	FIRESMART	FIRE-SMART. FOREST AND LAND MANAGEMENT OPTIONS TO PREVENT UNWANTED FOREST FIRES
FP7-ENV-2009-1	244060	Marine Environment	MARCOM+	Towards an Integrated Marine and Maritime Science Community

FP7-ENV-2009-1	244088	Environmental Technologies	FIRESENSE	Fire Detection and Management through a Multi-Sensor Network for the Protection of Cultural Heritage Areas from the Risk of Fire and Extreme Weather Conditions
FP7-ENV-2009-1	244236	Environment and Health	CHEMSCREEN	CHEMICAL SUBSTANCE IN VITRO/IN SILICO SCREENING SYSTEM TO PREDICT HUMAN- AND ECOTOXICOLOGICAL EFFECTS
FP7-ENV-2009-1	244103	Tools for Sustainable Development	CORPUS	Enhancing connectivity Between Research and Policymaking in Sustainable Consumption
FP7-ENV-2009-1	244250	Dissemination and Communication	CONGRESS	Conservation Genetic Resources for Effective Species Survival
FP7-ENV-2009-1	244089	Dissemination and Communication	MOUNTAIN.TRIP	Mountain Sustainability: Transforming Research into Practice, regional development, new communication tools
FP7-NMP-ENV-2009	247899	Environment and Health	NANOPOLYTOX	Toxicological impact of nanomaterials derived from processing, weathering and recycling of polymer nanocomposites used in various industrial applications
FP7-ENV-2009-1	244164	Dissemination and Communication	MARINETT	European Marine Research Knowledge Transfer and Uptake of Results
FP7-ENV-2010	265137	Land and Urban Management	CLUVA	CLimate change and Urban Vulnerability in Africa
FP7-ENV-2010	265099	Marine Environment	EUROMARINE	Integration of European marine research networks of excellence - Euromarine
FP7-AFRICA-2010	266200	Environmental Technologies	WASHTECH	Water, Sanitation and Hygiene Technologies
FP7-ENV-2010	265327	Environmental Technologies	BAT4MED	Boosting Best Available Techniques in the Mediterranean Partner Countries
FP7-ENV-2010	265172	Environmental Technologies	PANTURA	Flexible Processes and Improved Technologies for Urban Infrastructure Construction Sites
FP7-ENV-2010	265116	Environmental Technologies	AIRMONTECH	Air Quality Monitoring Technologies for Urban Areas
FP7-ENV-2010	265132	Environmental Technologies	MEMORI	Measurement, Effect Assessment and Mitigation of Pollutant Impact on Movable Cultural Assets. – Innovative Research for Market Transfer.
FP7-ENV-2010	265170	Tools for Sustainable Development	ERMITAGE	Enhancing Robustness and Model Integration for The Assessment of Global Environmental Change

FP7-ENV-2010	265191	Tools for Sustainable Development	INCONTEXT	InContext: Individuals in Context: Supportive Environments for Sustainable Living
FP7-ENV-2010	265155	Tools for Sustainable Development	LOCAW	Low Carbon at Work: Modelling agents and organisations to achieve transition to a low carbon Europe
FP7-ENV-2010	265144	Tools for Sustainable Development	VISION RD4SD	Producing a shared vision on how to harness Research & Development for Sustainable Development
FP7-ENV-2010	265167	Dissemination and Communication	WATERDISS2.0	Dissemination and uptake of FP water research results
FP7-ENV-2010	265275	Dissemination and Communication	ENVIMPACT	Increasing the impact of Central-Eastern European environment research results through more effective dissemination and exploitation
FP7-ENV-2011	283177	Natural Hazards	CATALYST	Capacity Development for Hazard Risk Reduction and Adaptation
FP7-ENV-2011-ECO-INNOVATION-OneStage	282864	Environmental Technologies	ECOWEB	EcoWeb a dynamic e-dissemination platform for EU eco-innovation research results
FP7-ENV-2011-ECO-INNOVATION-OneStage	283111	Environmental Technologies	ECO-PRO	Professional promotion of eco-innovative research results through a new media integrated platform for SMEs, research and the public
FP7-2011-GC-ELECTROCHEMICAL-STORAGE	285571	Environmental Technologies	ELCAR	E-Mobility Life Cycle Assessment Recommendations
FP7-2011-NMP-ENV-ENERGY-ICT-EeB	285490	Environmental Technologies	EEBGUIDE	Operational Guidance for performing Life Cycle Assessment Studies of the Energy efficient Buildings Initiative

Guidelines provided to the monitors:

Introduction

The ex-post FP7 environment assessment will follow a three step approach: overall analysis of a selection of finished (~100) projects (step 1); in depth analysis of a selection of projects with focus on thematic issues (step 2); strategic analysis employing meta-studies and other sources (step 3). This document contains the guiding Questions for Monitors for Step 1.

The assessment will be based on the following understanding of outputs, outcomes and impacts[118]:

- Output: product or service produced as a direct output; outputs are typically short-term and are intended to lead to results and contribute to intended long-term impacts);
- Outcome: results contributing to achieving overall objectives of projects; as such they too lead to desired changes that initially motivated policy intervention;
- Impact: typically long-term changes a project contributes to (impacts can be analysed in many dimensions including socio-economic, technological, cultural, political or environmental). Depending on when they occur, impacts can range from short- to long-term.

The assessment will apply a user perspective as illustrated in the different sections of this guide:

1. **Output-outcome-impact focus on science (excellence)**
2. **Output-outcome-impact focus on businesses (innovation)**
3. **Output-outcome-impact focus on policy (EU environmental policies)**
4. **Output-outcome-impact focus on cross-cutting issues**
5. **Output-outcome-impact focus on European Added Value**
6. **Output-outcome-impact focus on Grand Challenges**

The questions have been drafted as an intended guideline for the Monitors, providing them with a basis from which to work. The Monitors are not obliged to secure answers for each question, only those that are relevant to the particular project. Where necessary, the Monitors should also add comments on aspects of particular differentiation and note. This is particularly relevant given the context of the range of funding instruments which structure the projects that are under review; for example, the range of funding instruments indicates that some projects are structured as laboratory research focused, some are structured as network and dissemination focused, while some are structured with their focus on funding agencies. The Monitors' reports are an essential input in the ex-post FP7 environment assessment. Apart from forming a significant contribution to the assessment per se, the content of the monitoring reports will guide the analysis in the consequent steps. We will be relying on your expertise and insights to identify projects that are promising in terms of impacts and thus worthy of further investigation. Quality of reports is of vital importance. However, please avoid writing large texts or copy-pasting parts of the final projects' reports into the monitoring reports, which should be 15 pages max. Be as comprehensive and concise as possible. While the primary source is the projects' final reports you may need to interview some projects' coordinators or partners to get better insights about actual or potential achievements.

1. Output-outcome-impact focus on science (excellence)

1.1 Publication Outcome

[118] Source: amended from ERAWATCH (2013) 'A guidebook to assessing environmental impacts of research and innovation policy'

What is (will be) the total number publications produced within the project that are recorded in the Web of Science (WoS), Scopus or other equivalent scientific citation index?

Explanations / Instructions: In all research fields, improving scientific excellence was one of the key objectives in FP7 in addition to innovation and support to policies. The most common approach to scientific excellence is the number, quality and citations of scientific publications. Journal quality is measures with the impact factor. Although some scientific fields still value other publication formats (e.g. books), the trend towards impact factor publications is evident in all scientific and social scientific disciplines. Scientific publishing takes time. It is therefore most likely that the bulk of publications will only appear after the project end. We therefore partly need to work with estimates of future publications related to the project. In specific the following information should be derived:

- *What is the total number of WoS, Scopus or other equivalent publications produced in the project?*
- *What is the estimated total number of WoS, Scopus or other equivalent publications listed publications expected as an outcome of the project*
- *What is the number of special journal issues produced in your project (communication with the project coordinator)*
- *Impact Factor: Has the project research affected publication habits of projects partners towards higher/lower impact factor journals?*
- *Interdisciplinarity: Has the project research affected publication habits of projects partners towards more/less interdisciplinary journals?*

Please take note however that the interest behind this set of questions is about what difference the project made in publication dynamics (increase in publishing, more highly rate journals targeted, etc.) rather than the absolute numbers of publications produced.

1.2 Scientific excellence of participants

Has the project been able to attract the most excellent researchers and improved the excellence of participating researchers?

Explanations / Instructions: From view point of scientific excellence, a research program was successful when most excellent participants could be attracted for participation and when researchers excellence improved through the collaboration in the program. Scientific excellence at individual level is usually measure with the so called h-factor and with the impact factor of journal they publish in. However, average h-factors and journal impact factors vary with the scientific disciplines. The typical range of h-factors and journal impact factors for the particular research fields needs therefore be acknowledged. The questions ca be as follows:

- *Has the project been able to attract the most excellent researchers in the respective scientific fields (measure by h-factor and/or high impact factor publications or another indicator usually applied in that scientific field)*
- *Has the project execution led to an increase of excellence scoring (measure by h-factor and/or high impact factor publications or another indicator usually applied in that scientific field) of participants or is this likely to occur?*
- *Can you indicate whether and how the project has offered to improve scientific excellence for early career researchers?*

1.3 Research debate/agenda

Explanations / Instructions: There is a tendency of the scientific communities to self-organize at international levels and to jointly shape an agenda of international research cooperation. In the environment area most prominent examples are the IPCC program, the Future Earth Program of ICSU (International Council of Scientific Unions), the IPBES (Intergovernmental Platform for Biodiversity and Ecosystem

Services). Active interaction in these platforms can be seen as one measure of scientific excellence and international integration. The questions can be as follows:

- *Has the project or its participants interacted with international fora shaping the research agenda in this field (e.g. IPCC, Future Earth, IPBES); provide the name of the initiative and explain how your project contributed to it.*
- *Has the project interacted with other FP7 projects of similar scope and/or took other means to shape the research policy debate and the research agenda in Europe and beyond?*

2. Output-outcome-impact focus on businesses (innovation)

Here the basic question is: how helpful FP7 projects have been for creating new business around clean technological and other forms of sustainable economics. Here we should address the quality and level of cooperation between research and business. Moreover, we should investigate how the data and possible innovations produced in the research project have helped businesses to create new product and services. What kind of evidence do we have for observable direct and indirect benefits of this sort?

2.1 Project classification

- What was the targeted topic of the project or call: choose from the list in Annex A?
- Please indicate the type of innovation on which your project would mainly relate to:
  - Core: low-risk, short-term, not creating new markets or using new technology
  - Adjacent: medium-risk, medium term, new market, largely applying existing technology base
  - Transformational: game-changing, breakthrough, disruptive: high-risk, long-term, creating entirely new products or services, based on new technology
- Please classify the project results aiming at industrial innovation according to the Technology Readiness Levels (TRL) defined in Annex B.

2.2 Innovation output &outcome

What new products, services, technologies or infrastructures project has produced?

New or modified products, technologies or infrastructures are the most common tangible outcome of innovation policies. These can be both direct and indirect outputs and outcomes of specific research and innovation projects, instruments or programs. The types of related outcomes can range from developing and testing a product prototype, through introducing a new technology to the market, to supporting a wide diffusion of existing technologies.

2.3Innovation impact

Has the project had a wider socio-economic impact?

Explanations/Instructions: Here we are referring to the following set of impact types:

a) *Impact on production system and business models. Here we focus on how the production system delivers value to users. This includes the production processes (e.g. design and manufacturing of products and technologies) as well as service systems associated with products. On the level of impacts, the focus is on how new or modified goods or services diffuse and whether and to what extent they substitute existing products or services. The latter allows the analysis of potential substitution and rebound effect.*

b) *Impact on technical infrastructures and built environment. This is closely related to the production system, but the focus is on how new or modified products (notably new materials and technologies) influence lasting infrastructures and the built environment. The area is introduced to emphasise the relevance of infrastructures for generating or avoiding environmental pressures and impacts.*

c) *Impact on jobs.* Has the project helped to create new jobs?

d) *Impact on competitiveness. Has the project had direct or indirect impact on competitiveness of the participating industries and / or their respective sector(s)?*

e) *Impact in terms of expected patents and spin-offs*

f) *Impact on the reputation of the participating industries / SMEs*

2.4 Impact on Open Innovation

TO WHAT EXTENT AND HOW DID THE PROJECT ADDRESS/APPLY PRINCIPLES OF OPEN INNOVATION?

Explanations / Instructions: open innovation principles may have been applied in various phases of the project:

- *research organisation and execution via the engagement of businesses and research communities but also users and/or competitors;*
- *research exploitation via the examination of various channels and application of practices like licensing, joint ventures or spin-offs;*
- *research ownership via the creation of Intellectual Property (in the form of patents, designs, prototypes, etc.) and joint ownership by partners (SMEs, large enterprises, research/academic institutions, etc.)*
- *new or modified social practices and new forms of organization; here we mainly talk about changes in behavior at the organisational level (i.e. company) that may take the form of increased collaboration between industry and research community, collaboration across industries or with competitors, etc.*

3. Output-outcome-impact focus on policy

Here we refer to possible contribution of the project on European environmental policies (including sustainable, development, climate change, biodiversity, soil, GEO, maritime, water, waste, and land use). There is increasing requirement for evidence-informed policy development, decision-making and practice. Productive engagement is required between a broad range of stakeholders within the research and user communities, with the longterm goal to improve policy systems across Europe. Despite best efforts, research output cannot be used if it cannot be accessed (for example, an online research portal that enables users to identify quality assured research carried out across Europe, on domain specific areas, would be useful to assist policy makers). At the same time it is not uncommon that policy-makers are less engaged than anticipated of that they suffer a lack of traction for different reasons. Engagement as well as lack of engagement of the policy world is equally important to note.

Structuring the Science-Policy Interface as a tool for transformation: questions

3.1 Relevance to policy areas

- Which policy area would you say your project mainly relates to?
- In responding to the call, did the coordinator focus on the overall objective of the call topic, or on how their research area could be adapted to address the call?
- Did the consortium dialogue with national and/or pan-European policy agencies when addressing the design of the project?

3.2 Consortium composition

- Was the consortium composed of a mixture of representatives of both the

research and policy communities?

3.3 Project design

- Did the project include a "Science-Policy Interface Panel" as part of its structure ab initio. For example did the project:
    - Engage policy makers in the concept and design of the project?
    - Work with policymakers to understand underlying problem?
    - Consider alternate design to accommodate constraints and realities from the policy-makers perspectives without compromising scientific rigour and objectivity?
    - Apply a continuous, iterative process in refining objectives and measures by using short term outcomes to inform the long-term objectives?

3.4 Dissemination - synergies

- How did the project address communication and dissemination of results and outputs, beyond the traditional academic avenues? Are support tools available to use the best available research evidence in decision making? Tools would, for example address:
    - using research to clarify a problem
    - using research to frame options for a policy issue
    - preparing policy briefs
    - using policy dialogues in decision making
- Did the project produce, for dissemination to policy makers:
    - Topic summaries
    - Policy briefings – to include and overview work beyond your own project, to include the broader body of evidence
    - Workshops with policy makers, from which the project approach was further refined
- How did the project interface with other research projects working on complementary themes, in particular those funded via FP, ERANet and/or other pan-European funding structures and programmes?

4. Output-outcome-impact focus on cross-cutting issues

Here we are interested in the broader impacts/contribution of projects in areas related to the European Research Area (like (gender issues, mobility, international cooperation, open access, or issues related to young or senior researchers and issues associated with 'science with and for society')

4.1 Gender issues

To what extent and how did the project address gender issues in research in a direct or indirect way?

Explanations / Instructions: gender issues may be addressed at three levels:

- *At the proposal writing stage: there is usually a section asking if and what gender issues the proposal raises/addresses*
- *At the proposal organisation level: in some cases attention is paid so that the composition of the research team is balanced in relation to gender;*
- *During the execution of research; in some cases the research itself may have been oriented to deal/address gender issues or impacts on gender may be anticipated.*

4.2 Young researchers

To what extent and how did the project benefit young researchers? In what way?

Explanations / Instructions: young researchers may have been affected in a number of direct or indirect ways:

- *Direct ways: the project may have provided for the execution of PhD research or post-doc research,*
- *Indirect ways: the resources available under the project may have led participating organisations to hire young researchers.*

4.3 Senior researchers

To what extent did the project include senior researchers (55+)? What was their share in the overall team?

4.4 Mobility

To what extent and how did the project facilitate mobility of researchers (across countries, across sectors (academia-industry) or across institutions)?

4.5 Continuity of research

To what extent and how did the project continue over time?

Explanations / Instructions: continuity of projects may occur in a variety of ways:

- *The networks of people/organisation formed continue or are expanded to collaborate in some way or another after the project end*
- *The specific area or issue of research continues to be or becomes more important for the (ex) project participants*
- *The project results prove useful in other research areas than those initially thought of*
- *At the end of the project industrial partners may express interest in exploiting the research results further with own resources or under other national / European public funding opportunities or by exploring venture capital type of resources. If this is the case it would be important to be as detailed as possible about the level of intended investment, i.e. own sources, national / European funding, VC funds targeted, etc.*
- *In some cases the consortium (or a part of it) might have received funding previously through the FPs or other European funding programmes to address aspects of the policy topic which are addressed in this FP7 project. It would also be important to highlight these cases too.*

4.6 Science with and for society

To what extent and how did the project involve society (societal organisations, NGOs, general public, pressure groups, etc.)?

Explanations / Instructions: society may be targeted for a variety of purposes as shown below.

- *Raising awareness: the project may have included dissemination of the research results in the wider public through activities like science fairs/exhibitions, articles/interviews in the popular media/press, and summaries of the project/results in plain language available on the project website and widely distributed. Such information would be available in the final reports as project outcomes (this would be at the outcome level following Technopolis-Katharina's logic chart)*
- *Training: some projects may have also included in their (dissemination) activities visits and presentations to schools and other education institutions, and / or development of curricula. Such information would be available in the final reports as project outcomes or can be retrieved during interviews in case of unintended / later effect. (this would be at the outcome level or impact-action level if unintended following Technopolis-Katharina's logic chart)*
- *Empowerment: the project may have deliberately included societal organisations (NGOs, pressure groups, etc.) as core partners. In these cases it would be important to find out*

- *what the role of these organisations was in the project , how actively they were engaged and in which activities, and*
- *if and how the experience from this participation changed their organisational behaviour, e.g. they are not more inclined to participate in research projects; they have retained collaboration with (some of) the partners; they have now more resources in research execution, etc. Such indirect impacts would be retrievable during interviews. (this would be at the impact-action level following Technopolis-Katharina's logic chart and addressing issues of behavioural additionality)*

- *Behavioural change: research results may lead to R&I policies which in turn can lead to widely-disseminated new practices in households. This can be linked with dissemination of new knowledge (e.g. on daily hygiene), specific technology (e.g. ICT) or pricing mechanisms supported by public policy.*

4.6 International cooperation

To what extent and how did the project lead to benefits in relation to international cooperation?

Explanations / Instructions: by default FP research leads to internationalisation of research activities as it is a prerequisite of participation. The extent to which this is done can be examined in various ways by means of specific impacts on international networking, or examining added value: for example

- *To what extent could the specific research be undertaken without international cooperation?*
- *To what extent and how did participation in the project enlarge the international networks of the participants?*
- *To what extent and how did the project provide access to new markets?*
- *Other?*

4.7 Open access and transfer of scientific knowledge

To what extent and how did the project address/apply principles of open access?

Explanations / Instructions: open access may refer to scientific knowledge, data as well as infrastructures. Indications that the project contributed to the various aspects of open access can be found at two levels as shown below. While open access to scientific results starts becoming commonplace, there may be controversial issues about open access to data. It is worth noting such cases too.

- *At the output level: the proposal explicitly mentioned a primary focus on open access principles for the dissemination of produced knowledge and data, or project activities were based on the pre-condition of open access to existing infrastructures (facilities, data-bases, etc.) or project activities aimed at creating (new) open-access infrastructures. Such information would be available in the final reports*
- *At the impact – action level: the content of the research might have been directed to facilitate or enable adoption of open access principles in various settings, like harmonisation and opening up of databases, definition of criteria for sharing infrastructures, etc. Such information would also be available in the final reports but might also make sense to raise this issue in interviews if the reviewer considers it worthwhile.*

5. Output-outcome-impact focus on European Added Value

5.1 European Added Value

To what extent and how does the project outcomes and impacts reflect European added value?

Explanations / Instructions: European added value has different dimensions as explained below:

- *Infrastructures: access to infrastructures and databases is important in environmental research. However this is sometimes hampered by different national rules and settings, or incompatibility and lack of interoperability of systems. Projects may lead to harmonising or enabling inter-connectedness national infrastructures (output level) or contribute to creating (new) joint European infrastructures (impact level). Relevant information would be in the final reports. Relevant information would be in the final reports but is also an interesting impact item to discuss in interviews.*
- *Environmental challenges: although bound by context and natural specificities, environmental problems usually cross national – borders. This coupled with limiting research budgets to deal with specific issues makes international collaboration imperative. Some projects may have been explicitly organised in partnerships including actors from several regions or countries facing similar environmental problems and jointly looking for possible solutions. Information of such an approach would be included in the final reports.*
- *Coordination of national policies to avoid duplication; this is directly related to dealing with challenges that cross borders especially under limiting public resources*
- *Building up research capacity, including infrastructures; projects may target regions of the Union or research areas that would otherwise be unable to command sufficient resources if they rely exclusively on national or sub-national government funds;*
- *This is also related to pooling resources to attain critical mass, especially where a multi-disciplinary approach is needed*
- *The potential for leveraging additional resources from the private sector in areas in which market developments can be expected.*

6. Output-outcome-impact focus on Grand Challenges

In this section we are interested in the possible contributions of project towards dealing with Grand Societal Challenges. For instance:

- What was the main original scientific contribution to knowledge of your project?
- Is this contribution to knowledge relevant for one or more of the Grand Societal challenges and why? Is this contribution to knowledge relevant for sustainable development and why?
- How could this contribution to knowledge turn into a contribution for solving Grand Societal Challenges or for sustainable development and what is needed for that?
- Is there an interaction with other projects of the framework program or at national or international levels to achieve a critical mass required to address this problem?

* * *

Annex A: Topics of the Theme Environment

Climate change, pollution and risks

- Pressures on environment and climate
- Environment and health
- Natural hazards

Sustainable management of resources

- Conservation and sustainable management of natural and man-made resources and biodiversity
- Management of marine environments

Environmental technologies

- Environmental technologies for observation, simulation, prevention, mitigation, adaptation, remediation and restoration of the natural and man-made environment
- Protection, conservation and enhancement of cultural heritage, including human habitat
- Technology assessment, verification and testing

Earth observation and assessment tools for sustainable development

- Earth and ocean observation systems and monitoring methods for the environment and sustainable development

Annex B: Technology readiness level for FP7 projects

(source: NASA)

Where a topic description refers to a TRL, the following definitions apply:

TRL 1 – basic principles observed

TRL 2 – technology concept formulated

TRL 3 – experimental proof of concept

TRL 4 – technology validated in lab

TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)

TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)

TRL 7 – system prototype demonstration in operational environment

TRL 8 – system complete and qualified

TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

Appendix VI: Chapter 2: Types of outputs of relevance to impacts

– Published papers in peer-reviewed journals

– Conference contributions and reports

– Books, book chapters and research monographs

– Patents

– Software, computer code and algorithms

– Digital artefacts such as datasets, archives, film and other non-print media, web content such as interactive tools

– Standards documents

– Technical reports

– Research based clinical case studies that add new knowledge

– Teaching and curriculum materials

Appendix VII: Participation to FP7-Environment

General overview

In the period 2007-2013, FP7-Environment issued 29 calls for proposals, eliciting 2,589 proposals, of which 19.05% were retained for negotiations. Thus FP7-Environment funded 493 projects, involving 7,102 participations (14.4 per project on average). Table 1 compares rates of participation amongst the 10 FP7 Cooperation themes.

Table 1: Number of participations and EU contributions by Cooperation themes (%)

	Participations	%	EU contribution (X 1,000 €)	%
Health	11124	13,94	4754226	18,42
Food, Agriculture and Fisheries, and Biotechnology	7813	9,79	1841975	7,14
Information and Communication Technologies	21940	27,49	7706069	29,85
Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP	10156	12,72	3239194	12,55
Energy	4161	5,21	1660133	6,43
Environment (including Climate Change)	7102	8,90	1717516	6,65
Transport (including Aeronautics)	8969	11,24	2279309	8,83
Socio-economic sciences and Humanities	2708	3,39	570557	2,21
Space	2598	3,25	702585	2,72
Security	3068	3,84	1028413	3,98
General Activities	183	0,23	312688	1,21
TOTAL COOPERATION	**79822**	**100**	**25812665**	**100**

Source: e-Corda

The number of participations correlate almost perfectly with the EU contribution (R-Square = 99.5%). This means that the average size of projects is proportional to budgets all around the Cooperation specific programme.

Table 2 presents the breakdown of participants by type of organisation.

Table 2: Breakdown of participations by activity type (%)

	Public body (excl. research and education)	Non-profit Research organisations	Private for profit (excl. Education)	Secondary and Higher Education Establishments Organisations	Other	All
Environment	7,6	35,7	19,5	34,2	3,0	7102
Cooperation (all, excl. JTIs)	5,3	25,1	33,6	33,2	2,8	79822

Source: e-Corda

The FP7-Environment programme was characterized by a low participation of industry, of which vast majority were SMEs.

The proportion of "private for profit" organizations (i.e. industry) that participated in FP7-Environment is below the average of the Cooperation specific programme, while there are more non-profit research organization and public bodies. The only Cooperation programme with a clearly lower participation of industry was "Socio-economic sciences and humanities" (5.2%), while "Health" presented a similar proportion (19.2%).

1,033 SMEs participated to FP7-Environment (74.6% of industry, or 14.5% of all participations). This proportion of SMEs is comparable to other programmes such as Health (79.8%); Food, agriculture and fisheries (74.3%); or Socio-economy and humanities (75.4%), and clearly above Transport, Energy, Security, ICT (below 50%), or Industrial Technologies and Space (below 60%).

The category "Other" includes NGOs and Civil Society organizations (CSOs), including WWF, the Club of Rome, the Paul Getty Trust, European networks such as the European Science Foundation, fair trade organizations such as Max Havelaar, think tanks and experts groups, etc. They represented 3% of the FP7-Environment participants, which appears low considering the importance of citizen-involvement in an area such as environment.

Beneficiaries by organization type

The total number of beneficiaries (i.e. organizations with at least one participation) was **2,963**, of which **1,121** from industry (37.8%). This means that organizations participated in 2.4 projects in average. However, the dispersion is huge, as shown in Figure 1.

The majority of participants (68.4%) were involved in one single FP7 project. The number of participations by beneficiary decreases very rapidly, but 122 organizations (4.1%) were involved in 10 projects or more.

The fact that beneficiaries repeat participation can be considered as an indicator of the attractiveness and quality of the programme. It is indicative that such organizations had a positive experience the first time, and that led them to submit further proposals. It can be a symptom of attractiveness of the FP7-Environment programme, either to belong to a certain elite of R&I organizations, or to ensure continuity of research.

It is also important to reach a right balance between new participants and experienced ones. If participation was dominated by traditional players, it would become a "closed club" – something contrary to key principles of FP7 and the European Research Area.

Figure 1: Number of organizations by number of participations (and detail)

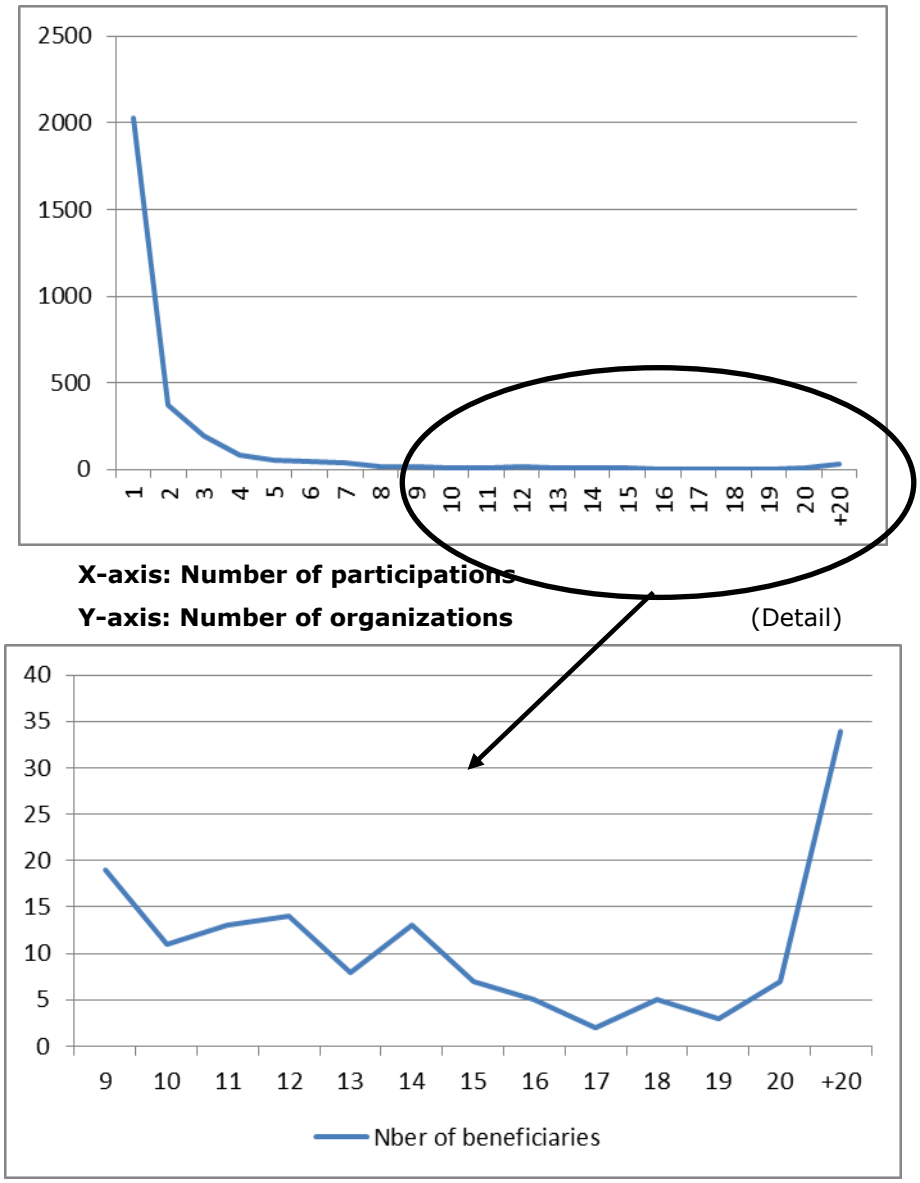

Table 3 shows the 21 FP7 beneficiaries who received higher European Commission's financial contributions, and those who participated more times.

Table 3: Top 21 organizations in terms of EU financial contribution and number of participations.

Organization	EC contribution (€)
CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	24415703,29
NATURAL ENVIRONMENT RESEARCH COUNCIL	22890031,18
STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	21777704,18
JRC -JOINT RESEARCH CENTRE-EUROPEAN COMMISSION	20621930,21

Organization	Number of participations
JRC -JOINT RESEARCH CENTRE-EUROPEAN COMMISSION	74
CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	69
CONSIGLIO NAZIONALE DELLE RICERCHE	65
NATURAL ENVIRONMENT RESEARCH COUNCIL	57

CONSIGLIO NAZIONALE DELLE RICERCHE	17100045,89
FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V	16907346,49
WAGENINGEN UNIVERSITY	15252407,78
NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK - TNO	15090071,03
AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	14449355,32
MAX PLANCK GESELLSCHAFT ZUR FOERDERUNG DER WISSENSCHAFTEN E.V.	14039467,44
UNIVERSITEIT UTRECHT	13910037,49
STICHTING DELTARES	13061940,67
VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK N.V.	12471045,5
EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZURICH	12447174,14
ALFRED-WEGENER-INSTITUT HELMHOLTZ- ZENTRUM FUER POLAR- UND MEERESFORSCHUNG	11919210,82
AARHUS UNIVERSITET	11470119,86
HELMHOLTZ-ZENTRUM FUER UMWELTFORSCHUNG GMBH - UFZ	11386648,66
POTSDAM INSTITUT FUER KLIMAFOLGENFORSCHUNG	11142472,23
STICHTING VU-VUMC	10685548,15
INTERNATIONALES INSTITUT FUER ANGEWANDTE SYSTEMANALYSE	10010349,82
THE UNIVERSITY OF EXETER	9643994,05

STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	51
AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	49
MAX PLANCK GESELLSCHAFT ZUR FOERDERUNG DER WISSENSCHAFTEN E.V.	41
WAGENINGEN UNIVERSITY	40
FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V	38
EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZURICH	35
NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK - TNO	34
POTSDAM INSTITUT FUER KLIMAFOLGENFORSCHUNG	34
HELMHOLTZ-ZENTRUM FUER UMWELTFORSCHUNG GMBH - UFZ	31
INTERNATIONALES INSTITUT FUER ANGEWANDTE SYSTEMANALYSE	29
AARHUS UNIVERSITET	29
DANMARKS TEKNISKE UNIVERSITET	29
STICHTING DELTARES	27
ECOLOGIC INSTITUT gemeinnützige GmbH	27
VERENIGING VOOR CHRISTELIJK HOGER ONDERWIJS WETENSCHAPPELIJK ONDERZOEK EN PATIENTENZORG	26
UNIVERSITEIT UTRECHT	25
STICHTING VU-VUMC	25

Source: e-Corda

The ranking is dominated by major research institutions, such as the Joint Research Centre (EU), the French *Centre National de la Recherche Scientifique (CNRS),* le *Consiglio Nazionale delle Ricerche* (CNR, Italy), the *Consejo Superior de*

Investigaciones Científicas (CSIC, Spain), the *Max Planck Institute* and the *Fraunhofer Institutes* (Germany) or TNO (Netherlands).

There are also some universities, such as Wageningen, Utrecht and Amsterdam (the Netherlands), Aarhus University and the Danish Technological Institute (Denmark), the Swiss Eidgenössische Technische Hochschule Zürich (ETH Zürich), or the University of Exeter (UK).

Another relevant type of organizations in the top 21 are national environmental agencies, working at the interface between science and policy, such as the Natural Environment Research Council (UK) or Ecologic (Germany).

There are also research centres focused on environment and related areas, including Deltares (Netherlands), Potsdam Institute for Climate Change Research and the Helmholtz Centre for Environmental Research (Germany), the International Institute for Applied Systems Analysis (Austria) or VITO (Belgium).

Industrial participation

There are no industrial participants in this top 21. The main private for-profit organizations in terms of grants received are **KWR Water B.V.** ("Watercycle Research Institute", Netherlands), **NGI** (consultant on offshore energy, construction and transportation, natural hazards and Environmental Engineering, Norway) and **Acciona Infraestructuras** (Spain), ranked respectively 83rd, 102nd and 116th.

When considering the number of participations, the three main private-for profit partners were Acciona (11 participations), the Sustainable Europe Research Institute (SERI, a Pan-European think tank based in Austria) and KWR Water (eight participations).

Most of the private-for-profit organizations are consultants, engineering firms and/or private research organizations. Producers of specific components (e.g. Idonaut srl., specialized in the design, manufacturing and support of high-performance and innovative oceanographic sensors and instrumentation) and even publishers (Pensoft Publishers Ltd, Bulgaria) are also evident.

These data show that industry played a very secondary role in the research activities funded through FP7-Environment. There are however some major industrial participants, such as **Acciona** (Spain, specialized in the development and management of infrastructure, renewable energy, water and services; turnover: € 7,056 billion in 2012[119]), **Veolia** (France, whose main activities are water supply and management, waste management, energy and transport services; revenue in 2013: € 22.3 billion[120]), **Electricité de France**, **Proctor and Gamble**, **Statoil** (Norway), **Nestlé**, **Unilever, Solvay** or **BASF** – but with few participations in most cases.

In more detail, some of the top EU companies in terms of R&D investment[121] did participate to the FP7- Environment programme, namely: **Daimler** (ranked 2nd by its R&D investment, 1 participation), **Nokia** (ranked 7th, 1 participation), **Bayer** (ranked 3rd, 1 participation), **Philips** (ranked 19th, 1 participation), **Continental** (ranked 21st, 2 participations), **BASF** (ranked 23rd, 1 participation), **Unilever** (ranked 31st, one participation) or **ZF** (ranked 38th, 1 participation) – amongst the 50 top ranked EU industries in terms of R&D investment. These companies participated in one or two occasions.

Participation by country

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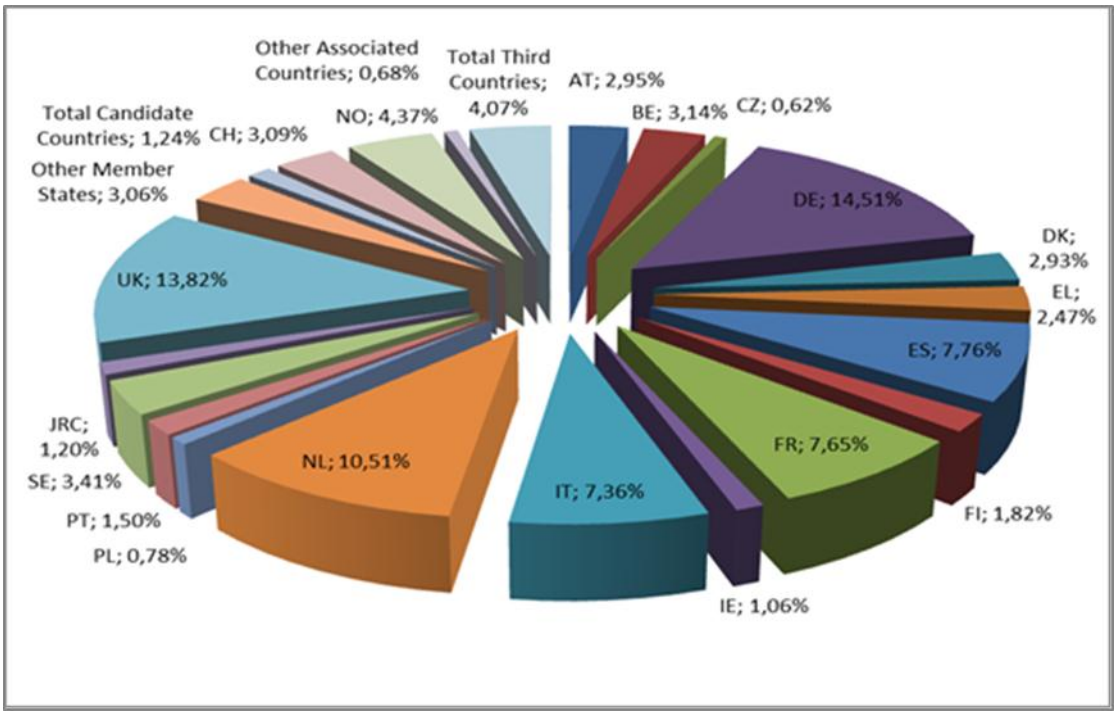
[119] Acciona's Annual Report 2012, at: http://annualreport2012.acciona.com/

[120] http://www.finance.veolia.com/key-key-figures.html

[121] According to: European Commission-Joint Research Centre (2013) *2013 EU Industrial R&D Investment Scoreboard*. Luxembourg: Publications Office of the European Union. At: http://iri.jrc.ec.europa.eu/scoreboard13.html

All Member States have been well represented in FP7-Environment projects, while there are differences in the intensity of involvement. The main beneficiaries are Germany (14.5% of total grants), the UK (13.8%), the Netherlands (10.5%), followed by Spain, France and Italy (less than 6% each). The share of funding received by Member States that joined the EU after 2004 is below 1%. It is also important to mention that Third Countries received 4.1% of the total funding, comparable to a relevant "associated country" such as Norway.

Figure 2: Distribution of EU's contributions by country



Source: e-Corda

EU funding by country correlates well with national GDPs (R-square = 81.8%) and R&D investments (R-square = 72.7%)[122]. This means that the higher the GDP of a country (and therefore, its R&D investment), the more likely it received FP7 grants[123]. The same apply to the whole FP7. One of the main priorities of FP7 being excellence, one could expect this significant correlation between national efforts and success in FP7. The picture would change completely if Structural Funds – focused on cohesion – were included in the analysis.

Figure 3 shows the regression between national R&D expenditure on R&D and FP7-Environment contribution. We can observe which countries have been the most performing compared with their R&D effort[124]:

– The UK, the Netherlands, Spain, Italy and, to a lesser extent, Greece have been the most performing countries, compared with their R&D investment.

– On the contrary, and despite being amongst the main FP7-Environment beneficiaries, Germany and France have received a lower amount of grants than expected.

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[122] Based on Eurostat statistics. Reference year for GDP: 2013. Reference year for R&D investments: 2011.

[123] The relationship is nevertheless inelastic: 0.6.

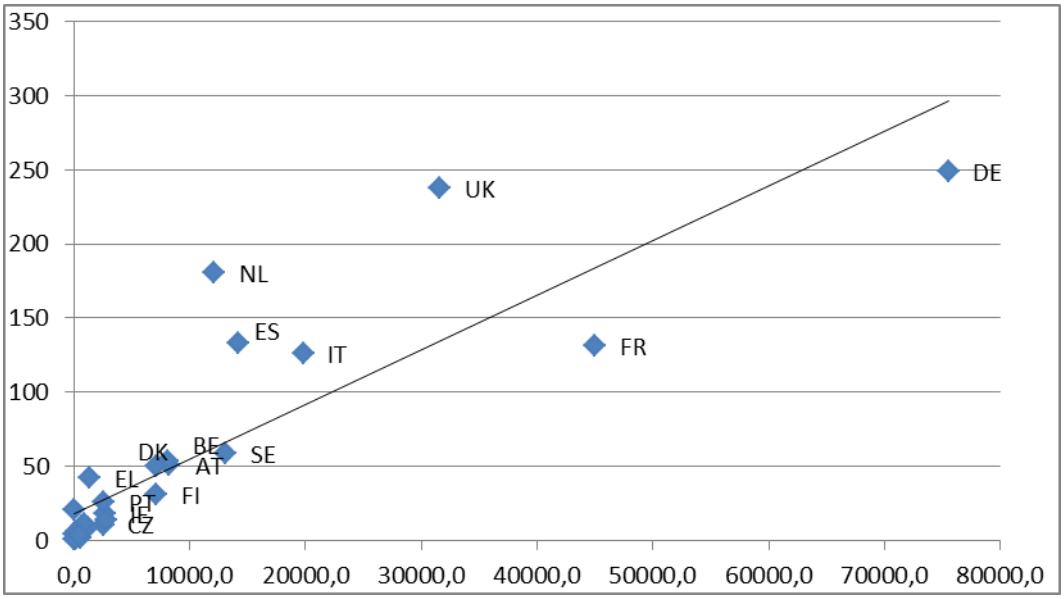
[124] Those situated below the regression line («likely EU contribution») can be considered under-performing, and vice-versa. An analysis of the regression's residuals allows a more detailed view.

– Other countries are close to the expected contribution, but most of them (especially the Member States that joined the EU after 2014) under-performed.

This is indicative that Member States need to attain a certain critical mass in terms of national R&D effort to be in a position of really benefitting from FP7-Environment grants. There are however exceptions, positive (Greece, with a low level of R&D investment but results more positive than expected) and negative (France and Germany).

Benefits of access to EU Framework Programme funding are often crucial in countries where national funding has declined; for example while the UK contributes 11.5% to the overall EU budget, it has won 14.5% of the FP7 research funding.

Figure 3: Regression between national R&D investment and FP7-Environment contribution (EU Member States only)



X-axis: R&D investment Y-axis: EU contribution (FP7-Environment)

Participation and success rates

The FP7-Environment calls received 2,589 eligible proposals, with a success rate of 18.85% – which is close to the Cooperation average (19%). The success rate was lower for Collaborative Projects – CPs – (17.3%) than for CSAs (27.44%).

Table 4: Success rates by instrument

	All funding schemes	CP	NoE	CSA	BSG
Environment (incl. Climate Change)	18,85%	17,26%	20%	27,44 %	20%
Cooperation	19%	17%	31%	32%	15%

An overall success rate of under 20% is considered by most proposal submitters to be low. There are two associated implications: (i) it is a measure of the attractiveness of the programme and of the intensity of the competition; (ii) considerable effort is dissipated in unsuccessful proposals. In principle, the lower the success rate, the higher the expected degree of excellence of projects, but this is an a priori analysis to be validated by projects' outputs and outcomes.

Table 4 presents the FP7-Environment success rates by country of proposers, either as simple beneficiary either as coordinator.

Table 5: Success rates by country: Member of consortia and Coordinators

	Applicants from a country	Success rate	Proposed coordinators from a country	Success rate
AT - Austria	866	23,09%	94	18,09%
BE - Belgium	1135	26,26%	71	25,35%
BG - Bulgaria	298	18,12%	7	0,00%
CY - Cyprus	174	13,22%	6	0,00%
CZ - Czech Republic	396	17,93%	17	0,00%
DE - Germany	3184	25,82%	341	26,69%
DK - Denmark	619	27,79%	67	16,42%
EE - Estonia	117	18,80%	3	0,00%
EL - Greece	1207	14,50%	149	10,74%
ES - Spain	2595	19,38%	270	18,89%
FI - Finland	497	20,93%	49	14,29%
FR - France	1864	25,80%	147	19,05%
HR - Croatia	151	17,22%	2	0,00%
HU - Hungary	383	15,93%	23	17,39%
IE - Ireland	249	29,32%	20	30,00%
IT - Italy	3095	17,06%	387	11,37%
LT - Lithuania	87	19,54%	3	33,33%
LU - Luxembourg	51	17,65%	2	0,00%
LV - Latvia	72	13,89%	3	0,00%
MT - Malta	85	11,76%	3	0,00%
NL - Netherlands	1806	28,96%	197	32,49%
PL - Poland	545	17,80%	32	0,00%
PT - Portugal	721	17,20%	48	8,33%
RO - Romania	462	17,53%	16	18,75%
SE - Sweden	881	23,72%	75	17,33%
SI - Slovenia	357	19,89%	20	20,00%
SK - Slovakia	160	13,13%	7	0,00%
UK- United Kingdom	2.983	26,32%	333	20,42%
Total for MEMBER	**25.040**	**22,24%**	**2392**	**18,81%**
IS - Iceland	77	28,57%	4	25,00%
ME - Montenegro	15	13,33%	0	0,00%
MK - Former Yugoslav Republic of Macedonia	59	6,78%	1	0,00%
RS - Serbia	123	21,95%	6	33,33%
TR - Turkey	333	18,62%	18	5,56%
Total for CANDIDATE	**607**	**19,28%**	**29**	**13,79%**
AL - Albania	32	12,50%	0	0,00%
BA - Bosnia and Herzegovina	29	17,24%	1	0,00%
CH - Switzerland	663	29,11%	34	38,24%
FO - Faroe Islands	6	33,33%	0	0,00%
IL - Israel	293	16,72%	32	0,00%
MD - Moldova (Republic of)	19	5,26%	0	0,00%
NO - Norway	660	32,12%	80	23,75%
Total for ASSOCIATE	**1.702**	**27,38%**	**147**	**21,77%**

Total for TIERS	**20.522**	**19.86 %**	**21**	**9,52%**
TOTAL	**374.765**	**22.29 %**	**2.589**	**18,85%**

Source: e-Corda

EU Member States which joined post-2004 secured lower success rates than the average. However, other countries such as Greece, Spain, Finland, Italy, Luxembourg and Portugal are also below the average. On the contrary, Ireland, the Netherlands, Denmark, the United Kingdom and Belgium present the highest success rates.

The cases of France and Germany are particularly interesting. They under-performed when compared with national R&D investments, but their success rates are high, and above the average. This paradox may be explained by (i) the availability of national R&D programmes, which reduces the need of applying for international funding, and (ii) a higher interest for other Cooperation programmes, more relevant to the national strategic areas of research and innovation.

Spain, Italy and Greece, which over-performed in FP7-Environment grants compared with their R&D expenditure, present success rates below the EU28 average. These cases are the opposite to those of France and Germany; they apply more often for EU funding, with lower success rates, but overall the balance is positive, and international cooperation is likely to increase the level of excellence of participants.

The excellent performance of Switzerland and Norway merits emphasis. These two associated countries present success rates higher than the best amongst EU Member States.

Participation and success rates by country demonstrate that FP7-Environment was focused on scientific excellence. The main beneficiaries were those that invest more in R&D. A certain critical mass of R&D effort is necessary to really benefit from the programme. FP7-Environment gave relevant opportunities to countries such as Spain, Italy and Greece, which presented good levels of participation and funding even if their success rates were below the EU28 average. They could be an example to follow for Member States that acceded to the EU after 2004.

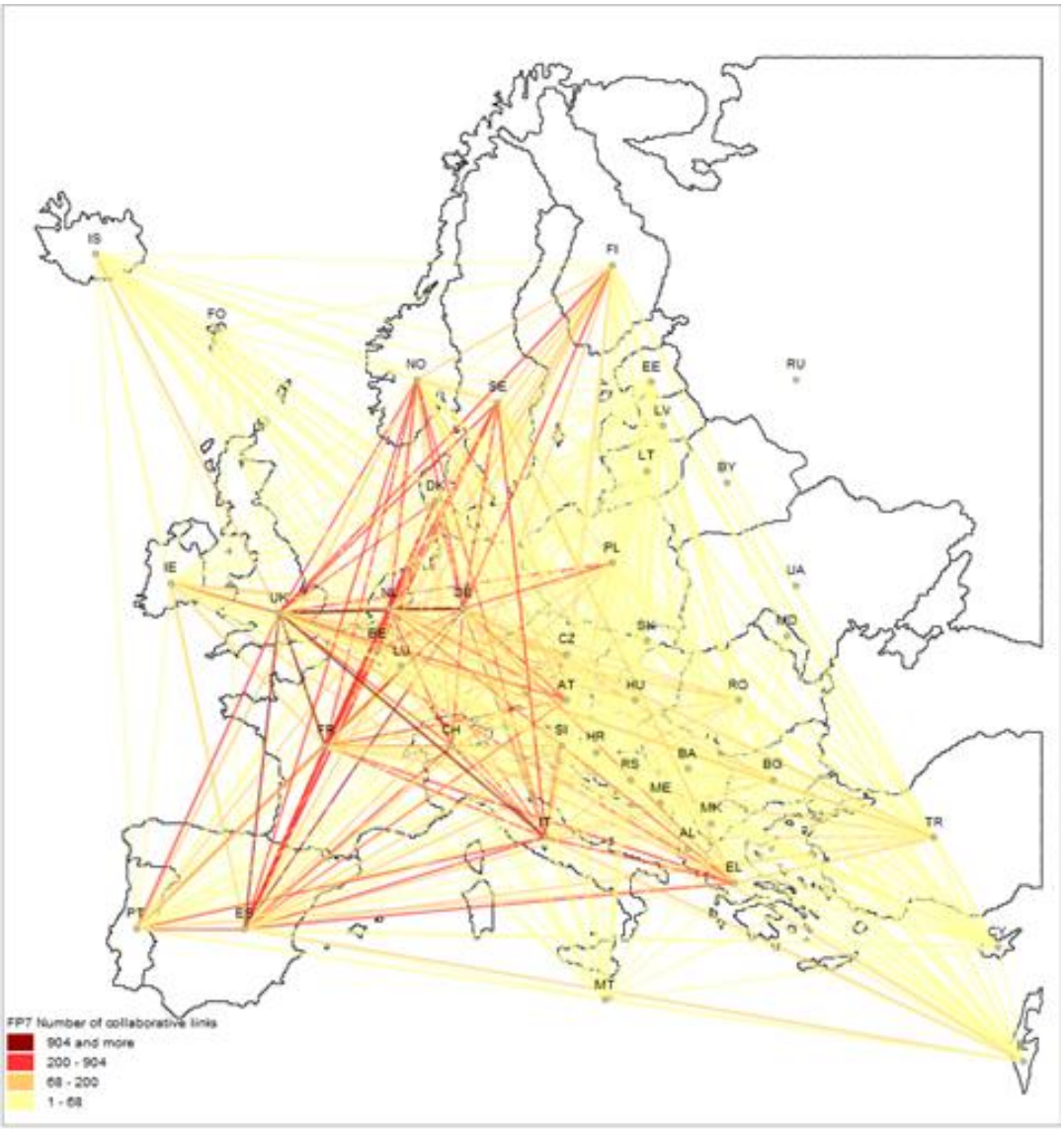
Collaborative links by country and by organization

One of the notable impacts of FP7-Environment is its promotion of transnational collaboration and the ERA. The programme supported 96,362 inter-institutional collaborations, of which 91,557 (94.75%) were trans-national. Most links were established between Member States (80,775), but Switzerland and Norway (associated countries) had exhibited a critical importance.

Figure 4 presents transnational collaborations. It is evident that a group of countries have created some critical axis for international networking: Germany, Spain, France, Italy, the Netherlands and the UK; to a lesser extent, Switzerland and Norway.

As expected, the more one country participates in FP7 Environment, the more it collaborates with organizations from abroad. Amongst the post-2004 Member States, Poland appears as the one with most links with other countries, especially with Germany and the UK.

Figure 4: FP7-Environment collaborative links. Member States, Associates and Candidate countries



Beneficiaries by funding instruments

Compared with the whole FP7, FP7-Environment presented a greater number of CSAs, compensated by a reduction in the number of CPs. The higher number of CSAs is linked with the policy support function of FP7-Environment. There was only one NoE funded through FP7-Environment, namely the project LIAISE, almost finalized in July 2014 (Table 4)

Table 6: Number of projects by funding scheme, FP7 Cooperation and FP7 (Environment)[125]

Absolute Nos.	No. of projects	EU Funding (Mo. €)	No. of projects	EU Funding (Mo. €)
	FP7	**FP7**	**ENV**	**ENV**
CP	5,706	23,812.3	375	1,575.8
NoE	54	292	1	7
CSA	1,204	1,688.8	108	120.9
BSG	12	18,7	9	13.8
Total	***6,976***	***25,811.7***	***493***	***1,717.5***

Percentages	% of projects	% EU Funding	% of projects	% EU Funding
	FP7	**FP7**	**ENV**	**ENV**
CP	81.79	92.3	76.06	91.7
NoE	0.77	1.1	0.20	0.4
CSA	17.26	6.5	21.91	7
BSG	0.17	0.07	1.83	0.8
Total	***100%***	***100%***	***100%***	***100%***

In terms of funding, the breakdown by financial scheme of FP7-Environment is similar to the breakdown of the whole FP7 (Cooperation). The average cost of projects by instrument is also rather similar (Table 6).

Table 7: Average cost of projects, FP7 Cooperation and FP7 (Environment)[126], Mo. €

	FP7	ENV
CP	4,173	4,202
NoE	5,407	6,996
CSA	1,403	1,120
BSG	1,557	1,537
Total	**3,700**	**3,484**

The legal base of FP7 defined other instruments including the Joint Technology Initiatives (JTIs), ERA-NETs, Article 169 Initiatives or the Risk Sharing Finance

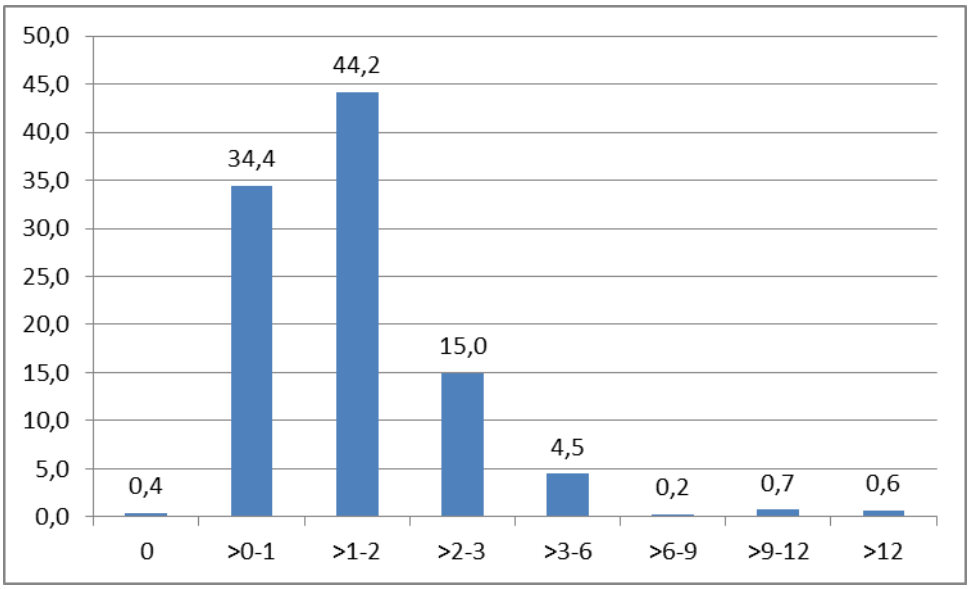
[125] CP include CP-CSA. BSG means projects on Benefit of Specific Groups. Source: eCorda, extraction 4/04/2014.

[126] CP include CP-CSA. BSG means projects on Benefit of Specific Groups. Source: eCorda, extraction 4/04/2014.

Facility (RSFF). These instruments addressed completely different objectives (including the coordination between Member States of nationally held funding programmes), rules and management system and are not covered by this evaluation.

Appendix VIII: Percentage of FP7-Environment publications by SJR index

Percentage of FP7-Environment publications by SJR index



Source: EC's Respir database. Extraction: 6/11/2014

Appendix IX: Factors leading to excellent publications and patents results
Multivariate regressions

Model 1, Multivariate regression, OLS

Dependent variable: No. of High ranked publications (No_PUB_HI)

Date of the analysis: 6/11/2014

Number of projects finalised: 211

Explanation: In a first stage, we introduce all variable that may influence the number of high ranked publications.

	Coefficient	*Erreur Std*	*t de Student*	*p. critique*	
const	668,384	717,326	0,9318	0,35260	
Intrument_CP_IP	-1,74315	5,33187	-0,3269	0,74407	
Intrument_CP_Other	-4,8433	5,29174	-0,9153	0,36118	
Intrument_CSA	-1,50425	5,4585	-0,2756	0,78316	
Intrument_BSG_CSO	-2,17137	5,90031	-0,3680	0,71326	
EC_CONTRIBUTION	9,02646e-07	4,42276e-07	2,0409	0,04260	**
NBR_OF_PARTICIPANTS	-0,129509	0,0700367	-1,8492	0,06594	*
NBR_PRC	0,0617256	0,276557	0,2232	0,82362	
NBR_OF_PRC_SME	-0,279329	0,421657	-0,6625	0,50846	
QT_DURATION	-0,0074086	0,0509812	-0,1453	0,88461	
Year_Start	-0,331319	0,356613	-0,9291	0,35400	
No_PUB	0,516596	0,0190979	27,0500	<0,00001	***
No_PATENT	-1,28162	1,15828	-1,1065	0,26987	
ADDITIONAL_RES	0,110678	0,03404	3,2514	0,00135	***
TOTAL_WF	-0,0144542	0,00645503	-2,2392	0,02627	**

Moy. var. dép.	5,990521	Éc. type var. dép.	14,14920
Somme carrés résidus	4229,876	Éc. type de régression	4,645535
R2	**0,899389**	R2 ajusté	0,892203
F(14, 196)	125,1501	**p. critique (F)**	**1,47e-89**
Log de vraisemblance	-615,6924	Critère d'Akaike	1261,385
Critère de Schwarz	1311,663	Hannan-Quinn	1281,708

Model 2, Multivariate regression, OLS

Dependent variable: No. of High ranked publications (No_PUB_HI)

Date of the analysis: 6/11/2014

Number of projects finalised: 211

Explanation: Secondly, we simplify the model keeping only the variables that were statistically significant (plus the instrument, see core report).

	Coefficient	*Erreur Std*	*t de Student*	*p. critique*	
const	0,185906	2,69056	0,0691	0,94498	
Intrument_CP	-2,90512	1,82747	-1,5897	0,11347	
Intrument_CSA	0,61412	2,38388	0,2576	0,79697	
Intrument_BSG_CSO	0,000924226	3,27118	0,0003	0,99977	
EC_CONTRIBUTION	8,90367e-07	4,11996e-07	2,1611	0,03186	**
No_OF_PARTICIPANTS	-0,142097	0,0644126	-2,2061	0,02851	**
No_PUB	0,522996	0,0178524	29,2956	<0,00001	***
ADDITIONAL_RES	0,115444	0,0334202	3,4543	0,00067	***
TOTAL_WF	-0,0146763	0,00626851	-2,3413	0,02019	**

Moy. var. dép.	5,990521	Éc. type var. dép.	14,14920
Somme carrés résidus	4313,552	Éc. type de régression	4,621062
R2	**0,897399**	R2 ajusté	0,893336
F(8, 202)	220,8488	**p. critique (F)**	**1,77e-95**
Log de vraisemblance	-617,7590	Critère d'Akaike	1253,518
Critère de Schwarz	1283,685	Hannan-Quinn	1265,712

It results that the EC contribution, the number of publications, the number of participants, the number of additional researcher and the total workforce explain almost 90% of the variance of the number of high ranked publications.

The model is not optimal because of the co-linearity between independent variables.

Model 3, Multivariate regression, OLS

Dependent variable: No. of Patents (No_PATENT)

Date of the analysis: 6/11/2014

Number of projects finalised: 211

Explanation: We follow a similar logic with the number of patents as dependent variable

	Coefficient	*Erreur Std*	*t de Student*	*p. critique*	
const	73,4331	43,8122	1,6761	0,09531	*
Intrument_CP_IP	-1,65295	0,306095	-5,4001	<0,00001	***
Intrument_CP_Other	-1,64724	0,303606	-5,4256	<0,00001	***
Intrument_CSA	-1,66742	0,314039	-5,3096	<0,00001	***
Intrument_BSG_CSO	-1,7662	0,340421	-5,1883	<0,00001	***
EC_CONTRIBUTION	7,23514e-09	2,72e-08	0,2660	0,79052	
NBR_OF_PARTICIPANTS	-0,00889249	0,00426119	-2,0869	0,03819	**
NBR_PRC	0,0383421	0,0167905	2,2836	0,02346	**
NBR_OF_PRC_SME	0,0131612	0,0259196	0,5078	0,61218	
QT_DURATION	0,00446472	0,00311973	1,4311	0,15398	
Year_Start	-0,0357665	0,0217871	-1,6416	0,10226	
No_PUB	0,0011581	0,00117183	0,9883	0,32422	
ADDITIONAL_RES	-0,00240351	0,00208682	-1,1518	0,25082	
TOTAL_WF	7,01672e-06	0,000397055	0,0177	0,98592	

Moy. var. dép.	0,080569	Éc. type var. dép.	0,335448
Somme carrés résidus	16,08585	Éc. type de régression	0,285752
R2	**0,319271**	R2 ajusté	0,274350
F(13, 197)	7,107362	**p. critique (F)**	**2,86e-11**
Log de vraisemblance	-27,84765	Critère d'Akaike	83,69531
Critère de Schwarz	130,6213	Hannan-Quinn	102,6637

The factors that influence the number of patents are the instruments, the number of participants and the number of companies involved in the project. Interestingly, the number of SMEs and the budget are not statistically significant.

The model is significant, but explains around one-third of the variance of the dependent variable.

Model 4, Multivariate regression, OLS

Dependent variable: No. of Patents (No_PATENT)

Date of the analysis: 6/11/2014

Number of projects finalised: 211

Explanation: We simplify the model keeping only the variables that were statistically significant

	Coefficient	*Erreur Std*	*t de Student*	*p. critique*	
const	1,76972	0,3066	5,7721	<0,00001	***
Intrument_CP_IP	-1,60776	0,301747	-5,3282	<0,00001	***
Intrument_CP_Other	-1,66334	0,298071	-5,5803	<0,00001	***
Intrument_CSA	-1,75629	0,300132	-5,8517	<0,00001	***
Intrument_BSG_CSO	-1,81021	0,331146	-5,4665	<0,00001	***
NBR_OF_PARTICIPANTS	-0,00666076	0,00358837	-1,8562	0,06487	*
NBR_PRC	0,0412832	0,0164162	2,5148	0,01269	**
NBR_OF_PRC_SME	0,001704	0,0257056	0,0663	0,94721	

Moy. var. dép.	0,080569	Éc. type var. dép.	0,335448
Somme carrés résidus	16,84577	Éc. type de régression	0,288070
R2	**0,287112**	R2 ajusté	0,262530
F(7, 203)	11,67963	**p. critique (F)**	**1,85e-12**
Log de vraisemblance	-32,71751	Critère d'Akaike	81,43501
Critère de Schwarz	108,2499	Hannan-Quinn	92,27411

Again, the model is not optimal because of the co-linearity between independent variables.

Appendix X: Innovation under FP7-Environment

Background

In 2008, one year after the start of FP7, the financial crisis hit Europe. In response to the economic downfall, new European policies[127] emerged to stress the role of innovation to increase Europe's competitiveness:

> "*At a time of … increasing global competition, Europe's competitiveness, … , our future standard of living depends on our ability to drive innovation in products, services, business and social processes and models"*

and also as the way to address the EU's long-term societal challenges:

> "*Innovation is also our best means of successfully tackling major societal challenges, such as climate change, energy and resource scarcity, health and ageing*".

Already at that time, a major hurdle to reach these objectives was recognized:

> "*Perhaps the biggest challenge for the EU and its Member States is to adopt a much more strategic approach to innovation."*

With regard to FP7, a strategic decision was made to *integrate the research and innovation dimensions*, strengthening the support to *the whole chain of research and innovation*, *from blue sky research to market uptake*, and also boosting the contribution to *nurturing fast-growing SMEs*.

The Europe 2020 strategy already set the context for innovation as *smart, sustainable and inclusive growth*[128]. This vision defined, in fact, a major role for the Environment theme of FP7. The new policies put the FP7 Environment organisation to the difficult task to adapt its research agenda and project management from promoting excellent research to also supporting industrial and social innovation, without changing its budget and management. The process of adapting to the new policies would continue beyond FP7, with its successor, Horizon 2020[129].

How could the EU manage innovation?

How to move from a research agenda aimed at turning Europe into the *world's leading research area by promoting excellence in research*[130] to another one where the new priority was increasing Europe's competitiveness and stimulating smart, sustainable and inclusive growth through industrial and social innovation? – Such a change requires a new methodology for allocating resources, different players (e.g. industrial participation and commitment), as well as innovation-oriented specific tools and expertise.

Another problem was that, in 2010, models for managing public integrated research and innovation programmes were not readily available. The US SoSP and SciSIP innovation policy studies[131] had started out only in 2005-2006 and could not be

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[127] Communication from the Commission (2008) *A European Economic Recovery Plan*, COM (2008) 800 final;

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions (2010) *Europe 2020 Flagship Initiative: Innovation Union*, COM(2010) 546 final

[128] Communication from the Commission (2010) *Europe 2020: A strategy for smart, sustainable and inclusive growth*, COM (2010) 2020 final;

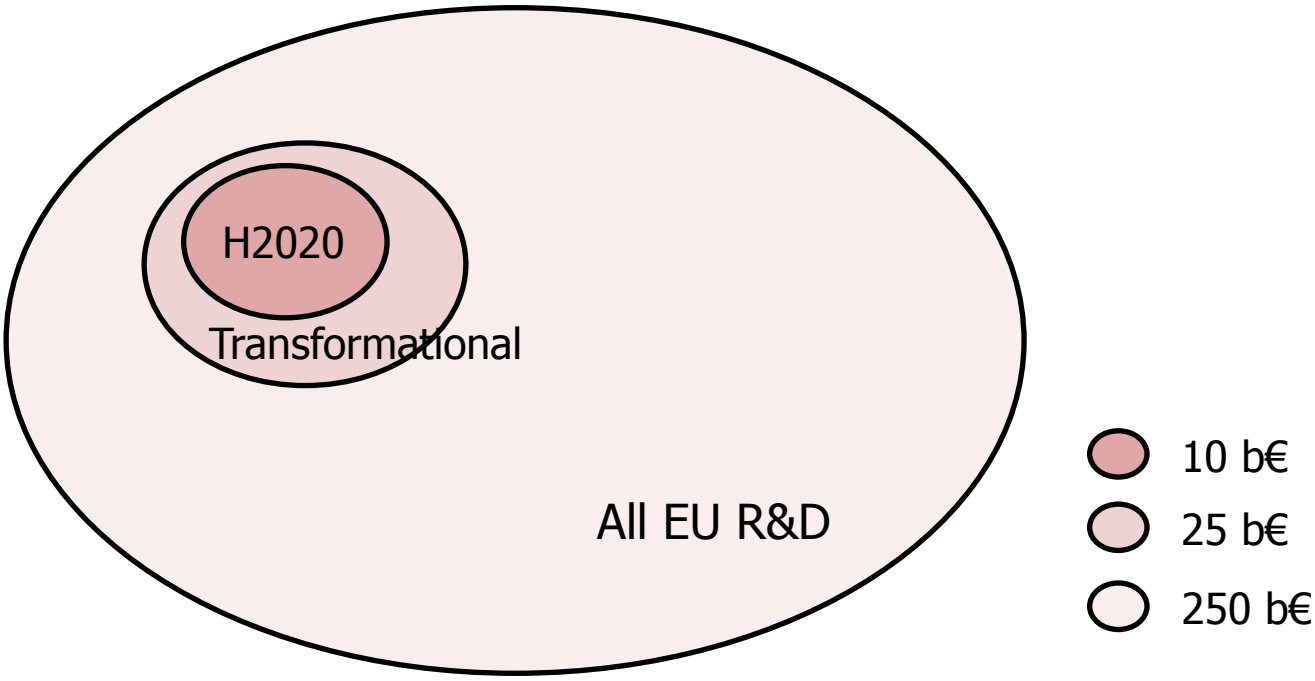
[129] By comparison with its successor, Horizon 2020, FP7 initially concentrated more on science than on innovation. The official title of FP7 details activities from research to demonstration, while Horizon 2020 is "*the framework programme for research and innovation*". Innovation is a step beyond demonstration activities mentioned in FP7's title, and is in this context much closer to the market.

[130] Decision No 1982/2006/EC of the European Parliament and of the Council of 18 December 2006, art. 4.

[131] http://scienceofsciencepolicy.net/

considered to provide an actual model for innovation. European projects on Responsible Research and Innovation (RRI) such as RES-AGORA delivered their first (informal) conclusions just recently[132]. Private equity models for innovation were well established in 2010, and their primary role, as with that of the Framework Programme, is to provide risk funding (rather than area-specific expertise), but they are notoriously bad in managing the early phase of innovation[133]. FP funding, on the other hand, focuses precisely on this early phase. It has its biggest potential for changing the focus of industry by triggering transformational innovation directed at future societal needs, and such an ambition fits well with the size of the Programme's budget (see figure below).

Figure 1: Order of magnitude of EU R&D expenditures per year[134]



One option for the Programme managers of FP7 would have been to lend concepts from the well-developed and proven research and innovation portfolio management models used in industry and translate them to the needs of FP7. The critical issue in these models is to make sure that resource allocation reflects the size or growth of business activities[135] – which accidentally is also a preliminary conclusion of RES-AGORA. In order to realise this, FP7 Programme management could have considered the following measures (cf. Table 1):

- inventorying the areas with European potential for increased competiveness and smart, sustainable and inclusive growth, taking into account the EU's opportunities and threats as defined in the policy documents;
- defining the actors that could realize growth and setting realistic growth rates and targets for each of the areas;

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[132] ESOF Copenhagen, 2014. See: http://res-agora.eu

[133] E.g. Idinvest partners: Market Outlook for 2012.

[134] Data from Eurostat and from of the average percentage of transformational R&D in industry. APQC Benchmarking Study. 2003 and 2004. See three-part series: Cooper, R.G., Edgett, S.J. & Kleinschmidt, E.J., "Benchmarking best NPD Practices", at *Research Technology Management*, Vol. 47:1 Nov-Dec. 2003; May-June 2004; and Nov.-Dec. 2004.

[135] Goffin, K. and Mitchell, R. (2010) *Innovation Management. Strategy and Implementation using the Pentathlon Framework*. Palgrave, 2nd edition.

- analysing and estimating the necessary R&D investments into core, adjacent and transformational technology[136] to spark the desired growth for each area;
- analysing the readiness of the market to invest in exploitation of the resulting (leads for) innovations, e.g. by checking internal rates of return on existing innovations in the designated areas in various phases of development;
- taking into account stimulation measures already planned at the national level;
- and creating some basis for balancing the anticipated macro-economic effects (e.g. more jobs, less imports, etc.) of innovation in each of the areas.

In short: Programme management needed a rationale for positioning and quantifying FP7-Environment funding with respect to innovation, a rationale that would help to decide how much funding would be awarded to each area of innovation, and which (combinations of) actors and which phases of technology would be targeted. The same rationale would also supply the information to quantify financial instruments for the follow-up (e.g. nurturing fast-growing SMEs) at the end of the Programme.

Was the projects and programme management adapted to the new priority?

Traditionally, project management of FP7-Environment ends effectively when a project is finalised. At that point the project's contribution to excellent research and towards creating the ERA is more or less secure – even if further outcomes and impacts can still come.

For projects aiming directly at industrial or social innovation, project management requires activities beyond the duration of the project in order to secure a fair chance of realisation of the innovation potential within European society[137]. Innovation project management would also have to deal with innovation-related issues and commercial interests:

- evaluation of the project by experts with some background in innovation;
- measures to avoid conflicts of interests standing in the way of fair project evaluation, protection of sensitive information or implementation of innovation;
- procedures for securing IP from successful projects;
- procedures and funding to secure successes for further research and implementation by European industry.

Without such measures, industry parties could be uninterested in participating and committing in the Programme. It should be noted that the Environment Programme's investment of more than €600 million in projects with a prime focus on breakthrough innovation, would, in industry terms, typically correspond to a future cumulative turnover of some €100 billion. Such numbers warrant a serious effort on selecting evaluators and reviewers with the right expertise and without conflicts of interest, protecting concepts and ideas presented in proposals to leak to competitors, in order to gain the necessary confidence level from successful innovators. Proposals evaluation would include a consideration of the expected economic and social impact but also the innovation capacity and reputation of the consortium in innovation, and the commitment of industry or societal partners to collaborate and invest towards implementation of the project's successes.

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[136] Nagji, B. and Tuff, G. (2012) "Managing your innovation portfolio", in *Harvard Business Review*, May.

[137] Innovations created in Europe do not necessarily secure a competitive lead of EU industry. For example, a successful FP7-Environment project was invited to present its results in a US technology fair with the offer that winners would acquire a free programme for implementation by US industry.

Table 1 compares the actual response of FP7 management, as evidenced from available documents, with the measures compiled in the previous section. The main conclusion is that FP7 programme management seems less quantitative, structured and detailed in translating policy objectives into a rationale for quantifying and positioning research funding for the various areas of innovation than the best practice of innovation portfolio management by industry. This confirms that quantitative strategic positioning of research in the field of environment is indeed challenging.

Table 1: Expected versus actual management response towards the innovation priority of FP7-Environment.

Expected response	Actual response	Source
Programme management		
Inventory of research areas with need/potential for innovation	General: list of challenges, distinction between opportunities and threats Specific: standardisation Specific: research areas with potential for growth	Internal training[138], sheet 9 Internal training, sheets 13,14 European policy documents[139]
Defining the actors that can realise growth	General: SME and industry participation	Internal training, sheet 12
Define relevant phases of innovation	General: lab results, prototypes	Internal training, sheet 11
Setting realistic target growth rates		
Estimating required R&D budget to realise targets		
Checking if industry/societal partners are able/willing to invest		
Quantifying national programme efforts		
Balancing FP 7 research portfolio with regard to expected benefits		
Project management		
Evaluation & assessment by experts in innovation	Expert evaluators from business and industry with expertise in exploitation	Internal training, sheet 16 Appendix C, responses 1, 2
Quantitative impact assessment	Need for impacts on economy, society; plan for exploitation, industrial application; specific to challenge/objective/area	Internal training, sheet 14 Appendix C, responses 1
Dealing with conflicts of interests of reviewers	Reviewers are asked to declare that they have no conflicts of interest Reviewers to be selected from end-users	Procedure for hiring reviewers Appendix C, response 3 Internal training, sheet 17
Securing IP from projects	Methodology for project officers to deal with IPR	IPR Seminar[140]
Securing implementation by EU industry (prior to execution)	Industry-friendly topics Presentation of call to	Internal training, sheets 12,15

[138] DG Research & Innovation, Internal training on innovation, presentation 2011

[139] For example: *The raw materials initiative — meeting our critical needs for growth and jobs in Europe*, Communication from the Commission (2008)699 final: "To tackle the technological challenges related to sustainable mineral production, the Commission will promote research projects that focus on the extraction and processing of raw materials in its 7th Framework Programme (FP7)".

[140] DG Research & Innovation, IPR Seminar, presentations January 29th, 2014

	stakeholders	
Securing implementation by EU industry (after execution)	Reviewers to be selected from end-users Brokerage events with investors Business assistance to projects	Internal training, sheet 17 Appendix C, response 3
Building internal knowledge base about success factors (team/database)		

In fact, most expected response measures were foreseen by the Commission, although not all of them could be carried out before the end of the programme. The most important observation regarding project management is that the awareness of the crucial importance of protection of knowledge relating to industrial innovation, whether it is in evaluating proposals, in reviewing projects, in securing IP or in controlling the fate of the innovation process, is perhaps less strong than in industry, although the issue appears at several places in FP7 management documents. Here, the gap between managing public research and industry innovation research is very wide indeed and new management culture and tools may be required to deal with this important aspect of innovation.

Despite these structural problems, coming from the fact that the radical re-orientation of FP7 towards innovation was not followed by to same extent by management changes, FP7-Environment obtained some relevant results related to innovation – even if below the potential of such a programme.

It is important to mention that innovation was not well covered by FP7 projects reporting. For this reason, a survey was designed to estimate the present and future impact of the Environment Programme on innovation. However assessing innovation through the (present) results of the Programme **underestimates** its actual outcomes and impacts. Most projects launched when the policy priority became innovation are still ongoing.[141]

Innovation survey: Methodology for estimates and analysis of the results

The survey data were analysed in order to understand innovation in FP7-Environment. It aims to answer the following questions:

- Did FP7-Environment create value for money, when it comes to innovation?
- To what extent did FP7-Environment contribute to EU policy targets?
- What lessons for the management of H2020 can be learnt from the innovation output of FP 7 Environment?

Before answering these questions, it is necessary to introduce some key data, assumptions and methodology to analyse the survey data. This is also a reminder

[141] The projects which emerged from calls after this "reorientation" will be mostly still running and hence, for instance, their final reports will not be available yet. A non-exhaustive, indicative list of some topics from FP7-Environment calls which emphasised innovation, and which projects were still running at the start of this Ex post evaluation, shows the relevance of this observation:

- ENV.2011.3.1.9-1 Eco-innovation (part of the Eco-innovation Call)
- ENV.2012.6.3-1 Innovative resource efficient technologies, processes and services
- ENV.2012.6.5-2 Demonstration and exploitation of most promising prototypes and tools
- derived from European research activities
- ENV.2013.6.3-1 Turning waste into a resource through innovative technologies, processes and services
- ENV.2013.6.3-2 Eco-innovative demonstration projects
- ENV.2013.WATER INNO&DEMO-1 Water innovation demonstration projects

to the reader about the inherent inaccuracy of the analysis; alternative assumptions could be made.

Methodology for estimates

Table 2 shows the estimate amounts allocated to innovation (see Figure 2 of the core report), around €647 million in total.

Table 2: FP7-Environment investment in projects with innovation as a primary objective.

Year of Call	Mio €
2007	38
2008	39
2009	52
2010	109
2011	88
2012	138
2013	183
Total	**647**

As explained in Box 7 of the core report, the survey was based on two sub-samples. Sample A was focused on 41 projects pre-selected by POs because of their potential excellence on innovation, and sample B (70 projects) was a random one. The number of respondents was: 15 to sample A and 19 to sample B (see Table 4 in the core report).

All projects that reported innovations implemented were in sample A, and three of them were also in sample B.

The projects pre-selected in sample A came from the following calls:

Table 3: Number of pre-selected projects, by year of call

Year of Call	Number	%	Out of 41/ €million
2007	8	19,5	0,2105
2008	8	19,5	0,2051
2009	5	12,2	0,0962
2010	9	22,0	0,0826
2011	7	17,1	0,0795
2012	4	9,8	0,0290
Total	**41**	**100**	

At least three methodologies could be followed for extrapolating the results from the survey to the whole FP7-Environment, two purely statistical and a more complex one.

1- Purely statistical, by number of projects: Based on the results of sample B (randomly selected projects), we can determine the number of exploited innovations by project, and then multiply by the total number of FP7-Environment projects.

2- Purely statistical, by funding: Based on the results of sample B (randomly selected projects), we can determine the number of exploited innovations by funding, and then multiply by the total FP7-Environment funding.

These two techniques are not satisfactory, due to the very low number of projects that provided data on actual exploited innovations in the random sample.

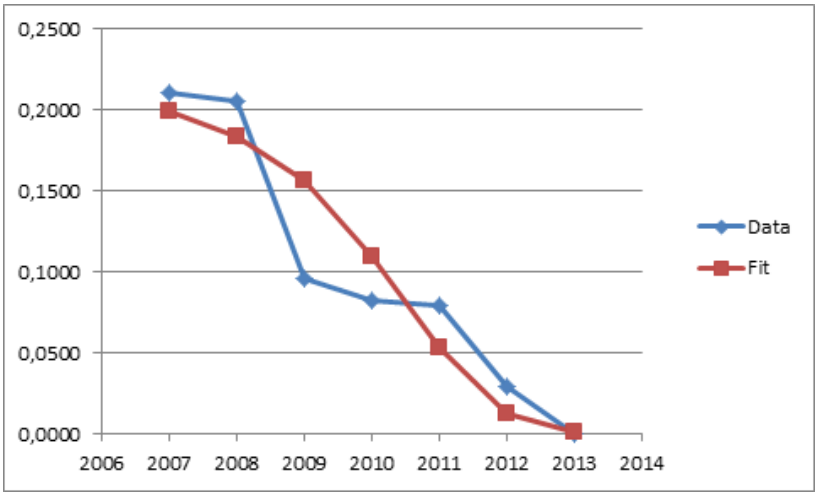
3- Not statistical technique: Knowing that:

- the budget allocated to innovation projects increased enormously from 2009-2010 and
- all projects that reported implemented innovations came from the first years of the programme and were already finished,

we can assume that (i) the number of actual innovations is proportional to the innovation funding, (ii) the 41 pre-selected projects reflect the investment in innovation of the FP7-Environment calls of FP 7 Environment from 2007 to 2012, and (iii) in the absence of more data, the 15 pre-selected projects that responded to the survey are representative of the sample of 41 projects.

In addition, Table 3 above shows that projects need some time to be sufficiently mature to give actual innovative results. Figure 2 presents the distribution of pre-selected projects for every million euros of grant. Eventually, i.e. many years after a call, it is expected that the number of successful innovation projects per €1 million will be the same for every year of FP7. Indeed, the figure shows that for the calls of 2007 and 2008, there were similar ratios number of projects/€ million. Then the number goes down, to reach zero for the call 2013. This distribution allows to determine which part of the innovations from the €647 million of funding have been reported by the POs. Through the expected/fitted curve it is also possible to predict how many additional projects the POs would report next year if they were asked again, or at which time a survey would address 80% of all successful innovation projects.

Figure 2: Number of pre-selected innovative projects per million euros of funding and year of the call (actual and expected)



Based on the fitted curve, it is possible to estimate that the 41 pre-selected projects represent €188.3 million (~ €190 million) of FP7-Environment funding allocated to innovation.

Under all these assumptions it is possible to calculate a factor that will allow extrapolations from the survey's data on outputs and impacts on innovation, to the whole programme. Outputs and impacts of the 15 pre-selected projects should be multiplied by a factor:

$$\frac{41}{15}\frac{635}{190} \approx 9$$

This is probably an under-estimate because POs may have missed projects with substantial innovation output from calls in the period 2007 through half of 2010. For this analysis, a prudent approach is followed; it is considered that all innovative projects were pre-selected by POs.

Innovation outputs and impacts

A first observation is that, of the 15 responses sample A, only 6 were able to give a reasonably complete estimate of the market size and potential of their innovation, and only 3 were able to give an indication of the savings on energy and raw material resources resulting from their innovation.

None were able to indicate a level of government saving. This is quite embarrassing because these impacts are extremely relevant for projects with a focus on innovation in the environmental field. In the years to come, it will be essential to record a minimum of output parameters of projects in relation to these impacts.

A second observation is that there is a clear distinction between projects with estimated market sizes/resource savings of the order of a billion euro and more, and other projects that do not come close to this threshold. An analysis of innovation can obviously limit itself to the projects with very large impact.

The six projects able to provide market data reported the sales and market levels below.

Table 4: Market data from sample A (pre-selected projects)

Type of Innovation	Realised sales (€ millions)	Total market size (€ millions)	Potential for resources savings (€ millions)
Sorting process for paper waste	1	5	1.5
Sorting process for plastic waste	0	630	28000
Sorting process for moist fine waste	3.5	1500	9000
Monitoring device for water quality	0.05	0.5	
Improved Ash Dec process	90	6000	
Low-noise pavement for roads	40-80		

All the 4 projects with very large initial sales, market size or resource saving potential reported slow expected market uptake: 1-3% of the market in 5-7 years starting from the end of the project. This confirms that the respondents for these projects had a realistic view on market development (compare e.g. Everett Rogers[142]).

[142] See for instance Rogers, E.M (2003) *Diffusion of Innovations*. New York: Simon and Schuster. 5th edition.

On that basis, it is now possible to estimate the order of magnitude of the total market size (sales) and the total resource saving *potential*, i.e. about **€8 billion** and **€37 billion** respectively. In the absence of specific data, it is often assumed in portfolio analysis that transformational innovations that make it into implementation have a lifetime of 20 years and ultimately reach about 20% of their total market. These numbers seem consistent with the slow uptake predictions for the projects with very large market or resource saving potential. With such admittedly simplistic estimates, the set of 15 projects would generate **around €1.5 billion of sales and €7.5 billion of resource saving** over their innovation lifetime.

In extrapolating these numbers to the entire investment of FP-7 Environment in innovation projects, it should be considered that a large probable error results from the fact that the data of the survey cover only approximately one tenth of the funding in innovation. Probability theory shows that for a large batch of projects in which some fraction p results in very large impacts, the estimated number of such projects in some small sample of N projects will be found to be

$$Np \pm \sqrt{Np(1-p)} \cong Np \pm \sqrt{Np}\,; \text{ for small } p$$

In other words, the sampling error will be roughly equal to the square root of the number of successful projects. Since the survey has only four projects with large impacts, the sampling error is relatively large (about ±2 projects with very large impact or 50%).

For FP7- Environment as a whole, the results of the survey extrapolate to **around €7-20 billion of sales and €30-100 billion in terms of resource saving**. Obviously, these numbers are crude estimates, but considering the fact that they are based on several projects with similar potential, their order of magnitude is likely to be right.

Did FP7-Environment generate value for money in terms of innovation?

The numbers above may be compared to the expected numbers for research in general. Overall, R&D expenditures in the EU are 2% of GDP. In accordance with the objectives of FP7, all respondents of the pre-selected projects reported that their innovations were transformational or adjacent. Transformational research is typically 10-15% of total R&D and adjacent research represents around 30%[143]. Therefore, FP7-Environment research funding, being in the range of transformational - adjacent, should ultimately trigger approximately 3-4 times its research investment in terms of adjacent and core research funding and 150-200 times its research investment in terms of GDP (provided that there are no major upstream bottlenecks, such as e.g. acquiring subsequent R&D budgets, financing roll-out).

The data of the survey indicate that projects with innovation as a first objective spent about 67% of their budget on innovation activities. For FP7-Environment, this would mean 150 – 200 times 0,67*640 million or €75 billion of GDP. In relation to this number, the projected returns of 10-30 billion euro of GDP are very reasonable, since innovation in the environment field has important impacts beyond innovating GDP. According to German data used by Professor Huether from the *Deutschen Wirtschaft* of Koeln, €50 billion of resource saving imply around €25-50 billion reduction of raw materials and energy imports.

None of the 15 projects supplied numbers for savings on government spending. This is a pity, because it is clear that the 4 projects with very large market size/resource saving potential are likely to involve also considerable savings on government expenditures. For example, the project developing low-noise pavement for roads explicitly mentioned that the noise reduction of this technology is similar

[143] Nagji, B. and Tuff, G. (2012) op. it.

to noise screens, implying that implementation of this technology may save the construction and cost of noise screens. Similarly, the plastic sorting process saves costs of recycling plastics, costs that are often directly covered by levies that are ultimately paid by consumers. Whereas €1 billion of research must generate a large multiple in GDP in order to be economically efficient, €1 billion of research is already well spent if it cuts expenditures of citizens or governments by more than 1 billion.

Therefore, all over, FP7-Environment is likely to have given value for money in terms of innovation.

To what extent did FP 7 Environment contribute to EU policy targets?

Some of the EU policy targets relating directly to the Environment theme, as well as questions asked in the survey are on resource efficiency. The background of these policies is to cut the present EU's commercial deficits in energy and raw materials, which, together, are between €400 and €500 billion per year. In order to have a significant impact on these deficits, innovations would have to reduce net resource use by €100 billion per year or €2000 billion over typical lifetimes of innovation portfolios. It is clear from the data that FP7-Environment did not manage to realise such impact. The main reason was already presented: FP7 management had no means of quantitatively addressing the science and technology development at the required scale.

Conclusions

FP7-Environment spent about one third of its €1.9 billion budget on projects mainly focused on innovation. However, the European Commission was not equipped with the necessary tools, expertise and knowledge to properly manage innovation projects, when this topic became the main priority. For example, the FP7 projects hardly covered innovation-related outcomes, with the exception of IPR.

In the framework of the ex post evaluation of FP7-Environment, an innovation survey had to be carried out to cover this field. It was launched at a very early point in time, when many projects were still ongoing, to assess the impact of this investment. On the basis of the data from the survey, the part of the FP7-Environment budget spent on innovation is expected to deliver 20-60 innovations with very large economic impacts, creating a total of €7-20 billion of turnover and €30 to €100 billion of raw materials and energy savings during the lifetime of the innovative products and processes. The survey also included a question on expected government savings as a result of the innovations, but the projects returned no significant data on this aspect. It is quite possible that the economic impact of FP7-Environment in terms of savings of public expenditures will turn out to be its most important contribution, but the present data do not allow any remotely reliable estimate of this impact. Nevertheless, the impact that can be estimated suggests that FP7-Environment money was well spent with regard to innovation.

Next to the return on investment of the Programme, it is interesting to compare the expected savings on raw materials and energy with EU policy targets. Europe imports of the order of €400-500 billion of raw materials and energy per year. A significant reduction of these imports, e.g., by 20%, would require a portfolio of innovations saving some €2000 billion over the innovations' lifetimes of 20 years. In this respect, then, FP7-Environment falls short, not because of its quality but rather in terms of the size of its budget and its allocation strategy. In order to reach EU policy targets on research efficiency, levels of research and innovation funding for relevant subjects would have to be increased by an order of magnitude without compromising the quality of the funded research. A better synergy with Structural and Cohesion Funds could increase the investment.

It is clear from the survey that most innovative projects had a very dim notion of the economic and societal returns of their projects. They were unable to quantify

the direct societal benefits of their action, even in economic terms. In order to further improve the return on R&D investment and tune the calls to EU policy targets, some kind of quantitative innovation management is needed, relying on close monitoring of project results.

Appendix XI: "Innovation Survey" questionnaire

Q1. In your final report to the Commission, you provided the following information on the project outputs and outcomes. Can you correct or update, if appropriate?

– Number of IPR applications: …. Confirm/Update: ….

– Owners of the IPR applications: …. Confirm/Update: ….

Q2- Did your project develop or implement any innovation[144] *or potential innovation?*

– Yes

– No, there is no innovation implemented or developed. **[End of questionnaire]**

Q3. Please classify the project results aiming at innovation according to the Technology Readiness Levels (TRL) defined here below[2]*.*

TRL 1 – basic principles/phenomena observed

TRL 2 – innovation concept (e.g. technology concept) formulated

TRL 3 – experimental proof of concept

TRL 4 – concept validated at smallest possible scale, at laboratory/test panel conditions (e.g. technology validated in lab)

TRL 5 – concept validated in relevant environment (e.g. industrially relevant environment in the case of key enabling technologies)

TRL 6 – concept demonstrated in relevant environment (e.g. industrially relevant environment in the case of key enabling technologies)

TRL 7 – system (e.g. prototype) demonstration in operational environment

TRL 8 – system complete and qualified

TRL 9 – actual system proven in operational environment (e.g. competitive manufacturing)

Q4. ***[If TRL 6 or higher in Q3]*** *Is your implemented innovation…?*

a) Internal to the firm

b) Commercialised

c) Other. Please precise:

Q5. Characterize your main innovation(s)[145]

a) New or significantly improved product

b) New or significantly improved service

c) New or significantly improved process

d) New or significantly improved marketing method

e) New or significantly improved organisational method

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[144] An **innovation** is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relation. The minimum requirement for an innovation is that the product, process, marketing method or organisational method must be new (or significantly improved) to the firm. Source:

http://ec.europa.eu/enterprise/policies/innovation/glossary/index_en.htm

[145] When a project developed or implemented more than one innovation, the "main innovation" will be (i) the one that is actually implemented (e.g. in the market or internal to the firm), or (ii) if several ones were implemented, the one considered more relevant (e.g. that produces a higher income or advantages to the firm), or (iii) if none is exploited yet, the one considered with more potential.

f) Other. Please precise:

Q6. Briefly describe your main innovation(s) or potential innovation(s)
[Open text, 300 characters maximum]

Q7. What was the research area providing the innovation or potential innovation?
[More than one answer allowed]
Climate change
Environment and health
Natural hazards
Marine
Cultural heritage
Water management
Waste management
Air quality
Soils
Resource efficiency
Energy efficiency
Technology assessment, verification and testing
Biodiversity and sustainable management of natural resources
Earth observation
Sustainable development
Other. Precise.

Q8. What was the estimated part (%) of the total budget dedicated to innovation (this is meant in the widest sense: all costs necessary for achieving the results linking to innovation).

Less than 25%
Between 26% and 50%
Between 51% and 75%
More than 75% but less than 100%
100% (i.e. the whole project's budget was dedicated to innovation)

Q9. Please break down the budget amount dedicated to innovation, in percentages, for: SME's (as a group), large companies (as a group), universities and science & technology institutes (as a group) and others.

SMEs:
Large companies:
Universities and science & technology institutes:
Other (e.g. NGOs, CSOs):

[The sum must be 100%]

Q10. Please indicate the type of innovation on which most of the innovation budget was spent.
[More than one answer allowed]

Core innovation: low-risk, short-term, not creating new social behaviour, new markets or using new technology

Adjacent innovation: medium-risk, medium term, new market, largely applying existing technology base or based on existing behaviour of citizens

Transformational innovation: game-changing, breakthrough, disruptive: high-risk, long-term, creating entirely new products or services, based on new technology or new social behaviour

Q11. Did the original project proposal contain any reference to the reputation/achievements of the participating researchers and industries in terms of innovation?

Yes/No

Q12. ***[If Yes in Q11]*** *Indicate for which type of partners: SME, Large companies, Science & Technology institutes or others* ***[More than one answer allowed]***

SMEs

Large companies

Science & Technology institutes

Others (please precise)

Q13. Have you involved (potential) end users in your project?

Yes, end user organisation included in the consortium

Yes, end user organisations outside of the consortium were consulted

No.

Q14. Please define the (potential) users of the main innovation of the project (e.g. public/private sector, area of activity)

[Open text with the main characteristics of main users: 300 characters maximum]

Q15. If the potential users are constrained to a certain geographical area because of the nature of the product, process, service or concept, or because of the validity of a patent, please specify the region of interest. (e.g. Europe, developing countries)

Q16. How big is the potential market of potential users?

Estimate number of potential users:

Q17. Based on the results at the end of the project, please estimate how many years would be needed, starting from the end of the project, to deliver the innovation to a certain, relevant, fraction of the potential users or market share.

(For example: a new design for a LED light for a bike that generates its energy from the vibrations of the bike, could be put into large-scale production in collaboration with an existing electronics company within one year and reach 4% of the EU market in three years from the end of the project)

Number of years from end of project….

Percentage of potential market…

The following questions aim at estimating average impacts of your innovation in the future (put zero when effect is not considered of relevant magnitude):

Q18. Estimate the number of units sold and the average price of your commercialized innovation

Number of units sold:

Average commercial price:

Not pertinent: No commercial innovation

Q19. Estimate the cost savings of raw materials per unit of your commercialized innovation, compared with a similar product, service, process or method in the market.

Saving raw materials costs (in EUR):

Q20. Estimate the cost savings of energy per unit of your commercialized innovation, compared with a similar product, service, process or method in the market.

Saving energy costs (in EUR):

Q21. Is part of your production exported outside the EU, or do you expect to export it?

Yes/No

Q22. ***[If Yes in Q21]*** *Estimate the estimate average price of your innovation outside the EU and the number of units sold.*

Price per unit:

Number of units sold:

Q23. Have you carried out a technical assessment of your innovation (e.g. Life Cycle Assessment), from the resource efficiency/ environmental point of view?

Yes/No

Q24. Could you estimate the savings in government spending in EU countries generated by your innovation, per user and per year? For example, a new material used in roads could prolong their lifetime, and therefore save public money.

Estimate savings in EUR:

Unknown:

Q25. Is there any commitment from industry, civil society organisations or national or EU funding to continue the research and innovation activity carried-out during the project lifetime?

Yes/No

Q26. ***[If Yes in Q25]*** *Please indicate the committing party/parties: industry, civil society organisations, national or sub-national funding, EU funding, other (several answers allowed)*

Industry

Civil society organisations

National or sub-national funding

EU funding

Other, please precise

Q27. Please indicate size of committed investments in the research and innovation activity, if known.

EUR:

Not known:

Q28. Which of the statements below best reflects the status of innovation development as a result of your project?

Condition at time of survey
Research was continued after the project, so the implementation phase of the innovation has not started yet
There is no party (i.e. entrepreneur, industry, government agency) taking up the innovation
An entrepreneur has been found, but funds have yet to be organised
An entrepreneur has been found and venture capital/risk capital to the extent of approx. 1% of the target cumulative turnover of the innovation has been acquired
Industry has committed to investing approx. 1% of the target cumulative turnover of the innovation into implementation and roll-out
Industry has committed to investing approx. 1% of the target cumulative turnover of the innovation into implementation and roll-out and the technology has been validated in a real-life implementation
None of the previous. Please describe:

Q29. Could you please tell us who provided the information in questions Q14 to Q28?

– The Project Coordinator only

– The Project Coordinator and/or other project partner(s). Please mention the name of their organisation:

Appendix XII: EU Environmental Policies and Strategies with relevance to the FP7 Environment and Climate Programme

Topic	*Strategy or Policy*
Biodiverstiy	Action Plan for Biodiversity Halting the Loss of Biodiversity by 2010 – and Beyond (COM (2006)
Climate Change	European Climate Change Programme II Energy and Change Policy package approved 2008: targets by 2020: cut greenhouse gases by 20%; reduce energy consumption by 20%; meet 20% energy needs from renewable sources.
Data	INSPIRE Directive: Infrastructure for Spatial Information for Europe (environmental data). A data sharing policy for the environment and related policy areas, to agree common data definitions in energy, climate change, biodiversity, marine environment and human health.
Energy	Sustainable Energy Policy
Environment	6th Environmental Action Plan and associated Thematic Strategies (air, waste, marine protection, biodiversity, soil, pecticides, urban)
Freshwater	Water Framework Directive
Health	Action Plan on Environment and Health REACH Directive (chemicals); CAFÉ Directive (air quality)
Innovation	Europe 2020 Strategy and related flag ship initiative - The Innovation Union
Natural Hazards	Natural Hazards
Marine	Marine Strategy Framework Directive (environmental pillar of the EU Maritime Policy); Integrated Maritime Policy for the Union (the Blue Book) EU Strategy for Marine and Maritime Research (science pillar of the Maritime Policy) Water Framework Directive Common Fisheries Policy
Resources	Europe 2020 Strategy and related flag ship initiative - A Resource Efficient Europe.
Sustainable Cities	Sustainable Cities Sustainable Development Strategy
Technology	Action Plan on Environmental Technologies
Water	Water Framework Directive: to improve the quality of all freshwater systems in Europe.
ERA	ERA

Appendix XIII: Exemplar projects in providing policy outputs and impacts

– Examples of FP7 Environment projects impacting Climate Change policies

MEDIATION was one of five FP7 Environment projects (CLIMATECOST, CC-TAME CLIMSAVE, RESPONSES, MEDIATION) funded at different overlapping stages, in the area of climate change impacts, vulnerability and adaptation that organized Technical Workshops on "Climate Change Impacts and Adaptation: A dialogue between research and policy" in Brussels (2011, 2012). The workshop aimed at enhancing and facilitating interaction and dialogue between the policy directorate generals of the European Commission (DGs CLIMA, ENV, AGRI, SANCO, MARE, ENER, REGIO and ENTR). The workshops facilitiated the DGs to articulate possible contributions of the research projects to their interests and the adaptation research projects elaborated crosscutting issues for intensifying future collaboration. discuss new research results.

– Empowering local communities for biodiversity. The TESS project

TESS ("*Transactional Environmental Support System*") designed a decision support system for policy makers to integrate local knowledge into their decision making, while also guiding and encouraging local activities that restore and maintain biodiversity and ecosystem services. The project aimed to enlighten, encourage and empower local communities to support biodiversity restoration across Europe, through an internet system that unifies all available knowledge to guide decisions for the benefit of biodiversity and livelihoods. Tess concluded that environmental information needs to be gathered and used freely by ordinary citizens, within a common EU-wide framework. Such an approach would demonstrate that land-managers are part of the solution to conserving and restoring Europe's biodiversity.

– FP7-Environment and IPCC

FP7-Environment projects played a key role in the development and aggregation of climate change models, with a strong input to the International Panel on Climate Change (IPCC). While such models are developed at national level, FP7-Environment projects played a unique coordination role, ensuring the completeness of the systems. FP7-Environment allowed an international co-development of climate change models, creating a process of mutual learning and an efficient knowledge creation. With its funding activities in this field, the Commission contributes to the creation of international standards that avoid fragmentation of research and funding. Something similar happens in other areas, such as greenhouse gases (GHG) measurement or carbon in the sea, where the EU is leader thanks to its coordination and standardisation role – not to mention the impact of research in these field on policy (e.g. Directives).

– FP7-Environment and GEOSS

Some FP7-Environment investments are exemplary of European added value to research, beyond that at national levels. This is clearly the case of Earth Observation. The FP7-Environment programme had a pivotal role in implementing the Global Earth Observation System of Systems (GEOSS; reviewed in a separate report[1]) The report concludes the relevance to the EU of these actions: opening up of access to essential global, regional and national datasets; adoption of compatible data policies in EU Member States and pan-European organisations; direct and indirect contribution to the Europe 2020 Strategy and related policies (including capacity building in developing countries); mobilisation of the research community; or potential to foster and stimulate growth and innovation for industry (especially

SMEs). GEOSS is critical to tackle global challenges such as climate change, energy and food security, and health[146].

– LiveDiverse, example of excellent impact on international organisations acting at the science-policy interface

LiveDiverse (Sustainable Livelihoods and Biodiversity in Riparian Areas in Developing Countries) focused on producing knowledge that would contribute to improving strategies to promote sustainable livelihoods and the protection and preservation of ecosystems. The partners involved in LiveDiverse collectively had well-established long-term linkages with UNEP, UNESCO, UNDP, FAO, GEF, Global Water Partnership, World Bank, Secretariats of Biodiversity Convention, Ramsar, Climate Change Convention, WWF, Birdlife International, Conservation International, Flora and Fauna International, Nature Conservancy, Wildlife Conservation Society. Informally, when possible the lessons and results of the project have been communicated in the events or interactions with these fora. During the project implementation stronger links have been established with the following international fora: IUCN, IASC, OECD Water Governance initiative, UNWC.

[146] A more detailed assessment is provided in a separate report: Connolly, N. et al. (2014) *op.cit.*

Appendix XIV: Add-value of FP7 to the UK

Key Facts: Excellent research in Horizon 2020 will provide significant value to the UK.

The UK won more than 16% of all Framework Programme 7 (FP7) funding to EU member states and 27% of European Research Council (ERC) funding - far higher than the UK contribution to the EU budget (c. 11.5%) or the UK share of overall EU spending (c. 5.6%).11

Funding for competitiveness and innovation makes up nearly 18% of the UK's receipts from the EU, almost the same as our structural funding. FP7 alone is 13% of the UK's receipts from the EU - higher than in any Member State except the Netherlands.

The UK received €3.7 billion in research and innovation funding from (FP7) in 2007- 2011, second only to Germany. The then 20 Russell Group universities alone won over €1.5 billion, 16% of all EU research funding to universities.

FP7 has funded UK participation in nearly 90,000 collaborative links across the EU, ranging from leading academics to SMEs. Growth and jobs depend on world-class research and innovation:

- €1 of EU FP7 funding lead to an increase in industry added value (contribution to growth) of €13 on average.
- High quality university research attracts private investment. 22% of UK R&D funds are from abroad, higher than any large economy and double the EU average.

Source: UK Russell Group Universities: Russell International Excellence Group, February 2013

Appendix XV: Thirteen remarkable FP7-Environment projects

This analysis is based on the review of 85 projects that were explored and rated between 0, 0.5 or 1, with regard to:

- innovation output and outcome (question 2.2)
- innovation impact (question 2.3)
- impact on open innovation (question 2.4)

Thirteen projects were flagged with three times the higher score (1), meaning that they have produced substantial contribution for all of these areas:

1. AquaFit4Use

The main innovation in the project is to adapt and combine technologies into new target-specific applications and demonstrate the industrial feasibility in pilot scale. The project used the experience and know-how from research in four water intensive using sectors (chemical, paper, textile and food) to develop innovative concepts for the four sectors. The type of innovation could be considered as adjacent (medium-risk, new market and largely applying existing technology base).

- *Highly potential results for commercial exploitation, tested at pilot scale.*
- *Developed solutions for achieving sustainable water use, close cooperation between industry and the research community.*

2. ENRIECO

ENRIECO was not a research project but a coordination action. However, it developed several important products, particularly a detailed inventory of existing "environment-health" birth cohort studies and its implementation into a searchable database. It contains wealth of information in a structured format on all birth cohorts, their key characteristics, contacts, available data, major outcome etc. It is fully available online for researchers as well as other stakeholders, policy makers, etc.

ENRIECO presented case studies based on two different approaches (centralised and de-centralised) in combining multiple cohort data and results. These lead to identification of number of pros and cons and development of a set of practical recommendations and serve thus as a valuable proof-of-concept.

- *Information on all birth cohorts, searchable database.*
- *A valuable proof-of-concept, societal benefits.*

3. HERMIONE

HERMIONE was not geared towards a substantial innovative output – rather, mostly existing technologies and protocols are being adopted within novel environments. Despite this, the project still managed to generate an innovative benthic mapping technique, through which a cold water refuge was discovered in the North Atlantic, and also to propose an innovative proxy for methane seeps in the sea – foraminifera.

- *An innovative benthic mapping technique, outstanding employment impact, a valuable proof-of-concept, societal benefits.*
- *A database (with a total of 498 datasets)*

4. IMPRINTS

IMPRINTS related to the "Climate change, pollution and risks" thematic area, addressing the "Natural Hazards" theme. The project focused on flash flood and

debris flow modelling to deliver new methods, algorithms and tools that can forecast such events, and on the development of prototype web-based platform and innovative early warning systems to enhance preparedness and facilitate emergency response.

The type of innovation generated by the project can be characterised as adjacent: the exploitable foregrounds have been further developed in the medium term, and rely on an existing technology base (models, radar measurements, data, etc.).

- *New products and services, Flash Flood Early Warning system (the main tool for flood forecasting used by the EU Civil protection mechanism)*
- *Job creation, relevant information available*

5. LoRe-LCA

The deliverable D.3.2 of the project "Guidelines for LCA" for buildings and designers can be considered as one of the most important outcomes of the project. It can be applied by the construction industry to create more sustainable buildings and infrastructures. This is a direct result of the project, supporting the diffusion of LCA. The development of LCA methodologies valuable for technology assessment (building systems, buildings as whole, constructions) has been a key component of the project. The guidelines can be found in the project's website.

- *LCA guidelines & methods, furthers creation of more sustainable buildings and infrastructures*
- *Promotes and facilitates the uptake of new technologies*

6. MarineTT

The project documentation presents evidence on the innovation impact of the project. It reports, for example, that the 'Knowledge Capture and Analysis Methodology' developed during the lifetime of MarineTT has been adapted and applied to other knowledge management projects including Marine Genomics for Users (MG4U), Supporting Governance and Multi-Stakeholder Participation in Aquaculture Research and Innovation (AquaInnova) and Aquaculture Infrastructures for Excellence in European Fish Research (AQUAEXCEL). There is a certain continuity between those projects and MarineTT, since the coordinator of MarineTT is partner in all the above projects. This may explain the 'transfer' of the methodology.

- *On-line database, new methodology > applied to other management projects*

7. MEECE

MEECE's innovation output and outcome has been considerable. The project contributed extensively to the expansion of applications of modelling in forecasting marine ecosystem changes within different future scenarios. Some of the outputs of MEECE have had a lasting effect as they have influenced future research and policy directions within the same thematic. For instance, a number of the MEECE regional modelling tools were used through the GMES Marine Core service through the development of Operational Ecology.

- *Contributing to the expansion of modelling in forecasting marine ecosystem changes*
- *Strong influence on further research agenda and policy directions*
- *Allows online users access to its model library and library of meta-analysis databases*

8. MEMORI

The project has developed a dosimeter which is sensitive to indoor climate and light, and to oxidizing acidic air pollutants, commonly present in indoor locations. The dosimeter will provide a non-destructive early-warning system for early assessment of environmental impact on indoor cultural heritage. Pollutants are, with light and incorrect climate, one of the main common environmental threats for cultural heritage, therefore it is important to assess their levels /aggressiveness in the vicinity of museum artefacts and archival collections in order to properly react.

- *A dosimeter to indoor climate and light, oxidizing acidic air pollutants*
- *A prototype of a portable reader for in-situ measurements and results evaluation*

9. SafeLand

The major innovation outputs appear to be identified on the Project website, which summarises its output for 'end-users'. In relation to the three areas identified above, they include: (1) guidelines and recommendation for Improving knowledge on landslide hazard and risk mapping; (2) a quantitative risk assessment, that includes guidelines for landslide susceptibility, hazard and risk assessment and zoning Identification, and the identification of landslide hazard and risk "hotspots" in Europe; (3) a methodology for predicting the changes in the landslide risk during the next 50 years at selected sites in Europe; (4) guidelines for the development of new monitoring and early warning technologies, with particular reference to remote sensing techniques; and, (5) a compendium of tested and innovative mitigation measures for different landslide types together with a web-based "toolbox" to identify appropriate landslide risk mitigation technologies.

- *Guidelines and recommendation for improving knowledge on landslide hazard and risk mapping.*
- *A quantitative risk assessment, a methodology for predicting the changes in the landslide risk.*
- *A prototype of a portable reader for in-situ measurements and results evaluation.*

10.SECOA

This ambitious project is somehow unique in the deepness of analysis achieved at a rather micro scale, for Integrated Coastal Zone Management (ICZM) and Marine Spatial Planning (MSP). It is based on a comparison of a large range of environmental conflict situations in coastal cities case studies: 27 in total, for 16 cities, from 3 regional ecosystems: Northern Europe, Mediterranean, and Asia.

Taking advantage of the large case study basis, SECOA-project identified and tested a great number of approaches tools, both for basic data collection and situation analysis and for assessing their "usefulness" in urban coastal management. They include S-AHP, DPSIR, sustainability indicators, Multi Criteria Analysis, Conflict analysis Framework and Scenario Analysis. These methods were at times combined with participatory methods involving representatives of stakeholder groups (local and national) in the case study areas. Multi Criteria Analysis (MCA) was used in two different ways in SECOA – one for calculating Flooding Hazard Maps for each urban area and looking at institutional responses, in a more expert based approach, and one in a more participatory setting to evaluate alternative development scenarios for areas with conflictive use interests.

- *Various handbooks and Toolboxes for ICZM, a software model acting as scenario generator.*
- *Scenario building methodologies, public awareness, database available.*

11. VISION RD4SD

The Project offers the "vision and principles" for novel sustainable development of European research. It is a new infrastructure/network for all European member countries which determines the tools and development of the sustainable research relevant to policy makers.

The project had a wider socio-economic impact on the dialog infrastructures. It focused on the planning and managing of experimental research which required changes towards sustainability.

- *A new infrastructure/network for all European member countries (sustainable research).*
- *The projects has increased collaboration between policy makers (agencies and governmental institutions) and academia*

12. W2Plastics

The impact of innovations in this project can be multidimensional including technological, economic, social and environmental. The MDS technology is a complete new entrant into the field of waste recycling and has the potential of transforming the recycling into clean, environment friendly and high margin business to producing high quality raw materials. This technology, with its capability to process complex post-consumer wastes in a cost effective manner, offers an opportunity to increase the recycling rates of high quality PP and PE significantly and has the potential of replacing 5-10 million tonnes of Polyolefin in Europe per year.

- *A new waste sorting technology (MDS) along with integrated process (Ultrasound) and quality control (Hyperspectral Imaging)*

13. WASHtech

From the impact assessment part of the final project report and efforts made to ensure the availability of the tools to stakeholders through own websites and to a wider international community through the RWSN website, the impact of the innovations in the project can be considered significant. The innovations are being used as validation, monitoring and project/programme appraisal tools and are expected to help in more effective investment in new technologies, informed decision making, participatory action research to identify obstacles and opportunities for uptake and scaling up technology beyond pilot testing and in participatory development, implementation and evaluation of sustainable WASH technologies.

- *A Technology Applicability Framework, a Technology Introduction Process, new WASH technologies for their sustainable implementation and operation*

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«*Environment, including climate change*» was one of the 10 Themes within the specific «Cooperation» programme of the *Seventh Framework Programme of the European Community for research, technological development and demonstration activities* (FP7 2007-2013). This report assesses the rationale, objectives, participation, outputs, outcomes and impacts of the FP7-Environment programme. The analysis of outputs, outcomes and impacts is subdivided into the areas of scientific excellence, innovation, cross-cutting issues, support to policy and European added-value.

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