IMPACT-SC5

ASSESSING THE IMPACT PATHWAYS OF IA/RIA SC5 PROJECTS THROUGH THE USE OF PORTFOLIO ANALYSIS

D3.2: Portfolio Impact Assessment report

This document has been produced for the purpose of the Policy Co-Creation Workshop "Fighting and Adapting to Climate Change"

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The content of the document constitutes a subset of the total Deliverable D3.2 Portfolio Impact Assessment which has been submitted to the EC for review and approval. The content is the responsibility of the IMPACT-SC5 consortium and does not reflect the opinion of the EC.

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Contents

List of Figures

List of Tables

1 Introduction

The current document constitutes a subset of the **deliverable D3.2: Portfolio Impact Assessment Report** elaborated in the framework of the IMPACT-SC5 project, which has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 869746.

Overall, the IMPACT-SC5 project – "*Assessing the impact pathways of IA/RIA SC5 projects through the use of portfolio analysis*" – aims to review the impacts of the projects granted under Horizon 2020 Societal Challenge 5 (SC5) as described in its Work Programmes and Calls (e.g. Water-2014, Waste-2015, EE-2014, etc.). This evaluation and impact assessment focusses on the 87 Research and Innovation Action (RIA) and Innovation Action (IA) projects funded under the SC5 Work Programme 2014-2015 and looks at them in terms of their scientific, economic, societal and environmental performance, both individually and across portfolios of projects.

All the information obtained from the literature review, the survey and the interviews were previously analysed at project level, in Work Package 2 *"Exploration of SC5 projects"*. This document represents the second deliverable of Work Package 3: "Contextualisation and impact assessment of project portfolios" and aims at analysing the impact pathways of aggregated groupings of projects in order to draw meaningful policy-relevant conclusions. The evaluation aims to develop an evidence-based opinion on the performance and effectiveness of the projects and the impacts made to date, while identifying the aspects that have enabled or hindered the achievement of the goals of the projects.

Thus, the portfolio impact assessment will complement the project-level analysis, measuring the collective impacts that projects have made together.

This deliverable reports the methodological approach used in the impact assessment of the IMPACT-SC5 project portfolios and presents the results of the impact pathways analysis for each project portfolio.

It also identifies the policy-relevant conclusions that emerged from the analysis.

In order to facilitate the reading of this deliverable, it has been structured in the following manner:

- **Chapter 1** provides introductory information about the context in which this deliverable has been elaborated;
- **Chapter 2** reports the findings of the two Climate Change project clusters and project portfolio impact assessment exercise
- **Chapter 3** introduces the assumptions and evaluation framework for the portfolio impact assessment exercise;
- **Chapter 4** explains the selection process and identifies the project portfolios selected for impact assessment analysis purposes.

2 Project portfolios impact assessment

In the following section, the characterisation of each project cluster as well as the scientific, environmental and societal and economic impact pathways assessment will be performed.

As a result of the above, general conclusions on the extent to which the project clusters have contributed to the achievement of the specific objectives and expected results for each impact pathway will be presented at project portfolio level.

2.1 Project portfolio 1: CLIMATE CHANGE project portfolio

This project portfolio relates to **twelve (12)** projects under the header 'Climate Change', divided over two clusters:

- Project cluster 1.1: **ten** (10) projects aimed at fighting, adapting to and mitigating climate change.
    - Four (4) projects awarded under “Disaster Resilience & Climate Change”, topic 1: Science and Innovation for adaptation to climate change: from assessing costs, risks and opportunities to demonstration of options and practices (call reference DRS-09-2014/2015). These projects are: RESIN, EU-CIRCLE, RESCCUE and BRIGAID.
    - Two (2) projects awarded under “Disaster Resilience & Climate Change”, topic 3: Mitigating the impacts of climate change and natural hazards on cultural heritage sites, structures and artefacts (call reference DRS-11-2015). These projects are: STORM and HERACLES.
    - One (1) project awarded under “Energy strategies and solutions for deep renovation of historic buildings” (call reference EE-03-2014). This project is: RIBuild.
    - One (1) project awarded under “The economics of climate change and linkages with sustainable development: Economic assessment of climate change” (call reference SC5-3a). This project is TRANSrisk.
    - Two (2) projects awarded under “The economics of climate change and linkages with sustainable development: Linkages between climate change actions and sustainable development” (call reference SC5-3b). These projects are GREEN-WIN and CD-LINKS.
- Project cluster 1.2: **two** (2) projects working to advance Earth-system Models (call reference SC5-01-2014). These projects are CRESCENDO and PRIMAVERA.

Table 1: Projects considered under the CLIMATE CHANGE project portfolio

Project clusters	Project Acronym	Project name	Project URL
Project cluster 1.1: FIGHTING, ADAPTING AND MITIGATING CLIMATE CHANGE	RESIN	Climate Resilient Cities and Infrastructures	http://cordis.europa.eu/project/id/653522
	EU-CIRCLE	A pan European framework for strengthening Critical Infrastructure resilience to climate change	http://cordis.europa.eu/project/id/653824
	RESCCUE	RESilience to cope with Climate Change in Urban arEas - a multisectoral approach focusing on water	http://cordis.europa.eu/project/id/700174
	BRIGAID	BRIdges the GAp for Innovations in Disaster resilience	http://cordis.europa.eu/project/id/700699
	STORM	Safeguarding Cultural Heritage through Technical and Organisational Resources Management	http://cordis.europa.eu/project/id/700191
	HERACLES	HEritage Resilience Against CLimate Events on Site	http://cordis.europa.eu/project/id/700395
	RIBuild	Robust Internal Thermal Insulation of Historic Buildings	http://cordis.europa.eu/project/id/637268
	TRANSrisk	Transition pathways and risk analysis for climate change mitigation and adaption strategies	http://cordis.europa.eu/project/id/642260
	GREEN-WIN	Green growth and win-win strategies for sustainable climate action	http://cordis.europa.eu/project/id/642018
	CD-LINKS	Linking Climate and Development Policies - Leveraging International Networks and Knowledge Sharing	http://cordis.europa.eu/project/id/642147
Project cluster 1.2 ADVANCED EARTH SYSTEM MODELS	CRESCENDO	Coordinated Research in Earth Systems and Climate: Experiments, kNowledge, Dissemination and Outreach	https://cordis.europa.eu/project/id/641816
	PRIMAVERA	Process-based climate sIMulation: AdVances in high resolution modelling and European climate Risk Assessment	https://cordis.europa.eu/project/id/641727

2.1.1 Project cluster 1.1: Fighting, adapting and mitigating climate change

The analysis of these ten projects addressing Climate Change incorporates information from the following main sources:

- The IMPACT-SC5 extract of EU CORDIS database (for the ten projects);
- European Commission datasets related to: Publications, Intellectual Property, Innovation, Open Data, Gender and Demos-Market Replication (for the seven projects);
- Thirty-three (33) survey results covering the ten projects, of which six (6) correspond to project coordinators' answers (for six (6) out of the ten (10) projects); and
- Seven (7) interviews representing seven (7) out of the ten (10) projects.

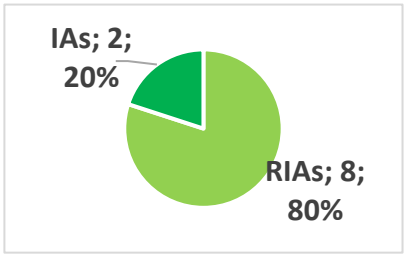
Other sources such as ORBIS database and projects' and companies' websites have been used to gather information about the private for-profit entities (excluding the Higher and Secondary Education Establishments) participating in this cluster of projects.

In the following sections, data is analysed for each of the two clusters individually. In the last sections of the document, the data and analysis for the portfolio as a whole is presented.

2.1.1.1 Project Cluster 1.1: Characterisation

The cluster of projects 1.1 "Fighting, adapting to and mitigating climate change" is characterised by the following data:

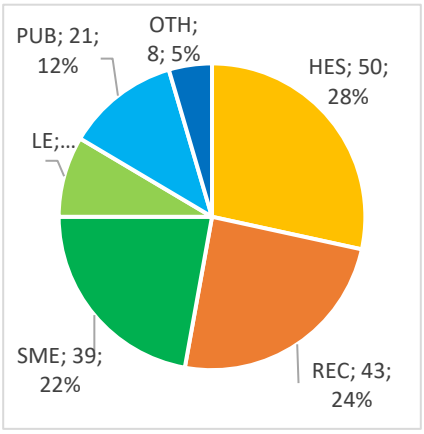
Figure 1: A snapshot of the 1.1 project cluster characteristics

FUNDING SCHEME	IMPLEMENTATION PERIOD
	Jan. 2015 — June. 2020 AVERAGE IMPLEMENTATION PERIOD: 3 years & 8 months

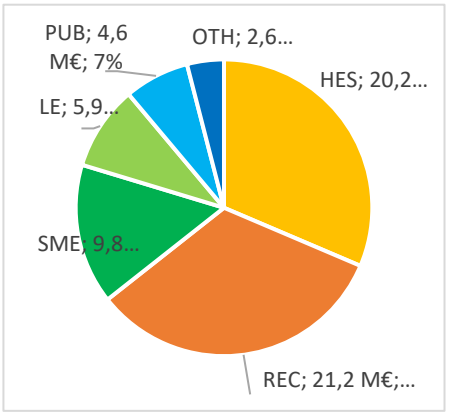
COST & FUNDING			
TOTAL COST:	68 M€	AVG COST PER PROJECT: 6.8 M€	
TOTAL EC CONTRIB.:	64.3 M€	AVG EC CONTRIB. PER PROJECT: 6.4 M€	

PARTICIPANTS

By type of activity



By assigned EC contribution (M€)



	COUNTRIES	ORGANISATIONS
EU27 [+UK]:	18	154
ASSOCIATED COUNTRIES:	5	8
COUNTRIES WITH BILATERAL SCIENCE & TECHNOLOGY AGREEMENTS:	8	11
REST OF THE WORLD:	2	3
TOTAL NUMBER:	33	176

1. FUNDING SCHEME and TOPIC

- Two (2) Innovation Actions (IA) and eight (8) Research and Innovation Actions (RIA) make up this cluster of projects.
- Of the ten (10) projects, three (3) were funded under programme EU 3.5.1 (topics SC5-3a & b) and seven (7) funded under cross-cutting topics (DRS-09, DRS-11 and EE-03). All ten (10) relate to fighting, adapting to and mitigating climate change.

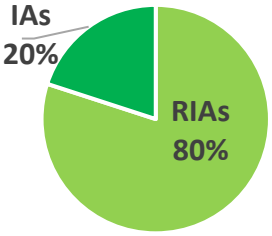


Figure 2: Project cluster 1.1: Distribution of projects by funding scheme (%)

2. IMPLEMENTATION PERIOD

- The total implementation period was from January 2015 until June 2020 (with the start and end of the RIBuild project).
- The average implementation period of the projects was 3 years and 8 months.

3. PARTICIPANTS

- A total number of one hundred and seventy-six (176) organisations were involved in the implementation of these projects. The largest consortium consisted of twenty-five (25) partners and the smallest one ten (10). The average number of participant organisations per project was seventeen (17).
- In terms of the type of activity of each participant, out of the one hundred and seventy-six (176) organisations involved in the project cluster, fifty-four (54) were private for-profit entities (excluding Higher or Secondary Education Establishments) (PRC). Forty-three (43) participants were research organisations (REC), fifty (50) were Higher or Secondary Education Establishments (HES), twenty-one (21) were public bodies (PUB) and eight (8) represented other types of organisations (OTH). Under the last category, the following type of organisations were involved:

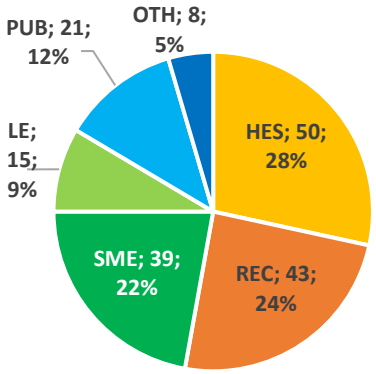


Figure 3: Project cluster 1.1: Distribution of participants by type of activity (number, %)

  - Two (2) international research centres, one (1) on the environment and the economy and the other (1) on structural economic reform;
  - One (1) international organisation on emergency management;
  - One (1) international association working with the financial sector;
  - Two (2) European associations, one representing local authorities and the other representing materials research; and

  - Two (2) national non-profit organisations, one for social and environmental entrepreneurship and for archaeology.

- In the case of the RIA projects, the average participation of private companies accounted for 31% of organisations.
- Regarding the private for-profit entities (excluding Higher or Secondary Education Establishments) (PRC), nine (9) organisations took part in more than one project funded by the SC5 WP 2014-2015, and two (2) of them have joined more than one project included in this cluster of projects.
- In terms of the size of the PRCs involved in this project cluster, thirty-nine (39) organisations were Small and Medium enterprises (72% of the total PRCs participations), with the highest number of thirteen (13) in BRIGAID and lowest of zero (0) in CD-LINKS.
- Five (5) out of the ten (10) projects included in this cluster were coordinated by research organisations, two (2) were led by private for-profit entities (excluding Higher or Secondary Education Establishment), and three (3) by education establishments.
- Under this project cluster, organisations from thirty-three (33) different countries were involved. In each project, nine (9) different countries are represented on average.
- Fifteen (15) organisations from non-EU 27 countries participated in these projects. Six (6) projects included partners from thirteen (13) non-European countries.

4. COST AND FUNDING of PROJECTS

- The total cost of the projects in this cluster was 67,957,372 EUR with a total EC maximum contribution of 64,327,633 EUR. This represents an average share of European funding of 95% of the total cost of the project cluster.
- The cost of projects ranges from 3,925,012 EUR to 8,817,445 EUR. The average cost of the projects included in this cluster is 6,795,77 EUR.
- Accordingly, the EC maximum contribution ranges from 3,624,762 EUR to 7,739,805 EUR. The average EC contribution amounts to 6,432,763 EUR.
- In terms of the EC contribution received by the type of activity of each organisation involved in the projects' implementation, the figures and shares are shown in the table and graph below:

Table 2: Project cluster 1.1: EC maximum contribution by type of organisation (€)

Type of organisation	EC Max. Contribution (EUR)
PRC (Large Enterprise): Private for-profit entities (excluding Higher or Secondary Education Establishments)	**5,921,025**
PRC (SME): Private for-profit entities (excluding Higher or Secondary Education Establishments)	**9,842,766**
REC: Research Organisations	**21,207,210**
HES: Higher or Secondary Education Establishments	**20,204,708**
PUB: Public bodies (excluding Research Organisations and Secondary or Higher Education Establishments)	**4,567,016**
OTH: Other	**2,584,906**
TOTAL	**64,327,633**

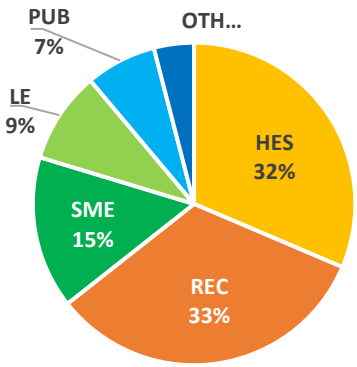


Figure 4: Project cluster 1.1: EC maximum contribution by type of organisation (%)

According to the data above, the private for-profit entities (PRC), which represent 31% of the number of organisations participating in the projects under this cluster, received 25% of the funding (15% has been allocated to Small and Medium-sized Enterprise and 10% to large enterprises).

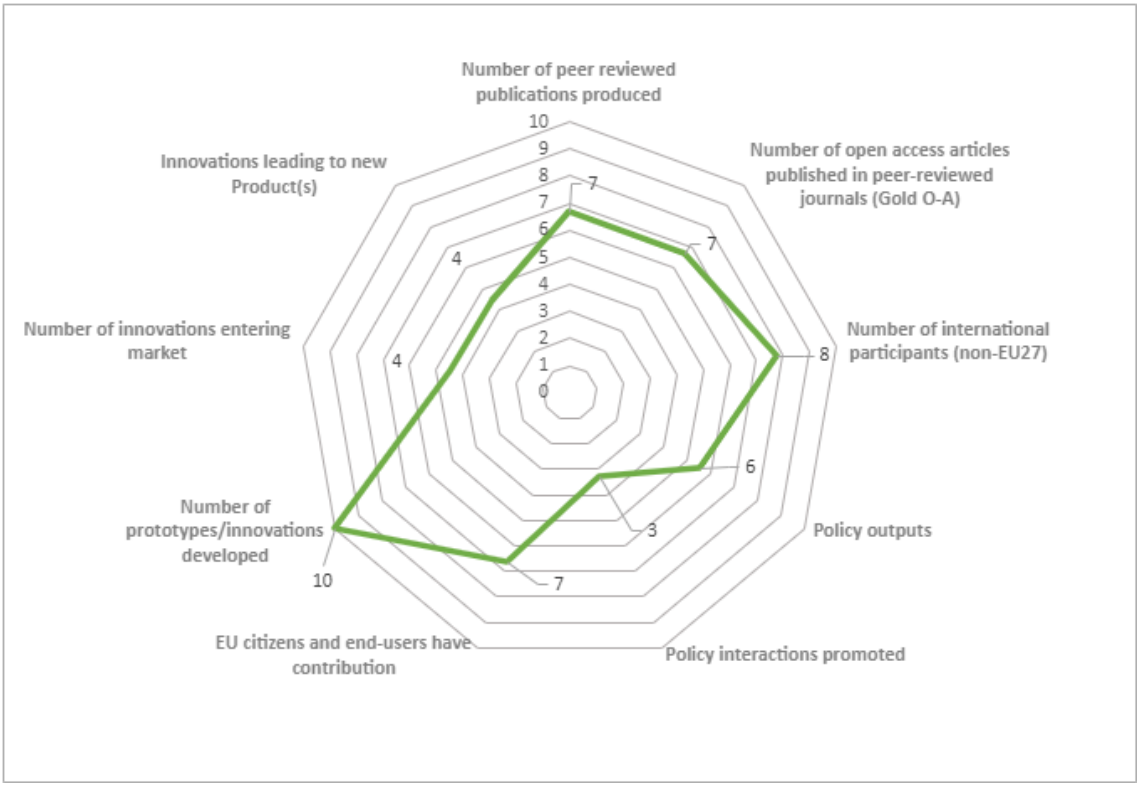
In the case of Research Organisations (REC), they accounted for 24% of the number of organisations involved and received 33% of the funding. As to the Higher or Secondary Education Entities (HES), they constituted 28% of the organisations involved in the projects and received 31% of the allocated funding. Public Bodies and Other types of organisations combined represent 17% of the participants with11% of funding.

This indicates that Research and Higher or Secondary Education organisations received, in general terms, a higher proportion of funding compared to other types of organisations involved.

2.1.1.2 Project cluster 1.1: Impact pathways assessment

The radar chart below shows the data for this cluster for the selected nine key indicators:

Figure 5: Project cluster 1.1 radar chart



The projects of cluster 1.1 show a balanced performance contributing considerably to some indicators belonging to the three impact pathways.

In terms of the scientific impact pathway, the projects of this cluster have notably contributed to the three related indicators, ranking in the top 30% percentile when it refers to peer-reviewed publications and open access publications. The international focus of this group of projects ranks in the top 20% percentile, with – as shown in the table above – twenty-two (22) organisations and fifteen (15) countries outside the EU [+UK].

By means of the environmental and societal impact pathway, this group of projects have performed above average in terms of citizen engagement (top 30% percentile) and policy outputs production (top 40% percentile), but below average when it comes to policy interactions promoted (bottom 30%). This data represents eight (8) projects out of the ten (10) in this cluster, as no data is available for two projects.

Lastly, regarding to the economic impact pathway, this project cluster ranks in the highest percentile by means of number of prototypes and innovations. However, when it comes to number of innovations entering the market or innovations leading to new products the results achieved are more modest.

When compared to the other clusters in our analysis, cluster 1.1 comes first with the number of prototypes and innovations developed. However, for the other two economic indicators, cluster 1.1 ranks below average in the bottom 40% out of ten clusters. As with the policy outputs and interactions above, it could indicate that projects produce enough results, but insufficient attention in proactive dissemination (through policy interaction) and exploitation (innovation leading to new products entering the market). This outcome can only partly be attributed to the fact that this cluster has eight

(8) RIA and (only) two (2) IA projects, as there is no significant difference in outcome between these two types of action. Projects have not reported about Technology Readiness Level (TRL) at start and completion of projects.

With all the above in mind, the following sections assess the scientific, societal and economic impact pathways of cluster 1.1.

2.1.1.2.1 Project cluster 1.1: Scientific impact pathway assessment

Consistent with the Work Programme, it was expected that the projects under the fighting, adapting to and mitigating climate change cluster of projects should achieve or contribute to the achievement of the following specific objectives and expected impacts:

Table 3: Project cluster 1.1: Scientific specific objectives and expected impacts

Specific objectives	Expected impacts
Creating high quality new knowledge, reducing the knowledge gaps • To **strengthen the knowledge base**, through a more coherent approach to the identification and assessment of the performance and impacts of different adaptation measures. • To develop a **standardised method** to assess climate change impacts, vulnerabilities and risks. • To **identify and assess the performance** of adaptation measures. • To **support, test and disseminate technological and non-technological options**, including ecosystem- based approaches, to address climate-related risks and climate-proof critical infrastructure assets and systems. • To **develop effective adaptation strategies, systems and technologies** for better risk management and mitigating damage. • To **identify and address research gaps** or barriers**.** • To **develop and demonstrate innovative energy and environmental assessment methodologies** and tools. • To develop a **comprehensive economic assessment of climate change**. • To **enhance international research collaboration**. • To develop a **science dialogue between the EU and international partner countries** (focus on G20). • To develop **technological and socio-economic mitigation pathways and adaptation strategies** in the context of wider sustainable development goals. • To contribute to **major international scientific assessments** (e.g. Intergovernmental Panel on Climate Change (IPCC)).	**Creating high quality new knowledge, reducing the knowledge gaps** • To improve **information availability** for decision making (at both public and private sectors) and to prioritise relevant interventions. • To contribute to the **development of technological and performance standards** for adaptation options. • To develop **innovative environmental assessment methodologies**, integrated monitoring technologies and systems, improved methods of surveying and diagnosis. • To allow **better understanding of the historical and technological contexts** of heritage materials and objects. • To **optimise the design and implementation of renovation** projects. • To provide **scientific underpinning** for the implementation and review of the 'Roadmap for moving to a low-carbon economy by 2050'. • To contribute to **major international scientific assessment** (e.g. Intergovernmental Panel on Climate Change (IPCC)). • To **increase collaboration and cooperation** in scientific research between the EU and key target countries in the area of climate action.

EQ1: To what extent has the project cluster produced the expected outputs? (From the IMPACT-SC5 short-term scientific indicators)

From a quantitative point of view, the table below presents the IMPACT-SC5 short-term scientific indicators measured for the current cluster of projects:

Table 4: Project cluster 1.1: Scientific impact pathway indicators

KEY IMPACT PATHWAYS	SHORT-TERM INDICATORS		Value
Creating high quality new knowledge; reducing knowledge gaps	S.1.a	Number of peer reviewed publications produced	229
	S.1.b	Number of publications in the top 10% of impact ranked journals by SC5 subject category (such as: water, waste, resource efficiency, climate action).	N/A
	S.1.c	The project portfolio has incorporated and/or developed gender knowledge (e.g. outcome of sex/gender analysis) (Y/N)	YES (6 out of 10 projects)
Strengthening human capital in R&I	S.2	Number of recruited early stage researchers for the project	N/A
	S.3.a	Share of men/women participants (researchers)	948 men (60 %) 631 women (40%)
	S.3.b	Share of men/women participants (non-researchers)	521 men (54%) 444 women (46%)
Fostering diffusion of knowledge and open data	S.4.a	Number of open access articles published in peer-reviewed journals.	85
	S.4.b	Number of open access datasets, software.	26
	S.5	Number of open research infrastructures accessed.	7 (3 projects)
Partnerships and international openness	S.6	Number of participations in activities organised jointly with other H2020 project(s) (SC2 programme)	YES (8 out of 10 projects, no exact number available)
	S.7	Number of international participants (non-EU27)	44

Creating high quality new knowledge, reducing the knowledge gap

In terms of **publications**, based on the data provided by the European Commission and the survey, the projects have generated **two hundred and twenty-nine (229) peer reviewed articles**. In addition, the projects delivered one hundred and eighty-two (182) conference proceedings, nineteen (19) monographic or books (including book chapters), eight (8) thesis dissertations and fourteen (14) publications of other types.

From the survey and interview, **one hundred and twenty-four (124)** of the above-mentioned publications (from six of the ten projects) were reported as published **in peer-reviewed journals**. There is no information about the number of the publications published in the top 10% of impact ranked journals.

Related to the **gender dimension**, most of the answers received in the survey considered that the projects have contributed to the generation/incorporation of gender knowledge, however the survey shows very different perceptions among partners in terms of the extent to what each project has

contributed to the development of gender knowledge. Answers from different partners in the same project range from “not at all” to “to a great extent”.

Except for one project, the survey responses indicate that the partners consider that their work has **addressed gaps** in the knowledge base needed to understand change in the environment, with five (5) projects reporting considerable to great advances in addressing knowledge gaps.

Strengthening human capital in R&I

Regarding the contribution of these projects to **strengthening human capital** in research and innovation, no official information is available about the number of early-stage researchers recruited for the projects and that have been retained beyond the life of the project or about the number of PhD degrees achieved supported by the projects. However, in the interviews, the project coordinators stated that more than seven (7) PhD theses have been supported (based on reports from five (5) out of ten (10) projects).

More related with the **share of men and women** involved in the project, three out of ten of the project coordinators were women. According to the data provided by the European Commission, the overall share of women involved in this cluster of projects was 56% (one thousand and seventy-five (1075) women vs on thousand our hundred and sixty-nine (1469) men); respectively 40% of researchers and 46% of non-researchers.

Fostering diffusion of knowledge and open data

As was mentioned above, the project cluster generated two hundred and twenty-nine (229) publications. Of those, eighty-five (85) (37%) have been granted with golden open access and seventy-nine (79) (34,5%) with green open access.

Seventy-three (73) conference proceedings, eight (8) thesis dissertations and nineteen (19) other type of publications have been published under Green Open Access. In addition, twenty-four (24) conference proceedings, three (3) monographic or books and one (1) other publication have Gold Open Access.

Moreover, **twenty-six (26) open access datasets** were produced, and **seven (7) open research infrastructures** have been accessed.

Partnerships and international openness

From the survey, at least **eight (8) projects under this cluster have collaborated with other H2020 projects**, especially in conferences, workshops and other joint dissemination activities, having resulted in joint scientific/research cooperation (other than dissemination) in five (5) of the projects.

As to the participation of international organisations, twenty-two (22) non-EU27 [+ UK] partners were involved in the ten projects in this cluster. Of those, five (5) come from European or associated countries (one (1) from Albania, one (1) from Norway, three (3) from Switzerland, two (2) from Turkey). The other partners come from countries outside of Europe: Israel (1), Brazil (1), Chile (1), China (2), India (2), Indonesia (2), Japan (2), Kenya (1), Russia (1), South Africa (1) and South Korea (1). The most diverse project in terms of partners from different countries is CD-LINKS.

EQ2: To what extent and how has the project cluster contributed to its scientific specific objectives and expected impacts?

Aligned with the specific objectives and expected impacts of the Work Programme, this cluster of projects has **focused on applied research, translating knowledge into developing, advancing or harmonising methods, techniques and tools as well as demonstrating these through models, pilots and case studies.** Information about the options for mitigation or adaptation and to support decision-making has been captured in **databases and Resilience Action Plans**.

As the projects were focused on fighting, adapting to and mitigating climate change, much **effort was expended in involving stakeholders** (ranging from end-users to volunteers) and **making the projects' results available** ranging from toolkits, an ICT platform for knowledge transfer, summer school, research exchange programme and interacting with relevant sectors (e.g. tourism, cultural heritage and building renovation).

Some projects were quite broad, addressing urban resilience to cope with the effects of climate change. **Others were very specific**, such as combating the impact of climate change on historical buildings and cultural heritage sites. One project (BRIGAID) developed a methodology, Test and Implementation Framework (TIF), aimed at innovators to systematically bridge the gap between idea and application development.

Projects have been **active in disseminating their results** and some report that their methods and tools have already been picked up by end-users as well as other Horizon 2020 projects. In some projects' **dissemination has been organised with other Horizon 2020 project** (in some cases using the common dissemination booster). Particularly projects awarded under the same or similar topic (such as the Disaster Resilience (DRS) call see the benefit of joint activities.

2.1.1.2.2 Project cluster 1.1: Environmental and societal impact pathway assessment

Regarding the environmental and societal impact pathway, it was expected that the current cluster of projects contributes to the achievement of the following specific objectives and impacts:

Table 5: Project cluster 1.1: Environmental and societal specific objectives and expected impacts

Specific objectives	Expected impacts
Addressing EU policy priorities • To **protect and reduce the vulnerability of sensitive resources, economic sectors, green and technical infrastructure and society** from climate change related threats. • To **develop frameworks for monitoring the performance and effectiveness of developed approaches,** and for ensuring their optimum performance, addressing also post-implementation requirements, as well as operational and organisation/governance needs for successful replication and follow-up. • To **safeguard cultural heritage sites**, structures and artefacts for future generations. • To **preserve cultural heritage** as part of individual and collective identity. • To **target the needs and requirements of users**, **such as decision makers** at local, regional, national and international level responsible for disaster mitigation and safeguarding of cultural heritage assets. • To develop **innovative and affordable building renovation** solutions for historic buildings. • To **improve energy performance** without loss of comfort. • To provide **evidence-based estimates of costs and benefits**, as well as risk and opportunities associated with different mitigation pathways. • To **develop tools for evidence-based decision making**. • To **examine the impacts on green growth, innovation dynamics, job creation and social cohesion**. • To **examine actual and prospective mitigation and adaptation policies** in various countries to support evidence-based policy making. **Strengthening the uptake of innovation in society** • To provide **support for capacity-building and knowledge-sharing** goals under the United Nations Framework Convention on Climate Change (UNFCCC).	**Addressing EU policy priorities** • To **enhance implementation in the medium-term of the EU Adaptation Strategy** as well as of the EU Disaster Prevention Framework. • To **promote market uptake of innovative technological and non-technological climate change adaptation solutions**. • To achieve **more effective advice and input to restoration and adaptation policies** of government organisations thereby promoting improved practices for the guardians of cultural heritage assets. • To deliver **significant improvements in energy performance** at both building and district level. • To **reduce, already in the short-term, the uncertainties in assessing and computing the costs, benefits and economic values** of mitigating options. • To **facilitate EU and global climate policy goals** and mainstream climate change mitigation options across multiple scales and sectors. • To **integrate climate action** in the broader development agendas for developing countries. **Strengthening the uptake of innovation in society** • To **support for capacity-building and knowledge-sharing goa**ls under the United Nations Framework Convention on Climate Change (UNFCCC).

EQ1: To what extent has the project portfolio /cluster produced the expected environmental and societal outputs? (From the IMPACT-SC5 short-term environmental and societal indicators)

The table below presents the IMPACT-SC5 short-term environmental and societal indicators measured for the current cluster of projects:

Table 6: Project cluster 1.1: Environmental and societal impact pathway indicators

KEY IMPACT PATHWAYS		SHORT-TERM INDICATORS	VALUE
Addressing EU policy priorities	S.8.a	Number of policy outputs (policy briefs, policy recommendations, etc.) aimed at addressing specific EU policy priorities, cluster (waste, raw materials, water.) challenges or Sustainable Development Goals (SDGs).	- YES (7 out of 8 projects) - NO (1 out of 8 projects) - No data for 2 projects
	S.8.b	Number of policy interactions promoted (e.g. forums, conferences, consultations) in relation to EU policy targets.	- YES (6 out of 8 projects) - NO (2 out of 8 projects) - No data for 2 projects
Strengthening the uptake of innovation in society	S.9	EU citizens and end-users have contributed to the co-creation of R&I content (co-creation with Non-Governmental Organisations / Civil Society Organisations as core partner in the design of the project) (Y/N)	- YES (6 out of 8 projects) - NO (2 out of 8 projects) - No data for 2 projects

Addressing EU Policy priorities

When referring to the **number of policy outputs** addressing specific EU policy priorities, cluster, challenges or Sustainable Development Goals (SDGs) generated by the projects under the current cluster, an exact number it is not available. However, **seven (7) projects have generated policy related outputs**, especially by means of **direct dissemination of project results to policy makers** (workshops, events etc.) ranging from local to global level, or by **issuing policy recommendations**. From the survey responses, eight (8) out of ten (10) projects report that they have **considerably to greatly contributed to policy development** (in the form of strategy papers, expert groups, etc.).

All projects report they have contributed to the SDG **Climate Action** (considerable to great extent). Other SDGs addressed by the projects to a considerable or great extent are **Clean water and sanitation, Affordable and clean energy, Life on land, Industry, innovation and infrastructure, Responsible consumption and production, Sustainable cities and communities and Partnerships to achieve the goal**.

Regarding the number of **policy interactions** promoted, **six (6) projects** have answered in the survey that they **have participated in several conferences, discussion forums or experts or focus groups**, at local/regional, national, European and international level and that in most of the cases those considerably contributed to the achievement of the projects' impacts. From the responses it seems that consortia are either very active (participating in a broad range of events) or not at all.

Strengthening the uptake of innovation in society

Six (6) projects in this cluster have used some form of participatory approach. Of these, **four (4) have used workshops with the participation of users, online platforms or face-to-face interactions** and the voluntary collection of monitoring data **to a considerable to great extent**. The role of **citizens** was that of **pilot users or participants in crowdsourcing activities** (voluntary collection of data, data validation and cross-checking of scientific data).

According to the survey responses, **nine (9) projects** have to some extent contributed to **social** and **public sector innovation**, with two (2) projects reporting they have greatly contributed.

EQ2: To what extent and how has the project cluster contributed to its environmental and societal specific objectives and expected impacts?

From an environmental point of view, the cluster of projects has contributed to **raising awareness of the need to act to fight climate change** through mitigation or adaptation (indicating a growing awareness of the need to act to already occurring changes). Projects have facilitated this by **developing practical tools, methods and techniques** to help practitioners and policy makers understand the issue (monitoring, measuring) as well as the options available to them (planning, decision-support, economic models).

The projects responding to the **Disaster Resilience & Climate Change** topics, perhaps due to the visibility and urgency of climate related disasters such as wildfires and flooding, show a **high level of end-user and citizen engagement**. For example, bringing together a city network of practitioners, co-creation of approaches and tools, organising world café and citizen participation / crowdsourcing were used.

In terms of scope and scale, projects have worked on **achieving results with an international reach by developing frameworks or tools that can be applied in diverse economies and settings** (e.g. carbon transition pathways, coastal flood risk management) while others have been very specific and local (historic buildings and cultural heritage sites).

Apart from individual and collective action by consumers/citizens, public and private sector organisations, a **method to scale-up and ensure the sustainability of the project's results** is to a) raise the topic on the political agenda; b) embed outcomes into (new) policy. All ten (10) projects have **engaged with policy makers, ranging from local to EU level**.

In general terms, projects report that their **policy outputs have directly influenced policy** (such as local masterplans or the new mission on climate) and/or that they have **produced soft policy tools such as planning tools, assessment framework, evidence-based packages** to mobilise and direct financial resources and institutional frameworks, trade-off and decision-making methods. To develop these, projects have engaged with policy makers at local, regional, national and EU level (depending on the scale and scope of their project; as mentioned above some projects had a very local scope, others a European/international scope).

Projects consider that, if their recommendations are considered and implemented (the proviso being that the projects have only recently finished therefore long-term impacts are not yet known), the benefit would be:

a) assure environmental integrity, resilience, and sustainability.

b) enable ecosystems and society to adapt to climate change and other environmental changes.

c) protect and sustainably manage the natural resources and ecosystems.

2.1.1.2.3 Project cluster 1.1: Economic impact pathway assessment

Related to the economic impact pathway, it was expected that the current cluster of projects would contribute to the achievement of the following specific objectives and impacts:

Table 7: Project cluster 1.1: Economic specific objectives and expected impacts

Specific objectives	Expected impacts
Generating innovation-based growth • To **develop eco-innovative solutions** to help mitigate the effects of climate change and natural hazards on cultural heritage sites. • To **prove replication potential** of the proposed solutions. **Creating more and better jobs** • To **boost cultural heritage as motor for tourism** (jobs) in Europe. **Development and adoption of innovative technological solutions** • To support the **development of innovative adaptation and long-term risk options.** • **TRL achieved: 4-6**. • To develop **cost-effective conservation and restoration techniques, risk management, disaster prevention and quick damage assessment**.	**Generating innovation-based growth** • Effective **guidelines and contribution to standardisation**. • **Reduced fragmentation in this sector** through increased collaboration and cooperation. • More **sustainable and effective safeguarding and management of European cultural heritage** through more reliable predictive and cost-effective maintenance, improved risk management, diagnosis and treatment. • **Reduced fragmentation in this sector** through increased collaboration and cooperation and a fostering of an interdisciplinary approach. **Development and adoption of innovative technological solutions** • Rapid **large-scale deployment and market uptake of innovative technologic and non-technological climate change adaptation solutions** with high replicability. • National and local **efforts towards climate-proofing of key European economic sectors** and services. • Support the i**mplementation of the Energy efficient Buildings PPP roadmap**. • Support for **technological, institutional and socio-economic innovation** in the area of climate action. • Accelerated **transfer of low-carbon and adaptation technologies and knowledge** to emerging and developing countries.

EQ1: To what extent has the project cluster produced the expected economic outputs? (From the IMPACT-SC5 short-term economic indicators)

The table below presents the IMPACT-SC5 short-term economic indicators measured for the project cluster:

Table 8: Project cluster 1.1: Economic impact pathway indicators

KEY IMPACT PATHWAYS	SHORT-TERM INDICATORS		VALUE
Generating innovation-based growth	S.10.a	The project leads to innovative products (Y/N)	- YES (6 out of 8 projects) - No data for 2 projects
	S.10.b	The project leads to innovative processes or methods (Y/N)	- YES (7 out of 8 projects) - No data for 2 projects
	S.10.c	Number of Intellectual Property Rights (IPR) applications (patent, copyright, trademarks)	- YES (1 project reported 2 IP applications (not specified which type). - NO (5 projects) - No data for 4 projects.
	S.11	The project has contributed to regulation/standard harmonisation (Y/N)	- YES (4 projects contributed to a small to moderate extent). - NO (2 projects) - No data for 4 projects.
Creating more and better jobs	S.12	Number of full-time equivalent (FTE) jobs created through CS5 support, by type of job (researcher, non-researcher) and contract duration (short-term-long term); particularly in participating SMEs	Direct - Scientific jobs: 23 short-term - Technical jobs: 5 short-term - Administrative jobs: 5 short-terms (based on data from 2 projects only; 8 projects did not report on jobs created)
Leveraging investment in R&I	S.13.a	Amount of national public investment mobilised within the project.	- NO (2 projects) - No data for 8 projects
	S.13.b	Amount of national private investment mobilised within the project.	- NO (2 projects) - No data for 8 projects
	S.13.c	Amount of EU public private investment mobilised within the project.	- NO (2 projects) - No data for 8 projects
	S.13.d	Amount of trans-national private investment mobilised within the project.	- NO (2 projects) - No data for 8 projects
Development and adoption of innovative technological solutions	S.14.a	Change in Technology Readiness Level (TRL) from start to end of the project.	- YES (2 projects; TRL change not specified) - No data for 8 projects
	S.14.b	Number of joint public-private publications	- YES (3 out of the 10 projects, of which 2 projects with 4-5 publications and 1 project with > 5 publications) - NO (2 projects) - No data for 5 projects

Generating innovation-based growth

Based on the survey results, project coordinators and project partners from all ten (10) projects have identified that the projects under this specific cluster have contributed considerably to greatly to **generating partnerships** and boosting international openness, but also to generating **technological progress** and delivering **technological innovations**. Indeed, seven (7) projects included in the cluster

report they have considerably to greatly **progressed technological innovation**, with the three (3) remaining projects reporting modest progress.

For one project, **a (1) patent application** has been filed. For the other projects, no applications have been filed or no information is available from the survey responses. Two (2) projects have applied for **copyright protection for publications**. Twelve (12) organisations indicate that protection of the SC5 project **intellectual property is considerably to greatly important for them** (it should be noted that the survey is dominated by a high share of responses from one project).

In terms of innovative outputs generated by the projects in this cluster, six (6) report that they have produced **prototypes or demonstrations** (55), **new or modified products** (137) or **services** (16) and **new or modified processes** (10).

Based on the data provided by the European Commission, the current project cluster's main innovative results are in **testing activities** (150), number of **prototypes** (56) and **innovations in market** (26 in general and 20 by SMEs). Out of the ten projects, only the two (2) Innovation Action projects report that demonstration/piloting activities have taken place.

All ten projects report that they have contributed to the **creation or development of standards** and **regulations**, with survey answers ranging from a small to considerable or great extent of contribution. To a lesser extent, projects have contributed to the **harmonisation of standards**. There has been no (reported) contribution to the **setting up** or contributing to the work of **existing standard committees**.

Creating more and better jobs

In terms of **creating more and better jobs**, according to the survey results, twenty-three (23) scientific jobs, five (5) technical jobs and five (5) administrative jobs have been created within the projects (all short-term). However, this information cannot be considered as relevant enough for analysis since it is information from only two of the ten projects. No information about the number of the jobs retained once the projects have come to an end is available.

Leveraging investment in R&I

To this regard, the available information does not permit definite conclusions to be drawn since the survey information comes from only two of the ten projects. In any case, it seems that, considering the gathered data, none of the projects has managed to leverage additional funding from public and /or private sources.

Development and adoption of innovative technological solutions

Regarding the change in the Technology Readiness Levels (TRLs) achieved, two (2) out of the ten (10) projects report having achieved a change in TRL. They do not specify at which TRL they started and finished during the project.

By means of joint public-private publications, three (3) projects have stated in the survey that they have developed collaborative outputs, of which two (2) projects with four to five (4-5) joint publications and one (1) project with more than five (5) joint publications.

EQ2: To what extent and how has the project cluster contributed to its economic specific objectives and expected impacts?

When it comes to economic objectives and impact, projects report that their results support the **generation of innovation-based growth and the development and adoption of innovative technological solutions**, meaning that the science, technology development/advancement and processes and methods coming out of their projects are made available as openly and broadly as possible. Eight (8) out of ten (10) projects were Research and Innovation Actions and therefore did not have the specific objective of creating new businesses, products, or services (and resulting from that more and better jobs). One way through which partners could create business opportunities is through consultancy services, to help organisations use and implement the new frameworks, methods, and tools.

One way in which some projects contributed to the uptake and scaling of innovative solutions is to **engage in standardisation**. Although they note that the standardisation process takes several years, they have worked with (pre-) standardisation bodies for example on adaptation requirements for disaster resilience problems related to climate change and sustainable cities.

Although for most projects the development and market introduction of innovative products and services was not an objective, one project mentions that their **work resulted in a spin-off** company to exploit the result. One project provided, through their **Test and Implementation Framework (TIF), direct support to twenty-five (25) SMEs**, some of which have gone on to become successful. Indirectly, the method supported more than one hundred and twenty (120) innovators to develop and test their ideas (technical, commercial, and societal). The TIF method could be taken up by some partners as consultancy, to continue working with and supporting SMEs.

None of the projects has been able to leverage complementary or follow-up funding. In some cases, (part of) the consortium has applied for funding from later Horizon 2020 calls.

The two Innovation Actions had the highest number of private company involvement, with ten (10) (of which five (5) SMEs) and fourteen (14) (of which thirteen (13) SMEs) respectively. Even though the Innovation Action requires investment from private companies (with funding rate 70% of direct eligible cost), **the companies apparently did not participate to strengthen their own innovation capacity or growth** as neither report direct exploitation of the results.

2.1.2 Project cluster 1.2: Advanced Earth System Models

The analysis of the two (2) Advanced Earth System Models projects incorporates information from the following main sources:

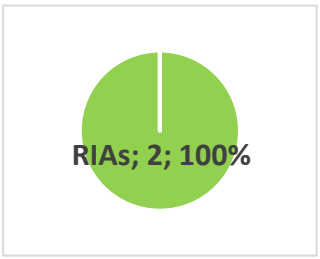
- The IMPACT-SC5 extract from EU CORDIS database (for the two (2) projects);
- European Commission datasets related to: Publications, Intellectual Property, Innovation, Open Data, Gender and Demos-Market Replication (for the two (2) projects);
- Four (4) survey results covering the two (2) projects, of which one (1) from the project coordinator (for one of the projects) and the other three from partners (for both projects); and
- Two (2) interviews representing the two projects.

Other sources such as the ORBIS database and projects' and companies' websites have been used to gather information about the private for-profit entities (excluding the Higher and Secondary Education Establishments) participating in this cluster of projects.

2.1.2.1 Project cluster 1.2: Characterisation

This cluster of projects is characterised by the following data:

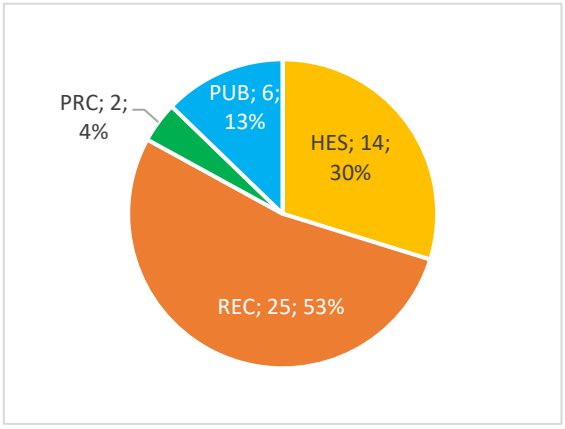
Figure 6: A snapshot of the 1.2 project cluster characteristics

FUNDING SCHEME	IMPLEMENTATION PERIOD
	 Nov. 2015 — Oct. 2020 AVERAGE IMPLEMENTATION PERIOD: 4 years & 11 months

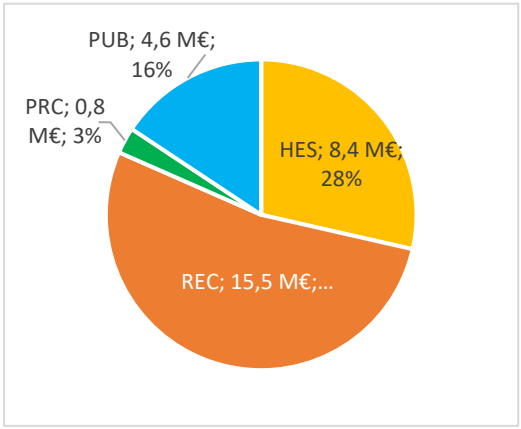
COST & FUNDING			
TOTAL COST:	30 M€	AVG COST PER PROJECT:	15 M€
TOTAL EC CONTRIB.:	29 M€	AVG EC CONTRIB. PER PROJECT:	14.7 M€

PARTICIPANTS

By type of activity



By assigned EC contribution (M€)



	COUNTRIES	ORGANISATIONS
EU27 [+UK]:	10	46
ASSOCIATED COUNTRIES:	2	3
COUNTRIES WITH BILATERAL SCIENCE & TECHNOLOGY AGREEMENTS:	0	0
REST OF THE WORLD:	0	0
TOTAL NUMBER:	12	47

1. **FUNDING SCHEME and TOPIC**

- Two (2) Research and Innovation Actions (RIA) make up this cluster of projects.
- Both were funded under programme EU 3.5.1 (topic SC5-01-2014 Advanced Earth-system models).

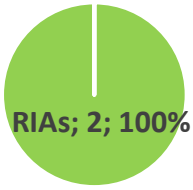


Figure 7: Project cluster 1.2: Distribution of projects by funding scheme (%)

2. **IMPLEMENTATION PERIOD**

- The total implementation period was from 1 November 2015 until 31 October 2020 (with the start and end of the CRESCENDO project).
- The average implementation period of the projects was 4 years and 11 months.

3. **PARTICIPANTS**

- A total number of forty-seven (47) organisations were involved in the implementation of these projects. The PRIMAVERA and CRESCENDO consortia were close in size with twenty (20) and twenty-three (23) partners respectively.
- In terms of the type of participant, out of the forty-seven (47) organisations involved in the project cluster, two (2) were private for-profit entities (excluding Higher or Secondary Education Establishments) (PRC), of which one was an SME. Twenty-five (25) participants were research organisations (REC), fourteen (14) were Higher or Secondary Education Establishments (HES), six (6) were public bodies (PUB). There were no other types of organisations (OTH) involved.

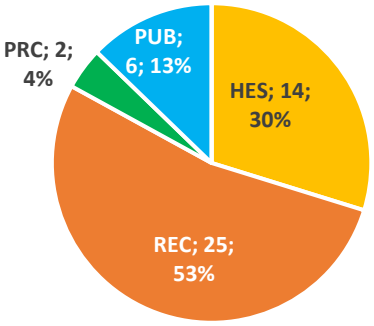


Figure 8: Project cluster 1.2: Distribution of participants by type of activity (number, %)

- One project was coordinated by a public body (PRIMAVERA, Met Office UK) and one by an education establishment (CRESCENDO, University of Leeds). The coordinator of CRESCENDO was stationed at the Met Office and coordination took place while writing the proposal.
- The twenty PRIMAVERA consortium partners were all from the EU-27 + UK. The twenty-three CRESCENDO partners were from the EU-27 + UK, Norway and Switzerland. In other words, both consortia comprised partners from Europe only.

4. **COST AND FUNDING of PROJECTS**

- The total cost of the projects in the "Advanced Earth System Models" cluster of projects was 29,971,481 EUR with a total EC maximum contribution of 29,306,846 EUR. This represents an average share of European funding of 98% of the total cost of the project cluster. The total project cost of both projects was very similar with the total cost of CRESCENDO at 15,003,511 EUR and PRIMAVERA 14,967,969 EUR.

- In terms of the EC contribution received by the type of organisation involved in the projects' implementation, the figures and shares are shown in the table and graph below:

Table 9: Project cluster 1.2: EC maximum contribution by type of organisation (€)

Type of organisation	EC Max. Contribution EUR
PRC (Large Enterprise): Private for-profit entities (excluding Higher or Secondary Education Establishments)	**708,896**
PRC (SME): Private for-profit entities (excluding Higher or Secondary Education Establishments)	**91,500**
REC: Research Organisations	**15,540,744**
HES: Higher or Secondary Education Establishments	**8,369,213**
PUB: Public bodies (excluding Research Organisations and Secondary or Higher Education Establishments)	**4,596,491**
OTH: Other	-
TOTAL	**29,306,846**

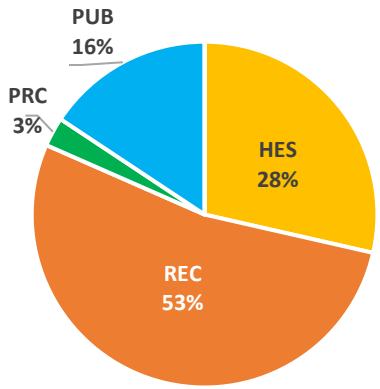


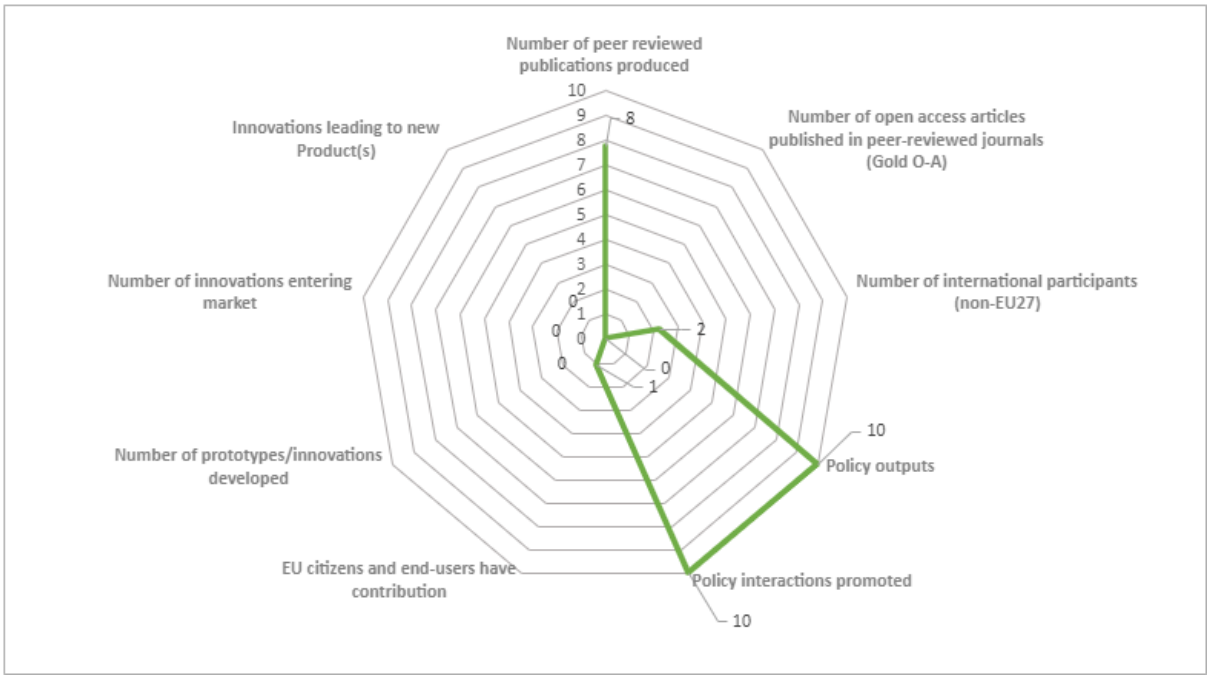
Figure 9: Project cluster 1.2: EC maximum contribution by type of organisation (%)

According to the data above, the private for-profit entities (PRC), which represent 4% of the number of organisations participating in the projects under this cluster, received 3% of the funding. In the case of Research Organisations (REC), they accounted for 53% of the number of organisations involved as well as 53% of the funding. As to the Higher or Secondary Education Entities (HES), they constituted 30% of the organisations involved in the projects and received 29% of the allocated funding. Public Bodies represented 13% of the participants with 16% of funding.

2.1.2.2 Project cluster 1.2: Impact pathways assessment

The radar chart below shows the data for this cluster for the nine selected key indicators:

Figure 10: Project cluster 1.2 radar chart



As shown in the radar chart above, and consistent with the project clusters' specific objectives and expected impacts, the projects of cluster 1.2 focus mainly at producing scientific knowledge as well as policy outputs and policy interactions rather than generating economic impact.

When compared to the other clusters of our analysis, cluster 1.2 comes third in terms of the number of peer reviewed publications produced and second in the policy outputs and interactions related indicators. Based on the interviews that were conducted after completion of the project, both projects are expected to produce at least double the number of publications. This is particularly so because the projects have generated a lot of new data, which still needs to be analysed and can lead to new results in the coming years. From the chart it looks as if the projects did not contribute much to the Open Access policy of scientific information, but this is because the chart focuses on Gold Open Access publications of which this cluster produced only three. However, all other publications were published under the Green Open Access regime.

Both projects had strong links with the international science-policy initiatives, notably the Intergovernmental Panel on Climate Change (IPCC) as well as national and regional policy initiatives.

In contrast, this cluster ranks in the lowest position when it comes to the economic impact related indicators, not having developed any innovation leading to marketable new products and services.

With all the above in mind, the following sections assess the scientific, societal and economic impact pathways of cluster 1.2.

2.1.2.2.1 Project cluster 1.2: Scientific impact pathway assessment

Consistent with the Work Programme, it was expected that the projects under the advanced Earth-system Models cluster of projects should achieve or contribute to the achievement of the following scientific specific objectives and expected impacts:

Table 10: Project cluster 1.2: Scientific specific objectives and expected impacts

Specific objectives	Expected impacts
Creating high quality new knowledge, reducing knowledge gaps • To significantly **improve the prediction of the climate system** (in a seamless way from seasonal-to-decadal and centennial timescales). • To **maintain Europe's leadership** in the field of climate science. • To **progress the development of both climate modelling** and climate science for climate services. **Fostering diffusion of knowledge and open data** • To **support the post-AR5 IPCC process** and other relevant international scientific assessments.	**Creating high quality new knowledge, reducing knowledge gaps** • To develop a **new generation of advanced and well-evaluated global climate and Earth-system models**. • **Science-based assessment of impact of climate** variability and change. **Fostering diffusion of knowledge and open data** • To establish a **solid scientific basis for future science cooperation and policy actions** at European and international level.

EQ1: To what extent has the project cluster produced the expected outputs? (From the IMPACT-SC5 short-term scientific indicators)

From a quantitative point of view, the table below presents the IMPACT-SC5 short-term scientific indicators measured for the current cluster of projects:

Table 11: Project cluster 1.2: Scientific impact pathway indicators

KEY IMPACT PATHWAYS		SHORT-TERM INDICATORS	Value
Creating high quality new knowledge; reducing knowledge gaps	S.1.a	Number of peer reviewed publications produced	251
	S.1.b	Number of publications in the top 10% of impact ranked journals by SC5 subject category (such as: water, waste, resource efficiency, climate action).	N/A
	S.1.c	The project portfolio has incorporated and/or developed gender knowledge (e.g. outcome of sex/gender analysis) (Y/N)	YES (1 out of 2 projects)
Strengthening human capital in R&I	S.2	Number of recruited early-stage researchers for the project	30-40 (1 out of 2 projects)
	S.3.a	Share of men/women participants (researchers)	188 men (65 %) 102 women (35%)
	S.3.b	Share of men/women participants (non-researchers)	0 men 0 women
Fostering diffusion of knowledge and open data	S.4.a	Number of open access articles published in peer-reviewed journals.	3
	S.4.b	Number of open access datasets, software.	4
	S.5	Number of open research infrastructures accessed.	0
Partnerships and international openness	S.6	Number of participations in activities organised jointly with other H2020 project(s) (SC2 programme)	YES (1 out of 2 projects)
	S.7	Number of international participants (non-EU27)	17

Creating high quality new knowledge, reducing knowledge gap

In terms of **publications**, based on the data provided by the European Commission, the projects have generated **two hundred and fifty-five (255) publications**, of which **two hundred and fifty-one (251)**

peer reviewed articles. In addition, the projects delivered two (2) conference proceedings, one (1) book chapters and one (1) publications of other types.

From the interviews, both coordinators expect the number of peer-reviewed publications to double by the time the projects are completed as there are many in the pipeline. There is no information about the number of the publications published in the top 10% of impact ranked journals. However, in the case of one of the projects, the coordinator in the interview added that **11 articles have been published in high-impact peer reviewed journals and that 570 publications have used the project's data**.

Related to the **gender dimension**, three of the four answers received in the survey considered that the projects **have contributed to the generation/incorporation of gender knowledge**, however the survey shows very different perceptions among partners in terms of the extent to what each project has contributed to the development of gender knowledge. Answers from different partners in the same project range from "not at all" to "to a great extent".

Strengthening human capital in R&I

Regarding the contribution of these projects to strengthening human capital in research and innovation, no official information is available about the number of early-stage researchers recruited for the projects and that have been retained beyond the life of the project or about the number of PhD degrees achieved supported by the projects. The coordinator of the one of the projects reported in the interview that the project **advanced the career development of thirty (30) to forty (40) PhD students and forty (40) to sixty (60) young postdocs**. Additionally, two employees working on the project were promoted. The coordinator of the other project stated that **many masters, PhD, and post-doc students were started, and the project is expected to positively influence the career path** of those young researchers involved in the project also beyond the lifespan of the project.

More related with the share of men and women involved in the project, both coordinators were male, although there were some female work package leaders.

Fostering diffusion of knowledge and open data

As was mentioned above, the project cluster has two hundred and fifty-five (255) publications. Of those, three **(3) have published under golden open access and all others under green open access rules.**

Moreover, **four (4) open access datasets were produced**. One of the projects followed the open access principles of the international CMIP6 project of the World Climate Research Program and delivered its simulations open access to the international research community. In the case of the other project, new metrics and tools for higher resolution models have been incorporated into widely used software package ESMValTool, making them available to the wider research community. An enhanced Data Management Tool was released as open-source software for future projects to use. One project publishes all its data onto the Coupled Model Intercomparison Project (CMIP) Earth System Grid Federation (ESGF) node and available globally to download. They expect the dataset to be of significant relevance for analysis and modelling for the next 5-10 years.

In addition, one of the projects reached three hundred and fifty (350) to four hundred (400) young students via a dedicated school collaboration network that was set up in the UK, France and Sweden for a four-year period.

Partnerships and international openness

As well as interacting with each other as related projects in the same cluster, both project coordinators report to have had **active collaborations with other European projects**. Projects mentioned are Blue-Action, APPLICATE, CRECP, JPI-Climate, CONSTRAIN, Climate /Earth system modelling centres and climate modelling initiatives (CORDEX). Collaboration involved **sharing data and results** (i.e., going beyond the more typical joint communication and dissemination activities). Important for the success of the projects was the **interaction with research infrastructure projects IS-ENES3** (as the cost of supercomputing was not part of the project funding).

As to the participation of international organisations, **seventeen (17) non-EU27 partners have been involved** in the two projects in this cluster. All of those come **from European countries**: fourteen (14) from the United Kingdom (including the project coordinators), one (1) from Switzerland and two (2) from Norway.

EQ2: To what extent and how has the project cluster contributed to its scientific specific objectives and expected impacts?

Both projects were **science-driven** and therefore, out of the three impact-pathways under investigation, **the impact on science has been most notable**. Both projects report that collaborating with highly skilled research groups and being able to compare and run different models and experiments has generated a **huge amount of new data, the value of which goes well beyond the scope, duration, and consortium partners of the projects themselves**.

As described above, both projects first and foremost contributed to the **body of knowledge by submitting their results to peer review and publishing under an open access regime**. During proposal writing, the two coordinators – both in the UK Met Office – coordinated the writing to ensure **both projects were complementary**. Although both awarded under the same call, the scope of each project was different.

One project's objective was to further develop European Earth system models (ESM) in their simulations of relevant aspects of the Earth system (physical, chemical, biological processes). The project is a continuation of FP7 projects EMBRACE and COMBINE. Whereas one of the projects focused on the Earth system components of climate models the other focused on the underpinning physical climate models and their resolution capabilities. Its goal was to better understand the role of model resolution on global climate processes and their impact on European weather and climate.

Collaboration on developing **standard definitions, tools and metrics** allows a systematic comparison of the effectiveness of different models and different (time and space) resolutions.

Both projects brought together European research groups and their models to run parallel experiments and simulations, improving the **European understanding of the Earth system** as well as **contributing to the global research community** through the Coupled Model Intercomparison Project (CMIP).

In addition to the climate science, the projects addressed **technical and computational requirements** needed to run the models at high-resolution as well as the need to **standardise protocols and data standards**. The projects produced much **new scientific data that needs processing and analysing**, providing insights into climate change up to 2050.

Both projects also actively collaborated with other (Horizon 2020) research projects:

- **Sharing models, tools and data** across the EU and globally. Although the projects comprised European partners only, there was collaboration with Japan, the USA and China. PRIMAVERA's simulations were used by H2020 APPLICATE and Blue-Action, resulting in joint journal papers. CRESCENDO collaborated with IS-ENES3 on research infrastructure as well as APPLICATE and CONSTRAIN.
- **Using simulations and data** generated by other projects (e.g. atmospheric cyclones by US scientists).
- **Organising joint events and meetings**, helping with common communication channels and exploitation efforts.

Projects often involve the same partners in different constellations. It can be concluded that the **climate science (modelling) community is a global yet closely knit community**.

2.1.2.2.2 Project cluster 1.2: Environmental and societal impact pathway assessment

Regarding the environmental and societal impact pathway, it was expected that the current cluster of projects contributes to the achievement of the following specific objectives and impacts:

Table 12: Project cluster 1.2: Environmental and societal specific objectives and expected impacts

Specific objectives	Expected impacts
Addressing EU policy priorities • Provide **trustworthy science-based climate information** to government, public and private decision makers. • Support the **post-AR5 Intergovernmental Panel on Climate Change process** and other relevant international scientific assessments. **Strengthening the uptake of innovation in society** • Provide **robust, credible, and trustworthy climate predictions and projections**. • Develop **new methods for representing uncertainties in Earth-system models**.	**Addressing EU policy priorities** • Support the development of **effective climate change policies and optimize private decision-making**. • Establish a **solid scientific basis for future science cooperation and policy actions** at European and international level. **Strengthening the uptake of innovation in society** • In the medium and long-term, **improve the resilience and competitiveness at global scale of European business sectors.** • Better **assessment of reliability of regional responses** and their impacts on key economic sectors.

EQ1: To what extent has the project portfolio /cluster produced the expected environmental and societal outputs? (From the IMPACT-SC5 short-term environmental and societal indicators)

The table below presents the IMPACT-SC5 short-term environmental and societal indicators measured for the current cluster of projects:

Table 13: Project cluster 1.2: Environmental and societal impact pathway indicators

KEY IMPACT PATHWAYS	SHORT-TERM INDICATORS		VALUE
Addressing EU policy priorities	S.8.a	Number of policy outputs (policy briefs, policy recommendations, etc.) aimed at addressing specific EU policy priorities, cluster (waste, raw materials, water.) challenges or Sustainable Development Goals (SDGs).	- YES (2 out of 2 projects)
	S.8.b	Number of policy interactions promoted (e.g. forums, conferences, consultations) in relation to EU policy targets.	- YES (2 out of 2 projects)
Strengthening the uptake of innovation in society	S.9	EU citizens and end-users have contributed to the co-creation of R&I content (co-creation with Non-Governmental Organisations / Civil Society Organisations as core partner in the design of the project) (Y/N)	- NO (2 out of 2 projects)

Addressing EU Policy priorities

When referring to the number of policy outputs, addressing specific EU policy priorities, challenges or Sustainable Development Goals (SDGs) generated by the projects in this cluster, **both projects have generated policy recommendations** (international to national) **and briefs** (national and European).

The projects have primarily addressed Sustainable Development Goals (SDG) **Climate Action** and moderately Life below water, Life on land and Sustainable cities and communities.

Strengthening the uptake of innovation in society

Within this project cluster, citizen engagement and the co-participatory approaches with civil society organisations have not been applicable.

EQ2: To what extent and how has the project cluster contributed to its environmental / societal specific objectives and expected impacts?

From an environmental point of view the projects have contributed to a **better understanding of the climate processes and change affecting Europe**. The function of the Earth system models is to **improve the understanding of climate processes and on that basis provide the science base for political and business decision-making**. From that perspective, both projects participated in the main global initiative, the **Intergovernmental Panel on Climate Change** (IPCC), providing future projections, as well as the **Conference of the Parties** (COP). At EU level, policy events have been organised with the European Commission and Parliament.

The projects **interacted with the science and policy communities at global** (IPCC, World Climate Research Programme) as well as national and regional levels. Projections are, for example, being used in Dutch and UK reports and projections. By selecting 2050 at the data for which to run models and simulations, the **results can inform decisions being made now** (or in the near future) on building, transport, water and the environment.

Dissemination activities and sharing of results were done with international initiatives and in close communication with funders of climate change research and high-level users of climate information.

Results have also been disseminated to international agencies and commercial organisations. One of the projects engaged professional science communicators and encouraged researchers interested in science communication to become involved. Training workshops of science communication were organised. A dedicated school collaboration network in the UK, France and Sweden meant that 350-400 young students were reached.

2.1.2.2.3 Project cluster 1.2: Economic impact pathway assessment

Related to the economic impact pathway, this current cluster of projects was not expected to have a direct contribution to the achievement of economic impacts.

Table 14: Project cluster 1.2: Economic specific objectives and expected impacts

Specific objectives	Expected impacts
• N/A	• N/A

EQ1: To what extent has the project cluster produced the expected economic outputs? (From the IMPACT-SC5 short-term economic indicators)

The table below presents the IMPACT-SC5 short-term economic indicators measured for the project cluster:

Table 15: Project cluster 1.2: Economic impact pathway indicators

KEY IMPACT PATHWAYS	SHORT-TERM INDICATORS		VALUE
Generating innovation-based growth	S.10.a	The project leads to innovative products (Y/N)	- NO (2 out of 2 projects)
	S.10.b	The project leads to innovative processes or methods (Y/N)	- NO (2 out of 2 projects)
	S.10.c	Number of Intellectual Property Rights (IPR) applications (patent, copyright, trademarks)	- NO (2 out of 2 projects) - NO (2 out of 2 projects)
	S.11	The project has contributed to regulation/standard harmonisation (Y/N)	NO (2 out of 2 projects)
Creating more and better jobs	S.12	Number of full-time equivalent (FTE) jobs created through CS5 support, by type of job (researcher, non-researcher) and contract duration (short-term-long term); particularly in participating SMEs	- N/A
Leveraging investment in R&I	S.13.a	Amount of national public investment mobilised within the project.	- N/A
	S.13.b	Amount of national private investment mobilised within the project.	- N/A
	S.13.c	Amount of EU public private investment mobilised within the project.	- N/A
	S.13.d	Amount of trans-national private investment mobilised within the project.	- N/A
Development and adoption of innovative technological solutions	S.14.a	Change in Technology Readiness Level (TRL) from start to end of the project.	- N/A
	S.14.b	Number of joint public-private publications	- N/A

Both projects were science-driven and therefore **do not have direct technology transfer or commercialisation results**. Nevertheless, one of the project's team engaged with end-users (business sectors such as reinsurance and energy) to get a better understanding of their requirements. A dedicated user interface and interviews conducted were used and as a result **storyline approaches were produced to illustrate risk assessment and potential impacts of future climate change for example on the energy grid system**.

2.1.3 Final Conclusions: CLIMATE CHANGE project portfolio

In this section we present the results for the two clusters 1.1 and 1.2 under this portfolio.

2.1.3.1 CLIMATE CHANGE project portfolio: Characterisation

- The CLIMATE CHANGE portfolio comprises twelve (12) projects, of which **ten (10) are Research and Innovation Actions and two (2) are Innovation Actions**. These were funded under seven different calls from three work programmes:

Table 16: Calls funding the CLIMATE CHANGE project portfolio

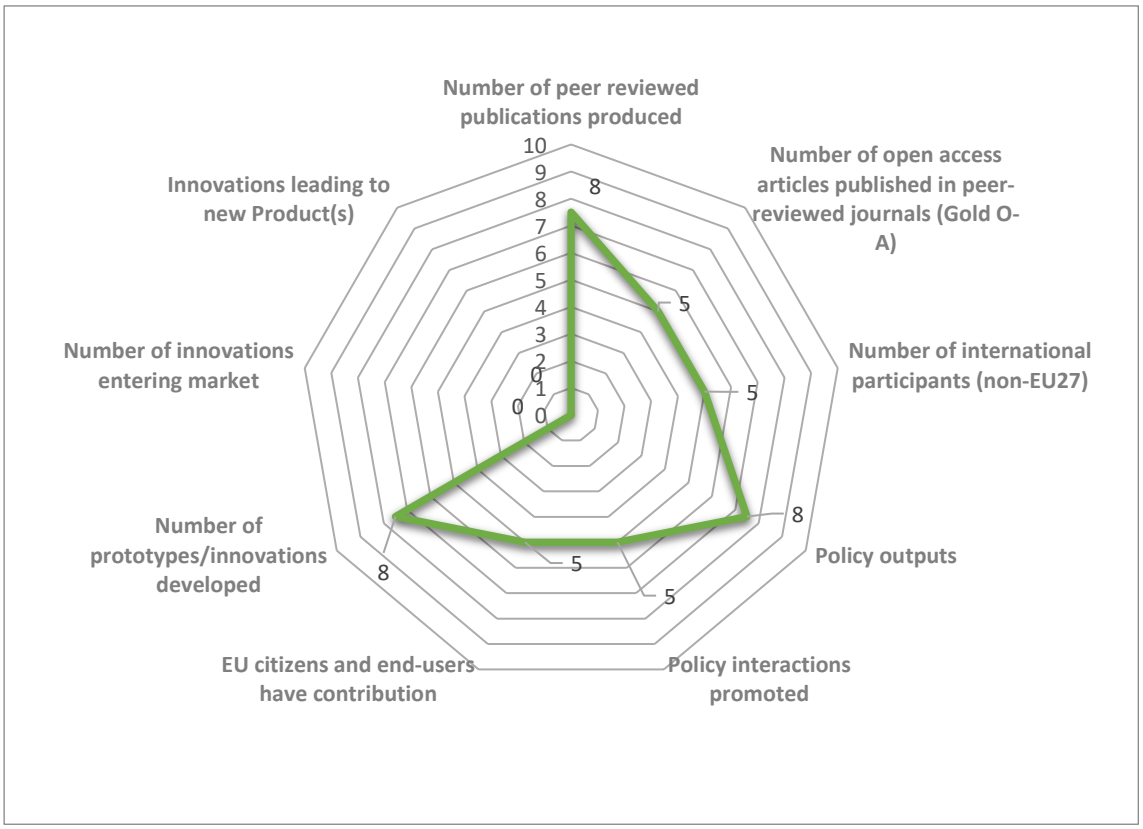
Work programme	Call topic
SC3: Secure, clean and efficient energy	EE-03-2014
SC5: Climate action, environment, resource efficiency and raw materials	SC5-1 SC5-3a SC5-3b
SC7: Secure societies – protecting freedom and security of Europe and its citizens	DRS-09-2014 DRS-09-2015 DRS-11-2015

- The CLIMATE CHANGE project portfolio accounts for an average project cost of EUR 8.2 million, an EC maximum contribution of EUR 7.8 million and a duration of 4 years and 3 months. It should be in terms of budget **the two (2) projects in cluster 1.2 are twice the size of the ten (10) projects in cluster 1.1.** The total budget of the twelve (12) projects was EUR 98 million, of which portfolio 1.2 comprised 31%.
- In terms of the type of participants, the CLIMATE CHANGE project portfolio involved **two hundred and twenty-three organisations (223)**, distributed by type of activity as follows: forty (40) small and medium enterprises, sixty-eight (68) research organisations (REC), twenty-seven (27) public bodies (PUB), sixty-four (64) Higher or Secondary Education Establishments (HES), sixteen (16) large enterprises and eight (8) from other types of organisations.
- **Universities and research organisations make up 59% of the project participants**, demonstrating the relatively high emphasis on knowledge gathering that characterises climate change mitigation and adaptation.
- Most private sector participants were part of cluster 1.1., with **only one (1) SME and one (1) large entity** included in cluster 1.2.
- In general terms, within this project portfolio, research organisations and higher education establishments are partners that, on average, receive the highest funding allocations (43% and 30% respectively).

2.1.3.2 CLIMATE CHANGE portfolio: Impact pathways assessment

The radar chart below shows the data for the project portfolio CLIMATE CHANGE for the nine key indicators:

Figure 11: CLIMATE CHANGE project portfolio radar chart



In line with the objectives and expected impacts of the portfolio 1 topics, this portfolio spanned the range from new research to improve our understanding of the Earth's climate system and the impact of climate change on social infrastructures and assets as well as the development of new or improved standards, products and services to mitigate and adapt to the impact of climate change. As well as delivering high quality new knowledge in the form of publications, this portfolio also performed well in terms of developing prototypes and innovations (albeit limited to projects under 1.1 project cluster).

In this context, when comparing this portfolio with the other portfolios of our analysis, it is observed that portfolio 1 ranks within the top three positions in the scientific and environmental and societal related indicators and second position in terms of prototypes and innovations developed. The portfolio has been relatively weak in delivering and translating messages and solutions to the market. The portfolio is placed in the last position in terms of innovation related indicators. These figures are strongly influenced by the non-economic focus of project cluster 1.2, nevertheless is also visible in cluster 1.1. Interestingly, the data doesn't point to a difference in performance between Research and Innovation Actions and Innovation Actions, begging the question if the latter had the intended result of addressing higher TRL projects aimed at bringing innovation to the market.

With all the above in mind, the following sections assess the scientific, societal and economic impact pathways of portfolio 1: CLIMATE CHANGE.

2.1.3.2.1 CLIMATE CHANGE portfolio: Scientific impact pathway assessment

Overall, this portfolio can be said to have a **predominantly research orientation**, with only two (2) Innovation Actions and ten (10) Research and Innovation Actions, as well as a dominance of research

organisations and universities in the consortia, where cluster 1.1. was focused on applied research and cluster 1.2 was focused on basic research. Two (2) out of the twelve (12) projects were coordinated by private companies (one RIA, one IA).

Creating high quality new knowledge, reducing the knowledge gaps

This portfolio of projects has contributed to the **understanding of the impact of climate change by adding to the body of knowledge, having developed or advanced tools, methods, models and databases as well as guidelines and action plans**. Jointly, the projects have published four hundred and eighty (**480) peer-reviewed articles (with more expected towards the end of the projects)**, placing this cluster in the top 25%. Most of these **outputs have been made widely available** through the project websites, dedicated dissemination activities and by liaising with end-user communities (such as cities or the building sector). In some cases, project results have already been taken up by other projects.

Seven (7) out of the twelve (12) projects mention that they have supported young researchers through their projects; most of these are PhDs and postdocs with a few master theses. No information is available about the retention of young researchers beyond the duration of the projects, although one mentions career advancements have been made as result of working on the project.

Out of the two hundred and twenty-three (223) participants, **sixty-one (61) were from non-EU27, representing 27%**. Most of these were from Europe/Associated Countries (Norway, Switzerland, UK, Israel, Turkey and Albania) and countries with bilateral S&T agreements (Brazil, Chile, China, India, Japan, Russia, South Korea and South Africa) indicating that **having such an agreement in place facilitates international collaborative projects.**

2.1.3.2.2 CLIMATE CHANGE portfolio: Environmental and societal impact pathway assessment

In terms of interaction with policy makers and policy outputs produced, **the portfolio scores in top 20% in terms of number of outputs and about midway (50%) when it comes to policy interactions** promoted. All projects have been highly aware of the relevance and need to engage and inform policy makers. Depending on the project this was **sometimes at local level** (climate adaptation, cultural heritage) **as well as at international/global level** (IPCC). Formats of policy related outputs ranged from the **development of decision-making or forecasting tools**, **databases, methods and frameworks as well as evidence-backed policy recommendations**. **Interactions** were in the form of **consultation, direct involvement, establishing or working with networks and the organisation of events and meetings**.

Six (6) out twelve (12) projects have involved EU citizens and end-users in participatory activities, such as **co-creation, crowdsourcing and crowdsensing of data**. Apart from the two Advanced Earth-models projects, this portfolio has worked to **bridge the step from (applied) research to implementation by working with both public and private practitioners and end-users** (building networks and communities of practice). To make the information broadly available, **databases, methods and tools have been made available in the public domain**. Also, projects have organised student information days and competitions/awards.

The environmental and societal impact in most cases is reported as having **raised awareness of the impact of climate change and the need (and options) for mitigation and adaptation**. In the longer term, projects consider that their impact – if recommendations are followed – will be to assure environmental integrity, resilience and sustainability and to enable ecosystems and society to adapt to climate change and other environmental changes. None of the projects have quantified their impact in terms of prevention or reduction.

2.1.3.2.3 CLIMATE CHANGE portfolio: Economic impact pathway assessment

Seven (7) out of twelve (12) projects report a contribution to innovation-based growth, either **indirect** (standardisation, consultancy services based on project results) or **direct** (direct support to start-up/SME product development, spin-off, new products on the market). With **fifty-six (56) prototypes / innovations developed**, this portfolio ranks in the top percentile (top 20%). In contrast, the portfolio scores **lowest of all portfolios when it comes to the number of innovations entering the market** (26) and **innovations leading to new products** (five (5) out of twelve (12) projects). No information is provided on the advancement of technology readiness levels (TRL) and projects have not been able to leverage investment in research and innovation.

2.1.3.3 CLIMATE CHANGE portfolio: Success factors and barriers

The following success factors and barriers have been identified during project implementation.

Success factors

- The number one success factor cited is the **composition and excellence of the consortium.** The collaboration with highly skilled, diverse (public and private) and motivated organisations in different countries is considered a critical factor to achieving the objectives. Knowing each other before the start of the project is seen as advantage (trust) but not essential (some consortia build on existing partnerships for consecutive projects and even programmes).
- **Having clear and well-defined goals**. A core team that can develop a clear core concept helps in finding the right partners and maintaining the scope during the implementation. The better and clearer written the proposal, the easier the implementation. On the other hand, allow flexibility between the proposal and the implementation when changes need to be made.
- **Engaging stakeholders**, **such as end users**. These can be needed to validate the results as well as provide access to data that can otherwise be difficult to obtain (such as data held by public sector organisations.

Barriers

- **Aligning different agendas with diverging interests** is seen as a barrier as it takes time and can lead to (scientific) disagreement about the direction of the project.
- While having the right stakeholders and data available is a success factor, **difficulty in reaching the right people** (policy, investment) **and having access to data** is at the same time seen as a barrier.

2.1.3.4 CLIMATE CHANGE portfolio: Next steps

Eight (8) out of twelve (12) projects explicitly mention they want **to continue the work from their project** in some form or another. Some will continue the activity at national level, but most indicate they will or already **looking at follow-up funding from EU calls and tenders**.

3 The evaluation framework for portfolio impact assessment

3.1 The evaluation framework for portfolio impact assessment

The evaluation framework for portfolio impact assessment relies on the work delivered in previous work packages and tasks of the project. More specifically, it is based on the results from:

1. The evaluation framework;
2. The list of indicators developed in the project;
3. The individual project reports; and
4. The development of the project clusters and portfolios.

Each of these is considered in turn in greater detail below.

1. The **evaluation framework** that resulted from *Task 1.1: Development of the evaluation framework* included in *Work Package 1: Preparation of the evaluation of SC5 RIAs and IAs*.

   The evaluation framework developed at the initial stages of the project has guided the portfolio impact assessment in several ways:

   - The evaluation framework focus on **performance and effectiveness** assessment criteria.

     In this regard, the project portfolio impact assessment has analysed the capacity of project portfolios to generate outputs and to contribute to the specific objectives and expected impacts as defined in the SC5 Work Programme 2014-2015.

   - The consideration of the three different types of **impact pathways**: Scientific Impact Pathways; Environmental and Societal Impact Pathways; and Economic Impact Pathways.

     The project portfolio impact assessment exercise reviews the results and impacts achieved within the three above-mentioned impact pathways.

   - The intervention logic for achieving **short-term, medium-term and long-term results**.

     The project portfolio impact assessment takes into consideration, to the extent possible, these three timeframes.

   - The evaluation questions, associated with the following concepts: i) The capacity of projects to produce the **expected results**; ii) The extent to which the project portfolio has contributed to its **specific objectives and expected impacts**; iii) the **factors hindering or influencing positively** the achievement of the expected results of the project portfolio; and iv) the actions that have been undertaken to ensure a **wider impact contribution** of the results from each project portfolio.

     The project portfolio impact assessment has compiled information to feed the above-mentioned evaluation questions, combining the analysis of the quantitative and qualitative information available for each project portfolio. These evaluation questions have been answered in different sections of the project portfolio impact assessment report, as shown in this table:

Table 17: Consideration of the evaluation questions in the project portfolio impact assessment report

Evaluation questions of the evaluation framework	Section of the project portfolio/cluster impact assessment report	Scope
The capacity of projects to produce the expected results	Impact pathways assessment EQ1: To what extent has the project portfolio/cluster produced the expected outputs? From the IMPACT-SC5 short-term indicators, for each impact pathway.	○ Analysis of quantitative data stemming from SC5 CORDIS Dataset, European Commission databases, surveys. ○ At project portfolio/cluster level.
The extent to which the project portfolio/cluster has contributed to its specific objectives and expected impacts	Impact pathways assessment EQ2: To what extent and how has the project portfolio / cluster contributed to its specific objectives and expected impacts? for each impact pathway.	○ Analysis of qualitative information retrieved in the interviews. ○ At project portfolio/cluster level.
Factors hindering or influencing positively the achievement of the expected results of the project portfolio	Success factors and barriers.	○ Analysis of qualitative information retrieved in the interviews. ○ At project portfolio/cluster level
Actions that have been undertaken to ensure a wider impact contribution of the results of each project portfolio/cluster	Next steps.	○ Analysis of qualitative information retrieved in the interviews ○ At project portfolio/cluster level.

2. **The list of indicators** resulted from *"Task 1.2: Development of indicators" under WP1: Preparation of the evaluation of SC5 RIAs and IAs.*

   The defined list of indicators has been used here to guide the quantitative analysis of the three impact pathways and to measure the impacts achieved by each project portfolio / cluster.

3. **Individual project reports** delivered by Task 2.5: Project Analysis, as encompassed in Work Package 2: Exploration of SC5 projects.

   The individual project reports have been useful inputs to the impact assessment at cluster and portfolio level (see later (in point 4) the distinction between clusters of projects and project portfolios). For the sake of consistency, the order of the information presented in the individual project impact assessment reports has been maintained when presenting the conclusions at portfolio and cluster levels. In addition, the methodology used in building the radar charts at individual project level has also been used to develop the radar charts at project cluster and portfolio levels. Thus, in the same way as at individual project level, the following approach has been followed to enable comparable indicators to be presented in the same chart at portfolio / cluster level:

   Step 1: To calculate the values of each indicator for each cluster of projects and project portfolio.

   Step 2: To sort every indicator included in the radar chart from its highest to its lowest value.

   Step 3: To calculate the percentile into which a project cluster / portfolio falls, for every indicator.

Step 4: To multiply the identified percentiles by 10 (to have a scale of 0 to 10) and to plot the figures onto the radar chart.

The outcome of this process is that every indicator is shown in a scale from 0 to 10, describing how a project cluster/portfolio has performed for each specific indicator (where 10 is the maximum value across all the assessed project clusters/portfolios).

To make the comparison even clearer, the median and average values of every indicator depicted in the radar chart has been calculated for all project clusters / portfolios. The median values have been preferred (over the average values) since the average is heavily biased from outliers (values in the distribution that are too large or too small).

However, in contrast to the radar charts built at the individual project level (for which only scientific indicators were considered), at cluster and portfolio level, indicators measuring the three impact pathways under exploration in this project (scientific, environmental and societal and economic) have been included. For indicators to be included in the radar charts, the data availability criterium has been applied. Indeed, indicators selected to measure the economic performance of the project clusters / portfolios have resulted in two new indicators not previously considered (in the indicator list delivered in Task 1.2). They have been included here as reliable information to feed them is available in the datasets provided for this task by the European Commission.

4. The **development of the project portfolios** undertaken in *Task 3.1: Portfolio development* in *Work Package 3: Contextualization and impact assessment of project portfolios*.

   During *Task 3.1: Portfolio development*, two ways of building consistent project portfolios were proposed. A deeper analysis of the nature and scope of the projects under exploration and of the available information for each project portfolio was conducted to decide the project clustering criteria to be finally applied. Further information about the selected project portfolios will be presented in section three of this document.

   Two different levels of project groupings have been used for impact assessment:

   - Project portfolio: Projects contributing to a same scientific field are grouped under a project portfolio. In total, five project portfolios are considered here.
   - Cluster of projects: Projects contributing to a more specific field of knowledge under a same scientific field are grouped into a cluster of projects. The total number of clusters of projects considered here is ten.

   It should be noted that a portfolio may consist of one or more clusters (e.g. the Waste portfolio contains two clusters – industrial waste and urban waste clusters).

3.2 Scope and contents of the project portfolio assessment

Based on the inputs outlined above, the project portfolio impact assessment involves the analysis and presentation of information as expressed hereunder:

For each project cluster:

- Characterisation of the cluster of projects

  A characterisation of the project clusters is conducted focusing on the following concepts: i) Funding scheme and topic(s); ii) Implementation period; iii) Participants (number, type of activity with a focus on the participation of private companies and its size, international partners); and iv) cost and funding of projects (overall and by type of participant).

- Impact pathway assessment

  The scientific, environmental and societal, and economic impacts for each cluster of projects are analysed according to the following methodology:

  - From the "scope" and "expected impacts" sections of the SC5 Work Programme 2014-2015 for each topic, extraction of the specific objectives and expected impacts allocated to the projects grouped in a same cluster for each impact pathway.
  - Completing the indicator tables for each impact pathway with the figures for each cluster of projects. In order to extract the indicators, information compiled in the IMPACT-SC5 extract from the CORDIS database, the datasets provided by the European Commission and information retrieved in the survey and /or interviews has been analysed.
  - Quantitative analysis of the indicator values to measure the extent to which the cluster of projects has produced the expected outputs for each impact pathway. A radar chart combining nine indicators measuring the three impact pathways under exploration graphically shows some of the results achieved at project cluster level.

Table 18: Indicators considered in the radar charts

Impact pathway	Indicators
Scientific	• Number of peer reviewed publications produced • Number of open access publications in peer-reviewed journals (Gold) • Number of international participants (non-EU27)
Policy / societal	• Policy outputs • Policy interactions promoted • EU citizens and end-users have contributed
Economic	• Number of prototypes / innovations developed • Number of innovations entering the market • Innovations leading to new product(s)

Due to the lack of reliable quantitative information two new indicators, not considered in the indicators list developed under task 2.1 of the current project, have been selected to build the radar chart: Number of prototypes / innovations developed and Number of innovations entering the market. Those indicators have been selected because reliable and comparable information can be retrieved from the datasets provided by the European Commission.

  - Qualitative analysis of the information retrieved in the interviews conducted with project coordinators in order to measure the extent to which the cluster of projects has achieved its expected objectives and impacts for each pathway: scientific, environmental and societal, and economic.

For each project portfolio:

At portfolio level, the conclusions are presented as follows:

- Characterisation of the project portfolio

  Conclusions related to the nature of the project portfolio in terms of number of Research and Innovation Action / Innovation Action, type of activity of participants, presence of non-EU27 organisations, etc.

- Impact pathway assessment

  The most relevant findings about the extent to which the results delivered by the project portfolio have contributed to the achievement of the specific objectives and expected impacts for each impact pathway. The findings are identified by inferring common and different aspects between the projects under the same portfolio.

  A radar chart combining some of the indicators related to the three impact pathways under exploration shows graphically the results expressed in the indicators tables included in the report at project portfolio level.

- Success factors and barriers

  In this section, the factors hindering or influencing positively the achievements of the project portfolio's expected objectives and impacts are considered. Within this endeavour, the information collected in the interviews is the only source of information.

- Next steps

  From the interviews, the actions that have been undertaken to ensure the sustainability and the spread of outputs and impacts of the projects such that they increase the overall impact of their project portfolios are identified in this section of the report.

The results of the present document together with the findings included in the deliverables D3.3 "Case study Report (single)", D3.4 "Case studies report (cross-case studies analysis)" and D3.5 "Cross-Societal Challenges Comparative Analysis Report" will constitute the basis for the extraction of policy recommendations that will be reported in the deliverable D4.1 Synthesis report of the IMPACT-SC5 project.

3.3 Main limitations of project portfolio impact assessment

Overall, the main limitations faced during the elaboration of the project portfolio impact assessment report are related to **data availability** and **data consistency,** as well as to the high share of **projects under exploration that have only recently finished**.

In terms of **data availability**, limitations have been perceived in several ways.

Firstly, as a result of *Task 1.1 Development of the Evaluation Framework* and *Task 1.2 Development of indicators*, a wide range of Key Performance Indicators (KPI) were designed covering different projects' expected results for each impact pathway. In this regard, many of the KPIs were designed based on the projects' final (or interim) report outline. In this case, some constraints have been faced due to the

General Data Protection Regulation (GDPR) and personal data confidentiality restrictions, according to which such **reports have not been disclosed to the consortium**. To compensate for this, European Commission services shared a number of semi/fully anonymised datasets incorporating some of the outputs achieved by the SC5 projects that partially removed the effects of the restrictions.

However, some of the indicators listed as a result of Task 1.2 relate to **concepts that might have not been measured before or, at least, are not included in the datasets provided by the European Commission**. Consequently, no records were available. The indicators for which there was this lack of information are summarised below:

- Number of publications in the top 10% of impact ranked journals by SC5 subject category (such as: water, waste, resource efficiency, climate action);
- Number of early stage researchers recruited for the project; and
- Number of full-time equivalent (FTE) jobs created through SC5 support, by type of job (researcher, non-researcher) and contract duration (short-term/long-term); particularly in participating SMEs.

To partially address this limitation, quantitative information was collected through the survey and /or interviews conducted with project coordinators.

However, another limitation confronted relates to the **participation of SC5 beneficiaries in the data collection activities**. Despite the efforts made by the consortium members to involve as many SC5 project beneficiaries as possible in the survey and interviews, for a number of SC5 projects it was not possible to collect any information, e.g. where project beneficiaries did not respond for some reason, perhaps that they had changed jobs or roles, or that they did not have time or were not interested because the project concerned had finished.

In further detail, around two hundred and fifty (250) responses to the survey were recorded, including at least one answer from each of eighty-one (81) projects (either from partners or coordinators).

In addition, a total of sixty (60) interviews were conducted with project coordinators and/or key project partners. For twenty-seven (27) projects, the only source of qualitative information was the Literature Review Report (Deliverable 2.1).

Moreover, during the process it has been perceived that often **project partners, or even project coordinators, were not fully acquainted** with the results achieved in terms of the above-mentioned indicators.

Therefore, to overcome the aforementioned limitations, several approaches have been implemented:

i. In the case of indicators requiring data from one or more information sources (datasets from the European Commission, the survey, interviews, etc.): The most reliable source of information has been chosen. Limitations related to the inconsistency of data among the different data sources will be explained below.

ii. In the case of indicators for which quantitative information (e.g. an exact number of early stage researchers hired by the project) was not available but a qualitative answer was received in the interview / survey (e.g. yes, the project has recruited early stage researchers but an exact

number is not available), the indicator has been reported in a qualitative manner (providing YES/NO type of answer).

iii. In the cases of indicators for which neither quantitative nor qualitative answers have been collected, the indicator has been reported as "not available". As a result of theIMPACT-SC5 project, the relevance of these indicators (the ones that have not been able to be fed), the appropriateness to consider them in future impact assessment exercises as well as the way to collect the necessary information to feed them should be analysed.

iv. In general terms, due to the lack of specific quantitative data to feed the indicators in the list, qualitative analysis on the extent to which projects have contributed to achieve the expected results has been prevalent.

Inconsistency of data was observed in different figures being found for the same indicator using the different available sources of information. To address this, the main sources of information used to carry out the impact assessment exercise are as follows:

- Literature review exercise based mainly on CORDIS website and projects' webpages and social media;
- IMPACT-SC5 extract from the CORDIS database dated the 11th May 2020;
- Anonymised data provided by the European Commission;
- Survey; and
- Interviews.

In the cases in which **the data coming from the different sources was not consistent**, it was necessary to decide which one of the above provided the most reliable information. The prioritisation adopted is as follows, ordered from the most to the least reliable: Interview, Survey, European Commission provided databases, CORDIS database, literature review.

Discrepancies were also identified in cases in which more than one project partner participated in the survey. The **lack of a common perception among all the partners on the extent to which a project has contributed to the different specific objectives or expected impacts** has hindered the achievement of relevant and definite conclusions in this study. To overcome this limitation, the answers that have been chosen by most of the survey respondents have been identified as the most relevant and judged to be the most reliable (i.e. the coming from the person most likely to be in possession of accurate information).

During the impact assessment exercise, it has also been noticed that many **projects deliver outputs, such as publications, after the end of their contractual lifespan**. These results are not included in any official project report or database but have been identified during some interviews. This has led to a discrepancy between the data in the datasets provided by the European Commission and the figures finally considered in the assessment exercise.

In addition to the constraints related to data availability and consistency, other limitations have been encountered since **most of the projects under scrutiny have only very recently finished**. Indeed, almost the 75% of the target projects finished in 2019, 2020 or in the first months of 2021. The

remaining 25% finished in 2018. Hence, in most of the cases, it is not possible to identify the totality of real impacts, with the assessment exercise therefore focussing on short-term impacts and expected longer-term impacts whenever possible.

4 Selected project portfolio

4.1 Criteria for the selection of project portfolio

In the context of the IMPACT-SC5 project, the deliverable *D3.1: Report on portfolio development* defined two different ways of building topic-driven project portfolios.

The first option aggregated projects that belonged to the same *"programme"* as defined by the European Commission.

The second option grouped projects around common or highly related scientific fields such as i) Climate change; ii) Environment, ecosystems and biodiversity; iii) Raw Materials; iv) Waste; and v) Water. Within the second option, projects funded under different European Commission's programmes and topics could conform a project portfolio.

For the purpose of the project portfolio impact assessment, it was decided by the project team to use scientific fields-based portfolios aiming at drawing more relevant conclusions when grouping projects that tackle common challenges from different research areas and standpoints (i.e. option two).

Before making the decision and considering the previously mentioned data availability limitations, the project team checked the existence of enough information (survey responses and interviews) to allow for the execution of a sufficiently relevant impact assessment exercise for scientific fields-based project portfolios.

This process resulted in the project portfolios and project clusters presented below:

Table 19: Scientific field-based project portfolios

Portfolio	Programmes Included	Project cluster description	Topics included	# of projects	Max. EC Contribution (€)
Portfolio 1	**Climate Change**				
Project Cluster 1.1	EU 3.5 EU 3.5.1	Fighting, adapting and mitigating climate change	DRS-09-2015 DRS-09-2015 DRS-11-2015 SC5-3a SC5-3b EE-03-2014	10	64,327,633
Project Cluster 1.2	EU 3.5.1	Advanced Earth System Models	SC5-1	2	29,306,846
Portfolio 2	**Environment, Ecosystems, Biodiversity**				
Project cluster 2.1	EU 3.5 EU 3.5.2	Protecting the environment, sustainably managing natural resources, water, biodiversity and ecosystems	BG-01-2015 BG-08_2014 SC5-06 SC5-07	7	68,654,214
Project cluster 2.2	EU 3.5 EU 3.5.5	Environment, Ecosystems and Biodiversity: observation and monitoring data	SC5-4 SC5-16	9	60,756,821
Portfolio 3	**Raw Materials**				
Project cluster 3.1	EU 3.5.3	Sustainable production of Raw Materials	SC5-11a-2014 SC5-11b-2014 SC5-11c-2015 SC5-11d-2015 SC5-11e-2015	12	85,694,642
Project cluster 3.2	EU 3.5.3	Sustainable substitution of Raw Material	SC5-12a-2014 SC5-12b-2015	4	18,677,201
Portfolio 4	**WASTE**				
Project cluster 4.1	EU 3.5.4	Industrial Waste	WASTE 1 WASTE 3	7	55,808,020
Project cluster 4.2		Urban Waste	WASTE 6a WASTE 6b	7	49,222,532
Portfolio 5	**WATER**				
Project cluster 5.1	EU 3.5.4	Water resources / resilience	WATER-1a-2014 WATER- 1b-2015 WATER-2a-2014 WATER-2b-2015 WATER-5c-2015	16	78,790,155
Project cluster 5.2		Water treatment (technologies)	WATER-1a-2014 WATER- 1b-2015 WATER-5c-2015	13	59,201,331