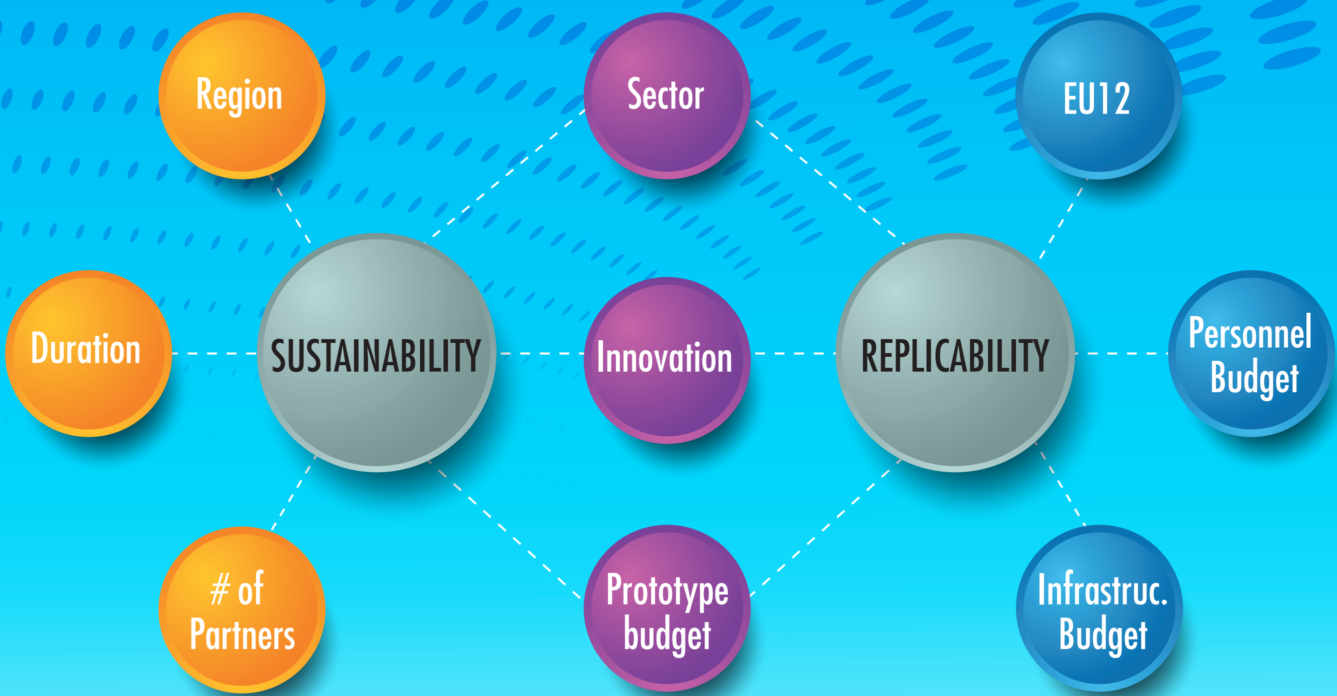
LIFE Programme

LIFE: CONTRIBUTING TO EMPLOYMENT AND ECONOMIC GROWTH

FINAL REPORT



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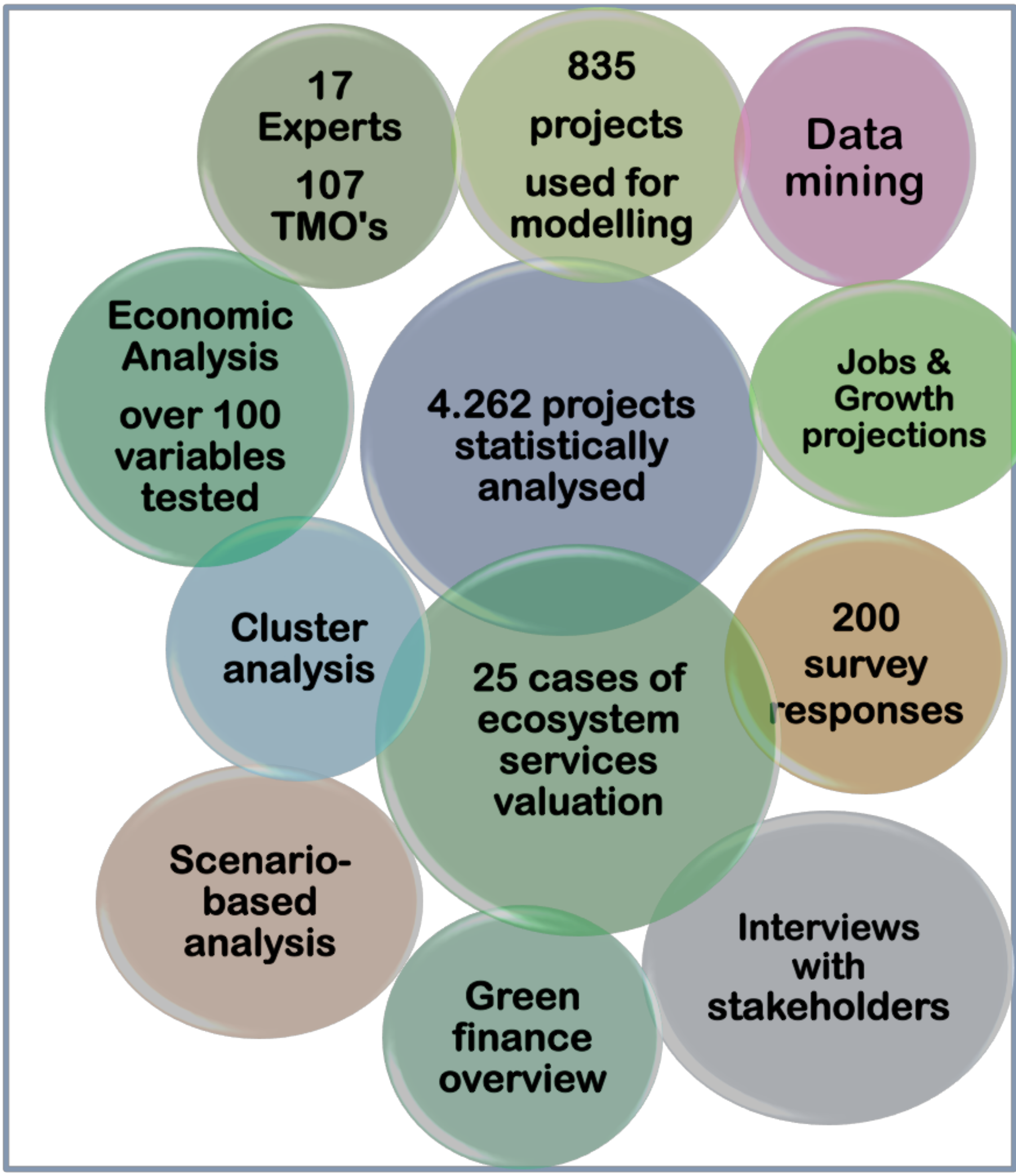

Methods and Resources: an Overview

Executive Summary

Structure of the Study

This report (the "Study") was prepared as the deliverable of Task 9.3 "LIFE past, present and future contributions to employment and economic growth" and Task 9.4 "LIFE effectiveness and replicability". The Study has been developed by a group of **17 Neemo and Ernst & Young (Prague) experts**, who prepared the four main parts of the Study: Lida Ampatzi, Richard Bobek, Svetoslav Danchev, Pavlos Doikos, Francisco Greño, Ondrej Hartman, Dominik Herman, Bent Jepsen, Sira Jiménez-Caballero, Petr Krucky, Zornitza Marinova, Chryssanthi Pegka, Tomas Schwardy, Romana Smetankova, Andreas Troumbis, and Tomas Vakrman. The general coordination, structuring, and checking of the study was carried out by Christos Kissas.

This Study is divided into four parts, complementing each other, and several annexes.

Part I is focused on the statistical and econometric analysis of LIFE projects, their sustainability and their replicability potential. The methodology used in this part is centred on extracting raw data, turning data into variables, categorising qualitative data, selecting the appropriate statistical tools and methods, setting the main equations between variables, and performing standard econometric analysis with the use of sophisticated models, such as probit and logit regression. In addition to econometric models, surveys as well as qualitative and cluster analyses have been performed.

The data on which the above analysis was based varies with the type of method applied. A complete database of over 4.000 LIFE projects covering the 25-year period from 1991 to 2016 was used in order to study the projects main characteristics: categorisation, geographical and temporal distribution, etc. A subset of 835 projects, for which sufficient data were available, was then used to map out sustainability and replicability potential. The main determinants of these two fundamental variables were extracted via state-of-the-art data mining procedures from Neemo's LIFEtrack Dory database. After a thorough analysis of the data mining results, a set of around 100 variables were tested econometrically as determinants of sustainability and replicability potential. As an additional quality control check, the robustness of results was tested by comparing the output of four different methods of regression analysis. Finally, a clustering of projects was constructed and an examination of projects representing each cluster was performed, in order to confirm the results obtained by the econometric analysis. The methodology used is thus based on the best available scientific techniques, in order to obtain credible results and to minimise subjectivity and biases.

Part II examines the economic impact of selected LIFE projects under different replication scenarios. The purpose of this part is to analyse the potential of LIFE projects that are considered as the most likely to be replicable and sustainable for job creation and for their contribution to economic growth in the context of competitive market economy. As forecasting the economy is inherently uncertain, it was chosen to formulate three alternative scenarios (a baseline, a low growth, and high growth), as a more realistic approach. The assumptions behind these scenarios for each project are clearly determined and stated, and the overall methodology is thoroughly explained. For each project, specific growth drivers were established and estimated under the three scenarios. Assumptions on the rate of diffusion of the projects output were made, where possible, and projections were established by multiplying such rates with the total area of potential use of the projects technology.

Part III deals with the specificity of LIFE Nature projects' replication. It is widely known that Nature projects apart from their direct contribution to growth and employment also create considerable value that is not registered through market mechanisms. In order to capture and estimate this non-market value, a sample of 25 carefully selected and largely representative LIFE Nature and Biodiversity projects, funded during the 2004-2010 period, was used. For these projects the analysis has been structured around three major pillars: a) the pairing of conservation or restoration activities and actions undertaken with a strict definition of ecosystem services provided; b) the monetary valuation of these services, according to the best estimates available worldwide; and c) the construction of empirical "rules" governing the relationship between LIFE funding and the creation of qualified employment and transfers to specific sectors of the local/national economy.

Besides technical and methodological aspects that are addressed in the Study, two important traits of the LIFE funding process are highlighted: a) regarding effectiveness, the hidden economic potential of LIFE Nature projects through monetary valuation of ecosystem services appears in some cases extremely important, although a high degree of uncertainty still persists; monetary valuation of ecosystem/biodiversity services might be used as a prerequisite for future funding; b) regarding replicability, alternative approaches to future project selection strategies are presented, in light of which a new LIFE proposal evaluation framework might be welcome in order to take the lessons learned in the earlier phases of this funding mechanism into account.

Part IV is a special report which presents an overview of the relatively new and not yet fully known field of Green Finance, highlighting its potential for financing the replication of LIFE projects. Innovative products, such as green bonds and instruments developed by experimental organisations such as the Global Innovation Lab are discussed. Similarly, green loans, funds, yieldcos, and specific initiatives by international development institutions are presented. Yet, this Part is only an introduction to the vast and extremely complex sphere of financing the green economic revolution. A more in depth analysis of tailor-made instruments for financing LIFE replication should probably be the object of an upcoming study.

Key messages

Readily available data on LIFE projects mainly takes the form of reports. There are several thousands of documents, such as mission reports as well as evaluations of inception reports, mid-term reports, final reports, and monitoring files accessible online in Neemo's database "LIFEtrack Dory." However, a striking feature of this documentation is that these reports are mostly "flat" word documents, with few structured data that can be used directly for analytic purposes. As a consequence, it takes a huge effort to extract economic and other pertinent variables from this documentation in order to conduct a quantitative study. Thus, the need for reliable indicators on LIFE projects is one of the most important aspects that should be developed, and recent work done by the EC with help from Neemo is critical for future analyses and assessments of the Programme.

Among the results of the statistical analysis (presented in Annex 1 of Part I), the distribution of projects between the two major categories, Environment and Nature, across countries leads to the idea of "clustering". It seems that certain countries tend to specialise in ENV and others in NAT projects. It may be interesting to take a closer look at these "specialisations", in relation to the type of beneficiaries, and evaluate the desirability of such specialisation.

Also, the distribution of the average and aggregate EC contribution per country reveals another pattern of clustering: recipient countries tend to be in an either “low average/high aggregate contribution”, or in a “high average/low aggregate contribution” category, or in other words, more projects with lower contribution vs. less projects with higher contribution.

There is also a high concentration of projects on certain economic sectors of high economic importance and “recognised markets,” such as waste management, waste water, and protection (air, soil), which account for roughly 70% of all projects.

Among the major determinants of Sustainability and Replicability are: the level of innovation, personnel and infrastructure budgets, the amounts spent on prototypes, the number of beneficiaries, and to a certain degree the economic sector.

Interestingly enough, several variables display a non-linear (U-shaped or a Hump-shaped) relation with sustainability and replicability, which means that there seems to be an optimal region of values that maximises the variable’s influence on the projects’ potential to be sustainable and replicable. The most interesting of these effects concerns the level of innovation; innovative projects tend to be more sustainable and replicable, but the effect levels off for those projects that could be considered as “too innovative.” In a scale of innovation of 0 to 9, the peak influence is obtained around a value of 7.4. This finding is important management information for LIFE projects, as it can be interpreted as an indication that innovative LIFE projects are highly desirable, i.e. being more financially sustainable and replicable under real life/ market conditions. On the other hand, projects focused mainly on innovation (“too innovative”) might be better suited to other EU funding Programmes that do not target wide replication and sustainability, (thus acting as direct catalysts for change), but rather focus on scientific/technological excellence that eventually (in a time span of some years) can enter the market. This finding determines a key project characteristic: potential to deliver change over time.

Similar results were obtained for the variable “prototype budget”, where a middle value gives the highest positive influence on both sustainability and replicability, which corroborates the previous finding.

Another conclusion drawn from the econometric analysis is that a higher number of (associated) partners has a significantly negative impact on sustainability, as it probably complicates the management of the project after the grant period. Therefore, smaller and easier to manage partnerships have more chances of successful replication.

As expected, sustainability and replicability are highly correlated and share several common determinants.

The impact of LIFE on employment is far from being negligible. On a large sample of projects, findings show that during the grant period, the average project created 31 person-years in full time equivalent (FTE) jobs, both directly and indirectly. If we consider only direct job creation (estimated only from personnel costs), an average project attains 21 person-years. **Projection of theses figures to a typical population of 1 000 projects corresponding to an entire programming period equivalent to LIFE+, leads to a total jobs creation of 31 000 FTE equivalents person-years for the implementation period,** (21 000 if only direct jobs creation is considered).

Scenario-based analysis performed on a sample of high-potential projects leads to impressive conclusions on the of LIFE projects' ability to both boost employment and induce economic growth. **For the same as above 1 000 project population and by using the most conservative figures, we obtain within a five year period from the start of replication approximately 43 500 FTE person-years, and an estimated contribution to economic growth of € 9,3 billion.**

Nature projects' replication through market mechanisms is not yet common. Still the non-market value created by Nature and Biodiversity projects, as measured by monetisation of the associated ecosystems services is considerable, and in some cases extremely high. This value creation potential should be systematically calculated, reported and communicated to decision makers, stakeholders and the public and taken into consideration in decision-making on financing such projects. The field of financial instruments/market transactions for ecosystem services is currently under development and is expected to grow significantly over the next decade.

Projections made on the basis of a sample of representative (though not random) Nature projects, by using internationally accepted valuation databases and by adopting the most conservative figures, estimate the value created by LIFE during a programming period in Nature projects at € 43 billion.

The results obtained regarding the types of Nature projects and replicability may be interesting to be taken into account when defining the selection criteria for evaluating LIFE project proposals (or similar development initiatives by national/regional funding authorities or other international funding bodies). A good start might be to require an estimation of ecosystem services valuation to be included in the proposal, in order to be taken into account in the selection procedure.

To summarise, the Programme-wide projections elaborated by this Study lead to the conclusion that in addition to the environmental benefits, LIFE is also making a considerable contribution to the European economy in terms of Jobs and Growth. For an initial "investment" of € 2,1 billion (that is: the amount allocated to LIFE+), one gets the following increase of employment and economic development:

Jobs:
Implementation: 31 000 FTE
Replication: 43 500 FTE
Total: 74 500 FTE

Growth:
Implementation: € 2,1 bn
Replication: € 9,3 bn
Total: € 11,4 bn

Nature projects:
Creation of value: € 43 bn

The way forward

However, replication through market mechanisms pre-supposes readily available finance. And it is generally accepted that in the current situation of financial markets and economic context, there is a financing gap, especially for new ventures, start-ups, and innovative projects. Though a glimmer of hope may come from the emerging world of green finance, where at least one type of financial product is becoming mainstream: the so-called green bonds. These instruments show exponential growth over the last few years and cover all areas of environmental investments. Lately, a strong effort of standardisation and certification has produced notable results, by bringing confidence among investors and financial institutions. The next big step, currently in the process, is to develop the green bonds market, from a niche market to a mainstream one, a process finance professionals call "going from billions to trillions". In this landscape, there is certainly a business opportunity for the LIFE community to specifically design and promote the appropriate mechanisms for financing LIFE projects' replication. The creation of a specific LIFE replication instrument, probably based on a type of green bond could be the way forward in this area.

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PART I: Statistical Analysis and Modelling

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Abbreviations

AB	Associated Beneficiary
BIO	Biodiversity
CA	Climate Action
CAWI Survey	Computer-Assisted Web Interviewing Survey
CB	Coordinating Beneficiary
EC	European Commission
ENV	Environment
EU	European Union
EU12	EU of 12 member states: BE, DN, ES, FR, GE, GR, IT, LU, NE, IR, PT, UK
HICP	Harmonized Index of Consumer Prices
INF/GI	Governance and Information
NAT	Nature
NGO	Non-Governmental Organization
No.	Number
OLS	Ordinary Least Squares
R&D	Research and Development
TCY	LIFE-Third Countries Programme
TMO	Technical Monitoring Officer

Introduction

The main aim of Part I is to analyse key determinants and their impact on the sustainability and replicability of LIFE financed projects. The sustainability is perceived as the ability to continue or follow up on the activities performed (outputs achieved) during the project's life; i.e. it is the viability of the project after the end of LIFE financing – the continuation or follow-up is ensured by the beneficiary itself, its partners or successors. Replicability is considered to be the probability of utilization of the projects´ outputs (best practices, guidelines, know-how, patents, software etc.) by an entity other than or successor to the beneficiary or its partners, especially in a competitive market environment.

The evaluation team focused primarily on projects from the Environment type, where there is a higher potential for replicability via market mechanisms and these concepts are viewed as crucial for the success of the projects. Therefore, the detailed analysis of LIFE projects is based on factual data related to a selected subset of **835 projects** covering the seven-year period 2009 – 2015 (from 1 January 2009 to 1 January 2016) and corresponding to LIFE+ Programme and LIFE14/15 calls. Within the frame of the analysis, the impact of selected determinants of sustainability and replicability was examined through a combination of quantitative and qualitative methods. For the purposes of the study, the following approaches were employed to gather, tailor and interpret the data:

- Data mining from LIFETRACK DORY database including text mining
- Approximately 200 individual web surveys among technical monitors on sustainability, replicability and the level of innovation of LIFE projects
- Econometric modelling
- Cluster analysis with case studies of 12 randomly selected projects
- Consultations with stakeholders (technical monitors of the projects, NEEMO representatives, local authorities etc.)
- Desk research of external factors affecting LIFE projects
- Development of a scoring model predicting the sustainability and replicability of a potential LIFE project.

In addition to the above mentioned activities, which were envisaged within the Task 9c, a statistical analysis of the basic characteristics of the projects co-financed by the LIFE Programme was conducted, covering **4 262 projects within the 25-year period 1991-2016**. The results of this additional analysis are also presented within this study (Annex 1 of Part I).

Part I of the study is divided into the following four fundamental chapters:

- Chapter 1: Methodology of the study
- Chapter 2: Likelihood of sustainability and replicability of the selected projects
- Chapter 3: Key determinants of sustainability and replicability of the selected projects
- Chapter 4: Cluster analysis

Main findings

The econometric model revealed that there are six main determinants out of **more than 100 variables** that were examined (factors potentially affecting the sustainability and replicability of LIFE projects) which are significantly affecting the sustainability and replicability of LIFE projects. Three of these characteristics were identified as significantly influencing both the sustainability and replicability of the projects.

The following **three determinants affect both the sustainability and replicability** of LIFE projects:

- **Level of innovation** (indicated by the TMOs in DORY and surveys) – More innovative projects possess a prerequisite to be both more sustainable and more replicable. However, the econometric model revealed that this does not apply to extremely innovative projects. Such projects often face difficulties linked to the institutional and legal constraints, a fact which was also confirmed by the TMOs and beneficiaries. For the sake of consistency, the level of innovation corresponds to the definition in DORY where the scale from 0 to 9 was not defined in detail.
- **Sector (based on economic and/or environmental activities)** – Projects implemented within manufacture, construction and water related sectors (according to the International Standard Industrial Classification of All Economic/Environmental Activities)[1] tend to be more sustainable. Manufacture and construction projects are more performance and output oriented while focus of projects aimed at water is often in line with global or currently relevant issues (drought, floods etc.) – making all these types of projects more sustainable. Likewise, projects aimed at health (e.g. reduction of health-threatening substances) prove to be more replicable as their focus is also often in line with actual issues. On the other hand, the model showed that projects focusing on waste and power are less likely to be replicable as they might be constrained by institutional and legal boundaries specific for individual countries and the market structure in the individual countries (including distortions of the market – monopoly, lobby etc.).
- **The amount of budget allocated to prototype within the project** – Projects focusing heavily on prototypes tend to be more sustainable and replicable. On the contrary, projects perceiving any prototype only as a by-product of their primary activities and/or prototype construction is not their primary focus are less likely to be sustainable and replicable. In the case of sustainability, the amount spent on prototypes was estimated to be significant; whereas in the case of replicability, the percentage of the total budget allocated to fabrication of prototypes was revealed to be significant.

The following three factors proved to be significant **only for the sustainability** of LIFE projects:

- **Region (based on the location of the coordinating beneficiary) –** As far as the regional differences are concerned (in terms of the cardinal directions division according to the UN nomenclature), projects implemented in the Eastern region are slightly more sustainable as they are more performance-oriented and draw on higher potential of the region (these are corresponding features to the Baltics as well). Similarly, countries of the Southern region can build on a higher potential of their economies to grow up but some of them suffer from various constraints.
- **Duration of the project –** The model showed that projects with very short or very long implementation periods tend to be less sustainable. Longer lasting projects face higher risk of change of the external factors while shorter lasting projects include also the early terminated projects that were fully unsuccessful.

[1] *Table 1*: Sectors by economic and environmental activities presents the sector categories can be found at the beginning of *Chapter 2: Likelihood of sustainability and replicability of the selected projects*.

- **Number of associated beneficiaries –** A higher number of partners has a significantly negative impact on sustainability of projects. Based on the qualitative data gathered within the study, the higher the number of partners the more complex is the coordination of these partners. Moreover, a higher number of partners increases the risk of conflict related to the ownership of the project results after the end of the project. The achieved outputs are also fragmented among the group of partners.

The following three factors proved to be significant only **for the replicability** of LIFE projects:

- **Personnel budget (as % of the total budget)** – Projects in which personnel costs are close to 50% of the overall budget are on average more replicable. However, the model revealed that projects reliant on the personnel budget either too much or too little tend to be less replicable.
- **Infrastructure budget (as % of the total budget)** – Projects with higher relative infrastructure budgets demonstrate higher level of replicability. Projects with no or low infrastructure costs might assume a specific infrastructure which is already present – decreasing their potential for replication as the specific infrastructure might be absent elsewhere. Furthermore, projects aimed at methodologies and guidelines which do not need any infrastructure budget are in some reliant on preceding data collection etc. which makes them less replicable.

Furthermore, although it was not included in the preferred model specification, the implementation within the Eurozone was estimated as well. The estimation suggests that the projects implemented within the Eurozone tend to be more replicable.

Based on the econometric model, the evaluation team identified several key characteristics of a potential LIFE project which can either increase or decrease the probability of sustainability and replicability of the projects. The key determinants of Sustainability and Replicability of the projects are summarized in the Table 1.

Table 1. Key determinants of Sustainability and Replicability

Sustainability		*Replicability*	
+	−	+	−
Projects focusing on prototypes	*Projects with low non-zero prototype budget*	*Projects with medium personnel budget*	*Project with either high or low personnel budget*
Projects implemented in the Eastern or Baltic countries	*Projects with high number of associated beneficiaries*	*Projects focusing on prototypes*	*Projects with low non-zero prototype budget*
Manufacture, construction and water-related projects	*Extremely innovative projects*	*Projects with higher infrastructure budget*	*Power and waste-related projects*
Innovative projects		*Projects focusing on health issues*	*Extremely innovative projects*
		Innovative projects	

This study is, to the best of our knowledge, the most extensive, comprehensive, and scientifically elaborated study ever done on sustainability and replicability of the LIFE Programme.

Chapter 1: Methodology of the study

1.1 Available data

For the purpose of the study, two key sources of information were available:

- Monitoring database of the LIFE Programme – LIFETrack DORY
- Data obtained from the technical monitors of individual projects.

The primary source of information was the monitoring database of LIFE projects – LIFETrack DORY (further referred to as "DORY").

1.2 General approach of the study

To focus the scope of the study in accordance with the requirements of the project sponsor we created individual parts of the main research as follows:

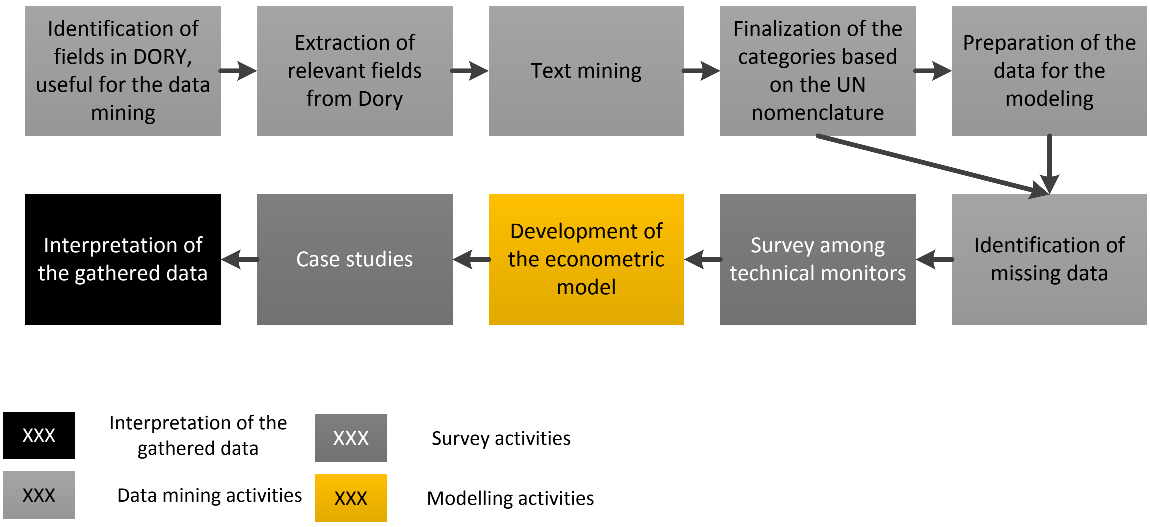
1. Basic characteristics of LIFE projects
2. Likelihood of sustainability and replicability of the selected projects
3. The key determinants of sustainability and replicability of the selected projects
4. Cluster analysis

In order to elaborate the above-stated parts of the main research, a specific study design/methodology was developed. We employed both quantitative and qualitative methods and used a wide range of data sources. The study was divided into four main areas:

- Data mining
- Modelling
- Survey analysis
- Interpretation of gathered data.

Figure 1: Approach of the evaluation team during the development of the study depicts the overall approach of the evaluation team during the development of the study. The four key areas are indicated with different colours.

Figure 1: Approach of the evaluation team during the development of the study



The above mentioned key areas of the study are described in detail in the following chapters.

1.3 Data mining

The primary goal of data mining was to gather pertinent data on all projects and to select the most relevant projects for further analysis. Out of the full set of all LIFE projects we selected those types of projects having an adequate probability of sustainable and replicable outcomes. After a desk research of the data, (i) majority of Nature projects was assessed to be inherently not market-oriented and not generating any substantial direct economic values; (ii) projects beginning before 2008 were excluded as the full set of desired information would not be accessible due to excessive time distance. The key source of information for the evaluation purpose was the DORY database. The runtime environment for DORY is completely provided by IBM Notes – the application provides both front-end user interface for the TMOs and also the back-end.

DORY is a monitoring tool used by NEEMO to coordinate the monitoring of LIFE projects, assign workflows and tasks to particular monitors and allow traceability of the whole monitoring process. It is a database of monitoring reports (mission reports, progress reports, mid-term reports and final reports) and the collection of project monitoring files. Consequently, it provides information about the projects, reports and project visits.

The first step in data mining was **to identify relevant fields in the DORY database** which can serve as a source of information. A detailed analysis of data stored in DORY was performed and key fields containing relevant information were determined.

DORY is a IBM Notes application. That means the data in DORY are not stored in a traditional relational database (like Oracle or MS SQL), which is required for modelling. Therefore, no direct processing of DORY data was possible and, before the actual modelling, **the data had to be extracted from DORY** and prepared for modelling. We extracted key information of the database included in the various reports of the database (mission reports, mid-term reports, final reports…) and in the project monitoring files.

We identified in DORY three types of data in individual fields:

- **Structured data** – basic information, i.e. categories, dates, overall project measures (e.g. budget, duration, beneficiary, total cost).
- **Semi-structured data** – part of rich text fields and contain further details mainly in a table format in pre-defined structure (e.g. financial expenditure table).
- **Unstructured data** – free text in full sentences or without any structure. The texts entered in these fields have descriptive character and their length & structure is based only on the author.

The identified structured and semi-structured fields were extracted directly to our SQL database. We created view for respective fields for projects, reports and missions in Lotus Domino and through ODBC (Open Database Connectivity) we extracted them to SQL database. Semi-structured and unstructured data were extracted through a developed Lotus Script. To prepare the fields for analysis, we needed to correct evident inconsistencies (e.g. inconsistent using of the decimal delimiter, thousands delimiter, inconsistent categories etc.).

Unstructured data (rich text) were extracted from the Word files, as there was no other suitable way to extract long texts from IBM Notes**. Unstructured data were processed by a set of text mining tools.** Text mining is a machine learning discipline that automates the understanding of text without the necessity of reading it. In mathematical language, a text mining algorithm is a tool that extracts structured information (e.g. topic discussed within the text or sentiment of the text – for example negative/neutral/positive assessment) from the unstructured text. The main goal of text mining activities was to identify the sector/focus of all projects in the database because we expected the sector to play a significant part in the level of sustainability / replicability.

Firstly, we needed to separate the units of text including desired information from the surrounding text in the exported MS Word files. For this purpose, we defined unique keywords delimiting parts of the text, which were of our interest. For example, the text describing the background of the project always starts with the word "*1. Background*" and ends with the word "*2. Project objectives*" (which is the starting text of the next field). These keywords had to be identified manually. Software SPSS was utilized for parsing (i.e. conducting a syntactic analysis) from MS Word documents.

The identified units of text including desired information were processed through a text mining tool in order to identify concepts (keywords). For this purpose, we used Natural language processing. This process started with tagging parts of speech where nouns, pronouns, verbs and adjectives were identified (e.g. in sentence "The project is aimed at minimizing the high water pollution" the tool identifies words "Project, water, pollution" as nouns, "high" as adjective, "aimed" as verb etc. and matches the adjectives to corresponding nouns based on internal logic and internal English dictionary).

Subsequently, the text mining tool (incorporated into the SPSS software) analysed all nouns and related pronouns, verbs and adjectives and sorted them by their frequencies. As a result, it created a list of words and word combinations we refer to as "concepts". Apart from frequency, the most important criterion we set was the "matching algorithm" used by the SPSS Text Analytics for extraction. In our case, we set the match in order to select the keywords independently of their surroundings (match type "no compound") to maximize the probability of identification of the topics in the text.

In the next step, the concepts were assigned to categories. A category represents already quite specific information about the text belonging to one or other area known from real-life (e.g. whether the project is related to "waste water management" or not). The category is defined either by a simple list of concepts or a rule based on multiple concepts combined with logical operators. The categories were derived automatically by the SPSS Text mining module using WordNet semantic network (words organized into synonymous sets, with each representing one underlying lexical concept). However, the results using the WordNet semantic network could not have been fully used as final result due to the fact that this semantic network is a general library and in some cases it does not fit the topic of the LIFE projects. The network sometimes contained misleading concepts from our perspective (e.g. the concept "resources management" was in category called "universities"). Therefore, further tailoring of the categories was essential. For this reason we manually **organized the concepts into categories using the UN nomenclature**.[2]

Additionally, useful keywords from our projects database were gathered by the team to enhance the categories and concepts. As a result, we created categories respecting more precisely the scope of LIFE projects. To validate the results of text mining we employed a second unsupervised approach in which we enabled the algorithm to create the background categories clusters based on the word frequencies in background through latent "*Dirichlet allocation*" (i.e. statistical model for topic mining), which means we developed a model which uses statistical allocation for clustering projects based on the frequencies of words in the relevant document. Then, we manually identified the sector of the projects in all the clusters and compared it with the previous text mining method.

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[2] Available at:

http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=27&Lg=1 and
http://unstats.un.org/unsd/class/intercop/expertgroup/2011/AC234-29.PDF

Through this approach, a set of inputs for the modelling phase was gathered and adapted for the next steps of the evaluation.

As anticipated, DORY did not contain sufficient data, especially regarding the assessment of the possible future sustainability and replicability of LIFE projects. We identified missing data (i.e. the data for which any fields in DORY are not defined, fields in DORY are not filled in, or fields in DORY are not filled in with an adequate level of reliability) necessary for the modelling phase and sought different sources of information containing these data. The Butler database was one source, CAWI (Computer-Assisted Web Interviewing) survey was the other (see below).

1.4 Survey

As mentioned above, the DORY database did not contain enough relevant information for the purpose of the modelling phase. The key missing information was an assessment of the level of sustainability and replicability of the projects. For this purpose, a **survey in the form of computer assisted web interview**[3] was conducted among 107 TMOs, covering 835 projects. The TMOs evaluated the possibility of further use of projects´ outcomes after the end of LIFE financing on all assigned projects. The response rate of the survey was 78% and we gathered information on replicability and sustainability for 764 projects from the selected sample of 835 projects. The TMOs not only classified projects on a four-grade scale (from 1 to 4) but some of them provided particular reasons/causes of such classification. The survey proved to be an invaluable source of information as it provided us both with inputs for the modelling phase and with description of main factors behind sustainability and replicability.

Besides the econometric analysis, the qualitative analysis (*Section 3.3 Qualitative* analysis) and cluster analysis (*Chapter 4: Cluster analysis*) consisting of individual case studies was conducted based on the information gathered through the survey.

1.5 Econometric analysis and modelling

Detailed econometric analysis was conducted in order to assess (i) the sustainability and (ii) the replicability of LIFE projects. Output of the analysis further leads to evaluation of the probability that a given project falls into a particular sustainability/replicability category. For this purpose, two econometric models were developed – one regressing the level of sustainability on selected explanatory variables and one regressing the level of replicability on selected explanatory variables.

The econometric analysis examines statistical relationships among different variables of the data series. It quantifies an *explanatory power of the explanatory variables*.[4] In our case, sustainability (or replicability in the second case) of the projects is the dependent variable while the explanatory variables consist of its possible determinants (such as economic activity, environmental activity, scope, region etc.). Results of the analysis are further tested for statistical significance. If the coefficients obtained are statistically significant, they are interpreted (after a transformation) as impact of the explanatory variables on the probability of reaching a particular sustainability/replicability level. For example, a higher level of innovation suggests a higher level of sustainability while higher number of associated beneficiaries suggests a lower level of sustainability.

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[3] *https://emeia2.ey-vx.com/survey/TakeSurvey.asp?EID=52MB69ML8B8LJB864lll6B029B0p6L1B64K*

[4] In particular, an econometric analysis quantifies a magnitude of explanation of variation in the dependent variable by variation in the explanatory variables.

Data employed for the econometric analysis were collected from the DORY database and from the TMOs via a questionnaire. Data from DORY consist of both structured and unstructured data. We assessed correctness and completeness of the structured data; we especially controlled for outliers present among the structured data.[5] As explained above, robust text mining was employed to obtain the unstructured data[6] – the procedure was key for categorization of the projects (based on the type of (i) economic and (ii) environmental activity).[7]

The model employed is **a discrete ordinal dependent variable model**. In particular, we ran an ***Ordered Probit*** non-linear regression. The selected type of model is the same for both sustainability and replicability analysis (i.e. the following applies to both cases). The model employed best fits the character of the dependent variables. Both dependent variables are so called ordinal variables. An ordinal variable is a variable that is categorical and ordered. This is the case of our dependent variables as they are the categorical variables[8] taking value from 1 to 4 where 1 is the lowest value assigned and 4 is the highest. Therefore, the dependent variables are non-negative, discrete and ordinal. *Ordered Probit* provides a transformation to ensure that the fitted values of the model lie within the range of observed values of the dependent variable.

The core methodology employs an *Ordered Probit* model with explanatory variables comprising project key characteristics. The boundary values between each sustainability (or replicability) score are then estimated along with the model parameters:

$Y_i^* = X_i\beta + \varepsilon_i$ with:

$Y_i = 1$ if $Y_i^* <= \kappa_1$,
$Y_i = 2$ if $\kappa_1 < Y_i^* <= \kappa_2$,
$Y_i = 3$ if $\kappa_2 < Y_i^* <= \kappa_3$,
$Y_i = 4$ if $Y_i^* > \kappa_3$,

where:

Y_i are the observed sustainability/replicability scores (from 1 to 4),
Y_i^* is the unobservable true sustainability/replicability score,
X_i is a vector of variables explaining the variation in sustainability/replicability scores,
β is a vector of coefficients,
κ_i are the threshold parameters (cutpoints) to be estimated,
κ_0 is taken as $-\infty$, and κ_I is taken as $+\infty$,
ε_i is a disturbance term, which is assumed to be normally distributed.

No intercept[9] appears in the parameterization as the effect is absorbed into the cutpoints. The coefficients and cutpoints are estimated using maximum likelihood estimation. Through a specification of the model, we also allow for observations to be independent across the regional clusters but not necessarily independent within those clusters. In other words, we take into account the possibility of certain systemic patterns within the clusters, which are based on the projects´ region of implementation.

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[5] Outliers are data taking extreme or unusual values.

[6] For more information on the method used, please see *Section 1.3 Data* mining

[7] UN Economic and Environmental Activities Nomenclature were used for the categorization of the projects.

[8] They consist of categories such as: project is fully replicable, project is hardly sustainable, etc.

[9] Intercept is a constant which corresponds to the expected mean value of Y (the dependent variable) when all X=0 (the explanatory variables are equal to zero).

The coefficients obtained show the sign and the statistical significance of the impact of the project characteristics on the probability that a project reaches a certain sustainability/replicability level. Nevertheless, the coefficients cannot be interpreted directly, as for example elasticities or marginal effects. However, the coefficients can be mathematically transformed in order to estimate how the probability of a project reaching a given sustainability/replicability level varies when value of the observed explanatory variable is varying (the one corresponding to the particular coefficient) ceteris paribus (i.e. keeping all the remaining explanatory variables constant).

In *Ordered Probit Model*, an underlying score is estimated as a linear function of the explanatory variables and a set of cutpoints. The estimated cutpoints tell us how to interpret the score. The probability of observing outcome *i* corresponds to the probability that the estimated linear function, plus random error (u_j), is within the range of the cutpoints estimated for the outcome:

$$Pr(outcome_j = i) = Pr(\kappa_{i-1} < \beta_1 x_{1j} + \beta_2 x_{2j} + \ldots + \beta_k x_{kj} + u_j <= \kappa_i) = \Phi(\kappa_i - X_j\beta) - \Phi(\kappa_{i-1} - X_j\beta),$$

where $\Phi(.)$ is the standard normal cumulative distribution function, u_j is assumed to be normally distributed, $\beta_1, \beta_2, \ldots, \beta_k$ are the estimated coefficients, $\kappa_1, \kappa_2, \ldots, \kappa_{I-1}$ are the estimated cutpoints (where I is the number of possible outcomes), κ_0 is taken as $-\infty$, and κ_I is taken as $+\infty$.

Through this, it is possible to estimate the probabilities of each event. If we estimate the probabilities without specifying the values of all variables, we can for example get probabilities for each category (the level of sustainability / replicability) when all independent values are set to their mean values. However, it is possible to estimate probabilities for an entirely particular profile as well.

The decision on relevance of the possible explanatory variables is made on the basis of both manual and automated stepwise regression and economic reasoning. The automated backward stepwise regression follows the logic: (i) fit the full model on all explanatory variables which are taken into account, (ii) while the least-significant term is insignificant (based on a significance level set beforehand), remove it and re-estimate the reduced model. This procedure is complemented with a manual (both forward and backward) stepwise regression in order to preserve robustness of the model and to incorporate the economic reasoning. Thus, omitted-variable bias are avoided.

The preferred model specifications are further assessed by an auxiliary goodness of fit measure. As any standardized measure of the goodness of fit of a model (such as the coefficient of determination, its modifications or similar indicators) is not available for the *Ordered Probit* modelling, the percentage of correct predictions is employed as the main appraisal of the model's precision. We also employ various robustness checks to ensure that the model results are correct and reliable. The robustness checks should confirm the estimated coefficients' signs and the statistical significance.

Besides an obligatory variation of the explanatory variables' list (via both manual and automated stepwise regression) and a basic *Ordinary Least Squares* (*OLS*) estimation as a benchmark, we employed the *Ordered Logit Model* and the *Poisson Regression* as well.

The *Ordered Logit* model works principally in the same way as the *Ordered Probit*[10] with the exception of assuming the standard logistic distribution instead of the standard normal

[10] Both approaches provide a transformation to ensure that fitted values of the model lie within the range of values of the dependent variable. "*For the majority of the applications, the logit and probit models will give very similar characterisations of the data because the densities are very similar [...] That is, the fitted regression plots will be*

distribution. The standard normal distribution is a default distribution assumed in economics, so the *Ordered Probit* model is of our primary interest.[11] Furthermore, we employed the *Poisson Regression,* which assumes a non-negative Poisson distribution and the cardinal data.

Based on the character of the gathered data, at first we interpreted the results of the econometric model and then we used the information from qualitative research for validation of the results from the econometric model.

1.6 Cluster analysis

Cluster analysis, consisting of individual case studies conducted after the CAWI survey, served as another source of qualitative information validating the results obtained from the econometric analysis. In order to select appropriate projects, the cluster analysis was employed to create groups of projects with similar characteristics, and subsequently, 20 projects were randomly sampled out of these clusters.

Clusters were primarily distinguished by different project categories (UN classification of economic activities and environmental activities) and further classified by the EC contribution scope (four clusters in EUR 500 000 intervals).[12] We took into account other categories which could possibly enter the clustering process such as regions, duration, indication whether the beneficiary is inexperienced etc. Nevertheless, any other classification splits the clusters into insufficiently small groups. Moreover, some of them (such as the regional clusters which are composed primarily by *South* cluster) are not meaningfully distributed. As the project categorization (in term of economic and environmental activities) and the EC contribution scope are of our primary interest, we employed the clustering based on these two characteristics.

Based on the above mentioned, we first obtained 16 basic clusters according to the classification of economic and environmental activities (further referred to as "sector clusters"). In the case of **14** of them, it was not reasonable to further select a sample for each EC contribution cluster. Therefore, we employed only the EC contribution clusters, which covered a majority of the projects' distribution among the individual selected sector cluster. For example, if the sector cluster composed by projects relevant for the *Transport and storage* economic activities and the *Protection of air and climate* activities can be further split into the EC contribution clusters containing the following number of projects: 3, 13, 3 and 5, we randomly sampled one project out of the 13 projects relevant for the sector cluster and *From EUR 500 000 to 1 000 000* EC contribution cluster as it covers a huge portion of this sector cluster (13 out of 24).

In the case of the *Wastewater management* and *Waste management* sectors, we split the sector clusters further by the EC contribution classification as these two sector clusters contained a sufficiently huge amount of projects. We sampled out of **two** additional EC contribution clusters within the *Wastewater management* cluster and out of **four** additional EC contribution clusters within the *Waste management* cluster.

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virtually indistinguishable, and the implied relationships between the explanatory variables and […] will also be very similar." (Brooks 2013)

[11] Stock and Watson (2006) suggest that the logistic approach was traditionally preferred since the function does not require the evaluation of an integral and thus the model parameters could be estimated faster. "*However, this argument is no longer relevant given the computational speeds now achievable and the choice of one specification rather than the other is now usually arbitrary."* (Brooks 2013)

[12] EUR 0 to 500 000; EUR 500 000 to 1 000 000; EUR 1 000 000 to 1 500 000; and above EUR 1 500 000.

In conclusion, we drew up 20 clusters (**14 + 2 + 4**) representing all of the main groups of projects within the LIFE Programme. Out of these 20 clusters, we randomly sampled one project for each cluster as a case study. For the purpose of case studies, we used semi-structured interviews with individual beneficiaries (see *Chapter 4: Cluster analysis*). The goal of the case studies was to gather information on factors, which (from the beneficiary´s point of view) impact the sustainability and replicability and to identify the best practise and lessons learned.

Due to various reasons causing some of the projects to be unavailable for the case studies, the final number of conducted case studies dropped to 12. Some of the projects are already terminated without any relevant contact person left.

Chapter 2: Likelihood of sustainability and replicability of the selected projects

The goal of the second part of the main research presented in *Chapter 2*: Likelihood of sustainability and replicability of the selected projects is to analyse the statistical distribution of projects in the **selected sample of 835 projects** according to the assessment of sustainability and replicability performed by the TMOs.

The chapter builds directly on the data gathered via questionnaires filled in by the TMOs and data collected through text mining from the DORY database. It summarizes the actual level of sustainability and replicability of LIFE projects according to the TMOs answers. As a result, an extensive **mapping of LIFE projects' sustainability and replicability** since 2009 to 2016 is presented. In total, 835 projects were identified as relevant for the analysis while 764 of them were effectively examinable as a full set of relevant data was gathered.

The selected sample of 835 projects consists of the types of projects having an adequate probability of sustainable and replicable outcomes. (The focus here are of course ENV projects, for which sustainability and replicability is evaluated through market mechanisms; for NAT projects, see Part III of this Study). After carrying out the desk research, (i) majority of Nature projects was assessed to be inherently not market-oriented and not generating any substantial direct economic values; (ii) projects beginning before 2008 were excluded as the full set of required information would not be accessible due to excessive time distance.

The following categories of Sustainability and Replicability have been defined (for a more detailed analysis, see Chapter 3, Tables 5 and 6):

Categories of Sustainability:

1: Project is not sustainable
2: Project is hardly sustainable
3: Project is likely to be sustainable
4: Project is highly/fully sustainable

Categories of Replicability:

1: Project is not replicable
2: Project is hardly replicable
3: Project is likely to be replicable
4: Project is highly/fully replicable

The assessment of likelihood of sustainability and replicability presented in this chapter is only based on the statistical relationships. The actual key determinants of the level of sustainability and replicability observed are investigated in detail in *Chapter 3: The key determinants of sustainability and replicability of the selected projects.*

In the second part of the main research, the LIFE projects are analysed from the following perspectives:

- **Selected 835 projects** – detailed statistical data on selected LIFE projects with potential of creating jobs and economic growth after the end of LIFE financing. The parameters used for the statistical analysis are:
  - Sustainability and replicability of the project
  - Country/region of the project beneficiary
  - Budget/EC contribution

- Duration of the project
- Number of partners
- Start time of the project
- Sector of the project
- Country of partners
- Level of innovation.

The statistical analysis is performed mainly on the data from the DORY database. The additional source of information is the Butler database and results of the CAWI survey.

Findings

About 17% of the projects in the sample are classified as fully sustainable. Conversely, about 10% of the projects are evaluated as not sustainable at all. The rest of the projects (73%) are either conditionally sustainable or sustainable to a limited extent.

As expected, the least sustainable projects gain by far the highest average EC contribution in comparison to the remaining (positive) classes of sustainability. On average, the projects classified as not sustainable at all get about EUR 1.5 million, whereas the average EC contribution of all other sustainability classes is close to EUR 1 mil.

On the other hand, there is virtually no difference in the average duration of the projects among the different classes of sustainability.

Projects implemented in the Western region are to the largest extent (almost 80% of them) classified decisively (i.e. classified as either fully sustainable or not sustainable at all). Projects implemented in the Eastern region are the least evaluated as unsustainable (only about 17% of them are not sustainable or hardly sustainable).

About 17% of the projects in the sample are evaluated as fully replicable while 7% of them fail to demonstrate any level of replicability. Additionally, the remaining 76% of the projects are either conditionally replicable or replicable to a limited extent.

Curiously enough, it seems that on average the less replicable a project in the sample, the higher is the EC contribution it gets. Projects classified as not sustainable at all gain the average EC contribution of about EUR 1.3 million whereas the likely replicable projects and fully replicable projects gain about EUR 0.95 million and EUR 1.05 million of the average EC contribution, respectively. This finding might be explained by the project's size, that is: the higher the contribution, the more expensive is the projects, thus the more difficult will be to gather the money for replication without LIFE finance.

Projects which are classified as not replicable at all last on average up to six months less than the others (the average duration of the not replicable projects is 3.5 years), which should be related to the early termination of unsuccessful projects.

With regard to the correlation between sustainability and replicability, it surprisingly turns out that the level of replication is a prerequisite for the level of sustainability rather than vice versa. However, it is crucial to keep in mind that the assessment of likelihood of sustainability and replicability is based on mere statistical relationships. A detailed investigation of actual determinants of the level of sustainability and replicability is presented in *Chapter 3: The key determinants of sustainability and replicability of the selected projects*. In any case, this means that projects which are not sustainable might still be replicable – including cases where a project is sustainable in theory but financially unsustainable due to external factors specific for the project in question (in other words, the same project replicated in more suitable conditions might be effectively sustainable elsewhere).

As far as the regional categorization is concerned, the level of replicability follows the same pattern as the level of sustainability. Likewise, projects implemented in the Western region are to the largest extent (38%) classified decisively (either fully replicable or not replicable at all) whilst projects implemented in the Eastern region are the least unsustainable (less than 20% of them). All countries that joined the EU after 2004 exhibit a substantially higher level of replicability.

Generally speaking, the EC contribution allocation corresponds to the distribution of projects among individual sectors.

(i) Two leading sectors with respect to economic activities, *Water supply, sewerage, waste management* and *Agriculture, forestry and fishing*, account for almost a half (49%) of all projects. Similarly, about 47% of the total EC contribution is allocated to these two sectors. Five sixths (83%) of the total EC contribution is then allocated only to five sectors.

(ii) Likewise, about 46% of all projects are classified as part of two leading sectors with respect to environmental activities – these are *Waste Management* and *Protection of Air & Climate*. Correspondingly, the aggregate EC contribution allocated to these sectors accounts for 45% of the total EC contribution. In comparison to sectors with respect to economic activities, allocation of the EC contribution is distributed more equally among the sectors with respect to environmental activities.

Nevertheless, there are evident differences when focusing on the average EC contribution allocation among individual sectors.

(iii) Sectors of Power (*Electricity, gas, steam and air conditioning supply*), Science (*Professional, scientific and technical activities*) and Information (*Information and communication*) gain the highest average EC contribution while the sector of *Arts, entertainment and recreation* has significantly lower average EC contribution than any other sector with respect to economic activities.

(iv) As far as environmental activities are concerned, *Management of Natural Forest Resources* gain the highest average EC contribution with a significant margin ahead of the following sectors of *Management of fossil energy*, *Use of fossil energy*, *Use of wild flora and fauna* and *Use of natural forest resources*. The remaining sectors with respect to environmental activities receive quite similar average EC contributions.

Detailed statistics depicted below in this chapter consist of various combinations of variables, such as the level of both sustainability and replicability, financial indicators (total and average EC contribution), regional classification and sector categorization (based on both economic and environmental activities). Additional figures describing the structure of the sample in detail are presented in *Annex 1*.

In general, the figures refer to the selected sample of LIFE projects covering the period from 2008 to 2016 (which accounts for 835 projects in total) accessible in the DORY as of February 9, 2016.

Sector categorization corresponds to the UN nomenclature of (i) economic and (ii) environmental activities. A list of abbreviated names of the sectors (referred to in the text) is depicted in *Table 1*: Sectors by economic and environmental activities.

Table 1: Sectors by economic and environmental activities

Sector by environmental activity		Sector by economic activity	
Energy (management):	Management of fossil energy	Agriculture:	Agriculture, forestry and fishing
Energy (use):	Use of fossil energy	Construction:	Construction
Flora & Fauna (use):	Use of wild flora and fauna	Health:	Human health and social work
Forest (management):	Management of natural forest resources	Information:	Information and communication
Forest (use):	Use of natural forest resources	Manufacture:	Manufacturing
Noise:	Noise and vibration	Mining:	Mining and quarrying
Protection (air & climate):	Protection of air and climate	Power:	Electricity, gas, steam and air conditioning supply
Protection (biodiversity):	Protection of biodiversity and landscape	Public:	Public administration and defence
Protection (other):	Other environmental protection activities for environmental protection	Recreation:	Arts, entertainment and recreation
Protection (R&D):	Research and development for environmental protection	Science:	Professional, scientific and technical activities
Protection (soil & water):	Protection and remediation of soil, groundwater and surface water	Trade:	Wholesale and retail trade; repair of motor vehicles and motorcycles
Water (management):	Management of water resources	Transport:	Transport and storage
Water (use):	Use of water resources	Waste & Water:	Water supply, sewerage, waste management
Waste (management):	Waste management		
Wastewater (management):	Wastewater management		

For better readability of the report, the relevant figures are marked according to the area of interest of the figure. The following pictograms (*Table 2*: Indication of the figures) were selected to indicate the focus of the figure.

Table 2: Indication of the figures

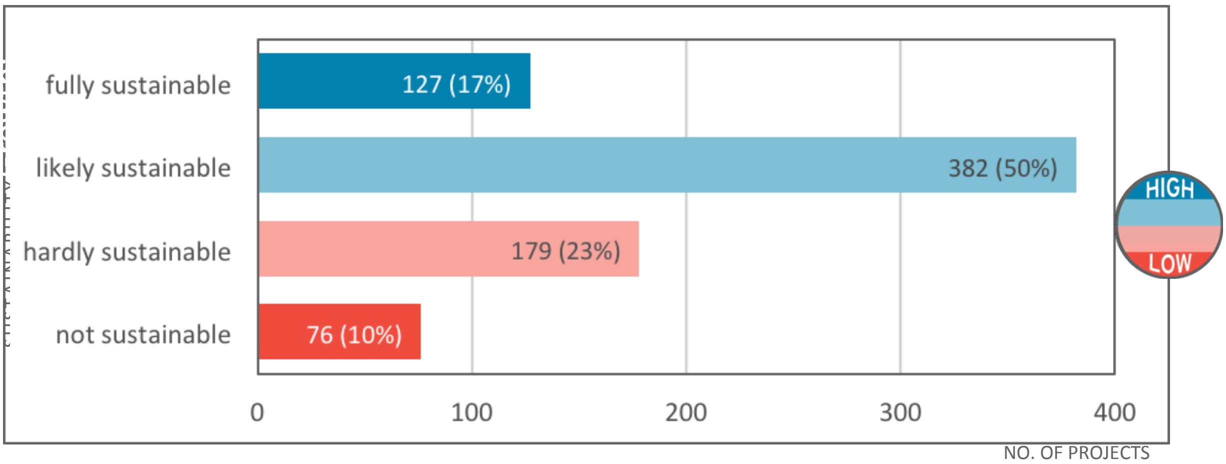
Depicted variables		Simplified legend	
	Regions, Countries	HIGH / LOW	Colours by magnitude
	Sectors		
	Financials (EC Contribution)		
	Time (Duration)		

Grey-and-white pictograms indicate the types of variables depicted in the particular figure (regional, sector categorizing, financial, or time variables). If the figure is portrayed in colour, the coloured pictogram serves as a simplified legend (colours by magnitude of sustainability, replicability or financial variables are depicted).

2.1 Distribution of projects per sustainability

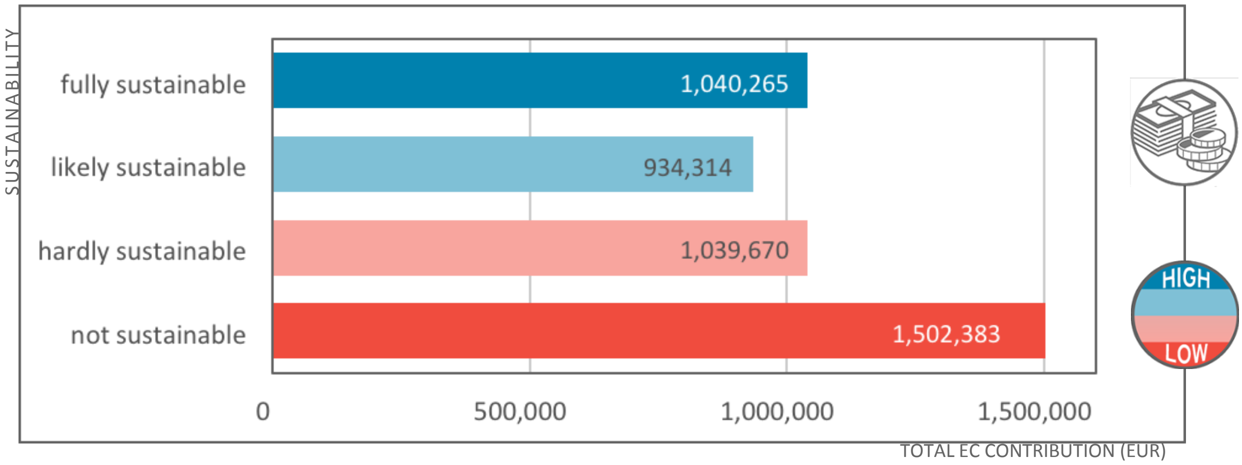
About 17% of the projects in the sample are evaluated as fully sustainable. In contrast, about 10% of the projects are classified as not sustainable at all. The rest of the projects are either conditionally sustainable or sustainable to a limited extent. As depicted in detail in *Figure 2*: Number of Projects per Sustainability, half of the projects are evaluated as likely sustainable and almost one quarter of them (23%) as hardly sustainable.

Figure 2: Number of Projects per Sustainability category



As expected, the least sustainable projects gain by far the highest average EC contribution among all classes of sustainability. Project classified as not sustainable at all gain, on average, about EUR 1.5 million whilst the average EC contribution of all other sustainability classes is close to EUR 1 mil. For detailed information see *Figure 3*: Average of EC Contribution per Sustainability.

Figure 3: Average of EC Contribution per Sustainability category



In contrast, there is virtually no difference in the average duration of the projects among the different classes of sustainability. The finding is portrayed in *Figure 4*: Average of Duration per Sustainability.

Figure 4: Average of Duration per Sustainability category

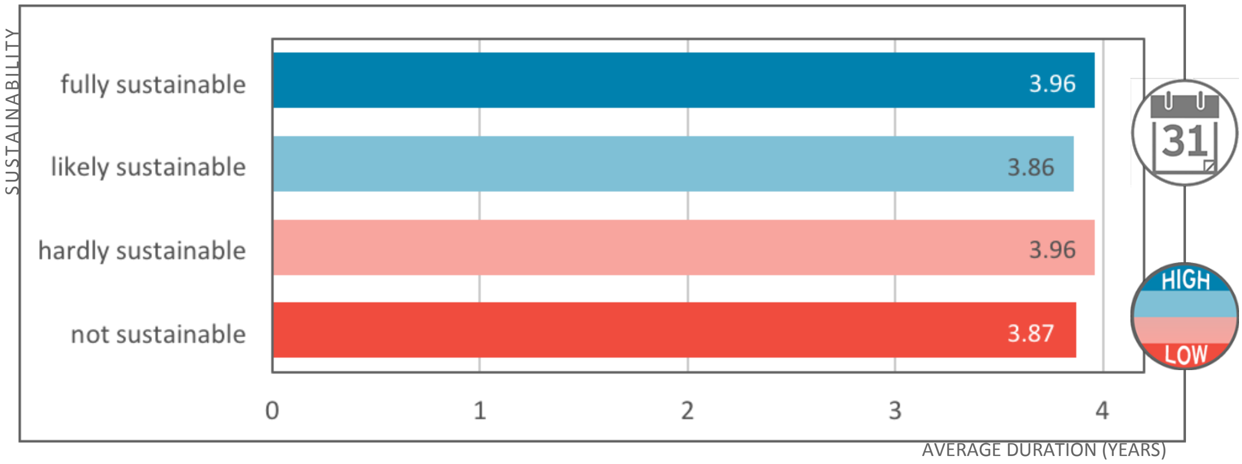
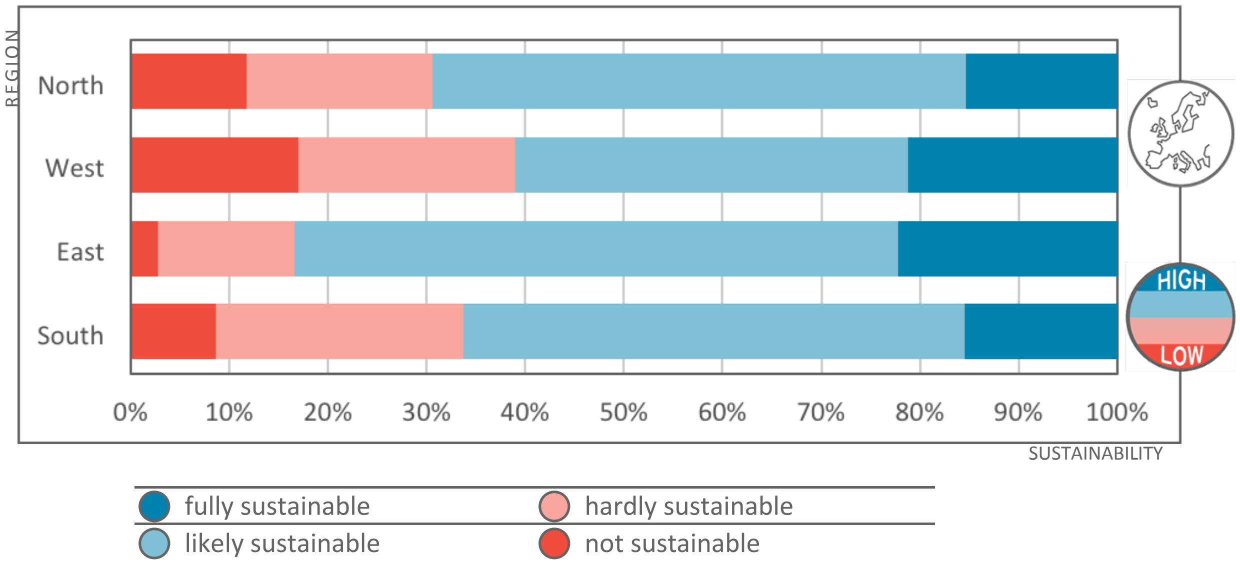


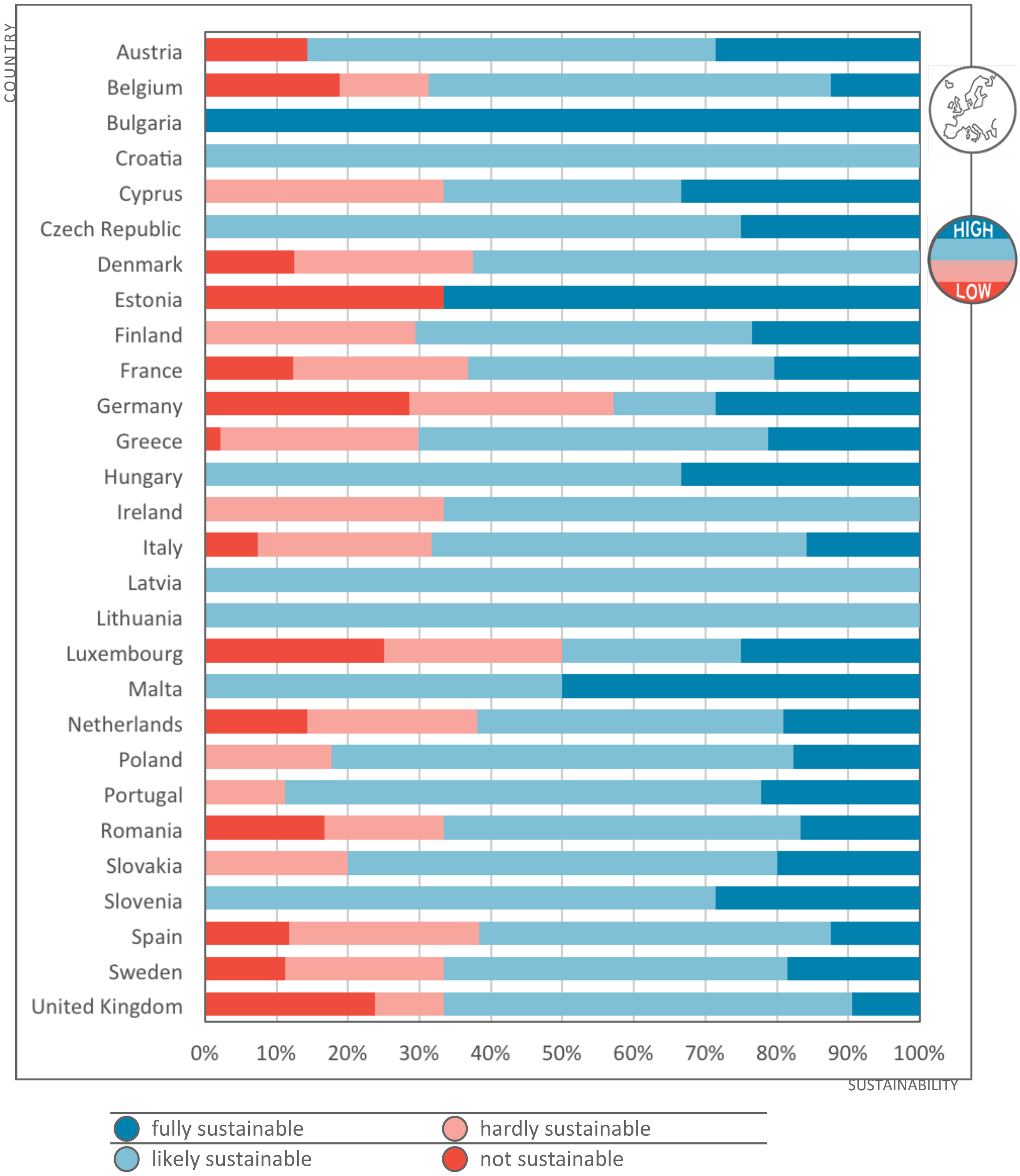
Figure 5: Number of Projects per Sustainability per Region



With regard to the regional categorization, projects implemented in the Western region are to the largest extent classified decisively (as either fully sustainable or not sustainable at all) – almost 40% of them are classified decisively. Projects implemented in the Eastern region are the least unsustainable (only about 17% of them are evaluated as not sustainable or hardly sustainable). For more detail see *Figure 5*: Number of Projects per Sustainability per Region.

The level of sustainability with respect to the individual countries of the projects' implementation is depicted in *Figure 6*: Number of Projects per Sustainability per Country. Countries that joined the EU after 2004 exhibit a higher level of sustainability of the projects.

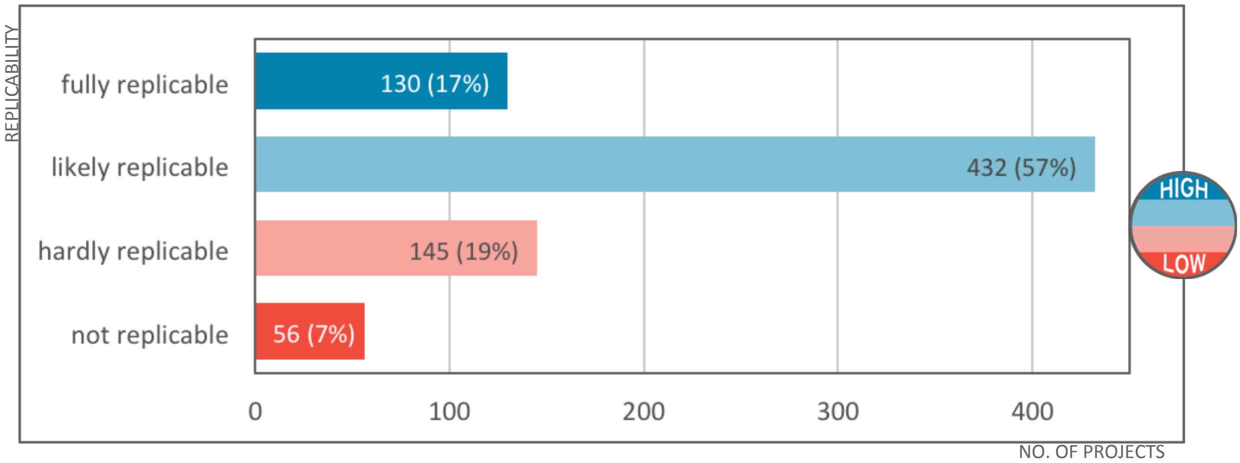
Figure 6: Number of Projects per Sustainability per Country



2.2 Distribution of projects per replicability

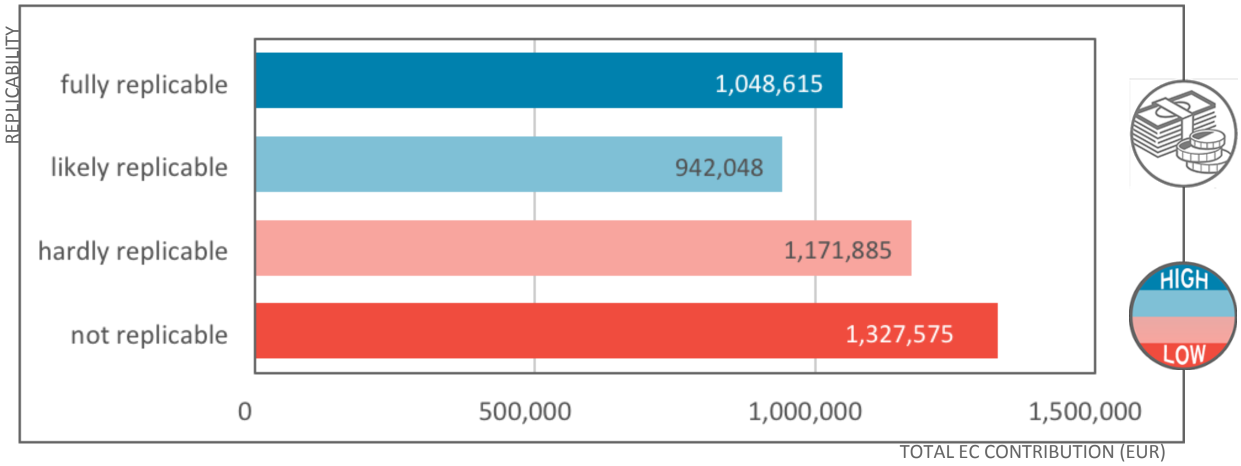
Similarly to the assessment of the level of sustainability, about 17% of the projects in the sample are evaluated as fully replicable. On the other hand, only 7% of them fail to demonstrate any level of replicability. The remaining 76% of the projects are either conditionally replicable or replicable to a limited extent. In particular, more than a half (57%) of the projects is classified as likely replicable while 19% of them as hardly replicable. For more detail see *Figure 7*: Number of Projects per Replicability.

Figure 7: Number of Projects per Replicability category



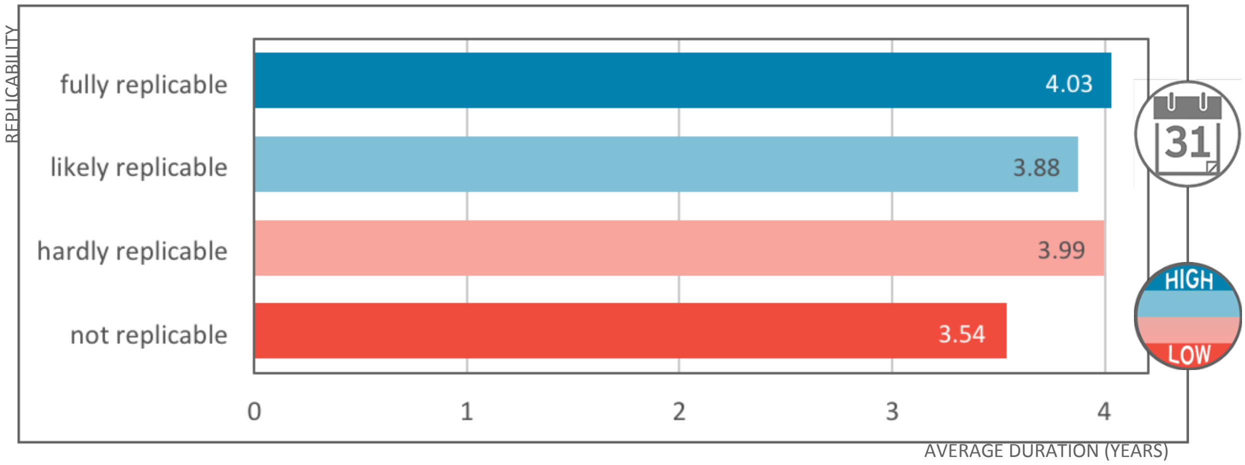
As depicted in *Figure 8*: Average of EC Contribution per Replicability, the less replicable a project in the sample is, the more EC contribution it gains on average – with the exception that the likely replicable projects gain even lower average EC contribution than the fully replicable projects. Projects classified as not sustainable at all gain an average EC contribution of more than EUR 1.3 mil.

Figure 8: Average of EC Contribution per Replicability category



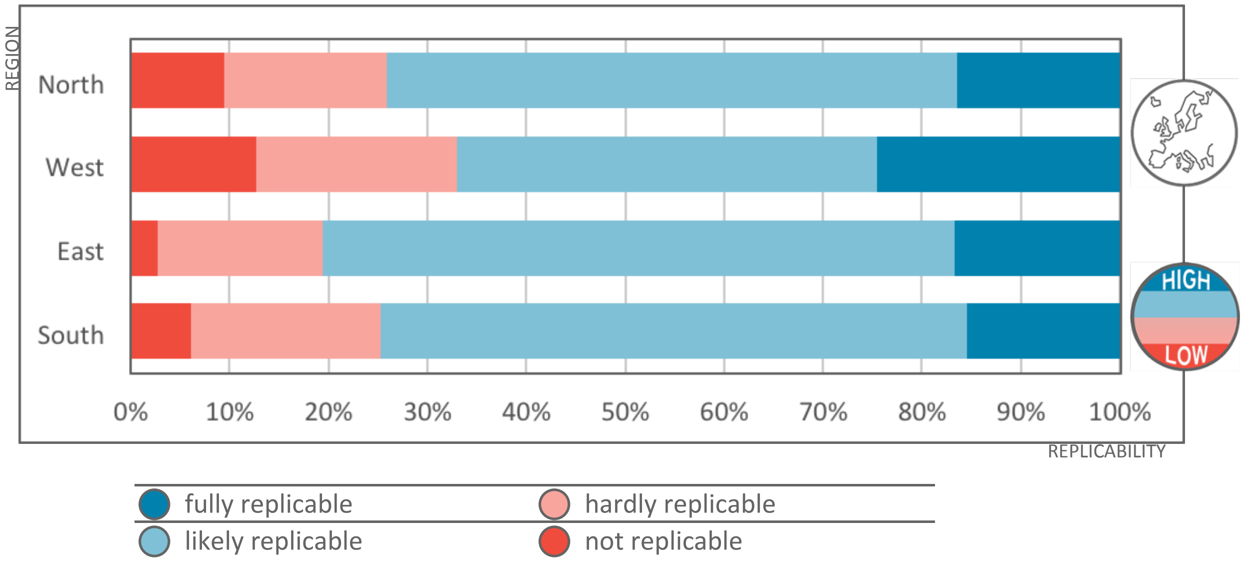
The only replicability class that exhibits the average duration of the projects substantially distinctive of the others is the class of projects that are not replicable at all. Projects not replicable at all last on average up to six months less (about 3.5 years), as depicted in *Figure 9*: Average of Duration per Replicability. The duration of projects falling into the other classes of replicability is close to four years.

Figure 9: Average of Duration per Replicability category



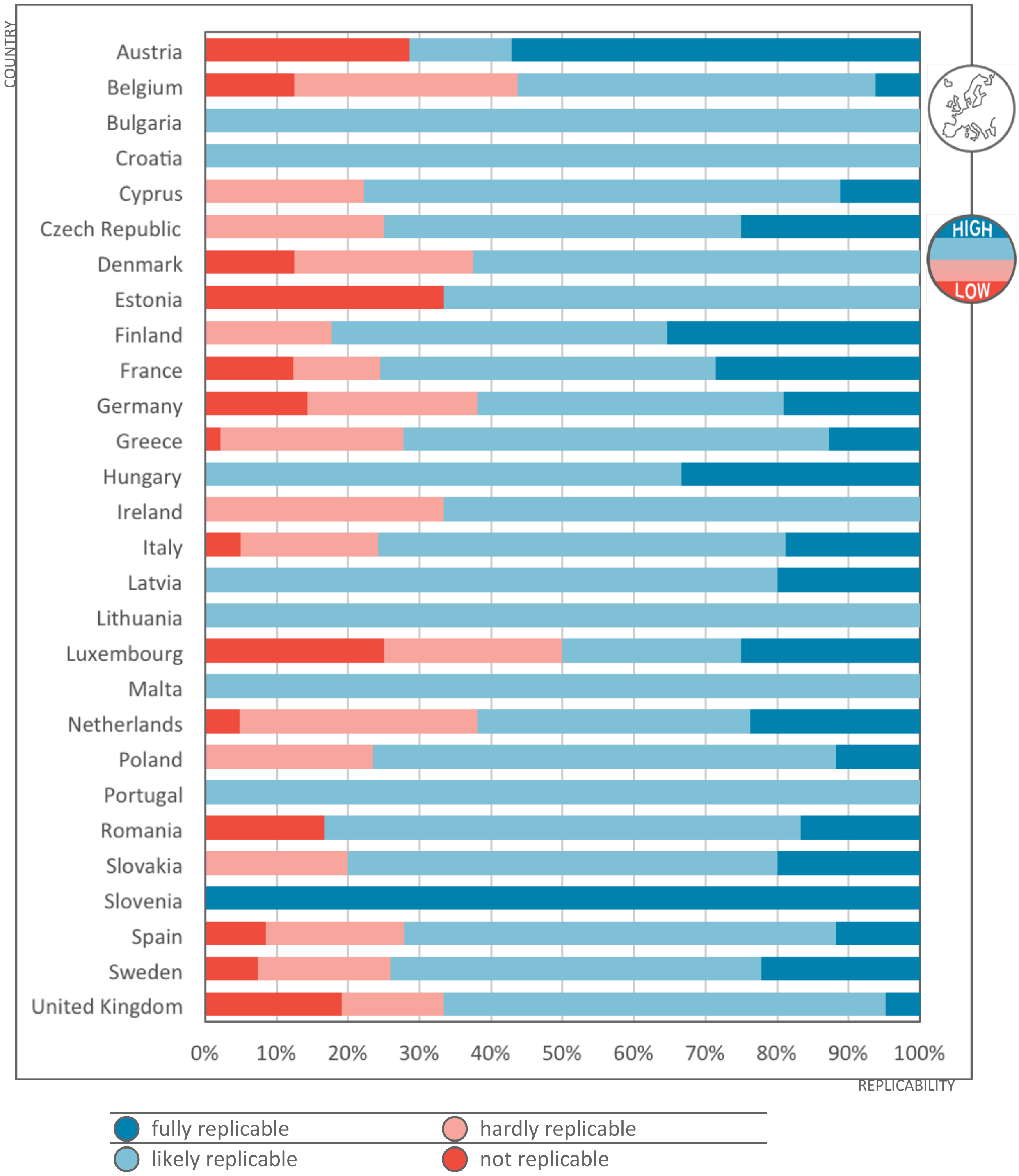
Similarly to the level of sustainability, projects implemented in the Western region are to the largest extent classified decisively as either fully replicable or not replicable at all (about 38% of them). Likewise, projects implemented in the Eastern region are the most replicable (still less than 20% of them are evaluated as not replicable or hardly replicable). For more detail see *Figure 10*: Number of Projects per Replicability per Region*.*

Figure 10: Number of Projects per Replicability per Region



Projects implemented in countries that joined the EU after 2004 exhibit a substantially higher level of replicability. The level of replicability for individual countries is depicted in detail in *Figure 1*: Number of Projects per Replicability per Country but no strong conclusions can be drawn from it.

Figure 1: Number of Projects per Replicability per Country



The value of the statistical correlation between the levels of sustainability and replicability is equal to 0.68, indicating a substantial correlation between these two measures of the post-project phase of the subset of LIFE Programme financing. Surprisingly, it reveals that at least a minimum level of replication is a prerequisite for a positive level of sustainability rather than vice versa. However, it is crucial to keep in mind that the assessment of the likelihood of sustainability and replicability is based on mere statistical relationships. A detailed examination of actual determinants of the level of sustainability and replicability is presented in *Chapter 3: The key determinants of sustainability and replicability of the selected projects*. In any case, the finding implies that projects which are not sustainable might be still be replicable

– including cases where a project is sustainable in theory but financially unsustainable due to external factors specific for the project in question (in other words, the same project replicated in more suitable conditions might be effectively sustainable elsewhere). A full list of the percentage of exact match between the level of sustainability and replicability is depicted in *Table 3*: Percentage of match between the level of Sustainability and Replicability*.*

Table 3: Percentage of match between the level of Sustainability and Replicability

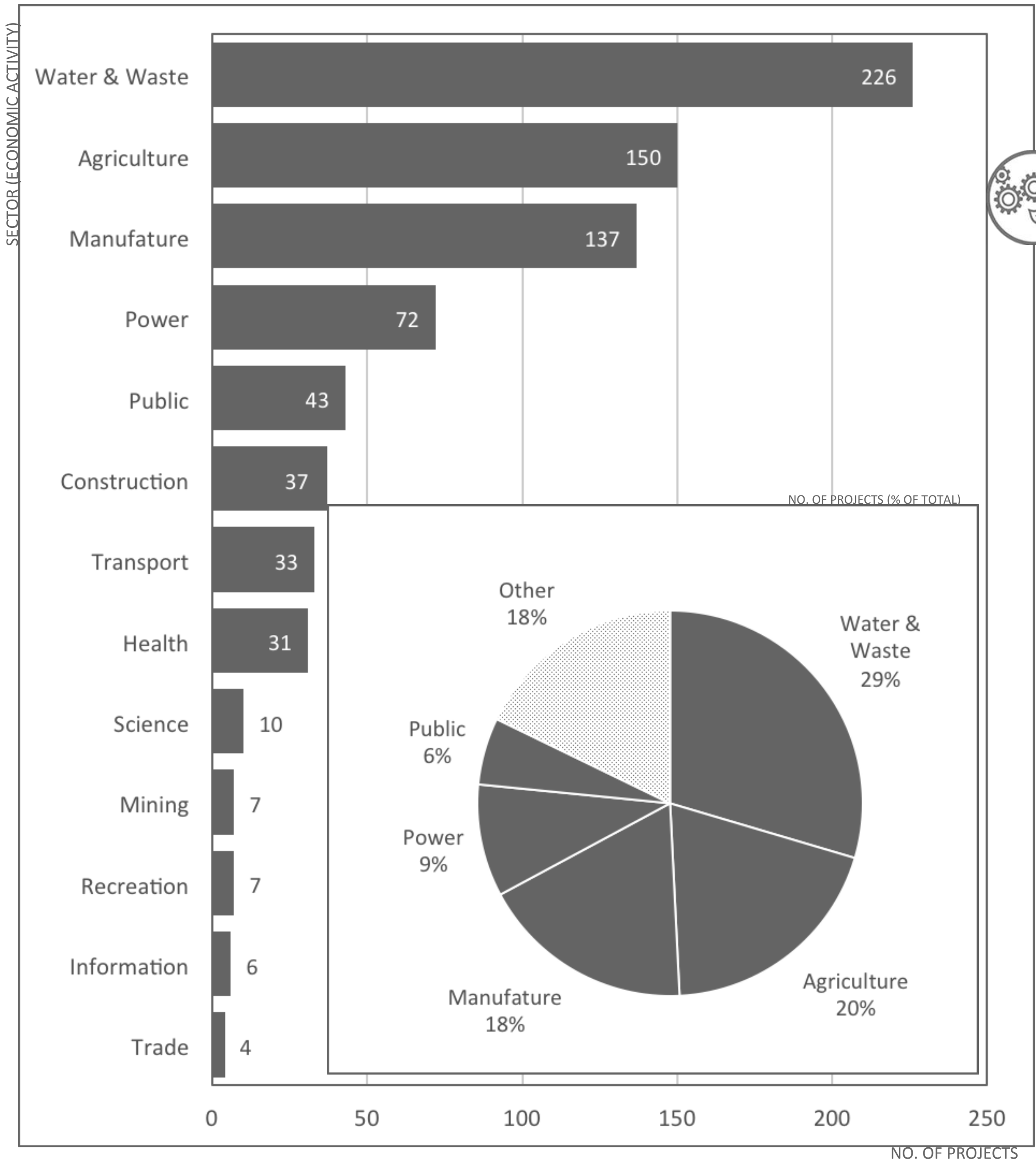
Sustainability		Replicability	
fully sustainable:	54% match with replicability	fully replicable:	52% match with sustainability
likely sustainable:	79% match with replicability	likely replicable:	78% match with sustainability
hardly sustainable:	53% match with replicability	hardly replicable:	**65% match with sustainability**
not sustainable:	67% match with replicability	not replicable:	**91% match with sustainability**

2.3 Distribution of projects per sector

A general overview of data about the sector categorization is presented below. There are no distinctive conclusions from the data; the overview works primarily as a source of general knowledge about the investigated dataset.

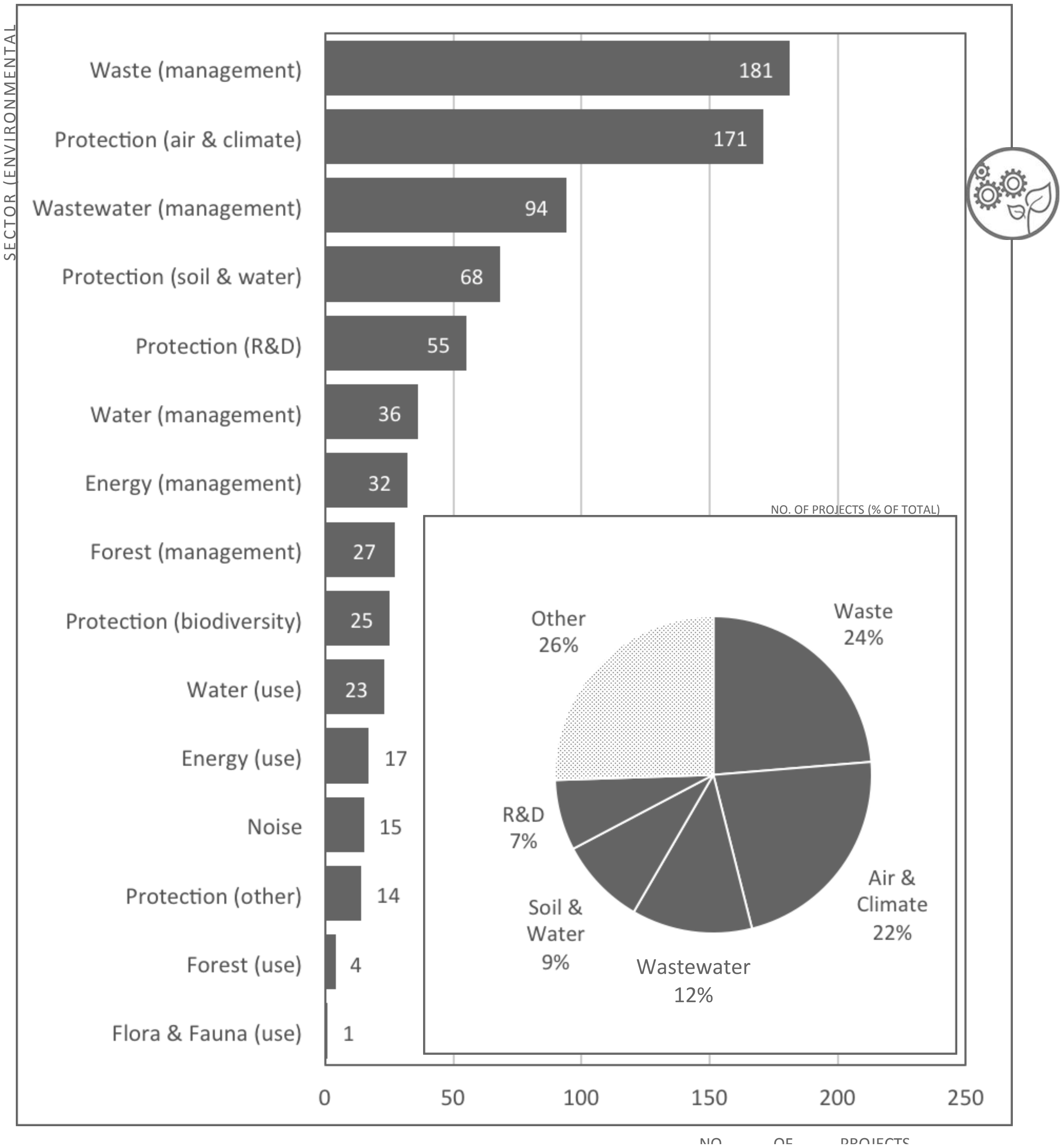
As depicted in *Figure 12*: Number of Projects per Sector (Economic Activity), *Water & Waste* and *Agriculture* sectors of economic activity account for almost half (49%) of all projects, and four of the most represented sectors account for more than three thirds of all projects (together with *Manufacture* and *Power*). The lowest number of projects is implemented within sectors of *Trade*, *Information*, *Recreation*, *Mining* and *Science*.

Figure 12: Number of Projects per Sector (Economic Activity)



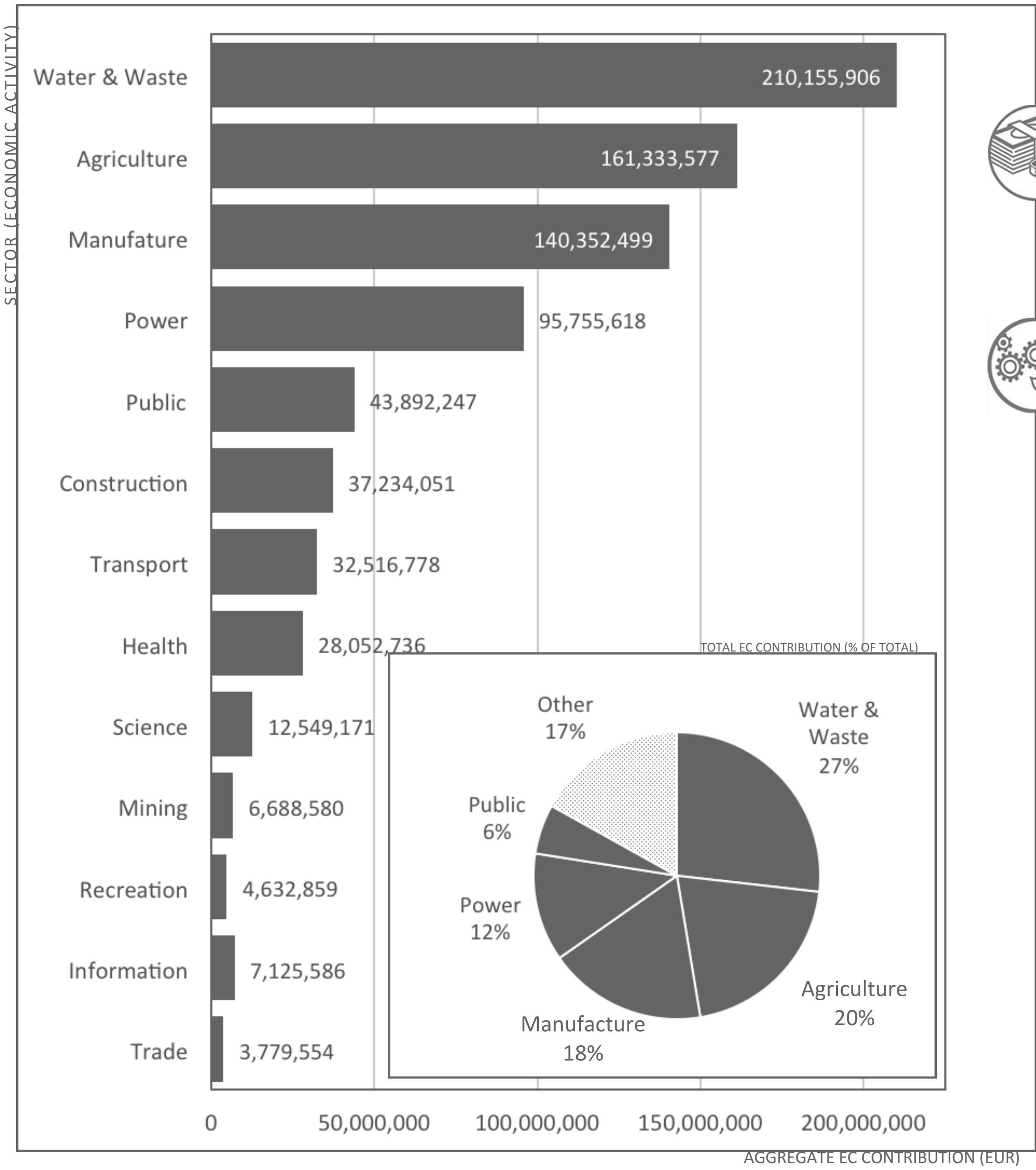
The five most represented sectors of environmental activity (*Waste Management*, *Protection of Air & Climate*, *Wastewater Management*, *Protection of Soil & Water* and *R&D for Environmental Protection*) account for three quarters of all projects. The highest number of projects was implemented in the sectors of *Waste Management* (181) and *Protection of Air & Climate* (171). In contrast, there is only one project implemented within the *Use of Wild Flora and Fauna*, and four within the *Use of Natural Forest Resources*. For detailed information see ***Figure 13***: Number of Projects per Sector (Environmental Activity).

Figure 13: Number of Projects per Sector (Environmental Activity)



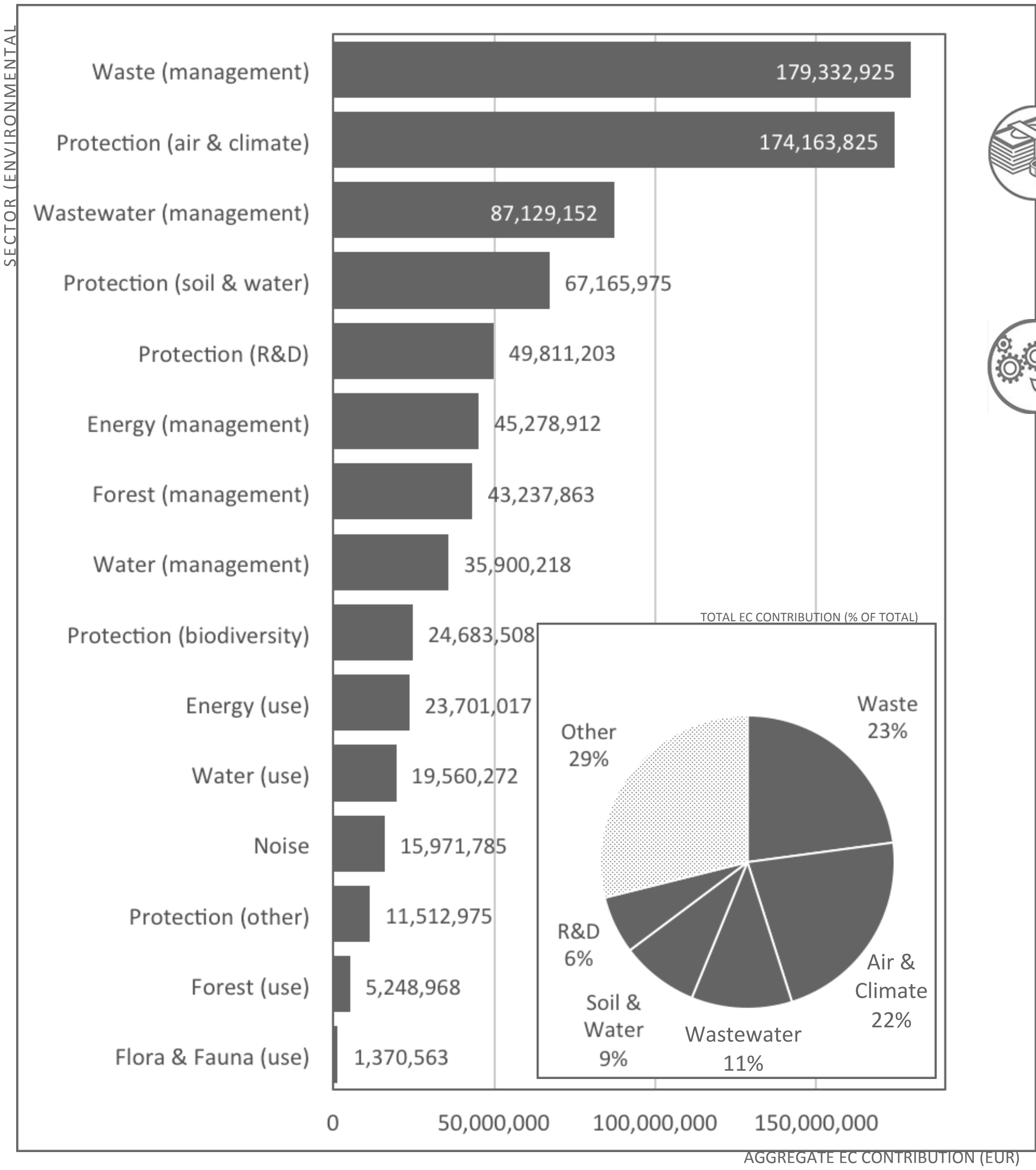
Generally speaking, the EC contribution allocation is in compliance with the distribution of projects among individual sectors. The aggregate EC contribution allocated to individual sectors is portrayed in *Figure 14*: Aggregate EC Contribution per Sector (Economic Activity). More than 80% of the total EC contribution was assigned to only five sectors of economic activity, and projects implemented within *Water & Waste* and *Agriculture* sectors account for almost half of the total EC contribution (EUR 210.2 mil. and EUR 161.3 mil., respectively). The finding corresponds to the fact that these two sectors are the leading ones in terms of the number of projects as well. Similarly, the lowest amount of EC contribution was assigned to *Trade*, *Information*, *Recreation*, *Mining.*

Figure 14: Aggregate EC Contribution per Sector (Economic Activity)



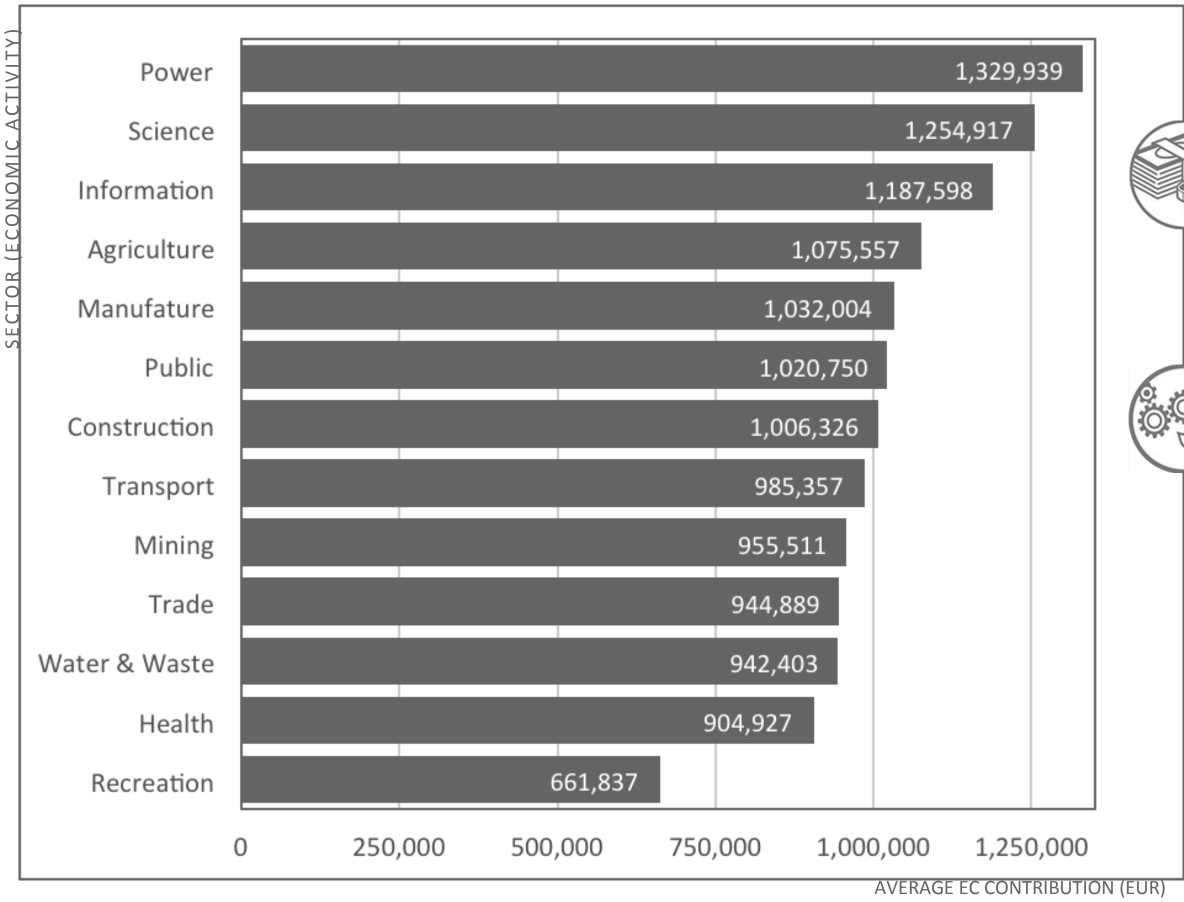
As depicted in *Figure 15*: Aggregate EC Contribution per Sector (Environmental Activity), almost three quarters of the aggregate EC contribution were assigned to only five sectors of environmental activity (*Waste Management*, *Protection of Air & Climate*, *Wastewater Management*, *Protection of Soil & Water* and *R&D for Environmental Protection*), with the first two sectors accounting for almost half of the total EC contribution. This is in compliance with the distribution of projects among the mentioned sectors as well. Correspondingly, the lowest total contribution was allocated to the *Use of Wild Flora and Fauna* and the *Use of Natural Forest Resources*.

Figure 15: Aggregate EC Contribution per Sector (Environmental Activity)



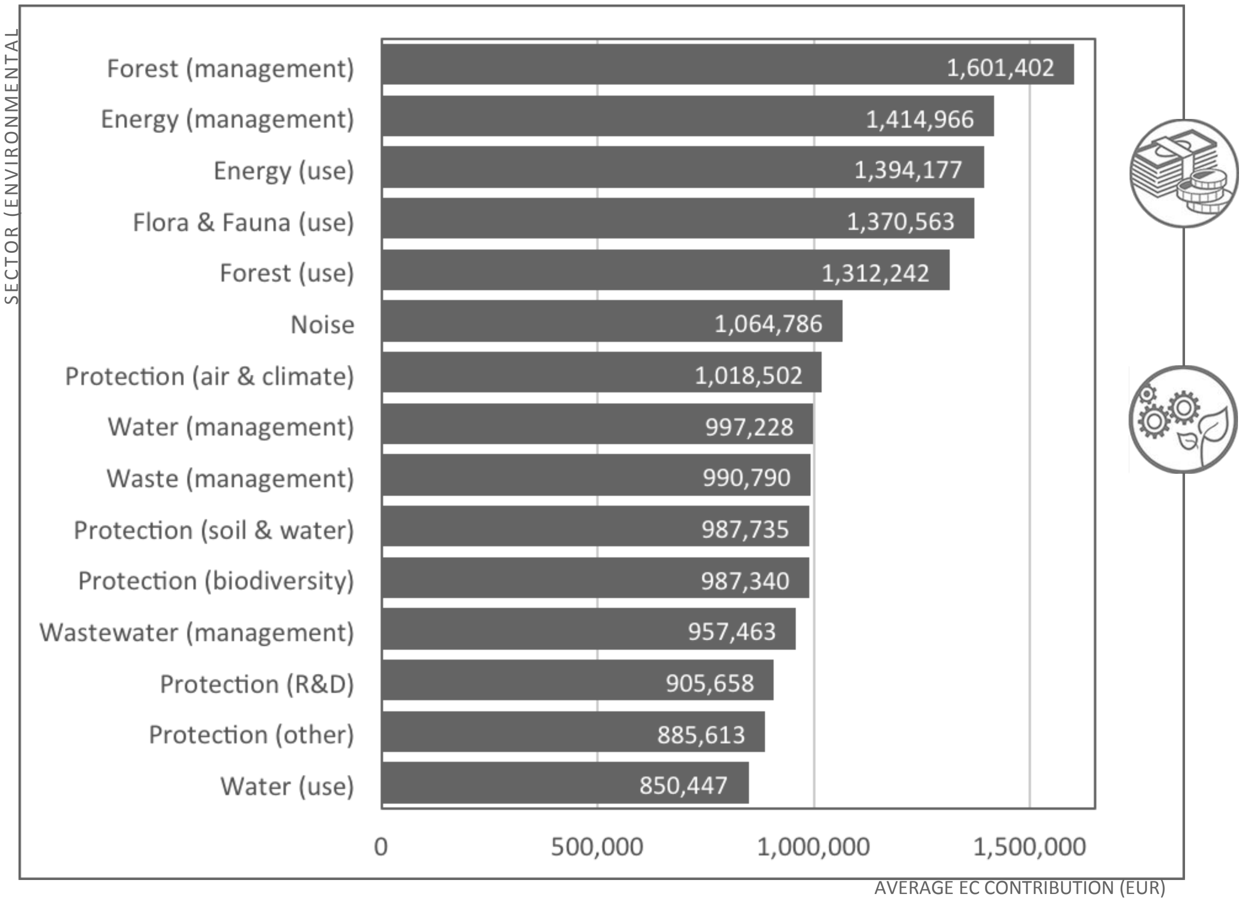
The economic activity sectors with the highest average EC contribution include *Power* (EUR 1.33 mil.), *Science* (EUR 1.25 mil.) and *Information* (EUR 1.19 mil.) while the sectors with the lowest average EC contribution are *Recreation* (EUR 0.66 mil.), *Health* (EUR 0.90 mil.) and *Water & Waste* (EUR 0.94 mil.). *Water & Waste* sector has the highest total EC contribution but its average EC contribution is one of the lowest. However, there is no clear identifiable pattern between average and total costs. For detailed information see *Figure 16.*

Figure 16: Average of EC Contribution per Sector (Economic Activity)



As depicted in *Figure 17*, the sectors with the highest average EC contribution include *Management of Natural Forest Resources* (EUR 1.60 mil.), *Management of Fossil Energy* (EUR 1.41 mil.) and *Use of Fossil Energy* (EUR 1.39 mil.). In contrast, *Use of Water Resources* (EUR 0.85 mil.), *Other Environmental Protection Activities* (EUR 0.89 mil.) and *R&D for Environmental Protection* (EUR 0.91 mil.) sectors have the lowest average EC contribution.

Figure 17: Average of EC Contribution per Sector (Environmental Activity)



For a more comprehensive overview of the dataset under investigation see *Annex 1*.

Chapter 3: The key determinants of sustainability and replicability of the selected projects

The goal of the third part of the main research presented in *Chapter 3*: The key determinants of sustainability and replicability of the selected projects is to identify the key determinants of the level of sustainability and replicability of the projects. For this purpose, a detailed econometric analysis was conducted. In particular, **two econometric models were developed** – the one regressing the level of sustainability on selected explanatory variables and the one regressing the level of replicability on selected explanatory variables. Both models employed are the discrete ordinal dependent variable models (in particular, the *Ordered Probit* non-linear regressions). Further information relating to the methodology is presented in *Section 1.5 Econometric analysis and modelling*. Additionally, multiple robustness checks[13] as well as some of the non-preferred[14] specifications of the model can be found in *Section 3.4 Robustness checks.*

The econometric analysis was conducted on the selected **sample of 764 projects**. In total, 835 projects were identified as relevant for the analysis but only 764 of them were effectively examinable as a full set of relevant data was gathered. Individual regressions could be conducted on even lower number of observations according to the amount of missing data in a particular case (depending on which explanatory variables are included). This information is always reported in the econometric tables.

The selected sample under investigation is the same sample as in *Chapter 2*: Likelihood of sustainability and replicability of the selected projects. Therefore, the econometric analysis builds directly on the data gathered via questionnaires filled in by the TMOs and data collected through text mining from the DORY database. We asked the TMOs to respond to questionnaires because of the lack of data in the database. In particular, the information about the level of sustainability, replicability and innovation of the projects were not available. All required information was completely obtained for 764 projects. The selected sample under investigation contains only those types of projects, which have an adequate probability of sustainable and replicable outcomes. After carrying out the desk research, (i) majority of Nature projects was assessed to be inherently not market-oriented and not generating any substantial direct economic values; (ii) projects beginning before 2008 were excluded as the full set of required information would not be accessible due to excessive time distance.

Sustainability

Based on the results of the survey conducted among 107 TMOs (for more information see *Section 1.2.2. 1.4* Survey), the probability of sustainability of 764 selected projects was examined. The sustainability is related to the sector of the project, region and country of the beneficiary, budget of the project, duration of the project etc.

For the purpose of the study, four groups / categories of projects were created based on the probability of their sustainability as listed in *Table 4*: Categories of Sustainability.

[13] Using methodologically different types of model.

[14] Either simplified or alternative models.

Table 4: Categories of Sustainability

1	Project is not viable / sustainable (it is not economically sustainable).
2	Project is hardly viable / sustainable (economic sustainability is very low; it can become viable only through significant changes of project's outputs or by significant external political, economic, social, technological, legal, environmental (PESTLE) changes which are unlikely).
3	Project is likely viable / sustainable (its economic sustainability is possible; it can become viable through changes or by minor external PESTLE changes which are likely).
4	Project is fully viable / sustainable (it is viable so far and / or the probability of future economic sustainability is almost assured).

Replicability

Based on the results of the survey, the probability of replicability of the selected projects was examined. The replicability is related to the sector of the project, region and country of the beneficiary, budget of the project, duration of the project etc.

For the purpose of the study, four groups / categories of projects were created based on the probability of their replicability as listed in *Table 5*: Categories of Replicability.

Table 5: Categories of Replicability

1	Replication of the project is not possible (there are barriers impossible to overcome, including no interest of potential adopters).
2	Project is hardly replicable (there are internal or external barriers which can be removed through significant efforts or by significant external political, economic, social, technological, legal or environmental (PESTLE) changes).
3	Project is likely replicable (there are only minor internal or external barriers which can be removed).
4	Project is highly/fully replicable (project is already replicated or the probability of replication is almost assured).

The econometric analysis examines statistical relationships among different variables of the data series and quantifies explanatory power of the explanatory variables. The coefficients obtained show the sign and statistical significance of the impact of the project characteristics on the probability that a project reaches a certain sustainability/replicability level.

Quantitative findings of the econometric analysis are further supplemented by qualitative knowledge based on the conducted case studies and TMOs responses and remarks. Therefore, some of the **interpretations of the econometric model are interlinked with relevant parts of the qualitative analysis**. The number (or letter) of paragraph from *Section 4.3. Qualitative analysis*, which is relevant for an individual interpretation, is indicated (by number / letter in grey circle) **on the right side of the page** next to the lines of interpretation.

We asked the TMOs to respond to questionnaires and the beneficiaries to participate in semi-structured interviews because the econometric model alone is not fully self-explanatory. The quantitative findings had to be validated and extended by the qualitative knowledge. For detailed information on the qualitative analysis and the case studies see *Section 4.3. Qualitative analysis* and *Chapter 4: Cluster analysis*.

Findings

As explained in detail in *Section 1.5 Econometric analysis and modelling*, coefficients estimated by the models cannot be interpreted directly, as for example elasticities or marginal effects, because the coefficients only show the sign and statistical significance of the impact of the project characteristics on the probability that a project reaches a certain level of sustainability/replicability. Three different characteristics were identified as significantly influencing both the sustainability and replicability of the projects.

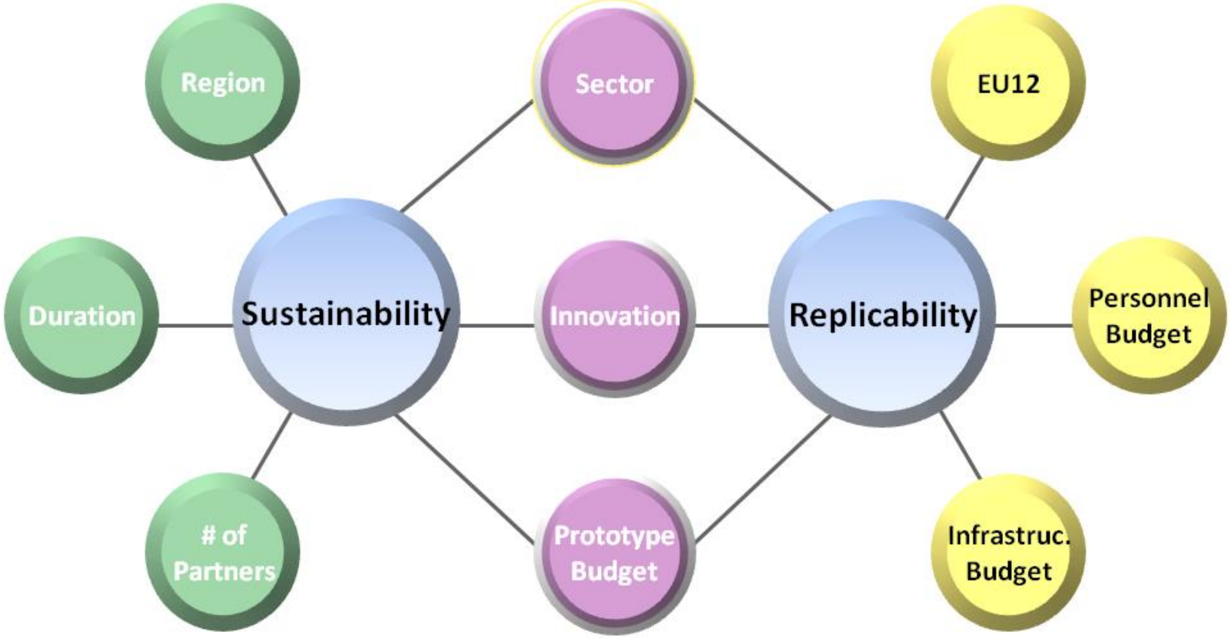
1. **Level of innovation**: more innovative projects tend, on average, to be both more sustainable as well as more replicable, while extremely innovative projects tend to level off in terms of sustainability, which might be explained by the difficulties linked to institutional or legal constraints of very innovative solutions.
2. **The amount of prototype budget allocated within the projects**: projects that either do not focus on prototypes at all, or focus on them heavily, tend to be both more sustainable and more replicable. Projects that focus on prototypes heavily are the most sustainable and replicable. On the contrary, projects perceiving any prototype only as a by-product of their primary activities or prototype construction is not their primary point of focus are the most likely to be less sustainable and replicable.
3. **The sector categorisation of the projects**: projects oriented at manufacturing, construction and water are, on average, more sustainable. Similarly, projects oriented at health are, on average, more replicable. Only two sector categories tend to exhibit a significantly negative influence – these are projects oriented at waste and power. Waste and power oriented projects are less likely to be replicable. The sector categorization is stated in *Chapter 2: Likelihood of sustainability and replicability of the selected projects* in *Table 1*: Sectors by economic and environmental activities*.*

Furthermore, there are three other characteristics of the projects identified by our econometric analysis of sustainability as having significant influence. Region of implementation of the projects, their duration and the number of partners (i.e. associated beneficiaries) are estimated to affect the level of sustainability.

Likewise, there are three other characteristics of the projects identified as having significant influence on replicability. Country origin with respect to the period of accession to the European Union (in particular, a difference between EU12 vs. other countries), and the amounts of personnel and infrastructure budgets are estimated to affect the level of replicability.

Further analysis on significant factors and reasoning behind the findings is presented in *Sections 3.1. Sustainability* and *3.2. Replicability*. A visual summary of the dependent variables (sustainability and replicability of the projects) and significant factors influencing them is depicted in *Figure 18*: Dependent variables and significant factors influencing them*.*

Figure 18: Dependent variables and significant factors influencing them



We must stress that in our econometric analysis, we initially tested about 100 different variables potentially entering the models as explanatory variables. These were sector categorization dummy variables (economic and environmental activities), geo-historical dummy variables (including regions, countries, or EU accession period), time variables (e.g. duration), financial variables (total costs, EC contribution, personnel budget, external assistance budget, prototype budget, infrastructure budget, and their percentage shares on the total costs), variables absorbing various kind of information on both coordinating and associated beneficiaries (including number, experience, or regional dispersion), level of innovation variable, and control variables absorbing insider information from DORY database (including missions required, Layman electronic, communication plan, actions delayed, actions terminated). Via the control variables, we control for various qualitative features of the projects (such as quality of management or intention for dissemination activities). The control variables serve as proxy variables in the model. The decision on the relevance of the variables was made on the basis of stepwise regression and economic reasoning. For more information on the methodology see *Section 1.2.3. Econometric analysis and modelling*.

3.1 Sustainability

There are six types of variables of primary interest, which turned out to influence the level of sustainability of projects in the LIFE Programme with a strong statistical significance. The level of innovation influences the sustainability positively, while the number of partners (i.e. associated beneficiaries) influences it negatively. The amount of prototype budget allocated within the project exhibits a U-shaped effect (when especially the projects focusing on prototypes heavily seem to be the most sustainable), whereas the duration of the project exhibits a hump-shaped effect (meaning that extremely short or too long lasting projects tend to be less sustainable). The region of implementation and sector categorization influence the sustainability depending on the particular classification. A visual summary of the statistically significant factors influencing the sustainability of projects is depicted in *Figure 19*: Sustainability and statistically significant factors influencing it .

Figure 19: Sustainability and statistically significant factors influencing it

We also investigated the following variables: about 20 other sector categorization variables (based on both economic and environmental activities), more detailed geo-historical categorization variables, more than 10 other financial variables, variables focused on the attributes of both coordinating and associated beneficiaries etc. Nevertheless, none of these turned out to be statistically significant and therefore relevant for the analysis of sustainability. Variables representing the amount of EC Contribution, energy sector, and the duration of projects are preserved in the final model specification in order to prevent an omitted-variable bias.

Final specification of the model restricts observations to be **independent across** the **regional clusters** but allows them to be possibly **dependent within** those **clusters**. In other words, certain phenomena might not affect observations individually, but they might affect groups of observations (the clusters) uniformly within each group. Particularly, some unobservable features of individual projects belonging to the same region, e.g. quality of institutional framework, might be correlated while they are not correlated with projects implemented in different regions.

As no standardized measure of goodness of fit (such as the coefficient of determination, its modifications or similar indicators) is available for the Ordered Probit modelling, the percentage of correct predictions is employed as the main examination of the model's accuracy. The preferred model specification within the analysis of sustainability determinants provides **53% probability of the exact match** of predictions with the observed values (in comparison to 25% probability of a pure random match). Furthermore, the model specification provides almost **94% probability of an approximate match** of predictions with the observed values (i.e. prediction deviation of no more than one unit of the level of sustainability on a scale from 1 to 4).

The results of the econometric modelling are depicted in *Table 6*: Econometric results on Sustainability with further explanation in the following paragraphs

Table 6: Econometric results on Sustainability

Dependent variable: SUSTAINABILITY	Model Specification: Ordered Probit
EC Contribution (mil. EUR)	-0. 123 (0.086)
Prototype Budget (mil. EUR)	-0.359*** (0.120)
Prototype Budget^2 (mil. EUR^2)	0.0993*** (0.0249)
Northern	-0.193*** (0.025)
Scandinavian	0.180*** (0.067)
Baltic	0.466*** (0.033)
Eastern	0.148** (0.061)
Southern	0.447*** (0.041)
Spain	-0.800*** (0.048)
Italy	-0.522*** (0.031)
Greece	-0.355*** (0.034)
Portugal	-0.450*** (0.028)
Manufacture	0.253** (0.108)
Construction	0.257* (0.147)
Energy	0.349 (0.227)
Water	0.436*** (0.094)
Innovation	0.717*** (0.166)
Innovation^2	-0.0486*** (0.011)
No. of Partners	-0.0272*** (0.005)
Duration (months)	0.0573 (0.036)
Duration^2 (months^2)	-0.000566* (0.0003)
Quality of Management (set of proxy variables)	+
Cutpoint 1	2.249*** (0.508)
Cutpoint 2	3.299*** (0.457)
Cutpoint 3	4.763*** (0.448)
Observations	590

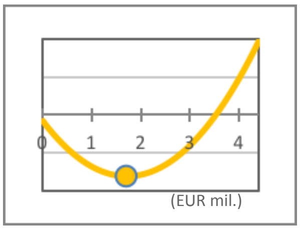
Note: Standard errors are reported in parentheses. ***, **, and * denote significance at the 99%, 95%, and 90% levels. "Observations" indicate the number of projects for which suitable data was available.

The results of our econometric model are depicted in detail on the left-hand side in Table 7. Coefficients estimated by the model only show the sign and statistical significance of the impact of the project characteristics on the probability that a project reaches a certain level of sustainability. The magnitude of the coefficients is not directly interpretable. Positive sign of a coefficient corresponds to positive impact of the characteristic on the level of sustainability and vice versa. More asterisks means higher statistical significance. Cutpoints 1 to 3 are estimated to separate the various levels of sustainability. For more information on the methodology see *Section 1.2.3. Econometric analysis and modelling. The number / letter of paragraph from Section 4.3. Qualitative analysis, which is relevant for an individual interpretation is indicated on the right side of the page next to the lines of interpretation.*

The regression includes squares of variables that are suspected to have a non-monotone effect on Replicability (the turning-point appears when βjxi equals βj+1xi2). For the full set of proxy variables for the quality of management see Section 3.4 Robustness checks.

The amount of EC contribution is not estimated to be statistically significant in the preferred model specification. Thus, although the negative coefficient suggests that projects more reliant on the EC financial support are rather less sustainable, **no further conclusion should be deducted from the results**.

Prototype costs prove to be strongly statistically significant with a U-shaped effect (the bottom is at approximately EUR 1.8 mil.) when in particular the positive extreme values exhibit a positive outcome. **Projects which focus on prototypes heavily are more sustainable**.



U-shaped effect of Prototype Budget

Projects that do not focus on prototypes at all tend to be slightly more sustainable than projects with a low non-zero prototype budget (such projects perceive any prototype only as a by-product of their primary activities or prototype construction is not their primary point of focus). Nevertheless, the substance of high prototype costs is driven by only tens of projects of the dataset; therefore, this interpretation should be regarded with caution. As explained in the table note, the regression includes squares of those variables that were suspected to have a non-monotone effect on Replicability – the variable of prototype budget was one of them. Thus, the figures depicting the U-shaped / hump-shaped effects portrays functional value of:

$\beta_j x_i + \beta_{j+1} x_i^2$, where β's are the coefficients of the given variable x_i.

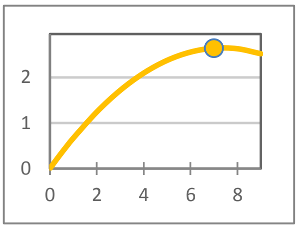
Regarding the regional differences, the Western region has been set as the benchmark region to which the model compares the others (without loss of generality). So we want to compare four different regions (North, South, West, East), but some of them are not homogenous enough. Therefore, we add another variable covering more details (e.g. Scandinavian, Italy etc.). In the first example, we divide the Northern region by distinguishing Scandinavia and Baltics.

Coefficients of a triplet of variables, Northern, Scandinavian and Baltic, suggest that projects allocated in the United Kingdom and Ireland are less sustainable. If we control for the subsets Scandinavian and Baltic, the only two countries not examined in detail are UK and Ireland. Thus, the coefficient Northern alone belongs only to these two countries (UK and Ireland). If we want to get the estimate for Scandinavia, we must add up coefficients Northern and Scandinavian (-0.193+0.180=-0.013). Likewise, to get the estimate for Baltics, we need to add up coefficients Northern and Baltic.

Projects in the UK and Ireland are often more quality-oriented and/or with a specific focus; moreover, it is more common to terminate a project if it is turning out to be not suitable in any way. In contrast, projects implemented by Baltic countries are more sustainable. The social and economic background of the Baltic countries is much closer to the one of the Eastern countries. Furthermore, an innovative approach is often employed in the Baltics projects. As the coefficients on Northern and Scandinavian effectively cancel out, projects in Scandinavia seem to be on the same level of sustainability as the Western ones.

However, the above regional differences are not very stable as far as sustainability and replicability is concerned, and thus should be viewed and interpreted with caution.

Not surprisingly, **projects relevant for the manufacturing and construction sectors are significantly more sustainable** as these are more performance and output oriented. Such projects should be sustainable by definition. This might be the case for the energy sector as well but the positive coefficient in the preferred model specification is not statistically significant enough. **Projects aimed at water show a positive sustainability** as their focus is often in line with global or currently relevant issues – it is then easier to get sufficient financing for such projects. This hypothesis emerges especially from the comments of TMOs.



Hump-shaped effect of Innovation

The level of innovation is strongly statistically significant and manifests a hump-shaped effect (the peak is at approximately the 7.4 value on a scale from 0 to 9) meaning that **more innovative projects are more likely to be sustainable with the exception of extremely innovative projects** which might be facing difficulties linked to the institutional or legal constraints. With the exception of the extreme cases, a higher level of innovation usually allows the reduction of costs incurred within the projects or to make some other competitive advantage in order to succeed in the market.

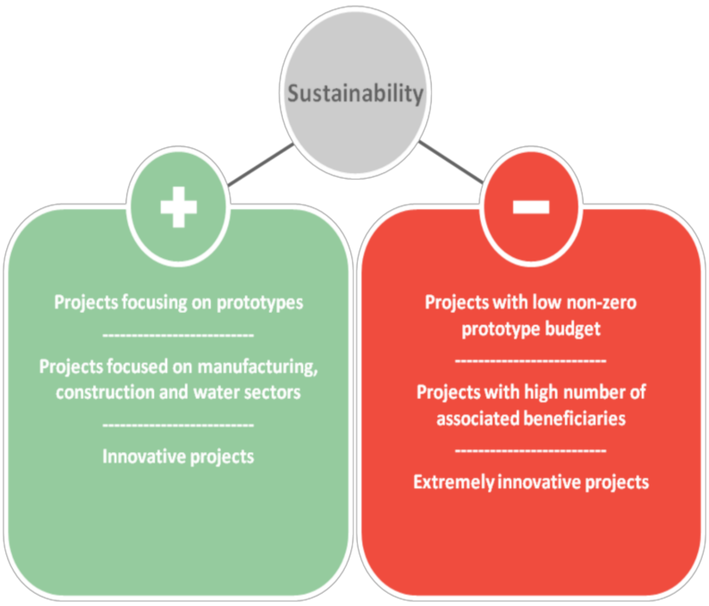
Higher number of Partners (i.e. associated beneficiaries) **has a significantly negative impact on sustainability** of the projects. The higher the number of Partners, the more difficult is the coordination of the project. Moreover, a high number of Partners also increases the risk of conflict related to the ownership of the project results after the end of the project.

Although the model controls for the project's duration, the duration does not turn out to be conclusively statistically significant (it is only significant at 89.1% and 93.8% significance level in the case of its 1st and 2nd order respectively). Nevertheless, the coefficients suggest a hump-shaped effect (the peak is at approximately 4 years), which means that too short or too long lasting projects are rather less sustainable. Longer lasting projects face higher risk of change of the external factors while shorter lasting projects include also the early terminated projects which to be completely unsuccessful.

There are also three proxy variables controlling the quality of management and monitoring of projects.[15] These are all statistically significant with an anticipated impact – **<u>poor management of the project decreases its sustainability</u>**.

A figure summarizing the distinctive characteristics of projects influencing sustainability in either positive or negative way follows (*Figure 20*: List of the projects typologically influencing Sustainability in either positive or negative way).

Figure 20: List of the projects typologically influencing Sustainability in either positive or negative way



3.2 Replicability

There are six types of variables of primary interest, which turned out to influence the level of replicability of projects in the LIFE Programme with a strong statistical significance. Similarly to the analysis of sustainability, the level of innovation influences the replicability positively and the share of prototype costs on the total costs exhibits a U-shaped effect where especially the projects focusing on prototypes heavily prove to be the most replicable. The share of infrastructure costs on the total costs is positively linked with the level of replicability, while

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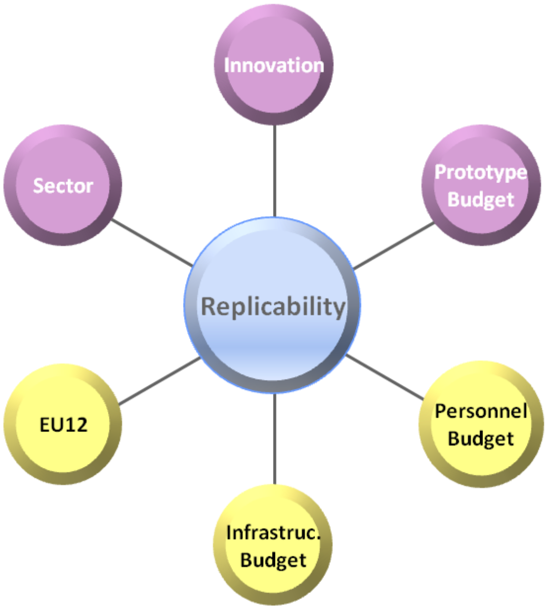
[15] For full set of proxy variables for the quality of management, see *Section 3.4* Robustness checks.

the amount of personnel costs exhibit a hump-shaped effect (meaning that projects reliant on the personnel budget either a lot or only negligibly are more likely to be less replicable). Geopolitical categorization of the country of implementation and sector categorization influence the sustainability depending on the particular classification. A visual summary of the statistically significant factors influencing the replicability of projects is depicted in *Figure 21*: Replicability and significant factors influencing it.

Figure 21: Replicability and significant factors influencing it



We also investigated the following variables: about 20 other sector categorization variables (based on both economic and environmental activities), different geo-historical categorization variables, time variables (e.g. duration), proxy variables standing for the level of dissemination activities etc. Nevertheless, none of these turned out to be statistically significant and therefore relevant for the analysis of replicability. Variables representing the share of EC contribution on the total cost, number of partners, number of beneficiary's projects, or few non significant regional variables are preserved in the final model specification in order to prevent an omitted-variable bias.

Similarly to the analysis of sustainability, the final specification of the model restricts observations from being **independent across** the **regional clusters** but allows them to be possibly **dependent within** those **clusters**. Once again, some unobservable features of individual projects belonging to the same region might be correlated while they are not correlated with projects implemented in different regions.

Likewise, as no standardized measure of goodness of fit is available for the Ordered Probit modelling, the percentage of correct predictions is used to test the model's accuracy. The preferred model specification within the analysis of replicability determinants provides **60% probability of the exact match** of predictions with the observed values (in comparison to 25% probability of a pure random match). Therefore, this model is even more accurate than the one used within the analysis of sustainability. Besides this, the model specification provides **96.5% probability of an approximate match** of predictions with the observed values (i.e. prediction deviation of no more than one unit of the level of replicability on a scale from 1 to 4).

The results of the econometric modelling are depicted in *Table 7*: Econometric results on Replicability with further explanation in the following paragraphs.

Table 7: Econometric results on Replicability

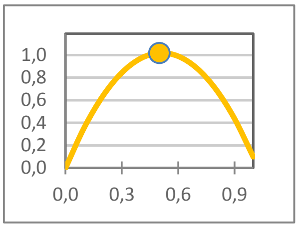
Dependent variable: **REPLICABILITY**	Model Specification: *Ordered Probit*
EC Contribution (% of Total Costs)	1.547 (2.659)
EC Contribution^2 (% of Total Costs^2)	-2.755 (2.925)
Personnel Budget (% of Total Costs)	3.973*** (1.401)
Personnel Budget^2 (% of Total Costs^2)	-3.874*** (1.010)
Prototype Budget (% of Total Costs)	-2.641** (1.026)
Prototype Budget^2 (% of Total Costs^2)	4.258** (2.067)
Infrastructure Budget (% of Total Costs)	2.267** (0.973)
Northern	-0.345*** (0.087)
Eastern	-0.433** (0.188)
Southern	-0.179 (0.109)
EU12	-0.563*** (0.098)
Power	-0.313*** (0.096)
Health	0.650*** (0.198)
Waste	-0.158*** (0.057)
Innovation	0.757*** (0.120)
Innovation^2	-0.0496*** (0.007)
No. of Partners	-0.0133 (0.018)
No. of Beneficiary's Projects	-0.0356 (0.026)
Cutpoint 1	0.989 (0.990)
Cutpoint 2	2.080* (1.111)
Cutpoint 3	3.798*** (1.256)
Observations	680

Note: Standard errors are reported in parentheses. ***, **, and * denote significance at the 99%, 95%, and 90% levels. "Observations" indicate the number of projects for which suitable data was available. The regression includes squares of variables which are suspected to have a non-monotone effect on *Replicability* (the turning-point appears when $\beta_j x_i$ equals $\beta_{j+1} x_i^2$).

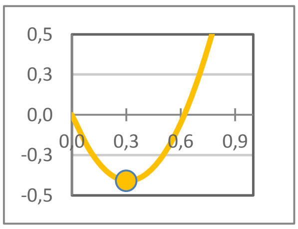
The results of our second econometric model are depicted in detail on the left-hand side in Table 8. Coefficients estimated by the model only show the sign and statistical significance of the impact of the project characteristics on the probability that a project reaches a certain level of replicability. The magnitude of the coefficients is not directly interpretable. Positive sign of a coefficient corresponds to positive impact of the characteristic on the level of replicability and vice versa. More asterisks means higher statistical significance. Cutpoints 1 to 3 are estimated to separate the various levels of replicability. For more information on the methodology see *Section 1.2.3. Econometric analysis and modelling. The number / letter of paragraph from Section 4.3. Qualitative analysis, which is relevant for an individual interpretation is indicated on the right side of the page next to the lines of interpretation.*

Although the model controls for the amount of the EC contribution (as % of the total costs), it is strongly statistically insignificant in the preferred model specification. Nevertheless, individual parts of the budget (personnel, prototype, and infrastructure budgets) turn out to have an influence on replicability.

Personnel costs (as % of the total costs) manifest a hump-shaped effect (the peak is at approximately 51%) with a strong statistical significance. **Projects in which personnel costs represent ca. 50% of the overall budget are**, on average, **more replicable**. Reversely, projects reliant on the personnel budget either too much or too little are more likely to be less replicable. On the other hand, similarly to the analysis of sustainability determinants, prototype costs (as % of the total costs) exhibits a U-shaped effect (the bottom is at approximately 31%) suggesting that projects which either do not focus on prototypes at all or focus on them heavily are more replicable. **Projects**



U-shaped effect of Personnel Budget



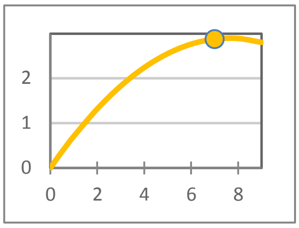
U-shaped effect of Prototype Budget

which focus on prototypes are by far the most replicable, while projects that perceive any prototype only as a by-product of their primary activities or prototype construction is not their primary point of focus are the least replicable.[16] Infrastructure costs (as % of the total costs) influence replicability of projects with a strong statistical significance. As explained in the table note, the regression includes squares of variables, which were suspected to have a non-monotone effect on Replicability – the variables of personnel and prototype budgets were two of them. Thus, the figures depicting the U-shaped / hump-shaped effects portrays functional value of $\beta_j x_i + \beta_{j+1} x_i^2$, where βs are the coefficients of the given variable x_i.

Projects with a relatively higher infrastructure budget are more likely to be more replicable. Projects with none or low infrastructure costs[17] might assume a specific infrastructure / background already present which could make them less replicable. Projects aimed at methodologies and guidelines which do not need any infrastructure budget are often reliant on preceding data collection etc. which makes them less replicable as it would be time consuming and costly to first collect the data.

In the case of replicability, regional variables do not play such a crucial role as in case of sustainability, and above all, they do not prove such a conclusive statistical significance. Although coefficients for Northern and Eastern region are estimated to be statistically significant in the preferred model specification, it is necessary to keep in mind that the model is not stable enough with respect to the regional variables.[18]

Projects relevant for the health sector are significantly more replicable since their goal usually matches global and currently relevant issues so that it is easier to get sufficient financing for such projects. In contrast, **projects aimed at power and waste prove a lower level of replication** as they might be constrained by institutional and legal boundaries specific for individual countries and the market structure (including disruptions such as monopoly, lobby etc.).



Hump-shaped effect of Innovation

Similarly to the analysis of sustainability determinants, the level of innovation is strongly statistically significant and exhibits a hump-shaped effect (the peak is at ca. 7.6 value on the scale from 0 to 9). Likewise, **more innovative projects are more likely to be replicable with the exception of extremely innovative projects**, which might be facing difficulties linked to institutional or legal constraints.

Although the model (and its alternative specifications) controls also for variables absorbing various kind of information on both coordinating and associated beneficiaries, the duration of projects or proxy variables standing for the level of dissemination activities, none of these prove to be statistically significant.

A figure summarizing the distinctive characteristics of projects influencing positively or negatively replicability is presented in *Figure 22*: List of the projects typologically influencing Replicability in either positive or negative way.

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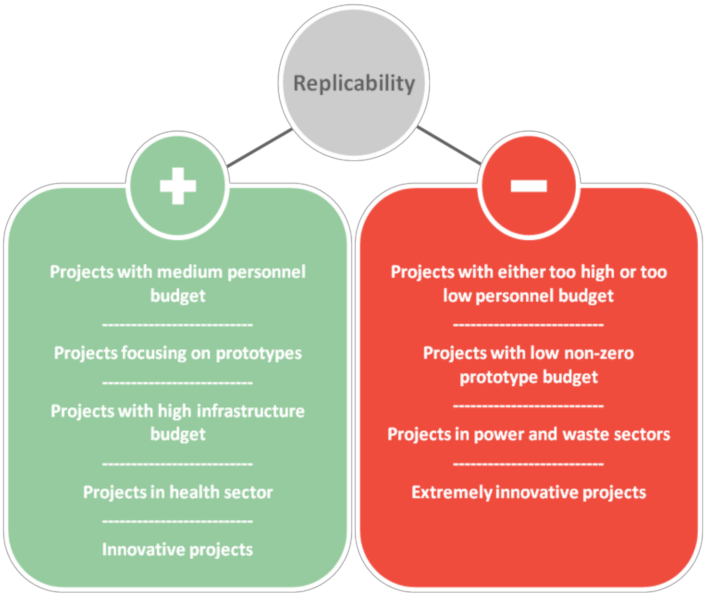
[16] Similarly to the analysis of sustainability determinants, the interpretation should be regarded with caution as the substance of high prototype costs is driven by only tens of projects of the dataset.

[17] Variable "Infrastructure Budget as % of Total Costs" is effectively interchangeable with variable "Infrastructure Budget Up To 5% of Total Costs" in the model. If interchanged, neither coefficient nor statistical significance (nor structure of the rest of the model) does substantially change.

[18] For more detail on this, see robustness checks stored in *Section 3.4* Robustness checks.

Figure 22: List of the projects typologically influencing Replicability in either positive or negative way



3.3 Qualitative analysis

The questionnaire regarding the sustainability and replicability of LIFE projects provided the evaluation team with a significant amount of qualitative information relating to projects from the selected sample. Based on this information, and together with the results of the case studies (see *Chapter 5*), the following analysis describing the key factors / determinants affecting the sustainability and replicability was developed. The following conclusions are based exclusively on information obtained from the TMOs and beneficiaries.

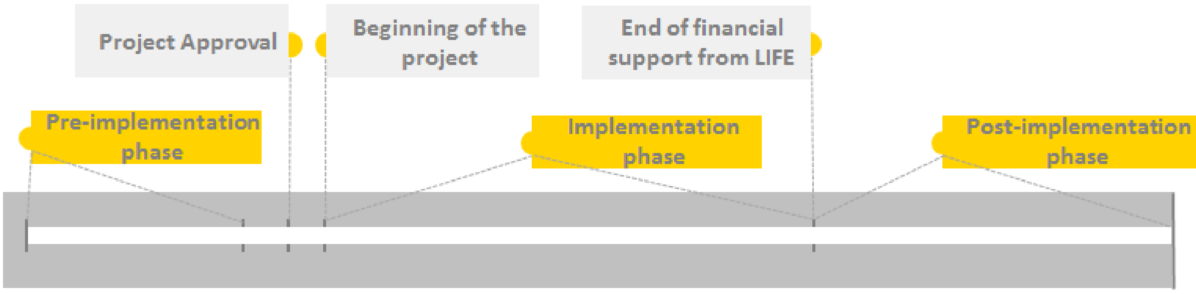
The quantitative findings of the econometric analysis had to be validated and extended by the qualitative knowledge, as the econometric model alone is not fully self-explanatory. There is a need of economic reasoning for every coefficient estimated; otherwise, the estimation is meaningless. The aim of the qualitative analysis is to gather information on factors, which from the point of view of TMOs and beneficiaries, affect the sustainability and replicability and to identify the best practice and lessons learned.

The factors influencing sustainability and replicability can be internal or external; their influence on sustainability and replicability can be positive or negative.

Internal factors

Internal factors are analysed in relation to the life cycle of the project. *Figure 23*: Lifecycle of a LIFE project depicts the lifecycle of a typical LIFE project in which both positive and negative internal factors may be present.

Figure 23: Lifecycle of a LIFE project



Pre-implementation phase

Based on the information from TMOs and beneficiaries, we have identified the following factors affecting the sustainability and replicability in the pre-implementation phase of the project:

1. **Scope/design of the project**: Design of the project plays a cardinal role in the future sustainability and replicability of LIFE projects. According to the TMOs and beneficiaries, projects focused on market solutions tend to have higher probability of sustainability and replicability after the end of LIFE financing. Projects focused on methodologies / evaluations etc. depend heavily on sources of public financing which is very unstable and not easily predictable, thereby affecting the sustainability and replicability of these projects via market solutions. Projects focused on data collection and following processing of the gathered data often face decreased replicability due to necessity of collecting the necessary data repeatedly for every new area / region which is often the most costly part of the project.
2. **Maturity of the sector**: TMOs perceive projects focusing on advanced sectors, relevant for a majority of EU countries (e.g. automotive, construction), as more probable in sustaining or replicating the obtained results / outputs, than projects focusing on niche sectors.
3. **Relevance of the solution for potential users**: Projects dealing with widely used technologies also tend to have better results in terms of the sustainability and replicability. This corresponds to the view on projects focusing on global or currently relevant issues (e.g. water scarcity, health etc.), which according to the TMOs tend to be more successful in terms of sustainability and replicability. Projects built on obsolete technical solutions or solutions that are not in line with the newest trends tend to be less sustainable and replicable.
4. **User/customer targeting**: Even if the project focuses on a relatively large sector it is necessary to target a relevant segment of customers. Projects focusing on areas in which the final user of the project's outputs does not represent significant market power, face the situation of having relevant results influencing important aspects of daily life (reduction of pollutants, noise, stress etc.), but due to fragmented nature of final users, the project is not sustainable because it is not possible to obtain serious clients among the potential users.
5. **Compliance with the legislation**: For certain projects sustainability and replicability is highly dependent on an expected change of legislation or on successful approvals and authorizations, necessary for further use of the project outputs, even from the very beginning of the project. Due to their innovative character, a significant number of projects do not meet the prerequisites for authorization, even if the final product meets all necessary standards, only because the existing legislation is not ready for an

innovative solution. Assessing the probability of changing existing authorization standards seems to be a vital starting point of innovative projects, primarily in the Southern region.

6. **Stakeholder analysis**: Detailed stakeholder analysis even before the start of the projects can prevent later failure of the project. Identification of possible suppliers of inputs/complements necessary for the implementation and further development of the project solution was not performed for every relevant project. In a number of cases, the beneficiary identified too late that for the commercialization of the project outputs a reliable network of suppliers must be in place in order to bring the solution to the market. In such cases, even promising projects lost their ability to survive after the end of LIFE financing. For projects focusing on public issues (health, environment, traffic, energy etc.), it is vital to incorporate the key public authorities into the project from the beginning (i.e. development of the proposal) to ensure the long-term support of relevant national or regional public bodies.
7. **Structure of the project team**: The implementation structure of the project team, especially the allocation of tasks between beneficiary and its partners, was identified by both the TMOs and the beneficiaries as another very important factor. From the TMOs perspective, appropriately defined competencies and responsibilities of the coordinating beneficiaries (CB) and associated beneficiaries (AB) and ex ante agreement on the ownership and further utilization of projects outputs have positive impact on future sustainability or replicability of the project.
8. **Market position**: The TMOs highlighted the market position of the CB or AB as a significant factor in the replicability and sustainability of the project after the end of LIFE financing. The TMOs expresses their opinion that market leaders tend to have better results with the commercialization of the project outputs than small entities with low share in the respective market. Strong partners often play a significant role in transferring the "laboratory results" into real production conditions.
9. **Financial analysis**: Financial analysis carried out at the beginning of the project can provide the beneficiary and its partners with an overview on possible sustainability of the project after the end of LIFE financing. According to the TMOs, in many cases the financial analysis does not provide the user with enough reliable data and if conducted properly, it would definitely discourage the beneficiary from applying for financing within the LIFE Programme. A properly executed financial analysis of the project is considered highly relevant and crucial, especially in cases in which the potential market of the expected outputs is distorted (monopoly, strong lobby, dumping prices etc.).

Implementation phase

Based on the information from TMOs and beneficiaries, we have identified the following factors affecting the sustainability and replicability in the implementation phase of the project:

10. **Capacity and competencies of the beneficiary**: During the implementation phase, stability of the beneficiary and its partners and their ability (capacities and competencies) to deliver the project in line with the formal requirements of the LIFE Programme and stated goals is the first key factor of success. Internal financial difficulties may cause premature end in a significant number of projects. In many cases, the key partner (private subject) of the project responsible for co-financing of the project ceased to exist leading to premature ending of the project. Several beneficiaries (both AB and CB) proved not to be able to implement a LIFE project due to their weak management skills, internal financial problems or lack of capacity or due

to inability to satisfy formal requirements of the LIFE Programme. Even projects with promising “technical” results faced serious difficulties because of poor administration of the grant. Because a number of the project teams include a relatively high number of partners, coordination of these partners proved to be an indicator of managerial abilities of the project management team. A high number of partners also increases the risk of conflicts related to the ownership of the project results after the end of the project.

11. **Motivation of the beneficiary**: Capacity and skills of the project team comes in hand with motivation of the beneficiary to develop a solution that is both sustainable and replicable. In some cases, especially when co-financing from external public sources is ensured, the motivation to bring a really sustainable and replicable solution cannot be satisfactory.
12. **Dissemination of results**: Continuous dissemination of achieved or planned outputs of the project proved to support the future sustainability and viability of the projects. Postponing the dissemination activities to the end, or after the end of the LIFE project raises the risk of a limited range of these activities due to the end of financial support and thus limited capacities of the beneficiary. Especially it seems useful to utilize a final user of the project outputs (usually a member of the project team AB or CB) to spread information among potential adopters of the project results, as the user shares similar characteristics as the potential adopters. As a typical example, a municipality acting as an associated beneficiary adopts a new approach to treat communal waste water, and then shares its experience with similar municipalities through established communication channels. According to the TMOs and beneficiaries, dissemination of the achieved project results in this way is very successful in comparison with standard dissemination activities (conferences, websites etc.).
13. **Stakeholder management**: Involvement of a relevant stakeholder in the project is crucial for its further sustainability and replicability. Especially in projects in which a public body is the final user of the project outputs it is very important to grip their attention and initiate mutual cooperation. Lack of cooperation / motivation for a further use of the project outputs by a public body was one of the most frequent causes for limited sustainability of LIFE projects during and after the end of financial support.
14. **Confidentiality**: During the project, especially when the project is implemented by a private company, confidentiality of specific data related to the company is one of the most important factors limiting the replicability. It is the reason why the company does not provide all of the necessary data for the potential adopter to assess the attractiveness of the project.
15. **Testing**: Replicability of the project outputs depends heavily on the availability of relevant tests, preferably in real conditions. A number of the analysed projects focused on prototypes / technical solutions terminated even before relevant tests had been completed, or the majority of tests were performed only in “laboratory conditions.”

Post-implementation phase

Based on the information from TMOs and beneficiaries, we identified the following factors affecting the sustainability and replicability in the post- implementation phase of the project:

16. **Available financial resources**: Availability of both internal and external financial sources is the crucial factor in ensuring the sustainability of the project outputs. Beneficiaries from a public sector, NGOs, academic sector etc. depend to a large

extent on external financial sources mostly from the EU / national / regional subsidy programmes. In this case, it is crucial to identify multiple possible sources of further financial support and not be over-reliant on only one source / programme. The TMOs reported that in many cases beneficiaries relied on the approval of follow-up projects from the LIFE Programme but in fact their projects were not recommended for further support. In these cases, the beneficiary usually terminated all activities related to the project and sustainability of the project rapidly dropped to zero. The key reason for termination of after LIFE activities is that the beneficiary is not able to sustain the team necessary for continuation of the project activities due to lack of available financial resources required for relatively high wages of the project team members.

17. **Commercialization skills**: In many cases (especially in the academic sphere), the beneficiary and its partners do not intend to commercialize the final outputs from the beginning even if there is a strong potential to do so because there is not such a strong pressure on value for money as in the case of private companies. Especially in eastern countries (but according to several beneficiaries and TMOs this applies for all EU countries), commercialization of applied research is still not optimal in the academic sector. Therefore, several promising projects are not sustainable or replicated into the market.

External factors

External factors may affect the sustainability and replicability of a project across all its phases (preparation, implementation and post-project). Based on the information from TMOs and beneficiaries, we have identified the following external factors affecting the sustainability and replicability of the projects:

A. **Economic cycles**: The economic crisis that affected almost all sectors was the key global external factor, very frequently mentioned by the TMOs and beneficiaries. From the TMOs perspective, the sustainability and replicability of projects was negatively influenced especially in the sectors heavily affected by the crisis (e.g. construction). Private investors usually decreased their willingness to finance new projects whilst banks rethought their stance on providing loans. According to the respondents, the negative impact of the crisis was very strong especially in the countries affected most by the crisis (Southern region). On the other hand, several global factors played in favour of selected projects. The project focused on currently relevant issues (water scarcity, extreme weather – floods, drought etc.) became more sustainable / replicable. A number of projects have very good results regarding the efficiency and effectiveness of a current production process but replicability of the project results is limited due to stagnating character of the selected economic sector. This proved to be the key barrier to replicability in the textile industry.

B. **Political and legal environment**: The most frequent factors affecting the sustainability and replicability of projects, both positively and negatively, are political and legal issues. Many projects depend heavily on political will to adopt or further replicate the project results (e.g. projects in water management, soil protection, waste management, pollution sectors). As already stated before, involvement of relevant public bodies into the preparation and implementation of the project is crucial. In a number of cases, even if the right people from the relevant authorities were engaged in the project from the very beginning, the project lost the support of the public body due to a change of political establishment and subsequent change of the political/strategic priorities of the relevant public body. In this case, it is necessary to link the project to the EU strategies which tend to be more stable from the long-term perspective rather than to the local/national strategies which are often subject to a change. Changes in legislation were frequently cited by TMOs as a very important factor. A number of projects reacted to planned changes of legislation (e.g. stricter limits for water discharging, higher obligatory recycling quotas, reduction of emissions etc.). Due to the complex character of the legislative process these changes are very often not adopted in practice within the foreseen date. In this case project relying on the legislative change have lover probability of sustainability and replicability (one of the most frequent comment of TMOs was that the project can become sustainable/replicable after the announced/planned legislation enters into force). Even if the relevant legislation is in place and the project aims at enabling compliance with this legislation, the lack of will/competencies to enforce the existing laws sometimes favours cheaper solutions, which are not in line with the valid legislation. Sudden changes in legislation can have devastating effect for implemented projects in cases in which the proposed / developed solution was no longer in line with the new legislation and the project lost its potential for sustainability.

C. **Public procurement**: Obligation of public entities to use the institute of public procurement to acquire new technologies/approach/methodology etc. limits the ability of a public entity to choose the preferred solution developed within the LIFE Programme. Especially in eastern EU countries, it is problematic to choose a preferable solution because the price is the key selection criterion used in public tenders (e.g. in the Czech Republic, it is obligatory to use the price criterion for selected tenders carried out by the Ministry of Environment with a minimal weight of 70%).

D. **Market**: In economy sectors in which market disruptions can be clearly identified (strong negative lobby, monopoly etc.), efficiency and effectiveness of a project solution do not necessarily ensure high probability of sustainability and replicability of a project. Changes in both local as well as global markets can significantly affect the sustainability and replicability of LIFE projects. TMOs and beneficiaries most often cited a change in costs of the inputs / complements of the developed solution (energy costs, raw material costs such as nickel etc.) as a significant factor. Due to the limited information value of predictions of the inputs' costs, negative impacts of this factor can be only partially eliminated. Another very frequent factor is the change of price of the substitutes. A number of projects have very good results regarding the efficiency and effectiveness of a current production process but replicability of the project results is limited due to stagnating character of the selected economic sector. This proved to be the key barrier to replicability in the textile industry.

E. **Final user/customer**: The final users play a significant role in the sustainability and replicability of selected LIFE projects. A shift in the customer perception of individual products is a crucial factor of competitiveness of the LIFE project outputs. The LIFE projects often come up with innovative products (or innovative processes of production) which are very often more costly than available substituents and the added value lies in reduction of negative environmental impacts of the production. In this case, it is crucial that a sufficient number of potential customers are willing to pay an increased cost for the environment friendly approach of the producer. As the length of the project usually exceeds 3.5 years, a significant risk of customer habits change limits the predictability of competitiveness of LIFE projects outputs.

3.4 Robustness checks

As the first step to preserve robustness of the model, the decision on relevance of the possible explanatory variables was made on the basis of both manual and automated stepwise regression and economic reasoning. As the second step, further robustness checks were employed to ensure that the model results are correct and reliable. The robustness checks should confirm the estimated coefficients' signs and the statistical significance.

Besides the variation of the explanatory variables' list (via stepwise regression), a basic *Ordinary Least Squares* regression (*OLS*) was estimated as a benchmark, and the *Ordered Logit Model* and the *Poisson Regression* were employed as well.

The *Ordered Logit* model works effectively in the same way as the *Ordered Probit.* The only difference lies in the assumption of different type of distribution. The *Ordered Logit* assumes the standard logistic distribution instead of the standard normal distribution, which is assumed by the *Ordered Probit* model. Furthermore, we employed the *Poisson Regression* which involves a non-negative Poisson distribution and the cardinal data. For detailed information on the methodology see *Section 1.5 Econometric analysis and* modelling.

Although the robustness checks consist of various non-preferred model specifications (based on the methodological reasoning), potential substantially different results obtained would suggest an inconsistency and require further investigation. Nevertheless, this is not the case as all additional estimations confirm the output of the preferred model specification as presented in *Tables 9*, *10* and *11*. There is no substantial inconsistency between the coefficients and their statistical significance estimated by the different models.

Table 8: Robustness checks on econometric modelling (Sustainability)

Dependent variable: **SUSTAINABILITY**	Model Specification: *Ordered Probit*	*Ordered Logit*	*Poisson Regression*	*OLS*
EC Contribution (mil. EUR)	-0. 123 (0.086)	-0. 261 (0.163)	-0.033* (0.018)	-0.055* (0.033)
Prototype Budget (mil. EUR)	-0. 359*** (0.120)	-0. 603* (0.311)	-0.0959*** (0.034)	-0. 263** (0.080)
Prototype Budget^2 (mil. EUR^2)	0.099*** (0.025)	0.159*** (0.010)	0.025*** (0.006)	0.066** (0.016)
Northern	-0.193*** (0.025)	-0.477*** (0.053)	-0.0530*** (0.007)	-0.157*** (0.014)
Scandinavian	0.180*** (0.067)	0.397*** (0.142)	0.0547*** (0.017)	0.169** (0.040)
Baltic	0.466*** (0.033)	1.057*** (0.071)	0.112*** (0.011)	0.338*** (0.013)
Eastern	0.148** (0.061)	0.264* (0.150)	0.0375** (0.015)	0.118* (0.037)
Southern	0.447*** (0.041)	0.830*** (0.117)	0.107*** (0.005)	0.332*** (0.026)
Spain	-0.800*** (0.048)	-1.470*** (0.113)	-0.198*** (0.008)	-0.567*** (0.021)
Italy	-0.522*** (0.031)	-0.988*** (0.076)	-0.124*** (0.004)	-0.367*** (0.010)
Greece	-0.355*** (0.034)	-0.697*** (0.076)	-0.082*** (0.007)	-0.238*** (0.208)
Portugal	-0.450*** (0.028)	-0.907*** (0.064)	-0.105*** (0.006)	-0.281*** (0.016)
Manufacture	0.253** (0.108)	0.417* (0.221)	0.064** (0.028)	0.172 (0.075)
Construction	0.257* (0.147)	0.412** (0.208)	0.072** (0.051)	0.198 (0.098)
Energy	0.349 (0.227)	0.651 (0.407)	0.088* (0.051)	0.228 (0.143)
Water	0.436*** (0.094)	0.721*** (0.175)	0.108*** (0.015)	0.319* (0.046)
Innovation	0.717*** (0.166)	1.248*** (0.266)	0.224*** (0.043)	0.441** (0.053)
Innovation^2	-0.0486*** (0.011)	-0.084*** (0.017)	-0.015*** (0.003)	-0.029** (0.004)
# of Partners	-0.0272*** (0.005)	-0.044*** (0.008)	-0.007*** (0.002)	-0.017 (0.008)
Duration (months)	0.0573 (0.036)	0.010* (0.054)	0.016 (0.011)	0.041 (0.024)
Duration^2 (months^2)	-0.000566* (0.0003)	-0.001** (0.0004)	-0.0002* (0.0001)	-0.0005 (0.0002)
Early Termination	-0.658*** (0.218)	-1.122*** (0.362)	-0.204** (0.085)	-0.492* (0.178)
Missions Required	0.249*** (0.055)	0.462*** (0.127)	0.068*** (0.016)	0.179** (0.050)
Layman Electronic	0.171** (0.083)	0.316 (0.215)	0.045* (0.024)	0.111 (0.076)
Constant	---	---	-0.119 (0.143)	0.264 (0.472)
Cutpoint 1	2.249*** (0.508)	3.904*** (0.758)	---	---
Cutpoint 2	3.299*** (0.457)	5.788*** (0.658)	---	---
Cutpoint 3	4.763*** (0.448)	8.245*** (0.649)	---	---
Observations	590	590	590	590

Note: Standard errors are reported in parentheses. ***, **, and * denote significance at the 99%, 95%, and 90% levels. “Observations” indicate the number of projects for which suitable data was available. The regression includes squares of variables which are suspected to have a non-monotone effect on *Replicability* (the turning-point appears when $\beta_i x_i$ equals $\beta_{i+1} x_i^2$).

Table 9: Robustness checks on econometric modelling (Replicability)

Dependent variable: **REPLICABILITY**	Model Specification: *Ordered Probit*	*Ordered Logit*	*Poisson Regression*	*OLS*
EC Contribution (% of Total Cost)	1.547 (2.659)	5.022 (4.885)	0.533 (0.749)	1.300 (1.635)
EC Contribution^2 (% of Total Cost^2)	-2.755 (2.925)	-6.648 (4.940)	-0.786 (0.814)	-1.960 (1.759)
Personal Budget (% of Total Cost)	3.973*** (1.401)	7.179*** (2.300)	0.861*** (0.303)	2.333* (0.823)
Personal Budget^2 (% of Total Cost^2)	-3.874*** (1.010)	-6.992*** (1.723)	-0.838*** (0.215)	-2.272** (0.584)
Prototype Budget (% of Total Cost)	-2.641** (1.026)	-4.933*** (1.609)	-0.589*** (0.197)	-1.675* (0.543)
Prototype Budget^2 (% of Total Cost^2)	4.258** (2.067)	7.774** (3.010)	0.954*** (0.394)	2.682* (1.072)
Infrastructure Budget (% of Total Cost)	2.267** (0.973)	4.668 (2.867)	0.650** (0.313)	1.531 (0.846)
Northern	-0.345*** (0.087)	-0.675*** (0.153)	-0.072*** (0.020)	-0.198** (0.056)
Eastern	-0.433** (0.188)	-0.814** (0.317)	-0.079* (0.044)	-0.238 (0.124)
Southern	-0.179 (0.109)	-0.377** (0.185)	-0.038 (0.023)	-0.096 (0.060)
EU12	-0.563*** (0.098)	-1.078*** (0.166)	-0.115*** (0.022)	-0.330** (0.070)
Power	-0.313*** (0.096)	-0.572*** (0.117)	-0.072** (0.030)	-0.196* (0.080)
Health	0.650*** (0.198)	1.120*** (0.301)	0.124*** (0.045)	0.368* (0.142)
Waste	-0.158*** (0.057)	-0.247** (0.105)	-0.036*** (0.013)	-0.093* (0.037)
Innovation	0.757*** (0.120)	1.317*** (0.209)	0.226*** (0.027)	0.453*** (0.031)
Innovation^2	-0.0496*** (0.007)	-0.085*** (0.013)	-0.015*** (0.002)	-0.029*** (0.002)
# of Partners	-0.0133 (0.018)	-0.030 (0.031)	-0.002 (0.004)	-0.008 (0.016)
# of Beneficiary’s Projects	-0.0356 (0.026)	-0.065 (0.039)	-0.007 (0.007)	-0.020 (0.018)
Constant	---	---	0.190 (0.278)	1.077 (0.529)
Cutpoint 1	0.989 (0.990)	2.216 (1.655)	---	---
Cutpoint 2	2.080* (1.111)	4.281** (1.892)	---	---
Cutpoint 3	3.798*** (1.256)	7.186*** (2.152)	---	---
Observations	680	680	680	680

Note: Standard errors are reported in parentheses. ***, **, and * denote significance at the 99%, 95%, and 90% levels. “Observations” indicate the number of projects for which suitable data was available. The regression includes squares of variables which are suspected to have a non-monotone effect on *Replicability* (the turning-point appears when $\beta_i x_i$ equals $\beta_{i+1} x_i^2$).

Table 10: Alternative model specification

Dependent variable: **REPLICABILITY**	Model Specification: *EU12 version*	*Eurozone version*
EC Contribution (% of Total Cost)	1.547 (2.659)	3.117 (2.392)
EC Contribution^2 (% of Total Cost^2)	-2.755 (2.925)	-4.671* (2.469)
Personal Budget (% of Total Cost)	3.973*** (1.401)	3.502*** (1.073)
Personal Budget^2 (% of Total Cost^2)	-3.874*** (1.010)	-3.413*** (0.714)
Prototype Budget (% of Total Cost)	-2.641** (1.026)	-2.306* (1.272)
Prototype Budget^2 (% of Total Cost^2)	4.258** (2.067)	3.702 (2.258)
Infrastructure Budget (% of Total Cost)	2.267** (0.973)	2.467** (1.168)
Northern	-0.345*** (0.087)	0.129 (0.120)
Eastern	-0.433** (0.188)	0.336 (0.217)
Southern	-0.179 (0.109)	-0.182* (0.105)
EU12	-0.563*** (0.098)	---
Eurozone	---	0.260** (0.112)
Power	-0.313*** (0.096)	-0.283** (0.110)
Health	0.650*** (0.198)	0.658*** (0.221)
Waste	-0.158*** (0.057)	-0.183** (0.075)
Innovation	0.757*** (0.120)	0.756*** (0.121)
Innovation^2	-0.0496*** (0.007)	-0.0499*** (0.007)
# of Partners	-0.0133 (0.018)	-0.0136 (0.018)
# of Beneficiary's Projects	-0.0356 (0.026)	-0.0382 (0.026)
Cutpoint 1	0.989 (0.990)	1.986** (0.812)
Cutpoint 2	2.080* (1.111)	3.074*** (0.917)
Cutpoint 3	3.798*** (1.256)	4.780*** (1.070)
Observations	680	680

Note: Standard errors are reported in parentheses. ***, **, and * denote significance at the 99%, 95%, and 90% levels. "Observations" indicate the number of projects for which suitable data was available. The regression includes squares of variables which are suspected to have a non-monotone effect on *Replicability* (the turning-point appears when $\beta_i x_i$ equals $\beta_{i+1} x_i^2$).

Chapter 4: Cluster analysis

Cluster analysis consisting of individual case studies was conducted based on the information gathered through **the semi-structured interviews with individual beneficiaries**. It serves as a source of qualitative information validating the results obtained from the econometric analysis.

In order to select appropriate projects, the cluster analysis was employed to create groups of projects with similar characteristics. Subsequently, **20 projects representing the main groups of projects within the LIFE Programme were randomly sampled** out of the clusters (one project for each cluster). For more information on the methodology see *Section 1.2.4. Cluster analysis*. The goal of the case studies was to gather information on factors which (from the beneficiary´s point of view) impact the sustainability and replicability and to identify the best practice and lessons learned.

As explained in the Methodology chapter, clusters were distinguished by different project categories (UN classification of economic activities and environmental activities) and potentially further classified by the EC contribution scope (4 intervals by EUR 500 000).[19]

Other categories were also taken into account, which could possibly enter the clustering process such as regions, duration, indication whether the beneficiary is inexperienced etc. Nevertheless, any other classification splits the clusters into insufficiently small groups. Moreover, some of them (such as the regional clusters which are composed primarily by *South* cluster) are not meaningfully distributed. As the project categorization (in term of economic and environmental activities) and the EC contribution scope are of our primary interest, we employed the clustering based on these two characteristics.

Only the *Wastewater management* and *Waste management* sectors were further divided based on the EC contribution classification as these two sector clusters contained a sufficiently significant number of projects. We sampled out of two additional EC contribution clusters within the *Wastewater management* cluster and out of four additional EC contribution clusters within the *Waste management* cluster.

Unavailability of some of the projects for the case studies brought **the final number of conducted case studies to 12**. Some of the projects were already terminated without any relevant and available contact information. The initial list of sampled case studies and the final list of conducted case studies is portrayed in *Table 11*: List of sampled and conducted case studies.

The cluster analysis served the evaluation team primarily to confirm the results of the econometric study. Furthermore, the outputs of the cluster analysis provided a qualitative complement to the quantitative part of the study (the why behind what). Together with the interviews, the results of the cluster analysis/case studies were a key source of information for the qualitative study in Section 4.3.

[19] From EUR 0 to 500 000, from EUR 500 000 to 1 000 000, from EUR 1 000 000 to 1 500 000, and from EUR 1 500 000 and more.

Table 11: List of sampled and conducted case studies

Clusters	**Conducted**
Agriculture, forestry and fishing *(economic activity)* Management of natural forest resources *(environmental activity)*	NO
Agriculture, forestry and fishing *(economic activity)* Protection and remediation of soil, groundwater and surface water *(environmental activity)*	NO
Agriculture, forestry and fishing *(economic activity)* Protection of air and climate *(environmental activity)*	YES (4.8)
Construction *(economic activity)* Protection of air and climate *(environmental activity)*	NO
Construction *(economic activity)* Waste management *(environmental activity)*	YES (4.9)
Electricity, gas, steam and air conditioning supply *(economic activity)* Management of fossil energy *(environmental activity)*	NO
Electricity, gas, steam and air conditioning supply *(economic activity)* Protection of air and climate *(environmental activity)*	YES (4.2)
Human health and social work *(economic activity)* Research and development for environmental protection *(environmental activity)*	YES (4.3)
Manufacturing *(economic activity)* Protection of air and climate *(environmental activity)*	YES (4.12)
Manufacturing *(economic activity)* Research and development for environmental protection *(environmental activity)*	NO
Manufacturing *(economic activity)* Waste management *(environmental activity)*	NO
Public administration and defence *(economic activity)* Protection of air and climate *(environmental activity)*	NO
Transport and storage *(economic activity)* Protection of air and climate *(environmental activity)*	YES (4.6)
Water supply, sewerage, waste management *(economic activity)* Management of water resources *(environmental activity)*	YES (4.5)
Water supply, sewerage, waste management *(economic activity)* Waste management *(environmental activity)* From EUR 0 to 500 000 *(EC contribution scope)*	YES (4.7)
Water supply, sewerage, waste management *(economic activity)* Waste management *(environmental activity)* From EUR 500 000 to 1 000 000 *(EC contribution scope)*	YES (4.11)
Water supply, sewerage, waste management *(economic activity)* Waste management *(environmental activity)* From EUR 1 000 000 to 1 500 000 *(EC contribution scope)*	YES (4.1)
Water supply, sewerage, waste management *(economic activity)* Waste management *(environmental activity)* From EUR 1 500 000 and more *(EC contribution scope)*	NO
Water supply, sewerage, waste management *(economic activity)* Wastewater management *(environmental activity)* From EUR 0 to 500 000 *(EC contribution scope)*	YES (4.4)

Water supply, sewerage, waste management *(economic activity)* Wastewater management *(environmental activity)* From EUR 500 000 to 1 000 000 *(EC contribution scope)*	YES (4.10)

1. Asbestos denaturing with innovative ovensystems (ADIOS) / LIFE09 ENV / NL / 000424

<table>
<tr><th colspan="6">Asbestos denaturing with innovative ovensystems (ADIOS) / LIFE09 ENV/NL/000424</th></tr>
<tr><td>Beneficiary</td><td colspan="2">Twee "R" Recyclinggroep B.V.</td><td>Associated beneficiary</td><td colspan="2">None</td></tr>
<tr><td>Cluster</td><td colspan="5">Water supply, sewerage, waste management (economic activity)
Waste management (environmental activity)
From EUR 1 000 000 to 1 500 000 (EC contribution scope)</td></tr>
<tr><td>Total costs</td><td>10 474 800 EUR</td><td>EC contribution</td><td>1 461 982 EUR</td><td>Country</td><td>NL</td></tr>
<tr><td>Duration</td><td colspan="5">31. 8. 2010 – 28. 2. 2013</td></tr>
<tr><td>Main goal</td><td colspan="5">The ADIOS project aims to demonstrate that asbestos denaturing by means of thermal treatment is feasible on a large scale and that this denatured asbestos has safe industrial uses. The project will construct a pilot plant with a tunnel oven to demonstrate a prototype thermal treatment process for denaturing asbestos.</td></tr>
<tr><td>Major outputs</td><td colspan="5">• Demonstration of a feasible, large-scale, thermal denaturing process for asbestos
• 20 000 tonnes of AFC-waste denatured
• Demonstration of the suitability of the new denatured material for use in modern industries
• Agreed legislation on asbestos disposal.</td></tr>
</table>

The project has a good chance of commercialization. The beneficiary is already in contact with private companies from different European countries that are interested in these plants for asbestos denaturation. However, the project finished too early to achieve all of the foreseen goals. The beneficiary waited for too long for a government license required for the project activities. The project ended soon after receiving the license and the European Commission did not permit extension of the project. The beneficiary further explained that if the extension had been approved, the project would have been more successful.

Being a private entity, the beneficiary is able to invest own resources in continuation of the project in order to achieve the foreseen goals. Moreover, after a difficult search and negotiations, a new investor was finally identified to help finance the project. Thus, the sustainability of the project is ensured at the moment and the beneficiary continues with the project, which should run for the next few years. The beneficiary also submitted a new LIFE Programme application to continue with the innovated project but the proposal was also not accepted. The European Commission did not find the newly proposed project innovative enough to receive further support from the LIFE Programme.

Replicability of the project is in general very high due to the fact that asbestos was used extensively across Europe. At the moment, there are discussions among professionals as well as the general public about the safe elimination of the asbestos used in buildings and other constructions. The high replicability of the project is confirmed by the fact that the private investor from the Netherlands has already been supporting the project and other international companies have already been in touch with the beneficiary.

The long waiting time is a rare practice and should not further influence the chances of replicating the project in other European countries. The beneficiary explained that further steps to disseminate the project results will be taken after the planned goals are fully achieved.

2. Environmental TRY for Innovative Dynamic Environmental and energetic Analyses (ET IDEA) / LIFE09 ENV/IT/000124

Environmental TRY for Innovative Dynamic Environmental and energetic Analyses (ET IDEA) / LIFE09 ENV/IT/000124					
Beneficiary	NIER Ingegneria S.p.a.		**Associated beneficiary**	• Dipartimento di Ingegneria Energetica, Nucleare e del Controllo Ambientale – University of Bologna, Italy	
Cluster	Electricity, gas, steam and air conditioning supply *(economic activity)* Protection of air and climate *(environmental activity)*				
Total costs	1 240 763 EUR	**EC contribution**	619 056 EUR	**Country**	IT
Duration	1. 9. 2010 – 31. 12. 2012				
Main goal	The ET IDEA project aimed to develop and test the typical reference years (TRYs) concept as an innovative tool for the reconstruction, standardization and analysis of meteorological data for the whole Italy.				
Major outputs	• Development of new methods for identifying and completing missing meteorological data • Calculation of solar radiation from other variables • Development of a method for expanding the meteorological data across wider geographical areas • Software package containing TRYs for 1 500-2 000 locations across Italy relevant for environmental and energy applications.				

The project was not meant to be commercialized from the beginning of the project's preparation stage. The project rather aimed at research and standardization of meteorological data collection in Italy.

The sustainability of the project is not well ensured. The project set up a website with a database of the collected meteorological data. However, no new data have been uploaded since the end of the project; thus, the effect and possible usefulness of the data have been decreasing. There are no other activities performed by the beneficiaries relating to the ET IDEA project.

The project further focused on research into different approaches to meteorological data collection in different countries. As the methods in different countries vary significantly, there is a potential for replicability of the project in other countries in order to develop a common approach for such data collection. As a result, one central European database for the meteorological statistics could be established. However, this would require a political will to support such a crucial step.

The beneficiary discussed the methods and results of the project with the Italian political authorities in order to include the standards into the national regulations and further develop the national database. However, there was no political will to further discuss the methods. As the data and database do not aim to be commercialized, the governmental support is crucial; due to the lack of support, the replicability is low at the moment.

Currently, the beneficiary intends to apply for support from the LIFE Programme for a new project to develop other methodologies for typical reference years (TRYs) – from a different perspective (environmental). The project does not have any further dissemination activities at the moment and is not in communication with potential new partners or investors. Even though the sustainability and replicability were analyzed during the project preparation (both were supposed to be ensured), it did not ensure successful results in both regards.

3. The impact of geological environment on health status of residents of the Slovak Republic (GEOHEALTH)/ LIFE10 ENV/SK/000086

The impact of geological environment on health status of residents of the Slovak Republic (GEOHEALTH)/ LIFE10 ENV/SK/000086					
Beneficiary	State Geological Institute of Dionýz Štúr		**Associated beneficiary**	None	
Cluster	Human health and social work *(economic activity)* Research and development for environmental protection *(environmental activity)*				
Total costs	417 678 EUR	**EC contribution**	207 273 EUR	**Country**	SK
Duration	1. 9. 2011 – 31. 8. 2016				
Main goal	The project's main objective is to reduce the negative impact of geological conditions on the health of the population of the Slovak Republic.				
Major outputs	• The production of datasets of environmental and health indicators requiring monitoring and assessment • The identification of areas of the country where people's health has suffered due to unfavorable (contaminated) geological conditions • An assessment of environmental indicators and their negative effects on hum				

	an health – to form the basis for relevant guidelines • A proposal for measures to reduce the negative impacts of geological conditi ons on health status of people living in the Slovak Republic • Implementation of the proposed measures in the areas identified, as well as awareness-raising activities. For example, in the project's final year, 10 public information meetings will be organised for people living in the 'risk areas'.

The GEOHEALTH project was not meant to be commercialized from the beginning, as the main goal was research – data collection, analysis and proposal of changes.

The sustainability of the project was already ensured by applying for further support from the LIFE Programme with a follow-up project (LIFE12 ENV/SK/000094). The first project focused on general research into the water quality in Slovakia. The follow-up project continues the research in a specific area; thus applying the project results on a specific (and problematic) case.

The beneficiary explained that the replicability of the project on the international level is not very probable. Each country has very specific circumstances regarding the water quality and control. Therefore, if the project were supposed to be replicated in a different country, significant adjustments would have to be done. On the contrary, the follow-up project can be replicated in other regions in Slovakia where a similar issue with soft water occurs.

Further sustainability of the project and replicability of the follow-up project in Slovakia are now dependent on the motivation of the Slovak government. The beneficiary explained that they have been in communication with the authorities. However, there has not yet been any political will to change the water standards to ensure the right composition of the water. Furthermore, private companies (i.e. waterworks companies) do not want to voluntarily take additional steps to change the composition of the distributed water. Such additional investment would be expensive for these private entities. Thus, new national norms are needed if the composition of water is to change in accordance with the project's results.

The project is still running and more activities to spread the information and project results among the public are planned. The beneficiary explained they intend to open discussions with more municipalities and public about the water quality. However, according to the discussions, the political authorities have not yet been persuaded about the project results because the project has not been running for a long period. Thus, research and pilot projects are needed in order to gain credible data based on a longer testing period.

4. Nanoremediation of water from small waste water treatment plants and reuse of water and solid remains for local needs (LIFE RusaLCA) / LIFE12 ENV/SI/000443

Nanoremediation of water from small waste water treatment plants and reuse of water and solid remains for local needs (LIFE RusaLCA) / LIFE12 ENV/SI/000443			
Beneficiary	Slovenian National Building and Civil Engineering Institute	**Associated beneficiary**	• Esplanada d.o.o., Slovenia • Jozef Stefan Insitute, Slovenia • Občina Šentrupert, Slovenia • Structum d.o.o., Slovenia

				• Vekton d.o.o, Slovenia • Zavod za zdravstveno varstvo Novo mesto, Slovenia	
Cluster	Water supply, sewerage, waste management *(economic activity)* Wastewater management *(environmental activity)* From EUR 0 to 500 000 *(EC contribution scope)*				
Total costs	852 388 EUR	**EC contribution**	426 192 EUR	**Country**	SI
Duration	1. 7. 2013 – 31. 12. 2016				
Main goal	The project will test an innovative nanoremediation process to treat urban wastewater and to recycle sludge as different types of composites. The treated water will be used for secondary purposes in households and for common public needs.				
Major outputs	• A reduction of drinking water consumption of up to 30% through the development of a return-loop of treated urban wastewater in the Slovenian municipality of Šentrupert • A 117-litre reduction of drinking water consumption in favor of using remediated water, through a return-loop connected to a small-scale wastewater treatment plant for households • One-third of the remediated water - or up to 24 liters per day per capita - will go towards various public uses, such as irrigation and watering of green areas and fire-fighting.				

The commercialization of the project is possible. The proposed prototype of the wastewater treatment plant can be used in different regions of the world and according to the beneficiary the designed plant is easier for use and less expensive than the commercial substitutes.

The designed prototype of the plant should be used by the associated beneficiary even after the end of the project; thus, the sustainability of the project should be ensured. The beneficiary expressed that further dissemination activities funded from internal sources have been planned, even after the end of the project, in order to promote the prototype.

The potential replicability of the project is high as the use of the prototype is not limited to a particular region but the subject of wastewater is relevant for the whole planet. Furthermore, the issue of limited water resources is relevant for many regions of the world. The beneficiary explained that companies from different parts of the world, e.g. Middle East, Australia or Spain, have already expressed interest in the prototype. Demonstrations of the plant have already taken place and the beneficiary plans to continue with the demonstrations on the international level (conferences, meetings) to further inform about the project's results and to increase the potential replicability.

The beneficiary appreciated the active approach of the local municipality involved in the project, especially for promoting the project across the region (among other municipalities and citizens) and active use of the prototype with a promise to use it further after the end of the project. On the contrary, the local residents did not express much interest in the project. However, such an attitude towards wastewater is common among people (the issue of drinking water attracts more people when it concerns them directly). The beneficiary deems that a political will is essential for the wastewater treatment plant implementation and that customs and attitudes of the citizens will change eventually.

5. Integrated coastal area Management Application implementing GMES, INspire and sEis data policies (LIFE + IMAGINE) / LIFE12 ENV/IT/001054

Integrated coastal area Management Application implementing GMES, INspire and sEis data policies (LIFE + IMAGINE) / LIFE12 ENV/IT/001054					
Beneficiary	Geographical Information Systems International Group		**Associated beneficiary**	• EPSILON ITALIA SRL, Italy • Fondazione Graphitech, Italy • ISPRA, Italy • Laboratorio di Monitoraggio e Modellistica ambientale per lo Sviluppo sostenibile (LAMMA), Italy • Regione Toscana, Italy	
Cluster	Water supply, sewerage, waste management *(economic activity)* Management of water resources *(environmental activity)*				
Total costs	1 521 258 EUR	**EC contribution**	754 628 EUR	**Country**	IT
Duration	2. 7. 2013 – 1. 7. 2016				
Main goal	The aim of the LIFE+ IMAGINE project is to provide coastal area managers with applications that address two scenarios of relevance to the Liguria/Tuscany coast: soil sealing impacts, and flooding and landslide prediction.				
Major outputs	• Implement, in a synergetic way, INSPIRE, SEIS and GMES in coastal areas, thereby helping to harmonize heterogeneous spatial information • Standardize operational workflows foreseen by the European environmental legislation, making them re-usable and easily extendible to other themes and regional/local authorities • Establish a cross-regional monitoring model to be applied in coastal areas, helping to achieve environmental quality targets and to meet several regional obligations • Provide decision makers, planners and stakeholders involved in coastal area risk management with an increased knowledge base on the implementation of environmental policy and legislation.				

The project aims to build a 3D client[20] that would be used by professionals and various local authorities. Such a client can potentially be commercialized – the client is now available for registered users, but registration is free of charge.

The client for the data analysis is now ready in a BETA version. The beneficiary plans to find an investor in order to upgrade the client into a professional tool. There are already discussions with the associated beneficiary regarding funding after the end of the project. Thus, sustainability of the project should be ensured and the 3D client should be further developed.

The issue of landslides and soil consumption has been discussed in most of the coastal regions in Italy and in other coastal countries; therefore, the replicability of the project is probable. The developed client can be used by various municipalities and regions in order to analyze the local data to adjust the coastal planning and emergency plans.

Dissemination of the project results should continue after the end of the project. The coordinating beneficiary is a member of the European Geospatial Association, which makes the dissemination among other international members, through meetings and conferences, easier. Furthermore, the National Institute for Environmental Protection and Research (ISPRA) is the associated beneficiary so the project results can be spread also on the national level.

The negative effects of landslides and soil consumption directly affect the citizens and there are discussions about possible solutions among the political representatives and also public in Italy. Thus, the project results and the proposed client that aim to help in dealing with the negative effects should be welcomed and no barriers to sustaining and replicating the project in Italy or other coastal countries should appear. However, no such plans have been set as yet.

6. Innovative Methods of Monitoring of Diesel Engine Exhaust Toxicity in Real Urban Traffic (MEDETEOX) / LIFE10 ENV/CZ/000651

<table>
<tr><th colspan="6">Innovative Methods of Monitoring of Diesel Engine Exhaust Toxicity in Real Urban Traffic (MEDETEOX) / LIFE10 ENV/CZ/000651</th></tr>
<tr><td>Beneficiary</td><td colspan="2">Institute of Experimental Medicine AS CR, v.v.i</td><td>Associated beneficiary</td><td colspan="2">• Technical University of Liberec,
• Ministry of Environment of the Czech Republic</td></tr>
<tr><td>Cluster</td><td colspan="5">Transport and storage (economic activity)
Protection of air and climate (environmental activity)</td></tr>
<tr><td>Total costs</td><td>1 223 524 EUR</td><td>EC contribution</td><td>611 762 EUR</td><td>Country</td><td>CZ</td></tr>
<tr><td>Duration</td><td colspan="5">1. 9. 2011 – 31. 8. 2016</td></tr>
<tr><td>Main goal</td><td colspan="5">The aim of the project is to apply existing methods of complex mixture toxicity assessments on exhaust emissions from real driving. Results of the project should be used for the improvement of legislation for regulating vehicle</td></tr>
</table>

[20] The client is a technological infrastructure with interoperable data and web services that is able to analyze the data and visualize the results.

	emissions in the EU.
Major outputs	• Miniature portable on-board systems for vehicle emissions monitoring • Miniature detectors of particle length for vehicle emissions monitoring • Portable Fourier Transform Infra Red spectrometer for measurement of unregulated pollutants • Standardized protocols for sampling and toxicity testing of diesel emissions under various real traffic conditions as tool for hazard identification and risk assessment based on toxic events of vehicle emissions • Particle size distribution and particle counts have been measured in vehicle exhaust and in ambient air near roadways • Acellular tests of DNA adducts and oxidative DNA damage have been demonstrated.

From the very beginning (i.e. preparation of the application), the project was not designed for commercialization.[21] The project aimed to focus on the change of legislation at EU level as it was very problematic to push any legislative changes at the national level.

According to the beneficiary, sustainability of the project outputs was very limited at the national level by the interest of relevant possible users of the outputs (i.e. Ministry of Environment, Ministry of Transport etc.) being restrained. Hence, sustainability of the project is ensured by the beneficiary who plans to use several national grant schemes (i.e. Technology Agency of the Czech Republic, Operational Program Research, Development and Education) and considers the option of submitting a new LIFE program application.

Replicability of the project is generally very high as the project outputs can easily be replicated in any EU member state or region and are relevant for any conditions. The beneficiary provides guidance to potential adopters of the project outputs that strengthens replicability of the project.

The overall interest on the project outputs dramatically increased after the “dieselgate” scandal. The increased interest of relevant stakeholders brought significant media attention to the project outputs (e.g. Czech National Television, BBC1, WRD).

After the dieselgate story broke, the beneficiary was contacted by mainly academic entities and the project outputs have been shared with several universities. Currently, the beneficiary is delivering emissions monitoring devices to the European Commission.

The beneficiary does not expect any further commercialization of the project outputs, beyond the existing cooperation with universities as the technical solution developed within the project has not brought any significant market response. Following the dieselgate scandal, a new legislation is being prepared by the European Commission. The new legal act shall change the way emissions are measured from current laboratory conditions to real driving conditions. In this case, the developed systems for monitoring may be adopted by commercial users but the technical solution can be devised by any other similar scientific organization.

The extension of the project outputs can be used for small motorised machinery (chainsaws, brush cutters etc.) and for local fireboxes which also produce a significant amount of emissions. The beneficiary is already looking for any relevant external sources of financing.

[21] Commercialization of LIFE projects has been prohibited for 5 years from the end of the project.

7. Microwaves ecofriendly alternative for a safe treatment of medical waste (MEDWASTE)/ LIFE10 ENV/RO/000731

<table>
<tr><th colspan="6">Microwaves ecofriendly alternative for a safe treatment of medical waste (MEDWASTE)/ LIFE10 ENV/RO/000731</th></tr>
<tr><td>Beneficiary</td><td colspan="2">National Research and Development Institute For Nonferrous And Rare Metals</td><td>Associated beneficiary</td><td colspan="2">• National Institute of Research-Development for Microbiology and Immunology, Romania
• AMK Drives, Bulgaria</td></tr>
<tr><td>Cluster</td><td colspan="5">Water supply, sewerage, waste management (economic activity)
Waste management (environmental activity)
From EUR 0 to 500 000 (EC contribution scope)</td></tr>
<tr><td>Total costs</td><td>623 553 EUR</td><td>EC contribution</td><td>300 580 EUR</td><td>Country</td><td>RO, BG</td></tr>
<tr><td>Duration</td><td colspan="5">1. 9. 2011 – 31. 10. 2013</td></tr>
<tr><td>Main goal</td><td colspan="5">The project aims to demonstrate the feasibility of microwave technology for the treatment of medical waste.</td></tr>
<tr><td>Major outputs</td><td colspan="5">• Demonstration of an innovative technology that could be considered a Best Available Technique (BAT) for updating of the BAT Reference Documents (BREF) in the medical waste treatment sector
• Design and production of the prototype for treating medical waste so that it is non-infectious and safe to dispose of without special handling
• Technical documentation, based on the demonstration of the innovative technology and equipment developed during the project implementation, as basis for policies designed to ensure sustainable management and treatment of medical waste.</td></tr>
</table>

The commercialization of the project is possible due to the fact that the developed equipment is less expensive than the standard models for medical waste treatment. However, no discussions or negotiations are currently ongoing. Furthermore, the European market is very competitive in this regard and the beneficiary has not yet focused on any further commercialization.

At the moment, further research is essential in order to continue with the project in Romania. The project is currently not sustainable, as the beneficiary does not have sufficient financial resources and time that would allow the organization to continue with the research.

During the project implementation, the national legislation in Romania became stricter on the regulations of the medical waste treatment (even stricter than in most EU countries). This unexpected and fast change of the norm (compared to the usual practice) significantly influenced the possibility of the project results being implemented into common practice in Romania’s hospitals and clinics. Thus, further research is vital to adjust the proposed method of medical waste treatment to the current regulations. The suggested technique is sufficiently strict for majority of the European countries (the beneficiary does not expect the norms to change in other countries as happened in Romania).

The beneficiary explained that in terms of replicability, there is a great potential for disseminating the project into other countries. During presentations on international events, private companies showed interest in the proposed solution of waste treatment. However, the interest in the proposed solution did not evolve into any further action.

Further steps in terms of research need to be taken in order to continue with the project. As the market competition is high in Europe, the beneficiary prefers to develop an appropriate method for the local market. Thus, the beneficiary has been looking for a partner to invest in the activities.

8. Mobile demonstration line for generation of Renewable ENERGY from micronized biomass (MORENERGY)/ LIFE11 ENV/PL/00044

Mobile demonstration line for generation of Renewable ENERGY from micronized biomass (MORENERGY)/ LIFE11 ENV/PL/00044					
Beneficiary	Instytut Mechanizacji Budownictwa i Górnictwa Skalnego		**Associated beneficiary**	None	
Cluster	Agriculture, forestry and fishing *(economic activity)* Protection of air and climate *(environmental activity)*				
Total costs	3 214 270 EUR	**EC contribution**	1 482 135 EUR	**Country**	PL
Duration	1. 7. 2012 – 30. 9. 2015				
Main goal	The project aims to demonstrate an innovative technology using ‘micronisation’ methods for generating pollutant-free energy from waste biomass. A full-scale prototype demonstration installation will be designed and built to test and document the performance of ‘micronisation’ techniques in biomass energy production. The main anticipated project results relate to validation of the new technology on a commercial-scale and raising awareness about the benefits of such technology among targeted stakeholders.				
Major outputs	• Create and launch the Prototype of Demonstration Installation; • Produce an Environmental Impact Statement, taking into account the technology’s environmental impact; • Produce an energy balance report, taking into account the energy needs of the technological process; • Produce an economic assessment, taking into account the economic viability of technology; and • Carry out 10 demonstration events which explain the technology’s operations and prospects for reducing the EU dependency on fossil fuels.				

The commercialization of the project was planned from the beginning and the beneficiary is currently in discussions with potentially interested companies and investors.

The prototype built during the project is completed and can be further replicated and used. However, at the moment there is a complication due to a small damage caused during the prototype demonstration and the prototype cannot be used (but it should be operating shortly).

The beneficiary explained that further demonstrations to potential users (private companies and local municipalities) are planned in order to disseminate the project results. The method of prototype demonstration has proved to be useful. The beneficiary will be able to fund these activities from internal resources.

The replicability of the project can be ensured through various international companies and investors. The prototype is potentially very useful for a broad spectrum of entities in Europe (e.g. juice producers) or also in South-East Asia (e.g. palm oil producers) but also for the Polish government and local municipalities as the issue of biomass and the production of energy has been broadly discussed. Due to several demonstrations performed by the beneficiary, information about the prototype was spread and the communication with potential investors began. Furthermore, the price is comparable to other traditional solutions; thus, the potential commercialization is possible.

9. ROADTIRE - Integration of end-of-life tires in the life cycle of road construction / LIFE09 ENV/GR/000304

ROADTIRE - Integration of end-of-life tires in the life cycle of road construction / LIFE09 ENV/GR/000304					
Beneficiary	Aristotle University of Thessaloniki		**Associated beneficiary**	• Decentralised administration of Thessaly-Sterea Ellada, Greece • Sant' Anna School of Advanced Studies, Italy • University of Thessaly (UTH), Greece	
Cluster	Construction *(economic activity)* Waste management *(environmental activity)*				
Total costs	1 467 997 EUR	**EC contribution**	733 851 EUR	**Country**	GR, IT
Duration	9. 9. 2010 – 8. 9. 2012				
Main goal	The objective of the project was to demonstrate an innovative use of recycled end-of-life tires in road construction. After the research, the results were used in a pilot project to lay a demonstration road surface.				
Major outputs	• Reduced environmental impacts from EOL-tire disposal and temporary storage • Improved environmental performance of public works and especially road construction and maintenance • Facilitation of concrete proposals for modification in existing regulations and standards for public works involving road manufacturing and maintenance.				

The project did not aim primarily for the commercialization of the results as the main goal was the research and development of the road mixture and its testing in a pilot project on two local roads. The project further aimed to encourage the government to adopt measures to include the use of old tires in road construction.

The project is sustainable as a topic of research of the coordinating beneficiary, i.e. the university. The beneficiary explained that the project was a milestone for the laboratory where the research continues. Since the project was implemented by the university, the results were spread among students and the wider public. However, the viability of the project in the sense of building new roads with the mixture is not yet real. The fact that construction of road from old tires is more expensive than regular road mixtures is crucial in the current political and economic situation in Greece.

Replicability of the project ROADTIRE is potentially high due to the final outcome, i.e. “the recipe” for a road mixture that is ready for use and already received a positive feedback from the road users. The report was provided to the Greek authorities. Unfortunately, they did not follow up with any real actions. Even though the government expressed an interest, the need for longer research and testing was requested. Furthermore, after the end of the project the beneficiary has not been able to further promote the project and persuade the authorities to further action nor communicate the result to the international public due to insufficient funds available at the university. On the other hand, many results, including certifications for the road mixture were presented to the expert public at conferences and in expert journals.

Several crucial barriers occurred during the project implementation, which could not have been avoided. The political crisis in Greece between 2010 and 2012 influenced the communication of the results to political authorities (frequent changes of the political representatives prevented deeper discussion and long-term cooperation was not possible). Furthermore, the economic crisis led to lower government spending and diminished any political will to change regulations in order to promote environmental benefits compared to the regular practice.

The beneficiary expressed their intention to apply for further research funds from the LIFE Programme or other financial sources within the EU in order to further test the mixture and put the authorities under pressure to consider legislative changes. Moreover, the beneficiary pointed out that the influence of the LIFE representatives / EU would have a positive impact on presenting the project results on the national level (government, ministries) and their willingness to accept the proposed changes.

10. Recovery of dredged SEDIments of the PORT of Ravenna and SILicon extraction (SEDI.PORT.SIL) / LIFE09 ENV/IT/000158

<table>
<tr><th colspan="6">Recovery of dredged SEDIments of the PORT of Ravenna and SILicon extraction
(SEDI.PORT.SIL) / LIFE09 ENV/IT/000158</th></tr>
<tr><td>Beneficiary</td><td colspan="2">MED INGEGNERIA S.r.l.</td><td>Associated beneficiary</td><td colspan="2">• University of Bologna, Italy
• Parco Delta Po Emilia-Romagna
• University of Ferrara, Italy
• ISPRA, Italy
• GEOECOMAR, Italy
• DIEMME Enologia SpA, Italy
• CRSA Med Ingegneria Srl, Italy</td></tr>
<tr><td>Cluster</td><td colspan="5">Water supply, sewerage, waste management (economic activity)
Wastewater management (environmental activity)
From EUR 500 000 to 1 000 000 (EC contribution scope)</td></tr>
<tr><td>Total costs</td><td>1 969 614 EUR</td><td>EC contribution</td><td>931 192 EUR</td><td>Country</td><td>IT, RO</td></tr>
<tr><td>Duration</td><td colspan="5">1. 9. 2010 – 28. 2. 2013</td></tr>
<tr><td>Main goal</td><td colspan="5">The aim of the project was to demonstrate an integrated approach to the sustainable management of sediment dredged from ports. The project sought to reduce the environmental impact of the dangerous dredged material and turn the waste into an important resource.</td></tr>
<tr><td>Major outputs</td><td colspan="5">• Demonstration of the efficiency of treatment processes applied to polluted sediment (soil washing) and associated water (pump&treat) on the sediment of the Port of Ravenna
• Demonstration of the efficiency and the productivity of extraction of metallurgic silicon from polluted port sediments through a plasma treatment. This process is highly innovative because it has never been applied to polluted marine sediments
• Identification and planning of the best possible reuses of decontaminated sediment and extracted silicon
• Demonstration of the efficiency of a plasma torch for decontamination of the finest fraction of dredged sediments
• Creation of a Business and a Master Plan to analyze the realization of a treatment plant at the Port of Ravenna
• Evaluation of the replicability of the process in a different geographical and administrative context in Europe.</td></tr>
</table>

In the beginning, the project was not meant to be commercialized but was aimed to test the existing methodologies of recovering sediments in different processes. Moreover, the project aimed to design a plan to construct a pilot plant for the sediment recovery.

The beneficiary deems that the project is partly sustainable. Some steps of the sediment recovery are already being implemented but the whole chain is not yet sustainable due to the high financial demands of this complex solution. However, as the Port of Ravenna was a co-financer of the project, the project results are applied directly in the port. According to the beneficiary, the port is now in the phase of building the plant to implement one of the steps of the soil washing. Furthermore, the beneficiary explained that the proposed solution is highly demanding in energy consumption and high energy prices in Italy limit the viability of the project as well as its replicability within Italy. However, the associated beneficiary from Romania is searching for an investor to build the plant, as the costs of energy are lower in Romania.

Replicability of the project and the project's solution for the sediments recovery is high. However, the project cannot be fully replicable, as the methodology always needs to be adjusted as each port has a different composition of sediments.

The beneficiary also pointed out that after the end of the project, the results were presented at different conferences and also at EXPO to support their dissemination. Different international stakeholders showed an interest in the presented solution and were in further contact with the beneficiary (Spain, France). The potential of using the proposed plans for the port's sediments recovery is high as the ports are frequently dealing with excessive amounts of sediments.

The sustainability and replicability of the project was further affected by the fact that the coordinating beneficiary went bankrupt approximately a year after the end of the project; therefore, the dissemination of the results could not have been fully coordinated and completed. The beneficiary also expressed that further research is needed due to high energy consumption and low sustainability (in regions with high energy prices). The beneficiary is at the stage of searching for a new grant or investor to find less energy consuming solution for the soil recovery.

11. Development and demonstration of a waste prevention support tool for local authorities (WASP Tool) / LIFE10 ENV/GR/000622

Development and demonstration of a waste prevention support tool for local authorities (WASP Tool) / LIFE10 ENV/GR/000622			
Beneficiary	HAROKOPIO PANEPISTIMIO (Harokopio University of Athens)	**Associated beneficiary**	• Trans-municipal Company of Solid Waste Management of Chania, Greece • EPEM S.A., Greece • Environmental Technology LTD, Cyprus • Municipality of Paralimni, Cyprus
Cluster	Water supply, sewerage, waste management *(economic activity)* Waste management *(environmental activity)* From EUR 500 000 to 1 000 000 *(EC contribution scope)*		

Total costs	1 804 081 EUR	EC contribution	893 261 EUR	Country	GR, CY
Duration	1. 10. 2010 – 30. 9. 2014				
Main goal	The WASP Tool project aims to prevent the production of waste through the development and proactive implementation of waste prevention strategies at the local authority level. The overall objective is to investigate, demonstrate and optimize the waste prevention potential of three Mediterranean municipalities, covering different geographic and waste policy contexts in Greece and Cyprus.				
Major outputs	• The identification and evaluation of the most efficient waste prevention actions that have been used throughout the EU • The design and development of an internet-based waste prevention decision support tool (WASP Tool) containing all available information on waste prevention actions and allowing local authorities to select and implement optimum customized waste prevention programs and prepare waste prevention plans • The pilot development and implementation of three waste prevention strategies by the participating local authorities, with four priority waste prevention actions carried out as part of each waste prevention strategy • The delivery of 300 home compost bins and training for the respective homeowners.				

The project was not meant to be commercialized from the beginning, as the goal was to develop a plan for waste management for municipalities and not commercialize the outputs. The developed web tool is available online and is free of charge.

The sustainability of the project is ensured by the fact that the coordinating beneficiary is a university that is able and also plans to further develop their research activities and spread the information about the project among the students. Currently, the main output of the project, i.e. the web-based tool for waste management is being translated into English. This activity is now supported by the university (as the project has already ended). Furthermore, the developed pilot plans for three municipalities are in place. The beneficiary claims that they are in communication with other municipalities in order to develop their waste plans. Also, the beneficiary is currently seeking new possibilities to further fund the project.

The beneficiary explained that due to the development of new legislation and a new National plan in Greece, the timing of the project related to waste prevention management is perfect. As the new norm requests the local municipalities to develop the waste plans, there is a great potential for replicability of the project. The fact that the web tool is also being translated into English means the project can be further replicated in other European countries.

The Greek financial crisis resulted in a limited willingness of the political authorities, limited funds and possibilities for development and support of new environmental politics and waste development in particular. On the contrary, determination of the public to control environmental politics and the increased interest in saving and prevention of waste (due to limited available financial resources) contributes to acceptance of such proposed changes.

The beneficiary expressed their interest to further discuss the project results and possible further steps with relevant ministries to develop new prevention plants on the national level. Furthermore, the beneficiary plans to be in contact with more municipalities and control more consistently the waste plans implementation. However, such steps need to be supported financially and the beneficiary is looking for new possibilities of funding at the EU and local (Greek) level.

12. Zero Emission Firing strategies for ceramic tiles by oxy-fuel burners and CO2 sequestration with recycling of byproducts (LIFE ZEF-tile)/ LIFE12 ENV/IT/000424

Zero Emission Firing strategies for ceramic tiles by oxy-fuel burners and CO2 sequestration with recycling of byproducts (LIFE ZEF-tile)/ LIFE12 ENV/IT/000424					
Beneficiary	Ceramica Alta S.r.l.		**Associated beneficiary**	• University of Padova-Department of Industrial Engineering, Italy	
Cluster	Manufacturing *(economic activity)* Protection of air and climate *(environmental activity)*				
Total costs	1 256 701 EUR	**EC contribution**	593 475 EUR	**Country**	IT
Duration	1. 7. 2013 – 31. 12. 2015				
Main goal	The objective of the LIFE ZEF-tile project is to demonstrate the feasibility of applying oxy-fuel technologies to the firing stage of ceramic tile production in order to facilitate CO2 sequestration. For this purpose, the project will set up a demonstrative roller kiln with burners modified in order to use pure oxygen.				
Major outputs	• An innovative zero emission firing process for ceramic tiles • Direct recycling of 100% of the gas processing byproducts of ceramic tile production as milling or glazing water, and as carbonates for ceramic body composition • An evaluation of the investment costs (expected to be 50% higher), and energy and running costs (expected to be 20% higher due to the need of oxygen supply and energy for CO2 compression), and a comparison with the environmental benefits in order to assess the costs of CO2 sequestration.				

The beneficiary explained that the prototype of the designed kiln[22] is now ready for commercialization and there are ongoing discussions with potential buyers. The purpose of the designed kiln is very specific – the kiln can potentially be used by any producers of ceramic anywhere in the world.

The beneficiary explained that the kiln prototype is being used in the production process and no particular research or continuation of the project in terms of development is needed. Additional research, adjustments and improvement of the kiln prototype can be done during the production process.

[22] Kiln is a furnace or oven for burning, baking or drying, especially one for calcining lime or firing pottery.

The beneficiary believes that the replicability of the project is very high. The main environmental issues regarding ceramic production are high CO_2 emissions and the low energy efficiency of the kilns and both of these aspects are addressed by the presented kiln. However, there are no particular environmental norms that would require decreasing the emissions during the ceramic production.

Private companies were contacted through various meetings, information materials and through the project website. The beneficiary expressed that further demonstrations of the prototype are planned to demonstrate the designed kiln and to attract new investors.

The beneficiary confirmed that the cooperation between the private company (the coordinating beneficiary) and the university (associated beneficiary) was very beneficial as the university brought in highly skilled people crucial for the project's implementation. In addition, the beneficiary expressed that cooperation with the relevant political authorities would be valuable in order to influence creation of a new environmental norm for lower emissions from ceramic production.

Chapter 5: Direct jobs creation by LIFE projects

In this chapter, we will examine **the impact of LIFE projects** (projects of the LIFE+ Programme and LIFE14/15 calls in particular) **on employment during their implementation and post-implementation phase**. The impact during the implementation phase is measured in person-years which represent a full-time individual's working time for a year, i.e. 2 person-years correspond to either two individuals working full-time for a year, or one individual working full-time for two years. The impact during the post-implementation phase is also measured in FTEs (full-time equivalents) per year, i.e. the workload of a full-time individual for a year. A sensitivity analysis consisting of various scenarios (low impact, reference and high impact) is presented in order to offer the reliable estimates.

The estimation of the impact is based on **a sample of 1 464 projects with start dates from 1 January 2009 to 1 January 2016**. The results of the study on jobs creation are primarily based on the data obtained from the DORY database and also from information collected from the TMOs via questionnaires. The approach was determined by the availability and reliability of the data in the database. Interpretation of the results should always be perceived in the context of the employed data.

Information about the start dates of the projects was available for 4 221 projects (out of the total of 4 262 projects accessible in the DORY database on 9 February 2016). Information about the amount of personnel budget was available for 2 341 projects of the previous subset (4 221 projects). Comprehensive information required for the study was available for 1 464 projects of the previous subset (2 341 projects). Projects beginning before 2008 were excluded as the full set of required information would not be accessible due to excessive time distance. Therefore, the final dataset of 1 464 projects consists of projects of LIFE+ Programme and LIFE14/15 calls.

The analysis examines only the direct impact of the projects – further indirect impacts are not estimated due to lack of required data. There is no multiplication effect taken into account, nor changes in Gross Value Added or in Gross Domestic Product on the supply side of the economy which should be all influenced by the increase in the labour income and amount of external assistance. Furthermore, the amount spent on infrastructure, prototypes and equipment which increases investments (on the demand side of the economy) was not the object of the study.

5.1 Impact on employment during the implementation phase

Methodology

Data which were processed included information about the personnel budget, amount of EC contribution, start date and duration of the projects in the sample. Furthermore, number of person-years corresponding on average to the personnel costs was calculated based on the data of hourly wages used within the financial evaluations of LIFE projects conducted by EY (which accounts for 206 projects from all EU countries with the exception of Croatia and Czech Republic).

All financial data were discounted by HICP (Harmonized Index of Consumer Prices) of each single country in order to obtain figures in real terms with 2015 as the reference year. This ensured consistency in calculating the number of person-years generated on average by the personnel costs over time. The amount of personnel costs was divided by median hourly wage (with respect to particular country, all in real terms) to obtain the number of person-years generated by the projects in the sample. Under more conservative assumption, the median hourly wage was replaced by average hourly wage in the last step (average hourly wage assumes lower number of men-years corresponding to a given amount of personnel costs as it is always higher than the median hourly wage with the only exceptions of Denmark and Estonia).

The amount of person-years produced by individual projects was then aggregated to obtain the magnitude of the total impact of the projects in the sample on employment during their implementation phase. The number divided by the sum of all projects in the sample and the aggregate of EC contribution in EUR million allocated to the projects in the sample further provided the estimates of the impact per project and per EUR 1 million, respectively.

Results

The impact of the projects in the sample on employment during their implementation phase equals to 30 381 person-years in total. This means that **a typical project produces nearly 21 person-years during its implementation phase**.

If we take a substantially more conservative estimate of the impact by considering the mean hourly wage instead of the median hourly wage, the impact of the projects in the sample on employment during their implementation phase does not change substantially and is equal to 26 104 person-years. That corresponds to nearly 18 person-years produced by a typical project and about 15 person-years generated by every million of EU funding.

The methodology of the estimation differs only in the hourly wage taken into account (either mean or median hourly wage). The procedure of obtaining the results is otherwise the same.

The findings obtained by both methods are together depicted in *Table 13*.

Table 13: **Impact on employment during the implementation phase (comparison of two methods)**

Total	30 381 person-years
*Total**	26 104 person-years
Per Project	21 person-years
*Per Project**	18 person-years

Note: The first estimate presented (deep blue) corresponds to the results of the less conservative methodology, the second one* (light blue) corresponds to the results of the more conservative methodology.

5.2 Impact on employment during the post-implementation phase

Methodology

The data used in he previous *Section* were further processed. Aggregate of the projects' duration was employed in order to estimate the person-years per a year of project during its implementation phase. The number was further multiplied by a coefficient based on the information about the level of sustainability of the LIFE projects. Results of the multiplication then give the estimates of the impact of the projects in the sample on employment during their post-implementation phase.

The coefficient reflecting the level of sustainability is constructed in the following manner: portion of the projects assessed as fully sustainable times 1 (representing full sustainability) plus portion of the projects assessed as likely sustainable times 0.66 (representing likely sustainability) plus portion of the projects assessed as hardly sustainable times 0.33 (representing hardly sustainability) plus zero, i.e. $c = 0.17*1 + 0.5*0.66 + 0.23*0.33 + 0.1*0 = 0.576$. The portions of the projects by their level of sustainability are depicted in detail in *Figure 40: Number of Projects per Sustainability category*. We assume the distribution of the level of sustainability to be the same for both samples under investigation. For more detailed information see *Chapter 2: Likelihood of sustainability and replicability of the selected projects.*

Different scenarios are further distinguished by reference, pessimistic and optimistic assumptions about the manifested level of sustainability. The reference scenario assumes the distribution of the level of sustainability to fully correspond to the TMOs answers. In contrast, the lower impact scenario assumes the distribution to be pessimistic by 20% while the higher impact scenario assumes the distribution to be optimistic by 20%. This means that the coefficient c = 0.576 is further multiplied by either 0.8 or 1.2 coefficients.

Results

In order to forecast the impact on employment during the post-implementation phase, it was necessary to normalize the measured impact during the implementation phase. For this sake, the amount of person-years generated per year of project was calculated. Consequently, the impact during the post-implementation phase is measured in FTEs per year.

The impact of the projects in the sample on employment during their implementation phase equals to approximately 5.2 person-years per a year of project.

Based on the data about sustainability of the LIFE projects gathered via questionnaires filled in by the TMOs (the data corresponds to the selected sample of 835 projects, for more detailed information see *Chapter 2: Likelihood of sustainability and replicability of the selected projects*), the impact on employment during the post-implementation phase is estimated.

Reference scenario

<u>The impact of the projects in the sample on employment during their post-implementation phase might amount to 4 375 FTEs per year</u> in the reference scenario. This means that, on average, one project might produce 3 FTEs per year during its post-implementation phase.[23] In consequence, every million of EU funding might generate about 2.5 FTEs per year even after the end of the EU funding.

Low impact scenario

The impact of the projects in the sample on employment during their post-implementation phase might amount to 3 500 FTEs per year in the high impact scenario. This means that, on average, one project might produce about 2.4 FTEs per year during its post-implementation phase. In consequence, every million of EU funding might generate nearly 2 FTEs per year even after the end of the EU funding.

High impact scenario

The impact of the projects in the sample on employment during their post-implementation phase might amount to 5 250 FTEs per year in the high impact scenario. This means that, on average, one project might produce about 3.6 FTEs per year during its post-implementation

[23] Effectively, there would be certain portion of terminated projects producing no FTEs at all while the sustained projects would generate higher that the average number of FTEs.

phase. In consequence, every million of EU funding might generate almost 3 FTEs per year even after the end of the EU funding.

Estimates of the total impact and impact per project for the reference, low impact and high impact scenarios are summarized in *Table 14.*

Table 14: **Low Impact, reference, and high impact scenario in post-implementation phase**

Low impact scenario	
Total	3 500 FTE's per year
Per project	2,4 FTE's per year
Reference scenario	
Total	4 375 FTE's per year
Per project	3 FTE's per year
High impact scenario	
Total	5 250 FTE's per year
Per project	3,6 FTE's per year

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PART II: Scenario-based impact on Jobs & Growth

List of Tables & Figures

In this part, we examine the economic impact of selected LIFE projects under different replication scenarios. The purpose here is to analyse the potential for jobs creation and contribution to economic growth of LIFE projects that are considered as the most likely to be replicable and sustainable in the context of competitive market economy. As forecasting in economy has inherent uncertainty, we chose to formulate alternative scenarios (baseline, low and high growth), as a more realistic approach. The assumptions behind these scenarios for each project are clearly stated, and the overall methodology is presented here below.

For this study, we selected a sample of 10 projects with significant prospects for commercial replication (Table 1). They cover a broad range of environmental management areas, from efficient irrigation (IRRIGESTLIFE) and planting techniques in desertified environments (Green Deserts) to the decontamination of end-of-life ships (RECYSHIP).

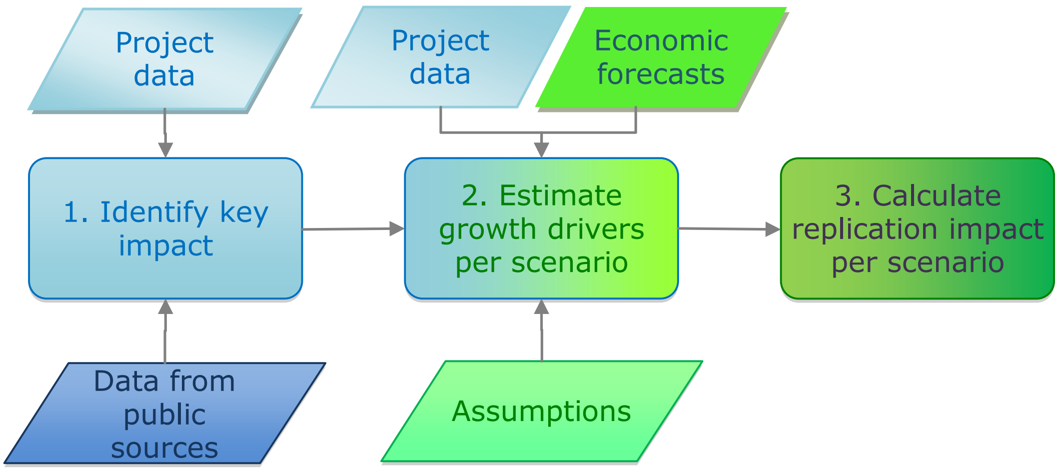
Table 1: Projects selected for the estimation of the replication impact

Project Acronym	Description	Country
GREEN DESERTS	New planting techniques for tree cultivation in desertified environments	Spain
SOL-BRINE	Energy autonomous system for the treatment of brine from seawater desalination plants	Greece
EDEA-RENOV	Development of Energy Efficiency in Architecture: Energy Renovation, Innovation and ICTs	Spain
GREENWOOLF	Green hydrolysis conversion of wool wastes into organic nitrogen fertiliser	Italy
GREEN SINKS	Manufacturing of composite sinks from recovered waste	Italy
IRRIGESTLIFE	Telemanagement network for an optimised irrigation	Spain
DYEMOND SOLAR	Low Cost Production of Energy Efficient Dye-Sensitized Solar Cells	Sweden
DOMOTIC	Models for Optimisation of Technologies for Intelligent Construction	Spain
RECYSHIP	Dismantling and decontamination of out-of-use ships	Spain
ELINA	Sound management of a waste stream	Greece

1. Methodology

The general approach followed in this section for each project consists of three steps. First, we establish the impact of a project's output at a full scale of implementation, using the project documentation and estimates based on other sources (*Figure* 1). The impact is examined in terms of output, cost reduction, investment and employment, as applicable according to the specifics of each project.

Figure 1: Flowchart of the estimation of the medium-term projected economic impact from replication



There are several ways a LIFE project can have an impact on economic growth. A project might result in the commencement of an economic activity that produces goods or services. For example, the replication of the Green Deserts project gives rise to the production of tree-planting boxes and the planting of saplings. In another example, the SOL-BRINE project generates two marketable products – distilled water and salt. The production of these marketable goods and services is recorded in national accounting terms as additional output in the economy.

Another possible impact on growth may come from reducing the use of resources for the production of the same amount of output. For example, the EDEA-RENOV and DOMOTIC projects provide tools and techniques for reducing the use of energy in dwellings and other buildings, without compromising the thermal comfort of the buildings' tenants or visitors. As energy is generated using marketed primary resources, lower use of energy implies lower costs for the energy consumers. For the enterprises consuming energy, paying less for energy results in cost gains. If they do not pass these gains to the consumers through lower prices, their products achieve higher **Gross Value Added (GVA)**. This in turn result in higher gross domestic product (GDP), given that GDP equals GVA plus taxes and subsidies on products. On the other hand, if the enterprises reduce the prices for their products as a result of the cost gains, due to competitive pressures, this would most probably increase the demand for other products and services in the economy, as the consumers spend at least some of the savings coming from lower prices. Similarly, for the buildings in the residential sector, lowering the energy costs generates savings to the households, which in turn leads to higher spending elsewhere, increasing the volume of output in the economy.

Lastly, the replication of some of the projects involves investment in machinery, equipment and other technology goods and services in order to produce new output or realise the above cost savings. In both cases, the expenditure on these capital goods is accounted for as gross fixed capital formation, which is a demand component of GDP and thus also leads to output growth. Apart from its contemporaneous impact on GDP through higher demand for capital goods and services, investment expenditure also has a significant long-term impact on the economy, as raising the capital stock improves the infrastructure in the economy and boosts the productivity of labour.

Higher output result in more jobs in the economy, as the production of more goods and services requires higher labour input. Most projects examined in this chapter have a quantifiable impact on employment, either in order to produce new output or to install technologies that lower the use of natural resources.

In the second step of the estimation process, we establish the drivers that determine how the impact of each project would evolve over the medium term (until 2020) under three different growth scenarios (reference, low and high growth). **The choice of growth drivers differs according to the specifics of each project.** In cases where the demand for the output generated by the project depends closely on the growth of the wider economy, as in the demand for the distilled water and salt produced by the SOL-BRINE project, the growth projections are based on macroeconomic forecasts published by the European Commission (DG ECFIN).

An assumption on the rate of diffusion of the project's output is another common driver for a number of projects. For these projects, we first determine the size of the potential market and then project over the medium term its diffusion rate – that is, the market share that the project output is anticipated to achieve under each scenario. For example, in the Green Deserts project, we first determine the size of the potential market, using data on areas in Spain that are under the threat of abandonment and desertification. We then assume that about 0.025% of this area will be reforested employing the output of the project by 2020 under the reference growth scenario. Multiplying the diffusion rate with the total area with potential use of the technology, we obtain a projection on the area reforested with Green Deserts technologies until 2020 under the reference growth scenario.

B. The reference, low growth, and high growth scenarios

Given the inherent uncertainty in making projections, we also estimate the replication impact of each project under two alternative scenarios. Under the low growth scenario, we make lower projections of the growth drivers in an attempt to capture the possibility that the project's replication, the wider economic environment or both would not progress as quickly as anticipated under the reference scenario. Correspondingly, we also estimate a scenario where the growth drivers progress faster than anticipated under **the reference scenario**.

Applying the replication drivers per scenario to the estimates of the impact of the project's output, we arrive at an estimate of the medium-term impact of a project following its commercial replication under **the three growth scenarios**. The details of this calculation differ in each case, depending on the key impact and growth drivers of each project, as evident in the detailed description of the estimation per project that follows. The general idea is to work out the replication impact over the medium term, combining the estimates of the impact of a project during its LIFE phase with the projected diffusion of the project until 2020. For example, the impact of the Green Deserts project in terms of additional output is estimated by multiplying the surface of the land that is anticipated to be reforested under the reference scenario with the revenue that the beneficiaries estimate to receive per hectare of reforested area.

In the remaining sections of this chapter, we present in detail the assumptions, the calculations and the resulting estimates of the anticipated medium-term economic impact of each project under the three growth scenarios. We conclude this chapter with a summary of the estimated impact for the sample of projects.

2. Case studies

Green Deserts - Tree cultivation in desert environments

The aim of the project Green Deserts was to demonstrate the feasibility and effectiveness of an innovative planting technology (water box), applied to restore the sponge function of degraded soils and to support plant life. The technology improves the level of plant survival, making planting economically feasible in areas of unfavourable physical characteristics, such as desertified and dry mountainous areas.

The key economic impact of the project comes from the additional economic activity of producing water boxes and planting saplings in forest restoration and other planting projects. This activity transpires both in additional output and in employment. The use of this technology for planting trees can also save water and energy resources, but the resource saving effects are not quantified here, not only because of lack of suitable data, but also based on the consideration that the technology is used primarily in terrains with unfavourable physical conditions where no tree planting would have been the most likely counterfactual scenario. Lastly, the use of this technology might also involve investment expenditure, over and above the spending on planting trees, stemming from the potential need to upgrade the production capacity of the manufacturing facility that produces the water boxes.

The key factor that would determine the size of the impact over time is the extent to which the technology will be used to reforest desert areas in Spain and potentially over a longer term in other suitable areas. In the Scenario of Reference Growth (SRG), we assume that the technology is used to reforest 0.025% of the land in Spain that is under the threat of abandonment and desertification (10 million hectares), deducting the national share of land used for permanent crops or as arable land (about 37% of the total land area of the country) as a proxy for the area where traditional reforestation methods might be more cost-effective. This implies that by 2020 more than 1,500 hectares are planted using the technology developed by the project (10 million hectares * 0.025% diffusion rate * 63% non-arable land). On an annual basis, the surface of the land used for planting with water boxes increases from 157 hectares in 2016 to 564 hectares in 2020. As a result, the turnover of the activity to manufacture water boxes and use them for planting saplings in 2020 reaches about €843,000 (564 hectares * 1660 USD per hectare planting expenditure, as reported by the project beneficiaries * 0.9 EUR/USD exchange rate). Overall between 2016 and 2020, the total output in this scenario equals €2.4 million.

Table 2: Projections on the impact of the project Green Deserts, 2016 - 2020

Impact 2016-2020	SLG	SRG	SHG
Additional employment (person-years)	165	351	658
Additional output (€ million)	0.9	2.4	4.7
Investment (€ million)	0.2	0.7	1.2

Next, in order to calculate the employment and investment impact, we calculate the number of trees and thus boxes that ought to be produced in order to plant the areas calculated above. First, we assume that the space between the trees planted in these areas, large enough to enable the development of their root system without cutting redundant saplings in a future point of time, equals 8 metres on average. This implies that the area that each tree occupies is 16 m^2 ((8 metre distance / 2 trees) ^2). As a result, the tree density of the planted areas stands at 625 trees per hectare (1/16 m^2 per tree * 10,000 m^2 in a hectare). Thus, about 353,000 trees are planted in 2020 in the SRG (564 planted hectares * 625 trees per hectare). This in turn corresponds to the number of boxes produced in that year.

Assuming that the maximum number of water boxes that the water-box production line can produce without further investment is 120,000 boxes per year, the need to produce 353,000 boxes under the SRG in 2020 implies that at least 3 production lines should be running by then to have enough production capacity, while one more line should be installed in 2020 to meet the demand for 2021. Therefore, 3 additional production lines should be installed by the end of 2020 under this scenario. Assuming that the cost to install a production line stands at €240,000, the investment cost under this scenario over the period from 2016 to 2020 totals €720,000.

For the estimation of the employment impact, we further assume that a person plants about 3 trees per hour or 5,280 trees per year. The project beneficiaries recommend that the planting is performed from October to May. This implies that the number of employees required to plant the trees would exceed the FTEs reported below, as the personnel employed for the planting of the trees will work for 8 months each year. Under the above assumptions, about 67 FTEs are needed for the tree planting under the SRG in 2020. In addition, assuming that a line with an annual capacity of 120,000 boxes per year employs full time 15 people, about 45 FTEs are employed for the production of water boxes in 2020 in the SRG (3 production lines in operation * 15 FTEs). As a result, the employment impact in 2020 totals 112 FTEs (45 FTEs for the production of the boxes and 67 FTEs for the planting of the saplings), while overall for the period between 2016 and 2020 employment totals 351 person-years.

Under the alternative scenarios, the diffusion rate is assumed to range between 0.01% and 0.05% of the land in Spain that is under the threat of abandonment and desertification, compared with 0.025% in the SRG. As a result, the area planted with trees using the technology of the project ranges between 630 hectares (10 million hectares * 0.01% diffusion rate * 63% non-arable land) in the Scenario of Low Growth (SLG) and 3,150 hectares (10 million hectares * 0.05% diffusion rate * 63% non-arable land) in the Scenario of High Growth (SHG). The hectares planted in 2020 alone are estimated to range from 226 in the SLG to 1,128 in the SHG. In value terms, this translates to output of €337,000 in the SLG (226 hectares * 1660 USD planting expenditure per hectare * 0.9 EUR/USD exchange rate) and €1.7 million in the SHG (1,128 hectares * 1660 USD planting expenditure per hectare * 0.9 EUR/USD exchange rate). Overall over the 5 years under examination, the value of output totals more than €940,000 in the SLG and €4.7 million in the SHG.

Regarding the number of boxes and thus planted trees in 2020, the estimate ranges from 141,000 in the SLG (226 planted hectares * 625 trees per hectare) to 705,000 in the SHG (1,128 planted hectares * 625 trees per hectare). This implies that two production lines are required in the SLG by 2020 to cover the required box production, while the corresponding estimate in the SHG stands at six production lines. As a result, the investment for installing box production lines ranges from €240,000 in the SLG (i.e. the investment cost of one additional line) to €1.2 million in the SHG (five additional lines, required to meet the demand for boxes in 2020 * €240,000 investment cost per production line).

Correspondingly, the estimate for the employment required for box production in the alternative growth scenarios in 2020 ranges from 30 FTEs in the SLG (15 FTEs per line * 2 lines in operation by 2020) to 90 FTEs in the SHG (15 FTEs per line * 6 lines in operation). The employment for tree planting, on the other hand ranges from 27 FTEs in the SLG (141,000 saplings per year / 5,280 saplings per FTE per year) to 134 FTEs in the SHG (705,000 saplings per year / 5,280 saplings per FTE per year). Taken together, the number of FTEs for the production of boxes and for tree planting in 2020 totals 57 FTEs in the SLG (27 FTEs for tree planting and 30 FTEs for box production) and 224 FTEs in the SHG (134 FTEs for tree planting and 90 FTEs for box production). Overall between 2016 and 2020, the project technology generates directly 165 person-years in the SLG and 658 person-years in the SHG.

SOL-BRINE – Treatment of brine from desalination plants

The SOL-BRINE project developed a system that uses solar energy to treat the brine generated from desalination plants. The system eliminates the environmentally harmful practice of disposing the brine at sea. In the process, the treatment system produces two marketable by-products – dry salt and water.

The key economic impact of the treatment system comes in the form of additional economic activity from the production of salt and water out of the brine stream. In addition, the installation of the treatment system generates the need for investment, augmenting the stock of capital in the economy. The installation of the system also requires labour for its design and construction, while the project generates some employment during its operation cycle as well. Finally, the environmental cost from the damage of brine disposal at sea seems to outweigh the financial cost of treating the brine, but since this particular environmental cost is not internalised in a market, the resulting cost reduction is not registered in financial or national accounting terms and hence it is not calculated here as well.

The output of the brine treatment system depends primarily on the production capacity of the system and on likely demand constraints. A full-scale implementation of the system for the needs of treating the brine from the existing two desalination units in the island of Tinos (with feed volume of 3600 m^3/day of seawater, generating 1500 m^3/day of fresh water and 2100 m^3/day of brine) can produce 1,850 m^3/day of distilled water and 126 tonnes/day of salt. However, it would not be reasonable to assume that the system works at full capacity at all times, given the strong seasonal and diurnal variations in water demand and the limited capacity and scope for storing fresh water. To take this into account, we assume in our calculations a baseline annual utilisation rate of the system at 55%, which can vary depending on the annual variations in water demand. This implies that at this utilisation rate the system produces about 371 million litres of distilled water per year (1850 m^3/day * 365 days * 55% utilisation). Correspondingly, the annual production of salt is estimated at 25,3 kt (126 tonnes/day * 365 days * 55% utilisation).

To arrive at an estimate of the value of output, we multiply the production volume of salt and water with the corresponding estimates for their price. Based on data presented in the project documentation, the price of salt is assumed to vary in the range of 0.10-0.30 €/kg. Correspondingly, the price of water ranges between 1.50 and 2.50 €/m^3. The value of the annual salt production thus ranges between €2.5 (25,3 million kg * 0.1 €/kg) and €7.6 million (25,3 million kg * 0.3 €/kg), while the value of water output varies between €556,500 and €927,500 per annum. The overall value of output of the brine treatment system, under the above assumptions, ranges between €3.0 and €8.5 million per year.

Regarding the impact on employment, jobs are needed both for the installation and the operation of the system. Based on employment data for the construction and operation of desalination plants in California, Australia and the Middle East, and taking into account the relatively small scale of the brine treatment system, we estimate that the installation of the system would require 8.6 full-time equivalents (FTEs), with 1.1 FTEs required for the operation of the system. The rather small employment impact comes from the fact that the operation of the system is quite automated, while it would not require significant overhead resources, given that it would operate in existing desalination facilities. The estimation of the contribution of the system in investment terms is considerably more straightforward, given that the investment cost of such an installation that uses both thermal and renewable energy is estimated in the project documentation at €260,000.

The above static impact estimates are projected over the medium-term horizon, using assumptions on the future course of key growth drivers under three scenarios. In the Scenario of Low Growth (SLG), we assume that the brine treatment system is implemented only in the municipality of Tinos, which participated in the project as a beneficiary. The design and construction of the system is assumed to take place in 2017 while the start of operation is set in 2018. Given that this is a pessimistic scenario, the annual GDP growth in Greece from 2017 to 2020 is assumed to stay at 1.0% on average. Based on historic data on water and total output in Greece, we assume that the income elasticity of water demand equals 0.4 (i.e. a change by 1% in total output in the economy leads to a change in water demand by 0.4%). This implies that water demand during that period would grow by 0.4% per year on average. As a result, the utilisation rate is projected to increase from 55% in the hypothetical case of full-scale operation in 2015 to 55.7% in 2020. In the pessimistic case, we assume that the prices of salt and water fall on the lower bound of the price range. In all scenarios, the calculations over the medium term are performed in constant price terms, assuming that the price and cost data follow the general inflation trend.

Table 3: Assumptions per scenario for the replication of the output developed in the project SOL-BRINE

Assumption	SLG	SRG	SHG
Number of installed brine treatment systems	1	2	3
Average GDP growth, 2017-2020, Greece	1.0%	2.7%	4.0%
Water consumption growth forecast, 2017-2020, Greece	0.4%	1.1%	1.6%
Price of salt in base year	0.10	0.20	0.30
Price of water in base year	1.50	2.00	2.50

Under the Scenario of Reference Growth (SRG), we assume that the brine treatment system is also implemented in the Attica region, which is recognised as having high replication potential in the project documentation. The construction of the Attica system, assumed to have the same characteristics with that of Tinos, is set to take place in 2018, with operation starting in 2019. The growth rate of the Greek economy in this scenario follows the central Eurostat projection for 2017 at 2.7%, throughout the period from 2017-2020, implying that the water consumption grows by 1.1% on average (2.7% * 0.4) during this period. As a result, the utilisation rate of both plants grows to 57.3% in 2020. In this scenario, the prices of salt and water fall in the middle of the corresponding ranges.

Lastly, in the Scenario of High Growth (SHG), we assume that identical brine treatment systems are implemented in Tinos, Attica and Central Macedonia. The system in Central Macedonia is constructed in 2019 and starts operation in 2020. Under this scenario, the Greek economy makes a stronger rebound from the crisis, achieving average growth rate of 4.0% between 2017 and 2020. This implies that water consumption over that period grows by 1.6% on average (0.4 demand elasticity * 4.0% GDP growth), resulting in a utilisation rate of 58.4% in 2020. The prices in the optimistic scenario hit the upper bound of the price range of both water and salt.

Table 4: Projections on the impact of project SOL-BRINE between 2016 and 2020

Impact 2016-2020	SLG	SRG	SHG
Additional output (€ million)	9.3	17.9	35.8
Additional employment (person-years)	12	23	32
Investment (€'000)	260	520	780

Multiplying the resulting utilisation rates, prices and production capacities and summing over the period from 2016 to 2020, we estimate that under the assumptions described above, the SOL-BRINE adds between €9.3 and €35.8 million of output to the economy (€17.9 million in the central case). In employment terms, the person-years required for the design, construction and operation of the brine treatment system range from 12 in the SLG to 32 in the SHG (23 person-years in the central scenario). Lastly, the SOL-BRINE system adds between €260,000 and €780,000 to the capital stock in the economy over the examined period.

EDEA-RENOV - Energy Renovation, Innovation and ICTs in Buildings

The project EDEA-RENOV (LIFE09 ENV/ES/000466) tested and proposed solutions for the reduction of the environmental impact of the housing construction sector. It focused on the areas of renovation, innovation in new constructions and the use of information and communication technology to limit energy consumption. As part of the project, energy rehabilitation studies were implemented in 14 dwellings in the Spanish region of Extremadura. In addition, the project developed an open-source monitoring system, comprising a kit of sensors, a mobile application and a web database, notifying the users when there are opportunities to improve the comfort and decrease the energy consumption in a dwelling.

The economic impact of the project transpires in terms of both saving of energy resources and additional economic activity for renovating existing dwellings. The additional economic activity takes the form of additional investment expenditure in repairing the housing stock, with a corresponding impact on jobs in related industries (e.g. construction).

The project took place in the autonomous Spanish region of Extremadura, with the Government of the region acting as the project coordinator. As evident from the dissemination plan, the project coordinator has a strong intention to apply the insights and tools developed by the project to the social and public housing in the region. Therefore, the extent to which the energy efficiency techniques developed by the project are applied in the Extremadura region is a key driver of replication, differing across the three growth scenarios. In the Scenario of Regular Growth (SRG), we assume that by 2020 about 0.25% of the households in Extremadura have their dwellings retro-fitted using the energy efficiency techniques of the project. Given that about 425,000 households reside in Extremadura, about 1,060 dwellings are renovated by 2020 in order to decrease the energy use in the region (0.25% diffusion rate * 425,000 households).

To estimate the energy savings of these households, we need to estimate the energy that they would consume if the energy efficiency techniques are not applied in their case. Using historic data on energy consumption from the Eurostat database, the annual consumption of electricity in Spain is estimated at 3,910 kWh per household. Correspondingly, the annual consumption of natural gas in the residential sector is estimated at 1,990 kWh per household. Therefore, the households with renovated dwellings would consume in total in 2020 under this scenario 4.2 GWh electricity (3910 kWh/household * 1060 households * 10^6 GWh/kWh) and 2.1 GWh natural gas (1990 kWh/household * 1060 households * 10^6 GWh/kWh) if we do not take into account the energy savings achieved by the programme.

Table 5: Assumptions per scenario, EDEA-RENOV

Assumption	SLG	SRG	SHG
Diffusion rate in Extremadura by 2020	0.10%	0.25%	0.50%
Energy price change per year on average (2016-2020)	-5.0%	0.0%	5.0%

In value terms, we should multiply these consumption estimates with projections of the price of electricity and natural gas. Under the SRG, we assume that the energy prices will change at the same direction and pace with overall inflation, therefore the price of electricity and natural gas in real terms will stay close to their current levels. As a result, the total electricity bill for the households with renovated dwellings, without taking into accounts the energy savings, would equal €1.2 million (4.2 GWh * 0.30 €/kWh) in 2020. Correspondingly, the total cost of natural gas consumption of these households, before netting the energy efficiency gains, equals €169,000 (2.1 GWh * 0.08 €/kWh). The total cost of energy consumption for these two energy sources thus equals €1.4 million (€1.2 million for electricity and €169,000 for natural gas).

According to the results of the project, the techniques and tools developed can lead to a reduction of the energy costs by 30% per household. Therefore, the total saving under the SRG equals €425,000 in 2020 (30% energy reduction * €1.4 million ex-ante energy cost). Over the course of the 5-year period under examination, the savings total €1.0 million under the SRG.

Table 6: Projections of the impact of project EDEA-RENOV between 2016 and 2020

Impact 2016-2020	SLG	SRG	SHG
Additional employment (person-years)	99	248	496
Cost reduction (€ million)	0.4	1.0	2.4
Investment (€ million)	5.8	14.6	29.2

The application of the techniques and tools of the project also lead to a reduction in the emission of greenhouse gasses (GHGs). This reduction has a significant economic benefit over the long-term, in the form of reduced climate change adaptation costs. However, given that the cost of the emission allowances for electricity generation is incorporated in the price of electricity, while the corresponding cost for the consumption of natural gas in the residential sector is not internalised in a market, no further gain is recorded in financial or national accounting terms between 2016 and 2020 from reducing the GHG emissions and thus the cost reduction estimates here do not include a quantification of the financial benefit from reducing GHG emissions.

Apart from reducing the use of energy resources, the renovation of dwellings creates additional activity, primarily in the construction sector. The project beneficiaries estimate that the investment cost of the energy efficiency works of the project ranges between 100 and 200 €/m^2. Assuming that the dwellings participating in the energy efficiency programme (social dwellings offered by the public authorities of the Extremadura region) would have an average size of 90 m^2 per dwelling, the total surface of the renovated dwellings by 2020 under the SRG stands at about 96,000 m^2. On an annual basis, the surface renovated each year increases from 9,600 m^2 in 2016 to 31,000 m^2 in 2020. As a result, the expenditure on energy efficiency interventions is estimated at €4.7 million in 2020 for this scenario (31,000 m^2 * 150 €/m^2 on average).

In addition to the construction works, the dwellings are fitted with a monitoring system, with a cost of 150 – 300 € per dwelling, depending on the size of the dwelling and other characteristics. Given that the number of dwelling innovated each year is assumed to increase from 106 in 2016 to 345 in 2020, the total cost of the monitoring system for 2020 under the SRG equals about €78,000 (345 households * 225 €/household on average). Therefore, the application of the tools and techniques of the project to a number of Extremadura households by 2020 generates €4.7 million investment. Over the 5-year period from 2016 to 2020, the investment generated by the project totals €14.6 million under the SRG.

Renovating houses in order to increase their energy efficiency is a labour-intensive activity. According to estimates quoted in a recent study by Cambridge Econometrics, about 17 full-time jobs are created per €1 million of investment in renovating residential dwellings, out of which 10 jobs are created in the construction industry, 6 jobs in manufacturing of materials used in the renovation and 1 job in services.[24] Using that estimate, we can expect about 81 jobs in 2020 under the SRG (17 FTEs/€ million of investment * €4.7 million investment) to be created by applying the techniques of the programme. Summing up the employment impact between 2016 and 2020, the project is expected to generate about 248 person-years between 2016 and 2020 in the SRG.

Under the alternative growth scenarios, the diffusion rate ranges from 0.1% to 0.5%. This implies that the number of households participating in an energy efficiency programme that utilises the insights of the project by 2020 varies from 425 in the Scenario of Low Growth (0.1% diffusion rate * 425,000 households) to 2,125 in the Scenario of High Growth (0.5% diffusion rate * 425,000 households). As a result, the electricity consumption of these households, without taking into account the energy savings, equals 1.7 GWh in the SLG (3,910 kWh/household * 425 households * 10^6 GWh/kWh) and 8.3 GWh in the SHG (3,910 kWh/household * 2,125 households * 10^6 GWh/kWh). The corresponding consumption of natural gas varies between 846 MWh in the SLG (1,990 kWh/household * 425 households * 10^3 MWh/kWh) and 4.2 GWh in the SHG (1,990 kWh/household * 2,125 households * 10^6 GWh/kWh).

We assume that the energy prices vary across the growth scenarios. In the low growth scenario, where the extent of energy efficiency interventions is limited, primarily due to subdued economic performance and therefore lack of public funding for such interventions, we assume that the economic conditions are adverse at global level, resulting in energy prices falling behind the pace of inflation by 5 percentage points each year. In contrast, the economic situation is assumed to be buoyant in the SHG, with the energy prices outrunning the course of inflation by 5 percentage points on average each year.

Under these price assumptions, the gross cost of electricity for the households participating in the energy efficiency programmes in Extremadura (without netting the energy savings) totals about €406,000 in the SLG (1.7 GWh * 0.24 €/kWh) and €3.0 million in the SHG (8.3 GWh * 0.36 €/kWh) in 2020. Correspondingly for natural gas, the cost varies between €55,000 in the

[24] Pikas et al. (2015) in Cambridge Econometrics (2015), Assessing the Employment and Social Impact of Energy Efficiency.

SLG (846 MWh * 0.07 €/kWh) and €411,000 in the SHG (4.2 GWh * 0.10 €/kWh). Therefore, the total gross cost of energy in 2020 equals €461,000 in the SLG (€406,000 cost of electricity and €55,000 cost of natural gas) and €3.4 million in the SHG (€3.0 million from electricity and €411,000 from natural gas). Applying the expected energy saving rate of 30% to the above gross cost of energy consumption results in expected savings of between €138,000 in the SLG and €1.0 million in the SHG. Overall between 2016 and 2020, the value of energy savings from the interventions of the project replication ranges from €367,000 in the SLG to €2,5 million in the SHG.

The associated investment cost for the construction works depends on the number and total surface of the renovated dwellings. On an annual basis, the number of dwellings participating in the programme increases in the SLG from 42 in 2016 to 138 in 2020, while in the SHG the number of households grows from 212 in 2016 to 691 in 2020. Correspondingly, the surface of the dwelling renovated in 2020 ranges from 12,000 m^2 in the SLG (138 households * 90 m^2 per household) to 62,000 m^2 in the SHG (691 households * 90 m^2 per household).

As a result, the investment in renovation works in 2020 equals €1.9 million in the SLG (12,000 m^2 * 150 €/m^2) and €9.3 million in the SHG (62,000 m^2 * 150 €/m^2). Correspondingly, the investment in the monitoring system ranges from €31,000 in the SLG (138 households * 225 €/household) to €155,000 in the SHG (691 households * 225 €/household). The total investment cost thus sums up to €1.9 million in the SLG and €9.5 million in the SHG. Overall between 2016 and 2020, the investment cost totals €5.8 million in the SLG and €29.2 million in the SHG.

Regarding the employment impact under the alternative scenarios, the replication of the techniques and tools of the project is expected to provide full-time employment to about 32 people in the SLG (17 FTEs/€ million of investment * €1.9 million investment) in 2020. Correspondingly, about 161 FTEs are expected in the SHG in 2020 (17 FTEs/€ million of investment * €9.5 million investment). Over the 5-year period, the employment impact sums up to 99 person-years in the SLG and 496 person-years in the SHG.

GREENWOOLF – Hydrolysis conversion of wool wastes into organic nitrogen fertiliser

Sheep shearing is a necessary activity for the well being of the livestock. About 75% of the coarse wool generated from the sheep shearing (200,000 tonnes per year in the EU) is a valueless by-product that cannot be used in the textile industry. Its untreated disposal has detrimental environmental effects, while existing treatment methods are often financially not attractive to the sheep owners.

The project GREENWOOLF (LIFE12 ENV/IT/000439) demonstrates the viability of converting the unusable coarse wool into organic nitrogen fertilizer, eliminating the need for the disposal of waste wool. Its key economic impact comes from the production of a new marketable product, which generates employment and the need for investment in equipment and other capital goods.

The full-scale replication of the output of the project was designed to treat one-third of the annual wool shearing production of the Piedmont region (1 tonne of coarse wool per day). Given that the shearing of sheep is usually performed after the end of the cold season and before the start of the hot season, we assume that the activity takes place 90 days in a year. This implies that about 90 tonnes of coarse wool are produced per year in the Piedmont region. Overall in Italy, given the country's share in the EU sheep livestock (9%), the production of coarse wool is estimated at 18,000 tonnes (9% share * 200,000 tonnes in the EU).

We assume that the key driver that would determine the replication outcome resides in the diffusion rate of the technology first in the Piedmont region, where the pilot was developed, and subsequently in the rest of Italy. In the Scenario of Low Growth (SLG), the replication in the Piedmont region is limited to the specification of the pilot plant (one third of the Piedmont region's needs by 2020), with a diffusion rate of 2% to the rest of Italy. In the Scenario of Regular Growth (SRG), the installation in the Piedmont region achieves full capacity before 2020, with further replication in the region occurring in order to absorb 50% of the coarse wool produced in the region. The diffusion rate in the rest of Italy in this scenario reaches 4% by 2020. Finally, the replication of the technology is assumed to cover two-thirds of the wool shearing needs in the Piedmont region by 2020 in the Scenario of High Growth (SHG), where the diffusion rate in the rest of Italy is also assumed to be higher at 6%.

Table 7: Assumptions per scenario, GREENWOOLF

Assumption	SLG	SRG	SHG
Diffusion rate in the Piedmont region by 2020	33%	50%	67%
Diffusion rate in the rest of Italy by 2020	2%	4%	6%

Under the growth assumptions of the SRG, the technology developed by the project is applied in 2020 to 45 tonnes of coarse wool in the Piedmont Region (50% diffusion rate * 90 tonnes of coarse wool per year) and 720 tonnes in the rest of Italy (4% diffusion rate * 18,000 tonnes). This adds up to 765 tonnes of coarse wool per year, out of which 574 tonnes (or 75%) are processed in the GREENWOOLF installations to turn a solid waste component with detrimental environmental characteristics into a fertiliser. Assuming that the wholesale price of the resulting fertiliser stands at about 0.50 €/kg, the value of the output generated by this technology in the SRG in 2020 stands at about €287,000 (574 tonnes * 0.50 €/kg). Overall, under this scenario, the value of output between 2016 and 2020 totals €588,000.

Table 8: Projections of the impact of project GREENWOOLF between 2016 and 2020

Impact 2016-2020	SLG	SRG	SHG
Additional employment (person-years)	102	180	264
Additional output (€'000)	300	588	875
Investment (€ million)	2.6	5.1	7.6

Under the SLG, the wool processed in the GREENWOOLF installations reaches 292 tonnes by 2020, out of which 22 tonnes come from the Piedmont region (33% diffusion rate * 90 tonnes of coarse wool * 75% share of unusable coarse wool) and 270 tonnes come from the rest of Italy (2% diffusion rate * 18,000 tonnes of coarse wool * 75% share of unusable coarse wool). Correspondingly, about 855 tonnes are processed in the GREENWOOLF installations in 2020 in the SHG, out of which 45 tonnes originate in the Piedmont region (67% diffusion rate * 90 tonnes of coarse wool * 75% share of unusable coarse wool) and 810 tonnes take place in the rest of Italy (6% diffusion rate * 18,000 tonnes of coarse wool * 75% share of unusable coarse wool). As a result, the value of output in 2020 under the alternative growth scenarios ranges from €146,000 in the SLG (292 tonnes * 0.50 €/kg) to €428,000 in the SHG (855 tonnes * 0.50 €/kg). Over the 5-year period under examination, the value of output varies from €300,000 in the SLG to €875,000 in the SHG.

The replication of the technology requires investment in the construction of the production facilities. Given that a full-scale treatment unit can process 150 kg of wool per day, about 43 treatment units should be in operation across Italy by 2020 under the SRG, in order to process the generated unusable coarse wool (574 tonnes / (150 kg per day * 90 days per year)). Together with the 9 more treatment units that should be constructed under this scenario to meet the demand for 2021 and without counting the cost of the initial treatment unit, the total investment cost between 2016 and 2020 is estimated at €5.1 million (51 treatment units * €100,000 installation cost per treatment unit).

Under the alternative scenarios, the number of units in operation by 2020 ranges from 22 in the SLG to 64 in the SHG. Taking also into account the units that should be installed by 2020 in order to operate in 2021, the investment cost between 2016 and 2020 ranges from €2.6 million in the SLG (26 treatment units * €100,000 installation cost per treatment unit) to €7.6 million in the SHG (76 treatment units * €100,000 installation cost per treatment unit).

Lastly, the operation of the treatment plants requires some employment. Under the assumption that the employment per plant aggregates to about 2 full-time equivalents (FTEs) in a year, where a greater number of people are employed only seasonally, while the off-season maintenance staff is also occupied with the maintenance of other facilities, we can expect that about 86 people (in FTE terms) are employed at the 43 treatment units in operation under the SRG. Between 2016 and 2020, this translates into 180 person-years of employment in total.

Under the alternative scenarios, the employment impact in 2020 ranges from 44 FTEs in the SLG (2 FTEs per treatment unit * 22 treatment units in operation) to 128 FTEs in the SHG (2 FTEs per treatment unit * 64 treatment units in operation). Aggregating over the period under examination (2016-2020), the employment impact resulting from the replication of the GREENWOOLF technology varies from 102 person-years in the SLG to 264 person-years in the SHG.

Green Sinks – Manufacturing of composite sinks from recovered waste

The aim of the project Green Sinks (LIFE12 ENV/IT/000736) was to create a new range of ecologically friendly sinks, using recovered inputs instead of organic and mineral raw materials. The recovered materials come both from a closed loop recycling (using the company production scraps and waste sinks) and from an open loop recycling (using the production waste of other industries).

The key economic impact of the project comes in the shape of new economic activity and cost savings (lower use of raw materials and energy). The beneficiary of the project, the Italian kitchen sink manufacturer Delta srl, anticipates that under a reference growth scenario it can market about 10,000 ecologically friendly sinks from 2016 to 2018, increasing gradually from 1,500 in 2016 to 5,000 in 2018.

Table 9: Assumptions per scenario, Green Sinks

Assumption	SLG	SRG	SHG
Ecogreen sinks sold in 2018 (thousands)	2.3	5.0	13.3
Turnover growth in 2018 over 2015	7.0%	15.0%	40.0%
Employment growth in 2018 over 2015	3.0%	6.5%	17.3%

The sales of Ecogreen sinks are expected to boost the marketing pull of the company, raising its overall turnover by more than the value of the Ecogreen sink sales. The company turnover is expected to increase by 15% overall by 2018, both from direct and indirect effects. Taking into account that the company's turnover in 2015 equalled €11.5 million, this implies that the additional output due to the project in 2018 is expected to equal €1.7 million (€11.5 million * 15%). Projecting the growth trend of turnover until 2020 under the regular growth scenario, the additional output generated as a result of the project is estimated to total €10.0 million between 2016 and 2020.

Higher output generates the need for higher employment. The project beneficiary anticipates that the employment in the company will increase by 6.5% by 2018. Assuming that the employment in Delta srl equalled 50 people, this implies that the company will employ 3.2 additional FTEs in 2018 (6.5% * 50 FTEs) to serve the needs for higher manufacturing of sinks. Assuming that employment grows at a constant elasticity with respect to output growth and that this elasticity equals 0.43 (6.5% / 15%), we can estimate the growth of employment over the remaining scenarios and years in the examined period. Applying this elasticity to the output growth projections, we estimate that the additional employment to produce the additional output totals 18 person-years between 2016 and 2020.

Table 10: Projections of the impact of project Green Sinks between 2016 and 2020

Impact 2016-2020	SLG	SRG	SHG
Additional output (€ million)	4.5	10.0	29.7
Additional employment (person-years)	8	18	51
Cost reduction (€'000)	47.0	104.5	312.7

The beneficiary of the project reported that the production of the ecologically friendly sinks also results in reduced cost of material and energy. Given that the average price of an Ecogreen sink stands at €85 and under the assumptions that the sink manufacturer operates at 35% gross profit margin and that the cost of materials and energy takes up about half of the total cost of goods sold, the cost of materials and energy is estimated at €27.6 per sink (€85 per sink * (1 - 35% gross profit margin) * 50% share of materials in total cost). The above price estimate incorporates a saving in terms of a lower cost of materials and energy by 15%, which implies that the cost of materials and energy for producing conventional sinks is higher by 17.6% (15% / (1 – 15%). Therefore, the unit cost saving equals €4.86 per sink (€27.6 cost of materials per sink * 17.6% imputed cost saving). Given the expectations for selling 1,500 sinks in 2016, the cost reduction achieved in that year in the reference growth scenario exceeds €7,300 in total (€4.86 cost savings per sink * 1,500 sinks). Overall between 2016 and 2020, the total cost saving from the production of Ecogreen sinks is estimated at €104,500 in the reference growth scenario.

Significant additional investment is not anticipated between 2016 and 2020, given that the replication presented here takes place in the facilities of the project beneficiary. It is reasonable to expect that any new equipment and machinery is put in place before the start of the mass production of Ecogreen sinks in 2016.

The project beneficiary has also estimated turnover growth under a low growth and high growth scenarios. Under the low growth scenario, turnover is expected to increase by 7% until 2018, while the corresponding cumulative growth in the high growth scenario stands at 40%. Projecting these trends growth to 2020 results in an estimate for the additional output of sinks between 2016 and 2020 at €4.5 million in the scenario of low growth and €29.7 million in the high growth scenario.
Applying the employment elasticity with respect to output to the output growth projections in the alternative scenarios results in expectations for higher employment in 2018 by 3% in the low growth scenario (0.43 elasticity of labour with respect to output * 7% output growth) and by 17% in the scenario of high growth (0.43 elasticity of labour with respect to output * 40% output growth). As a result, the additional employment between 2016 and 2020 in the two alternative scenarios equals 8 person-years in the SLG and 51 person-years in the SHG.

Regarding the cost reduction over the examined period under the two alternative scenarios, we need to estimate the sales of Ecogreen sinks first and then apply the cost reduction parameters to the alternative sales projections. Given that the turnover growth under the SLG is lower by 53% in 2018 compared to the reference scenario, we assume that about 2,300 sinks are sold in 2018 (5,000 sinks in the SRG * (1-53%)) in the low growth scenario. Correspondingly, the number of sinks sold in 2018 under the high growth scenario is estimated at about 13,300 sinks (5,000 sinks * 2.7 times higher output growth in the SHG than in the SRG). Applying the unit cost saving estimate to these projections results in the anticipation of material cost saving by about €11,400 (2,333 sinks * cost saving of €4.86 per sink) in the low growth scenario and €65,000 in the SHG (13,333 sinks * €4.86 per sink). Summing up the estimates over the projection period, the total cost reduction between 2016 and 2020 equals about €47,000 in the SLG and about €313,000 in the high growth scenario.

IRRIGESTLIFE – Telemanagement network for an optimised irrigation

The project IRRIGESTLIFE (LIFE11 ENV/ES/000615) developed a centralised smart irrigation system in the city of Vitoria-Gasteiz. The irrigation system uses climate data taken from sensors connected to the municipal Geographical Information System (GIS). As the irrigation system takes into account the weather conditions prevailing across the irrigation areas, it can calibrate better the water use to the actual irrigation needs.

The project beneficiaries calculated that the use of the smart irrigation system GestDropper, developed by the project and installed over an area of about 1.2 million m^2, resulted in 32% lower water consumption. Given that about 419 l/m^2 of water were used annually under the previous management system, about 155,000 m^3 of water are estimated to have been saved due to the project in 2015.

The reduction of the cost of water irrigation is the key economic impact of the project. While the installation of the system would require some labour resources, the tele-management system substitutes inefficient labour-intensive processes to manually control the numerous autonomous irrigation modules under the previous management system. Therefore, the employment impact from the replication of the project is uncertain and depends on whether the organisations responsible for maintenance of the green areas would redirect the freed labour resources to more productive activities or proceed to layoffs in order to cut their budget. The impact in investment terms is also not expected to be significant, as the technology developed by the project is intentionally based on readily available components and open-source software, which reduces substantially the investment cost and improves the likelihood and extent of replication.

To quantify the potential cost reduction from the replication of the technology, we developed three growth scenarios. As part of the project, the beneficiaries identified and contacted a number of cities in Spain and the rest of the EU, where the smart irrigation system can potentially be implemented with a similar success. We assume that under the Scenario of Regular Growth, the system is replicated in 20 of those cities by 2020, with a comparable set of results. Under the alternative growth scenarios, the number of successful replications ranges from 5 in the Scenario of Regular Growth (SRG) to 35 in the Scenario of High Growth (SHG).

Table 11: Assumptions per scenario, IRRIGESTLIFE

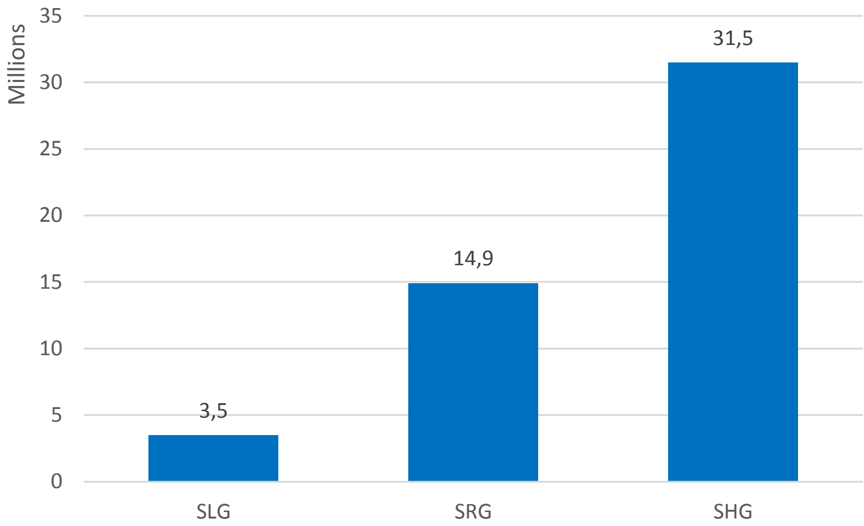
Assumption	SLG	SRG	SHG
Number of comparable cities with GestDropper by 2020	5	20	35
Price of water (€/m3)	1.50	2.00	2.50

The unit value of the saved water resources is another parameter that differs across the scenarios. We set the price of water at 1.5 €/m^3 in the SLG and at 2.5 €/m^3 in the SHG. Given that part of the cost of water is related to the cost of energy involved in water treatment and distribution, we can expect the price of water also to be higher under conditions of stronger economic growth.

Under the above assumptions, the volume of saved water resources under the SRG totals 3.1 million m^3 in 2020 (155,000 m^3 per replication * 20 replications). In monetary terms, this translates to savings of about €6.2 million (3.1 million m^3 * 2.0 €/m^3) in 2020 alone. Over the period of investigation (2016-2020), the cost reduction from the lower use of water resources totals €14.9 million (Figure 2).

Under the alternative growth scenarios, the volume of saved water resources in 2020 ranges from about 777,000 m^3 in the SLG (155,000 m^3 per replication * 5 replications) to 5.4 million m^3 in the SHG (155,000 m^3 per replication * 35 replications). This implies that the corresponding realised savings in monetary terms range from €1.2 million in the SLG (777,000 m^3 * 1.5 €/m^3) to €13.6 million in the SHG (5.4 million m^3 * 2.5 €/m^3). Overall from 2016 to 2020, the economic benefit of the project, in cost reduction terms, is estimated in the range from €3.5 million in the SLG to €31.5 million in the SHG.

Figure 2: Projections of the cost reduction impact of the project IRRIGESTLIFE between 2016 and 2020



DYEMOND SOLAR – Low Cost Production of Energy Efficient Dye-Sensitized Solar Cells

The project DYEMOND SOLAR (LIFE09 ENV/SE/355) demonstrated the potential of producing Dye-Sensitized Solar Cells (DSC) using screen-printing as a production method. The DSCs are based on the principle of photosynthesis, allowing for light to be captured in a variety of sub-optimal lighting conditions. Another advantage of this technology is that their performance is less sensitive to the impact of high temperature. Furthermore, the DSCs have flexibility and agility, which allows for more extensive set of applications, while both the required raw materials and the production process are readily available. As part of the project a pilot plant was constructed in Stockholm, Sweden.

The anticipated economic impact of the project can be expressed in all four magnitudes, quantified in this chapter. The production of DSCs generates employment and adds output to the economy. The manufacturing of DSCs also requires the installation of machinery and equipment, which adds to the capital stock of the economy. Finally, the output is produced at a lower cost, which increases the value added per unit of output in the economy.

To estimate the additional output generated by the project, we apply a capacity utilisation rate, assumed to vary across the three growth scenarios, to the total capacity of producing DSC with the technology developed by the project (20,000 m^2 per year). The capacity utilisation rate under the Scenario of Reference Growth (SRG) is assumed to equal 80%. This implies that the annual DSC production equals 16,000 m^2 per production line (20,000 m^2 capacity * 80% utilisation rate).

In the alternative scenarios, we can expect that the utilisation rates differ, which comes from the fact that in general demand varies more than installation capacity and as a result, the utilisation rates tend to be lower in periods of recession and higher in periods of strong growth. With 75% capacity utilisation rate, as assumed in the Scenario of Low Growth (SLG) the annual DSC production stands at 15,000 m^2 per production line (20,000 m^2 capacity * 75% capacity utilisation rate). In contrast, in the Scenario of High Growth (SHG), we assume that the capacity of the plant is utilised at 85%, which implies that annually 17,000 m^2 of DSCs are produced under this scenario.

Table 12: Assumptions per scenario for the replication of the technology developed in the project DYEMOND SOLAR

Assumption	SLG	SRG	SHG
Utilisation rate	75%	80%	85%
DSC production lines in 2020	3	6	12
Average decline of solar panel prices (relative to CPI)	10%	5%	0%

Assuming that the DSCs will sell at the market price for latest technology solar modules (about 50 cents per watt) and that 1 m^2 can generate 400W of electricity, the annual revenue per plant stands between €3.0 million (0.5 €/W * 400 W/m^2 * 15,000 m^2) and €3.4 million (0.5 €/W * 400 W/m^2 * 17,000 m^2), depending on the utilisation rate in each scenario. However, the prices of solar modules recorded a steep decline over the past few years, due to economies of scale and innovation and it is reasonable to expect that prices would continue to fall. The rate of price decline, relative to the overall rate of inflation, is expected to be higher in case of lower demand and more idle capacity, as is the case in the low growth scenario, where prices are assumed to fall by 10% fall each year. In contrast, we assume that in the SHG the rate of demand growth overruns the pace of added production capacity by a margin large enough to keep the prices of solar panels aligned with the general price inflation. As a result, the difference in the revenue per plant across the scenarios grows over time, with the revenue per plant falling below €1.8 million in the SLG and at about €2.5 million in the SRG.

The number of running DSC production lines is another key driver that differs across the scenarios. According to the project beneficiary, the technology would be successful if the global production capacity reaches at least 120,000 m^2 per year by 2020, which is equivalent to having 6 production lines of 20,000 m^2. We assume that this target is just about met in the scenario of regular growth. The value of output in this case equals €14.9 million (€2.5 million per plant * 6 plants) in 2020. Overall for the period from 2016 to 2020, the value of output generated by the technology of the project is estimated to total €42.3 million.

Table 13: Projections of the impact of the project DYEMOND SOLAR between 2016 and 2020

Impact 2016-2020	SLG	SRG	SHG
Additional employment (person-years)	270	480	750
Additional output (€)	18.8	42.3	85.0
Cost reduction (€)	7.2	13.4	22.4

Investment (€)	80.0	200.0	280.0

In the low growth scenario, we assume that only about 50% of the replication target is achieved (3 production lines or 60,000 m^2 total capacity). Taking into account the lower revenues per plant as well, the output value in 2020 is estimated at €5.3 million in this scenario (€1.8 million per plant * 3 plants). Summing the output figures over the 2016-2020 results in €18.8 million additional output in the SLG.
Accordingly, assuming that in the SHG the replication target is exceeded by 50% (9 running production lines with total capacity of 180,000 m^2), output reaches €30.6 million in 2020 (€3.4 million per plant * 9 plants). Overall between 2016 and 2020, the sales of DS cells are projected to total €85.0 million.

Additional economic impact comes from the reduced cost of producing the solar cells with the technology developed by the project. According to the project documentation, the project achieved 50% reduction of the production cost to less than 80 €/m^2. This implies that the cost of the technology, which formed the basis for the comparison was 160 €/m^2 (80 €/m^2 / (1 – 50%)) and the cost saving per m^2 equalled €80. However, as mentioned earlier, the solar technology is undergoing rapid change with significant decline of the production cost. Assuming that the production cost of the comparable solar technology declines at the rate of 5% per year, the cost saving per m^2 declines to €43.8 in 2020. As a result, the cost savings from producing solar modules with the DSC technology in 2020 ranges from €2.0 million in the SLG (43.8 €/m^2 cost saving * 45,000 m^2 annual production) to €6.7 million in the SHG (43.8 €/m^2 * 153,000 m^2). Overall for the 2016-2020 period, the cost reduction ranges from €7.2 million in the SLG to €22.4 million in the SHG, with a central projection of €13.4 million in the reference growth scenario.

At €40 million per production line, the DSC technology also achieves significantly lower investment cost. Taking into account that one full-scale production line is expected to be fully operational before 2016, the total investment cost over the period 2016-2020 ranges from €80 million in the SLG (2 additional production lines * €40 million per production line) to €280 million in the SHG (8 additional production lines * €40 million). In the reference growth scenario, the total investment cost is estimated at €200 million (5 additional production lines * €40 million).

By the end of the project, 30 people were employed at the DSC production line. Assuming that this number refers to full-time employees, this implies that by 2020 employment in the production of DSCs reaches 90 FTEs in the SLG (30 FTEs per production line * 3 production lines), 180 FTEs in the SRG (30 FTEs per line * 6 lines) and 270 FTEs in the SHG (30 FTEs per line * 9 lines). Summing over the examined period, the impact on employment stands at 480 person-years in the SRG, ranging from 270 person-years in the SLG to 750 person-years in the SHG.

DOMOTIC - Optimisation of Technologies for Intelligent Construction

The project DOMOTIC (LIFE09 ENV/ES/000493) demonstrated the energy efficiency potential of using technologies of automated or semi-automated control (or domotics) of energy-intensive home applications (e.g. lighting, heating, cooling and ventilation) in buildings attracting large numbers of visitors, such as education centres, institutions, museums and other public buildings. The domotic technologies were implemented in a secondary education training centre and a university in Zaragoza and a museum in Valladolid. The total area that was covered by the pilot action span 15,500 m^2, with a total implementation cost of about €108,000, generating cost saving due to reduction of energy consumption of €162,000 per year.

The replication potential of the project is significant, as it employs devices that are technologically mature and available in the market, the systems, equipment and components are modular, the tested models are adaptable, while the financial and environmental benefits are significant. At the time when the final report of the project was completed the beneficiaries had already signed an agreement with the Archdiocese of Zaragoza for the transfer of the models of the project to two public buildings in the city of Zaragoza.

The key economic impact of the project comes in the form of reduced use of energy resources. To calculate this impact, we assume that the average cost saving of the pilot project (10.5 €/m2) is applicable to the replication cases as well. Next, we estimate the cost savings under the three alternative growth scenarios, which differ with respect to the domotic technology replication area over the projection period (2016-2020).

Under the Scenario of Reference Growth (SRG), we assume that the area of replication totals 200,000 m^2 by 2020. On an annual basis, the newly renovated area each year grows from 20,000 m^2 in 2016 to 65,000 m^2 in 2020. As a result, the cost saving from reduced energy consumption under the SRG in 2020 stands at €2.1 million (200,000 m2 total renovated area by 2020 * 10.5 €/m^2). Summing over the projection period, the total cost reduction in the SRG is estimated at €5.1 million.

Table 14: Projections on the impact of project DOMOTIC between 2016 and 2020

Additional employment (person-years)	27	54	81
Cost reduction (€ million)	2.5	5.1	7.6
Investment (€ million)	0.7	1.4	2.1

Under the alternative scenarios, the area of replication by 2020 ranges from 100,000 m^2 in the Scenario of Low Growth (SLG) to 300,000 m^2 in the Scenario of High Growth (SHG). On an annual basis, the newly renovated areas in 2020 span 32,500 m^2 in the SLG and 97,500 m^2 in the SHG. Consequently, the cost savings in 2020 vary from €1.0 million in the SLG (100,000 m2 * 10.5 €/m^2) to €3.1 million in the SHG (300,000 m2 * 10.5 €/m^2). Overall between 2016 and 2020, the replication of the domotic technologies leads to cost savings ranging from €2.5 million in the SLG to €7.6 million in the SHG.

Another economic impact from the replication of the domotic technologies comes from the additional economic activity that comes with the need to install the automated systems. Given that this activity results in augmented value of the building stock, it can be accounted for as investment. Assuming that the average implementation cost of the pilot project (€7.0 per m^2)

remains applicable in the replication phase, the investment cost in the SRG in 2020 totals 453,000 (65,000 m^2 newly renovated area in 2020 * €7.0 per m^2 average implementation cost). Over the projection period, investment in the domotic technologies totals €1.4 million in the SRG. Under the alternative scenarios, investment in 2020 ranges from €227,000 in the SLG (32,500 m^2 * €7.0 per m^2) to €680,000 in the SHG (97,500 m^2 * €7.0 per m^2). Overall from 2016 to 2020, investment totals €697,000 in the SLG and €2.1 million in the SHG.

Given that the project automates processes that lead to cost saving, its employment impact is fairly limited. Using the estimate found in the literature that 17 jobs are created for each million of expenditure on energy efficiency interventions on average,[25] about 7.7 FTEs are generated in 2020 under the SRG (€453,000 investment cost * 17 FTEs per million of investment). In addition, the automated system incurs annual maintenance cost of about €27,000 per year, as reported by the project beneficiaries. Assuming that 90% of this cost is taken up by expenditure to cover the labour services of IT technicians and that the gross labour earning of the needed personnel equals €25,000 per FTE, this implies that about one FTE is required for the maintenance of the technologies installed by the pilot. We next assume that the ratio of employment per area of renovated building (1 FTE / 15,500 m^2 = 0.06 FTEs/'000 m^2) holds for the replication phase as well. As a result, we estimate that in 2020 about 12.6 FTEs would be required to maintain the installed automated systems (0.06 FTEs /'000 m^2 * 200,000 m^2 total renovated area). Therefore, about 20.3 FTEs are employed in 2020 for services related to the replication of the project in the SRG. Over the projection period, the employment impact totals 54 person-years in the SRG.

In the alternative scenarios, the employment for the installation of the automated system in 2020 ranges from 4 FTEs in the SLG (€227,000 investment cost * 17 FTEs per million of investment) to 12 FTEs in the SHG (€680,000 investment cost * 17 FTEs per million of investment). Correspondingly, about 6 FTEs are employed as maintenance staff in the SLG (0.06 FTEs /'000 m^2 * 100,000 m^2 total renovated area), while in the SHG the maintenance staff for the same year numbers 19 FTEs (0.06 FTEs /'000 m^2 * 300,000 m^2 total renovated area). In total for 2020, about 10 FTEs in the SLG and about 30 FTEs in the SHG are employed either for the installation or the maintenance of the domotic technologies. Overall between 2016 and 2020, the employment impact of the replication of the project ranges from 27 person-years in the SLG to 81 person-years in the SHG.

[25] Pikas et al. (2015) in Cambridge Econometrics (2015), Assessing the Employment and Social Impact of Energy Efficiency.

RECYCHIP - Dismantling and decontamination of out-of-use ships

The recycling of end-of-life ships generates valuable by products (i.e. steel), but also dangerous waste. Together with the strict EU regulation on dangerous waste, this creates incentives for scrapping ships outside the EU (mainly in Asia), where the standards of environmental protection and work safety are reduced.

The project RECYSHIP (LIFE ENV/E/000787) demonstrated the technical feasibility of safe and environmentally sound ship recycling in the EU. The project developed an integrated management system, together with three prototypes (an automated steel cutting machine, a tributyltin scraping machine and a bilge water treatment plant), which were installed and tested in the shipyard facilities of the company Navalria in Aveiro, Portugal. The pilot project scrapped three ships and a submarine, with a total gross tonnage (GT) of 1,250 tonnes. With the steel that was collected from the scrap, the pilot project raised €58,700, which is equivalent to €47 per tonne.

Provided that regulatory and financial measures are taken to increase the scrapping of EU-flagged ships in the EU, the project has significant replication potential. According to the project beneficiaries, the capacity of recycling end-of-life ships in the Iberian peninsula, given its existing port infrastructure and with the technology developed by the project, can exceed 1 million tonnes per year. Redirecting some of the scrapping activity to EU facilities will increase the related economic activity in the EU, increase the capital stock in shipyards performing this activity and create jobs in those shipyards.

To quantify this impact, we considered three growth scenarios, differing with respect to the total scrapping capacity that employs the recycling technology of the project and the achieved capacity utilisation rate. In the Scenario of Reference Growth (SRG), the treatment capacity that employs the RECYSHIP technology is assumed to reach 500,000 tonnes per year in 2020. Assuming a utilisation rate of 80%, this implies that ships with total tonnage of 400,000 GT are recycled in the RECYSHIP shipyards (80% utilisation rate * 500,000 GT capacity). If we consider the income per tonne generated in the pilot applicable to the replication phase as well, this translates to turnover of €18.8 million in 2020 (400,000 GT * 47 €/GT). Overall between 2016 and 2020, the replication of the RECYSHIP technology generates €45.6 million of output under the assumptions of the SRG.

Table 15: Assumptions per scenario for the replication of the technology developed in the project RECYSHIP

Assumption	SLG	SRG	SHG
Treatment capacity by 2020 ('000 tonnes per year)	200	500	1000
Utilisation rate (%)	75%	80%	85%

In order to give rise to this capacity, the technology generated by the pilot project should be appropriately replicated. Assuming that the capacity of the pilot project equals 60,000 GT per year, the pilot project should be replicated at least 8 times, in order to reach the required capacity of 500,000 GT (500,000 GT total capacity / 60,000 GT capacity of pilot), while a further expansion is required in 2020 in order to meet the recycling demand of the following year. At an investment cost of €450,000, this implies that the replication of the project leads to a higher investment expenditure in the economy by €4.1 million in the SRG (€450,000 * 9) between 2016 and 2020.

Table 16: Projections on the impact of project RECYSHIP between 2016 and 2020

Impact 2016-2020	SLG	SRG	SHG
Additional employment (person-years)	182	486	1,033
Additional output (€ million)	17.1	45.6	96.8
Investment (€ million)	1.4	4.1	8.1

According to the project beneficiaries, if 120 ships were recycled in a year using the technology of the project, 400 full-time jobs would be created as a result. This corresponds to 3.3 FTEs per ship over a year (400 FTEs / 120 ships). Taking into account that the ships calling at EU ports, according to the latest available data, had an average size of about 6,700 GT, this implies that we can expect about 0.5 FTEs per 1,000 GT of recycled ship capacity (3.3 FTEs / 6,700 GT). Therefore, the employment impact under the SRG is estimated at about 200 FTEs in 2020 (0.5 FTEs/GT * 400,000 GT). Overall between 2016 and 2020, the employment impact reaches 486 person-years under the SRG.

Under the alternative growth scenarios, the end-of-life ship treatment capacity ranges from 200,000 GT in the Scenario of Low Growth (SLG) to 1 million GT in the Scenario of High Growth (SHG). Considering that capacity growth is driven by high utilisation rates, the capacity utilisation rate also varies across the scenarios, from 75% in the SLG to 85% in the SHG. As a result, the tonnage of recycled ships equals 150,000 GT in 2020 in the SLG (75% utilisation rate * 200,000 GT capacity) and 850,000 GT in the SHG (85% utilisation rate * 1 million GT capacity). The corresponding revenue from selling the recycled steel ranges from €7.0 million in the SLG (150,000 GT * 47 €/GT) to €39.9 million in the SHG (850,000 GT * 47 €/GT). Summing over the project period, the impact of the pilot replication in output value terms ranges from €17.1 million in the SLG to €96.8 million in the SHG.

In investment terms, the number of replications by 2020 varies in the alternative growth scenarios from 3 in the SLG (200,000 GT total capacity / 60,000 GT capacity of pilot) to 19 in the SHG (1 million GT total capacity / 60,000 GT capacity of pilot + 3 more replication in order to meet the demand projected for the subsequent year). As a result, the investment expenditure ranges from €1.4 million in the SLG (€450,000 * 3 replications) to €8.1 million in the SHG (€450,000 * 19 replications).

Lastly, the employment impact in 2020 in the alternative scenarios equals 75 FTEs in the SLG (0.5 FTEs/GT * 150,000 GT recycled ships per year) and 426 FTEs in the SHG (0.5 FTEs/GT * 850,000 GT recycled ships per year). Overall between 2016 and 2020, the employment generated by replicating the technology developed by the project ranges from 182 person-years in the SLG to 1,033 person-years in the SHG.

ELINA – Management of a waste stream in Shipping

The project ELINA (LIFE11 ENV/GR/000606) took place in Greece between September 2011 and February 2015. **Its aim was to provide guidelines on the management of petroleum residues, commonly mixed with waste oils, generated in shipping and to demonstrate the possibility of on-shore collection and on-board separation of waste oils and petroleum residues.**

The guidelines identified a number of issues involved in the management of this waste streams that should be integrated in the National Waste Management Strategy of Greece. Furthermore, as part of its two pilot actions, the project team collected and analysed 7,236 tonnes from 487 on-shore plots, while the on-board mechanical adaptation of two passenger vessels generated 70 m3 of separated waste until the project end date.

The ELINA project demonstrated the technical feasibility of separating at source the shipping waste oils and petroleum residues. Meanwhile, the separation at source of this waste stream has substantial economic benefits as well.

Currently, the ship operators incur significant charges for the delivery of this waste stream. They pay at least €450 per tonne for management of the waste within Greece. The cost could go up to €1000 for trans-boundary waste management.

The separation at source reduces the volume of the waste stream significantly (-80%), which generates significant savings to shipping companies. Under the conservative assumption that all waste is disposed within Greece, incurring the lowest possible cost, **the separation at source is estimated to generate savings to the shipping companies of €360 per tonne of mixed waste**.

On the other hand, the waste management companies who collect and process the mixed waste lose revenue from the reduced waste volume. The lost net revenue that they incur, however, is lower than the cost savings for the shipping companies, as the waste management companies incur operating costs. **The highest loss of revenue seems to incur to the waste management companies with the lowest operating cost - the producers of Refuse-Derived Fuel (RDF) with €100 per tonne**. The RDF producers also pay for the disposal of the fuel to cement producers who use it as a substitute of solid fuels in the production of clinker. The price that they pay varies depending on the quality of RDF. Assuming that they pay €100 per tonne for RDF from the mixed waste stream and €80 per tonne for RDF from petroleum residues, **the net revenue loss for the waste managers is estimated at €196 per tonne. Subtracting this figure from the cost saving of the ship owners results in net cost saving of €164 per tonne of mixed waste.**

In order to achieve the operating cost savings, the ship owners have to make adjustments to the vessels, incurring investment costs. From the perspective of national accounts, this translates into a positive impact in terms of fixed capital formation. The investment per vessel for the two pilot vessels equalled €16,625.

The extent to which the cost savings and investment are realised depends on the replication of the pilot technology. Already by the end of the projects, one of the project partners (ANEK Lines), which operates passenger ships in Greece, declared its intention to implement the pilot on two more of its vessels within 2015-2016. Given its participation in the project and the considerable cost savings that it incurs, it is quite likely that by 2020 the technology is replicated to the whole fleet of ANEK Lines (10 ships currently).

A replication beyond the ANEK Lines fleet, however, depends strongly on policy changes. In particular, there is a possibility that the separation at source of the petroleum residues in passenger ships is included as a requirement in the Greek national waste management strategy. This would extent the scope of replication to all passenger ships in Greece.
Furthermore, the partners in the project intend to approach the International Maritime Organisation to communicate the project results and to initiate the integration of the requirement to separate the petroleum residues at source in the MARPOL convention. If such a policy change takes place, this would boost the likelihood of replication of the pilot of the project outside the Greek market.

We estimated the potential cost saving and investment impact from the replication of the pilot technology of the project ELINA under three scenarios. The Scenario of Low Growth (SLG) assumes no policy change and low economic growth in Greece and the EU, leading to low growth of fuel consumption in Greece and contraction of fuel growth in the EU.

Table 17: Assumptions per scenario for the replication of the pilot technology developed in the project ELINA

Assumption	SLG	SRG	SHG
Mandatory separation of WO & PR streams in Greece	No	Yes	Yes
Mandatory separation of WO & PR streams in MARPOL	No	No	Yes
Uptake in ANEK ships, 2020	100%	100%	100%
Uptake in other ships in Greece, 2020	0%	25%	50%
Uptake in other EU ships, 2020	0%	1%	10%
Average GDP growth, 2017-2020, Greece	1.0%	2.9%	4.0%
Average GDP growth, 2017-2020, EU-28	1.0%	2.1%	3.0%
Fuel consumption growth forecast, 2017-2020, Greece	1.0%	2.9%	4.0%
Fuel consumption growth forecast, 2017-2020, EU-28	-1.0%	0.0%	1.0%
Number of vessels, annual growth rate, 2015-2020, Greece	-1.0%	0.0%	1.0%
Number of vessels, annual growth rate, 2015-2020, EU	-1.0%	0.0%	1.0%

The Scenario of Regular Growth (SRG) assumes that the requirement of separation at source becomes part of the national legislation in Greece, with a transition period that extends beyond 2020. The MARPOL convention, however, remains unchanged, regarding the separation at source of petroleum residues. The GDP growth rates in this scenario correspond to the forecast of the European Commission for 2015-2016, extended until the end of the decade.

Lastly, the Scenario of High Growth (SHG) assumes that both the national legislation in Greece and the MARPOL convention include a regulatory requirement on the separation at source of petroleum residues. The growth rates in this scenario are higher compared with the SRG scenario.

Under the assumptions of the SLG, the estimated impact on cost savings from the replication of the project ELINA amounts to €0.6 million in total from 2016-2020. The operating costs for that period exceed investment, estimated at €0.1 million, reflecting the economic viability of the technology. If the scope of replication is extended through policy change to more vessels in Greece, **the impact in terms of cost savings reaches €18.5 million**. Under the same scenario, **the investment in the EU economy increases by €8.6 million**. **Lastly, if the MARPOL convention is amended as well, the impact of the pilot technology could reach €91,3 million in terms of cost savings and €24.8 million in investment terms.**

Table 18: Projections on the impact of the project ELINA between 2016 and 2020

Cost reduction (€ million)	0.6	18.5	91.3
Investment (€ million)	0.1	8.6	24.8

3. Conclusions and Projections

The replication of the technology obtained from the sample of 10 projects is anticipated to have a notable impact on jobs and growth (Table 19). Cumulatively the projects in the sample are anticipated to create about 1,840 person-years of employment under the reference growth scenario between 2016 and 2020. Significant share of this impact comes from the projects RECYSHIP (486 person-years) and DYEMOND SOLAR (480 person-years), where many jobs are created in shipyards for recycling ships and in the facilities producing dye-sensitized solar cells respectively. Other projects with significant job creation potential include Green Deserts (351 person-years), for the production of tree-planting boxes and for planting trees, EDEA-RENOV (248 person-years), for implementing energy efficient solutions in housing, and GREENWOOLF (180 person-years), for the conversion of wool wastes into fertiliser in micro-production facilities.

Table 19: Economic impact per project under the reference growth scenario, 2016-2020

Project Acronym	Employment (person-years)	Output (€ million)	Cost reduction (€ million)	Investment (€ million)
GREEN DESERTS	351	2.4	0	0.7
SOL-BRINE	22	263	0	0.5
EDEA-RENOV	248	0	1.0	14.6
GREENWOOLF	180	0.6	0	5.1
GREEN SINKS	18	10	0.1	0
IRRIGESTLIFE	0	0	14.9	0
DYEMOND SOLAR	480	42.3	13.4	200
DOMOTIC	54	0	5.1	1.4
RECYSHIP	486	45.6	0	4.1
ELINA	0	0	18.5	8.6
Total	**1,840**	**363**	**53.0**	**235.0**

In terms of output growth, the projects in the sample are expected to generate €363 million of output over the 5-year period between 2016 and 2020. Most of this output (€263 million) is expected to come from the sales of distilled water and salt, produced as a result of the replication of the SOL-BRINE project. Other projects with significant output generation potential include RECYCHIP (€45.6 million) and DYEMOND SOLAR (€42.3 million).

In terms of cost reduction, the savings generated by the projects in the sample are anticipated to reach €53.0 million over the next five years under the reference growth scenario. The projects with the largest contribution to this total are ELINA (€18.5 million), reducing the waste management cost of ships, IRRIGESTLIFE (€14.9 million), optimising the cost of irrigation in urban areas, and DYEMOND SOLAR (€13.4 million), lowering the cost of solar cell production. The two energy-efficiency projects – DOMOTIC and EDEA-RENOV – also have a notable cost-reduction potential, with €5.1 million and €1.0 million respectively.

To generate output growth or cost savings, most projects of the sample require investment in capital goods and services. In total, the projects in the sample result in an investment of €235 million over the examined period. Most of the investment comes from building the capacity needed to produce the solar cells of the DYEMOND SOLAR project (€200 million). Notable investment is also generated with the EDEA-RENOV project (€14.6 million), ELINA (€8.6 million), GREENWOOLF (€5.1 MILLION) and RECYSHIP (€4.1 million).

Under the alternative growth scenarios, the replication potential impact of the selected projects on employment varies from 865 to 3,365 person-years (Table 20). In output terms, the impact covers a range from €171 million in the low growth scenario (SLG) up to €752 million in the scenario of high growth (SHG). Correspondingly, the selected projects can lead to cost savings of €14 million under the SLG or €156 million under the SHG. Finally, the impact on investment ranges from €91 million in the SLG to €354 million in the high growth scenario.

Table 20: Economic impact of the selected projects per scenario, 2016-2020

Impact variable	SLG	SRG	SHG
Additional employment (person-years)	865	1,840	3,365
Additional output (€ mln)	171	363	752
Cost reduction (€ mln)	14	53	156
Gross Value Added (add. output+cost red.)(€ mln)	185	416	908

From the above results, it comes that the average high-replicability project creates within five years employment **ranging from 86,5 to 336,5 FTE person-years**, depending on the associated growth scenario.

It also contributes to growth (additional output plus cost reduction) by **€ 18,5 to € 90,8 million**.

Although our sample is not random, we can make a rough estimation of the total impact at Programme level taking into account the replicability frequencies estimated by survey in the previous part of the Study, and weighing by a coefficient structure to reflect the replication potential of the projects. According to Figure 45 of Part I: 17% of the projects are highly replicable, 57% moderately replicable, 19% hardly replicable, and 7% not replicable. If we assign a coefficient of 1 to the highly replicable category, 0,5 to the moderately replicable, 0,25 to the hardly replicable, and 0 to the non-replicable, we obtain a weighted index of:

17% X 1 + 57% X 0,50 + 19% X 0,25 + 7% X 0 = 0,5025

For a typical 1 000 projects population implemented during an entire programming period equivalent to LIFE+, and by using the most conservative figures (lowest range of the above Table 20), we get:

Employment creation: 1 000 X 0,5025 X 86,5 = ***43 466 FTEs person-years****, and*

Contribution to growth: 1 000 X 0,5025 X 18,5 = ***€ 9,3 billion***

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PART III: Evaluation of LIFE Projects from the perspective of Ecosystem Services

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Introduction and Objectives

The LIFE-Nature and Biodiversity funding mechanism produces economic impacts and social effects at various organizational and territorial scales. This funding mechanism – along with its institutional and procedural apparatus – does address the complexity of the fundamental question "Can the EU afford to conserve biodiversity?" in its territory, according to its role and engagement as a world champion in environmental-global change issues.

As a funding mechanism for nature and biodiversity, LIFE's rationale has evolved from purely supportive of intrinsic value-led conservation – e.g. aesthetic, ethical or cultural values – to science and economic rationalism arguments. This gradual evolution is significantly represented in the "two-way" examination of dependency in the relationship between conservation targets/results per se and economy, and vice versa. The actual scientific advances in representing nature in units (e.g. species, habitats or landscapes) and the accumulation of monetary valuation methods of- and data on- Goods and Services provided by Ecosystems do create the opportunity to integrate social conservation aspiration and ecological science with economics. Further, the EU support for conservation can be strengthened if arguments are framed in terms consistent with economic development, by treating units of nature as commodities and aligning nature conservation with the free-market delivery of public benefits.

Public benefits are of two different kinds. Those that emanate from direct impacts of LIFE funds on the job market and local "GDP"; and, those that indirectly originate as ecosystem services from the sustainable use of nature and biodiversity resources within the wider matrix of EU land/resource-use allocation system, especially regarding areas designated for of conservation, protection and/or restoration.

Political justification on conservation funding decisions tends therefore to rely more on cost/efficiency or cost/effectiveness criteria than to often intractable problems that are raised when different social groups hold different intrinsic values on nature.

The main objective of this work is to assess the indirect economic impact of a sample of 25 typical LIFE Nature and Biodiversity projects, from the perspective of the directly generated ecosystem services; (there are also public benefits through ecosystem services where the results of the projects are replicated elsewhere – but these are not covered by the present study). Additionally, some aspects of the direct economic impact, effectiveness and replicability of LIFE Nature and Biodiversity projects are also addressed (i.e. the core question emanating from the general description and goals of Task 9.4/NEEMO Contracts 03/04).

To achieve these objectives, this report had to tackle methodological challenges and technical issues related to the standardization and analysis of available information and data, in order to address in a constructive way the inverted relationship between "economy metrics" as the dependent variable and "conservation LIFE funds" as the independent driver. Some of these metrics -e.g. those related to employment- are *ex post* straightforward as accountability. Others, as those related to Ecosystem Goods and Services, are fraught with multiple uncertainties as to their potential for materialization. In particular, there is significant uncertainty on both the range of monetary values per class of ecosystem service (-s) -

especially in their local or regional version- and their interference as economic multiplier for local "GDP".

This report espouses the idea that getting the maximum of public benefits from EU investment to nature/biodiversity conservation seems one reasonable goal when relative funds are locked to a given financial ceiling. The novelty of this report, if any, relates to uncovering important features of the secondary economic effects of LIFE-Nature and Biodiversity projects [during the period 2004-2015]. These effects are complex, as they are direct -i.e. support and influence upon qualified employment and GDP, and indirect -i.e. their contribution to human welfare as part of the economic value of EU nature, through their monetary value as ecosystem/biodiversity services and goods.

The report is divided into three main sections: first, an explanation on the method used to assess how the implementation of the 25 selected LIFE Nature projects affected the quality of the ecosystem services, how these effects can be evaluated in monetary terms, their direct economic impact and their replicability and effectiveness; second, a section including a brief summary of the outcomes of these assessments26; finally, the report concludes on some key messages and recommendations.

[26] The report includes three annexes with a detailed analysis of the direct and indirect impact assessment of the 25 LIFE Nature projects.

Chapter 1: Methodology

As the European Commission highlights in the LIFE Programme website, "*LIFE projects have helped to improve the regulation of ecosystem processes in order to better facilitate natural services like pollination, disease control and resource purification. Non-material benefits obtained from ecosystems have been another positive outcome from LIFE's project activities and services covered here include aesthetic values connected with environmental 'capital' or cultural heritage*"[27].

However, the benefit that LIFE projects provide in terms of ecosystem services has not always been systematically assessed (particularly during the first programming periods), and has only recently been explicitly integrated (see below – Step 1 – a temporal comparison between the years of approval of the sample of the 25 LIFE Nature projects and the flourishing of relevant scientific works on ecosystem services). In 2011 it was established for the first time that all LIFE Nature and Biodiversity proposals containing concrete conservation measures must include two separate actions aimed to assess the socio-economic impact of the project on the local economy and population, and to assess the project's impact on the ecosystem functions. More concretely, LIFE guidelines for applicants currently explain that: *"(…) the direct linkages between the project measures and key ecosystem services provided, such as carbon sequestration, water purification, pollination, etc. should be clearly assessed. The impact of project actions aimed at restoring multi-functional ecosystems such as rivers, floodplains, forests, peatlands or mires should be assessed as far as possible in economic terms (monetary terms or if this is not possible there should be a qualitative estimation). All these should be consistent in so far as possible with the methodology on Mapping and Assessing Ecosystems and their Services (MAES) agreed at European level within action 5 of the Biodiversity Strategy*".

The new LIFE Regulation, approved in 2013[28], gives an increased importance to the socioeconomic impact of the projects. With the aim of reporting on the success of the LIFE Programme in relation to the performance indicators established in Article 3 Paragraph 3 of the LIFE Regulation, the multiannual work-programme for 2014-2017 defines a comprehensive set of outcome indicators on which all LIFE projects must report, including some of societal and economic character. In this respect, the recently elaborated LIFE indicator database[29] will undoubtedly constitute a valuable tool. This database already contains indicator data from hundreds or projects (inputs are up to the present made on a voluntary basis, but the idea is to progressively establish the database as a basic tool for systematic assessment).

The 25 typical LIFE Nature projects that are analysed in this report were approved for financing during the period 2004-2010, when no specific data were required in order to assess the projects' impact on ecosystem services. Therefore, the evaluation undertaken in this report is hindered by the lack of specific data. The information available (data contained in the ex post

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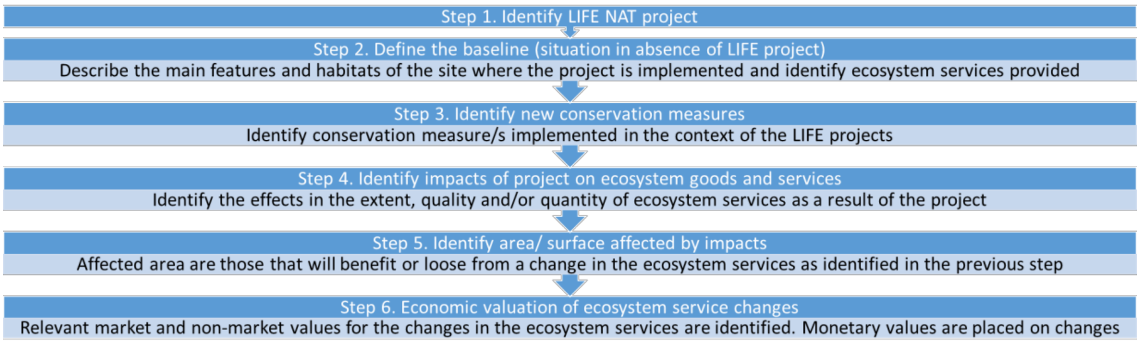
[27] http://ec.europa.eu/environment/life/features/2012/ecosystem.htm

[28] Regulation (EU) no 1293/2013 of the European Parliament and of the Council of 11 December 2013 on the establishment of a Programme for the Environment and Climate Action (LIFE) and repealing Regulation (EC) No 614/2007.

[29] http://ec.europa.eu/environment/life/toolkit/pmtools/life2014_2020/monitoring.htm

evaluation reports of the LIFE Nature projects and some additional sources such as web summary reports and/or communication material) is mostly limited to the number of hectares targeted/improved by the projects in the case of the land-based or site-related actions, populations of the targeted species, and other quantitative details related, for example, to stakeholder participation in the communication and awareness raising actions.

Taking all this into account, the approach of this report follows the methodological framework proposed in the document entitled "A" VISION OF THE PROJECT (based on the Memo of the meeting of Nat experts of 4th February 2016 and the topics debated), which builds on the ARCADIS Tool on Conservation Measures Toolkit[30] to assess the impacts of the marginal changes to Natura 2000 sites.



Source: Adapted from European Commission (2011)

According to this methodological framework, the work was initially organised in 5 steps:

- Step 1. Selection of a sample of projects
- Step 2. Baseline definition
- Step 3. Selection of conservation measures to be analysed in monetary terms
- Step 4. Identification of surface area affected by the selected conservation measures
- Step 5. Monetary valuation of ecosystem service changes induced by the selected conservation measures

However, it must be noted that in some cases there is no area affected as such, because some LIFE projects are based on species-oriented actions, which are not necessarily site-based (measures related to direct protection of species against unintentional or intentional disturbance, collection, capture, etc.). Having in mind these and other limitations (see the

[30] The 'Tool on Conservation Measures' (the Tool) has been developed under a project for DG Environment managed by ARCADIS Belgium with the support of the European Centre for Nature Conservation, and tested in 11 sites across the EU and candidate countries, in order to guide appraisal of the economic impacts of conservation measures taken to manage Natura 2000 sites in the EU (European Commission, 2011) . The Tool combines several approaches to economic evaluation of environmental impacts. It is based on the application of cost-benefit analysis (CBA) to specific changes occurring as a result of conservation measures, uses an ecosystem services approach to identify how changes to the natural environment will affect ecosystem good and services (e.g. TEEB, 2010) and draws on environmental valuation methods (e.g. value transfer techniques) . Although the scope of the Tool are the Natura 2000 sites, it can be used to analyse how conservation measures can influence ecosystem goods and services in all types of natural areas (protected and non-protected), and to value changes in ecosystem goods and services in monetary units.

Conclusion section), it was decided that this study would comprise not only a monetary valuation of the impact of a selection of the conservation measures implemented in the projects on a set of selected ecosystem services (based on the affected surface area), as explained above, but also an overall qualitative assessment of the projects' impact on the ecosystem services, considering the whole set of actions of the projects and the whole range of ecosystem services, in order to provide a more comprehensive overview of the effects that LIFE Nature projects can have in this respect. Additionally, other aspects such as the direct impact, replicability and effectiveness of the projects would also be assessed.

These additional tasks are integrated in the report as three supplemental steps:

- Step 6. Assessment of the project's overall impact on ecosystem services
- Step 7. Assessment of the direct economic impact of the 25 projects
- Step 8. Replicability and effectiveness

Step 1. Selection of LIFE NAT projects

As already mentioned, the database of this report consists of a sample of 25 LIFE Nature projects[31] that were approved for funding during the period 2004-2010. Qualitative information and data for each project follow systematically the format and the content of individual "Progress Evaluation Reports", and other sources such as web summaries and/or communication/awareness material were also available. Table 1 summarizes the official identity of the sampled projects.

These projects run across gradients of eco-regional differentiation, conservation status, problems and threats, conservation strategies and targets, and periods of implementation.

Table 1: Number, title and acronym of the 25-pool of sampled LIFE NAT projects.

Project n°.	Project title	Acronym
LIFE04 NAT/IE/000125	Developing a new model for the sustainable agricultural management of the Habitats Directive Annex I priority habitats of the Burren	BurrenLIFE
LIFE05 NAT/A/000077	Reducing the risk of great bustards (Otis tarda) colliding with overhead power lines	Grosstrappe
LIFE05 NAT/B/000089	Enhancing the connectivity of the habitats inside the Plateau des Tailles, and other similar areas in Wallonia	PLTTAILLES
LIFE05 NAT/DK/000153	Restoring and maintaining a favourable conservation status for the houting (Coregonus oxyrhunchus) in four Danish river systems.	Houting
LIFE05 NAT/LV/000100	Contributing to the protection and sustainable use of marine biodiversity in the Eastern Baltic Sea (costal and offshore waters of Estonia, Latvia and Lithuania).	Baltic MPAs
LIFE06 NAT/CZ/000121	Preservation of alluvial forest habitats in the Morávka	MORAVKA

[31] All projects selected were LIFE NAT projects, except LIFE10 INF/UK/000189. This information project was selected for having a very strong nature component (see details in Annex I). There was no LIFE BIO projects selected.

	river Basin (MORAVKA)	
LIFE06 NAT/H/000098	Improving the conservation status of 'Nagykõrösi pusztai tölgyesek' SAC.	HUNSTEPPICOAKS
LIFE06 NAT/IT/000060	Conserving and increasing the population size of priority plant and animal species in the ecological system of alkaline and calcareous fens in the Friuli plain.	LIFE FRIULI FENS
LIFE06 NAT/NL/000078	Restoring migration possibilities for 8 Annex II species in the Roer	Roer Migration
LIFE06 NAT/SK/000115	Restoration and Management of Sand Dunes Habitats in Zahorie Military Training Area	ZAHORIE SANDS
LIFE07 NAT/EE/000120	Saving life in meanders and oxbow lakes of Emajõgi River on Alam-Pedja NATURA2000 area	HAPPYFISH
LIFE07 NAT/GR/000285	Concrete Conservation Actions for the Mediterranean Shag and Audouin's gull in Greece including the inventory of relevant marine IBAs	ConShagAudMIBAGR
LIFE07 NAT/LT/000530	Restoring Hydrology in Amalvas and Žuvintas Wetlands	WETLIFE
LIFE07 NAT/P/000649	Initiating the restoration of seabird-driven ecosystems in the Azores	SAFE ISLANDS FOR SEABIRDS
LIFE08 NAT/CY/000453	Establishment of a Plant Micro-Reserve Network in Cyprus for the Conservation of Priority Species and Habitats	PLANT-NET CY
LIFE08 NAT/D/000004	Conserving and developing pastures (habitat types 4030, (*)6212, *6230, 6510, 8220, 8230) of the "Wetterauer Trockeninsel"	Wetterauer Hutungen
LIFE08 NAT/E/000062	Action to fight illegal poison use in the natural environment in Spain	VENENO NO
LIFE08 NAT/F/000474	Forests for the Capercaillie	Life+TétrasVoges
LIFE08 NAT/FIN/000596	Restoring the Natura 2000 network of Boreal Peatland Ecosystems	Boreal Peatland Life
LIFE08 NAT/RO/000500	Best practices and demonstrative actions for conservation of Ursus arctos species in Eastern Carpathians, Romania	URSUSLIFE
LIFE09 NAT/BG/000229	Conservation and restoration of Black Sea oak habitats	
LIFE09 NAT/PL/000260	Facilitating Aquatic Warbler (Acrocephalus paludicola) habitat management through sustainable systems of biomass use	Biomass use for Aquatic W
LIFE09 NAT/SE/000344	Management of the invasive Raccoon Dog (Nyctereutes procyonoides) in the north-European countries	MIRDINEC
LIFE09 NAT/SI/000374	Conservation and management of freshwater wetlands in Slovenia	WETMAN
LIFE10 INF/UK/000189	Futurescapes : promoting the development of green infrastructure in 34 priority areas throughout the UK	Futurescapes

The 25-long pool of projects is not a random sample per se of the > 400 (479) LIFE NAT/BIO projects approved for funding during the period 2004-2010. Besides general selection criteria related to weightings such as fund partitioning among Member States, accession history, geographical subdivisions of the EU territory (e.g. South-Eastern Europe vs. Central Europe, etc.), the main focus of this report requires a data-driven prioritization in sampling. This is mirrored in the Progress Evaluation Reports after the completion of the vast majority of projects: the inherent non-economic nature of LIFE NAT/BIO projects, and the set of available data per project de facto yield a limited number of usable projects in this ex post economic evaluation of impacts of LIFE NAT/BIO funding, either directly or indirectly.

What are the driving characteristics of the studied sample of projects as to their representativeness regarding the goals of this report?

1. They progress in parallel with major conceptual and technical developments in the domain of "ecosystem services" (Figure 1 Therefore, it is somehow possible to extract information on LIFE funding effects upon the relationship between biodiversity and ecosystem functioning, i.e. a functional relationship that allows for treating natural entities as service(s) providing units.

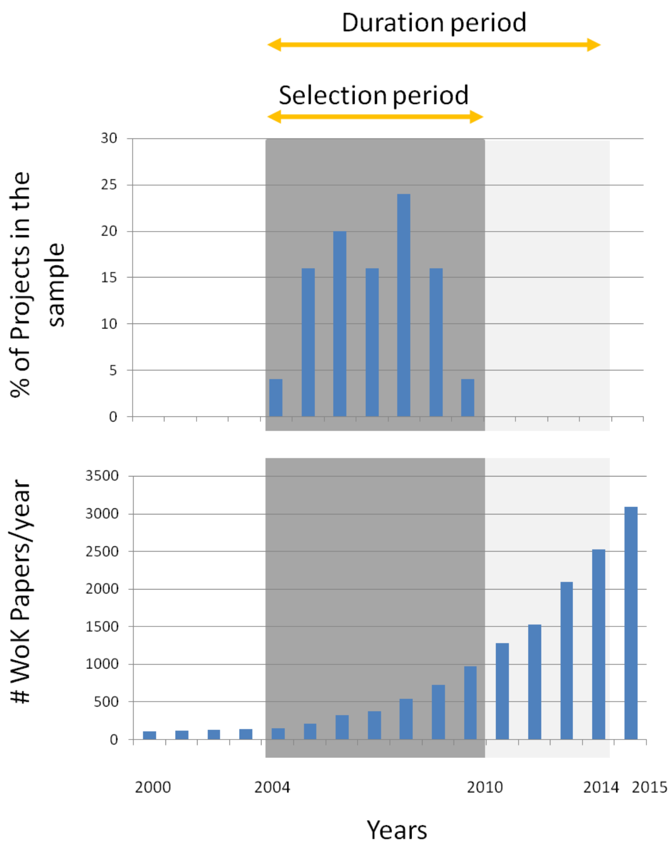
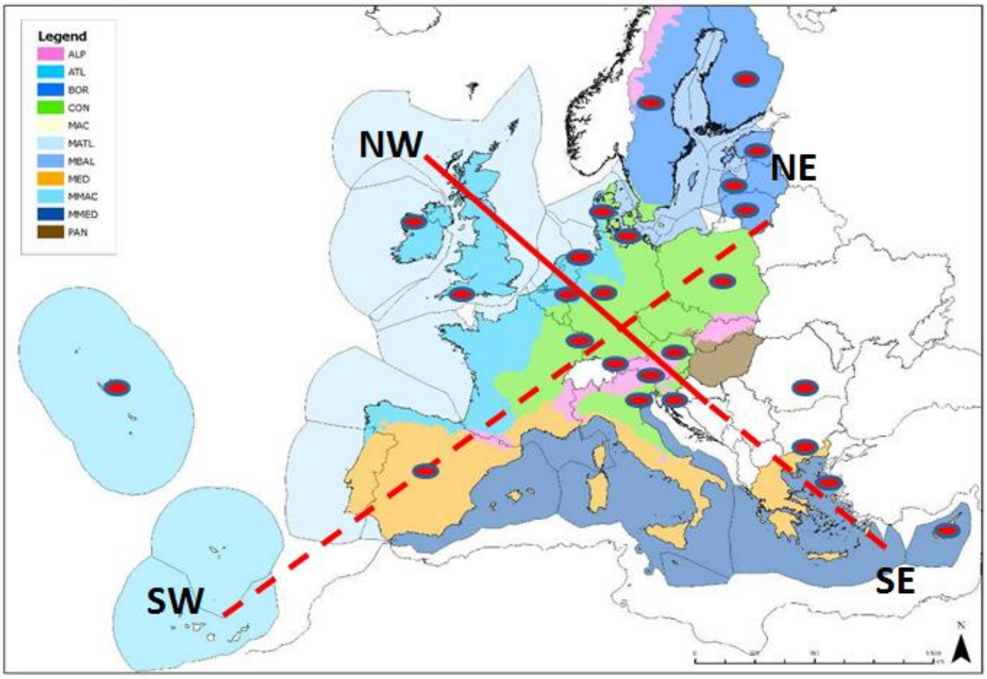


Figure 1: A comparison of temporal coincidence between the time extent of the years of approval of the LIFE NAT sample of projects and the flourishing of scientific concepts and techniques regarding "ecosystem services". [Upper panel]: the % distribution of the commencement of projects included in the studied sample; [Lower panel]: # of papers related to "ecosystem services"/year -a proxy- include in the Web of Knowledge database.

2. The European territory encapsulates multiple divides, e.g. national, cultural, political, economic or environmental. In this case, the most prominent is the inverted relationship

between biodiversity richness and economic welfare across Europe. The 25-pool of projects is ordinated along an South/East-North/West and a South/West-North/East gradients (Figure 2) This configuration encompasses eco-regional differentiation in Europe and exemplifies both natural and economic conditions.

Figure 2: The 25-pool of projects ordinated along an South/East-North/West and a South/West-North/East gradients



ALP=Alpine; ATL=Atlantic; BOR=Boreal; CON=Continental; MAC=Macaronesian; MED=Mediterranean; PAN=Pannonian; MATL=Marine Atlantic; MBAL=Marine Baltic; MMAC=Marine Macaronesian; MED=Marine Mediterranean

Figure 2 presents an attempted positioning of sampled projects within the eco-regional/bio-geographic space of the European continent. The faunistic and floristic realm and their subsequent ecosystemic complexes and services provided are highlighted in the report.

3. Every project addresses a series of conservation objectives. These objectives can be differentiated or classified along a gradient of targets, ranging from compliance to International Conventions to specific measures for conservation or restoration of ecosystems. More specifically, in a top-down sequence of identification traits, one can define 5 levels:

L1. - the Conventional framework, i.e. the Big 5 International Conventions that the EU as a supra-national entity and the 28 Member States individually have signed, i.e. CBD, Ramsar, CITES, WHC and Bonn Convention,

L2. - the Institutional framework, i.e. the 2 basic Directives (Habitats and Birds), although several bits of conservation-oriented legal/policy instruments/mechanisms have been adopted, e.g. The Water Framework Directive, the CAP/Agri-environmental schemes/Less-favoured-areas schemes, the Regional/Island Development schemes, the Innovation policies, the Biodiversity & Business initiatives, etc.

L3. - the 2 classes of Action regarding NAT/BIO, i.e. Maintenance and Restoration actions. According to EEA (report 11, 2007), in the period under evaluation these classes were defined as follows:

Class 1: Actions to maintain and enhance biodiversity:

- designation of new territories as nature reserves for nature conservation;
- management of the territories designated for nature conservation;
- application/implementation of conservation measures to maintain natural diversity;
- protection of the diurnal or seasonal migration pathways for species;
- regulation of a land use, when the corresponding impacts are positive for the state of biodiversity.

Class 2: Actions to protect and restore biodiversity:

- compensation for past disruption to the state of natural habitats (restore certain natural habitats and sites, e.g. wetlands, forest areas, etc.)
- reintroduction of species in habitats where their numbers have declined to establish a viable population or community
- restriction or forbid certain uses of biodiversity (this includes harvesting or capture of species. e.g. over fishing, deforestation, illegal trade of animal and plant species, etc.)
- regulation of a land use, when the corresponding impacts would have been negative for the state of biodiversity; these include cross-compliance measures applied to agricultural (and forestry) practices.

L4. - the **6 types of Measures**, to meet the biodiversity targets, i.e.

1. Development and management of protected areas;
2. Species conservation;
3. Habitat conservation;
4. Capacity building;
5. Awareness raising/Education;
6. Research/monitoring.

L5. - the **specific combination of Measures** proposed/undertaken/funded *per* project. A preliminary attempt to typify the rationale and the discourse of individual projects allows for the following attempted definition (-s).

L5.1. ***Development and management of protected areas***

It envisages all the measures and actions that are performed to designate new territories under protection and the costs that are liaised with this measure -i.e. defining boundaries of the new protected site, its delineation, etc.- or the preparation of the management plans for protected areas.

L5.2. **Species conservation**

It implies various measures directed towards protection and conservation of individual species. It might include all the costs for reintroduction of species, ex-situ, in-situ conservation, translocation, etc.

L5.3. **Habitat/site conservation**

It implies any measures that are directed to protect a particular habitat or site -i.e. actions against degradation of the habitat, such as deforestation, burning of vegetation, etc. In some cases, restoration measures for severely degraded habitats are applied, e.g. restoration of wetlands, afforestation, etc.

L5.4. **Capacity building**

A type of Measure regarded to be important in applied biodiversity conservation. Expenditures made to capacity building may refer to funds spent on equipping of the staff with relevant knowledge and/or technically in order to strengthen agencies or local institutions responsible for the development of conservation measures.

L5.5. **Awareness raising/Education**

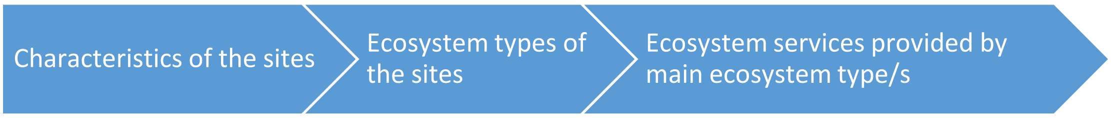
It addresses activities/components for the successful conservation of nature/biodiversity/ natural heritage through targeted activities towards education and raising awareness of the general public on biodiversity topics (by means of campaigns, publications, educational programs or establishment of eco-clubs).

L5.6. **Research/Monitoring**

It addresses the need for **Research** to evaluate the status of any species or habitat as a significant prerequisite to biodiversity conservation; **Monitoring** intends to track changes at species, population and habitat levels. LIFE funds allocated to research and monitoring might also account for the evaluation and monitoring of the effectiveness of species/habitat action plans or management of protected areas.

Step 2. Baseline definition

This step describes the main characteristics (habitats, species, land uses, conservation problems, threats, etc.) of the sites/ areas where the LIFE Nature projects were implemented. It must be noted however that a number of the selected projects (around 50% of the sample of 25 projects) did not target a specific site, but a high number of them - for example LIFE08 NAT/D/000004- Wetterauer Hutungen, implemented in 21 SCIs, particularly when projects were based on species-oriented actions, such as LIFE08 NAT/E/000062- VENENO NO, conceived to fight the use of illegal poison in Spain (in 173 Natura 2000 sites).



Initial conditions

The process starts identifying the initial conditions of the sites/areas where the 25 selected LIFE projects were implemented, in particular their main ecosystem types(for the purposes of this report and for simplicity's sake, we used "ecosystem types" as a main parameter, as in European Commission (2011), instead of the habitat types listed in Annex I of the Habitats Directive (HD). The main ecosystem type groups used are:

- Forests (Annex I HD: forests);
- Grasslands;
- Wetlands (Annex I HD: raised bogs and mires and fens, also humid grasslands, also freshwater habitats);
- Rivers and lakes (Annex I HD: freshwater habitats);
- Coasts and estuaries (Annex I HD: coastal and halophytic habitats);
- Dunes (Annex I HD: coastal sand dunes and inland dunes);
- Heath and scrub (Annex I HD: temperate heath and scrub, sclerophyllous scrub - matorral);
- Rocks and caves (Annex I HD: rocky habitats and caves)

Other ecosystem types considered, as in Rudolf de Groot et al (2012)[32], include:

- Marine / Open ocean;
- Cultivated;
- Multiple ecosystems.

The baseline condition is described in accordance with the Habitats Directive Art. 17 reporting requirements:

- unfavourable – bad (UNFAV-BAD),
- unfavourable – inadequate (UNFAV-IN)
- favourable (FAV),
- unknown (U).

[32] Global estimates of the value of ecosystems and their services in monetary units

Step 3. Selection of the conservation measures to be analysed in monetary terms

The purpose of this step is to identify the most relevant conservation measure/s implemented in the LIFE projects object of our analysis., for the monetary evaluation purpose

Conservation measure/s

Identification of conservation measures

This step selects the conservation measures of the project that will be further analysed in Step 6 of the evaluation (monetary valuation). In the context of this report, conservation measures are defined as all interventions addressed to enhance the conservation status of ecosystems/habitats/species in relation to the baseline situation.

In this step we selected single conservation measures or combinations of measures, ranging from general overarching approaches to specific, localized interventions. These measures are mainly actions to maintain, restore or improve the conservation status of habitats and species of Community Interest.

Steps 2 and 3 are summarized in Table 2.

Table 2: Project characteristics: initial conditions, problems targeted, objectives, selection of conservation measures to be analysed more in depth

Project title	
Affected site	
Site description	
Threats	
Initial conditions	
Conservation objectives	
Conservation measures	
Selection of conservation measure	

Step 4. Affected surface area on which impacts occur

This step identifies, on the basis of the available information, the surface area affected by the conservation measures selected for the monetary evaluation, for a number of ecosystem types selected in their turn as the most relevant in terms of impact of the conservation measures.

This second analysis is summarised in Table 3.

Table 3: Impact of the selected conservation measures on the ecosystem services

Conservation measure 1	
Ecosystem types	
Description of conservation measure	

Affected ecosystem services (important impact to be expected)				
Impact on ecosystem services				
Affected area				

Step 5. Economic valuation of changes in ES

In this step we collect evidence on monetary value of changes to ecosystem services obtained in previous works all around the world and estimate the value of changes to ecosystem services produced in our 25 case studies.

6.1. Collect evidence on value of changes to ecosystem services

Available valuation evidence is identified and selected for use in our monetary valuation. In the context of this report, the Ecosystem Service Value Database (http://www.fsd.nl/esp/80763/5/0/50) has been used to identify evidence on monetary values. The Ecosystem Service Value Database (ESVD) is one of the largest databases of its kind including actual values for a range of ecosystem services and biomes in which the value estimates are organized in monetary units/ha/year to allow retrieval for value transfer (Rudolf de Groot et al 2012).

The values contained in the ESVD have been have filtered and selected from sites, ecosystems and ecosystem services with characteristics that match policy sites to which we wish to transfer values. The selected values have then been adjusted and transferred to the areas under evaluation in our report (the so called **benefit or value transfer approach**), in order to estimate the monetary value of changes in ecosystem services induced by the selected conservation measures (e.g. €/year/ha).

The use of value or benefit transfer in valuations of nature conservation measures is a relatively new approach that it is judged to have worked successfully by the European Commission (2011). There are two main approaches to benefit transfer (Navrud, 2009):

(1) Unit Value Transfer

a) Simple unit value transfer

b) Unit value transfer with adjustment for income differences

(2) Function Transfer

a) Benefit function transfer

b) Meta Analysis

In approach (1) the unit value at the study site (ST)[33] is assumed to be representative for the policy site (PS)[34]; either without (a) or with (b) adjustment for differences in income levels between the two sites (using Gross Domestic Product – GDP - per capita or Consumer Price Index - CPI) and/or differences in the costs of living (using Purchase Power Parity (PPP) indices). In approach (ii) a benefit function is estimated at the study site and transferred to the policy site (a), or a benefit function is estimated from several study sites using meta-analysis (b).

- **Unit value transfer**: this may involve either the transfer of unadjusted values, or the transfer of adjusted values to estimate the value of the change in the provision of the policy good:
    - Unadjusted unit value transfer: unit value PS = unit value SS [e.g. €/household/year for PS = €/household/year for SS]
    - Adjusted unit value transfer: unit value PS = adjustment factor × unit value SG [e.g. €/household/year for PG = a €/household/year for SG]. Adjustments to transferred values are based on empirical evidence and control for differences between the policy good context and the study good context that cause the unit value to differ between the two contexts.
- **Function transfer**: The 'value function' estimated for the study good is used to estimate the value of the change in the provision of the policy good:
    - Factors determining the value of PG = Factors determining the value of SG [e.g. €/household/year for PG = f(XPG) = f (XSG)], where f is function and X is the set of factors (related to the good, the change, and the affected human population) that are found to influence the value of the study good.

Simple unit transfer (1a) is the easiest approach to transferring benefit estimates from one site to another. This approach assumes that the wellbeing experienced by an average individual at the study site is the same as will be experienced by the average individual at the policy site. Thus, we can directly transfer the benefit estimate from the study site to the policy site. The selection of these unit values could be based on estimates from only one or a few valuation studies considered to be close to the policy site (both geographically and in terms of the good valued), or based on an average WTP estimate from literature reviews of many studies (in terms of meta-analysis).

For transfer between countries with different income levels and costs of living, **unit transfer with income adjustments** (1b) needs to be applied. When we lack data on the income levels of the affected populations at the policy and study sites, **Purchasing Power Parities** (PPPs) can be used as proxies for income in international benefit transfers.

However, even if PPP adjusted GDP (or CPI) figures and exchange rates can be used to adjust for differences in income and cost of living in different countries, it will not be able to correct for differences in individual preferences, initial environmental quality, substitute sites and goods, and cultural and institutional conditions between countries (or even within different

[33] Study site: the site where the monetary valuation was undertaken in a certain database study

[34] Reference site: the site where the LIFE NAT project has been carried out and for which we want to obtain monetary values.

parts of a country). Transferring the entire **benefit function** (2a) is conceptually more appealing than just transferring unit values because more information is effectively taken into account in the transfer. The benefit relationship to be transferred from the study site(s) to the policy site could be estimated using either revealed preference (RP) approaches like TC and HP methods or stated preferences (SP) approaches like the CV method and Choice Experiments (CE). The main problem with the benefit function approach is the need of information that is, sometimes, not available.

Instead of transferring the benefit function from one selected valuation study, results from several valuation studies could be combined in a **meta-analysis** (2b) to estimate one common benefit function. Meta-analysis has been used to synthesize research findings and improve the quality of literature reviews of valuation studies in order to come up with adjusted unit values.

Transfer method for spatial transfer*:* If the policy site is considered to be very close to the study sites in all respects, **unit value transfer** can be used. If we have several equally suitable study sites to transfer from, they should all be evaluated and the transferred values calculated from a **value range.**

As already mentioned, for unit transfers between countries, differences in currency, income and cost of living between countries can be corrected for by using Purchase Power Parity (PPP) corrected exchange rates (see e.g. http://data.worldbank.org/indicator/PA.NUS.PPP). Within a country we can also use unit value transfer with an adjustment for differences in income level, and an income elasticity of WTP lower than 1.

Function transfer can be used when value functions have sufficient explanatory power and contain variables for which data is readily available at the policy site.

NAVRUD (2009) recommends unit value transfer as the simplest and most transparent way of transfer both within and between countries. This transfer method has in general also been found to be just as reliable as the more complex procedures of value function transfers and meta-analysis. Generally speaking, error bounds of ± 20-40 % should be used if the study and policy sites are very similar (if the sites are very similar, or the primary study was designed with transfer to sites similar to the policy site in mind, an error bound of ± 20 % could be used). If there is less similarity between study and policy sites (e.g. if the study and policy sites are not quite close), error bounds of ± 100 % should be used.

Transfer method for temporal transfer**:** The value estimate should be adjusted from the time of data collection to current currency using the Consumer Price Index (CPI) for the policy site country (NAVRUD, 2009). If we transfer values from a study site outside the policy site country, we could first convert to local currency in the year of data-collection, using PPP (Purchase Power Parity) corrected exchange rates in the year of data collection, and then use the local CPI to update to current-currency values. Even though CPI is based on the preferences of consumers, they could value environmental goods higher or lower over time than the basket of goods which provide the basis for calculating CPI. However, CPI seems to be the best proxy method available as there is no general rule for adjustments of preferences for health, environmental goods or other public goods over time.

6.2. Estimate the value of changes to ecosystem services

Once impacts have been valued in monetary terms in sub-step 6.1 (*Collect evidence on value of changes to ecosystem services)*, e.g. €/year/ha, monetary values for the change in ecosystem services can be calculated over the appropriate aggregation scale:

- Summing each impact over the appraisal time period. The present value of benefits is calculated by applying discounting to make all benefits comparable in present value terms. The time period used to consider the impacts on ecosystem services has been 20 years, which is considered sufficient to capture significant impacts (all conservation measures implemented in LIFE Nature and Biodiversity projects must be long-lasting and guarantees must be provided that their results will be sustained in the long-term - at least 20 years).
- Summing the impacts of a measure across the types of benefits. This is done by summing impacts from different ecosystem service categories.

Step 6. Assessment of the overall projects' impact on ecosystem services

The purpose of this step is to identify and briefly describe the impact that the projects as a whole (with all their conservation and communication actions) had on the whole range of ecosystem services, according to the available information[35].

Conservation measure/s → Impact on ecosystem services

The qualitative overall assessment is summarised for each of the 25 selected LIFE Nature project in the below Table 4. In this table, the "Ecosystem service" column lists different categories (provisioning, regulating, cultural & supporting) and types of ecosystem services, according to the definitions included in Annex IV. The remaining columns indicate whether the different types of ecosystem services were affected or not by the project, and how. Considering that the information available was not exhaustive, the effects of the projects on the ecosystem services was in some cases assumed by the authors of this report, even when not mentioned in the consulted information sources, as in many cases these effects are well known (for example, restoring bog habitats through removing draining infrastructures have a direct positive impact on water regulation, and the restored bog habitats usually provide benefits in terms of climate change mitigation).

The second column ("Ecosystem services affected) was filled-in using two type of symbols: + and (+). The first symbol + was used when the concerned type of ecosystem services was clearly affected by the project according to the available information; the second symbol (+) was used when the information did not allow to assert that the concerned ecosystem service was affected by the project but, considering the nature of the implemented measures it was highly probable that it was at least potentially affected by them. The results of this assessment for each project is contained in Annex I.

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[35] Annex IV briefly describes the ecosystem services provided by natural sites/areas where the LIFE Nature projects are implemented. This annex is based on information in Kettunen, M. et. al. (2009) and TEEB (2010).

Table 4: General impact of the project on the ecosystem services

Ecosystems services		Ecosystem services affected	Qualitative description of impact on ecosystem service	Quantitative description of impact on ecosystem service
Provisioning services				
Biodiversity resources	Food			
	Fibre/ materials			
	Fuel			
	Natural medicines			
	Ornamental resources			
Bio-chemicals & pharmaceuticals				
Water provisioning				
Cultural & social services				
Ecotourism & recreation				
Cultural values & inspirational services				
Landscape & amenity values				
Regulating services				
Climate / climate change regulation				
Water regulation				
Water purification & waste management				
Air quality regulation				
Erosion control				
Avalanche control				
Storm damage control				
Wild fire mitigation				
Biological control				
Pollination				
Regulation of human health (physical and mental)				
Genetic & species diversity maintenance				

It must be noted that this table presents an overview of the impact of the projects on the ecosystem services according to the assessment of the authors of this report. Consultation to other relevant experts with a more precise knowledge of the particular projects (e.g. site management team and monitoring experts of the projects) would have been desirable, although out of the scope of this work.

Step 7. Assessment of the direct economic impact of the 25 projects

This section offers elements of response to certain aspects of the relationship between LIFE NAT/BIO funding and its direct impact upon local economy and job market. More specifically, it raises the question of the effects of the strategy of "a" LIFE NAT/BIO project upon qualified employment (hereafter jobs) as well as transfer of conservation fund(s) to the (local) economy. In fact, this generic question treats "a" LIFE NAT/BIO project not as a list of conservation-related themes -their expected results- but rather as an operational entity identified by the fund allocation strategy and implementation procedures.

This question can be expanded to uncover certain structural traits that are specific to the peculiarities of conservation projects. The prominent of them are:

- what is the structural/conceptual concept of "a" LIFE NAT/BIO project regarding fund allocation? Is there a "consistent" similarity pattern in the rationale of conservation projects selected/implemented? Or, is the LIFE NAT/BIO funding strategy a collection of interesting per se local singularities?
- what is the primordial sink of funds within a project? Does it correspond to the establishment of a local human/scientific/management capital? Does it promote participatory mechanisms in nature conservation? Does it establish permanent or recurring conservation activities? Does it create legal/innovative/adding value adaptation under national/local policy-making conditions?

Methodologically, three descriptors/project were used as proxies to address the above question(s), besides the country/region/conservation target/period of implementation:

- the total budget (K or M€),
- the duration (in months), and
- the distribution of funds per standardized category of expenditures[36], i.e. (1) Personnel, (2) Travel, (3) External assistance, (4) Durable goods, (5) Land/rights purchase /lease, (6) Consumables, (7) Other costs and (8) Overheads. These 8 categories are uniform across all LIFE NAT/BIO projects.

A series of indicators representing the fund allocation or distribution pattern within each project were calculated; the Shannon diversity or entropy index and the **equitability** index were retained for further regression analysis against total budget, duration and fund allocation to "Job- related" and "transfer-to-the-local economy-related" categories. The 8 categories can be further grouped into 3 major classes of expenses:

- (1) Personnel Cost; and (2) Travel Cost: grouped into ***operational*** cost
- (3) External Assistance; and (4) Land-purchase/leasing/etc.: grouped into ***constitutional*** cost
- (5) Durable equipment; (6) Consumables; (7) Other cost; and (8) Overheads: grouped into ***project management*** cost.

Obviously, the sum of the percentage fund allocated to the three classes equals to 100% - or add to 1 in relative frequencies. This uniform body of information has been treated statistically and graphically in order to (1) create a potential indicator for future econometric models relating the "economic profile" of a project and the Jobs & Growth dependent variables; and, (2) to offer a robust method for comparing the projects as boundary objects/entities, between conservation and economy.

[36] Data on expenditures are provided in the official evaluation report of each project: it is the source of information upon which the following sections are developed.

Finally, the combination of these three descriptors -i.e. budget, duration, diversity- reflects the strategy of a project and allows for inferences on its direct impact(s) upon the relevant economy metrics.

Step 8. Effectiveness and replicability

Although being the core financial instrument for implementation of nature/biodiversity conservation policies of the EU [Habitats and Birds Directives], the LIFE-Nature and Biodiversity funding mechanism proves to be besides a thorough investment to comply to Conventional engagements and therefore a targeted sink of resources, a significant source of beneficial impacts upon a niche job market -e.g. qualified conservation-related personnel- as well as upon opportunities for sustainable growth and social capital construction at local and/or regional scales.

Effectiveness is defined here as a measure of LIFE projects conservation achievement(s) per cost; it differs from *efficiency* in that the later expresses the degree to which LIFE funding (/average project) is either minimized for achieving a given set of policy targets or this set is maximized for a given level of funding (Arponen et al. 2010). *Replicability* is examined as a multi-criteria qualitative trait of the LIFE-Nature and Biodiversity family of projects that might define future priorities for selecting and funding integrated conservation activities. It is actually the operational mirroring of effectiveness when land availability, socio-political opportunities, broader EU strategy and costs are confronted and/or ideally integrated with a solid scientific planning framework for biodiversity conservation at a EU scale.

Chapter 2: Results

Monetary valuation overall results

In the literature, ecosystem service values have been reported in many different metrics and currencies for different time periods and price levels (e.g., WTP per household per year, capitalized value for a given time horizon, marginal value per acre, etc.). The ecosystem service values contained in the ESVD are Values Estimated in Monetary units (VEM). These values are estimated using a range of approaches, including market prices, cost-based approaches, stated preference methods, revealed preference methods and production function approaches. They generally represent marginal values for a specific ecosystem service provided by an individual ecosystem (they are marginal values in the sense that they represent the change in value for a small change in the overall provision of the specific ecosystem service). **To aid direct comparison and aggregation, the values in the ESVD have been standardised to common spatial, temporal and currency units**, namely 2014 Euro per hectare per year (€2014/ha/year). The values were first adjusted to 2014 values using the Consumer Price Index (CPI) for each country, which reflects the effect of inflation, and then converted to euros using appropriate Purchasing Power Parity (PPP) conversion factors relative to the year 2014. The World Bank official exchange rates, CPI[37] and PPP[38] conversion factors were used for this purpose. For EU member states which have not adopted the euro, adjusted values using the CPI were first converted to the local currency using the PPP, and then converted into euros using the European Central Bank reference exchange rates[39].

Of the original value points input into ESVD (over 1300), we only used those in per hectare per year which could thus be converted into the standardized unit (i.e. €2014/ha/year). The following tables give an overview of the minimum and maximum values of the selected ecosystem services and present value of benefits for the 25 cases (more details can be found in Annex II). The present value of benefits was estimated considering a 20-year lifetime for all conservation measures and using a 5% discount rate. As already mentioned, a relatively long timescale is considered because many of the impacts of the conservation measures of LIFE projects are expected to have a long-lasting effect (e.g. at least 20years). Discounting is used in order to compare the values of different impacts over time on a consistent basis. (See the box of the next page for the method of calculation).

[37] http://data.worldbank.org/indicator/FP.CPI.TOTL
[38] http://data.worldbank.org/indicator/PA.NUS.PPP
[39] http://sdw.ecb.europa.eu/browse.do?node=2018794

Method of calculation of the Present Value of Benefits (PVB) per project

The Present Value of Benefit (PVB) is the value of benefits provided by the changes in ecosystem services induced by the conservation measures implemented in the projects. In order to estimate de PVB we first value the impacts of the project (i.e. the change in ecosystem services) in monetary terms (€/year/ha). Once the *different* impacts of the project have been valued, monetary values for the impacts/ change in ecosystem services are calculated over the appropriate aggregation scale:

- Summing the impacts of a measure across the types of benefits. This is done by summing impacts from different ecosystem service categories (B1, B2 ... BN).
- Summing each impact over the appraisal time period. The present value of benefits is calculated by applying discounting to make all benefits comparable in present value terms.

The following formula has been used:

$$\mathrm{PVB} = \sum_{t=1}^{T} \frac{\mathrm{B1t}}{(1+\mathrm{r})^{\mathrm{t}}} + \sum_{t=1}^{T} \frac{\mathrm{B2t}}{(1+\mathrm{r})^{\mathrm{t}}} + \ldots + \sum_{t=1}^{T} \frac{\mathrm{BNt}}{(1+\mathrm{r})^{\mathrm{t}}}$$

Where,

$B1_t$ = Benefit of Change in Ecosystem Service 1 during period t (value of an ecosystem service per hectare per year * number of hectares). This "$B1_t$" is calculated by multiplying the monetary value of the change in an ecosystem service (e.g. water regulation) by the number of hectares affected by the project.

$B2_t$ = Benefit of Change in Ecosystem Service 2 during period t (value of an ecosystem service per hectare per year * number of hectares)

BN_t = Benefit of Change in Ecosystem Service N during period t (value of an ecosystem service per hectare per year * number of hectares)

r = Discount rate (we used a 5% discount rate). The discount rate element is a way to account for the fact that money in the present is worth more than the same amount in the future. Discounting is used in order to compare the values of different impacts over time on a consistent basis.

t = Number of time periods/ years. A relatively long timescale is considered because many of the impacts of the conservation measures of LIFE projects are expected to have a long-lasting effect (e.g. at least 20years).

Table 5a: ecosystem services evaluation – minimum values

Minimum values (in € 2014)

Project information		Ecosystem type	CM	Genetic/ species diversity	Cultural values	Landscape/ amenity values	Recreation	Water regulation	Water provisioning	Fire control	Climate regulation	Prevention of extreme events	Food production	Water purification	Raw materials	Soil fertility	Erosion prevention	Ecological interactions	Pollination	Present Value of benefits (€2014)
Number	Acronym			Min. Value (€2014/ha/year)																Min. Value
LIFE04 NAT IE 000125	BurrenLIFE	Cropland	CM1	355			5.0											UNK		461,405
			CM2	355			5.0							820			69.6			32,032,543
LIFE05 NAT A 000077	Grosstrappe	No information	CM1	No information available on ecosystem types																
LIFE05 NAT/B/000089	PLTTAILLES	Grasslands	CM1	UNK			0.6	5.1		UNK							35.4			1,476,404
LIFE05 NAT DK 000153	Houting	Open water (Rivers)	CM1	1171			369	UNK										UNK		11,250,554
LIFE05 NAT LV 000100	Baltic MPAs	Marine/ open ocean	CM1	0.4									6.7							Info on ha. not available
LIFE06 NAT/CZ/000121	MOROVKA	Forest	CM1	12.8	1.2	UNK	0.1													84,187
LIFE06 NAT/H/000098	HUNSTEPPICOAKS	Forests: temperate forests	CM1	2.0	1.1							0.1	0.4	1.8		66.2				385,520
LIFE06 NAT IT 000060	LIFE FRIULI FENS	Wetlands: Peat-wetlands	CM1	63.6	2068			6939	1.8				1.1			19.3				23,317,104
LIFE06 NAT/NL/000078	ROER MIGRATION	Rivers and lakes	CM1	939			298													135,358,484
LIFE06 NAT/SK/000115	ZAHORI SANDS	Dunes	CM1	1.9						41416										360,020,767

LIFE07 NAT/EE/000120	HAPPYFISH	Rivers and lakes	CM1	619			180						24.9							36,977,551
LIFE07 NAT/GR/000285	ConShagAudMIBAGR	Multiple ecosystems	CM1	83.9																268,795
			CM2	83.9																Info on ha. not available
LIFE07 NAT/LT/000530	WETLIFE	Wetlands	CM1	43.6			0.8	4164						15.6						99,196,530
LIFE07 NAT/P/000649	SAFE ISLANDS FOR SEABIRDS	Multiple ecosystems	CM1	79.7			0.1										UNK	UNK		97,209
			CM2	79.7	UNK												UNK	UNK		Info on ha. not available
LIFE08 NAT/CY/000453	PLANT-NET	Grasslands	CM1	0.04			0.5													131
		Forest	CM2	0.03																8
		Grasslands	CM3	0.04			0.5													131
			CM4	0.04			0.5													131
			CM5	0.04			0.5													131
LIFE08 NAT/D/000004	Wetterauer Hutungen	Grasslands	CM1	UNK	UNK								71.1		30.7	UNK				97,832
LIFE08 NAT/E/000062	VENENO NO	Multiple ecosystems	CM1	29.1	UNK									UNK						Info on ha. not available
LIFE08 NAT/F/000474	Life+TétrasVoges	Forest	CM1	0.0				3.5								12.3	1.1			174,163
LIFE08 NAT/FIN/000596	Boreal Peatland Life	Wetlands	CM1				61.3	8512			359					23.7				884,615,455
LIFE08 NAT/RO/000500	URSUSLIFE	Multiple ecosystems	CM1	0.4	UNK								0.0						UNK	Info on ha. not available
LIFE09 NAT/BG/000229	BLACK SEA OAK HABITATS	Forest	CM1	9.3				1.4		UNK	346									529,242
LIFE09 NAT/PL/000260	Biomass use for Aquatic W	Wetlands	CM1	36.3	1180						167				1.0					85,034,770
LIFE09 NAT/SE/000344	MIRDINEC	Wetlands	CM1	83.1			83.1											UNK		-
LIFE09 NAT/SI/000374	WETMAN	Wetlands	CM1			UNK		5531			234					15.4				14,823,381
			CM2	172			395													726,370
LIFE10 INF/UK/000189	FUTURESCAPES	Multiple ecosystems		119																166,061,388

Note: UNK = Unknown

Table 5b: ecosystem services evaluation – maximum values

Maximum values (in € 2014)

Project information		Ecosystem type	CM	Genetic/ species diversity	Cultural values	Landscape/ amenity values	Ecotourism and recreation	Water regulation	Water provisioning	Fire control	Climate regulation	Prevention of extreme events	Food production	Water purification	Raw materials	Soil fertility	Erosion prevention	Ecological interactions	Pollination	Present Value of benefits (€2014)
Number	Acronym			Max. Value (€2014/ha/year)																Max. Value
LIFE04 NAT IE 000125	BurrenLIFE	Cropland	CM1	2651			47.8											UNK		3,459,987
			CM2	2651			47.8							820			185			94,958,461
LIFE05 NAT A 000077	Grosstrappe	No information	CM1	No information available on ecosystem types																
LIFE05 NAT/B/000089	PLTTAILLES	Grasslands	CM1	UNK			1.0	5.1		UNK							138			5,194,037
LIFE05 NAT DK 000153	Houting	Open water (Rivers)	CM1	1171			2041	UNK										UNK		23,471,387
LIFE05 NAT LV 000100	Baltic MPAs	Marine/ open ocean	CM1	4.6									170							Info on ha. not available
LIFE06 NAT/CZ/000121	MOROVKA	Forest	CM1	2851	1.2	UNK	355													19,166,037
LIFE06 NAT/H/000098	HUNSTEPPICOAKS	Forests: temperate forests	CM1	2550	0.1							0.1	34.7	1.8		66.2				14,285,352
LIFE06 NAT IT 000060	LIFE FRIULI FENS	Wetlands: Peat-wetlands	CM1	2256	2068			6939	3588				2767			19.3				45,179,599
LIFE06 NAT/NL/000078	ROER MIGRATION	Rivers and lakes	CM1	939			1637													135,358,484
LIFE06 NAT/SK/000115	ZAHORI SANDS	Dunes	CM1	96.3						41416										360,139,813
LIFE07 NAT/EE/000120	HAPPYFISH	Rivers and lakes	CM1	619			1298						197							94,865,504
LIFE07 NAT/GR/000285	ConShagAudMIBAGR	Multiple ecosystems	CM1	154																493,326
			CM2	154																Info on ha. not available
LIFE07 NAT/LT/000530	WETLIFE	Wetlands	CM1	1354			4504	4164						5366						619,257,950

LIFE07 NAT/P/000649	SAFE ISLANDS FOR SEABIRDS	Multiple ecosystems	CM1	146			1365										UNK	UNK		1,840,826
LIFE07 NAT/P/000649	SAFE ISLANDS FOR SEABIRDS	Multiple ecosystems	CM2	146	UNK												UNK	UNK		Info on ha. not available
LIFE08 NAT/CY/000453	PLANT-NET	Grasslands	CM1	0.04			0.9													233
LIFE08 NAT/CY/000453	PLANT-NET	Forest	CM2	4113																1,054,681
LIFE08 NAT/CY/000453	PLANT-NET	Grasslands	CM3	0.04			0.9													233
LIFE08 NAT/CY/000453	PLANT-NET	Grasslands	CM4	0.04			0.9													233
LIFE08 NAT/CY/000453	PLANT-NET	Grasslands	CM5	0.04			0.9													233
LIFE08 NAT/D/000004	Wetterauer Hutungen	Grasslands	CM1	UNK	UNK								71.1		30.7	UNK				97,832
LIFE08 NAT/E/000062	VENENO NO	Multiple ecosystems	CM1	169	UNK									UNK						Info on ha. not available
LIFE08 NAT/F/000474	Life+TétrasVoges	Forest	CM1	4960				3.5								116	125			53,380,510
LIFE08 NAT/FIN/000596	Boreal Peatland Life	Wetlands	CM1				9209	8512			358.8					23.7				1,788,136,284
LIFE08 NAT/RO/000500	URSUSLIFE	Multiple ecosystems	CM1	93.7	UNK								51.0						UNK	Info on ha. not available
LIFE09 NAT/BG/000229	BLACK SEA OAK HABITATS	Forest	CM1	2072				1.4		UNK	346									3,586,550
LIFE09 NAT/PL/000260	Biomass use for Aquatic W	Wetlands	CM1	1287	1180						167				109					168,518,541
LIFE09 NAT/SE/000344	MIRDINEC	Wetlands	CM1	2949			9813											UNK		Info on ha. not available
LIFE09 NAT/SI/000374	WETMAN	Wetlands	CM1			UNK		5531.4			234.0					15.4				14,823,381
LIFE09 NAT/SI/000374	WETMAN	Wetlands	CM2	210			2614													4,272,765
LIFE10 INF/UK/000189	FUTURESCAPES	Multiple ecosystems		219																304,798,940

Note: UNK = Unknown

A view on the overall results of the 25 cases shows that in 15 of the projects, all selected conservation measures and ecosystem services could be monetized. In 10 projects (MOROVKA, BLACK SEA OAK HABITATS, SAFE ISLANDS FOR SEABIRDS and others), various monetary values could not be assessed for not existing previous monetary value estimations or for not existing any surface area affected or being it unknown. Despite these blanks, the present value of benefits in almost all cases could be calculated. The present value of benefits could not be estimated for projects where data on affected area was missing. 14 of the 25 cases show benefits higher than 1 million Euros (when minimum values are considered) after the conservation measures are implemented. The remaining cases have a small benefit.

These tables also show that in some projects (SAFE ISLANDS FOR SEABIRDS, WETTERAUER HUTUNGEN and VENENO NO) very few monetary values could be assessed. Other projects, have well elaborated valuation. The most frequently valued services are genetic and species diversity (22 of 25 cases), recreation and ecotourism (12 of 25 projects), and water regulation (7 of 25 projects). Other services were only valued in four or fewer cases. The inability to value some ecosystem services in most of the projects suggests there is an important data gap. The tables also allow to figure out which ecosystem service is of the greatest importance and which are marginal.

Overall indirect economic impact of the 25 selected LIFE projects

The results of the assessment of the projects' impact on the whole range of ecosystem services are detailed in Annex I. Table 6 presents below the overall results for all the 25 projects.

The overall view presented in Table 6 shows how only part of the projects' impact on ecosystem services was considered for the monetary valuation (see right columns of the table). This is justified by the lack of data and quantitative details and the need of simplifying the exercise. However, taking this into account it seems reasonable to think that in a more in-depth analysis the monetary valuation would probably be higher for most of the projects.

As in the monetary valuation, in the overall assessment the ecosystem service most frequently affected by the project is genetic and species diversity (25 of 25 projects), which was expectable as all the projects targeted natural ecosystems, habitats and species. On the other hand, other services not always selected for the monetary valuation appear here as very frequently affected, as is the case of cultural values and inspirational services (20 of 25 projects), or ecological interactions (19 of 25).

The table shows a high rate of cases where the impact is considered only as highly probable [marked with the (+) symbol] because the information contained in the reference reports did not include sufficient data to allow considering a clear effect of the project on the concerned types of services. For example, in LIFE07 NAT/P/000649 - SAFE ISLANDS FOR SEABIRDS, the reference documents mention feral goats as an important erosion threat (a quite frequent problem in natural ecosystems under high grazing pressure), a problem that would in principle be tackled by the alien species elimination intervention within a fenced area; however, there was no data on how and/or to which extent the erosion problem was mitigated.

Only in three cases it has been considered that the project could have a potential/ actual negative impact: LIFE06 NAT/CZ/000121–MORAVKA, LIFE06 NAT/H/000098–HUNSTEPPICOAKS and LIFE06 NAT/NL/000078 – Roer Migration. In the case of LIFE06 NAT/CZ/000121 – MORAVKA, the information available does not allow to assess whether the chemical herbicides used to fight invasive alien species were adequate and correctly applied; otherwise, they could have a negative impact on water bodies (this is an aspect not always sufficiently considered in the LIFE Nature projects). In LIFE06 NAT/H/000098–HUNSTEPPICOAKS herbivores control was negatively perceived by the public (also a frequent problem that must be addressed though adequate communication campaigns) and the river restoration undertaken LIFE06 NAT/NL/000078 – Roer Migration made for kayak users no longer possible to practice their sport at the targeted site and so this was the only group that reacted negatively to the implementation of the project.

Some of the types of ecosystem services were clearly affected by the projects in all or most cases (species diversity, ecological interactions, water regulation, landscape and cultural values), while other types were most of the times only potentially or unclearly affected due to the lack of data (pollination, erosion control, water provisioning, food).

On the other hand, it could be interesting to establish the difference between long-term and short-term impact of the projects (for example, planting trees will have a impact on carbon sequestration only in the long-term). This is highlighted when relevant in Annex I.

Finally, Table 6 gives a clear picture of the uncertainty of the assessment, as many (+) symbols appear, meaning that the available information was insufficient for an in depth evaluation and only very rough estimations are possible with the method used in this report (see discussion on limitations/uncertainties in the Conclusions section).

Table 6: Ecosystem services evaluation uncertainty

Project number / acronym		Biodiversity resources (food)	Biodiversity resources (fiber, fuel)	Water provisioning	Ecotourism and recreation	Cultural values & inspirational services	Landscape & amenity values	Climate / climate change regulation	Water regulation	Water purification & waste management	Erosion control	Wild fire mitigation	Biological control	Pollination	Regulation of human physical/mental health	Genetic & species diversity maintenance	Nutrient cycling and decomposition	Ecological interactions	Evolutionary processes	TOTAL + (+)	TOTALONLY +	SELECTED FOR MONETARY VALUATION
LIFE04 NAT/IE/000125	BurrenLIFE	+			(+)	+	+			+	(+)	(+)	+			+	+	+		11	8	6
LIFE05 NAT/A/000077	Grosstrappe				(+)	+	(+)									+		+		5	3	2
LIFE05 NAT/B/000089	PLTTAILLES	(+)	(+)	(+)	(+)	+	+		+		+	(+)	+			+	+	+		13	8	4
LIFE05 NAT/DK/000153	Houting	(+)		(+)					+	(+)						+		+		6	3	4
LIFE05 NAT/LV/000100	Baltic MPAs	(+)				(+)										+		+		4	2	2
LIFE06 NAT/CZ/000121	MORAVKA				+	+				(-)						+		+	+	6	5	4
LIFE06 NAT/H/000098	HUNSTEPPICOAKS		(+)		+	+	+/-	(+)	(+)		(+)					+		+		9	5	4
LIFE06 NAT/IT/000060	LIFE FRIULI FENS			(+)	(+)	+	+		+	+			+			+	+			9	7	4
LIFE06 NAT/NL/000078	Roer Migration	+			+/-											+		(+)		4	3	2
LIFE06 NAT/SK/000115	ZAHORIE SANDS					+								(+)		+			+	4	3	3
LIFE07 NAT/EE/000120	HAPPYFISH	+			+	+	+		+							+		+		7	7	3
LIFE07 NAT/GR/000285	ConShagAudMIBAGR					+										+		+		3	3	1
LIFE07 NAT/LT/000530	WETLIFE					+		+	+					(+)		+	+	+		7	6	4

LIFE07 NAT/P/000649	SAFE ISLANDS FOR SEABIRDS				+	+	+			(-)	+				(+)	+		+	(+)	9	6	6
LIFE08 NAT/CY/000453	PLANT-NET CY	(+)			+			+				+				+				5	4	2
LIFE08 NAT/D/000004	Wetterauer Hutungen	+	(+)		(+)	+	+									+	+			7	5	4
LIFE08 NAT/E/000062	VENENO NO	(+)			(+)	+				(+)					(+)	+	(+)	+		8	3	4
LIFE08 NAT/F/000474	Life+TétrasVoges				(+)	+	+	(+)	+		+					+	+	+		9	7	4
LIFE08 NAT/FIN/000596	Boreal Peatland Life				+		+	+	+					(+)		+	+	+		8	7	4
LIFE08 NAT/RO/000500	URSUSLIFE	+			(+)	+								+		+		+		6	5	4
LIFE09 NAT/BG/000229	Black Sea Oak Habitats		(+)				(+)	+	+		(+)	+				+	+		+	9	6	4
LIFE09 NAT/PL/000260	Biomass use for Aquatic W		+		(+)	+	(+)	+	(+)					(+)		+	(+)			9	4	4
LIFE09 NAT/SE/000344	MIRDINEC					+									+	+		+		4	4	4
LIFE09 NAT/SI/000374	WETMAN					+	+	+	+					(+)		+	+	(+)		8	6	6
LIFE10 INF/UK/000189	Futurescapes				(+)	+										+		+		4	3	3
TOTAL +		5	1	0	7	19	10	6	9	2	3	2	3	1	1	25	9	17	3			
TOTAL + (+)		10	5	3	17	20	13	8	11	6	6	4	3	6	3	25	11	19	4			

Direct economic impact overall results

Results obtained through this overall approach applied on the 25 selected LIFE projects allows for a series of inferences regarding the LIFE NAT/BIO family of projects.

● **First**, the strategic identity of "a" project. Each project receives the above diversity indexes[40]. Hereafter, the example of the Irish project **LIFE 04 NAT IE 000125** is presented:

Richness $R = {}^0D$:	**8,00**
Shannon Entropy $H' = \ln({}^1D)$:	**1,339**
Shannon's equitability H'/H_{max}	**64,4%**
Simpson Dominance $\lambda=1/{}^2D$	**25,1%**
unbiased (finite samples):	**36,3%**
Gini-Simpson Index $(1-\lambda)$:	**74,9%**
unbiased (finite samples):	**63,7%**
equitability $\lambda/(1-\lambda_{max})$:	**85,6%**
Berger-Parker Index $\max(p_i)=1/{}^\infty D$	**54,2%**

Table 7: Various diversity indexes calculated on data regarding the fund allocation strategy of a LIFE NAT/BIO project. *In this example*: LIFE 04 NAT IE 000125**.** *Fund allocation categories taken into account = 8, one category dominates the expenditures scheme (Berger-Parker index = 54,2%), the fund allocation strategy deviates by 64,4% from an ideal situation of total equality between expenditure categories (Shannon's equitability).*

This strategic identity could be depicted through simple graphical representations. In the simplest graphical presentation of fund allocation/project, a "pie" graph is prepared. For example, in the above Irish **LIFE 04 NAT IE 000125** example, the pictorial form is as follows:

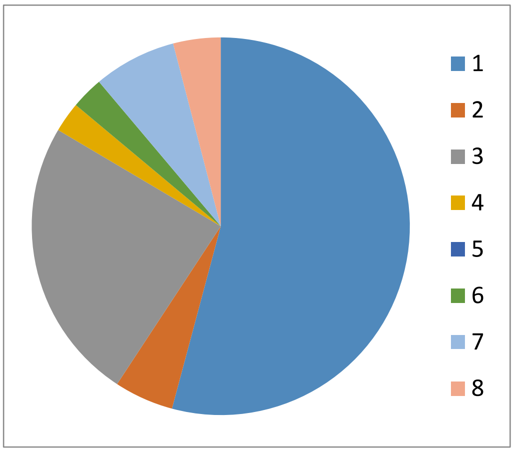

Figure 3. Pie chart for fund allocation among the 8 categories of expenditures. *In this example*: LIFE 04 NAT IE 000125**.**

Standardized colour legend: (1) personnel, (2) travel, (3) external assistance, (4) durables goods, (5) land/rights purchase /lease, (6) consumables, (7) other costs and (8) overheads.

This project allocated more than 50% of its funds to personnel expenses (i.e. conservation Jobs); the second more expensive component being transfers of funds for external assistance (i.e. hard field works/ additional work force)

A "bar" presentation is also useful to present the strategic identity of a project. For example, in the above mentioned Irish example, the graph would be:

[40] Calculations and graphs for the 25 LIFE NAT/BIO projects are presented in the Annexes of Part III.

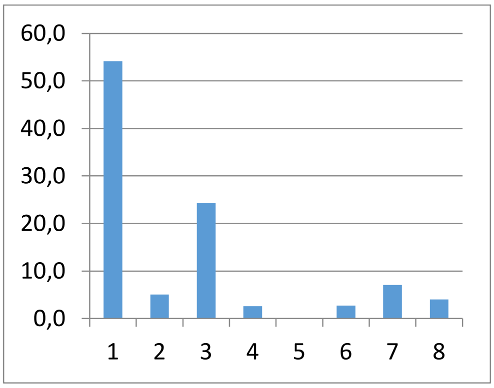

Figure 4: Bar chart for fund allocation among the 8 categories of expenditures. *In this example*: LIFE 04 NAT IE 000125**.**

Standardized legend: (1) personnel, (2) travel, (3) external assistance, (4) durables goods, (5) land/rights purchase /lease, (6) consumables, (7) other costs and (8) overheads.

● **Second,** relevant data on the three descriptors (budget, duration, indexes of diversity in fund allocation) are compiled in a unique Table 8 that serves as the data set for further statistical analysis. A typical segment of this data set (7 projects) is presented here below[41]:

Project	Budget (€)	Duration (months)	Operational cost (relative frequency)	Constitutional cost (%)	Monthly personnel revenues (€)	Total Transfers (€)	Monthly transfers (€)	Diversity	Equita-bility (%)
IE	2230487	65	0,6	24,3	20315	542008,3	8339	1,34	64,4
IT	2645000	70	0,1	85,6	2758	2264120	32345	1,11	53,2
A	5840760	60	0,055	92,4	5354	5396862	89948	0,35	16,8
B	3753300	60	0,342	64,4	21394	2417125	40285	1,3	61,6
DK	13385913	95	0,071	85,8	10004	11485113	120896	0,89	42,9
LT	3111316	52	0,592	24,3	35421	756049,8	14539	1,34	64,4
H	1863236	64	0,139	62	4047	1155206	18050	1,56	75

Table 8: Segment of the data set on the LIFE NAT/BIO descriptors. Operational cost corresponds to the sum of personnel and travel cost; it is a measure for qualified Jobs created or supported through LIFE funding: here it is presented as a relative frequency of the total budget. Constitutional cost corresponds to the sum of External assistance cost and the Cost for purchasing/leasing land for conservation; it is actually LIFE funding that is transferred to the wider community (e.g. hard work companies, specialized consultancy, non-specialized workforce, landowners...): here it is presented as % of the budget. Total transfers correspond to the entire duration of the project, although certain activities might be concentrated in a much shorter or specific period of time. In order to produce a comparative metric, Monthly transfers, i.e. total transfers divided by duration in months, are also included in the data set. Diversity and equitability are calculated as described in the text here above.

[41] The complete data set for the 25 sampled projects is presented in Annex III.

● **Third**, data on the 25 sampled projects show that the descriptor "budget" varies from <0,5 M€ to >10 M€. This large range of values is generated by both the variety and complexity of conservation targets of individual projects and non-conservation cost determinants such as unitary cost of activities involved, e.g. monthly salary or land price in the various regions. For significant trends in direct impacts of LIFE NAT/BIO upon Jobs and Transfers to be uncovered, it is necessary to strictly define "classes of budget" and run accordingly regression analyses within classes.

The average "project" could be benchmarked by a univariate naive model of an index of the form: $Budget_i = \mu + \varepsilon_i$ where *i*=1...25, *μ*: arithmetic mean value of the "budget" descriptor and ε_i: "noise" ~ *N*(0,SD), i.e. $\varepsilon_i \approx Budget_i - \mu = 0 \pm SD$. When projects are ranked in a gradient of increasing values of the "*Budget-μ"* index, significant inflection (or change) points are objectively identified in the corresponding descriptive curve (Figure 5). The most critical inflection point, i.e. when "*Budget-μ"* value ≥ 0, serves to differentiate "low budget projects" (15 over 25) from "high budget projects" (10 over 25), the limit being at 3 M€. Further, within the "high budget projects", subclasses might be identified using trends in the rate of change between them when ranked increasingly by analyzing absolute increments, i.e. absolute differences between "B-μ" values. Change points within the "high budget projects" were determined by identifying the second derivative of the index curve differing significantly from zero, i.e. at 5 M.

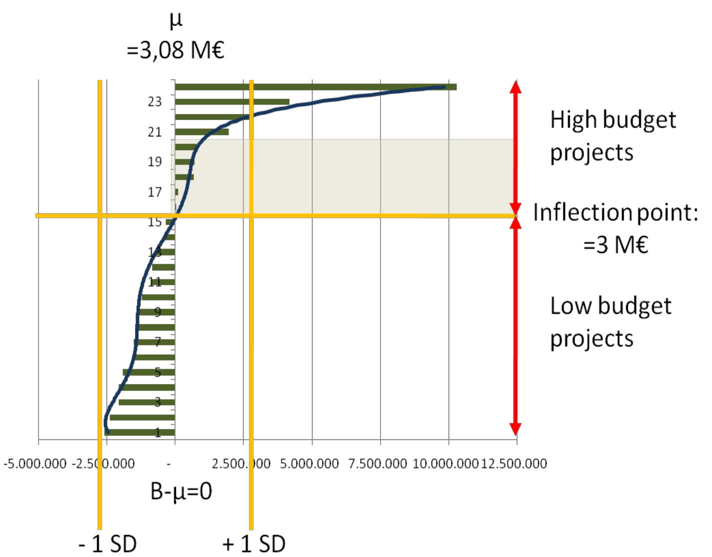

Figure 5: Definition of budget classes within the sampled LIFE NAT/BIO projects collection.

Low budget projects< 3 M€

High budget projects, subclass A: 3M<A<5M

High budget projects, subclass B: 5M<B

μ= 3,08 M€; ±1SD: standard deviation of the budget descriptor of the LIFE NAT/BIO sample.

Summary statistics of the 25 LIFE NAT/BIO projects sample are presented in Table correct

	Budget (€)	Duration (months)	Operational cost (relative frequency)	Constitutional cost (%)	Monthly personnel revenues (€)	Total Transfers (€)	Monthly transfers (€)	Diversity	Equitability (%)
Total 25 projects									
µ	3.079.935	52,1	0,4	32,9	24.254	1.398.127	21.691	1,3	60,8
SD	2.751.384	13,3	0,26	28,2	25.900	2.554.531	31.143	0,3	16,8
CV_{total}	**0,89**	**0,25**	**0,58**	**0,86**	**1,07**	**1,83**	**1,44**	**0,28**	**0,28**
Low budget projects									
µ	1.648.449	51,0	0,5	27,3	14.250	482.938	8.757	1,4	68,8
SD	693.512	9,7	0,2	22,2	8.526	567.877	8.371	0,2	10,2
CV_{low}	**0,42**	**0,19**	**0,43**	**0,81**	**0,60**	**1,18**	**0,96**	**0,15**	**0,15**
High budget projects									
µ	5.465.745	53,9	0,4	42,4	40.928	2.923.442	43.247	1,0	47,4
SD	3.267.511	18,3	0,3	35,5	36.069	3.742.858	42.772	0,4	17,6
CV_{high}	**0,60**	**0,34**	**0,81**	**0,84**	**0,88**	**1,28**	**0,99**	**0,37**	**0,37**

Table 9: *Average (µ), Standard deviation (SD) and Coefficient Variation (CV) of the main descriptors of 25 sampled LIFE NAT/BIO projects. Classes are defined according to the criteria presented here above. µ: arithmetic mean; SD: Standard Deviation; CV: coefficient of variation.*

LIFE NAT/BIO family of projects is heterogeneous as far as the structure *per se* of funding and internal fund allocation is concerned. The major structural difference among classes of budget refers to the strategy of fund allocation: in fact, a kind of conceptual dichotomy arises between "low" and "high" budget classes. "High" budget projects are not simply more expensive or longer in duration: they adopt a model of outsourcing of activities and resources in comparison to the "low" budget projects that adopt an in-house model of expenditures. High budget projects favour fund transfers[42] to the wider community, influencing therefore local economy *sensu lato* whereas low budget projects focus on supporting qualified personnel.

● **Fourth,** the ordination of the 25 sampled LIFE NAT/BIO projects into a 2D and/or a 3D fund expenditure space[43] suggests that the projects could be grouped into sub-groups with a clear identity each (Figure 6).

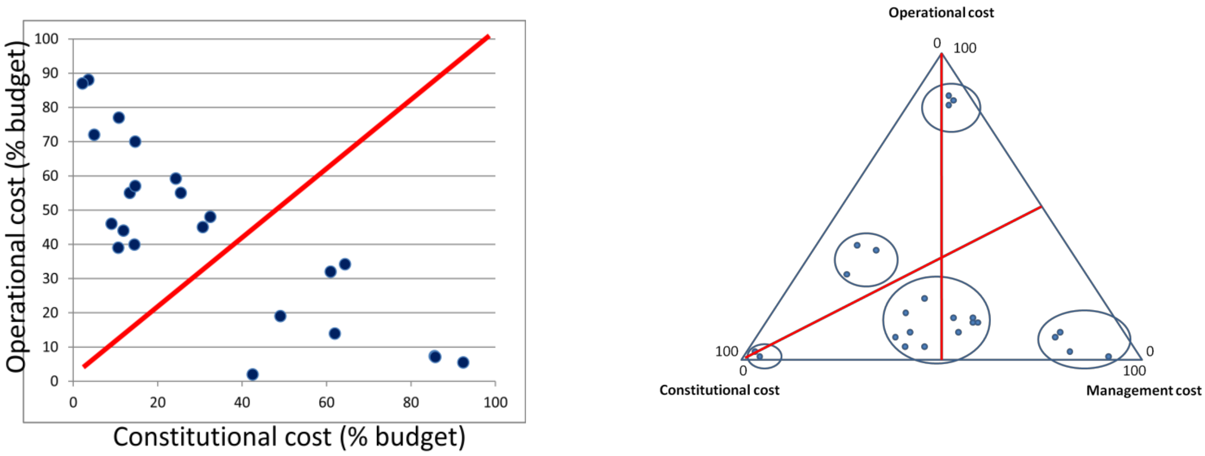

Figure 6: *[left panel] ordination of the sampled LIFE NAT/BIO projects in a 2D space "operational cost X constitutional cost": two sub-groups are clearly identifiable; [right panel] triangular ordination of the sampled projects in a 3D space of the three major classes of expenses: more sub-groups are identifiable.*

The major sub-groups are the following:

- **Sub group 1:** emphasis on hard direct field application of conservation or restoration measures. Funds are primarily allocated to land purchase or lease; funds are also transferred, apparently to external sub-contractors, for field-works and/or consulting, e.g. electric cable burial in the **LIFE 05 NAT A 000077** case or fencing in the **LIFE 06 NAT H 000098** case.

- **Sub group 2:** emphasis on capacity building, regulations, awareness and public participation, i.e. soft measures. Funds are primarily allocated to qualified personnel and travel, e.g. **LIFE04 NAT/IE/000125** and **LIFE 05 NAT LV 000100**.

- **Sub group 3:** a mixed strategy that comprises both hard and soft measures, around more sophisticated conservation concepts, e.g. landscape connectivity in the **LIFE 05 NAT B 000089** case. Apparently, this kind of strategy necessitates both expert personnel and funds for land purchase or lease.

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[42] By transfers we mean any expenditure that channeled funds towards external providers of services, work, or land.

[43] Calculations and graphs for the 25 LIFE Nature projects are presented in Annex III.

This sub-grouping is not neutral regarding both the ecosystem services issue AND the effects upon "Jobs & Growth". For instance, **sub-group 1** has *de facto* direct effects upon ecosystem functioning and therefore services. On the contrary, **sub-group 2** impacts upon human/social/legal capital in the perspective of a better use of ecosystems and the adoption of better practices in resource/service appropriation by local communities and economy sectors.

Further, regarding the question of Job creation and/or fund transfer to local economy, **sub-group 1** has rather minimal effects on job market of qualified personnel and superior effects upon jobs in the field workforce market. The opposite seems true in the case of **sub-group 2.**

● **Fifth,** regression analyses uncover interesting relationships between descriptors. The most meaningful among them regarding the direct impacts of LIFE NAT/BIO upon Jobs and Transfers are:

- **The duration of the project does influence significantly the total budget (Figure 7)**

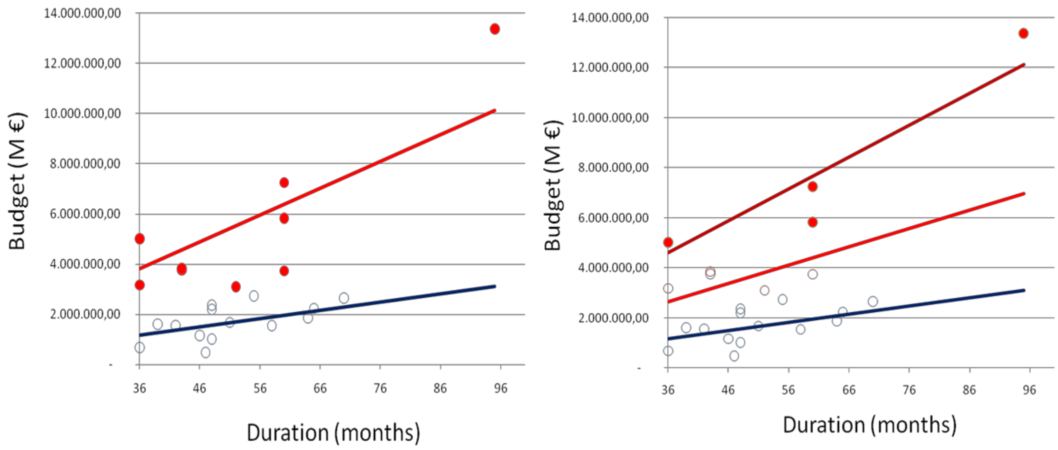

Figure 7: [left panel]: linear relationship between duration and budget of a LIFE NAT/BIO project.
Blue line: low budget projects, slope=32668 €/month, R2=0,34, p<0,05; red line: high budget projects: slope=106.471 €/month, R2=0,68, p<0,05. [right panel]: high budget projects are differentiated into two classes; Red line, 3M<Budget<5M €: slope=73443 €/month, R2=0,31, p<0,10; Brown line, Budget>5 M€: slope=127767 €/month, R2=0,88, p<0,05.

This is not trivial as it might seem at first glance, since the duration of a project is not a goal *per se* but a measure of its maturation; for instance, it reflects the necessity to complete preparatory actions, to implement technical works in the field and to achieve agreements with local/national Administration and stakeholders, e.g. land-owners. Therefore, duration *per se* does create direct impacts upon economy and job market.

- The total budget/funding of a LIFE NAT/BIO project does not influence significantly the fund expenditure diversity/equitability of a project (Figure 8).

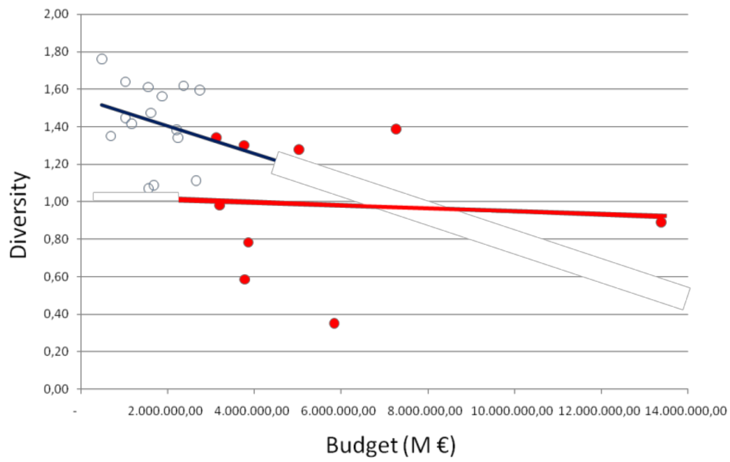

Figure 8: The two budget classes, low vs. high, differ significantly between them when data are fitted by a linear relationship, as to their origin constant. Blue line: low budget projects: b=1,551; Red line: high budget projects: b=1,04. However, in both classes R2 and p's are non-significant.

The budget *per se* of a LIFE NAT/BIO project is not a determinant of the internal allocation of funds. Therefore, it can't influence qualitatively the strategy of the project and its relative direct impacts upon Jobs and Transfers. On the contrary, when components of the total budget, such as the operational or the constitutional are used as drivers of either Jobs or Transfers significant linearities do appear: e.g. Figure 9.

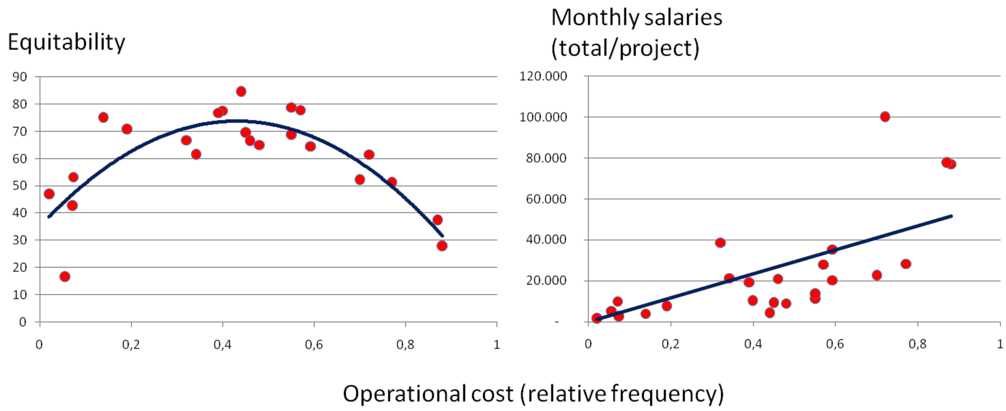

Figure 9: Best-fit relationships between operational cost of a LIFE NAT/BIO project and fund allocation strategy [left panel] or monthly expenditure for salaries (a proxy for Jobs) across the 25 sampled projects. ***[left panel]: 2nd degree polynomial, R2=0,69, p<0,05; [right panel]: linear, slope=58711 €/unit of operational cost, R2=0,47, p<0,05.***

- The equitability of fund expenditure within a project, i.e. the partitioning/ allocation of funds, does influence to a moderate degree the "Jobs" component of the project (Figure 10).

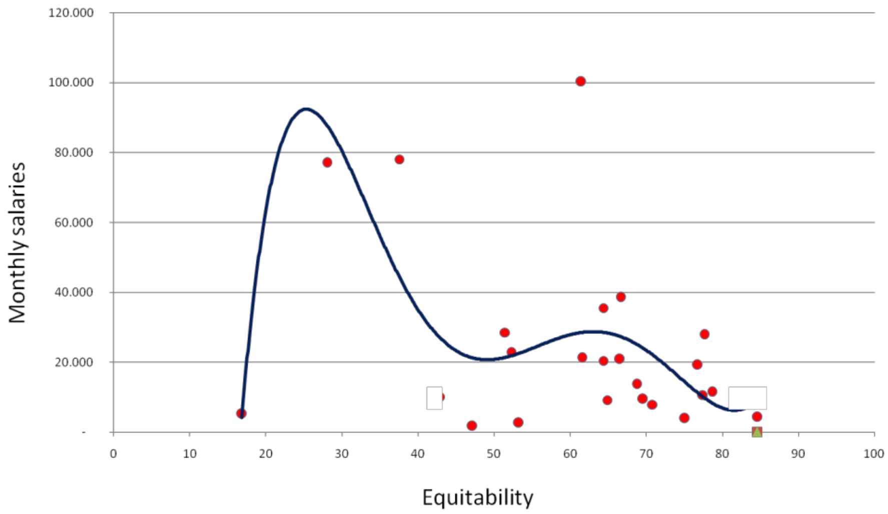

Figure 10: Best-fit relationship between monthly salaries (as a proxy for Jobs) and the equitability of fund allocation within a project, across the 25 LIFE NAT/BIO projects sample. Two peaks are observed in a 6th degree polynomial [R2=0,39, p<0,10], the first corresponds to the high budget projects, the second to the low budget ones.

As a generalization, projects that select an operational model that prioritize in-house based implementation of project's provisions and plans, mostly low budget projects, maximize their direct impact upon salaries (a proxy for Jobs) at a level of ca 65% of equitability in internal fund allocation. On the contrary, projects that adopt outsourcing strategies, mostly high budget projects, maximize impact upon salaries at 25% of equitability.

- **Equitability has a significant negative impact on fund transfers to external components of economy (Figure 11).**

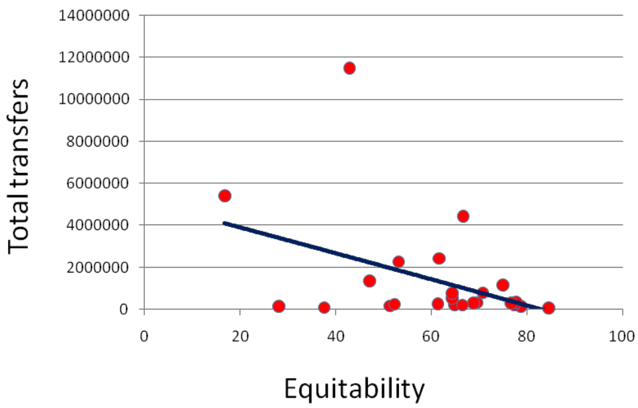

Figure 11: Best-fit relationship between total LIFE fund transfers to the wider community/economy and the equitability of fund allocation within a project, across the 25 LIFE NAT/BIO projects. First, 2nd and third degree polynomials do present a statistical pattern of ca R2=0,20, p<0,05.

The negative relationship between transfers to local economy and equitability presents the strongest significance among all studied dependencies. Therefore, to maximize the secondary effects upon "growth", presumably at a local scale, of the strategy of a project that is structurally oriented towards a high level supervision/ commanding of outsourced activities, either as external scientific/field work expertise or directing funds towards the acquisition/long-term leasing of land for conservation, the higher the investment on land purchase/leasing and/or the request for external assistance, the more significant the impact would be.

Chapter 3: Replicability and effectiveness overall results

In this report, *replicability* is viewed as a property of a LIFE NAT/BIO project that characterizes its potential to serve as a "model" that combines multiple traits enabling strategies for focused and goal-driven selection procedures for future LIFE funding. In fact, *replicability* should integrate a minimum set of driving criteria for fund allocation in space and time that might go beyond typical administrative weightings such as partitioning among Member States or peripheries.

Obviously, the first criterion is the ecological/conservation effects of conservation measures funded as a measure of response to the environmental policy commitments of European Union [Habitats and Birds Directives, Natura 2000 network, etc.]. The second criterion is cost-effectiveness in the sense of maximization of these effects for a given amount of funding. Additional criteria might emerge from traditional policy-analysis such as transaction cost(s), decision-making, or monitoring and evaluation; further, "new" dimensions might emerge from the analysis of interactions, e.g. various compensation payments, with major production sectors that steadily adopt environmental criteria, such as Agriculture, Energy, Transports, Urban Development etc.

The analysis of the sample of the 25 typical LIFE NAT/BIO projects shows that some core conceptual similarities concerning conservation effects do exist among the projects; the underlying hypotheses, properly stated, are presenting a consistent range of approaches that deal with the specific target of each project. They can be summarized as follows:

- In ecological setups where biodiversity/ecosystems co-evolve with traditional land use/practices, the intermediate disturbance hypothesis should be applied. Example: LIFE04 NAT/IE/000125. It applies mostly in cases where interactions with agriculture, and especially the abandonment on traditional practices, lead to abatement of several ecosystem services and biodiversity resources.

- Removal or control of accidental and/or voluntary death-causing factors (together with additional habitat management) increase the viability of populations. Example: LIFE05 NAT/A/000077 or LIFE08 NAT/E/000062.

- Conservation engineering methods increasing connectivity, lowering patchiness and supporting metapopulations (including stepping stones for migratory species): (a) Size increase of patches and increase of connectivity between fragments in altered landscapes might lower the risk of extinction of local populations. Example: LIFE06 NAT/IT/000060. **(b) Integrated measures/interventions at the landscape-level could allow for increase in connectivity and natural recolonisation of habitats.** Example: LIFE05 NAT/B/000089. **(c) Drastic and integrated measures/interventions at the riverscape-level could allow for increase in viability and sustainable population size of species.** Example: LIFE05 NAT/DK/000153.

- Designation procedures and implementation measures in marine areas and terrestrial SACs/SPAs could be trans-nationally replicated and improve the conservation status of habitats/species. Examples: LIFE05 NAT/LV/000100 or LIFE06 NAT/H/000098.

The relationship between budget (i.e. cost) and ecosystem service(s) value (i.e. a proxy for effectiveness) may be represented by a scatter graph of projects. More simply, this diagram plots each project on a graph measuring the project's effect upon ecosystem service(s) against the funds invested by the LIFE mechanism. It does not "map" any further attributes of the projects. However, it might be helpful in two cases:

- if (and when) a main sequence of projects is uncovered in such a diagram, it might represent a step towards an understanding of project evolution or the way in which projects priorities undergo sequences of dynamic and radical changes over time, i.e. in the various phases of development of the LIFE mechanism. Figure 12 presents the relationship between budget and ecosystem service(s) minimum value — and its hypothetical, randomly simulated boundaries — using a third degree polynomial. Within the 25-pool of sampled LIFE NAT/BIO projects, the most important factor driving the relationship appears to be the capital invested for land purchase/leasing[44].

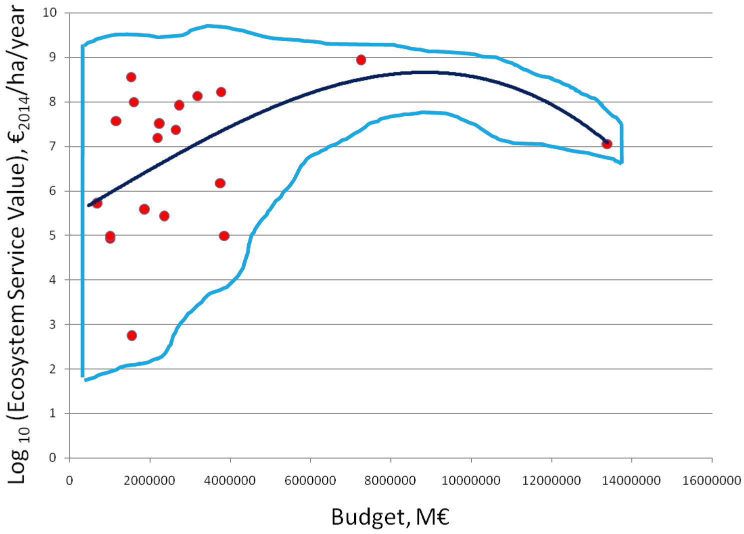

Figure 12: Relationship between LIFE NAT/BIO funds invested and minimum value of ecosystem service(s). Best fit [dark blue curve] is represented by a third degree polynomial (R2=0,17, p<0,5); boundaries [light blue lines] are the extreme limits of the core curve after 100 random simulations of the polynomial.

- if (and when) the question of replicability as a property for selecting future LIFE NAT/BIO projects does fall into the **"trap of preferential choice".** The challenges for the funding agency are depicted in the following figure:

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[44] In this Figure, as in the previous, there is a temptation to consider that we have an outlier effect: the statistics on projects that have been analysed clearly indicate that two (2) among them (LIFE05 NAT/DK/000153 and LIFE05 NAT/A/000077) do influence severely the final statistical significance as they are departing significantly from the "cloud" of the core projects. However, we cannot say these are “real” outliers, as they are integral part of the LIFE Programme, chosen for their specific qualities, rather than the product of some error in measurement or random effect, as in a typical econometric experiment.
In fact, these two projects share some interesting common characteristics:
- they are target-species conservation oriented;
- they adopt strong field-work interventions (mostly removal of established heavy infrastructure, related mainly to power production/distribution);
- they are based on a principle of indemnification/compensation of stakeholders for reversing land/resource use;
- they adopt a model of outsourcing of expertise and field-work;
- they "come" from EU Member States with high-GDP/capita.

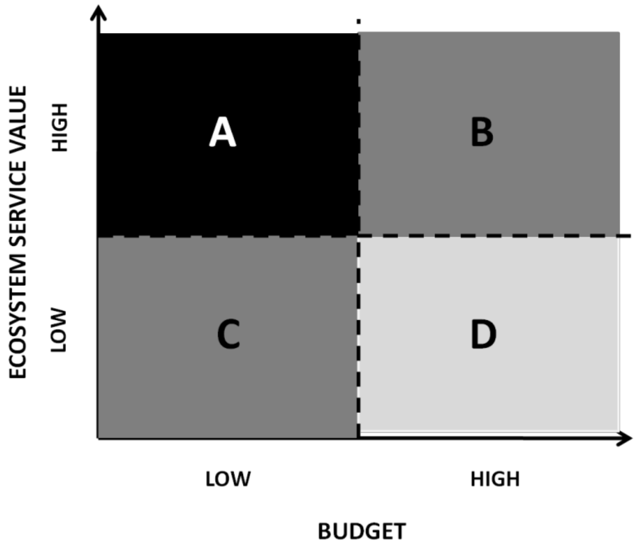

Figure 13: Rough definition of 4 classes of LIFE NAT/BIO projects based on the combination of "budget" and monetary "ecosystem service value".

Budget classes (low vs. high) might be defined objectively: e.g. limit of 3 M€ (see text for explanation).

Ecosystem value classes are more contentious to define, given the level of uncertainty of results of monetary valuation methods and the local peculiarities.

Projects of type A (low budget/high ESV) are by intuition examples of cost-effectiveness, assuming that their targets and expected results are compatible with the requirements and predictions of conservation science and policy. On the contrary, projects of type D (high budget/low ESV) should address questions of biological and ecological uniqueness and irreplaceability to justify their selection in the perspective of cost-effectiveness.

Competing projects of types B and C are those necessitating selection decisions that actually do mitigate the biases of preferential choice of the evaluation procedure. Figure 14 presents an example of such cases.

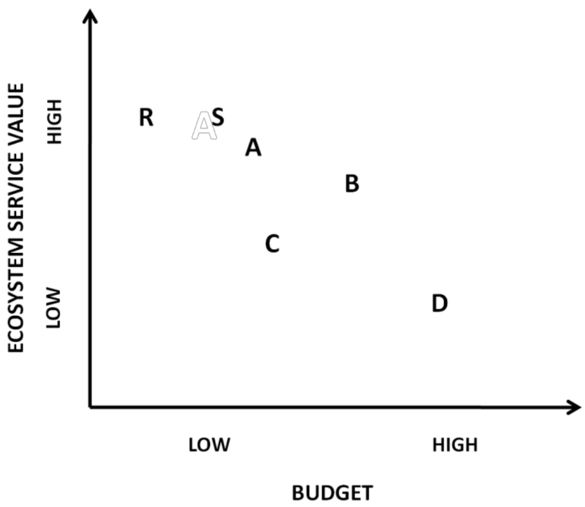

Figure 14: A graphical depiction of the problem of selecting between projects based on the criteria of budget and monetary value of ecosystem service(s).

First case: replicability as similarity

Suppose that the funding agency faces the problem of funding a proposal -that fully complies to technical excellence metrics- on the criterion of replicability by "adding" a new project of the type A (R or S) in comparison to a project of the type D.

In that case, the new proposal is highly similar to projects A and highly dissimilar to projects D (and to some extent projects B or C). If ***replicability*** is considered as bounded to ***similarity***, then it is highly probable that it would have reduced probability to get funded since a new competitive proposal to the choice set **reduces the probability** of selecting/choosing similar projects more than dissimilar ones. This is a **well known phenomenon** from the marketing and consumer behaviour research.

Second case: replicability as attraction

Suppose that the funding agency faces the problem of funding a proposal -that fully complies to technical excellence metrics- on the criterion of replicability by "adding" a new project of the class A in comparison to a project of the class C or D, but the new proposal has lower performance to some secondary criterion of effectiveness, e.g. regarding Jobs & Growth .

In that case, the new proposal is purposively designed to be highly similar to an older proposal A and dissimilar to D or C, but the "older" project dominates the "new" proposal on all or a series of critical attributes. At the same time, the "new" proposal does not dominate proposals of the class D or C. Under these circumstances, the funding agency will face a kind of ***asymmetrical decoy effect or an attraction effect***. This means that the "new" proposal will have increased probability to be chosen.

Third case: replicability as compromise

Suppose that the funding agency faces the problem of funding a proposal -that fully complies to technical excellence metrics- on the criterion of replicability by "adding" a new project that lies between extreme options, e.g. a C-project between A and D. In that case, three "equally" attractive proposals are competing, but as indicated by their pairwise comparisons and A and D are extremely different and C is a compromise that lies in between these previous extremes.

Research indicates that in that case when all three options are available for selection, the compromise is chosen more frequently than either of the extremes. The three above cases indicate that the question of replicability is extremely complexe and that the idea of selection of future proposals on the basis of single criteria or alternatives of discoursive strength and/or of intrenal project fund allocation prioritization might be naive. Complex multialternative decision making approaches should be adopted.

Chapter 4: Conclusions and Projections

The application of the described method for the monetary assessment has allowed to obtain economic values for some conservation measures implemented in a set of 25 LIFE Nature projects. The method applied combines inputs of changes in ecosystem services and environmental economics to value the impact of conservation measures on the ecosystem services. Inputs on ecosystem service changes were based on information mostly contained in the LIFE projects ex-post evaluation reports, and then linked to economic valuation evidence. Although this does not always provide an accurate picture due to uncertainties in monetary valuation (see below), the methodology is considered to be able to provide at least rough estimates of the benefits that the conservation measures provide, and constitutes a suitable method for identifying economic values associated with conservation interventions.

For the entire sample of 20 (out of the 25) projects that it was possible to obtain monetary values of direct ecosystem services benefits, we obtained an aggregate present value in the range of ***1,8 to 3,7 € billion. Extrapolating to the 479 projects of the 2004 – 2010, by taking the lowest figure of the range, we estimate the value created by LIFE during a programming period in Nature projects at € 43 billion[45].***

However, it must be emphasised that the method implies a number of limitations and uncertainties in the values obtained that can (and do) hinder accurate calculations. These are mainly related to:

1- The method itself.

- The method was based on a selection of conservation measures of the projects under study and on a selection of types of ecosystem services (those more likely to be affected by the conservation measures) instead of considering the whole project and the whole range of ecosystem services. This necessarily implies disregarding important impacts, as highlighted in the Results section.

- Calculations were based on a targeted site and a surface area affected by the projects. However, there was not always a targeted site and an affected area, as many LIFE Nature projects are species-oriented actions and so do not necessarily include land-based actions (such as habitat restoration) and/or focus on any specific Natura 2000 site (in many cases they do focus on a high number of sites), as was the case of the 50% of the selected LIFE projects of this study. Therefore, some of the projects under analysis did

[45] We also attempted a series of sensitivity analyses of the Present Value of Benefits (PVB) in order to illustrate the sensitivity of our results to variations in the discount rate and selected time horizon. The results are given in the Annexes, and are based on discount rates of 5 per cent and 2 per cent, and an expected life of the conservation measure of 20 and 30 years. As expected, the results are highly sensitive to the choice of the discount rate and the assumed length of life. Generally speaking, reducing the discount rate to 2 per cent leads to an increase of the PVB by approximately 30 per cent, while increasing the expected life from 20 to 30 years pushes the PVB up by around 40 to 50 per cent. Thus, the combined effect of a 30-year/2-percent vs. a 20-year/3-percent estimation is a notable increase of the ecosystem services value by roughly 80 per cent. However, in making the programme-wide projections, we preferred to keep the most conservative approach of the initial 20-year/5-percent hypothesis.

have a relevant impact on ecosystem services, but it could not be measured for not existing an “affected area”.

2- The economic valuations used as reference (Environmental Service Value Database).

  - The Environmental Service Value Database contained a wide range of sources, necessarily meaning a wide range of methods used and heterogeneous results.

  - Not all the ecosystem services had corresponding economic evidence in the Environmental Service Value Database used as reference for our assessment. Therefore, there were not always economic values of reference.

3- The available information on the LIFE projects under evaluation.

  - The available information on the projects’ impact on the ecosystem services was scarce and inaccurate (for many types of ecosystem services even inexistent), as in the programming periods when the LIFE Nature projects under evaluation were approved such data were not compulsorily and systematically required. This is the case of erosion control, landscape and amenity values and cultural values, among others.

The evaluation will be more accurate, and thus will have more reliable results, as knowledge of ecosystem services and studies on their economic value increases. On the other hand, a precise definition and description of the projects’ conservation measures and the results obtained from them is crucial for valuing their impact on ecosystem services. Both the LIFE Nature proposals and the monitoring and evaluation reports should make reference to clear and well-defined indicators. This will be possible in the future with the application of the new LIFE Regulation and the set of indicators established in the multiannual work-programme for 2014-2017. In this regard, the abovementioned LIFE indicator database will be of crucial importance for these kinds of analysis.

Application of the economic valuation method requires input from environmental economists, who are aware of relevant valuation evidence and methods (together with an in-depth analysis undertaken by experts in nature conservation, who know well the effect that the conservation measures have on the ecosystem services). In this sense, it is important to promote the use of databases that contain information on monetary values of changes in ecosystem services, such as the Environmental Service Value Database used in this study.

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PART IV: Special Report – Financing LIFE projects replication

Introduction

LIFE Programme has financed successfully implemented projects with strong sustainability and replicability attributes, bearing significant number of the characteristics of the green investments sought after investors. However, it is usually the case that the stakeholders involved in LIFE projects fail to attract the required funds thus projects though successful fail to replicate.

Therefore there is substantial ground for further exploration of newly developed or under development instruments and structures and for further elaboration on how these may be used to finance and successfully combined with completed LIFE projects.

Of course, a detailed analysis is necessary and will be required in an attempt to successfully fine tune and match specific LIFE projects with specific or alternative green financial instruments or structures currently available in the market.

1. The Global Landscape of Green Finance

The Global Landscape of Climate Finance 2015 of the Climate Policy Initiative (CPI) presents the most comprehensive information available on which sources and financial instruments are driving investments, and how much climate finance is flowing globally.

It aims to provide an updated picture on how, where, and from whom finance is flowing toward low-carbon and climate-resilient actions globally, and to improve understanding of how public and private sources of finance interact. It also tracks progress towards commitments made by developed country Parties to the UNFCCC (United Nations Framework Convention on Climate Change) to mobilize US$ 100 billion annually for climate interventions in developing countries by 2020.

Despite existing obstacles in both the definition of climate finance as well as in gathering data the CPI has used a methodology with special references on the amount of climate finance not included and refers to a 3year period. The amount of climate finance invested around the world after levelling off in 2012, and declining in 2013, increased by 18%, from US$ 331 billion in 2013 to an estimated US$ 391 billion in 2014 with he bulk of climate finance being provided by the private sector.

Public climate finance is on the rise, with contributions by governments and intermediaries reaching at least an amount of US$ 148 billion (range of US$ 144–152 billion) in 2014, an 8% increase from 2013 levels, and a 10% rise from 2012. Public actors are increasingly recognizing the benefits of climate action for achieving their goals as well as that managing climate change is in their national economic interest.

Private investment in renewable energies grew by 26% in 2014 after two years of decline, resulting in record volumes of new installed capacity (103 GW). With US$ 243 billion, private investment remained the largest source (62%) of global climate finance captured in Landscape 2015. Policy and market signals, predictable and stable profits, and the strategic potential of investments are key determinants of private actors' financing behaviour. Obtaining the requisite technical expertise, gaining access to finance, and managing project risks remain key challenges for enabling shifts in the patterns of private climate finance investments.

To deal with existing limitations CPI followed a uniform philosophy however, the data that are not captured by the Global Landscape 2015 if added could more than double the level the amount of Global Climate Finance invested around the world.

Available data continues to show that private actors rely primarily on their own balance sheets to finance renewable energy projects accounting for 72% or US$ 175 billion of total private investment in 2014.

Mostly, they relied on balance sheet financing to invest in solar PV projects in high-income and upper-middle income countries such as Japan, the US and China.

The reasons for investors' reliance on balance sheets can vary, including the size of the project (it can make more sense to finance small projects internally), difficulties in securing debt, high costs of capital, and other factors.

Public actors delivered more than half of their financing in the form of grants and low-cost loans, which accounted for 10% (US$ 14 billion) and 47% (US$ 69 billion) of total public finance respectively. Over the past three years, grants' share of total public finance averaged 9% (US$ 13 billion), while the share of low- cost loans averaged around 50% (US$ 71 billion), both with a +/- 10% from 2012 levels attributable to data uncertainties.

Grants made up more than half of government entities' and Climate Funds' respective commitments, and most of those for which we had project-level detail supported projects in low and lower-middle income countries – 34% of total grants (US$ 5 billion).

Twenty-six low-cost loans (including concessional loans) accounted for the majority of bilateral and national DFIs' financing – 64% (US$ 11 billion) and 78% (US$ 52 billion) respectively. 43% of low-cost loans (US$ 30 billion) helped reduce the capital costs of mitigation and/or adaptation projects in high- and upper-middle income countries.

Public concessional or lower-than-market-rate finance, including loans with longer tenors and grace periods, play a catalytic role by supporting the establishment of policy frameworks, strengthening technical capacity, lowering investment costs, and reducing investment risks for the first movers in a market. Country macroeconomic and institutional conditions and the existence and level of project-level revenues are key determinants of the appropriate combination of grants versus loans.

Multilateral (Development Finance Institutions) DFIs provided 84% (US$ 40 billion) of their commitments as market-rate loans – often blended with governments and Climate Funds' concessional resources – primarily for sustainable transport and renewable energy generation projects (35% or US$ 14 billion and 26% or US$ 10 billion of total market debt extended respectively). Around one third of the about US$ 2 billion external resources managed by multilateral DFIs for which we have details, supported the financing of greenfield renewable energy generation, and mostly targeted projects in Sub-Saharan Africa, East Asia and the Pacific, and Latin America and the Caribbean.

Multilateral DFIs also provided a significant portion of climate finance, around US$ 1.5 billion of their resources, in the form of risk management instruments.

These instruments, which can encompass credit guarantees, political risk insurance, and contingency recovery grants, can play a critical role in enabling private investments in the context of political uncertainty, or to back private equity and debt financing in countries with more challenging investment environments.

Due to the risk of double counting, these are not captured as part of Global Landscape of Climate Finance total estimate and are not officially supported export credit guarantees.

In this landscape, labelled green bonds are used to finance only a tiny fraction of the Global Climate Finance despite the high rates of growth recorded since their debut in the global bonds market.

Another financing instrument that has also financed a small fraction of Global Climate Finance and has steadily attracted a growing interest of investors mostly in the US, is the Yieldco structure. Fifteen US and European YieldCos grew in value from USD 12 billion in 2013 to more than USD 20 billion in 2015 (see BNEF, 2015c).

Despite the fact that well-established instruments continue to finance the bulk of green projects, investors are experimenting with new approaches. Governments and banks in order to broaden the instruments and structures available for climate financing and support the global environmental finance have formed specific structures such as Funds focused and prioritised in green development. They also, participate directly or indirectly to several institutions specially formed to support their development with initiatives such as EIB Initiatives, UNEP Initiative, the Climate Policy Initiative, or the Climate Bond Initiative or the Green Lab.

In the following section of our report a general view of all these newly developed or under development financing instruments, vehicles and institutions will be presented and analysed in some extent to provide the reader with fundamental knowledge and allow for further thought of their use and connection for financing of LIFE Programme projects replication.

2. Green Bonds

Green bonds (or climate bonds) are like ordinary bonds with proceeds earmarked for green investments that have been explicitly labelled as “green” by their issuers.

The first, ever, green bond was issued in 2007 by EIB (European Investment Bank). The World Bank followed shortly after, in 2008, and issued green bonds responding to specific demand from Scandinavian Pension Funds seeking to support climate focused projects while the issuance fell well within its efforts to encourage climate change adaptation and mitigation

The market has slowly caught on, but has seen rapid rates of growth reaching an over US$41.8 billion issuance in 2015 from US$807 million in 2007.

As the market grew rapidly, market players have sought to bring greater clarity to the definitions and processes associated with green bonds.

Using the experiences of the Multilateral Development Banks (MDB’s), originally the only issuers which still dominate the market, in early 2014 a group of banks initiated the development of the Green Bond Principles (GBP) - a set of voluntary guidelines framing the issuance of green bonds. In a second edition published in March 2015, the GBP encourage transparency, disclosure, and integrity in the development of the green bond market.

The GBP suggest a procedure for designating, disclosing, managing and reporting on the proceeds of the bond. They are designed to provide issuers with guidance on the key components involved in launching a green bond, including providing information to aid investors in evaluating the environmental impact of their green bond investments. The International Capital Markets Association acts as the GBP’s secretariat and facilitates the work of its members, including issuers, investors, banks underwriting green bonds and other market participants.

The GBP recognize several broad categories of potential eligible projects, which include but are not limited to the following:

- Renewable energy
- Energy efficiency (including efficient buildings)
- Sustainable waste management
- Sustainable land use (including sustainable forestry and agriculture)
- Biodiversity conservation
- Clean transportation
- Sustainable water management
- Climate change adaptation

Drawing from the practice of earlier issuers and the GBP, green bonds issuers have developed their own green bond definition and processes to suit their business profiles.

Investors in green bonds expect information from issuers in sufficient detail to allow them to assess green bond offers, such as how issuers track and use green bond proceeds and how they report the positive impacts expected from green projects.

The Investor Network on Climate Risk, (a North American non profit organization convened by CERES that advocates for leadership in sustainability), has articulated its expectations in a statement to guide issuers and other market participants.

The market has been relying on issuer disclosures, second opinions and commentary from academics, investment advisers, auditors, technical experts media and NGO such as CICERO, the Climate Bonds Initiative, Det Norske Veritas (DNV), Norway, Ockom, Sustainalytics and Vigeo among others.

Several green bond indices (for example Barclays, Morgan Stanley Capital International (MSCI), Standard's & Poors and Solactive are useful benchmarks for green bond portfolios and support transparency in definitions and processes.

The early issuance of Green Bonds by Multilateral Development Banks and the availability of Green Bond Principles have formed the basis for a number of issuers to develop their processes suitable for their business models and practices.

Many have worked with investors to fine tune the categories of eligible projects and disclosure and reporting agencies. Cities, States and State owned Entities (Subnationals) pioneered in the issuance of Green Bonds include the British Columbia, the City of Gotenburg together with Swedish Bank Skandinaviska Enskilda Banken (SEB), the City of Johannesburg, the State of Massachuseetts, the Bi-Lateral, Trade and Development Agencies, the Export Development Canada and the KfW Development Bank.

Similarly, Utilities companies include the District of Columbia Water and Sewer Authority (DC Water) and the CDF Suez. Among the corporates that have issued green bonds the Regency Centers Corporation and Toyota Financial Services are included. Commercial Banks currently involved in green bonds include Bank of America, ABN AMRO and Yes Bank.

In Europe, Institutional Investors (such as pension funds and insurance companies) and in the United States investors with strong environmental focus were the first green bond investors. Since then, green bonds have appealed to a broader group of investors including asset managers, companies, foundations and as well as to increasingly diverse type of investors.

The profile of issuers has also changed as the bond market has benefited from the participation of different kinds of issuers. 2014 and 2015 saw multiple "firsts" by other issuers such as commercial banks, corporations and municipalities.

2015 saw also the issuance of the China Bank guide on green bonds signalling the state's support and commitment to their use for financing environmental friendly projects.

The level of green bond issuance stood at US$ 41.8bln by the end of 2015. The majority of issuers remain the MDB's while 2014 saw the entrance of corporates and municipalities providing a broader spectrum of risk (and return) in green bond offerings. Important to note is also the fact that though other types of instruments have appeared to finance environmental projects, such as Yieldco's (publicly traded companies created by a parent company that bundle operating infrastructure assets to generate predictable cash flows that are then paid out in dividends to shareholders. In the United States and the United Kingdom, Yieldco's raised $4.5 billion in 2014.) or the instruments developed under the Global Innovation Lab for Climate Finance, they have not shown the dynamics the growth trends of green bonds issuance has shown.

Their pricing is the same as that of the ordinary bonds. Though the data available are not considered sufficient, a recent study by Barclays Bank showed that there is an extra 20 basis points (0.20) on their pricing in the secondary market.

Critics claim that funds raised by green bonds could have been raised by regular bonds. The additional attractive characteristic of green bonds is that they appeal to different types of investors, investors seeking or focused on sustainable and responsible investing (SRI) and investors that incorporate environmental, social and governance (ESG) criteria as part of their investment analysis. Furthermore, they have proven to be an effective tool to raise awareness about issuers' projects addressed to climate change and other environmental challenges.

The amount of just over US$ 40 billion of the total green bond issuance in 2014 compared to a total bond market of over US$90 trillion, or of US$ 391 billion of the total Climate Finance Market (as estimated by the Climate Policy Initiative), provides considerable prospects for the green bonds market to grow. So does the total of US$ 65.9 billion outstanding labelled green bonds to an estimated total outstanding Climate Aligned Bonds of US$ 531.8 billion according to a report conducted by the Climate Bonds Initiative.

Issues such as increased transparency around connecting the source of funding with the expected impact, possibly with a green rating scheme, or improvement of existing standards are of great importance and will assist to this direction. The role of the public sector will also be crucial.

During the UNFCC Paris Agreement COP21 in December 2015 green bonds appeared as a solution to the existing investment gap of climate finance.

3. The Green Lab – Global Innovation Lab for Green Finance

"The Lab" is a global initiative that supports the identification and piloting of cutting edge climate finance instruments. Developed by the UK, the U.S. and Germany is in partnership with several climate finance donor countries (Denmark, France, Japan, the Netherlands, Norway) and key private sector representatives. It forms part of broader government and private sector efforts to scale up climate finance.

Analytical and secretariat work of The Lab has been funded by the UK Department of Energy & Climate Change (DECC), the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), the U.S. Department of State, the Netherlands Ministry for Foreign Affairs, Bloomberg Philanthropies, and The Rockefeller Foundation.

Climate Policy Initiative serves as The Lab Secretariat and has led the analysis of proposed instruments, drawing on the expertise of Lab members and additional financial and investment leaders as appropriate.

Based on proposals from around the world, The Lab has identified, developed and delivered instruments with potential to drive investment in developing countries at scale. Up to date the Lab has called for proposed instruments in two cycles. The instruments outlined below are per cycle.

The instruments of 2014-2015 are at a more advanced stage of development or even are endorsed while those of 205-2016 are at the elaboration phase. They are mostly instruments to facilitate rather than provide finance. However, outlined here below included is a fund as well as a mechanism to provide finance to a group of aggregated small loans.

2014-2015 A Cycle Instruments

i. LONG TERM FX Risk Management
This instrument provides tools to address currency and interest rate risk for climate relevant projects in developing countries.

ii. Climate Investor One
Climate Investor One facilitates early-stage development, construction financing, and refinancing to fast-track renewable energy projects in developing countries.

iii. Energy Savings Insurance
This instrument insures the financial performance of energy efficiency savings projects. The pilot in Mexico is underway, and the challenge now is to replicate in additional sectors and regions.

iv. Renewable Energy Platform For Institutional Investors
By facilitating institutional investment in renewable energy projects, REPIN aims to increase the scale of available financing and to reduce its costs.

v. Agricultural supply chain adaptation facility
The instrument aims to provide farmers with know-how and finance for climate-resilient investments. The Facility does this by enabling development banks to partner with agribusiness corporations who empower farmers within their supply chains.

vi. Debt Fund for prepaid energy access
The Debt Fund would lend to energy service providers of prepaid solar home system products and services, providing the necessary working capital to expand energy access in Sub-Saharan Africa.

vii. Global renewable independent power supplier (GRIPS)
GRIPS will be a renewable energy service company, building and operating a diversified portfolio of hybrid energy plants in remote areas.

2015 – 2016 B Cycle Instruments

Following the 3 December Advisors' Meeting in Paris, in which Lab Advisors voted in six Lab ideas as finalists The Lab's Second Cycle (Lab 2.0, 2015-2016), the Secretariat led a scoping process with proponents for each idea. Again in this second cycle they are facilitating instruments and not financing instruments per se. The interesting issue in this cycle is the concept of "water bond".

The instruments, which will move forward from the scoping phase, are described below:

i. Water Financing Facility
The Water Financing Facility would help create bankable projects to attract domestic private investors and build climate-resilient water infrastructure in at-risk regions.

ii. Climate Smart Finance for smallholder farmers in developing countries
This instrument, currently a demonstration project, provides credit providers with an "out-of-the-box" set of tools for managing the issuance of loans to smallholders and incentivizing climate smart agricultural practices.

iii. OASIS Platform for catastrophe and climate risk assessment and adaptation
This open access platform aims to increase data and analytics to enable risk assessment for investments in insurance and resilience products, and climate adaptation.

iv. Small Scale Renewables Financing Facility
This instrument is a small-scale renewable energy financing facility that would support local project developers gain access to finance.

v. Mobilising `Equity to Drive Energy Efficiency Investments
To mobilize private capital at scale for energy efficiency financing in emerging economies in both private and public sector investments by providing the much needed risk (equity) capital.

4. Green Loans

European Investment Bank Green Loans (InnovFin EU Finance for Innovators)

The Risk-Sharing Finance Facility (RSFF) financed some 114 RDI projects to the tune of EUR 11.3bn, catalysing a further EUR 37.2 billion in private investment in European Innovation. Building on the success of its predecessor, InnovFin is a debt-based instrument set to double this and trigger a multiple of investments. Funded by Horizon 2020, it covers the full company lifecycle from SME to large cap, stimulating more investment in research and innovation notably by the private sector. InnovFin is demand driven and technology neutral with the potential to support low carbon technologies and first of a kind demonstration projects (e.g. renewable energy and smart grid sectors). By 2020, it is expected that the InnovFin products will make available more than EUR 24bn of financing for research and innovation by small, med-cap and large companies and the promoters of research infrastructures.

A mid-cap is a company, which at the time of the application employs less than 3,000 full-time employees on a consolidated basis and is eligible for Growth Financing (GFI) if it meets at least one of the following two conditions:

A. The company is a "fast growing enterprise" measured by employment or turnover. Annualized growth in sales or full-time employees > 10% a year over the last three years, or

B. The company is an "R&D or innovation-driven enterprise", if it meets at least one of the following conditions:

1) R&D to Sales ratio is equal of higher than 5% for the last fiscal year, or

2) The company undertakes to spend at least 80% of the loan amount on research, development and innovation activities over the next 36 months, or

3) The company has been awarded grants, loans or guarantees from the European R&D or innovation support schemes (e.g. FP7, Horizon 2020) or regional or national support schemes over the last 36 months, or

4) The company won an innovation prize over the last 24 months, or

5) The company registered more than one patent over the last 24 months, or

6) The company received cash investment from an innovation-driven VC, or

7) The company is registered in a science, technology, or innovation park, or technology cluster or incubator, in each case, for activities related to RDI, or

8) The company has benefited from tax credit related to innovation or investment in R&D in the last 24 months.

The UK Green Investment Bank

The UK Government established, Green Investment Bank Plc, is the first bank of its kind in the world financing infrastructure projects, which are green and profitable. The projects the GIB invests in are in sectors such as the Offshore Wind, Energy Efficiency, Waste and Bioenergy and onshore renewable.

Funded and supported by the UK Government the GIB uses the funds available to back green projects, on commercial terms, across the UK and mobilise private sector capital into the UK's green economy. Among its five specifically created five funds to finance small projects of £2 million are the UKCI (UK Climate Investments LLP) and the UK Green Investment Offshore Wind Fund.

The UKCI is a joint venture of the UK GIB and the UK Governments Department for Climate Change (DECC) aiming to adopt GIB's approach to projects in the UK. The joint venture will make minority equity investments of c. £10-30m into renewable energy generation and energy efficiency projects using proven technologies.

In addition its own investments in the UK's offshore wind market, the UK Green Investment Bank established the UK Green Investment Offshore Wind Fund, through its wholly owned subsidiary UK Green Investment Bank Financial Services Limited (GIBFS), to invest in operating offshore wind farms in the UK. It is the largest renewable energy fund in the UK attracting investors such as UK-based pension funds and international institutional investors among which one of the world's largest sovereign wealth funds and a leading European life and pension company.

5. Green Funds

European Investment Bank Equity Funds

Equity funds allow EIB to provide indirect equity or target projects that would otherwise be too small to benefit from its lending activities whilst enabling investment into new asset classes to gain experience and to potentially mainstream these into the EIB core business at a later stage.

Existing EIB equity funds are:

i. Eco-Enterprises II
Deploys expansion capital otherwise unavailable to growth stage sustainable ventures in fields such as organic agriculture, non timber forest products, sustainable forestry or ecotourism. Instruments used include quasi-equity, structured royalty streams and warrants, convertible notes and long-term debt financing.

ii. Dasos Timberland II
This fund targets sustainable forestry and biomass investments, mainly in Europe. It consists of a timberland portfolio well diversified in terms of geography, age, wood fiber and end use. The total size of the fund is EUR 300m and EIB's contribution stands at EUR 30m. EIB adds value by improving sustainable forest management and certification as well as exploiting identified market inefficiencies and benefitting from the delivery of ecosystem services.

iii. Glennmont Clean Energy Fund II
It is a renewable energy fund, managed by Glennmont, a spin- off of BNP Paribas, and aims to make around 15 investments, primarily in the onshore wind, solar, biomass and small hydro sectors in Europe. EIB committed EUR 50m to this fund targeting a total of EUR 450m in commitments. EIB investment took the fund to EUR 250m in size, and supported the establishment of a new investment house dedicated to renewable energy investment.

iv. Althelia Climate Fund
Althelia Climate Fund invests in projects that promote sustainable land use by reducing deforestation and protecting biodiversity. EIB investment of EUR 25m will help mobilize EUR 150m in total private equity investments in Africa, Asia and Latin America. Althelia is also supported by 50% loss guarantee from the US agency for International Development offering country risk coverage for up to 133m of the portfolio.

v. Global Energy Efficiency and Renewable Energy Fund
Advised by the EIB, this Fund of Funds was launched in 2008 with funding totaling EUR 112m from the European Union, Germany and Norway. In 2013 GEEREF was joined by private investors and the fund size rose to 200m by 2014.GEEREF aims to anchor new private equity funds focusing on renewable energy and energy efficiency projects in emerging markets and economies in transition (Africa, Caribbean and Pacific regions, non EU Eastern Europe, Latin America and Asia). As of the end of 2014 GEEREF has invested in seven funds aiming for a triple bottom: people, planet and profit. GEEREF aims to invest in total 14 funds, mobilizing private capital sector risk capital and further achieving a highly catalytic effect.

European Investment Bank Layered Risk Funds

Layered-risk funds are a special form of equity fund that allow the issuance of different tranches of capital in the form of shares and notes to offer investors different risk-return profiles in a type of public private partnership. Typically, the EIB acts as a cornerstone investor and sponsor and structures the fund around public resources targeting a specific policy outcome, such as extending financial cover- age to new or "underbanked" markets, or to demonstrate innovative financial structures. These funds channel finance and, in some cases, technical assistance to transactions that are too small to be handled directly by the EIB.

The capital structure of such an investment vehicle typically rests on the provision of a first-loss piece (termed Junior - C Shares in the figure) by donors. This risk cushion allows the EIB and other public financiers to invest in more senior A or B tranches, bringing the benefits of the EIB's financial strength as an AAA rated bank to achieve economic sustainability and stimulate investment from other sources. Once the asset side of the fund develops, this structure allows the possibility of issuing notes to private investors who remain most senior in the cash waterfall of the fund.

i. European Energy Efficiency Fund (EEEF)

In cooperation with the European Commission and managed by Deutsche Bank, EEEF aims to provide market-based financing for viable small-sized energy efficiency and renewable energy projects in the EU. Launched in 2011, EEEF deploys both debt and equity instruments to provide fast and flexible financing to support small and innovative projects with tailored financing solutions. Currently a EUR 265m fund, it intends to grow to EUR 800-900m by attracting public and private investors.

The EEEF is providing upfront financing to an energy service company (ESCO) by purchasing 70% of the energy savings expected to come from the retrofitting of the Jewish Museum. In addition to winning the European Energy Service Initiative's Award for the best European energy efficiency service project, the Jewish Museum project is an EEEF trailblazer in terms of financial structuring, designed to foster ESCO structures in the European market.

ii. Global Climate Partnership Fund (GCPF)

The EIB has secured approval to invest in an existing donor-supported debt provider, the GCPF, which can provide long-term liquidity to small local financial intermediaries or co-finance projects alongside them, potentially working to extend the overall tenor of the debt or through a subordinated loan.

Supporting the EU's climate change and environmental policy objectives, this debt fund focuses on financing small-scale energy efficiency and renewable energy investments. The EIB's participation will encourage a focus on sub-Saharan Africa and also contribute to the United Nations Sustainable Energy for All (SE4All) initiative.

iii. Green for Growth Fund (GGF)

GGF is the first specialised fund to advance energy efficiency and renewable energy in South-Eastern Europe – including Turkey – and Eastern Neighbourhood regions. Initiated by the EIB and KfW Entwicklungsbank (German government owned Development Bank), GGF was established to reduce energy consumption and CO2 emissions. With nearly EUR 290m committed by investors, GGF provides refinancing to financial institutions to enhance their participation in the energy efficiency and renewable energy sectors. It also makes direct investments in non-financial institutions having projects in these areas.

Green Climate Fund

The Fund is a unique global initiative to respond to climate change by investing into low-emission and climate-resilient development. The GCF was established by 194 governments, aiming to limit or reduce greenhouse gas emissions in developing countries, and to help adapt vulnerable societies to the unavoidable impacts of climate change.

GCF is accountable to the United Nations and guided by the principles and provisions of the UN Framework Convention on Climate Change (UNFCCC). Given the urgency and seriousness of the challenge, the Fund is mandated to make an ambitious contribution to the united global response to climate change.

Access to GCF resources to undertake climate change projects and programmes is possible for accredited national, regional, and international entities. Accredited Entities (AEs) can submit funding proposals to the Fund at any time.

Climate Investment Fund

Climate Investment Funds' stakeholder base includes: countries, civil society organizations (CSOs), indigenous peoples, private sector entities, multilateral development banks (MDBs), UN and UN agencies, GEF, UNFCCC Adaptation Fund, bilateral development agencies, and scientific and technical experts.

The $8.3 billion Climate Investment Fund (CIF) is providing 72 developing and middle income countries with urgently needed resources to manage the challenges of climate change and reduce their greenhouse gas emissions.

Since 2008, the CIF has been leading efforts to empower transformations in the energy, climate resilience, and transport and forestry sectors. CIF concessional financing offers flexibility to test new business models and approaches, build track records in unproven markets, and boost investor confidence to unlock additional finance from other sources, particularly the private sector and the multilateral development banks that implement CIF funding. Total CIF pledges of $8.3 billion are expected to attract an additional $58 billion of co-financing for a portfolio of over 300 projects and counting.

The CIF is comprised of four programs:

- The $5.6 billion Clean Technology Fund (CTF) provides middle-income countries with highly concessional resources to scale up the demonstration, deployment, and transfer of low carbon technologies in renewable energy, energy efficiency, and sustainable transport.
- The $1.2 billion Pilot Program for Climate Resilience (PPCR) is helping developing countries integrate climate resilience into development planning and offers additional funding to support public and private sector investments for implementation.
- The $780 million Scaling Up Renewable Energy in Low Income Countries Program (SREP) is helping to deploy renewable energy solutions for increased energy access and economic growth in the world's poorest countries.
- The $771 million Forest Investment Program (FIP) supports efforts of developing countries to reduce deforestation and forest degradation and promote sustainable forest management that leads to emissions' reductions and enhancement of forest carbon stocks (REDD+).

6. Yieldco's

Yieldco's is a new financing vehicle developed the last couple of years, mainly in the US, to finance projects in the area of energy and energy renewables. A YieldCo is generally defined as a company that predominantly distributes its cash flows from owned operating assets as dividends or other payments to investors. These financing vehicles are gaining popularity and momentum, specifically for portfolios of assets with contracted cash flows from investment grade counterparties. Due to relatively low market yields YieldCo's are exceedingly sought after as a low risk alternative.

YieldCo investment structures follow the pattern of Real Estate Investment Trusts (REITs) and Master Limited Partnerships (MLPs), a popular investor option mainly in the US since the 1980's, and apply it in a wider range of business areas to power infrastructure and generation.

For investors, REITs and MLPs provide two major benefits – tax advantages and liquidity. The ability to pass through untaxed earnings to investors avoids the often maligned issue of double taxation, in which corporate earnings are taxed along with investor income from interest, dividends, and capital gains. Additionally, the ability to trade on public markets provides investors with greater flexibility with regard to investment time horizon.

There are restrictions on the type of business which REITs and MLPs may pursue. REITs must generate a defined amount of earnings through real estate ownership or indirectly from mortgage interest. They typically own commercial and residential properties, which are highly differentiated, illiquid investment classes otherwise inaccessible to most investors. There are some small capitalization REITs that focus on investment in energy efficiency and renewable energy, but these are a small minority of the total asset class.

Unlike REITs and MLPs YieldCos have no technical restrictions on asset or income composition (again, other than market expectations of stability in cash flow). Consequently, YieldCos can be created from assets that would not generate the qualifying income required for pass-through treatment under the tax law currently applying in the US.

The YieldCo structure typically involves the sponsor company contributing cash-generating assets into a limited liability company (the LLC). The YieldCo then raises cash from the public through an initial public offering (IPO) of its stock, and uses the IPO proceeds to buy an interest in the LLC. The sponsor retains an economic interest in the LLC but typically has no economic interest in YieldCo, only a majority voting interest, which allows the sponsor to control investment and operational decisions.

<u>Example</u>:
An interesting example is the recent $431 million Initial Public Offering (IPO) in July 2013 of NRG Yield (NYLD), an equity carve out of NRG Energy's conventional, renewable and thermal generation assets.

NRG Yield, Inc. was formed as a Delaware corporation, on December 20, 2012, to serve as the primary vehicle through which NRG Energy, Inc., the leading integrated power company in the U.S, owns, operates and acquires contracted renewable and conventional generation and thermal infrastructure assets. The Company owns a diversified portfolio of contracted renewable and conventional generation and thermal infrastructure assets in the U.S.

The motivation for the deal, as stated in the prospectus, was for NRG Energy and NYLD to raise cash for growth and development opportunities, and to optimize the company's capital structure with low cost equity. NYLD's deal pipeline, acquisition opportunities intended to support dividend growth, is primarily composed of other NRG Energy generating assets to which NYLD has the “right of first offer.” NRG maintains ownership of 70 percent of the economic and voting rights in NYLD and interests appear to be operationally aligned. However, there are potential transactional conflicts between the two parties as NRG Energy could influence NYLD to overpay for assets acquired from NRG Energy.

YieldCos can theoretically deliver a combination of benefits that can address perceived limitations of other structures — namely, (1) the YieldCo offers a promise of regular and predictable cash distributions, unlike the majority of publicly traded stocks; (2) the YieldCo offers a tax shield to its investors (similar in net result to that of an MLP for certain periods); and (3) as a corporation for US federal income tax purposes, non-US investors and tax-exempt investors may have a greater investment appetite for this trending vehicle.

Fifteen US and European YieldCos grew in value from USD 12 billion in 2013 to more than USD 20 billion in 2015 (see BNEF, 2015c). See CPI, The Global Landscape of Climate Finance, 2015. A report published by Deutsch Bank in 2015, claims that Yieldcos (the renewable energy finance vehicles) currently financing 1% of the global climate finance, are likely to outgrow their oil and gas equivalents which have grown by 27% over the last 24 years and sets its expectations to a magnitude of 1 trillion in the next 10 years. The Deutsch Bank’s analyst also expect YieldCos to not only increase the availability of capital, but also to provide significantly lower cost of capital to the renewables sector.

7. Initiatives

European Investment Bank Initiatives

The EIB is involved in a series of innovative climate finance initiatives in collaboration with the European Commission, EU Member States and other international financial institutions both within and outside the EU. These initiatives aim to support new or innovative projects and products or provide risk-sharing/risk- reduction mechanisms to stimulate additional low-carbon project development.

Analytically described below, these initiatives are:

i. Debt for Energy Efficiency Projects Green (DEEP Green)

The EIB launched the DEEP Green initiative to complement its existing financing offer for energy efficiency investments in several EU countries. DEEP Green aims at developing a suite of new financial products for four key groups of players in the energy efficiency market: banks, public sector, ESCOs and utilities. Launched in 2014, the first concrete result in cooperation with the European Commission is the Private Finance for Energy Efficiency (PF4EE) scheme, helping local financial intermediaries to support the roll-out of national energy efficiency plans and ultimately to increase lending for energy efficiency projects. By providing long- term low-cost loans, credit risk protection and enhanced lending expertise to local banks, this initiative is expected to unlock at least EUR 500m of dedicated financing to reduce energy bills.

ii. Natural Capital Funding Facility (NCFF)

Also launched in 2014, NCFF is backed by EUR 125 m, provided by the European Investment Bank and the European Commission under the LIFE Programme. It represents a new and innovative approach to financing projects promoting the restoration, protection and enhancement of natural capital in the EU. As part of the NCFF, the EIB will lend directly to projects or provide credit lines to commercial banks so that they can make loans for eligible projects. In addition, the EIB can take shares in equity funds that invest in natural capital projects. Eligible projects will include nature conservation, green infrastructure, eco- system services, biodiversity offsets and compensation beyond legal requirements as well as sustainable agriculture, forestry, aquaculture and eco-tourism. This initiative demonstrates the potential for long-term private sector investment in projects currently seen as too challenging to be viable for the private sector on its own. The NCFF will start with a 3 to 4-year pilot phase and is expected to finance between 9 and 12 operations.

iii. Renewable Energy Performance Platform (REPP)

The UN has created the SE4All initiative to provide sustainable energy for all by 2030; for those who luck access to energy, the initiative aims to provide access. For those having access to energy, the initiative aims to provide cleaner and more efficient.

In support of the SE4All initiative and alongside the United Nations Environmental Programme (UNEP) the EIB has developed REPP to stimulate the bankability of innovative small and medium scale renewable energy projects in Sub Saharan Africa by helping them tom access risk protection and financing products. With REPP EIB seeks to mobilise private sector development activity and investment in small/medium scale projects through improved access to existing risk mitigation instruments, long term lending and results-based financial products. With REPP, the EIB seeks to mobilize private sector development activity and investment in small/medium scale projects through improved access to existing risk mitigation instruments, long term lending and results based financial support.

United Nations Finance Initiative (UNEP FI)

Founded in 1992 in the context of the Earth Summit in Rio, and based in Geneva, Switzerland, the United Nations Environment Programme Finance Initiative (UNEP FI) was established as a platform associating the United Nations and the financial sector globally. The need for this unique United Nations partnership arose from the growing recognition of the links between finance and Environmental, Social and Governance (ESG) challenges, and the role financial institutions could play for a more sustainable world.

UNEP FI is continuously building its membership, and works closely with over 200 members, who have signed the UNEP FI Statement of Commitment. The membership is made up of public and private financial institutions from around the world and is balanced between developed and developing countries. They recognize sustainability as part of a collective responsibility and support approaches to anticipate and prevent potential negative impacts on the environment and society.

Banking, insurance and investment, the three main sectors of finance, are represented and brought together in this unique partnership. In addition, UNEP FI develops selective collaborations, UN-driven and finance sector-driven, with other partner organizations, in order to increase awareness and raise support for critical activities. UNEP FI contributes the perspectives of financial institutions to the various United Nations and global activities on sustainable finance.

The Initiative's work includes:

• Capacity building and the sharing of best practices;

• Pioneering research and tools;

• Setting global standards and principles;

• Engaging stakeholders, both public and private;

• Facilitating the networking of members and stakeholders through global events and regional activities.

UNEP's cross-cutting themes are embedded throughout UNEP FI's activities, specifically in its thematic work areas of Climate Change, Ecosystems Management, Energy Efficiency and Social Issues.

The UNEPFI structure aims to Unlock Private Climate Finance for the implementation of the 2030 Agenda.

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