LIFE Project Number

LIFE13 ENV/ES/000660

FINAL Report

Covering the project activities from 01/06/2014 to 30/04/2018

Reporting Date

31/07/2018

LIFE+ PROJECT NAME or Acronym

LIFE ENERBIOSCRUB

Project Data

Project location	Spain
Project start date:	01/06/2014
Project end date:	31/12/2018; **Extension date:** 30/04/2018
Total Project duration (in months)	47 months
Total budget	1,889,758 €
Total eligible budget	1,878,558 €
EU contribution:	939,279 €
(%) of total costs	49.7
(%) of eligible costs	50
Beneficiary Data	
Name Beneficiary	CIEMAT
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1 List of contents

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2 Executive Summary

(maximum 5 pages)

Briefly describe the project objectives, key deliverables and outputs, and include a paragraph summarising each chapter of the main report. This summary should be a stand-alone text and must be provided in English as well as in the language in which the rest of the report is written.

The ENERBIOSCRUB project aims at achieving the policy objectives of the EU environmental management promoting the improvement of marginal scrub forests by obtaining solid biofuels and thus to achieve the Community's objectives in relation to the environment: climate change, forest management and renewable energy. The project aims to reduce the risk of forest fires by obtaining sustainable solid biofuels from shrub lands of high flammability risk by using innovative methods of management and harvesting in forests that are not enough known in Southern Europe.

Specific project objectives are the following:

- To contribute to a low carbon EU economy: Reduce dependence on fossil energy using local products and thereby reducing GHG emissions to reach the goals of the Kyoto and Rio agreements while contributing to the increase of the share of renewable energy to achieve the EU target of 20% by 2020.

- To reduce the amount of fuel available in shrub lands to lessen the virulence of forest fires and hence contributing to the conservation of natural capital of the EU in line with the objectives of the Environmental Action Plan of the EU 2020

- To promote economically viable management of marginal forests, proving that it is an alternative for creating jobs in rural areas and specifically in the areas selected for demonstrative activities within the project.

- To recommend policies that help promoting sustainable and cost effective management of marginal forests.

The project is structured in two preparatory actions A1-A2 and seven implementation actions B1-B7, containing an important effort of demonstration activities as explained in the technical part. The project already has an ambitious dissemination program that is being implemented through five blocks of actions D1-D5.

Four sites with different biomass applications and capacities for stable biofuel supply and use have been defined for the demonstration purposes: a pellet factory in As Pontes (A Coruña-Galicia) with 70,000 t / year capacity, a bioelectricity plant in Garray (Soria, Castilla y León) of 15 MWe nominal power, a two district heating networks in Fabero and Las Navas del Marqués (both in the region of Castilla y León).

The Project, whose completion was scheduled for December 31, 2017, has been extended, with the approval of the Commission, until April 30, 2018. The main actions carried out and the results obtained are summarized below

The preparatory action A1 and its finished deliverable include the results about the natural and socio-economic environment of the areas covered by the project. Preparatory action A2 (Selection of areas for demonstrative clearings) is reported in deliverable A2.

Concerning implementation actions, the key action B1 was finished in February 2017 with one year delay. The reasons, mainly weather and machinery availability. In resume, clearing and harvesting works started in December 2014 and finished in February 2017 resulting in 137 ha cleared and 1,629 t biomass collected. The conclusion is that the actions carried out have demonstrated the technical feasibility of using mechanized means for clearing, harvesting and logistics of biomass scrub.

In action B2, the methodology used for evaluating the pre-treatment and combustion of just harvested and stored shrub biomass has been successful. No significant problem has been identified. For the detailed study of the combustion process of the shrub biomass (pellets and crushed material), two pilot installations have been used, with 40 kWt and 500 kWt mobile grate boilers.

On the other hand in the B3 action, scrub has been introduced in existing combustion facilities in order to study their effect on boilers where other types of biomass are usually used and to evaluate emissions. Such installations have been three district heating boilers at Las Navas del Marqués, Fabero and CEDER, and a Power plant with a 49 MWt and 15 MWe in Garray.

The conclusion from B2 and B3 work is that, in general, scrub biomass combustion in domestic commercial boilers or stoves, when compared to the combustion of commercial wood grade A1 pellets, generates higher particulate and NOx emissions, and for the gorse, in particular, the recommended limits of SO2 and HCl can be exceeded. It is therefore necessary to have equipment adapted to these fuels when it comes to using them in small boilers and or stoves or use these resources in industrial boilers that are better adapted (particulate matter filters, NOx reduction, etc).

The action B4, suffered a small delay due to some technical difficulties: the bad results obtained after the application of LiDAR technology in some areas forced to look for other remote sensing technics such as the use of satellite imagery interpretation. One conclusion from the action B4 is that Both LiDAR and satellite information can be used to generate biomass prediction models. The non-parametric models based on remote sensing with LANDSAT gave worse adjustments than those obtained with LiDAR, however, they allow to obtain a first evaluation of the scrub resources with much shorter processing times. The information of available scrub surfaces in the study areas has permitted the integration of the information in the BIORAISE tool as was initially foreseen..

In action B5, the environmental impacts of the mechanized clearance carried out on shrubs formations within different ecosystems has been evaluated. In particular, the impacts on biodiversity (composition and shrub structure), physical and chemical properties of the soil, and on erosion and forest fire risks has been monitored. For that purpose, the impact is evaluated considering the situation of the shrub stands prior to shrub clearance, and performing a two-year monitoring after the clearance. From the environmental impact evaluation, the main conclusions have been drawn:

The monitoring of regeneration in the cleared stands has shown recovery rates in biodiversity one year after harvest between 30-70% depending on the locality, being able to affirm that the scrub formations studied respond to the clearing + biomass harvest with an active regeneration that tends to cover the ground in a few years.

With regard to erosion, it should be noted that harvesting operations have not had significant impacts with respect to erosion processes in any of the localities studied. No water erosion was observed after harvest in any of the study areas, neither one year nor two

years after harvest. Medium superficial grooves caused by the machinery have been observed in some plots, while the deep ones were scarce or absent.

Regarding the properties soil properties, a slight compaction has been observed, together with a small reduction of the values of PH, in the first year in almost all the zones. These properties have almost recovered the pre-clearing values after two years. It is interesting to remark that a significant increases have been found in the content of C and N for some places studied (Fabero, Figueruela, As Pontes and Merlan), both in the superficial horizons and in the deep ones of the soil two years after the clearing. The significant increases in the content of C and N in the soil are related to the significant increases found in the litter (dead biomass) and the weth climate of the locations.

It is important to highlight the variables related to the fire risk obtained in the project two years after clearing and assuming a modeled wind speed of 30 km / h are, on average, 84%, 93% and 72% for speed of propagation, the intensity of the line of fire and flame length, respectively. Therefore, clearing scrublands coupled to biomass harvesting is a good option for forest fires prevention if it were carried out at a landscape scale.

Regarding the Life Cycle Analysis (LCA) performed in action B5 for the whole value chains of the biofuels obtained in each zone, it is noticeable the high percentage of GHG emissions savings, which in all cases (thermal and / or electrical use) would be over 95%. % compared to the use of a fossil fuel such as diesel. However, net energy efficiency is less advantageous in the case of electricity production plants and especially when intense forced drying is required, as in the case of gorse. Drying from values greater than 50% humidity up to 30% or less, requires a lot of energy, and reduces the ratio of energy produced / energy consumed to a value close to 1, what means that we are using the same energy that we are generating, although the energy consumed is thermal and the energy produced is electrical and the economic balance can be positive.

In B6 and B7 it was found that in Spain almost two-thirds of the Spanish forest area is in private hands, and the fragmentation of the forest is high, without a clear policy towards forest associations, has a negative impact on its use. Although a planned and sustainable management of shrub formations would be highly desirable, at present shrub lands and low tree density forests are mostly unmanaged or virtually planned. Silviculture activities are limited to minor linear underbrush clearings in roads or trails edges for fire prevention and pastures clean-up. Integrating decisions across land use planning, transport and environment policy, is crucial for sustainable development of these lands. The LIFE + ENERBIOSCRUB project has contributed to gather the necessary knowledge to advance in the task of making the shrub lands manageable in a sustainable way. In the manuals, guides and publications produced in the framework of the project, an exhaustive review is made of many of the aspects that must lead to this management objective, including a discussion on the main barriers that have to be overcome, both technical and non-technical. Important recommendations are given so that in the near future, we reinvent technology and knowledge to use those resources that once, were an important source of energy and renewable products.

The methodology used in the socioeconomic evaluation in C2, both for the employment evaluation in the project implementation and the job creation assumed by design future scenarios has permitted obtaining interesting findings:

Based on scenarios of scrub biomass utilization, It was estimated that the generalization in the use of scrub pellets in local areas with medium-small production plants and also medium-small thermal installations, could have the following impact in terms of local employment: 3-5 direct jobs in the collecting labors, 5-7 jobs in the pellets manufacturing per 10,000 tons of pellets production, and 1-2 jobs in logistic work. In addition, there would

be a sector of distribution services, installation, etc., which could add another 2 jobs (indirect) more for every 10,000 t MS mobilized.

The communication and dissemination actions are briefly commented on the next paragraphs.

The WEB site http://enerbioscrub.ciemat.es/ is working and have been quite actively updated and improved along the duration of the project. The WEB site obtained 4.222 unique visitors and 7.698 until April 2018. Within its contents we can find pretty much information generated in the project (press releases, news, workshops, technical manuals, etc.). The dissemination materials such as leaflets, posters, roll ups were printed as foreseen and they have been used in the all the events the consortium organised. There were 4 technical manuals which have been performed along the project: scrub biomass for energetic purposes, good practice handbook for scrub recollection, environmental management of scrub formations and Lidar inventory handbook. Regarding workshops organised by the consortium, the objectives were overpassed in number of events. Perhaps the most important events in terms of attendees were the workshop held in EXPOBIOMASA 2015, the workshop organised in the Soria University (UVA) and the World Café event celebrated in EXPOBIOMASA 2017 in which many stakeholders collaborated for giving their feedback and contributions for the barriers detected in the project for using scrub biomass for energetic purposes. Also in this fair a stand was placed to improve the networking in the project and show some project's results.

Dissemination materials were produced: roll ups, leaflets, posters and they were used in biomass fairs like Silleda, EXPOBIOMASA '15 and EXPOBIOMASA '17 with 16.000 visitors, scientific / technical conferences like 24th EUBCE, Conama, 25th EUBCE or 7th Spanish Forestry Congress. In addition some of the project results were communicated by means of the AVEBIOM's newsletter and sent to an around 50.000 database.

Also, the project had a presence in the social networks, mainly in Twitter in which by means of the hashtag #ENERBIOCRUB, results of the project were communicated. The consortium produced several videos which are available from the WEB site and in YouTube and we have three appearances in the TV and five in the Radio.

The number of appearances in the written media was over the objectives .There were 41 appearances in general media (34 digital and 7 in paper) and 21 scientific / technical publications of the ENERBIOSCRUB project.

In addition the Consortium was present in about 13 workshops / seminars making presentations of the project. Also, the project was present in 4 international conferences with 6 presentations (24th EUBCE, 25th EUBCE, Wels' European Pellet Conference 2017 and Victam's International Pellet Conference in 2017.

Also there were some NETWORKING activities: participation in conferences of other Life projects (participation of one partner in one conference and during our workshop in EXPOBIOMASA also there was place for 3 other life+ projects) and an expert group has been created.

3 Introduction

(1 page)

- Description of background, problem and objectives.
    - For LIFE+ Environment Policy and Governance:
        - Environmental problem/issue addressed

- Outline the hypothesis to be demonstrated / verified by the project
- Description of the technical / methodological solution
- Expected results and environmental benefits

– Expected longer term results

  - LIFE+ Environment Policy and Governance: e.g. future contribution to the implementation, updating and development of European Union environmental policy and legislation, including the integration of the environment into other policies, future EU and Global applicability and reproducibility of demonstrated technology, future Market strategy and economic feasibility.

Description of background, problem and objectives.

 Environmental problem/issue addressed

The frequency and severity of forest fires in Europe is predicted to increase as climate patterns continue to change. Forest fires can have a significant negative impact, causing great damage to the environment and large volumes of atmospheric pollution, including significant emissions of greenhouse gases (GHGs). Forest fires are estimated to account for around 20% of global GHG emissions, emitting some 8,200 Tg of CO_2 and consuming around 5,130 Tg of biomass every year.

In Mediterranean countries, especially Spain, forest fires represent a big environmental and economic problem. According to the Spanish Ministry for Agriculture and the Environment, the average surface area affected for forest fires in the period 2002-2012 was 114,000 ha per year. In 2012, the figure was 210,000 ha. Figures indicate that around two thirds of the area affected by fires was scrubland (containing few trees).

 Outline the hypothesis to be demonstrated / verified by the project

The overall project objective of the ENERBIOSCRUB project is to contribute, in the framework of the overall objectives LIFE + Environment Policy and Governance, to reducing the emissions of greenhouse gases (GHG) to lessen the effects of the climate change, through the demonstration and deployment of technologies that contribute to substantially reduce GHG emissions. The project aims at promoting the improvement of marginal scrub forests by obtaining solid biofuels and thus to achieve the EU objectives in relation to the environment: climate change, forest management and renewable energy. The project aims to reduce the risk of forest fires by obtaining sustainable solid biofuels from shrub lands of high flammability risk by using innovative methods of management and harvesting in forests that are not enough known in Southern Europe. A necessary labour of demonstration and dissemination of scrub biomass use in specific applications such as pelletizing and combustion will be also carried out. Four sites with different biomass applications and capacities for stable biofuel supply and use have been defined for the demonstration purposes: a pellet factory in As Pontes (A Coruña-Galicia) with 70,000 t / year capacity, a bioelectricity plant in Garray (Soria, Castilla y León) of 15 MWe nominal power, a district heating network in Fabero (León-Castilla y León) of 500 kW and a district heating in Las Navas del Marqués (Ávila, Castilla y León).

 Description of the technical / methodological solution

The Project has investigated in looking for solutions to the management of shrub formations by means of the valorisation of the biomass obtained in these lands, both in the development and

demonstration of the harvest and the logistic chains, as well as in the development of solid biofuels and their testing in conventional boilers.

From the point of view of the energy use of biomass, the clearing and harvesting of the scrubland can be an innovative silvicultural practice that requires the use of a mechanical equipment specially designed for its application in shrub formations, allowing its felling, harvested and the extraction of biomass in the most appropriate formats in terms of quality and price, and that facilitate its subsequent energy use.

The clearing and harvesting integrated into a single machine is an interesting concept that has materialized in some relatively recent commercial machines and prototypes. Basically, these equipment can be classified into two types: harvesting baler machines, HBM and harvesting mulcher or crusher machine, HMM. Both types give rise to very different logistic systems, since in the first case, bales (bundles) are handled and in the second case it is necessary to move bulk crushed biomass.

With regard to the HMM, there is evidence of the realization of different prototypes in Spain and other countries. Two levels of development can be differentiated: brush cutting heads coupled to a tractor with crushed biomass sent out by a chimney to a separate container, and stand-alone machines including a container for the crushed biomass. About this last type of machines, there was hardly any information about yields and costs in simultaneous clearing and harvesting tasks before the ENERBIOSCRUB project.

Based on these two clearing-harvesting machines, two types of logistics systems were tested. The results of the project have shown that, although the harvester-crusher system is currently more productive than the harvester-baler system, logistics originated in the crusher system is much more complex than the bale system, generating many more losses of dry matter during crushed biomass transportation and storage due to problems of high moisture in the biomass piles. However, biomass bales use to have a brief natural drying and therefore less need of energy consumption for its preparation and transformation into solid biofuels.

- Expected results and environmental benefits

The main results and environmental benefits expected are the following:

- Using near 2,000 t of locally sourced biomass saving more than 3,400 t of CO_2 compared to a fossil fuel and contributing to a stable renewable energy generation.
- Demonstration of the technical and economic viability of the supply chain of shrub biomass based on mechanized harvesting methods in 5 different locations, reducing the risk of forest fires.
- Determination of the quality parameters of shrub biomass: energetic chemical characterization of 120 samples and production of up to 8 types of standardized quality pellets and chips.
- Establishment of patterns for shrub biomass combustion to ensure lower emissions than those established in the more restrictive regulations.
- Establishment of guidelines and policy documents for discussion by the main stakeholders involved.
- Production of consolidated documents on management guidelines and policies and recommend them to the decision-making centres.

Expected longer term results:

The results obtained so far permit foreseen a future mid-term consolidation of demonstrated cost effective mechanized systems for cleaning scrub invaded areas with high risk of fire. In most

cases the clearing costs could be even paid exclusively by the income received from the extracted biomass. This should the major outcome of the project, once the methods are refined. From a technical point of view, knowledge and expertise acquired from harvesting works carried out with the two different systems ("harvester-baler" and "harvester-mulcher") will provide a comprehensive overview of each system's capacities and limitations. This will allow establishing the most suitable harvesting system for different scenarios (in Spain and EU), according to the characteristics of the working sites. Results will also allow evaluating and extrapolating harvesting costs. Ultimately, data and knowledge acquired during the project will make it possible to include these innovative technologies as reliable harvesting tools for sustainable management of shrubs formations and young forest stands, keeping in mind that local adjustments will have to be considered regarding the characteristics of the different countries. An extensive use of these technologies at an EU level would require counting on reliable information about existing surface covered by shrubs and its characteristics, which would permit calculating potential surface to be harvested by using these systems, potential biomass to be obtained and an economic estimation of these activities.

The results of action B2 and B3, regarding the production and utilization of scrub solid biofuels in boilers, show that these fuels have good behavior and are suitable for mean size boilers which have demonstrated normal performances. Most of the biofuels obtained have worst characteristics than pure wood but much better than agro fuels like straw, tree pruning or energy crops.

With respect to environmental impacts, it is clear that two year evaluation after the clear-harvest operation is not enough to fully assess the evolution of the vegetation and soil, but it has been enough to evaluate important impacts such as fire risk and to understand the trends of the main soil and vegetation indicators.

One of the main consequences derived from the use of these innovative harvesting technologies and their possible applications is the establishment of a new management/exploitation model based on the cycle of shrubs' biomass, as a result of the use of this biomass for energetic purposes. It will constitute a new market, and will impulse the creation of new local businesses that can apply these technologies to the cycle of shrubs' biomass, from plants-growing to economic valorization. All this will indirectly impact rural development in a very positive way, and will help advancing towards a low-carbon economy aligned with EU energy policies.

From the point of view of policies, many interesting subjects arising from the project could be included in technical guidelines useful at an EU level. Project results will hopefully have an influence in European policies and strategies regarding sustainable management of shrubs, if an energetic use of shrubs' biomass in the short term is pursued. For example, it has been concluded that a locally managed shrub biomass for energy purposes will save more than 95% GHG emissions compared to light fuel oil.

4 Administrative part

(maximum 3 pages)

4.1 Description of the management system.

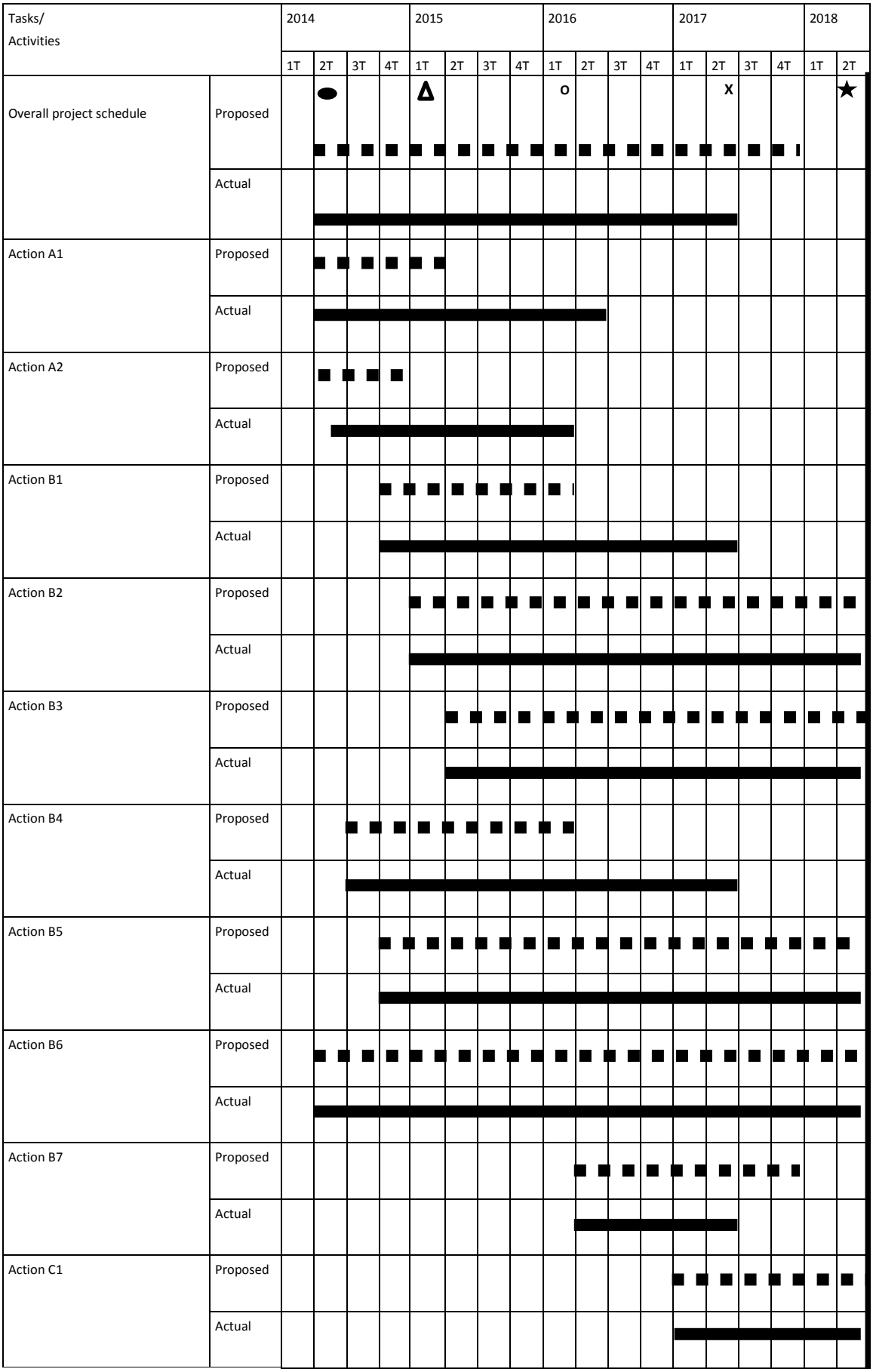
- Description and schematic presentation of working method, including overview of:
    - project phases
    - activities and tasks per phase
    - planning

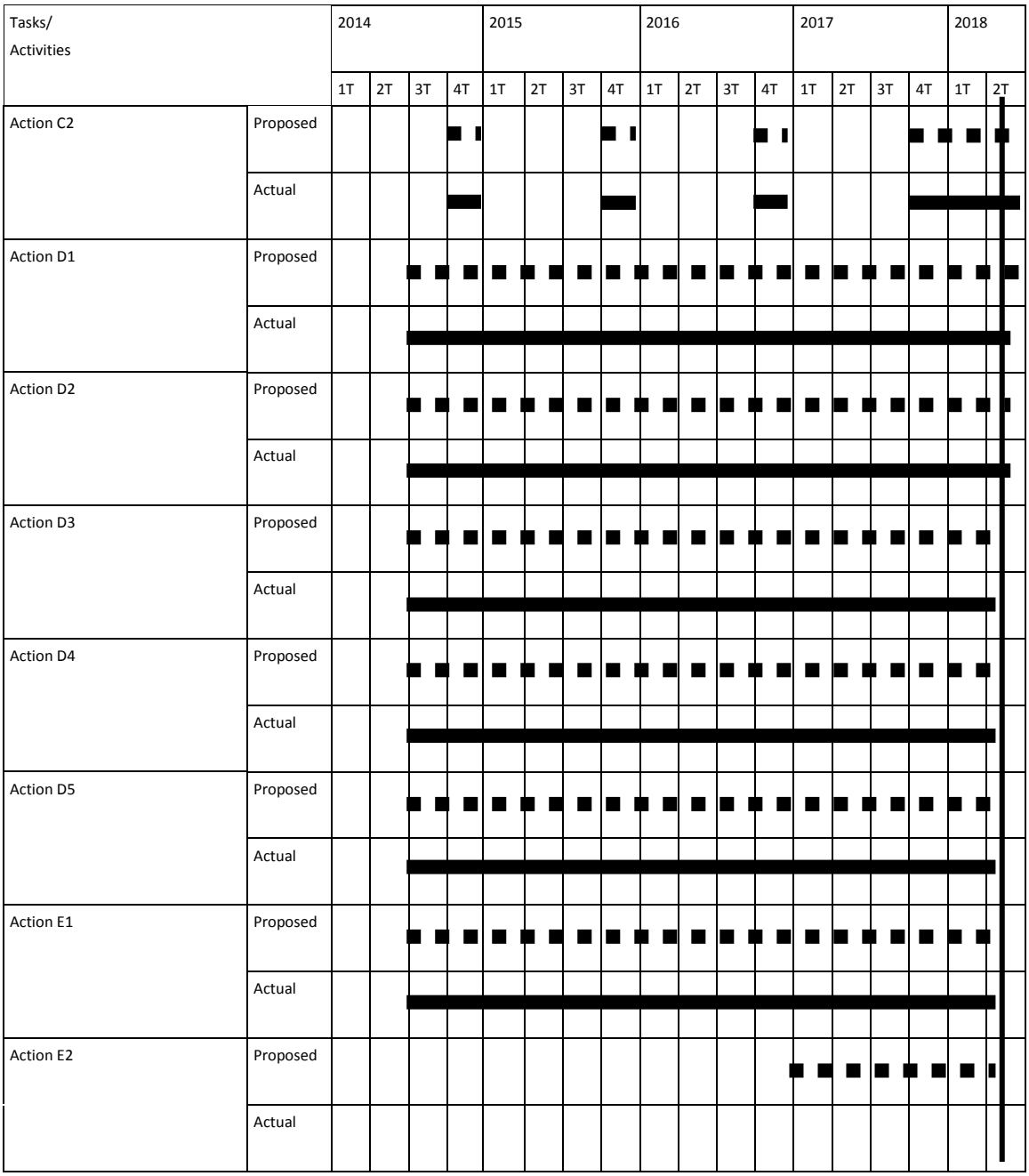
The project is organized in 2 preparatory actions (A), 7 implementation actions (B) and 5 dissemination actions (D). In addition, two monitoring actions (C) and two management actions (E) form the project structure. The order of actions and has been designed as follows: two preparatory actions A1 to define specific plots in order to develop the mechanized shrub clearing and harvest, A2 to set the protocol to be followed in clearing and data collection before and after harvest. Seven implementation actions to develop an important part of the demonstration activity:

B1 is the action in which clearing tests in the surfaces defined in the preparatory actions, are performed and technical and economic aspects evaluated. The leader of the action is TRAGSA, a company with large experience in conducting silvicultural works and expertise on technologies used in cost effective and environmentally friendly tasks. In the B2 action the key parameters of preparation, quality and combustion of the biomass obtained in the selected clearing locations, are evaluated. The leader of the action CIEMAT, uses their unique laboratories and pilot plants for characterization preparation and combustion in CEDER-CIEMAT in Lubia-Soria (Castilla y León). In the B3 action biomass is used, using the most suitable preparation (defined in B2), in industrial applications for the production of pellets, the generation of electricity and heat at the specified demonstration facilities.B4 and B5 actions are necessary to assess the importance of biomass resource in shrub lands, calculate carbon stocks and the impacts of the management of shrub formations by mechanized clearing and harvesting. These actions are led by two beneficiaries with experience in the study of biodiversity, fire, and soil carbon stocks as INIA and AGRESTA. Finally, a huge program of dissemination among the major players in the fields of forest policy, management, energy and environment, has been designed. The leader of these activities is AVEBIOM, an association that encompasses a large number of players in subject fields and with demonstrated experienced in conducting awareness campaigns, conferences and fairs as EXPOBIOMASA

The work plan was developed through indicated actions with a duration of 43 months finally extended up to 47 months, The critical and key task within the global work plan has been the action B1 on demonstration trials of clearing and collection of scrub biomass, because this action is at the beginning of the demonstration work to be performed in other actions such as B2, B3 and B5.

A Gantt with the progress of the actions is shown in next pages.


Tasks/
Activities
2014
2015
2016
2017
2018
1T
2T
3T
4T
Overall project schedule
Proposed
Actual
Action A1
Action A2
Action B1
Action B2
Action B3
Action B4
Action B5
Action B6
Action B7
Action C1
O
X



Legend:

●: Start date

Δ: Inception Report

O: Mid-term Report

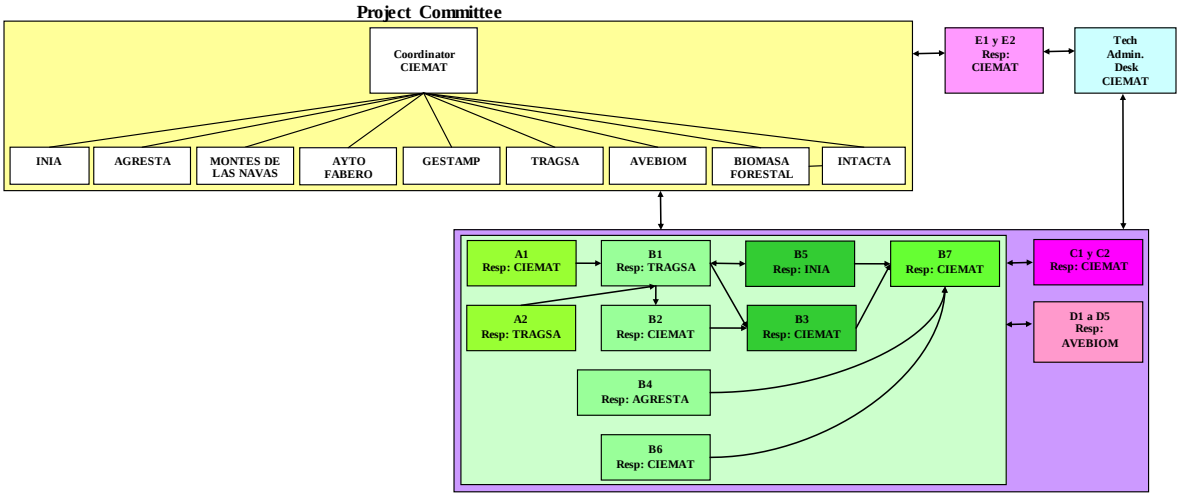
X: Progress Report

★: End date (including the extension from 1/01/2018 to 30/04/2018)

– Presentation of the coordinating beneficiary, associated beneficiaries and project organisation (**Organigramme** providing information about functions, tasks, persons and companies); describe what the **project manager** and other representatives of the coordinating beneficiary have done to organise/co-ordinate the project: meetings, seminars etc.

The coordinating beneficiary is the CIEMAT, the Spanish reference center on energy and environmental research. The project is coordinated by the CEDER-CIEMAT which is a territorial center located in the region of Castilla y Leon. The project is structured, as noted above in a central block 7 and 5 implementation and dissemination actions, respectively. The consortium was formed initially by the coordinator beneficiary and 8 associate beneficiaries, but in 2015 a new associated beneficiary (INNTACTA, ENVIRONMENTAL MANAGEMENT), directly related to BIOMASA FORESTAL activities, was added. Among the associated beneficiaries, the project counts with companies and public centers of prestige as TRAGSA (Company for agrarian transformation) leading the action B1 on scrub clearing and harvesting of biomass, INIA (National Institute of Agricultural and Forestry Research) leading the B5 action on environmental analysis, the Spanish association of biomass valorization (AVEBIOM), which organizes dissemination activities, prominent Stakeholders of the bioenergy sector, such as GESTAMP BIOMASS and BIOMASA FORESTAL which hold an important part in the demonstration program (actions B1 and B3). The consortium also involved two public beneficiaries representing local owners and users of shrub biomass resource scrub: The Municipality of Fabero (León) and Society Montes de las Navas (Ávila). These partners use biomass in municipal heat production facilities, thus completing the value chain of biomass. The inventory of biomass resources is carried out by the Cooperative AGRESTA (action B4).

In the flowchart of Figure 1 project organization with relationships between actions and responsibilities of each beneficiary is indicated.



After delivery of the Mid-term Report, in the Second Quarter of 2016, the key person of the financial and administrative area of the Coordinating Beneficiary, CIEMAT, left the entity.

After this situation, the general coordinator of the project, Luis Saul Esteban, took over the tasks of the overall project management. Due to the complexity and high workload that these tasks required for the correct project implementation, and in order to avoid delays and deviations in the achievements of the project objectives, the coordinator, after consulting with the monitor,

decided to resort to an external assistance for the project management. This service was contracted to EC-Innova as expert consulting in the support services for the technical and economic-administrative management and coordination of LIFE projects.

The staff of this external assistance attended the monitoring meeting held in April 2017. At this meeting, with the advice of the project monitor, communication and coordination mechanisms were established to ensure proper project management.

From this moment, a fluid communication between all beneficiaries has been maintained, which has sought a constant update of the financial information and documentary management of the whole project.

In this way, the Technical Office of the project is now composed by the project coordinator and the externa assistance of EC-Innova for the project management.

Persons responsible for the actions:

At the beginning of the project, at the first meeting of the Committee, the participating entities named people responsible for the implementation of the actions. Their roles are:

- Coordinating, monitoring and ensuring, both in content and time, the execution of the activities within each action under its responsibility.

- Communicating to the coordinator any significant deviation from the work relative to the fulfillment of the work program and the objectives of the project.

5 Technical part

(maximum 50 pages)

5.1 Technical progress, per task

This section concerns all project tasks except for:

- "project management" which is dealt with in the administrative part (section 4) and
- "dissemination", which is dealt with in section 5.2

In this section you should describe **what and how** has been done regarding the different technical/substantial components of the project (such as research, fieldwork, construction). You should indicate what has been done regarding each task (subtasks if appropriate) but avoid describing the objectives and targets as such. The description of the work done has to be sufficient to allow a good understanding of the project without a need to refer to the annexes. The technical details, however, should be given in the annexes. Any related reports or memos other than the official Progress Reports should be described shortly and attached furthermore as annexes.

5.1.1 Action A1: Description of the natural environment and socio-economic status of the areas covered by the project

(Task leader CIEMAT)

- **Describe the activities undertaken and outputs achieved in quantifiable terms (also indicate by whom they were done).**

This preparatory action has been carried out by CIEMAT with the collaboration of local partners Fabero (Ayto Fabero) and Navas del Marqués (MLN). The result of the action is embodied in a deliverable whose first version was sent with the initial report in March 2015. The updated deliverable contains all the information on the natural and socio-economic environment of the areas covered by the project. Initially, the preparatory study was planned for four zones which were extended to five, by indication of the Commission after the evaluation of the inception report as it was decided to include scrub clearing zones in an additional area that was not initially foreseen. The new zone is located in the province of Zamora and will complement the actions in the area of Fabero due to the difficult terrain in the area.

- **Compare with planned output and time schedule. (Please note that the overall progress of the project should also be presented using a Gantt-chart or similar – see section 4.1)**

		2014				2015				2016				2017			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
A.1 action	Proposed																
	Actual																

As can be seen, the action has been extended longer than initially proposed due to the request to add a new study zone, Figueruela de Arriba (Zamora)

- **Clearly indicate (when applicable) the indicators used to test the performance of the action.**

The progress of this action has been developed according to plan with the exception of zone 5 (Zamora) that was added later and whose information has been obtained and processed by the end of 2015. The following table shows the progress status of the action (now finished)

Indicadores	**Zona 1**	**Zona 2**	**Zona 3**	**Zona 4**	**Zona 5**	**% progreso**
Data collection	20	20	20	20	20	100

Results indicators are shown in the following table.

Resultados(informes y mapas)	Zona 1	Zona 2	Zona 3	Zona 4	Zona 5
Description of the physical environment, forestry, silviculture	1	1	1	1	1
Socieconomic analysis	1	1	1	1	1
Energy resources	1	1	1	1	1
Thematic maps	5	5	5	5	5

- **If relevant, clearly indicate how actions were modified, and any correspondence with the Commission approving the changes. (In particular this is required if there has been a significant over-spending of the foreseen budget for the action.)**

Not applicable

- **Clearly indicate major problems / drawbacks encountered, delays, including consequences for other tasks (technical, legal, financial/economic, market, organisational or environment related problems).**

Not applicable

- **Mention any complementary action outside LIFE;**

Not applicable

- **Outline the perspectives for continuing the action after the end of the project**

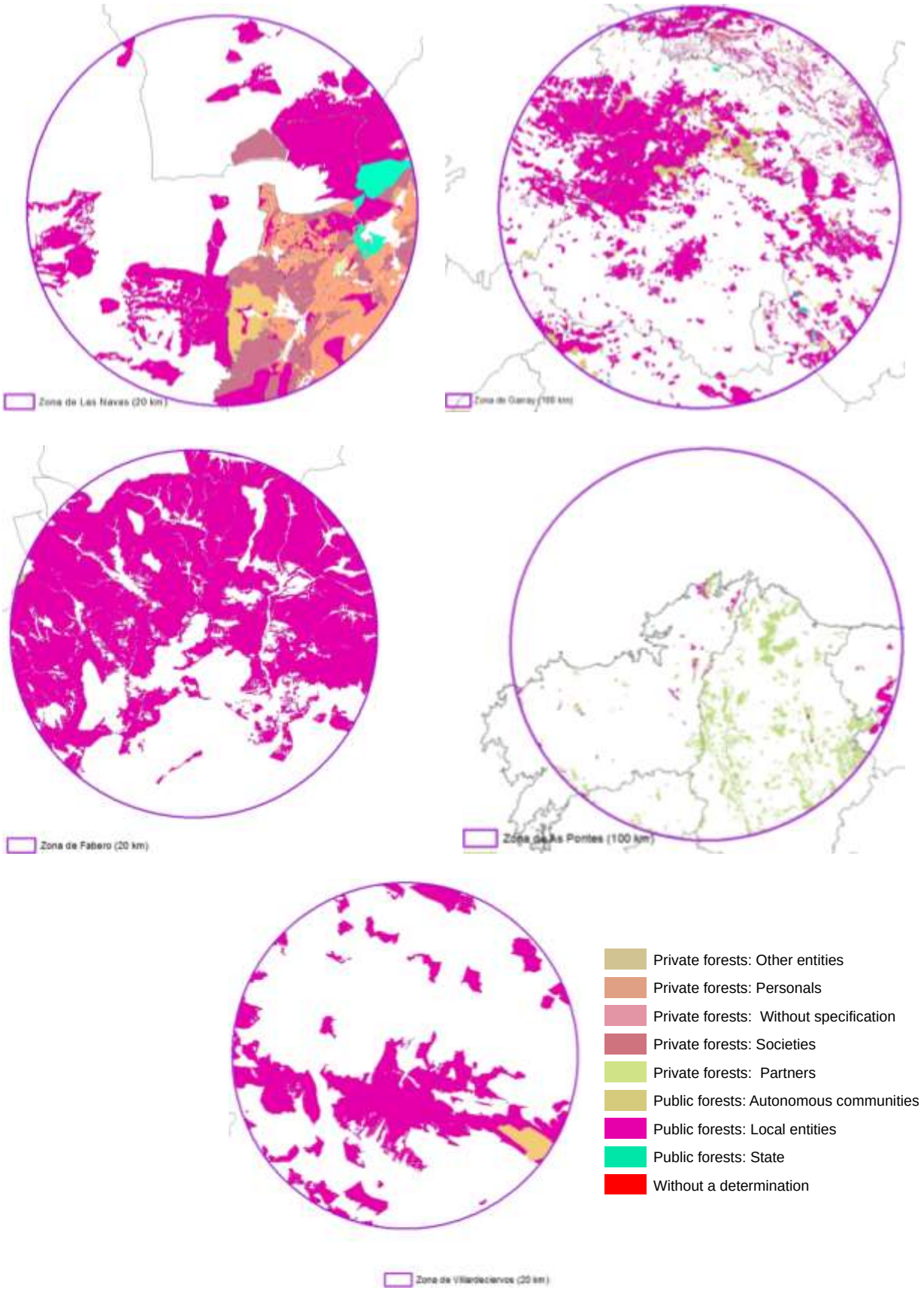
Not applicable

- **Include tables, photographs etc to illustrate the actions; for LIFE+ Nature and Biodiversity e.g. land purchase and non-recurring management activities**

Table: Summary of forest land data of the study areas

	LAS NAVAS		GARRAY		FABERO		AS PONTES		VILLARDECIERVOS	
FOREST DATA	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
GEOGRAPHYC AREA	125.664	100,0	3.141.600	100,0	125.664	100,0	1.795.796	100,0	128.098	100,0
FOREST AREA (F)	118.158	94,0	1.767.559	56,3	108.102	86,0	1.113.838	62,0	125.663	98,1
TOTAL SCRUB AREA (M)	40.014	31,8	720.803	22,9	48.441	38,5	244.962	13,6	51.641	40,3
HIGH HEIGHT SHURBS AREA (M1)	13.372	10,6	381.382	12,1	43.399	34,5	110.829	6,2	46.229	36,1
M1 in NATURA 2000 (M2)	5.903	4,7	150.068	4,8	32.048	25,5	19.017	1,1	-	-
M2/M1		44,1		39,3		73,8		17,2		-
M/F		33,9		40,8		44,8		22,0		41,1
M1/F		11,3		21,6		40,1		10,0		36,8
M2/F		5,0		8,5		29,6		1,7		-

Figure: The distribution of forest property in the five areas studied



5.1.2 Action A2: Design of the clearing and harvesting actions in the selected areas and planning of the follow-up study

(Task leader TRAGSA)

To define and design the demonstration action B1, for shrubs' biomass harvesting in four project locations in Galicia and Castilla y León regions.

- **Describe the activities undertaken and outputs achieved in quantifiable terms (also indicate by whom they were done).**

Action A2 began in July 2014. Four project locations were considered:

1: Las Navas del Marqués (Ávila).

2: Garray (Soria).

3: Fabero (León).

4: As Pontes de García Rodriguez (A Coruña).

In each of these locations:

- Field sites were located (compliant with the characteristics required for the project).

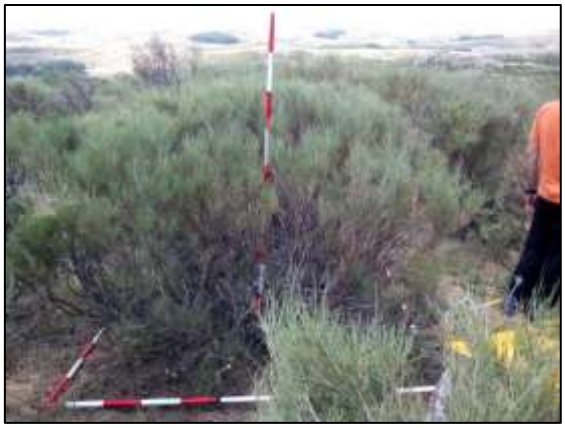
- Permissions were obtained from land owners (public and/or private).

- The necessary shrubs' surface was defined for each location, as well as the optimal time of the year for harvesting (taking into account weather, terrain, ecologic limitations...).

- Thematic maps were made of the field sites and their surrounding area.

- Technical guidelines for harvesting and data acquisition were prepared.

As a result, deliverable A2 was written and delivered on the 30th of September 2014.



Sample plot (before and after cutting shrubs for weighing biomass) in a field site in Navas del Marqués location.

- **Compare with planned output and time schedule. (Please note that the overall progress of the project should also be presented using a Gantt-chart or similar – see section 4.1)**

As a summary, all objectives established in action A2 are fulfilled,

The overall progress of the action is represented in the following table:

Table: Overall progress of the action A2 comparing proposed and actual.

		2014				2015				2016				2017			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
A.2 action	Proposed																
	Actual																

- **Clearly indicate (when applicable) the indicators used to test the performance of the action.**

Tasks developed in action A2 are described in deliverable A2, which shows a percentage of execution of 94.79%, and is included in the Annexes section.

DELIVERABLE	**ACTION N.**	**DEADLINE**	**COMPLETED**
Permissions from land owners, thematic maps, harvesting technical guidelines for action B1	A2	30/09/2014	100 %

The following table includes indicators of progress within this action.

Indicators	**Location 1 (Las Navas)**	**Location 2 (Garray)**	**Location 3 (Fabero)**	**Location 4 (As Pontes)**	**Progress %**
Permissions	25,00 %	25,00 %	25,00 %	25,00 %	100 %
Maps	25,00 %	25,00 %	25,00 %	25,00 %	100 %
Technical guidelines	25,00 %	25,00 %	25,00 %	25,00 %	100 %

In the following table shows indicators of results that have been achieved until this moment.

Results	**Location 1 (Las Navas)**	**Location 2 (Garray)**	**Location 3 (Fabero)**	**Location 4 (As Pontes)**
Field sites delimitation (hectares)	40/20	160/40	76/20	50/40
Harvesting guidelines for action B1	1/1	1/1	1/1	1/1
Data acquisition guidelines for action B1	1/1	1/1	1/1	1/1
Assessment Protocol harvesting	1/1	1/1	1/1	1/1
Maps showing harvesting works	1/1	1/1	1/1	1/1

- If relevant, clearly indicate how actions were modified, and any correspondence with the Commission approving the changes. (In particular this is required if there has been a significant over-spending of the foreseen budget for the action.)

Not applicable

- **Mention any complementary action outside LIFE;**

Not applicable

- **Outline the perspectives for continuing the action after the end of the project**

Not applicable

- **Include tables, photographs etc to illustrate the actions; for LIFE+ Nature and Biodiversity e.g. land purchase and non-recurring management activities;**

Not applicable

5.1.3 Action B1: Demonstrative tests of scrub clearing and harvesting. Techno-economic assessment

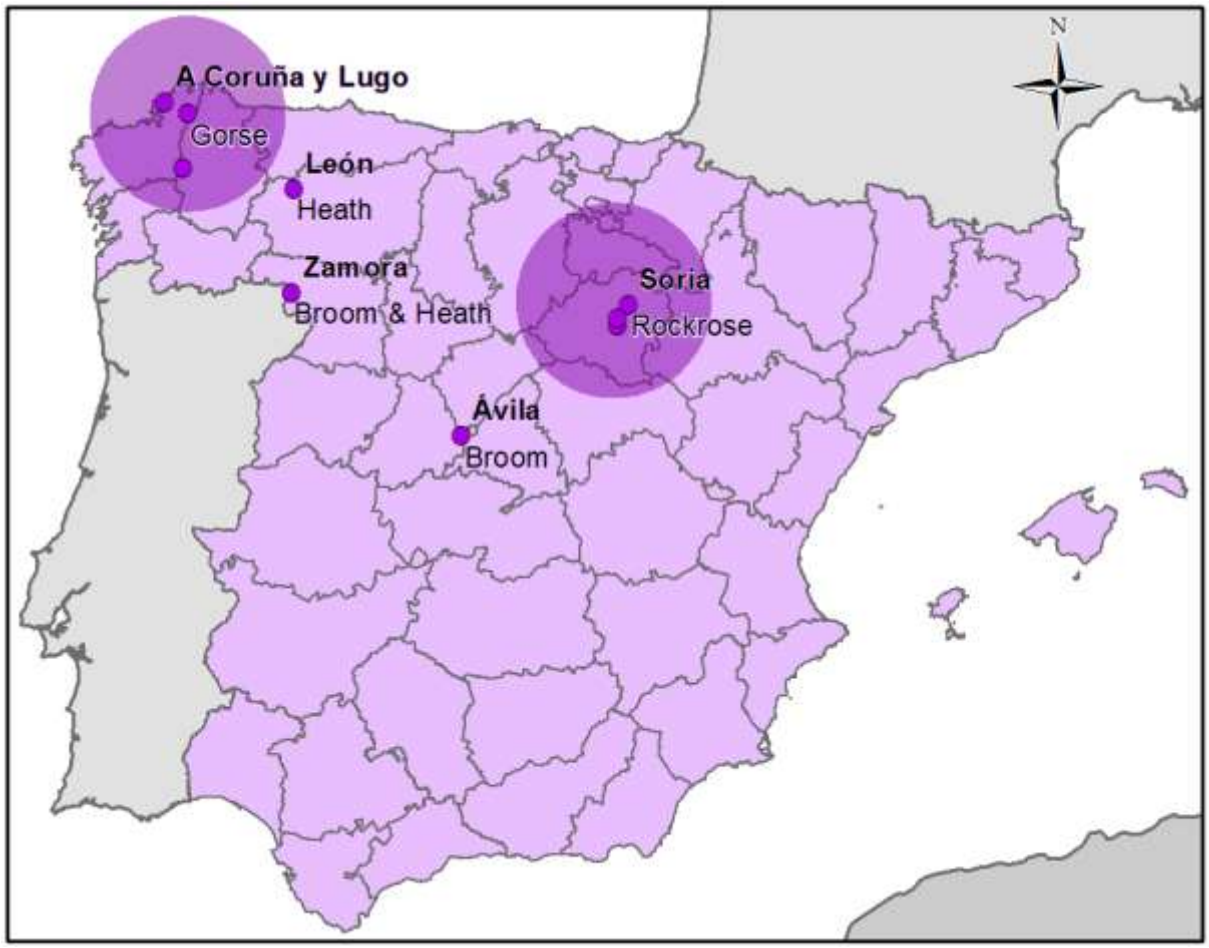
(Task leader TRAGSA)

To carry out the demonstration action B1 based on shrubs' biomass harvesting in four project locations, according to results from action A2, employing two different commercial harvesting systems ("harvester-baler" and "harvester-mulcher"), and to perform a technical and economic analysis of both harvesting systems.

- **Describe the activities undertaken and outputs achieved in quantifiable terms (also indicate by whom they were done).**

Action B1 described in this report aims at providing the project with some findings and conclusions resulting from the extraction of forest shrub material thanks to the use of two state-of-the-art pieces of equipment. Both perform clearing of shrubs but harvest the material differently: one in bales (bale-harvester) and the other in shreds (shred harvester).

The two devices were tested in six provinces and in five different plant formations, with variable heights and thicknesses within each testing plot. The vegetation harvested in Avila was broom (Genista cinerascens and Citysus scoparius); a mix of broom and heath (Erica australis and Genista florida) in Zamora; heath (Erica australis) in Leon; gorse (Ulex europaeus) in A Coruña and Lugo; and rockrose (Cistus laurifolius) in Soria. (see map below)



Action B1 started on the beginning of December 2014 and finished in February 2017. So far, the main tasks performed and outputs reached, are sumarised in the table below.

Zone number	Zone name	Location number	Location name	Machine used	Harvested area (ha)	Harvested fresh biomass (t)	Standing fresh biomass (t/ha)	Harvested fresh biomass (t/ha)	Humidity (% wet basis)	Clearing Starting date	Clearing End date
1	Las Navas	L1Z01	Majada Sta María	Bale - Harvester	10,8	137,3	33,9	12,7	33	11/12/2014	13/01/2015
		L1Z02	Matallana								
2	Garray	L2Z02	Lubia	Bale - Harvester	37,4	152,9	21,2	4,1	32	04/11/2015	08/02/2016
		L2Z03	Navalcaballo	Bale - Harvester	19,3	87,9	18,7	4,5	40	01/12/2015	03/02/2016
		L2Z04	Torretartajo	Bale - Harvester	27,2	145,2	18,6	5,4	41	09/02/2016	31/03/2016
3	Fabero	L3Z01	Argayo	Shred-Harvester	3,1	57,4	20,1	18,5	39,5	04/05/2015	07/05/2015
				Bale - Harvester	1	1,1	11,7	1,1	40,3	20/04/2016	21/04/2016
		L3Z02	Figueruela	Shred-Harvester	7,4	175	31,9	23,7	30,9	24/04/2015	29/04/2015
				Bale - Harvester	9,7	20,7	21,5	3,1	38,9	25/04/2016	27/04/2016
4	As Pontes		Endesa	Shred-Harvester	14,3	478	48	33,4	38,9	09/06/2015	27/08/2015
			INVIED	Shred-Harvester	4,2	285,2	90,8	68,6	49,5	16/11/2016	21/12/2016
				Bale - Harvester	2,1	75,1	68,6	35,6	49,3	15/11/2016	01/12/2016
			Merlán	Bale - Harvester	3,8	15,5	34,4	4,1	46,4	14/02/2017	17/02/2017
TOTAL					140,3	1.631,30	-	-	-	-	-

- **Compare with planned output and time schedule. (Please note that the overall progress of the project should also be presented using a Gantt-chart or similar – see section 4.1)**

The main problems in this action were related to the unavailability of the machinery/driver, the rain and the mechanical problems. Last tests finished in February 2017 with 12 months delay respect to the planed timetable (details are given in the approved extension request attached in the annex).Tasks developed in Action B1 are described in Deliverable B1.

The overall progress of the action is represented in the following table:

Table: Overall progress of the action B1 comparing proposed and actual.

		2014				2015				2016				2017				2018			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
B.2 action	Proposed																				
	Actual																				

- **Clearly indicate (when applicable) the indicators used to test the performance of the action.**

DELIVERABLE	ACTION N.	DEADLINE	COMPLETED
Report of harvesting results for each location	B1	01/03/2016	100 %

-

Indicators	Location 1 (Las Navas)	Location 2 (Garray)	Location 3 (Fabero)	Location 4 (As Pontes)	Progress (%)
Biomass sets harvested and delivered	25.00%	25.00%	25.00%	25.00%	100%
Number of reports finished (results)	25.00%	25.00%	25.00%	25.00%	100%

-

Results	Location 1 (Las Navas)	Location 2 (Garray)	Location 3 (Fabero)	Location 4 (As Pontes)
Equipment parameters: efficiency, fuel consumption, staff…	10/10	10/10	10/10	10/10
Terrain parameters: biomass density, rockiness, slope, rolling resistance…	10/10	10/10	10/10	10/10
Amount of harvested fresh biomass (tonnes)	137/250	376/500	255/250	853/1000
Assessment of equipment's problems and impacts (reports)	1/1	1/1	1/1	1/1
Assessment of harvesting technical and economic thresholds (reports)	1/1	1/1	1/1	1/1

- **If relevant, clearly indicate how actions were modified, and any correspondence with the Commission approving the changes. (In particular this is required if there has been a significant over-spending of the foreseen budget for the action.)**

Action delayed one year as explained above in this section.

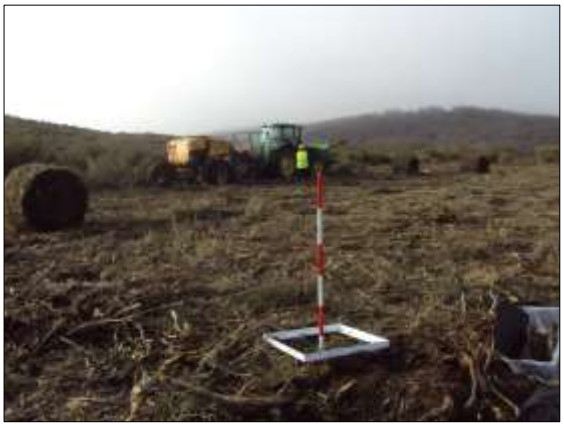
- **Mention any complementary action outside LIFE;**

Not applicable

- **Outline the perspectives for continuing the action after the end of the project**

In June 2018, CIEMAT and AGRESTA have formed a group called GO - ESENCIAL (provisionally approved on June 21, 2018) in the framework of the program promoted by the European Association for Innovation in Agricultural Productivity and Sustainability (AEI-AGRI) and managed by the Spanish Ministry of agriculture, MAPAMA. This group, whose objective is to manage of shrub formations, extract essential oils and biomass for solid, liquid biofuels and bioproducts development, participate 10 research groups, companies and associations.

- **Include tables. photographs etc to illustrate the actions; for LIFE+ Nature and Biodiversity e.g. land purchase and non-recurring management activities**



- Left: tractor with the "harvester-baler" system. Right: harvesting works on-going and staff in charge of time control. Sample plot at the forefront. Las Navas del Marqués location (Ávila).

"Harvester-mulcher" system working with staff in charge of time control in Figueruela de Arriba (Zamora).

"Harvester-mulcher" system working in Páramo del Sil (León).

Left: “Harvester-mulcher” system working in an area covered with tall *Ulex*. Right: “Harvester-mulcher” system unloading the collected biomass, As Pontes location (A Coruña).

Biomass bale. CEDER site in Lubia (Soria).

“Harvester-baler” working in Navalcaballo (Soria)

5.1.4 Action B2: Laboratory and pilot plant tests: preparation, characterization, biofuels production (pellets), combustion and emissions characterization

(Task leader CIEMAT)

The action B2 is divided in two main tasks: the evaluation of pre-treatment processes and combustion processes.

- **Describe the activities undertaken and outputs achieved in quantifiable terms (also indicate by whom they were done).**

Within the action B2, CIEMAT has carried out a study to evaluate the milling and pelletizing energy demand and the quality of pellets obtained utilizing different shrub feedstocks, and the combustion of the obtained biofuels. In particular, the main phases of the study are as follows:

Reception. All necessary raw materials are being obtained from the B1 action of the project. The biomass has been received as bales or chips. Some batches of the harvested biomass has been stored during one year in order to study the changes in dry mater and biomass composition and the possible effect on pretreatment and combustion.

Pretreatment tests. All the raw biomass materials were processed using a protocolized procedure in order to obtain pélets and crushed fuels.

Combustion tests. Combustions assays with just harves biomass and with 1 year stored ones, have been carried out in two boilers located at CEDER-CIEMAT (40 kWth for pellets and 500 kWth for crushed biomass).

Results

The behavior of the scrub during the milling process is difficult to predict, since it depends to a great extent on the humidity, the elasticity, the age of the plants and the format in which it is received (bales or pre-crushed). The energy yields and consumptions required have been similar with broom, heather and rockrose shrubs, obtaining values between 18 and 20 kg DM / h kW and 7.5 and 11 kWh / t DM. The milling of the RETRABIO pre-crushed gorse biomass, has shown the worst results both in milling yields and in energy consumption. In addition, the low density of the material and its thorny character make it difficult to feed the shredder.

In the refining process, the mills of rockrose and gorse at 4 mm are has shown the best results, with yields between 27 and 21 kg DM / h kW and 17 and 18 kWh / t MS, respectively. Lower production and higher energy consumption has been obtained with the broom and heather, due to the greater elasticity of its fibers, and therefore, greater resistance to breakage in the hammer mill.

During the pelletising process, the gorse is the scrub that presents a better performance followed by the broom, the heather and the rockrose.

Biomass storage: different types of storage management have been carried out, and several of them have been controlled in order to evaluate important aspects such as the evolution of humidity and dry matter losses due mainly to degradation biological of stored biomass. After the study of the stored lots, results indicate that the chosen collection system (baled or crushed) has a clear influence, both on the loss of dry matter and on the final humidity of the biomass, after a Storage period of approximately 12 months, although there is no doubt that weather conditions also plays a decisive role. The baled gorse biomass stored in As Pontes during 12 months, has suffered a decrease in dry matter of 18.8% compared to 30.5% of the crushed

biomass in the same period, and a final humidity of 57% compared to 72% of the crushed biomass. To contrast the influence of climatology, the same biomass crushed stored in Soria, has suffered dry matter loss of 22.0% and has reached a final humidity of 35% (less than half of As Pontes). On the other hand, the loss of dry matter baled gorse biomass stored in Soria was 14.4% and the final humidity 22%. If those figures are dramatic for the gorse, they are no less for other biomasses. For crushed biomass, only the heather collected in Fabero, has been studied in situ, where the biomass was stored for 13 months, obtaining a dry matter loss of 47.9% and a final humidity of 53%. The rest of biomasses evaluated have been broom in Las Navas del Marqués, rockrose, heather from Figueruela and heather from Palencia in CEDER. The broom and rockrose presented similar values of 13-14% of losses and 18% of final humidity, while heather showed very low loss values, between 4 and 7%, although these bales had been collected several months before the storage control was started and they were received very dry.

No influence regarding the storage period have been observed in the preparation processes: crushing refining or pelletizing.

Concerning the quality of the solid biofuels obtained, it can be concluded that with an adequate pre-treatment (for example, separation of fines), which implies the reduction of the ash, nitrogen and chlorine content of the obtained pellets, it could be possible to classify the pellets of broom, heather and rockrose within category B of ISO 17225-2, for use in commercial and residential applications. However, the gorse pellets, given their high sulfur and chlorine content, should be used only in industrial applications equipped with appropriate flue gas emissions abatement technologies.

With regard to combustion tests, it can be concluded that the combustion technology and the operating parameters in the used boilers determine the formation of slags on the grate. Thus, slags have been observed during the combustion of pellets in the 40 kW pellet boiler but they hardly appear in the 500 kW boiler using crushed biomass. Regarding the emissions, it has been noticed that shrub combustion entails higher NOx emissions than reference materials (pellets and chips from pine log wood) in the same boilers. On the other hand, it must be taken into account the emissions of SO2 and HCl during gorse and heather combustion. Finally, in general, it is remarkable the high particle emission during shrub combustion compared to reference material combustion; consequently fine removing in crushed biofuel and/or the use of equipment for particles removing in boilers ought to be considered in order to reduce such emissions. The test has also depicted that he shrub storage (1 year), has no significant effects over the combustion behavior and emission..

- **Compare with planned output and time schedule. (Please note that the overall progress of the project should also be presented using a Gantt-chart or similar – see section 4.1)**

The action B2 ought to be finished in June 2017. However, due to the late starting of the storage of gorse coming from the last clearing land (Merlán) in February 2017 and the 4 month extension, the action was finished in April 2018, in order to permit the evaluation the biomass quality and losses after 12 months of storage and the characterization of the stored gorse biomass pelletization and combustion

The overall progress of the action is represented in the following table:

		2014				2015				2016				2017				2017			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
B.2 action	Proposed																				
	Actual																				

- **Clearly indicate (when applicable) the indicators used to test the performance of the action.**

The following table includes indicators of progress within this action.

Indicators	Zone 1	Zone 2	Zone 3	Zone 4-5	% progress
Reception of just harvested biomass (5 tons)	25	25	25	25	100
Reception of biomass stored during 12 months (5 tons)	25	25	25	25	100
Making pellets and chips of just harvested biomass	25	25	25	25	100
Making pellets and chips of biomass stored during 12 months	25	25	25	25	100
Combustion assays with pellets	25	25	25	25	100
Combustion assays with chips	25	25	25	25	100

In the following table shows indicators of results that have been achieved until this moment.

Results	Gorse	Heather	Broom	Rockrose
Pellets of just harvested biomass (kg)	1000/500	1000/500	500/500	500/500
Pellets of biomass stored during 12 months (kg)	500/500	500/500	500/500	500/500
Chips of just harvested biomass (kg)	3000/3000	3000/3000	3000/3000	3000/3000
Chips of biomass stored during 12 months (kg)	3000/3000	3000/3000	3000/3000	3000/3000
Combustion assays with pellets	8/8	8/8	8/8	8/8
Combustion assays with chips	8/8	8/8	8/8	8/8
Analysed samples (nº)	20/20	20/20	20/20	20/20

3 preliminary combustion tests have been carried out with each shrub (pellets and chips) in order to define and to adjust the operating conditions and 1 optimised combustion test has been carried out and it is shown in the deliverable report.

With this report, two deliverables are attached with the procedures and results concerning biomass preparation and biomass combustion.

DELIVERABLE	ACTION N.	DEADLINE	COMPLETED
Results of tests in pretreatment pilot plant with just harvest biomass and stored during one year (B2-1)	B2	30/04/2018	100 %
Results of tests in pretreatment pilot plant with just harvest biomass and stored during one year (B2-2)	B2	30/04/2018	100 %

- **If relevant, clearly indicate how actions were modified, and any correspondence with the Commission approving the changes. (In particular this is required if there has been a significant over-spending of the foreseen budget for the action.)**

Not applicable.

- **Mention any complementary action outside LIFE**

There has not been any complementary action outside LIFE affecting the action B2.

- **Outline the perspectives for continuing the action after the end of the project.**

This approach is very likely and recommended with respect to this action, as the energy consumption, among other variables, both the four types of biomass without storing and the stored biomass could be compared to other biomass materials. It would be very interesting to expand our knowledge about solid biofuels. Therefore, there are great perspectives for continuing the action after the end of the project.

Taking into account the results obtained during combustion tests, it seems advisable to continue with the study on shrubs combustion. Thus, it is important to know the influence of different combustion technologies on slags formation and to study the mechanisms to decrease the emissions of NOx, SO2, HCl and particles, especially for gorse biomass. Furthermore, it would be needed to know the behaviour of these fuels during combustion in the long-term

- **Include tables. photographs etc to illustrate the actions; for LIFE+ Nature and Biodiversity e.g. land purchase and non-recurring management activities**

In the following figures (next pages) are illustrated the main results obtained within this action

Table: Specific mass flow and specific energy expressed in dry matter in milling (30 mm)

BIOMASS	**PRE-GRINDING**		
	Screen pore size (mm)	**Specific mass flow** (kg DM/h kW)	**Specific energy** (kWh/t DM)
Broom (from Las Navas)	30	18.06	8.95
Mixture: Broom and heather (from Figueruela)	30	19.98	7.46
Rockrose (from Garray)	30	17.88	10.68
Gorse (from As Pontes)	30	5.58	28.33

Table: Specific mass flow and specific energy expressed in dry matter in milling (4 mm)

BIOMASS	**FINE GRINDING**		
	Screen pore size (mm)	**Specific mass flow** (kg DM/h kW)	**Specific energy** (kWh/t DM)
Broom	4	11.02	45.79
Mixture: Broom and heather	4	11.96	57.93
Rockrose	4	26.56	16.81
Gorse	4	21.44	17.54

Table: Specific mass flow and specific energy for pelletizing tests

BIOMASS	**Die compression** (mm)	**Outlet pellet temperature** (ºC)	**Specific mass flow** (kg DM/h kW)	**Specific energy** (kWh/t DM)
Broom	35	91	6.9	112.7
Mixture: Broom and heather	35	83	6.7	121.7
Rockrose	35	91	5.9	132.6
Gorse	31	76	8.8	79.9

Figure: Aspect of pellets a) broom. b) broom and heather. c) rockrose d) gorse.

In the following tables, the average values of the emissions registered in the tested boilers are shown.

Table: Average values of the gas composition in pellet combustion tests carried out in MG40 boiler

Parámetro	Broom	Heather Figuer.	Rockrose	Gorse As Pontes	Pellets A1	Heather Palenc	Gorse Merlán
O_2 (%) d.b.	8.0	7.7	8.3	8.2	8.1	7.9	8.4
CO_2 (%) d.b.	11.3	13.0	12.7	12.3	12.7	10.1	11.5
CO (mg/Nm^3) d.b. [(1)]	623	60	71	22	295	37	728
NO_x (mg/Nm^3) d.b. [(1) (2)]	388	482	373	601	140	347	451
SO_2 (mg/Nm^3) d.b. [(1)]	7.0	79	59	132	13	122	70
HCl (mg/Nm^3) d.b. [(1)]	2.9	13	7.4	60	0.34	20	11
TOC (mg C/Nm^3) d.b. [(1) (3)]	3.3	1.7	1.7	1.7	1.2	1.9	3.4
Particles (mg/Nm^3) d.b. [(1)]	235	135	32	40	97	26	287

Table: Average values of the gas composition in milled biomass combustion tests carried out in MG500 boiler

Parámetro	Broom	Heather Figuer.	Rockrose	Gorse As Pontes	Pine chips	Heather Palenc	Gorse Merlán
O_2 (%) d.b.	8.7	10.1	9.6	10.4	8.8	8.2	8.0
CO_2 (%) d.b.	8.8	10.3	10.9	10.6	11.4	11.9	12.0
CO (mg/Nm^3) d.b. [(1)]	2102	2144	1159	1192	1558	909	1204
NO_x (mg/Nm^3) d.b. [(1) (2)]	335	330	224	305	126	264	342
SO_2 (mg/Nm^3) d.b. [(1)]	0	65	32	155	21	77	76
HCl (mg/Nm^3) d.b. [(1)]	0.70	0.61	0.87	n.d.	0.24	2.2	11
TOC (mg C/Nm^3) d.b. [(1) (3)]	30	20	13	13	43	8.3	18
Particles (mg/Nm^3) d.b. [(1)]	148	295	161	210	42	146	104

d.b.: dry basis; [(1)]: reference O_2 10%.;[(2)]: NO + NO_2. as NO_2.;[(3)]: Total organic carbon as C.

Control of stored biomass. Above left, rockrose bales at CEDER. Above right, gorse bales from Merlan at CEDER. Below, INVIED gorse biomass stored in As Pontes. Left, crushed and right, bales.º2

5.1.5 Action B3: Demonstration of the use of biofuels in industrial and residential facilities

(Task leader CIEMAT)

The action B3 is divided into two main tasks: pelletisation tests (BIOMASA FORESTAL and INTACTA) and combustion tests (CIEMAT).

Pelletisation tests (BIOMASA FORESTAL and INTACTA)

- **Describe the activities undertaken and outputs achieved in quantifiable terms (also indicate by whom they were done).**

In June 2015, the clearing of gorse scrub in the old slag heap located in As Pontes (A Coruña) was started and the obtained biomass was moved to the BIOMASA FORESTAL plant, where it was collected to be pelletised. 361.14 t of shrub biomass were received with moisture content between 17% and 27% and a bulk density of 91.4 kg/m3.

In September 2015, pre-treatment and pelletisation of the scrub were carried out. The process started with a crushing step (60 mm), and it was followed by a hammer milling (sieve 5 x 80 mm). During the milling, several blockages happened due to the material did not flow properly because of its low density and this fact slowed down the feeding of the hammer mill.

Once finished the milling, a rotating dryer was used to dry the biomass material. When this step is compared with the corresponding to the biomass mostly used in the plant (timber wood), it can be noticed low drying times due to the lower moisture content of the shrubs. The moisture content at the outlet of the dryer was between 3.7% and 12.2%.

After the drying, a new step of milling was carried out, using a 6 mm sieve, followed by the pelletisation of the material in two pellet presses. Several blockages were registered at the inlet of the mill and at the outlet (which corresponds to the inlet of the pellet presses), due to the low density of the material. Consequently, the velocity of pelletisation was lower than the values obtained with the timber wood biomass. 206.73 t of pellets were produced. Some characteristics of these pellets can be seen in next Table.

Table: Characterisation of pellets obtained

Moisture content (w.%) (w.b.)	**Bulk density (kg/m3) (WM)**	**Fines (w.%)**	**Mechanical durability (w.%)**	**Ash (w.%) (d.b.)**
6.8	640	0.05	98.4	7.4

w.%; weight %; w.b.: wet basis; WM: wet matter; d.b.: dry basis

It is especially remarkable the high ash content, which is higher than the value corresponding to the just harvested biomass. This increase in the ash content could be due to the drying process.

With regard to the electrical consumption/ t of pellets, it can be observed that it is higher than the annual ratio.

- **Compare with planned output and time schedule. (Please note that the overall progress of the project should also be presented using a Gantt-chart or similar – see section 4.1)**

All the activities corresponding to the scrub pelletisation within the action B3 have been carried out according to the planned time schedule at the beginning of the project.

The overall progress of the action is represented in the following table:

Table: Overall progress of the action B3 comparing proposed and actual (pelletisation tests).

		2014				2015				2016				2017			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
B.3 action (pellets)	Proposed																
	Actual																

- **Clearly indicate (when applicable) the indicators used to test the performance of the action.**

Regarding the activities corresponding to pelletisation in the action B3, indicators of progress and indicators of results are shown in next Tables.

Table: Indicators of progress of the action B3 (pelletisation tests).

Indicators	**Las Navas**	**Fabero**	**Garray**	**As Pontes**	**% progress**
Reception and store of the biomass (t)	n.a.	n.a.	n.a.	n.a.	n.a.
Tests with just harvested biomass (number)	n.a.	n.a.	n.a.	100	100
Tests with 12 months stored biomass (number)	n.a.	n.a.	n.a.	n.a.	n.a.

n.a: not applicable

Table: Indicators of results of the action B3 (pelletisation tests).

Indicators	**Las Navas**	**Fabero**	**Garray**	**As Pontes**
Reception and store of the biomass (t)	n.a.	n.a.	n.a.	800
Tests with just harvested biomass (number)	n.a.	n.a.	n.a.	1
Tests with 12 months stored biomass (number)	n.a.	n.a.	n.a.	n.a.

n.a: not applicable

Deliverables.

DELIVERABLE	ACTION	DEADLINE	COMPLETED
Report of pelleting tests of the scrub biomass from the coal mine of Endesa in As Pontes (A Coruña) project ENERBIOSCRUB (B3-2)	B3	01/02/2016	100 %
Report of measurements made in the pellet boiler at FCC services (B3-3)	B3	01/02/2016	100 %

- **If relevant, clearly indicate how actions were modified, and any correspondence with the Commission approving the changes. (In particular this is required if there has been a significant over-spending of the foreseen budget for the action.)**

This is not applicable to this action.

- **Clearly indicate major problems / drawbacks encountered, delays, including consequences for other tasks (technical, legal, financial/economic, market, organisational or environment related problems).**

This is not applicable to this action.

- **Mention any complementary action outside LIFE;**

There has not been any complementary action outside LIFE affecting the action B3.

- **Outline the perspectives for continuing the action after the end of the project**

The gorse is a complicated fuel to handle because it generates problems in the logistics handling in the facilities used to manage wood chips. The prospects for future use are conditioned on the entire process generating a product whose cost is acceptable compared to other biofuels.

- **Include tables. photographs etc to illustrate the actions; for LIFE+ Nature and Biodiversity e.g. land purchase and non-recurring management activities;**

Some pictures of the process are shown in the following figures.

Figure : (1) Scrub clearing. (2) Unloading of biomass in the plant.

Figure: Blockages in screw conveyors.

Figure: Pellets made with gorse.

In next Table it is shown a comparative of the electrical consumption of the process with gorse in Biomasa Forestal and the mean annual data based on wood chips.

	Total	Chipping	1st Milling	Drying and 2nd Milling	Pelletisation
Average annual consumption (kWh/t)	162	18	28	37	76
ENERBIOSCRUB gorse pelletisation test (kWh/t)	212	-	61	45	98

Combustion tests (CIEMAT)

- **Describe the activities undertaken and outputs achieved in quantifiable terms (also indicate by whom they were done).**

The objective of the combustion tests carried out within the B3 action is to demonstrate the use of the biomass obtained in B1 action in two sectors:

Industrial: 17 MWe power plant located in Garray.

Residential: two district heating facilities located in Las Navas del Marqués and Fabero. With the aim of increasing the kind of biofuels to use, an additional district heating located in Cuéllar has been used. On the other hand, with the objective of comparing the different shrub biofuels used in the same boiler, a boiler connected to a heating network at CEDER-CIEMAT has been used.

In this task, staff belonging to CEDER-CIEMAT has gone to the different locations with the proper instruments to measure gaseous and particle emissions during combustion.

In the first phase of tests, the used biofuels have been: broom pellets in Las Navas del Marqués, a blend of 50% commercial pellets and 50% heather + broom pellets in Fabero, chipped broom in Cuéllar, rockrose bales in Garray and milled shrubs (broom, broom + heather, rockrose and gorse) and milled pine (reference) in the boiler located at CEDER-CIEMAT.

In the second phase, biofuels have been prepared using shrubs stored during one year (broom and rockrose) and some improvements have been carried out in the boilers used. In this phase, emissions have been measured in Las Navas del Marqués (broom pellets), Fabero (broom + heather pellets) and Garray (grinded rockrose).

Considering the results obtained in Las Navas del Marqués, Fabero y Cuéllar, it can be concluded that an adjustment of combustion parameters is needed when a different biomass is used as fuel.

Regarding the results obtained in Garray, it can be concluded that rockrose can be used in this boiler if a proper pre-treatment of the fuel is performed in order to avoid problems during the feeding of the fuel to the boiler. With regard to the measured emissions, rockrose combustion does not entail higher emissions than the fuel usually burnt in the boiler, with the exception of the particles. However, particles are always lower than the limit established by the European Directive 2015/2193.

Taking into account the tests carried out in the boiler located at CEDER, it can be concluded that the tested shrubs do not entail operating problems (considering the time corresponding to the tests). Regarding the emissions measured, it is especially important the use of a particles abatement equipment in order to reduce the particles emitted, regardless of the fuel used. Furthermore, it is remarkable the high emission of NOx, SO2 and HCl during gorse combustion and the emission of HCl when the mixture of heather + broom is burnt.

- **Compare with planned output and time schedule. (Please note that the overall progress of the project should also be presented using a Gantt-chart or similar – see section 4.1)**

Action B3 had a completion date of June 2017, but once the extension of 4 months of project completion was approved, it was decided to carry out the last test in Fabero in January 2018. In this way, sufficient time was allowed for the Partner Ayuntamiento de Fabero to make the necessary improvements in the boiler before conducting the combustion test.

The overall progress of the action is represented in the following table:

Table: Overall progress of the action B3 comparing proposed and actual (combustion tests).

		2014				2015				2016				2017				2018			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
B.3 action (combustion tests)	Proposed																				
	Actual																				

- **Clearly indicate (when applicable) the indicators used to test the performance of the action.**

Regarding the activities corresponding to CEDER-CIEMAT within the action B3, indicators of progress and indicators of results are shown in Tables 2 and 3.

Table: Indicators of progress of the action B3 (combustion tests).

Indicators	**Las Navas**	**Fabero**	**Garray**	**As Pontes**	**% progress**
Combustion tests with pellets	50	50	-	-	100
Combustion tests with chips	-	-	100	-	100

Table: Indicators of results of the action B3 (combustion tests).

Indicators	**Las Navas**	**Fabero**	**Garray**	**As Pontes**
Reception and store of the biomass (t)	83	81	300	800
Tests with just harvested biomass	2	1	2	-
Tests with 12 months stored biomass	1	1	2	-

The material corresponding to Las Navas was received at CEDER-CIEMAT in order to be pelletised. In the proposal, broom biomass was considered to be chipped and to be burnt in the boiler located in Las Navas. However, when this material was tested to be fed in this boiler, it was noticed that it could not be fed properly. Consequently, the material was pelletised at CEDER-CIEMAT to be used in Las Navas and it was chipped to be used in the boiler located in Cuéllar.

Deliverables.

DELIVERABLE	**ACTION**	**DEADLINE**	**COMPLETED**
Report of results of combustion tests of action B3 (includes both stored and not stored biomass) (B3-1)	B3	01/02/2016 30/04/2018	

- **If relevant, clearly indicate how actions were modified, and any correspondence with the Commission approving the changes. (In particular this is required if there has been a significant over-spending of the foreseen budget for the action.)**

As explained before, due to the difficulties to feed milled biomass in the boiler of Las Navas, it was decided to transport the biomass to CEDER-CIEMAT in order to produce pellets to be tested in that boiler. In addition, in order to already test milled broom biomass it was decided to transport milled biomasss to the municipality of Cuéllar (Segovia) and test it in a bigger boiler able to feed such biomass.

In order to accomplish this change it has been necessary that the associated beneficiary MLN use the expected budget initially foreseen for biomass milling to transport the raw biomass to CEDER and the pellets and milled biomass from CEDER to Las Navas and Cuéllar respectively.

- **Mention any complementary action outside LIFE;**

There has not been any complementary action outside LIFE affecting the action B3.

- **Outline the perspectives for continuing the action after the end of the project**

Taking into account the measured emissions in the visited combustion plants, it seems advisable to continue with the monitoring of different boilers in order to:

- study the effect of shrubs combustion in the long-term;

- know the regulation of the boilers in residential and industrial sectors and their corresponding emissions.

- study the effect of the boilers technology on emissions.

- compare the combustion of the tested shrubs with other available biomass materials.

- study not only the emissions but also other parameters related to combustion as the slagging and fouling tendency.

- **Include tables. photographs etc to illustrate the actions; for LIFE+ Nature and Biodiversity e.g. land purchase and non-recurring management activities;**

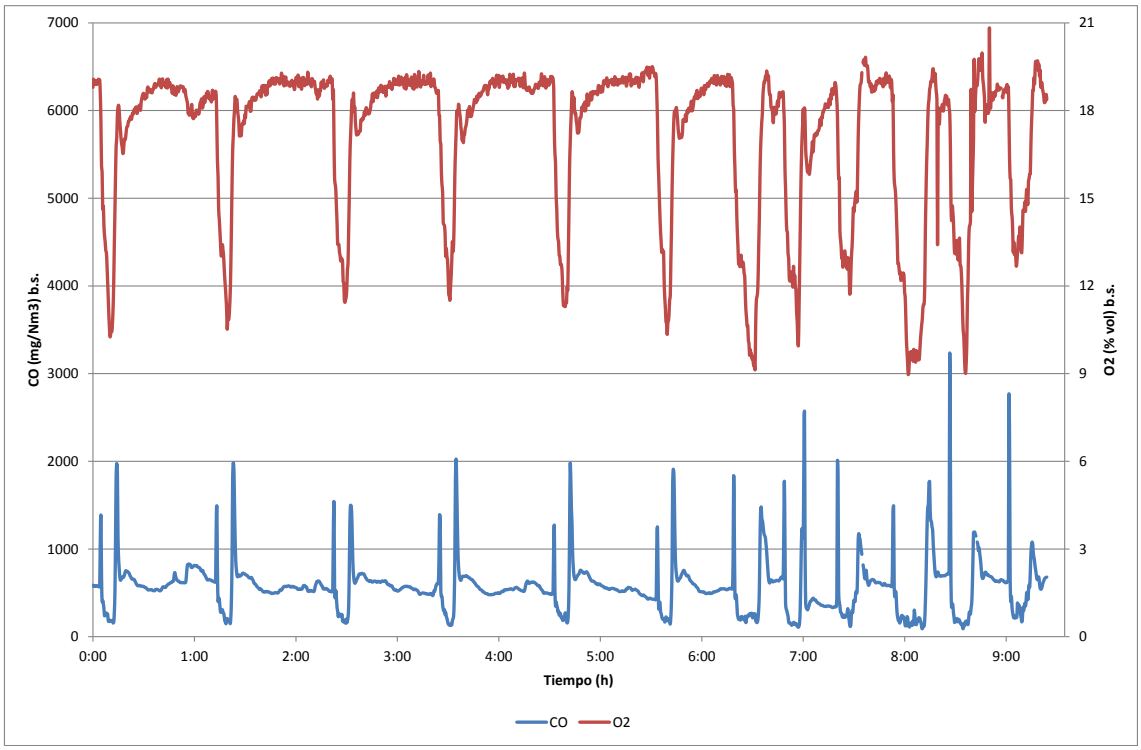


Figure . CO and O2 emissions at Fabero's facilities. Heather/pine pellet combustion before making improvements in the installation

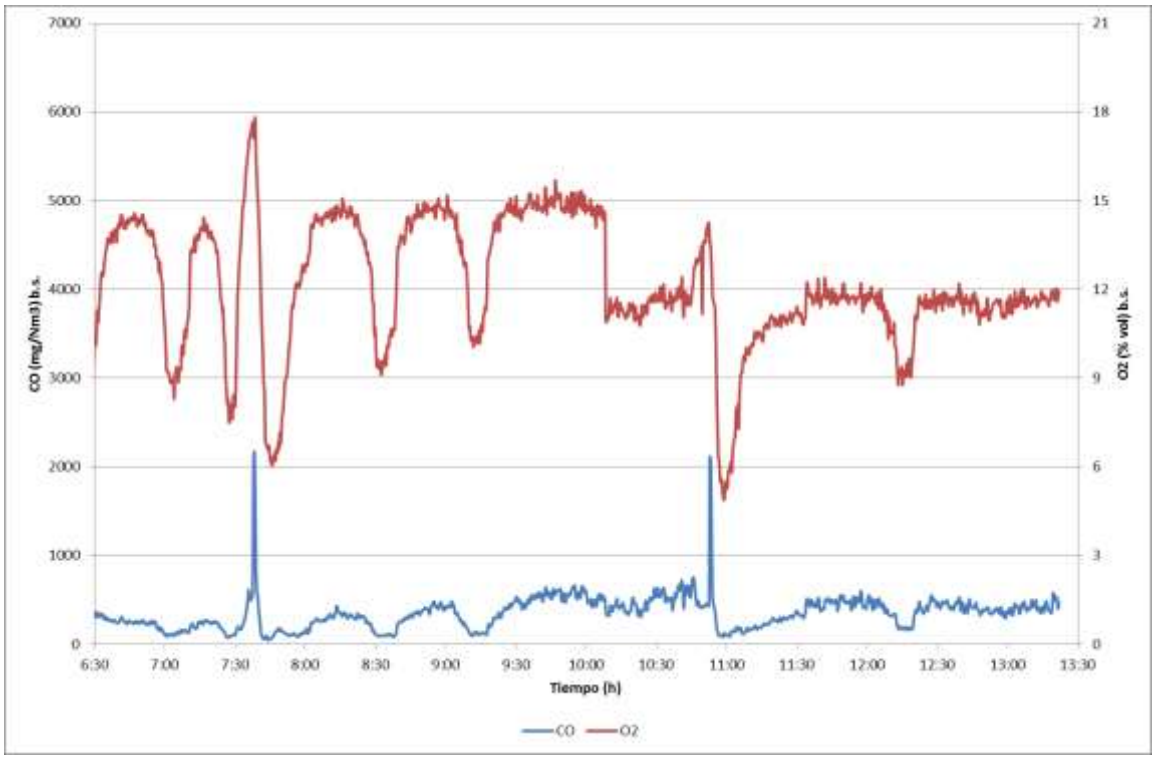


Figure. CO and O2 emissions at Fabero's facilities. Heather pellet combustion after making improvements in the installation

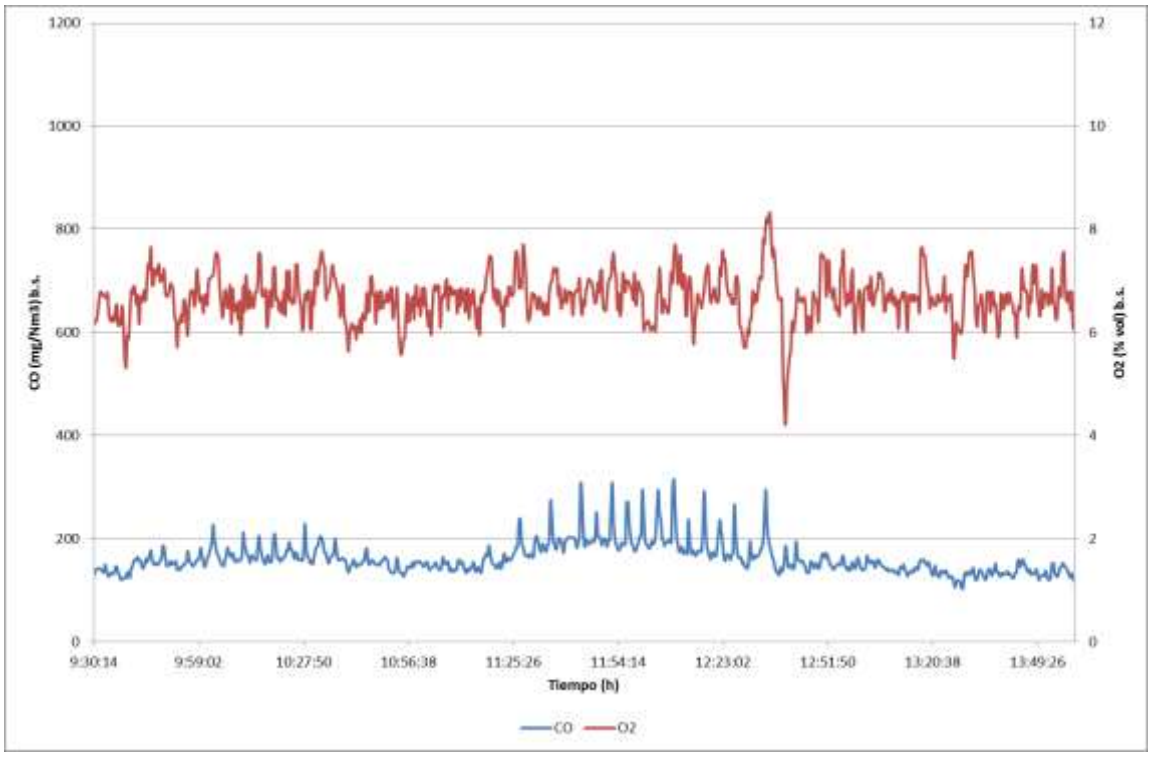


Figure . CO and O2 emissions at the Garray facilities (rockrose one year's storage)

5.1.6 Action B4: Inventory of scrub areas using LIDAR technology. Comparison with the results obtained in the harvesting

(Task leader AGRESTA)

- **Describe the activities undertaken and outputs achieved in quantifiable terms (also indicate by whom they were done).**

The main work within this action is developed by AGRESTA. A secondary part consisting of the chemical and energetic characterization of the shrub biomass gathered in the plots by AGRESTA, has been performed by CIEMAT

The activities developed by Agresta S. Coop in relation to action B4 are the following:

- Collection of LiDAR data.
- Processing LiDAR information.
- Obtainment of field data.
- Parametric model setting with LiDAR information.
- Obtainment if the satellite information.
- Processing of the satellite information.
- Collection of the shrub cartography from satellite information.
- Non-parametric model fitting with satellite information.
- Validations and comparisons between parametric and non-parametric models.

The activities developed by CIEMAT in relation to action B4 are the following:

The development of the chemical and energy analyses relating to the characteristics of biomass and required by ISO standards on quality of biofuels, in order to be able to compare the quality of the scrub biomass tested with other solid biofuels based on wood or herbaceous biomass.

For this purpose, 120 samples from different locations in the project locations have been subject of the following analyses:

Moisture content of fresh samples was determined at 105 ºC (ISO 18134-2:2015).

Ash and volatile matter contents determined at 550 and 900 ºC, respectively, according to ISO 18122:2015 and 18123:2015 standards.

C, H, and N determined using a TruSpec Leco elemental analyzer (ISO 16948:2015).

Cl and S by ion chromatography (Methrom) after the sample combustion in an automatic calorimeter (C-5000, Ika), and the recovery of chloride and sulfate in an aqueous solution (ISO 16994:2015).

Gross calorific value at constant volume (GCVv,d) determined using the afore-mentioned calorimeter, and net calorific value at constant pressure (NCVp,d) calculated afterwards (EN 14918:2009).

Major elements determined by analyzing the pre-ashed samples (550ºC) by ICP-OES using a Thermo Jarrell instrument and following ISO 16967:2015.

Minor and trace elements determined according to ISO 16968:2015 by ICP-MS using an iCAP instrument (Thermo Fisher Scientific). Hg was analyzed by thermal desorption followed by gold amalgamation and AAS using a DMA-80 instrument (Milestone)

- **Compare with planned output and time schedule. (Please note that the overall progress of the project should also be presented using a Gantt-chart or similar – see section 4.1)**

Action B4 was completed with a 6 months delay from the initially established schedule (4th quarter of 2016 instead of the 2nd). The reasons for the delay are explained below:

- The demonstration of satellite technology has been added to action B4 due to the difficulty of application of LiDAR technology in some areas (Fabero and As Pontes). In addition, it has been tested as a tool for obtaining shrub cartography.

- During the revision of the LiDAR point's classification (vegetation. buildings or other infrastructures) from PNOA, the existence of some significant errors induced a new reclassification process that was not planned initially. Due to the amount of LiDAR information to be reclassified, it was necessary to acquire LAStools software (Rapidlasso GmbH) to ease the reclassification process.

- The use of parametric models for the estimation of dry biomass from LiDAR information for big areas as Garray, required the classification and processing of a high amount of LiDAR units (2570 LiDAR units of 2x2 km); for that reason, the use of models for the Garray area was done with satellite information.

- The field inventory design, specifically the definition of the clearing area in the sampling points, allowed us to optimize the initially programmed schedules for data field collection, which rebounded positively in the time available for satellite information work.

- The project included a new demonstration area in Figueruela de Arriba (Zamora). In this area, it is programmed to estimate dry biomass with a non-parametric model fitted for *Erica arborea*, applied to the shrub cartography obtained from the Spanish forest map.

Table: Overall progress of the action B4 comparing proposed and actual.

		2014				2015				2016				2017			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
B.4 action	Proposed																
	Actual																

- **Clearly indicate (when applicable) the indicators used to test the performance of the action.**

The following table includes indicators of progress within this action.

Table: Indicators for monitoring progress corresponding to the action B4.

Indicators	Zone 1	Zone 2	Zone 3	Zone 4	% progress
Field work and sampling	25	25	25	25	100

LiDAR data management	25	25	25	25	100
Model fitting	25	25	25	25	100
Sample analysis	25	25	25	25	100

In the following table shows indicators of results that have been achieved until this moment.

Table: Indicators of results of the action B4.

Results	Las Navas	Fabero	Garray	As Pontes
Plots studied on the field	30/30	30/30	30/30	30/30
Maps integrated in BIORAISE	1/1	1/1	1/1	1/1
Production models	1/1	1/1	271	1/1
Characterized samples	30/30	30/30	30/30	30/30

Deliverables.

DELIVERABLE	ACTION	DEADLINE	COMPLETED
Report on shrub and biomass inventory in selected areas (B4-1)	B4	01/02/2016	100 %
Report on shrub biomass characterization	B4	01/06/2016	100 %

- **If relevant, clearly indicate how actions were modified, and any correspondence with the Commission approving the changes. (In particular this is required if there has been a significant over-spending of the foreseen budget for the action.)**

- Inventory field work in demonstrative areas L2-Las Navas del Marqués and L4-As Pontes has been subcontracted to local companies and supervised by Agresta staff due to the lack of availability of Agresta staff on that time period.

- Last, statistical regressions to obtain parametric models for the estimation of dry biomass from LiDAR data has been done by properly trained Agresta staff, being unnecessary to subcontract any external services as initially programmed.

- **Mention any complementary action outside LIFE**

There has not been any complementary action outside LIFE affecting the action B4.

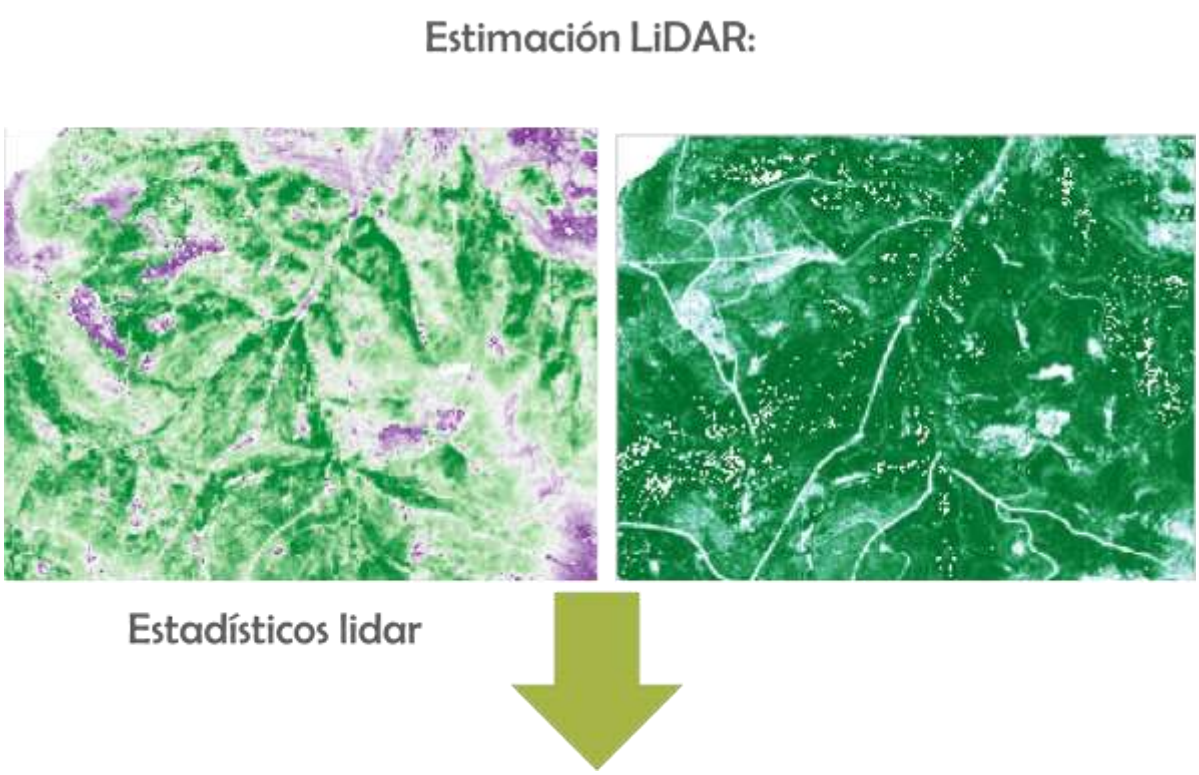
- **Outline the perspectives for continuing the action after the end of the project.**

Action B4 could be completed by the end of the Project by the following work proposals that are considered of interest:

- To test the use of satellite images available in medium resolution (Aster and Setinel) for fitting non-parametric models for species classification and dry shrub biomass estimation.

- To work with temporary satellite image series and its application in species classification and dry shrub biomass estimation, with the aim of integrating species phenology of the studied species when predicting these variables.
- To fit parametric (LiDAR information) and non-parametric (satellite information) models for other shrub species applying the methodology tested in action B4.
- To study the use of LiDAR and satellite methodology tested in action B4 for shrub combustible models integrating fire risk cartography to shrub cartography with the possibility of energetic exploitation.

- **Include tables. photographs etc to illustrate the actions; for LIFE+ Nature and Biodiversity e.g. land purchase and non-recurring management activities;**



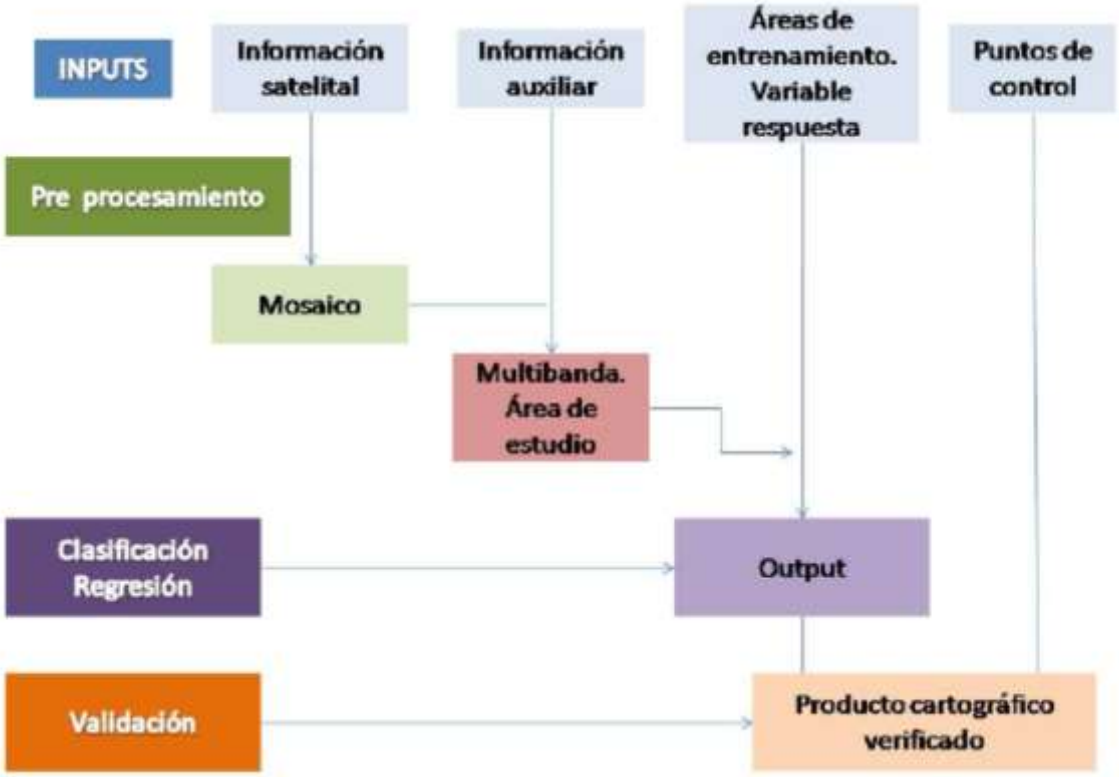

INPUTS
Información satelital
Información auxiliar
Áreas de entrenamiento. Variable respuesta
Puntos de control
Pre procesamiento
Mosaico
Multibanda. Área de estudio
Clasificación Regresión
Output
Validación
Producto cartográfico verificado

Table: Comparison between analytical values obtained for scrub biomasses studied and typical values of other biomass

ZONA		Las Navas	Soria	Fabero	As Pontes	Madera de coníferas	Chopo de corta rotación	Paja de cereal
Especie principal		Escoba	Jara	Brezo	Tojo			
Parámetro	Unidad							
Ceniza	% b.s.	1.4	2.6	1.4	1.5	0.30	2.0	5.0
$PCS_{v,0}$	MJ kg^{-1}	20.73	19.90	21.85	20.12	20.5	19.8	18.8
$PCI_{p,0}$	MJ kg^{-1}	19.36	18.58	20.47	18.78	19.1	18.4	17.6
C	% b.s.	50.6	49.4	54.0	50.4	51	48	47
H	% b.s.	6.3	6.0	6.3	6.2	6.3	6.2	6
N	% b.s.	1.1	0.47	0.58	0.85	0.10	0.4	0.5
S	% b.s.	0.06	0.04	0.06	0.06	<0.02	0.03	0.1
Cl	% b.s.	0.05	0.02	0.03	0.07	0.01	<0.01	0.4
O	% b.s.	40.4	41.4	37.6	41.1	42	43	41
Al	% b.s.	0.020	0.035	0.026	0.020	0.010	10	0.0050
Ca	% b.s.	0.17	0.76	0.22	0.15	0.090	0.50	0.40
Fe	% b.s.	0.012	0.046	0.015	0.016	0.0025	0.0030	0.010
K	% b.s.	0.31	0.21	0.16	0.27	0.040	0.25	1.0
Mg	% b.s.	0.067	0.068	0.086	0.068	0.015	0.050	0.070
Mn	% b.s.	0.014	0.013	0.013	0.010	0.010	0.0020	0.0040
Na	% b.s.	0.0046	0.0048	0.021	0.074	0.0020	0.0025	0.050
P	% b.s.	0.047	0.039	0.021	0.052	0.0060	0.10	0.10
Si	% b.s.	0.23	0.21	0.14	0.16	0.015	n.i.	1.0
Ti	% b.s.	0.0011	0.0016	0.0010	0.0017	<0.0020	n.i.	0.0070
As	mg kg^{-1}	0.10	<0.10	<0.10	0.15	<0.1	<0.1	<0.1
Cd	mg kg^{-1}	0.11	0.37	<0.10	0.23	0.10	0.5	0.10
Cr	mg kg^{-1}	<1.0	<1.0	<1.0	1.9	1.0	1	10
Cu	mg kg^{-1}	3.3	2.7	3.2	8.1	2.0	n.i.	2
Hg	mg kg^{-1}	0.0075	0.0074	0.013	0.0051	0.02	n.i.	0.02
Ni	mg kg^{-1}	1.1	2.0	4.6	2.1	0.5	n.i.	1.0
Pb	mg kg^{-1}	1.0	1.4	0.39	2.8	2.0	n.i.	0.5
Zn	mg kg^{-1}	23	28	11	28	10	n.i.	10

5.1.7 Action B5: Techno-economic and environmental evaluation of the biomass production chain: Biodiversity, fire risk, erosion

(Task leader INIA)

The action B5 is divided in two main tasks: the environmental site evaluation and the techno economic and life cycle analysis of the solid biofuels obtained.

Environmental site evaluation (INIA)

- **Describe the activities undertaken and outputs achieved in quantifiable terms (also indicate by whom they were done).**

The methodology and results regarding the environmental impact assessment are clearly showed in the handbook provided by INIA within the action B5 (attached to the final report). Furthermore, another deliverable is also provided with respect to the results of the whole studied locations. Anyway a short annex is also attached to this final report in order to show the natural evolution suffered by the shrub formations studied along a period of 10 years (2004-2014).

Selection of sampling points prior to shrub clearance for the environmental impact assessment

In the field, using a GPS, each of the sample points identified per location was redesigned and established as permanent plots (using real coordinates). A stake was placed to facilitate future identification along with the coordinates. Based on the reference point, a base line of 18 meters in length with a known direction (dependent on the plot) was established in each sample points, along which transects to inventory vegetation, soil and litter sampling were established.

Estimation of composition and biodiversity before and after shrub harvesting:

Three perpendicular vegetation transects to the base line of 25 m in length per sampling point were established at each location. The number of inventory points can be shown in table

Table1: Number of vegetation transects before and after harvesting at each location.

LOCATION	PREHARVEST	1 YEAR POST-HARVEST	2 YEARS POST-HARVEST
L1Z01-02 (Navas)	18	9	9
L3Z01 (Fabero)	18	9	9
L3Z02 (Figueruela)	18	12	12
L2Z01 (Soria-Ceder)	9	6	6
L2Z02 (Soria-Navalcaballo)	12	9	9
L2Z03 (Soria-Torretartajo)	12	12	12
L4Z01 (As Pontes) *	24	-	6
L4Z03 (Merlan) **	15	12	-

*In this location we could not carry out the 1 year post-harvest monitoring period as the authorization for performing harvesting works within the company was not renewed in the action B1. However, the Company allowed us to perform the environmental impact assessment during the second year post-harvest.

**In this location we could not perform the 2 year post-harvest environmental assessment due to the timespan of the project, as this location was selected in instead of As Pontes at the end of 2016. Therefore, only the pre-harvesting and the 1-year post harvesting were done.

Litter and soil sampling before and after shrub clearance:

The number of soil sampling and litter sampling can be shown in below tables. This number of samplings before and after harvesting differs from each other as some sampling points were not cut in the action B1 as planned in the beginning of the project (pre-harvested scenario).

Table : Number of soil samplings before and after harvesting at each location.

LOCATION	PREHARVEST	1 YEAR POST-HARVEST	2 YEARS POST-HARVEST
L1Z01-02 (Navas)	36	18	18
L3Z01 (Fabero)	36	18	18
L3Z02 (Figueruela)	36	24	24
L2Z01 (Soria-Ceder)	18	18	18
L2Z02 (Soria-Navalcaballo)	24	18	18
L2Z03 (Soria-Torretartajo)	24	24	24
L4Z01 (As Pontes) *	48	-	12
L4Z03 (Merlan) **	30	24	-

Table : Number of litter samplings before and after harvesting at each location.

LOCATION	PREHARVEST	1 YEAR POST-HARVEST	2 YEARS POST-HARVEST
L1Z01-02 (Navas)	36	18	18
L3Z01 (Fabero)	36	18	18
L3Z02 (Figueruela)	36	24	24
L2Z01 (Soria-Ceder)	18	18	18
L2Z02 (Soria-Navalcaballo)	24	18	18
L2Z03 (Soria-Torretartajo)	24	24	24
L4Z01 (As Pontes) *	48	-	12
L4Z03 (Merlan) **	30	24	-

*In this location we could not carry out the 1 year post-harvest monitoring period as the authorization for performing harvesting works within the company was not renewed in the action B1. However, the Company allowed us to perform the environmental impact assessment during the second year post-harvest.

**In this location we could not perform the 2 year post-harvest environmental assessment due to the timespan of the project, as this location was selected in instead of As Pontes at the end of 2016. Therefore, only the pre-harvesting and the 1-year post harvesting were done.

Evaluation of erosion processes due to the machinery before and after shrub clearance:

In each of the sampling points for each location along the vegetation transects, the erosive processes were quantified though out a visual assessment. For that purpose different codes were assigned to each erosive process identified: i) surface rutting, (ii) medium rutting, (iii) deep rutting, (iv) sheet erosion, (v) erosion in grooves or (vi) erosion in gullies.

Evaluation of fire risk with simulation modelling before and after shrub clearance:

To characterize and quantify changes in the combustibility of shrub formations subjected to mechanical clearing custom fuel models were developed for each of the locations three times along time, before and after one and two years of harvesting. For that aim, three whole representative plants of the main shrub species at each locality and date were selected, as well as the biomass contained in 3 replicas of $1m^2$ each. The maximum dominant height of the main species of the collected samples was also recorded.

.**Compare with planned output and time schedule. (Please note that the overall progress of the project should also be presented using a Gantt-chart or similar – see section 4.1)**

Basically two problems within the action B5 were found:

1) The delay of the action B1 in the execution of shrub clearing avoided carrying out the environmental impact assessment after harvesting on it. Therefore, the number of data after harvesting was lower than the pre-harvested scenario.

2) Moreover, there was a modification in relation to locality L4 (As pontes, NW Spain), which forced us to modify the working plan. Although the environmental impact prior to harvesting was assessed in L4 (Zona de Endesa, As Pontes), the 1 year post-harvest monitoring period had not been authorized due to internal legal changes within the Company. Specifically, the authorization to carry out the harvesting work on the premises of the company was not renewed between Endesa and Tragsa (action B1). Therefore, a new site with similar typology of scrub had to be selected in order to continue with the works.

The extension of 4 months of the project granted by the European Commission allowed us to carry out the pre-harvesting and the 1-year post harvesting assessment in Merlan, while the 2-year post harvesting assessment could not be done. However, the second year of monitoring performed in As Pontes allowed us to fulfil our objective, so all the objectives within the action B5 has been achieved. The overall progress of the action is represented in the following table:

Table: Overall progress of the action B.5.

		2014				2015				2016				2017				2018			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
B.5 action (site INIA)	Proposed																				
	Actual																				

- **Clearly indicate (when applicable) the indicators used to test the performance of the action.**

The main progress and results indicators corresponding to this action are showed in the following tables:

Table: Indicators for monitoring progress corresponding to the action B.5.

INDICATORS	L1 (Navas)	L2 (Soria)	L3 (Fabero)	L4 (AsPontes/Merlán)	L5 (Figueruela)	% PROGRESS
Study plots before the clearing	**20%**	**20%**	**20%**	**20%***	**20%**	**100%**
Data processing before clearing	**20%**	**20%**	**20%**	**20%***	**20%**	**100%**
Study plots after 1 year clearing	**20%**	**20%**	**20%**	**20%***	**20%**	**100%**
Data processing after 1 year clearing	**20%**	**20%**	**20%**	**20%***	**20%**	**100%**
Study plots after 2 the clearing	**20%**	**20%**	**20%**	**20%***	**20%**	**100%**
Data processing after 2 the clearing	**20%**	**20%**	**20%**	**20%***	**20%**	**100%**

Table : Indicators for monitoring results within the action B.5.

VARIABLE		L1Z01-02 (Navas)			L2Z01 (Soria-Ceder)			L2Z02 (Soria-Navalcaballo)			L2Z03 (Soria-Torretartajo)			L3Z01 (Fabero)			L3Z02 (Figueruela)			L4Z01 (As Pontes)			L4Z03 (Merlan)		
		Pre-harvest	Post-harvest (1 year)	Post-harvest (2 year)	Pre-harvest	Post-harvest (1 year)	Post-harvest (2 year)	Pre-harvest	Post-harvest (1 year)	Post-harvest (2 year)	Pre-harvest	Post-harvest (1 year)	Post-harvest (2 year)	Pre-harvest	Post-harvest (1 year)	Post-harvest (2 year)	Pre-harvest	Post-harvest (1 year)	Post-harvest (2 year)	Pre-harvest	Post-harvest (1 year)	Post-harvest (2 year)	Pre-harvest	Post-harvest (1 year)	Post-harvsest (2 year)
Biodiversity indices	M	1.21	0.91	1.08	1.36	1.04	No data	1.23	0.78	0.82	1.18	0.82	1.10	0.92	0.53	0.79	2.02	0.81	0.84	2.23	No data	2.23	0.45	0.36	No data
	Sh	1.01	0.88	0.93	1.26	0.99	No data	0.88	0.55	0.61	1.04	0.68	0.92	1.38	0.45	1.42	1.82	1.15	1.72	1.25	No data	1.25	0.75	0.62	No data
	Si	0.33	0.78	0.73	0.42	0.78	No data	0.45	0.98	0.84	0.40	0.86	0.52	0.28	0.88	0.28	0.18	0.87	0.31	0.44	No data	0.44	0.31	0.58	No data
Erosion index		Ns	Sr	Sr	Ns	Sr	Sr	Ns	Sr	Sr	Ns	Sr	Sr	Ns	Sr	Sr	Ns	Sr	Sr	ns	Sr	No data	ns	Mr	No data
Carbon (%)		2.49	2.46	2.35	1.65	1.92	2.01	1.66	1.68	1.34	1.33	1.35	1.64	5.89	7.81	7.27	4.04	5.89	4.69	5.41	No data	9.37	5.95	7.21	No data
Nitrogen (g/Kg)		1.72	2.01	1.95	0.98	1.25	1.75	1.25	0.84	0.73	1.33	1.15	1.64	2.56	2.85	5.71	2.27	2.47	3.98	4.21	No data	7.38	5.31	6.38	No data
Fire risk*	Pv	31.2	/-	5.0	16.3	/-	6.1	17.1	-/	P7.3	18.1	-	7.3	38.7	-/	16.8	50.1	-	12.8	63.8	No data	36.6	73.2		
	Ha	9.70	/-	2.99	4.52	/-	4.32	5.45	-/	4.52	6.90	-	4.52	3.92	-/	2.37	7.68	-	4.46	2.45	No data	4.45	13.46		
	Fi	5,051	/-	249	1,549	/-	758	1,466	-/	549	1,553	-	549	2,533	-/	664	6,420	-	952	1,973	No data	973	16,42		
	Fl	3.9	/-	1.1	2.4	/-	1.3	2.3	-/	1.4	2.1	-	1.4	2.8	-/	1.5	4.4	-	1.8	5.6	No data	2.6	6.7	2.8	No data

Biodiversity indices: M: Margalef Index; Sh: Shannon Index; Si: Simpson Index. Erosion index: Ns: no symptoms; Sr: superficial ruttings, Mr: Medium ruttings. Fire risk: Fire propagation velocity (Pv; m min^{-1}), heat per unit area (Ha; MJ m^{-2}), fire line intensity (Fi; kW m^{-1}) and flame length (Fl; m).

***Fire risk values before harvesting differed from the ones shown along the intermediate report. This fact was because we decided to carry out a more realistic simulation reconsidering the moisture values of some plants depending on the season in which these were sampled**

Deliverables

DELIVERABLE	ACTION	DEADLINE	COMPLETED
Environmental impact assessment of shrub mechanical harvesting for energy purposes (B5-1)	B5	30/04/2018	100 %
Report on the LCA of the biomass value chains (B5-2)	B5	30/04/2018	100 %
Carbon footprint of the project (B5-3)	B5	30/04/2018	100 %

- **If relevant, clearly indicate how actions were modified, and any correspondence with the Commission approving the changes. (In particular this is required if there has been a significant over-spending of the foreseen budget for the action.)**

This is not applicable to this action, as there has not been a significant over-spending of the foreseen budget for it.

- **Mention any complementary action outside LIFE**

There has not been any complementary action outside LIFE affecting the action B5.

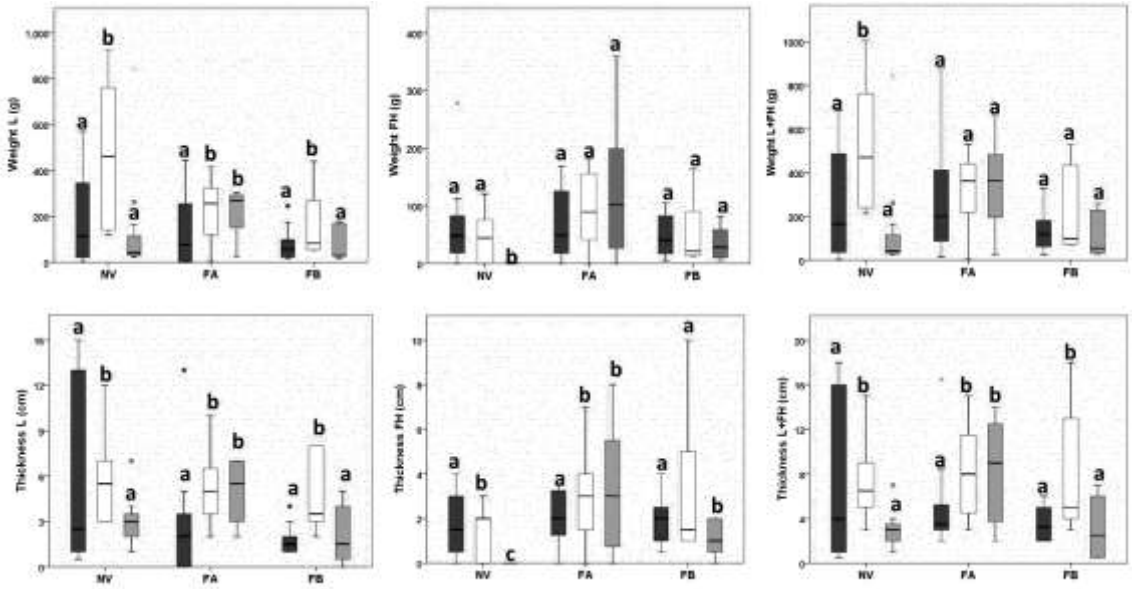
- **Outline the perspectives for continuing the action after the end of the project.**

This approach is very likely and recommended with respect to this action, as the evaluation of environmental impacts caused by mechanized harvesting, both at species biodiversity and soil level, would be very interesting to be carried out in subsequent years for testing the evolution over a longer time-span period. Therefore, there are great perspectives for continuing the action after the end of the project using INIA own resources.

- **Include tables. photographs etc to illustrate the actions; for LIFE+ Nature and Biodiversity e.g. land purchase and non-recurring management activities**

The main results with respect to biodiversity and soil analysis are summarized in the following two figures. Furthermore, in the deliverable B5 all the results and used methodology are illustrated with several figures, tables and pictures will are detailed.

Figure : Weight (g) and thickness (cm) of litter before harvesting (2015, in black), as well as one year (2016, in white) and two year (2017, in grey) after clearing for each locality (NV, FA, FB).



L: litter layer and recognizable remains; F+H: fragmented and humified remains. Values followed by the same letter do not differ significantly according to Newman-Keuls test (p<0.05).

Table : Fire behaviour variables simulated under three possible wind scenarios (0, 15 and 30 km h^{-1}) before harvesting (pre) and two years after harvesting (post-2).

Loc	Wind (km h^{-1})	S_r (m min^{-1})		H_a (kj m^{-2})		F_i (kW m^{-1})		F_l (m)	
		pre	*post-2*	*pre*	*post-2*	*pre*	*post-2*	*pre*	*post-2*
NV	***0***	0.8	0.2	9,700	2,991	122	9	0.7	0.2
	15	31.2	5.0	9,700	2,991	5,051	249	3.9	1.0
	30	75.5	5.0	9,700	2,991	12,203	249	5.9	1.0
FA	***0***	1.1	0.2	7,688	4,461	135	18	0.7	0.3
	15	50.1	12.8	7,688	4,461	6,420	952	4.4	1.8
	30	131.5	19.5	7,688	4,461	16,854	1,447	6.8	2.2
FB	***0***	0.8	0.4	3,928	2,367	50	15	0.5	0.3
	15	38.7	16.8	3,928	2,367	2,533	664	2.8	1.5
	30	88.8	16.8	3,928	2,367	5,814	664	4.2	1.5
CE	***0***	0.2	0.1	5,128	2,200	20	5	0.2	0.1
	15	8.1	1.6	5,128	2,200	732	68	1.8	0.6
	30	20.2	2.5	5,128	2,200	1,758	75	2.6	0.8
NA	***0***	0.2	0.1	3,451	2,125	9	2	0.2	0.1
	15	7.9	1.3	3,451	2,125	455	58	1.2	0.5
	30	12.2	1.3	3,451	2,125	701	62	1.6	0.5
TO	***0***	0.2	0.1	4,819	2,333	14	1	0.3	0.1
	15	7.9	1.0	4,819	2,333	636	38	1.5	0.4
	30	18.9	1.0	4,819	2,333	1,516	38	2.2	0.4
AS	***0***	2.3	0.4	27,731	3,036	1,068	23	1.9	0.3
	15	107.8	30.1	27,731	3,036	49,823	1,524	11.2	2.3
	30	293.7	45.7	27,731	3,036	135,764	2,311	17.8	2.7
ME	***0***	1.3	0.7	13,647	3,624	289	43	1.0	0.4
	15	73.2	39.9	13,647	3,624	16,424	2,412	6.7	2.8
	30	193.8	83.8	13,647	3,624	43,499	5,423	10.5	4.0

Fire propagation velocity (S_r; m min^{-1}), heat per unit area (H_a; kJ m^{-2}), fire line intensity (F_i; kW m^{-1}) and flame length (F_l; m).

Fire propagation velocity (S_r; m min^{-1}), heat per unit area (H_a; kJ m^{-2}), fire line intensity (F_i; kW m^{-1}) and flame length (F_l; m).

Life cycle analysis of the solid biofuels obtained (CIEMAT)

- **Describe the activities undertaken and outputs achieved in quantifiable terms (also indicate by whom they were done).**

- **Describe the activities undertaken and outputs achieved in quantifiable terms (also indicate by whom they were done).**

CIEMAT has carried out a study to assess the environmental impact and energy balance of shrub biomass solid biofuels (both milled biomass and pellet) utilization for thermal energy and electric production. In particular, the main phases analyzed in the life cycle of the system are schematized in the next figure. Within this system, three main subsystems were considered: the collection of forest biomass (subsystem 1 (S1)), the grinding plant to obtain chips (subsystem 2 (S2)) and the pellet densification plant (subsystem 3 (S3)), which are shown in the next figure.

- ✓ *Subsystem 1 (S1) Collection of forest biomass.*

Two biomass harvesting procedures have been analyzed: a harvester-baler and a harvester-mulcher, with different machinery requirements for biomass loading, transport and unloading. According to the radius of action of the potential consumer facilities (100 km for pellet factories, 100 km for electric power plants and 20 km for heating installations), different biomass road transport distances has been established in the analysis.

- ✓ *Subsystem 2 (S2) Grinding plant to obtain chips.*

The facility considered appropriate in calculations to obtain 30-50 mm biomass chips, was a 400 kW blade pre-shredder, with a production capacity of 20 t DM/h and a weight of 16 t.

- ✓ *Subsystem 3 (S3) Pellet densification plant.*

To obtain pelletized biofuels, the plant utilized in the pretreatment processes were a grinding plant (20 t DM/h of 30-50 mm chips), a rotary drum dryer provided with a biomass burner as heat source (4 t DM/h), a hammer mill plant (12 t DM/h of 4 mm chips) and a pellet plant with flat die press (4.5 t DM/h).

The power required for all pre-treatment stages in subsystem 3 was estimated at 1300 kW.

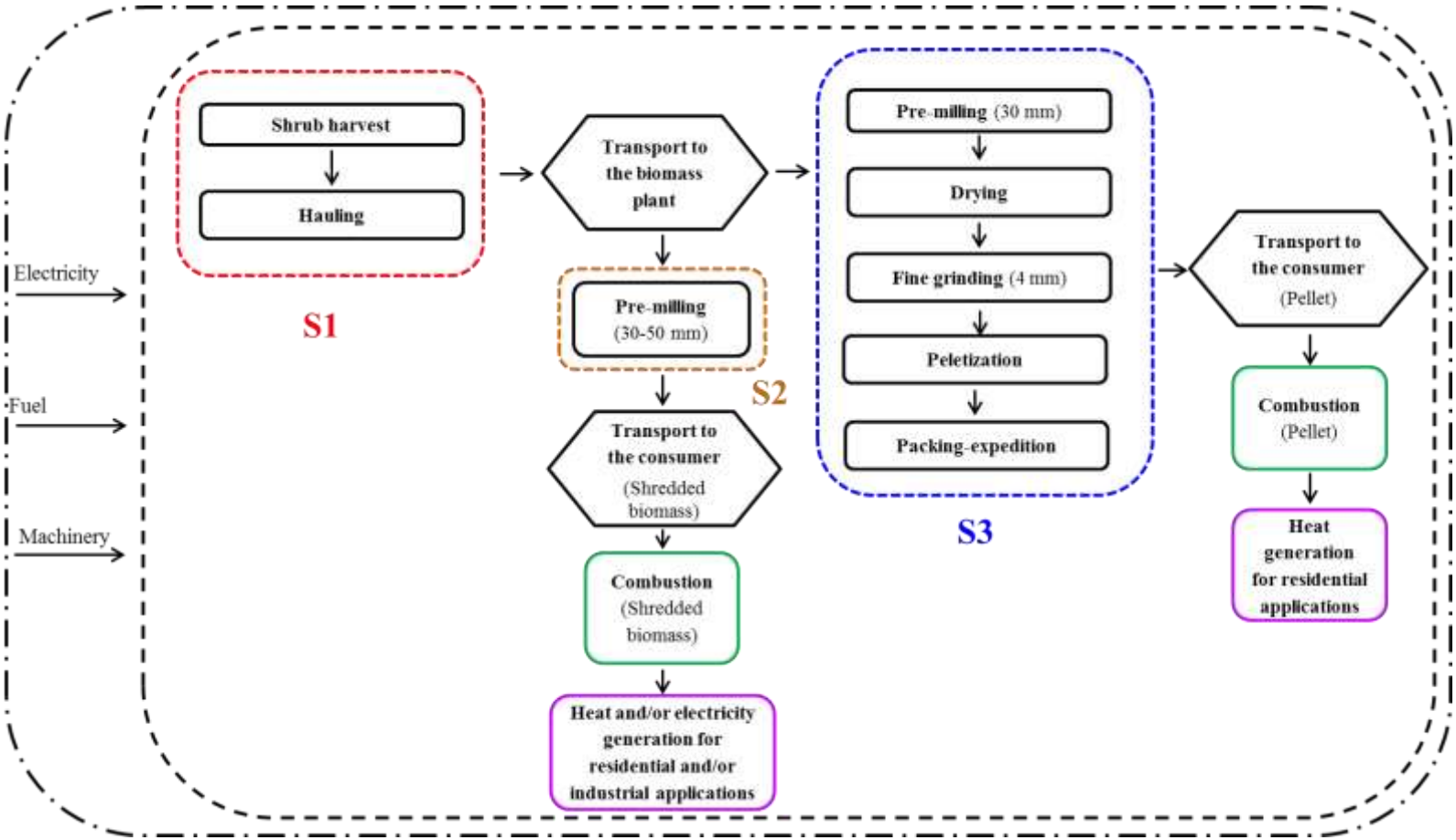


Figure: **Boundaries of the system and description of the subsystems.**

The methodology is resumed as follows:

-Data collection. All necessary information is being obtained from the different actions of the project (B1 and B2). TRAGSA send to CIEMAT all the information concerning harvesting operations, CIEMAT generate information about biomass transport, pre-treatment and combustion.

-Data review. The purpose has been to verify and validate that the data quality is good.

-Enter data into the SimaPro software. Simapro 7.1 software tool and the Ecoinvent 2.0 European database have been used to conduct the LCAs in this study.

-Obtain results. All results have been achieved, both in the assay conditions and the optimized scenario.

The ACV analysis has been performed at two levels: the **assay conditions** and **the optimized scenario**. The assay evaluation has been performed for the real operations carried out in the project, meanwhile the optimized scenario is that in which the different operations, based on the project results, should be the most suitable for each type of biofuel produced.

- **Compare with planned output and time schedule. (Please note that the overall progress of the project should also be presented using a Gantt-chart or similar – see section 4.1)**

Some of the activities in the action B5 have not been undertaken according to the planned time schedule at the beginning of the project.

The overall progress of the action is represented in the following table:

Table: Overall progress of the action B5 comparing proposed and actual.

		2014				2015				2016				2017				2018			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
B.5 action (Life Cycle Assessment)	Proposed																				
	Actual																				

- **Clearly indicate (when applicable) the indicators used to test the performance of the action.**

The following table includes indicators of progress within this action. As can be seen, in this table, 100% of the original target has been achieved.

Table: Indicators of progress of the action B5.

	Zone 1 (Las Navas)	**Zone 2** (Garray)	**Zone 3 -5** (Figueruela-Fabero)	**Zone 4** (As Pontes)
Phase 1: Inventory of the means used and products obtained (%)	100	100	100	100
Phase 2: Processing and analysing data of the system using SimaPro software	100	100	100	100
Phase 3: Interpreting the economic, energy and environmental results	100	100	100	100

In the following table shows some of the indicators of results that have been achieved.

Table: Indicators of results of the action B5 (optimized scenario).

Biomass (origin)	Biofuel produced	Boiler (use)	Harvest-Hauling			Pre-treatment peletization			Transports			Energy conversion			TOTAL				FS Comp.	**S**	**E_1**	**E_2**	**Cc**
			e	GHG	C	e	GHG	C	e	GHG	C	e	GHG	C	e_1	e_2	GHG_1	C					
Broom (Las Navas, L1Z01)	Pellets	Las Navas (heat)	2194.1	46.1	65.8	1884.0	69.4	80.8	1984.7	121.2	2.8	258.8	12.7	163	0.33	0.85	13.01	312.4	129	88.1	2.6	38.8	19.2
Rockrose (Garray, L2Z01)	Shredded	Garray (electricity)	427.2	7.6	70.0	136.1	5.2	n.a.	162.1	9.5	7.3	628.0	52.6	172	0.07	0.32	4.04	249.3	269	95.3	4.4	22.9	42.1
Heather (Figueruela, L3Z02)	Pellets	Fabero (heat)	664.8	11.4	30.1	2085.2	76.4	56.2	2488.6	152.0	4.1	258.8	12.7	163	0.27	0.85	12.56	253.4	129	88.5	3.1	32.2	14.8
Gorse (As Pontes, L4Z01)	Shredded	Curtis (electricity)	455.7	7.0	30.2	5362.5	85.4	n.a.	610.1	37.3	8.7	628.0	12.7	135	0.35	0.35	7.15	173.9	269	92.4	1.0	101.3	25.0

e: Specific energy consumed (MJ/t DM). e_1: Specific energy consumed (MJ/MJ of low calorific value (LCV) on dry basis). e_2: Efficiency (MJ net produced/MJ of low calorific value (LCV) on dry basis). S: GHG saving compared to light fuel oil (%). E_1: Net energy produced/energy consumed (MJ/MJ). E_2: Energy consumed/ net energy produced (%). GHG: Greenhouse gases emitted by unit of mass (kg $CO_{2\text{-}Eq}$ /t DM). GHG_1: Greenhouse gases emitted by unit of energy (g $CO_{2\text{-}Eq}$ /MJ of low calorific value (LCV) on dry basis). C: Specific cost (€/t DM). Cc: Specific cost per unit of net energy produced based on the low calorific value (LCV) on dry basis (€/GJ). FS Comp: Comparador fósil (g $CO_{2\text{-}Eq}$ /MJ of low calorific value (LCV) on dry basis). Diesel C. n.a.: Not applicable. DM: Dry matter.

Finally, the deliverables corresponding to life cycle assessment in the supply chain and the carbon footprint of the project have been done and sent at the end of the project (31/07/2018).

- **If relevant, clearly indicate how actions were modified, and any correspondence with the Commission approving the changes. (In particular this is required if there has been a significant over-spending of the foreseen budget for the action.)**

This is not applicable to this action, as there has not been a significant over-spending of the foreseen budget for it.

- **Mention any complementary action outside LIFE**

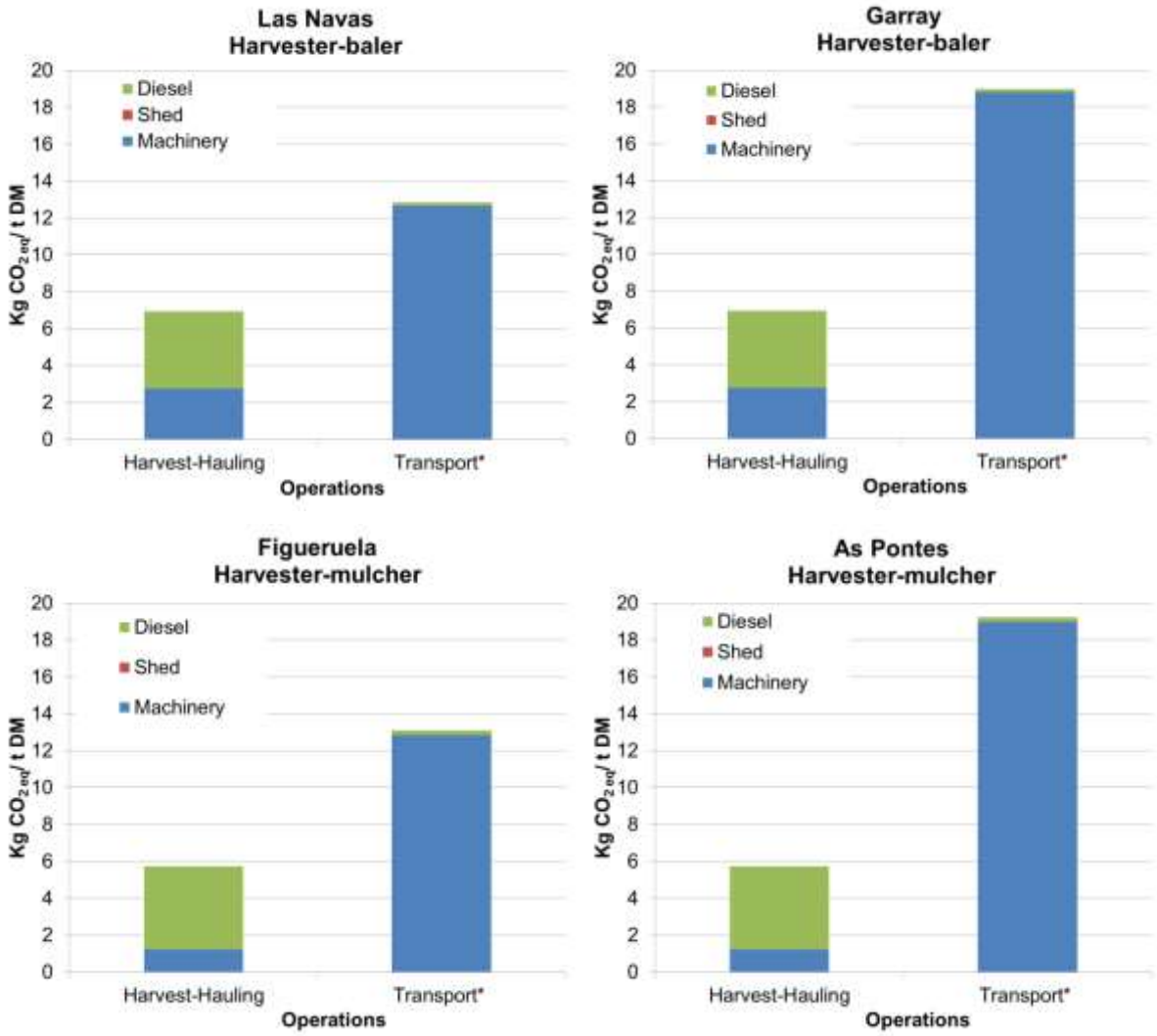
There has not been any complementary action outside LIFE affecting the action B5.

- **Outline the perspectives for continuing the action after the end of the project.**

This approach is very likely and recommended with respect to this action, as the energy evaluation and the environmental impact assessment of the harvested shrub biomass, pelleted and burned could be compared to other biomass. It would be very interesting to expand our knowledge about solid biofuels. Therefore, there are great perspectives for continuing the action after the end of the project.

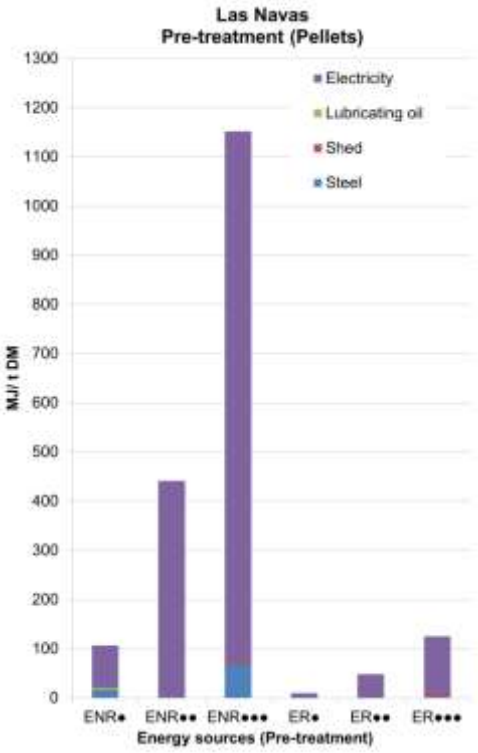
- **Include tables. photographs etc to illustrate the actions; for LIFE+ Nature and Biodiversity e.g. land purchase and non-recurring management activities**

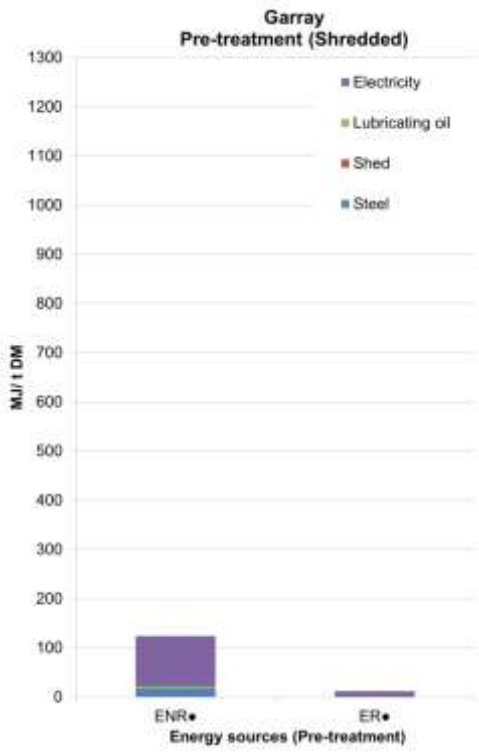
In the following figures (next pages) are illustrated some of the main results obtained within this action.

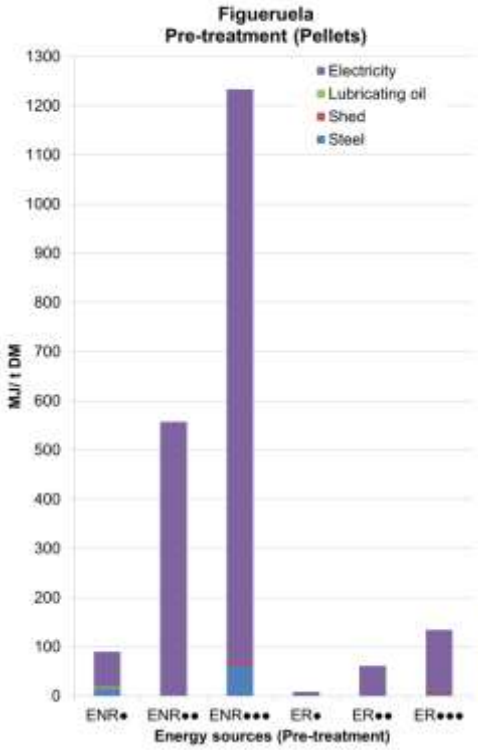


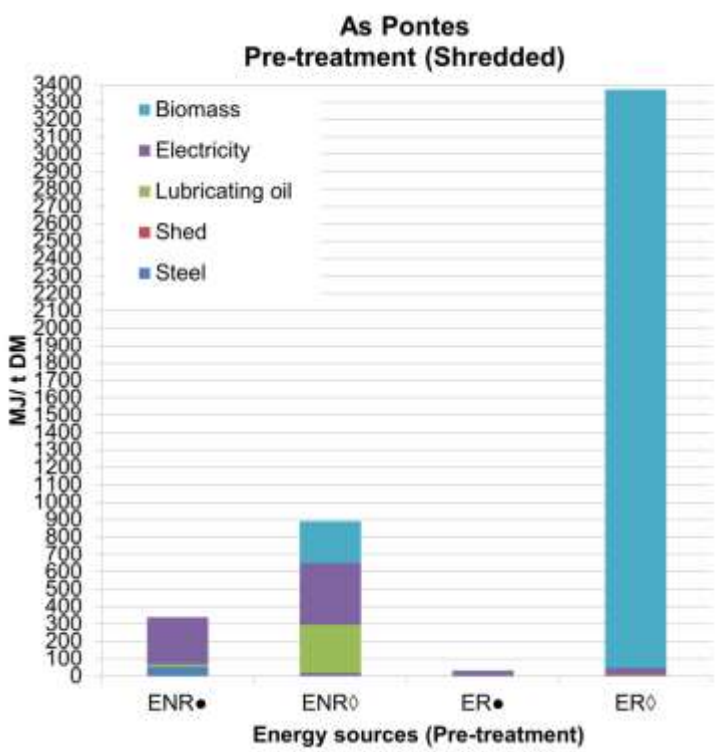
*Within the transport is included the emissions corresponding to the consumption of diesel necessary to carry out that transport.

Figure: Greenhouse gas emissions emitted during the stages of harvesting-hauling and transport at each location. (All calculations are based on CO_2 equivalents. considering the 100-year time frame for global warming potentials (GWP) (Optimized scenario).









ENR: Non-renewable energy ER: Renewable energy

●Pre-milling ◊ Drying ●●Fine grinding ●●●Peletization

** Within the transport is included the energy consumption corresponding to the diesel consumption necessary to carry out that transport.

Figure: Energy consumption during the stages of Pre-treatment at each location (Optimized scenario).

5.1.8 Action B6: Analysis of land ownership regime, legislation and applicable policies. Non-technical barriers for scrub use in biofuels production

(Task leader CIEMAT)

- **Describe the activities undertaken and outputs achieved in quantifiable terms (also indicate by whom they were done).**

The work in this action started with the beginning of the project. In February 2015, CIEMAT carried out the corresponding deliverable report (which is included in the Annex: Deliverables). It has been studied forest ownership in the action areas and the legal regime of use and forestry work.

The main results of the analysis carried out show that the highest percentage of scrubland in relation to total forest area is found in Fabero (45 %) followed by Garray (41%), Las Navas del Marqués (34 %) and As Pontes (22%). The proportion of scrub is more concentrated in private forests than in public ones, in proportions ranging between 94 % and 72 % of the total area of scrubland.

With regard to the legal regime of use and forestry work, it can be concluded that there is a high regional dispersion. There is a basic government regulation (Ley 21/2015. de 20 de julio. por la que se modifica la Ley 43/2003. de 21 de noviembre. de Montes http://www.boe.es/boe/dias/2015/07/21/pdfs/BOE-A-2015-8146.pdf), however, the competence in forest policy and management are decentralized in the regions (NUT-III). Some regions, such as Galicia, have their own legislation that includes, for example, an interesting figure, “the forest biomass manager", and an authorisation system that could serve as an example in other regions.

The main non-technical barriers identified are the following:

- Public or private ownership of the forest area: in Spain, practically two thirds of the Spanish forest area is in private hands, and the fragmentation of the forest, without a clear policy towards forest associations, has a negative impact on its use. The shrublands, as marginal lands, are often in a situation of "semi-abandonment or abandonenment"

- Determination of the legal nature of the forest area, such as those cases in which the forest is part of a protected natural area or is located in the Natura 2000 network. In these cases, there are no clear guidelines on how to manage shrublands.

- In relation to the treatment of scrubs or clearing with recovery or extraction of biomass, there are no clear rules that define whether the action mean a silvicultural/clearing activity with waste management, or it is a harvesting activity.

- There are no management plans and therefore the scope of the Administration regulations are not defined according to shrubland management tools or wider Forest Management Plans. In short, the planning of the Shrublands will make a difference and will be necessary for sustainable management.

- A legal classification of shrub biomass obtained with the purpose of allocating it to energy use or other uses is missing.

- Deposit or temporary storage of scrub biomass prior to its energy use. There is no regulatory framework that regulates the management and logistics of the resource obtained. In particular, it is not possible to establish temporary storage areas for the biomass obtained at or nearby of the clearing site. It would be convenient to have some normative element that establishes requirements so that this activity can be carried out in order that forestry managers and the competent administration have a frame of reference for decision making

- **Compare with planned output and time schedule. (Please note that the overall progress of the project should also be presented using a Gantt-chart or similar – see section 4.1)**

After the midterm, the work in this action has concentrated in the identification of the non-technical barriers. A preliminary deliverable was produced and is attached with the progress report in September 2017. The end of the action was initially foreseen in July 2016 with the execution of a deliverable, but as consequence of the conclusions of the events realized and the debate arose, it was considered necessary to realize a questioner to different actors in order to better evaluate the non-technical barriers. Hence, the action will be extended until the end of the project.:

		2014				2015				2016				2017			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
B.6 action	Proposed																
	Actual																

- **Clearly indicate (when applicable) the indicators used to test the performance of the action.**

Indicators of progress in this action are performed by region. Progress is measured in% being complete when 50% for each region is reached:

Indicators	**Castilla y León**	**Galicia**	**% progreso**
Definition of legal status of forest land	50	50	100
Identification of major legal barriers to the management of scrub land	50	50	100

With respect to the results indicators, the following table shows the progress

Resultados	**Castilla y León**	**Galicia**
Report about legal status of forest land (included in deliverable B6-1	1	1
Report on identification of major legal barriers to the management of scrub land in Deliverable B6-2	1	1

Deliverables

DELIVERABLE	**ACTION**	**DEADLINE**	**COMPLETED**
Report on the legal status of forests in the study areas (B6-1)	B6	31/10/2014	100 %
Report on non-technical barriers and proposal of a legal framework for their solution (B6-2)	B6	30/04/2018	100 %

- **If relevant, clearly indicate how actions were modified, and any correspondence with the Commission approving the changes. (In particular this is required if there has been a significant over-spending of the foreseen budget for the action.)**

Not applicable

- **Mention any complementary action outside LIFE**

CIEDA-CIEMAT has held a conference on "THE CHALLENGES OF CLIMATE CHANGE TO THE NEXT SUMMIT PARIS 2015" in November 2015 in Soria.

He has also published the next book which is closely related to the subject of this action:

BLASCO HEDO. E. Propiedad Forestal Privada y Energías Renovables. Monografía asociada a Revista Aranzadi de Derecho Ambiental. Núm. 23. Ed. Aranzadi. Cizur Menor (Navarra). 481 pgs

- **Outline the perspectives for continuing the action after the end of the project.**

In June 2018, CIEMAT and AGRESTA have formed a group called GO - ESENCIAL (provisionally approved on June 21, 2018) in the framework of the program promoted by the European Association for Innovation in Agricultural Productivity and Sustainability (AEI-AGRI) and managed by the Spanish Ministry of agriculture, MAPAMA. This group, whose objective is to develop managing tools of shrub formations, extract essential oils and biomass for solid, liquid biofuels and bioproducts development, participate 10 research groups, companies and associations

- **Include tables. photographs etc to illustrate the actions; for LIFE+ Nature and Biodiversity e.g. land purchase and non-recurring management activities**

In the Deliverables B6, the main activities and results obtained within this action until now are illustrated

5.1.9 Action B7: Proposal of management guideline and policies for the scrub areas use

(Task leader CIEMAT)

- **Describe the activities undertaken and outputs achieved in quantifiable terms (also indicate by whom they were done).**

This action started up in April 2016. An evaluation of the existing management plans in the regions of Castilla y León and Galicia was carried out through interviews and questionnaires. A first preliminary report was sent with the progress report in September 2017 but more information was collected through interviews, seminars and events like the Word Café celebrated in September 2017.

The most anticipated product of the project is to achieve a minimum definition of technical and non-technical criteria for the sustainable management of shrubs based on the results of actions B1 to B6. These criteria will allow forestry administrations to establish conditions for granting permissions for the execution of scrub handling operations as well as to guide companies and forest owners to carry out projects and management plans.

Many of these criteria and guidelines have been generated as an outcome of the results obtained in the main technical implementation actions from B1 to B5, although others such as legal and non-technical prospects have been obtained as a result of an interaction with actors such as owners, foresters, companies, lawyers, administrations and scientists who have actively collaborated with the project. Those criteria and guidelines have been collected in a specialized four guides and manuals generated in the project and published and distributed during the last year of the project

• Scrub clearance and cleaning of forests can generate very abundant biomass resources that currently have little or no value.

• Is it environmentally sustainable to clear? More time and research is necessary, but everything that it is positive if it is done in a planned way and taking into account the criteria and guidelines to minimize the impacts

• The biomass obtained from the shrubs has medium-high qualities for energy uses and could compete with wood pellets and wood chips

• The mechanized exploitation of the biomass of many shrubs can be profitable in the short-medium term (learning curve still ahead) an there is still a need to prospect an take advantage of synergies with other sectors such as livestock, hunting and fire prevention.

• It is necessary that administrations take the issue seriously. Help the forest owners and invest more in clearing that can be partially self-financed with biomass, mycological resources, pastures and beekeeping will help to save money in forest fires supression.

• Overcome inertias. The scrub biomass is not wood. Their treatment is different. Specific guidelines and regulations are required for its management, such as permission to temporarily store in the forest.

• For public aids, it is recommended to increase the effort in the realization of more forest enhancement treatments and less afforestation of crop lands, considering that it is a priority to take care of the existing forest lands, rather that creating new ones.

- **Compare with planned output and time schedule. (Please note that the overall progress of the project should also be presented using a Gantt-chart or similar – see section 4.1)**

The planned outputs have been gathered according to the initial work programme.

The action was initially planned to end in Decembers 2017 but due to the extension of the project, it finally ended in April 2018.

		2014				2015				2016				2017				2018			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
B.7 action	Proposed																				
	Actual																				

- Clearly indicate (when applicable) the indicators used to test the performance of the action.

Table: Indicators for monitoring progress of the action B7

Indicators	Castilla y León	Galicia	% progress
Evaluation of current management plans	50	50	100
Interviews and questionnaires	50	50	100
Technical guidelines for sustainable management	50	50	100
Proposals and evaluation by actors	50	50	100

Proposals of solution and guidelines for sustainable shrub formations management were evaluated at the World Café event in Valladolid and the conclusion are reported in B7-2 and in the manual published by CIEMAT

Table: Indicators of results of the action B7

Indicators	Castilla y León	Galicia
Report evaluation of current management plans (Deliverable B7-1)	1	1
Interviews and questionnaires	14	8
Technical guidelines for sustainable management (manuals)	4	4
Proposals and evaluation by actors	1	1
Writing a draft agreement between forest owners and industry	1	1

Deliverables

DELIVERABLE	**ACTION**	**DEADLINE**	**COMPLETED**
Report on the current instruments of forest management. technical and legal assessment	B7	1/12/2016	100 %
proposal for policies and technical guidelines for sustainable management of non-wooded land (B7-2)	B7	30/04/2018	100 %

- **If relevant, clearly indicate how actions were modified, and any correspondence with the Commission approving the changes. (In particular this is required if**

there has been a significant over-spending of the foreseen budget for the action.)

Not applicable

- **Clearly indicate major problems / drawbacks encountered, delays, including consequences for other tasks (technical. legal. financial/economic, market, organisational or environment related problems).**

Not applicable

- **Mention any complementary action outside LIFE;**

Not applicable.

- **Outline the perspectives for continuing the action after the end of the project**

Not applicable.

- **Include tables. photographs etc to illustrate the actions; for LIFE+ Nature and Biodiversity e.g. land purchase and non-recurring management activities**

Table. Diagnosis of the different barriers and their possible solutions for the management of shrub formations

ADMINISTRATIVE BARRIERS	MARKET BARRIERS	KEY ACTIONS	RESOURCES to carry to out the key actions (physical, economic, human, legal, etc.)	KEY PARTNERS
ADMINISTRATION BUROCRACY	LACK OF SPECIFIC MACHINERY AND FAILURES	LOBBY AGAINST THE ADMINISTRATION TO CARRY OUT FIRE PREVENTIVE SERVICULTURE	DEMONSTRATIVE ACTIONS IN REGIONS WITH GREAT SCRUB RESOURCES	PUBLIC ADMINISTRATIONS
ABSENCE OF SCRUB MANAGEMENT PLANS	LACK OF KNOWLEDGE ABOUT THE PRODUCT BY THE CONSUMER (QUALITY AND FORMAT)	PRIORITY LEGISLATION FOR RURAL DEVELOPMENT AND POLICIES AGAINST CLIMATE CHANGE	INTEGRATE THE SCRUBLAND IN THE MANAGEMENT PLANS	ENTITIES THAT MANAGE FIRE PREVENTION
FRAGMENTATION OF PRIVATE FOREST PROPERTY	MISSING IDENTIFICATION OF APROPIATE SCRUBS FOR MECHANIZED HARVESTING	IMPROVE COLLECTION AND CLEARING MACHINERY	INVOLVEMENT OF POLITICIANS AND ENTERPRISES	OWNERS, ENTREPRENEURS
SEASONAL RESTRICTIONS FOR CLEARING OPERATIONS	MISSING REAL EXPLOITATION CASES	IMPROVE THE QUALITY OF THE BIOMASS	PUBLIC FUNDING	UNIVERSITIES AND PUBLIC RESEARCH INSTITUTIONS

5.1.10 Action C1: Impact of the project in relation to the environmental objectives of Spain and the EU

(Task leader CIEMAT)

- **Describe the activities undertaken and outputs achieved in quantifiable terms (also indicate by whom they were done).**

This action depends on the results of other actions (B1, B2, B3 and B5) and started evaluation in 2017.

The impacts of the actions according to the environmental objectives are summarized below:
Demonstration of innovative technologies already tested in other geographical environments for shubs clearing and harvesting. Production costs not exceeding the cost of the wood biomass (€ 45 / t of wet biomass) at destination with a radius lower than 100 km, have been obtained.
Solid biofuels of standard quality that can replace the use of fossil fuels in industrial and domestic applications have been achieved.

Provide administrations, forest owners, energy management companies and end users of energy with elements that facilitate the transition towards a low carbon economy, in particular the 4 management manuals of shrub formations produced during the project. Three scientific articles have been published for the research community as well.
It has been demonstrated how the efficient use of natural resources must be undertaken. The scrubs generate biomass resources that are wasted while fossil resources are imported.

The clearing, in general, increases the carbon content in the soil: when the scrub is collected, a significant portion of aerial biomass and whole root biomass is left, and the layer of decaying dead matter is not touched, which also reduce the erosion risk. Contrary to what happens with forest fires that generate a brutal mineralization of biomass and leave it exposed to erosion. These facts have been shown in action B5.

With regard to biodiversity, the project has shown that well-planned clearing is not harmful to biodiversity,. It has been demonstrated that after clearing, an important recovery of the vegetation cover begins, reaching coverage figures above 80 % in the second year after clearing. In conclusion it can be affirmed that the shrublands studied respond to disturbances and in particular to the mechanical clearing and biomass extraction with an active regeneration that tends to cover the soil in a few years. The active germinating strategies in the rockrose, or sprouting in heather or legumes play a very important role in the stands regeneration, since they are robust and frugal species very well adapted to germination and regrowth after a sudden disappearance of the vegetation and putting the ground on light.

- **Compare with planned output and time schedule. (Please note that the overall progress of the project should also be presented using a Gantt-chart or similar – see section 4.1)**

This action that depended on the results of the implementation actions and especially B5 and B7, has been delayed in the same time as the aforementioned actions and has been extended until the end of the project as planned. The overall progress of the action is represented in the following table:

Table: Overall progress of the action C1 comparing proposed and actual.

		2014				2015				2016				2017				2018			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
C.1 action	Proposed																				
	Actual																				

- **Clearly indicate (when applicable) the indicators used to test the performance of the action.**

The following table includes indicators of progress within this action.

Table: Indicators of progress of the action C1.

Indicators	Zone 1 Navas	Zone 2 Garray	Zone 3-5 Fabero Figueruela	Zone 4 As Pontes Merlán
A-Contribution of 2,000 tons of the local renewable energy to avoid 3,400 tons of emissions of CO_2 to the atmosphere (monitored in the B1), TOTAL green tonnes collected : 1631,3*	137.3	386	254.2	853.8
B-The annual increase of organic matter in the soil (monitored in B5)	1	1	1	1
C-In the studied areas will be calculated forest fire risk (monitored in B5)	1	1	1	1
D-The acquisition and supply of biomass in its destination with a cost less than biomass of wood origin (monitored in the B1)	1	1	1	1
E-Obtaining of solid biofuels that they satisfy the standards applicable to chips (EN 14961-4) and pellets (EN14961-2) (monitored in the B2)	1	1	1	1

* El objetivo inicial de obtener 2.000 toneladas de biomasa no se ha cumplido por las razones que se explican en el entregable B1. Si se han cumplido las horas de trabajo de maquinaria establecidas. The main reason for not achieving the stated objective is that the machinery utilised has not given the expected yields and has generated some failures due to the fact that are new an prototype technologies working in a hard environment.

In the following table shows indicators of results that have been achieved.

Table: Indicators of results of the action C1.

Results	Zone 1 Navas	Zone 2 Garray	Zone 3-5 Fabero Figueruela	Zone 4 As Pontes
Environmental impacts (% variation between preclearing and two years after clearing)				
Biodiversity (Margalef Index)	-10,7	-21,2	-36,3	0,0
Erosion (cualitative)	no	no	no	no
Forest fire (Propagation velocity)	-84,0	-59,9	-65,5	-42,6
C content in soil (increase/decrease)	-5,6	8,6	19,8	73,2
N content in soil (increase/decrease)	13,4	20,1	99,2	75,3
Other impacts				
GHG savings considering optimised scenarios (%)	95.2	94.7	95.1	95.5
Shrub biofuels utilized (tonnes)	137.3	386	254.2	853.8
Money saved in vegetation cleaning (€) (Considering 600 €/ha)	6,480	50,340	12,720	14,640

Deliverables

DELIVERABLE	ACTION	DEADLINE	COMPLETED
Document for debate on guidelines and forest policy applied to scrub masses. C1-1 (questionnaires)	C1	30/04/2018	100 %
Report on follow-up of environmental objectives fulfilment. C1-2	C1	30/04/2018	100 %

- **If relevant, clearly indicate how actions were modified, and any correspondence with the Commission approving the changes. (In particular this is required if there has been a significant over-spending of the foreseen budget for the action.)**

Not modified

- **Mention any complementary action outside LIFE**

There has not been any complementary action outside LIFE affecting the action C1.

- **Outline the perspectives for continuing the action after the end of the project.**

It is still not known whether there will be perspectives for continuing this action after the end of the project.

- **Include tables, photographs etc to illustrate the actions; for LIFE+ Nature and Biodiversity e.g. land purchase and non-recurring management activities**

5.1.11 Action C2: Socio-economic impact of the project

(Task leader CIEMAT)

- **Describe the activities undertaken and outputs achieved in quantifiable terms (also indicate by whom they were done).**

Job creation by Scenarios in after LIFE

In this action, CIEMAT has developed a work in order to ort presents an estimation of the employment creation based on scenarios of shrub biomass production in the working zones. The conclusion was that the use of biomass from shrub clearing, even with mechanized techniques, can be an important socio-economic incentive. The results are shown in deliverable C2-1 and are resumed as follows:

Based on scenarios of biomass utilization of scrub in Garray (Soria), Las Navas del Marqués (Avila), Fabero (León), Villardeciervos (Zamora) and As Pontes (La Coruña), It was estimated that the generalization in the use of scrub pellets in local areas with medium-small production plants and also medium-small thermal installations, could have the following impact in terms of local employment: 3-5 direct jobs in the collecting labors, 5-7 jobs in the pellets manufacturing per 10,000 tons of pellets production, and 1-2 jobs in logistic work. In addition, there would be a sector of distribution services, installation, etc., which could add another 2 jobs (indirect) more for every 10,000 t MS mobilized

Job creation during the project implementation

CIEMAT has led study concerning to C2 action with the information sent by the rest of the partners. This information is used to complete questionnaires with the data concerning to personnel, travels, external assistances, equipment and consumables at the end of each year. This information has permitted to carry out estimations of the employment generation during the project lifetime, analyzing the impact by gender as well as the employment in the influence areas of the project. The results are shown in Deliverable C2-2.

- **Compare with planned output and time schedule. (Please note that the overall progress of the project should also be presented using a Gantt-chart or similar – see section 4.1)**

All the activities corresponding to the C2 action have been carried out according to the planned time schedule at the beginning of the project.

The overall progress of the action is represented in the following table:

Table: Overall progress of the action C2 comparing proposed and actual.

		2014				2015				2016				2017				2018			
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
C.2 action	Proposed																				
	Actual																				

- **Clearly indicate (when applicable) the indicators used to test the performance of the action.**

The indicators are divided into two steps: during the project and after the project. The indicators during the project can be seen in next Table.

Table: Indicators of progress of the action C2.

Indicators	**1st year**	**2nd year**	**3rd year**	**4th year**	**4th year**	**% progress**
Contribution to the questionnaire with data	20	20	20	20	20	100
Evaluation of the annual impact of the project phase	20	20	20	20	20	100

Deliverables

DELIVERABLE	**ACTION**	**DEADLINE**	**COMPLETED**
Prospective report of employment generation potential if available resources of the areas of action were used . Recommendations. C2-1	C2	30/04/2018	100 %
Report on employment generation during the project inside and outside the demonstration areas. C2-2	C2	30/04/2018	100 %

- **If relevant, clearly indicate how actions were modified, and any correspondence with the Commission approving the changes. (In particular this is required if there has been a significant over-spending of the foreseen budget for the action.)**

This is not applicable to this action.

- **Clearly indicate major problems / drawbacks encountered, delays, including consequences for other tasks (technical, legal, financial/economic, market, organisational or environment related problems).**

This is not applicable to this action.

- **Mention any complementary action outside LIFE**

There has not been any complementary action outside LIFE affecting the action C2.

- **Outline the perspectives for continuing the action after the end of the project.**

Not enough data yet

- **Include tables. photographs etc to illustrate the actions; for LIFE+ Nature and Biodiversity e.g. land purchase and non-recurring management activities**

Table: Template of the questionnaire used in the action C2.

PERSONNEL CORRESPONDING TO THE PARTNER (direct work)		
	Men	Women
Partial time		
Full time		
Average commitment to the project (% of work day)		
University graduate		

EXTERNAL ASSISTANCE	EA1		EA2		EA3	
Short description of the contact						
Invoiced amount without VAT (€)		€		€		€
Supplier's town						
Does it belong to the area of influence?						
Hours of personnel dedicated to the contract						
Men (hours)						
Women (hours)						

CONSUMABLES	CO1		CO2		CO3	
Short description of the contact						
Invoiced amount without VAT (€)		€		€		€
Supplier's town						
Does it belong to the area of influence?						
Hours of personnel dedicated to the contract						
Men (hours)						
Women (hours)						

TRAVELS	TR1		TR2		TR3	
Reason for the travel (short description)						
Invoiced amount without VAT (€)		€		€		€
Trajectory						
Does the destination belong to the area of influence?						
Total km of the travel						
Hours of personnel dedicated to the travel						
Men (hours)						
Women (hours)						

5.2 Dissemination actions

5.2.1 Objectives

Summarise the objectives of the dissemination plan set out in the revised project proposal.

It aims to a successful dissemination and exploitation of the project results by the targeted groups: mainly municipalities with forest, forest owners, forest companies, rural development groups, forestry machinery companies, political responsibles, etc.

The communication actions proposed in the Actions D are organized regarding the sort of audience it's intended to be reached. The design and language will be adapted depending on the target (technical audience, non - specialized audience, etc.)

The objectives in this communication strategy are:

1. Disseminate and exploit ENERBIOSCRUB project's results to the targeted and consequently increase the use of biomass coming from scrubs.
2. Disseminate and exploit ENERBIOSCRUB project's conclusions in order to spread lessons learnt and explain how to use the scrubs for thermal use in an economic and sustainable way.
3. Establishing a bidirectional communication with technicians from the public administration, technicians of the biomass sector, project developers and promoters.
4. Disseminate the results in a comprehensive manner, focusing on the environmental and societal benefits of the results reached.

5.2.2 Dissemination: overview per activity

For each activity and output (as for the technical progress – cf. above):

- Provide a description in quantifiable terms, and indicate who was responsible
- Compare with the planned activity – was the objective reached? What reactions and feedback was obtained?
- Provide a list of deliverables including:
    - Use of LIFE logo (and for LIFE+ Nature projects: Natura2000 logo) on documents and durable goods;
    - Erection of notice boards
    - Web site
    - (e)Mailing lists
    - Audio-visual products (if relevant): videos
    - Photographs (see Common Provisions clause related to use of photographs by the Commission)
    - Brochures, handouts, leaflets
    - Publications: handbooks
    - Press cuttings overview (press cuttings to be annexed)
    - Social Media used (Facebook, Twitter etc)

–

1) Website implementation and maintaining

CIEMAT is responsible for implementation and AVEBIOM Collaborates in contents generation and updating.

The website http://enerbioscrub.ciemat.es/ has been developed and has updated with project information and links to sites of interest. Appearance of project information in partner websites and connection with the project website:

[AGRESTA] http://agresta.org/life-enerbioscrub/

[AVEBIOM] http://www.avebiom.org/es/que-hacemos/List/listing/enerbioscrub-163/1

[CIEMAT] http://enerbioscrub.ciemat.es/es

[GESTAMP] http://www.gestampbiomass.com/es/media/actualidad/gestamp-biomass-participa-en-el-proyecto-life-enerbioscrub

[INIA] http://enerbioscrub.agripa.org/

[INTACTA] http://intacta.es/life-enerbioscrub/

[MONTE DE LAS NAVAS] https://montesdelasnavas.com/proyectos/proyecto-life-enerbioscrub

[TRAGSA] http://www.tragsa.es/_layouts/GrupoTragsa/Ficha-Proyecto.aspx?param=ESP.0000000288&pi=0&q=ENERBIOSCRUB

The objective was 10.000 visits to the web per year and 5000 unique visitors during the project duration

We obtained until 30th April 2018

4.222 unique visitors

7.698 visits

45.769 number of pages visited

The site WEB of the project has been continuously updated and improved. A part of updating the news, information, etc. from the project, the system was upgraded in June 2016 to a friendlier and nicer interface. We obtained 4.222 visits from unique users until the end of the project on 30th April 2018, which it's below the objective for the whole project but an significant improvement on the figures was obtained in the last year of project as until 31st march 2017 it had only 2.491 visits. This is due to an effort made by the partners after the follow up meeting held in Soria in April 2017, in which

the consortium decided to redirect the traffic through the WEB page in every communication by putting the link in all communications. Also, the WEB page obtained 7.698 visits (open sessions).

Report for the execution period of the project (1 October 2014 -→ 30 April 2018)

Besides the set-up of the WEB site, the main tasks we made during the project were updating the contents: information and News, Events, updating downloads.

The logo of Life+ is well located in the project's WEB

2) Elaboration of information material of the project

AVEBIOM is responsible for implementation and all the partners (except Intacta) have to participate

2.1) Information panels

Project roll-ups. CEDER- CIEMAT and AVEBIOM made two roll ups with the same design (see below). During EXPOBIOMASA 2015, the Roll up was exposed in the stand of AVEBIOM where around 15.000 people during the 3 days passed.

Also, the roll up was showed in EXPOBIOMASA 2017 (3 days, 16000 people) in the stand dedicated to the project with a panel designed for the occasion, leaflets, a video continuously playing and people from the consortium solving doubts and networking. The panel, showed below had 12 m x 1,5 m.

Also BIOMASA FORESTAL that was present in the fair of SILLEDA (Galicia) exposed their roll up.

The roll-ups were also used in the workshps organised by the consortium (Avebiom, in Expobiomasa, Tragsa in Madrid, INIA in Madrid, Biomasa Forestal in As Pontes, Agresta in Soria). Not all roll ups foreseen has been printed as they have been shared among partners.

Other designs of other partners are available in the digital annex.

In all documents, the logo of Life+ was placed-

2.2 Posters

All the partners had to develop a poster or wall chart summarizing the objectives, demonstrative work and results of the project. This poster will be placed in the places of transit to facilitate reading workers and visitors of different companies and institutions.

Tragsa has installed 6 noticeboards made of rigid weather proof materials in the different field plots where biomass harvesting has been carried out (see below).

Other posters were located in the scientific conferences by CIEMAT, INIA, AGRESTA in 7º Congreso Forestal Español and 24th and 25th EUBCE.

Also in EXPOBIOMASA a Poster was showed next to the stand.

- Las Navas del Marqués site: 1 panel in Matallana (L1Z02).

Due to espace, the other panels are available in the digital annex.

In all the posters, the logo of Life+ was placed well visible

2.3 Leaflets

The leaflets content and design have been written with the collaboration of CIEMAT and AVEBIOM and they have sent a digital version of the design to all the partners. Each partner can print their own copies and spread the leaflet project in electronic format via e-mail, Web or social networks and

distribute paper copies in all seminars, conferences or trade shows in which they participate or organize

The objective is print and distribute 3500 leaflets (500 leaflets per partner) during the project duration. During the project 3200 leaflets were printed, there were 500 leaflets not printed because the partner AGRESTA had not budget for it, but instead, when AGRESTA organised a workshop they printed several small poster to make communication.

AVEBIOM and CIEMAT design that can be seen below is similar to the roll up.

In all leaflets, the logo of Life+ was placed

Other Leaflets of other partners are available in the digital annex

2.4 Technical Manuals

The project consortium have created, designed and printed 200 copies of 4 technical manuals for disseminate the project

- INIA “Manual gestión ambiental matorrales” by May 2017
- AGRESTA “Manual divulgación sobre inventario LIDAR” by February 2018
- CIEMAT “Manual divulgación sobre biomasa matorral” by April 2018
- AGRESTA “Manual buenas practices desbroce” by November 2017

In all Technical manuals the logo of Life+ was placed

2.5 Divulgation video

TRAGSA was responsible in the project to produce an informative video of the scrub gathering and collecting demonstration works. This video was disseminated through the project website, the YouTube portal and was showed in a TV while the EXPOBIOMASA 2017 exhibition (with 16.000 visitors). The video must show two different biomass harvesting systems working in different conditions. It was performed by a specialized company, and use images and video clips acquired during the field works combined with voice and music.

The video can be seen in the following link https://youtu.be/t-xgmdh6-Ic

There are in total 29 videos uploaded on YouTube which obtained 4.163 visualisations in total. Some of the can be also found in the Diffusion area of the ENERBIOSCRUB's web there are several videos of the demonstration trials developed by CIEMAT. Also in Youtube, https://www.youtube.com/results?search_query=enerbioscrub some presentations can be found from the workshops organised in Madrid by INIA and TRAGSA. In the project's webpage, also can be found the videos from the AGRESTA's workshop.

The videos are available in the digital annex

The logo of LIFE+ was not possible to add to the videos but we include the name of the project and the program in every video information as you can see in the examples below

ENERBIOSCRUB PROJECT
Luis Esteban
Hace 10 meses • 219 visualizaciones
Sustainable management of shrubs formations for energy purposes «ENERBIOSCRUB» LIFE13 ENV/ES/000660.

ENERBIOSCRUB PROJECT
Luis Esteban
Hace 10 meses • 188 visualizaciones
Sustainable management of shrubs formations for energy purposes «ENERBIOSCRUB» LIFE13 ENV/ES/000660.

ENERBIOSCRUB PROJECT
Luis Esteban
Hace 10 meses • 148 visualizaciones
Sustainable management of shrubs formations for energy purposes «ENERBIOSCRUB» LIFE13 ENV/ES/000660.

2.6 LAYMAN Report

The layman report with the main conclusions of the projects was completed and printed in the last months of the project. AVEBIOM and CIEMAT were the responsible for its creation, graphic design and printing. 500 copies of the Layman Report were printed.

In the LAYMAN report, the logo of Life+ was placed

2.7 Divulgation in communication media

Dissemination of the project in different media, both professional technical and with informative scope.

AVEBIOM is the beneficiary responsible for implementation. All the partners have to collaborate.

2.7.1 Traditional media

Along the project, 6 press releases and several articles have been done that provided us 62 appearances in the media (21 in publications in specialised or technical media, 34 in general media's WEBs and 7 in paper general media).

Also we got 3 TV appearances.

- Noticias Castilla y León RTVE www.rtve.es/noticias/castilla-y-leon/ 13/06/2014. Launch of the project
- Canal 24 horas 01/12/2015. Collection trials in CEDER
- TV Galicia

In the digital annex can be found the video files

Regarding radio appearances, there were 5 during the project (3 CIEMAT, 1 TRAGSA and 1 NAVAS DEL MARQUES). In the digital annex can be found the audio files.

Below, some examples of traditional media publication can be found.

Publication in “Innovadores de el mundo” (left) and “El Correo de Zamora” (right)

2.7.2 Digital media

The Consortium is periodically uploading news to the news’ category in the Project’s web site http://enerbioscrub.ciemat.es/noticias

Moreover there were many publications in digital media (34 in traditional media and 16 in specialised media webs). Some examples can be found below:

Media name	Date	Description
www.efeverde.com Extracción de biomasa para prevenir incendios forestales	30/05/2014	Launch of the project
www.desdesoria.es La Comisión Europea financia un proyecto del programa LIFE+ liderado por el Ceder-Ciemat con 1,8 millones	31/05/2014	Launch of the project
humania.org La Comisio n Europea financia un proyecto del programa LIFE+ liderado por el CEDER-CIEMAT con un presupuesto de 1.889.758 euros	31/05/2014	Launch of the project
profesionaleshoy.es La Comisión Europea financia un proyecto del programa LIFE+ liderado por el CEDER-CIEMAT	31/05/2014	Launch of the project
www.sorianoticias.com La Comisión Europea financia un proyecto del programa LIFE+ liderado por el CEDER-CIEMAT	31/05/2014	Launch of the project
www.diariodesoria.es Nuevo proyecto del Ceder	01/06/2014	Launch of the project
CEDER-CIEMAT lidera un proyecto LIFE+ de la Comisión Europea http://www.ciemat.es/cargarAplicacionNoticias.do?texto=ENERBIOSCRUB&idArea=-1&identificador=519	02/06/2014	Launch of the project
www.desqbre.wordpress.com Fundación Andaluza para la divulgación de la innovación y el conocimiento El proyecto Life Enerbioscrub pretende reducir el riesgo de incendio forestal	02/06/2014	Launch of the project
www.dicyt.com Agencia Iberoamericana de Noticias para la difusión de la Ciencia y Tecnología del Instituto ECYT de la Universidad de Salamanca Un proyecto europeo extraerá biomasa de matorrales inflamables para reducir el riesgo de incendio	02/06/2014	Launch of the project
www.energias-renovables.com El periodismo de las energías limpias Cómo gestionar la biomasa del matorral para que produzca energía, no incendios	02/06/2014	Launch of the project
www.retema.es La Comisión Europea aprueba la financiación del proyecto Life ENERBIOSCRUB liderado por el CEDER-CIEMAT	02/06/2014	Launch of the project
salamancartvaldia.es La Comisión Europea destina 1,8 millones de euros a la prevención de incendios forestales	02/06/2014	Launch of the project
Tecnoenergía http://profesionaleshoy.es/energia/ La Comisión Europea financia un proyecto del programa LIFE+ liderado por el CEDERCIEMAT	02/06/2014	Launch of the project

www.ecoticias.com Noticias de Ecología y Medio Ambiente Proyecto europeo arrancará matorrales inflamables para reducir el riesgo de incendios	03/06/2014	Launch of the project
AUGPEE Asociación Uruguaya de Generadores Privados de Energía Eléctrica Un proyecto europeo extraerá biomasa de matorrales inflamables para reducir el riesgo de incendio	03/06/2014	Launch of the project
MásSalamanca.com Un proyecto europeo extraerá biomasa de matorrales inflamables,reduciendo los incendios	03/06/2014	Launch of the project
www.energynews.es El proyecto LIFE+ Enerbioscrub busca soluciones para reducir los incendios forestales mediante la recogida de biomasa	05/06/2014	Launch of the project
www.larazón.es Biomasa de matorrales para prevenir incendios	05/06/2014	Launch of the project
www.energiverde.com Nuevo proyecto para reducir los riesgos de incendios forestales	08/06/2014	Launch of the project
www.elbierzodigital.com Fabero participa en un novedoso programa europeo para aprovechar la biomasa	30/06/2014	Launch of the project
www.leonoticias.com Fabero se une a un programa europeo para fabricación de pellets con brezo	30/06/2014	Launch of the project
www.noticiascastillayleon.com Fabero participa en un proyecto europeo para producir biomasa con brezo	30/06/2014	Launch of the project
www.elnortedecastilla.es Soria investiga la forma más rentable de convertir el matorral en biomasa	07/07/2014	Launch of the project
www.dicyt.com Agencia Iberoamericana de Noticias para la difusión de la Ciencia y Tecnología del Instituto ECYT de la Universidad de Salamanca	16/06/2014	Kick off
www.desdesoria.es El Ceder-Ciemat lidera el proyecto Life+ Enerbioscrub, con un presupuesto de 1,8 millones	16/06/2014	Kick off
www.agenciaical.com Agencia de noticias de Castilla y León	16/06/2014	Kick off

www.presspeople.com Reunión del Life+ en el Céder de Lubia	16/06/2014	Kick off
www.sorianoticias.com El CÉDER lidera un proyecto de 1,9 M€ sobre incendios forestales	16/06/2014	Kick off
www.ecoticias.com Noticias de Ecología y Medio Ambiente	17/06/2014	Kick off
Reunión inicial del proyecto LIFE+ ENERBIOSCRUB http://www.ciemat.es/cargarAplicacionNoticias.do?texto=ENERBIOSCRUB&idArea=-1&identificador=539	17/06/2014	Kick off
20 minutos.es	14/12/2014	Recollection trials in las navas
El proyecto LIFE+ ENERBIOSCRUB comienza los ensayos demostrativos de desbroce http://www.ciemat.es/cargarAplicacionNoticias.do?texto=ENERBIOSCRUB&idArea=-1&identificador=705	19/01/2015	Recollection trials in las navas
El proyecto LIFE+ ENERBIOSCRUB presenta su portal web http://www.ciemat.es/cargarAplicacionNoticias.do?texto=ENERBIOSCRUB&idArea=-1&identificador=777	16/04/2015	WEB launch
El CEDER-CIEMAT participa en Expobiomasa 2015 http://www.ciemat.es/cargarAplicacionNoticias.do?texto=ENERBIOSCRUB&idArea=-1&identificador=899	05/10/2015	Expobiomasa 2015
http://agencias.abc.es http://agencias.abc.es/agencias/noticia.asp?noticia=1979296 Empresas gallegas, en un proyecto piloto de pellet para evitar incendios	12/09/2015	
Demostración de desbroce, empacado y valorización energética de matorral en el CEDER-CIEMAT con maquinaria innovadora http://www.ciemat.es/cargarAplicacionNoticias.do?texto=ENERBIOSCRUB&idArea=-1&identificador=942	17/11/2015	Recollection trials in CEDER
El mundo de Castilla y León. Innovadores \\CEDERG\grupos\PRETRATAMIENTOS BIOMASA\PROYECTOS\14_LIFE_ENERBIOSCRUB\PUBLICIDAD\prensaweb\BIOBALER_DEMOSTRACION-CECER\el_mundo_demostración ceder\artículo_innovadores_elmundo	05/01/2016	CASTILLA Y LEÓN NÚMERO 268 / MARTES 5 DE ENERO DE 2016 innovadorescyl@dv-elmundo.es

El diario de León-El Bierzo http://www.diariodeleon.es/noticias/bierzo/ciemat-testa-edificios-publicos-fabero-usar-matorral-biomasa_1053868.html?platform=hootsuite	16/03/2016	El Ciemat testa en edificios públicos de Fabero usar matorral como biomasa
La Opinion de Zamora\Comarcas\Aliste (pag 26) Un proyecto piloto transforma en Figueruela urces y retames en energía renovable http://www.laopiniondezamora.es/comarcas/2015/05/08/proyecto-piloto-transforma-figueruela-urces/841589.html	08/05/2015	Ensayos en Figueruela
La Voz de Galicia (en la edicción de Ferrol) Endesa cede 40 hectareas de suelo para un proyecto de biomasa http://www.lavozdegalicia.es/noticia/ferrol/as-pontes-de-garcia-rodriguez/2015/06/12/endesa-cede-40-hectareas-suelo-proyecto-biomasa/0003_201506F12C8991.htm	12/06/2015	Ensayos en As Pontes
La acción demostrativa tuvo lugar los días 14 y 15 de marzo de 2016, coincidiendo con la reunión del comité de proyecto que se celebró en la localidad de Fabero. http://www.ciemat.es/portal.do?IDM=61&NM=2&identificador=1051	11/04/2016	Ensayos de combustión en Fabero
Desde Soria http://www.desdesoria.es/?p=185394	11/04/2016	Continúan las acciones del proyecto LIFE+ENERBIOSCRUB que lidera el Céder de Lubia
Soria noticias http://sorianoticias.com/noticia/2016-04-11-continua-proyecto-antiincendios-life-enerbioscrub-ceder-31445	11/04/2016	Continúa el proyecto antiincendios LIFE+ENERBIOSCRUB del Céder
Heraldo de Soria http://www.heraldodesoria.es/noticias/soria/2016/04/11/el-proyecto-life-enerbioscrub-que-lidera-ceder-lubia-avanza-lucha-contras-los-incendios-forestales-841893-1521032.html	11/04/2016	El proyecto Life+Enerbioscrub que lidera el Ceder de Lubia avanza en su lucha contra los incendios forestales
ENERGY NEWS http://www.energynews.es/lifeenerbioscrub-innovar-gestion-biomasa-para-mayor-prevencion-incendios/	13/04/2016	LIFE+ENERBIOSCRUB: innovar la gestión de la biomasa para una mayor prevención de incendios

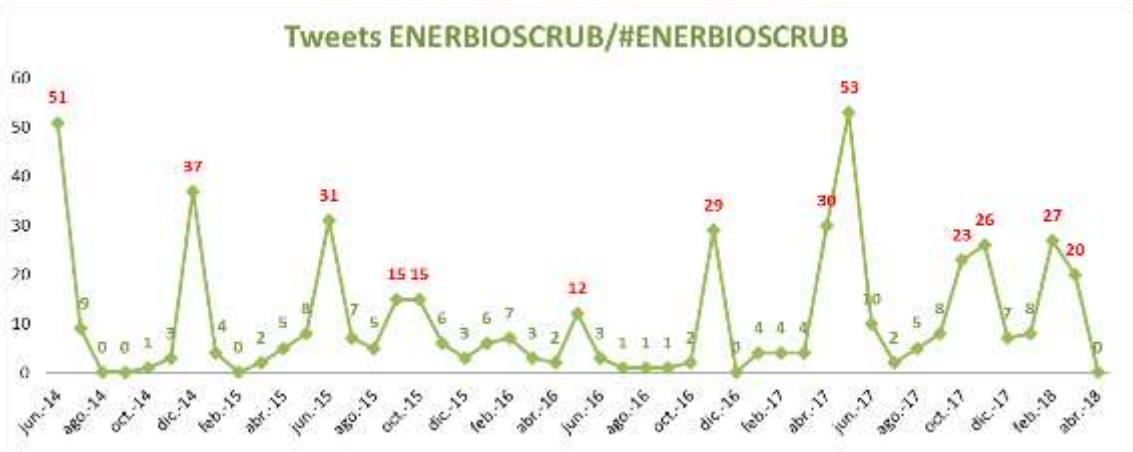
La opinión de Zamora http://www.laopiniondezamora.es/comarcas/2016/05/01/figueruela-saca-partido-monte/922158.html	03/05/2016	Figueruela saca partido al monte
La voz de Galicia http://www.lavozdegalicia.es/noticia/ferrol/valdovino/2016/11/30/biomasa-forestal-convertira-matorral-gallego-pellets/0003_201611F30C8991.htm	30/11/2016	Jornada conjunta con la reunión
Página de Bioforestal http://www.bioforestal.es/wp-content/uploads/2016/11/dossier-matorral.pdf	30/11/2016	Jornada conjunta con la reunión
El Norte de Castilla http://www.elnortedecastilla.es/soria/201701/26/ceder-lleva-proyecto-sobre-20170126144153.html	27/01/2017	Jornada CCOO - Participacion ciemat
La voz de Galicia http://www.lavozdegalicia.es/noticia/lugo/palas-de-rei/2017/02/17/estudian-calidad-toxos-palas-transformarlos-pellets/0003_201702L17C8992.htm	17/02/2017	Ultimos pruebas de recogida
Cosas de pueblo http://cosasdeunpueblo.siestasestoy.com/montes-de-las-navas-participa-en-expobiomasa-2017-con-el-proyecto-enerbioscrub-life/	30/09/2017	World Cafe

The Project consortium created the hashtag #ENERBIOSCRUB in twitter and all partners active in social networks may use it. To give more visibility to the news we put on twitter we include a widget of hashtag in the project's WEB site. This way all the tweets related with the project can be seen

There are more 500 tweets so far since the beginning of the project which includes about 150 photographies and 15 videos in which Enerbioscrub project is mentioned. AVEBIOM's twitter user has arouind 6000 followers so this figure could be considered as the impact could be considered

All the figures mentioned are until 30th April 2018.

We are publishing about all when there is some results, workshops, recollection trials, etc.

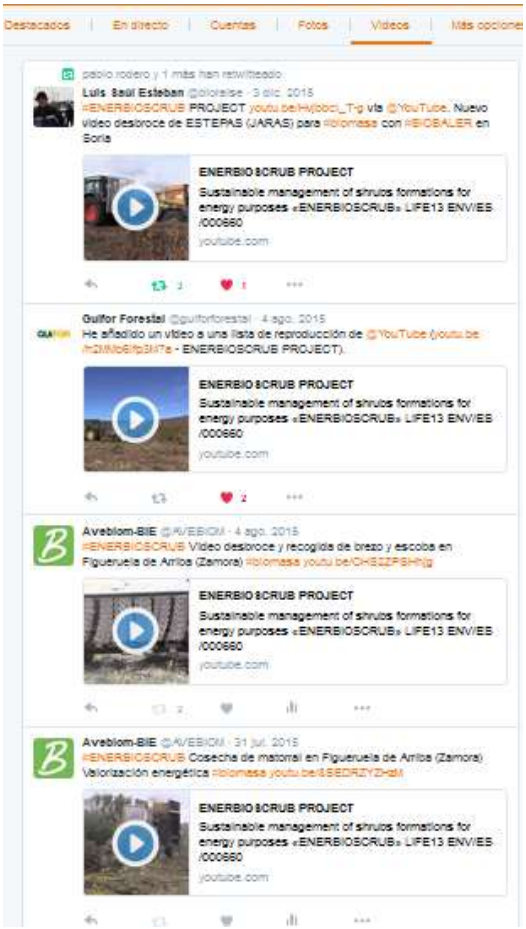


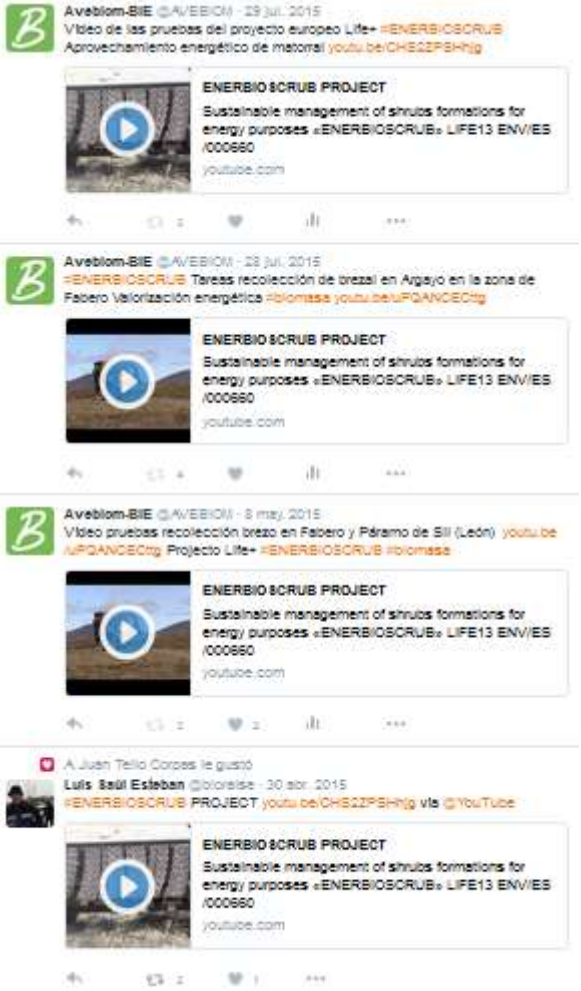
Below, some examples of the 150 photographs is mentioned the Project "ENERBIOSCRUB" or the #ENERBIOSCRUB hashtag in tweets


BIOMASA
DE MATORRAL
DE UNA FORMA
SOSTENIBLE
Y DISPONER DE UN
MODELO DE GESTIÓN
Y GENERAR EMPLEO
EN EL MEDIO


PROYECTO
Enerbioscrub

Below, some examples of the 15 videos published in twitter in which either “ENERBIOSCRUB” or #ENERBIOSCRUB is mentioned.





2.7.3 Specialized media

Regarding scientific publications (including posters and articles), the consortium fulfilled the objectives.

Partners	Objective of scientific national communications	No. done
CIEMAT	1	8
AVEBIOM	3	3
TRAGSA	3	3
INIA	1	5
AGRESTA	3	3
TOTAL	11	20

Partners	Objective of international scientific communications	No. done
CIEMAT	2	5
AVEBIOM	1	1
TRAGSA	1	1
INIA	2	3
AGRESTA	0	0
TOTAL	6	10

Regarding the scientific and technical communications (only counting posters and articles, not oral communications), in both, nationals and international, the consortium has fulfilled the objectives: 11/11 for nationals and 10/6 in internationals.

Find below a couple of examples:

ENERGÍA DEL MATORRAL

Primeros resultados del proyecto Enerbioscrub

Energy

Biofuels from broom clearings: Production and combustion in commercial boilers

BIE 27 (PDF), página 52 (April 2015). http://bioenergyinternational.es/ (left) Science Direct, available online 20 November 2017 (right)

Regarding impact of the publications, below is showed the impact of every media

Name of the Media	No. of publications of the project	Impact
Bioenergy International	5	Around 15.000 issues in paper. Distributed in PDF to 50.000 addressed directly and through the AVEBIOM's newsletter to 150.000 addresses.
Conama Conference	1	Conference with 7000 assistants.
Revista Transforma	1	Distributed in paper to 8,000 workers from Grupo Tragsa. Sent to 410 companies and published in the WEB (748 visits)
Conference 24th EUBCE	4	Conference with 1500 visitors. Publication with recompilation issued and available in the WEB
Conference 25th EUBCE	3	Conference with 1500 visitors. Publication with recompilation issued and available in the WEB

7º Congreso Forestal Español	5	Spanish conference with around 1200 visitors and all the contributions are available at the WEB
Biomass and Bioenergy	1	Scientific publication with an impact factor of 3.358, a 5-year impact factor of 4.232 and a CiteScore of 4.00
Energy	1	Scientific publication with an impact factor of 4.968, a 5-year impact factor of 5.582 and a CiteScore of 5.60
Forests	1	Scientific publication with an impact factor of 1.956, a 5-year impact factor of 2.252 and a CiteScore of 2.31

2.8 Organization and participation in conferences, technical seminars and conferences

AVEBIOM was the beneficiary responsible for implementation and will coordinate the communication actions.

Regarding the events that the consortium organised specifically for the project, a total of 6 were held during the project.

Participation in seminars or workshops for disseminating the project is progressing adequately as the figures established in the proposal have been already achieved (13 national participations in conferences while objective was 10 and 7 international participations made (including oral presentations) and posters while the objective was 4).

Worshops: organised by TRAGSA on 28/11/2017 (left) and by Agresta on 27/4/2017 (right)

Workshop organised by CIEMAT and AVEBIOM in EXPOBIOMASA ’15 (23/9/2015)

Special mention to the event organised by AVEBIOM and CIEMAT, called ENERBIOSCRUB World CAFÉ celebrated in September during the fair EXPOBIOMASA in which stakeholders of different sectors involved in the scrub biomass chain of value participated in a special group dynamic which served to create a document with proposals for solving the barriers to the use of this kind of biomass. Information regarding this event can be found here http://enerbioscrub.ciemat.es/es/eventos-realizados

ENERBIOSCRUB World Café in EXPOBIOMASA ’17 (28/9/2018)

Regarding the impact of the workshops assisted and organised we can see the number of assistants in the following table.

Type of event	No. of Events	No. Assistants
Workshops organised by 3rd entities	16	1000
Workshops organised by the consortium	6	305

2.9 "Networking" between actors and with other related projects

It has invited professionals with recognized expertise in the various project-related topics such as Environment, Forest Management, Employment and Energy, to evaluate the activities and results obtained in the project giving their opinions in order to adapt the results thereof to the real demands and needs of society allowing, at the same time to start working in the implementation of relevant initiatives in environmental governance.

Composition of the Expert Group can be found on the website of ENERBIOSCRUB http://enerbioscrub.ciemat.es/grupo-de-expertos

Apart of asking advice we are using this expert list as mailing list and sending information about the project.

The Project ENERBIOSCRUB participated in a workshop organised by FAEN about Life+ projects. 05/03/2015 "PROGRAMA LIFE+ COMO HERRAMIENTA DE DESARROLLO LOCAL A TRAVÉS DE PROYECTOS DE MEJORA MEDIOAMBIENTAL"

http://www.faen.es/news/disponibles-las-ponencias-de-la-jornada-programa-life-como-herramienta-de-desarrollo-local-a-traves-de-proyectos-de-mejora-medioambiental/

Pedro Abati. From Montes las Navas was present and gave a presentation with title "**Proyecto Life Enerbioscrub. Gestión sostenible de los matorrales para usos energéticos."**

Other projects participating:

Life Vineyards4heat

Life LifeBiobale.

Proyecto LifeHygenet.

Proyecto Life Rural Supplies

http://www.faen.es/news/disponibles-las-ponencias-de-la-jornada-programa-life-como-herramienta-de-desarrollo-local-a-traves-de-proyectos-de-mejora-medioambiental/

During the workshop celebrated in EXPOBIOMASA 2015 (23/09/2015) there were some Project invited to make a presentation

http://www.expobiomasa.com/es/desbroce-y-aprovechamiento-energetico-de-biomasa-de-matorral
Participant projects :
ENERBIOSCRUB
BIOBALE
VINEYARDS4HEAT

The presentations are available in the download section of the ENERBIOSCRUB WEB
http://enerbioscrub.ciemat.es/descargas

PROYECTO LIFE+ ENERBIOSCRUB– JORNADA EN EXPOBIOMASA (23/09/2015)

DEMOSTRACIÓN DE DESBROCE Y APROVECHAMIENTO ENERGÉTICO DE BIOMASA DEL MATORRAL

11.00 – 11.05 Presentación del proyecto ENERBIOSCRUB - Luis Esteban (coordinador del proyecto) y Pablo Rodero (coordinador de difusión y comunicación)

11.05 – 11.20 Inventario biomasa en masas de matorral mediante el uso de LIDAR- AGRESTA

11.20 – 11.35 Ensayos demostrativos de desbroce y acopio de biomasa – TRAGSA

11.35 – 11.50 Producción, caracterización y comportamiento en combustión de biocombustibles sólidos de matorral – CIEMAT

11.50 – 12.00 Impactos de la recolección mecanizada de matorral – INIA

12.00 – 12.10 Utilización de la biomasa del matorral en una red de calor - MLN

NETWORKING con otros proyectos LIFE+

12.10 – 12.25 Proyecto LIFE BIOBALE

12.25 – 12.40 Proyecto LIFE VINEYARDS4HEAT

12.40 – 13.00 DEBATE

Also in many actions of the consortium such as participations in fairs or workshops, there were implicit networking actions, for example in the EXPOBIOMASA 2015, information about the project was delivered in the AVEBIOM's stand and moreover during the participation in conferences and seminars contacts networking were made.

Special mention to the own stand exhibited in EXPOBIOMASA 2017 with panel designed for the occasion, leaflets, a video continuously playing and people from the consortium solving doubts and networking.

5.2 Evaluation of Project Implementation

In this section you should evaluate the following aspects of the project:

– Methodology applied: discuss the success and failures of the methodology applied. results of actions conducted and the cost-efficiency of actions

In spite of some delays in the implementation actions B1 that made necessary to ask an extension of four months, the project has been developed close to the scheduled program.

The preparatory action A1 is finished and the results are detailed in the corresponding deliverable A1. A new study area was added after the evaluation recommendations made to the inception report. Action A2 has been re-opened due to the need to find a new location for clearing scrub in As Pontes area as was explained in detail in the technical part.

The major uncertainties at the beginning of the project were related to the action B1. This action was key to develop the rest of actions. The uncertainties in B1 are derived from the following aspects:

- Difficulties associated with meteorological conditions.
- Lack of availability of the necessary equipment in times of trials.
- Breakdowns of equipment

At the stage of the mid-term mentioned uncertainties and difficulties caused a delay in the harvesting works that should have been finished on the 1st of March 2016. However, meteorological conditions caused extreme wet soils during the first 4 months of 2016 causing delays. The next photograph shows these problems in Figueruela and Fabero in April 2016.

The key action B1 was finished in February 2017 with one year delay. The reasons, mainly weather and machinery availability are detailed below and in the extension request annex. In resume, clearing and harvesting works started in December 2014 and finished in February 2017 resulting in 137 ha cleared and more than 1,629 t biomass collected.

The methodology developed in B1 has been appropriate for the results pursued Equipment employed is capable of performing shrubs' biomass harvesting with an acceptable quality. Nevertheless, so far harvesting the biomass yield is up to now, lower than expected.

On the one hand, the "harvester-baler" system required in las Navas del Marques, a lot of time for reparations and maintenance (mainly damages in the cutting system due to rocky soils), which decreased yields. Biomass losses (not harvested biomass that stays on the ground) were high, so

harvested amounts were lower than expected. It is considered that certain mechanical amendments and modifications in the cutting and feeding system, would considerably improve performance.

On the other hand, the "harvester-mulcher" system produced less biomass losses and reached a better productivity. Nevertheless, as it is a prototype, it also required a lot of time for reparations and maintenance, although problems decreased as the maintenance improved. Also in this case, it is considered that certain mechanical modifications would improve performance, such as a better design of the chimney in order to reduce the amount of mulched biomass that falls out of the storage unit.

The demonstration trials allowed improving the knowledge of the different productive chain phases, in order to evaluate the work, and define its advantages and disadvantages. A sustainable shrub land collection requires an appropriate mechanized clearing and harvesting system, and an evaluation of the logistic chain, in order to control the biomass quality before final destination. Throughout the ENERBIOSCRUB project, more than 1,600 tons of green biomass have been harvested, which is equivalent to 1,000 tons of dry matter (tDM), obtaining a productivity based on the effective work time between 0,6-2,1 tDM /h and 0,1-0,7 ha/h with BIOBALER, and between 3,3-4,5 tDM /h and 0,1-0,3 ha/h with RETRABIO.

Currently, mechanical improvement in both collecting systems are being studied in order to reduce harvesting biomass losses and increase collection efficiency, to improve their mechanical reliability, and to adapt each equipment to the type and species of vegetation to be processed.

The logistic chain after the harvesting operation is very important and is being studied. In the case of bales, following phases to be considered would be: deposit of bales in loading area, loading and transport to facilities where to be treated. It has been done as demonstration and evaluation activity in The Garray location, as can be seen in next photos:

Photos: Bale logistics in Garray. Up left, land loading with forwarder. Up right, forwarder unloading at roadside. Down left, truck loading. Down right. Truck unloading at GESTAMP power plant.

The bales are first hauled with a typical log forwarder from the land to a place in which a truck can get easy access. Second, the truck transports the bales to GESTAMP to be stored and crushed just before to be used in the boiler.

In the case of mulch collected by "harvester-mulcher" mulch is tipped by the harvester forming a pile, and then a loading machine is required in order to fill the trucks. Special 95 cubic meters walking floor trucks are used to transport the loose mulch.

Photos: mulch handling. Up, the harvester tip the load close to a road. Down left, a loader machine put the load into a 95 cubic meter truck. Down right, the walking floor truck unload the mulch at CEDER-CIEMAT.

The demonstration tests carried out have allowed to reach a greater knowledge about the different phases of the chains and to be able to evaluate advantages and disadvantages.

When making viable and sustainable use of shrub biomass, it is not only important to choose a good mechanized clearing-collection system, but also to evaluate the logistics chain and the consequences that our choice will have on the quality of the biomass. Taking into account also the yields obtained in the different phases of the process and in particular in the collection phase using both, the costs of the logistics chain have been estimated from harvesting to delivery at destination point in different locations of the project. The obtained costs do not include general expenses or industrial benefits of the possible company or companies involved in the logistics chain. Nor are biomass property payments or taxes included. Neither are possible incomes for carrying out clearing services or for sale of biomass.

The results obtained show that the costs for the fresh biomass collected and transported to the destination range from 22 to 45 € / t MH, with the highest costs being those obtained with baling method. In general, the costs are higher for the baling method due to the low efficiency in the harvesting of the biomass in the clearing phase, and especially in species such as the rockrose, where the brushcutter has presented poorer collection efficiencies. The low collection efficiency of the BIOBALER WB-55 (losses greater than 70% of the estimated above ground biomass), is due to problems in the transfer of biomass from the brushcutter to the baling chamber and unavoidable losses of fine material between the wrapping rollers. The CEDER, owner of one of these machines, is working on possible mechanical solutions to reduce these losses. The RETRABIO system has proved to be more efficient in harvesting, with the observed losses being less than 30% of the quantified aboveground biomass. However, after evaluating both systems and their biomass logistics chains, it can be concluded that there are a series of advantages and disadvantages (see table below): the logistic method based on bales has many advantages, while the one based on crushed biomass has many drawbacks. However, it must be borne in mind that in the bales-based model, the only drawback

detected, that of the high losses in harvesting, is a limiting factor in many uses and results in high costs per unit of biomass collected.

Table: main findings about both evaluated value chains. Advantages in green. Disadvantages in orange.

PHASE	CLEARING+BALING	CLEARING+CRUSHING
COLLECTION	MDE[1]: BIOBALER WB55 (commercial)	MDT[2]: RETRABIO (prototype)
	Machine coupled to tractor	Compact machine
	Medium tractor power: 200 HP	High power: > 300 CV
	Tractor + machine weight :14. 500 kg	Equipment weight: 17,000 kg
	Lower hourly cost	Higher hourly cost
	High clearing performance (ha / PMH)	Low mulching performance (ha / PMH)
	Good maneuverability	Poor maneuverability
	High losses of (waste) collection	Low-loss (waste) collection
	Possibility of the tractor used in other tasks.	Dedicated machine. Single-function
HAULAGUE		
	Necessary additional trailer coupled to tractor	Not necessary additional trailer
	Bales are stacked easy	Crushed on ground or on containers multilift
TRANSPORT		
	Truck with crane	Moving floor truck + front loader Truck multilift + containers
	Loader not required	Loader required
STORAGE		
	Few losses by degradation	High losses by degradation
	Good drying	Bad drying and high risk of spontaneous combustion
TRANSFORMATIONS		
	Need less forced dry: humidity low-medium	Need more forced drying: medium-high moisture
	Pre-shredder needed	Need screening + pre-shredder for oversized
	Few fines due to few degradation	Many fines due to degradation
	Little mineral pollution by previous handling	Risk of mineral pollution in previous manipulations
CONSUMPTION		
	Easy to store and handle	Difficult handling and storage
	Little risk of mineral pollution	High risk of mineral pollution

1: MDE. Baling system. 2: MDT. Crushing system

In action B2, the methodology used for evaluating the pre-treatment and combustion of shrub biomass has been successful. No significant problems were identified except the problems to store biomass in some locations due to the reticence of some owners and forest administrations.

Shrub biofuels present a higher ash content than other high quality biofuels. Sometimes, the biomass ash content origin is due to the soil mineral matter contamination during the scrub biomass handling. Occasionally, an increase in the amount of ash is related to an increase of the particle emissions in the combustion fumes.

Regarding to its composition, all shrub biofuels have high nitrogen content, compared to other woody biofuels. It is also remarkable the chlorine and sulfur content in some shrub biofuels, what can generate higher emission of NOx, HCl and SO2 when shrub biomass is burned.

These combustion fume gases do not prevent shrub biofuels from being used in biomass boilers, as long as their concentration is below the limits established in current regulations. Provided that the established regulation limits and legislation for these gases are met, their existence in the combustion fumes does not prevent shrub biofuels to be used in boilers. However, it is necessary to consider that the existence of HCl and SO2 in fumes can increase the heat exchangers fouling by ash deposition and the risk of equipment corrosion.

The use of shrub biofuels in commercial biomass boilers is feasible. However, it is necessary to adapt the boilers operation conditions to the use of the scrub, as it occurs when a new biomass fuel is introduced in any heating installation. For this adaptation, it is necessary to evaluate:

The ash automatic elimination time in the burner and in the heat exchanger, as well as the frequency of the equipment manual cleaning.

The fuel supply and combustion air levels, in order to avoid the burner to reach very high temperatures.

The use particle elimination systems after combustion, such as electro-filters or bag filters, if necessary, in order to comply with the current legislation

Concerning the methodology applied in the pelletising and combustion tests corresponding to the action B3, they have been, in general satisfactory. Two problems have been identified along the development of the combustion tests:

- On the one hand, in the proposal, broom biomass had been considered to be chipped and to be burnt in the boiler located in Las Navas. However, when this material was tested to be fed in this boiler, it was noticed that it could not be fed properly. Consequently, the material was pelletised at CEDER-CIEMAT to be used in Las Navas and it was chipped to be used in an additional location: a district heating in Cuéllar.

- On the other hand, the wet soil meant a problem in order to extract the rockrose bales to be burnt in Garray at the beginning of 2016. However, this fact was solved as soon as the soil conditions were suitable. Consequently, the emissions measurements were performed in Garray in the middle of May.

In action B4, we experienced some difficulties using LiDAR information for the characterisation of some shrub species (Erica arborea and Ulex europaeus). It is considered that the factors that affected negatively on the classification are the low penetrability of the laser pulses on the studied shrub types (heat and gorse) characterized by a high canopy cover, and the difficulties to discriminate between the pulses corresponding to soil and vegetation (returns classified as vegetation over 0.4 m) on low heights (under 1m) due to the low laser pulse density (0.5 pulses/m2) of the PNOA LiDAR flight. In order to solve these problems, satellite technology was tested as an alternative to LiDAR. The use of parametric models for the estimation of dry biomass from LiDAR information for big areas may require the classification and processing of a high amount of LiDAR units, which could be economically non-viable. The estimation of non-parametric models for the estimation of dry biomass from satellite information is a very interesting alternative for the estimation of shrub biomass at a large scale.

The methodology applied within the action B5 has been totally successful and it has not been identified any significant problems. The studied shrub lands respond to disturbances, particularly to clearing and harvesting labors, with an active regeneration that tends to cover the soil in a few years.

Regeneration monitoring in the harvested areas one year after the clearings, has shown biodiversity recovery rates between 30-70% depending on the location. On the other hand, it should be noted that harvesting operations did not have significant impacts regarding erosion processes in any of the

studied areas. No water erosion processes were observed. Only medium superficial furrows were seen in some plots, while deep furrows were scarce or nonexistent.

Regarding soil properties, a slight compaction and a reduction of pH values were observed in the first year, being the pre-clearing values nearly recovered two years later. It is important to note that significant increases in the carbon and nitrogen contents were found in some studied areas (Fabero, Figueruela, As Pontes and Merlán), both in the superficial and deep soil horizons. The significant increase of these elements in the superficial horizon is related to the increase of litter (dead biomass) and the humid climate of the place. It is important to highlight the new values of the wild fire risk variables two years after finishing ENERBIOSCRUB clearings.

Important findings are related to fire risk. Assuming a modeled wind speed of 30 km/h, the average values obtained, two years after the clearings, were: 84% reduction in the speed of fire spread, 93% in the intensity of the line of fire and up to 72% in the flame length. This shows the efficiency of the clearing labors on risk reduction due to the temporary reduction and elimination of the standing biomass fuel.

Regarding the Life Cycle Analysis (LCA) performed for the whole value chains of the biofuels obtained in each zone, it is noticeable the high percentage of GHG emissions savings, which, in all cases (thermal and / or electrical use), would be over 95%, compared to the use of a fossil fuel such as diesel. However, net energy efficiency is less advantageous in the case of electricity production plants, and especially, when intense forced drying is required, as in the case of gorse. Drying from values greater than 50% humidity up to 30% or less, requires an important amount of energy, and it reduces the ratio of energy produced / energy consumed to a value close to 1, what means that we are using the same energy that we are generating, although the energy consumed is thermal energy and the energy produced is electrical energy, and hence, the economic balance can be positive.

The project actions, B6 and B7 have progressed normally. The proposed methodology has worked well and there have been not noticeable difficulties.

In B6 and B7 it was found that in Spain almost two-thirds of the Spanish forest area is in private hands, and the fragmentation of the forest is high, without a clear policy towards forest associations, has a negative impact on its use. Although a planned and sustainable management of shrub formations would be highly desirable, at present shrub lands and low tree density forests are mostly unmanaged or virtually planned. Silviculture activities are limited to minor linear underbrush clearings in roads or trails edges for fire prevention and pastures clean-up. Integrating decisions across land use planning, transport and environment policy, is crucial for sustainable development of these lands. The LIFE + ENERBIOSCRUB project has contributed to gather the necessary knowledge to advance in the task of making the shrub lands manageable in a sustainable way. In the manuals, guides and publications produced in the framework of the project, an exhaustive review is made of many of the aspects that must lead to this management objective, including a discussion on the main barriers that have to be overcome, both technical and non-technical. Important recommendations are given so that in the near future, we reinvent technology and knowledge to use those resources that once, were an important source of energy and renewable products.

The methodology used in C1 to evaluate environmental impacts has been successful as explained in B5 action. In spite of the short time used for these types of evaluations, We have reach some interesting conclusions related to soil, forest fires risks etc. Delays in action B1 has ovoid the second year evaluation in the location of Merlan, but even though, the one year evaluation after harvest gave significant information.

The methodology used in the socioeconomic evaluation in C2, both for the employment evaluation in the project implementation and the job creation assumed by design future scenarios has permitted obtaining interesting findings:

Based on scenarios of biomass utilization of scrub in Garray (Soria), Las Navas del Marqués (Avila), Fabero (León), Villardeciervos (Zamora) and As Pontes (La Coruña), It was estimated that the

generalization in the use of scrub pellets in local areas with medium-small production plants and also medium-small thermal installations, could have the following impact in terms of local employment: 3-5 direct jobs in the collecting labors, 5-7 jobs in the pellets manufacturing per 10,000 tons of pellets production, and 1-2 jobs in logistic work. In addition, there would be a sector of distribution services, installation, etc., which could add another 2 jobs (indirect) more for every 10,000 t MS mobilized.

– Indicate which project results have been immediately visible and which results will only become apparent after a certain time period.

The project results are visible just immediately after the clearing. The satisfaction of the forest owners only few months after the works in B1 are patent. In the case of Torretartajo (Garray zone) as can be seen in the pictures below, the area has been cleaned creating new pastures and favouring the growing of natural forest tree vegetation (*Quercus ilex*).

Photo: Torretartajo location (Soria). Land aspect before clearing, just cleared in march 2016 and the 18th May the same year.

In addition, shrub biomass harvesting clearly reduces available vegetation that can act as fuel in case of a forest fire, thus helping to reduce fire risk and facilitating firefighting.

The conclusions obtained in action B4 will also be immediately visible for the general public and related stakeholders: In one hand, shrub available biomass estimation cartographies are integrated on the BIORAISE web platform (http://bioraise.ciemat.es/bioraise). On the other hand, the shrub characteristics of biomass collected in different location has been studied and some conclusions obtained. These conclusions will be soon available in publications (manuals) and workshops.

Shrub biomass Pellets were produced and tested in commercial pilot boilers in CEDER and in residential and industrial installations. The results of the project are really visible at local level as the boilers of Fabero and las Navas use shrub pellets in their respective heating installations and the boiler behavior and performance in both places don´t show significant differences with the wood pellets normally used.

Gorse pellets have been industrially produced and used in Galicia. The conclusion was that he uses of fuel generated don´t showed performance problems in the boiler, except for an excess of ashes that could be reasonably managed.

The trials of shrub biomass in the power plant of GESTAMP in Garray have shown good performances. The conclusion is that the rock rose biomass is good for the boiler but it need to be crushed to small particles to avoid feeding interruptions.

Concerning environmental impacts evaluated in action B5. The Project has served to demonstrate that the management of shrub biomass using mechanized techniques can be a very interesting sustainable option to reduce the risk of fires and therefore a good technique to face climate change, causing very little negative impact on the soil or in the regeneration of the new vegetation. Invest more in this option is seen as a necessary tool whose fruits will be obtained in the short term.

- Indicate effectiveness of the dissemination and comment on any major drawbacks

There were no major drawbacks for the dissemination along the execution period of the project.

Regarding the effectiveness, the WEB site created is a huge collection of all the information related to the sustainable management of scrub formations and even if during the project, the number of visits were below the objectives, we think that in the following months is going to be very visited since most of the information have been uploaded during last year and it's when the more visits were obtained, almost the same as in the 2,5 previous year. We obtained 4.222 visits from unique users until the end of the project on 30th April 2018 while until 31st march 2017 it had only 2.491 visits. In addition, in the last months, important information such as two technical guides have been uploaded.

With the workshops organized by the consortium and the workshops in which some partners have participated with a presentation, the objectives foreseen have been fulfilled and over passed in quality and quantitative terms with 16 presentations in events organized by 3rd parties and 6 events organized by the consortium. The impact obtained with these actions is more than 1300 stakeholders reached.

Also, the presence in several editions of the fair EXPOBIOMASA ('15 and '17) with stand, panels and posters was remarkable due to the big number of visitors (around 16000)

The number of publications in traditional and technical/Scientific have overpassed also the objectives (20 communications done and 11 was the objective in national publications and 10 international done and 6 was the objective). In terms of impact it's more complicated as it's not possible to have a global idea because the impact of some technical magazines was given in no. of issues (i.e. the 5 articles published along the project in the BIOENERGY INTERNATIONAL (Spanish Edition) had an average of 15.000 copies in paper and then a distribution of around 50.000 addresses in PDF and sent by AVEBIOM's newsletter to around 150.000) which it can be considered as most of the sector's biomass and forestry stakeholders. But in the case of scientific publications in which the consortium made an effort by publishing in renowned magazines (Energy, Biomass and Bioenergy or Forests) or conferences (24th & 25th EUBCE and 7º Congreso Forestal Español) but the impact was measured in

index (CiteScore, impact factor, 5-year impact factor) or in number of visitors to the conferences. Anyway the efforts were remarkable and the results of the impact are as good as they could be because they were published in the most important magazines of the sector.

Also, quite a remarkable communication was made in terms of Social Networks with more than 500 messages published in Twiter (AVEBIOM's twitter user has around 6000 followers so this figure could be considered as quite remarkable impact), with more than 150 photographs and about 29 videos published in Youtube with more than 4000 visualizations.

Regarding appearances in TV and Radio, we got 3 in TV and 5 in Radio.

Special mention to the Enerbioscrub World Café dynamic which was organized for around 40 people but more than 120 registrations were received but it was not feasible from the point of view of the dynamic. Anyway, there was a commitment to send the results and conclusion of the event to all the interested companies

Thanks to the dissemination of the project there were public administrations (regions of Spain with high potential of biomass from scrub formations) has been very interested in applying the results of the project (i.e. the Castilla la Mancha region). Also forestry owners, companies and even investigators from other countries have showed their interested..

5.3 Analysis of long-term benefits

In this section please discuss the following:

1. Environmental benefits
    a. Direct / quantitative environmental benefits:
        i. LIFE+ Environment Policy and Governance: e.g. reductions of emissions. energy or resource savings.

The project EnerBioScrub fights against climate change because, according to expert projections for the 21st century, the forest fire regimes will be more severe, with more fires, extreme weather events, and a greater area burned (BJ Stocks, and PC Ward, 2012. Climate change research report; CCRR-20). In this respect, adaptation means maintaining forest fuel densities under environmentally acceptable levels that allows us to ensure that the risk and virulence of forest fires are as low as possible.

On the other hand, forest fires emit huge amounts of air pollutants, while large amounts of wasted energy that could be used to replace fossil fuels when biomass is collected and used in proper energy production facilities. This, in terms of adaptation is not significant but it is in terms of mitigation.

Contrary to fire action, scrub clearing-harvesting techniques also can promote biodiversity when can aid to store more carbon. Clearing techniques can be also interesting to be applied in scrub formations included in habitats directive because they could help the perpetuation of the shrub formations and their defense against the natural progression of trees.

The positive and negative impacts of clearing scrub biomass and its energy recovery has been assessed in B5. We can say that with the current data the technologies and applications used in this project have demonstrated that shrub biomass is potentially available and profitable (depending on harvesting and processing costs) in different regions and that can be used residential heating and industrial heat and power applications. Assuming mobilization of 1.600 biomass tons al the end of the project. The estimated emissions are roughly 0.0117 kgCO2/prim. kWh. In an scenario of "change from fossil fuel" such as light fuel oil, taking into account a emission factor of 0.266 kgCO2/prim. kWh, The saving is 95%.

The Life Cycle Analysis (LCA) performed for the whole value chains of the biofuels obtained in each zone, has confirmed the high percentage of GHG emissions savings, which, in all cases (thermal and / or electrical use), would be over 95%, compared to the use of a fossil fuel such as diesel.

However, net energy efficiency is less advantageous in the case of electricity production plants, and especially, when intense forced drying is required, as in the case of gorse. Drying from values greater than 50% humidity up to 30% or less, requires an important amount of energy, and it reduces the ratio of energy produced / energy consumed to a value close to 1, what means that we are using the same energy that we are generating, although the energy consumed is thermal energy and the energy produced is electrical energy, and hence, the economic balance can be positive.

Other environmental benefits identified have been:

- The harvested areas, has shown biodiversity recovery rates between 64-100% depending on the location, after two years.
- Harvesting operations did not have significant impacts regarding erosion processes in any of the studied areas. No water erosion processes were observed. Only medium superficial furrows were seen in some plots, while deep furrows were scarce or nonexistent.

- Regarding soil properties, a slight compaction and a reduction of pH values were observed in the first year, being the pre-clearing values nearly recovered two years later.
- Significant increases in the carbon and nitrogen contents were found in some studied areas (Fabero, Figueruela, As Pontes and Merlán), both in the superficial and deep soil horizons. The significant increase of these elements in the superficial horizon is related to the increase of litter (dead biomass) and the humid climate of the place.
- Fire risk variables two years after clearings are dramatically reduced. Assuming a modeled wind speed of 30 km/h, the average values obtained, two years after the clearings, were: 84% reduction in the speed of fire spread, 93% in the intensity of the line of fire and up to 72% in the flame length.

b. Relevance for environmentally significant issues or policy areas (e.g. industries/sectors with significant environmental impact. consistency with 6th or 7th (as applicable) EU Environment Action Programme and/or important environmental principles. relevance to the EU legislative framework (directives. policy development. etc.)

Climate change is a global problem, and hence European. The European Union is determined to reduce emissions of greenhouse gases and, therefore, it has set up sectoral and cross-cutting policies. In the proposal for a European Parliament and Council Decision on the General Environment Programme of the Union 2020 : " Living well within the limits of our planet " (COM (2012) 710 final), a general framework for environmental policy until 2020 is proposed and nine priority objectives for the EU and its Member States are established. Achieving climate and environmental objectives and targets is a shared responsibility between the EU and its Member States. The Programme will be implemented at the appropriate level, in accordance with the principle of subsidiarity

The new Programme is based on initiatives taken within the framework of the European Strategy 2020 COM (2010) 2020 (OJ C 88, 2011.3.19), in particular in the EU's climate and energy package (Regulation (EC) No 443/2009 , Directive 2009/28/EC , Directive 2009/29/EC, Directive 2009/30/EC, Directive 2009/31/EC and Decision No 406/2009/EC (all these acts are published in OJ L 140, 2009.6.5)), the Roadmap to a competitive low carbon economy in 2050 (COM (2011) 112 (OJ C 140, 2011.5.11).), the EU Strategy on Biodiversity 2020 (COM (2011) 244 (OJ C 264, 2011.9.8), the Roadmap towards a Europe efficient in the use of resources (COM (2011) 571 (OJ C 37, 2012.2.10)) and the "Innovation Union" flagship initiative under the Europe 2020 strategy (COM (2010) 546 (OJ C 121, 2011.4.19)).

The proposed actions are intended to contribute to the priority objectives established in the aforementioned Programme:

Priority objective 2: turning the EU into an efficient in the use of resources, ecological and competitive low-carbon economy. In this sense, ENERBIOSCRUB project aims to launch permanent gears for reducing greenhouse gases by three means:

- Increasing the contribution of renewable energies.

- Encouraging the accumulation of organic matter in the soil and the sink effect of forests

- Reducing burned surface in forest fires and, thus, pollutant emissions into the atmosphere.

But it contributes not only to reduce greenhouse gas emissions. The ENERBIOSCRUB project also seeks to establish systems used to management and production of competitive forest products and able to generate employment in disadvantaged rural areas. This will take the following actions:

- Starting of demonstration of innovative technologies tested already in other geographical areas for clearing and harvesting of scrub.

- Obtaining of good quality solid biofuels that can replace the use of fossil fuels in industrial and domestic applications.

- Producing elements which facilitate the transition to a low carbon economy for governments, forest owners, energy management companies and end users of energy.

- Demonstration of the efficient use of natural resources. Scrub generates biomass resources which are wasted while fossil resources are imported. This can and must change.

Regarding the priority objective 1: to protect, preserve and improve the natural capital of the EU, the EnerBioScrub project contributes and can contribute in different ways:

- Reducing the impacts of forest fires on soil and ecosystems.

- Favouring the accumulation of carbon in the soil: when the scrub is harvested, an important part of aboveground biomass and the root biomass are left and the layer of decaying dead matter is not touched, allowing also for preventing erosion. Unlike what happens with forest fires, which generate a significant mineralization and favour the erosion of soil.

- In the resolutions of the "Rio + 20" Summit, it is urged to "achieve a world with a neutral soil degradation." In this regard, it is sought even to improve soil structure and quality with the actions of the project.

- With regard to biodiversity, the project shows that well-planned clearing is not only not harmful to biodiversity but it can be an important tool to maintain or improve biodiversity in areas that have, initially, high monospecific as a result of repeated fires.

- The EnerBioScrub project does not contemplate to act in areas covered by the Habitats Directive 92/43 EEC. However the proposals on the management of formations such as the European dry heaths (habitat 4030), which is the most important habitat of scrub in Spain in the directive, show that the perpetuation of this habitat requires the maintenance of low levels of soil fertility and the prevention of the invasion of tree species, facts where the clearing is always safer and advantageous than fire. Fire as clearing method has been recommended in this type of habitat in northern European countries, but it is questionable in Mediterranean countries due to the entailed risks. (Ojeda, F., 2009. 4030 European dry heaths. In: VV AA, Ecological preliminary basis for the conservation of habitat types of Community interest in Spain. Madrid. the Ministry of the Environment and Rural and Marine Affairs. 66. p). However, what is said and at the request of the authorities on environment and forests, some tests could be performed in areas covered by the Directive, under the supervision and with the instructions of the authorities.

2. Long-term benefits and sustainability

   a. Long-term / qualitative environmental benefits

      LIFE+ Environment Policy and Governance: e.g. long term sustainable technology. from product to functional focus. from end-of-pipe to prevention; high visibility for environmental problems and/or solutions; spin-off effect in other environmental areas etc.

The main long term environmental benefits can be resumed in two key aspects:

Climate change:

As indicated above, scrublands have a high potential as a source of bioenergy fuel in Spain. On an annual basis, some 3.75 million tonnes of biomass could be harvested sustainably from just 2% of Spain's scrubland (375,000 ha). This could substitute over 1.5 million tonnes of fossil fuel per year, reducing GHG emissions by 4.6 million tonnes of CO2, as well as having a positive economic impact.

Air pollution and biodiversity depletion:

In the Mediterranean countries, and specifically in Spain, forest fires are a major problem every year that causes enormous damage to ecosystems (biodiversity loss, soil impoverishment), to the economy, with human losses in many cases, and to air quality (particles and pollutant gases emission). According to the Ministry of Agriculture and Environment, the average fire-damaged area in the decade 2002-2012 was 114,000 ha and, in 2012, 210,000 ha were burnt. The figures indicate that approximately two thirds of the burned areas were non-forested areas (scrub). If an annual clearing of 375,000 ha is achieved in the long-term in Spain, the aforementioned environmental problems would be largely limited.

Therefore, sustainable management of scrub vegetation must be a priority in fire-fighting plans. Instead of levering the preventive forest clearing costs as a weakness, it should be reverted into strength by adequately valuing scrublands biomass and other low stocking forests biomass resources. Actually, using woody biomass from wildfire prevention treatments to generate renewable energy can also provide climate change benefits.

b. Long-term / qualitative economic benefits (e.g. long-term cost savings and/or business opportunities with new technology etc.. regional development. cost reductions or revenues in other sectors)

Promotion of a new comprehensive and sustainable management model based on the cycle of shrubs' biomass, which includes every step from harvesting to energy use in thermal facilities and involves a wide range of stakeholders (from land owners to final energy users). This new management model makes it possible to use a biomass source that was underused and that provides solutions for the maintenance and conservation of forest shrubs: profit obtained from biomass selling can cover harvesting costs (totally or partially), making it possible to invest in the management of shrubs formations. This will help reducing fire risk and dependence on non-renewable energy sources.

This new management/exploitation model will constitute a new market, and will impulse the creation of new local businesses that can apply these technologies to the cycle of shrubs' biomass: plants production and growing, harvesting, transport and loading, treatment and energy use (mainly thermal, but also electrical). All this will indirectly impact rural development in a very positive way, population establishment in rural areas and job creation.

The objective of shrub biomass costs below the level of current wood biomass costs, that is 45 €/t at 45 % w.b moisture content, in destination (4,5 €/GJ) has been met in the proyect. The improvement of machinery cutting devices and operators skill will contribute to further reduce the costs up to 4 €/GJ in locations with biomass densities between 10 and 15 green t /ha.

c. Long-term / qualitative social benefits (e.g. positive effects on employment. health. ethnic integration. equality and other socio-economic impact etc.)

The energy use of biomass entails benefits such as the generation of local employment. The biomass logistics chain needs labour force. Staff is needed in work crews in the forest and in the field, in the production centres, logistics centres, installation and maintenance of combustion equipment. According to data provided by the project, the generalization in the use of scrub pellets in local areas with medium-small production plants and also medium-small thermal installations, could have the following impact in terms of local employment: 3-5 direct jobs in the collecting labors, 5-7 jobs in the pellets manufacturing per 10,000 tons of pellets production, and 1-2 jobs in logistic work. In addition, there would be a sector of distribution services, installation, etc., which could add another 2 jobs (indirect) more for every 10,000 t MS mobilized.

In the areas chosen for the demonstration, the creating of alternatives based on forest resources seems to be a stable solution to the lack of jobs, due to the fact that the use of biomass for energy purposes is one of the few sectors in which a future green economy can be based on, because it is a renewable energy source and its exploitation can be carried out with sustainable criteria; furthermore, energy is one of the most necessary assets for human society.

d. Continuation of the project actions by the beneficiary or by other stakeholders.

The possibilities of financing activities after project completion is high.

The cost of biomass, as indicated in previous c) paragraph is expected to be attractive, below the market price of wood biomass. Demand in the thermal and electrical sector is abundant in Castilla y Leon and Galicia and important in the rest of Spain.

The first SME was recently involved through a Joint Venture with CIEMAT and AGRESTA to perform shrub clearings using a BIOBALER machine owned by CIEMAT and an adapted tractor belonging to the SME.

The venture capital investment option is also seen as interesting for the continuation of the activities. Arranging brush land clearing contracts with forest owners and biomass supply ones with users of heating and pelletizing plants will make it attractive investment for this type of investors. This option will permit the acquisition of the necessary machinery by SMEs. Investment-necessary for a BIOBALER and a tractor is around 250,000 €. We could foresee the following projects by regions: Castilla y Leon (2) Galicia (1), Extremadura (1) and Castilla La Mancha (1). Total 1.250.000 € capital invested by 2025.

3. Replicability. demonstration. transferability. cooperation: Potential for technical and commercial application (transferability reproducibility. economic feasibility. limiting factors) including cost-effectiveness compared to other solutions. benefits for stakeholders. drivers and obstacles for transfer. if relevant: market conditions. pressure from the public. potential degree of geographical dispersion. specific target group information. high project visibility (eye-catchers). possibility in same and other sectors on local and EU level. etc.

The use of the clearing systems as BIOBALER has been studied and data are shown by some authors in Canada and USA (see P. Savoie, D. Current, E. Robert, et al. Harvest Natural of shrubs with a Biobaler in various environments in Quebec, Ontario and Minnesota. Applied engineering in agriculture (2012) Volume 28, Issue 6, Pages: 795-801).

The ENERBIOSCRUB Project results will be relevant because there are not documented experiences and demonstrative actions in the area of Mediterranean scrub. The recent acquisition of a BIOBALER machine by CEDER-CIEMAT is allowing for performing work well above the objectives considered in the project and carrying out a sufficient number of hours in clearings which will generate better and more reliable estimates of cost and feasibility of the method. These new demonstrative actions will allow greater replicability and interest by stakeholders from different Mediterranean regions.

Definitely, this knowledge will allow us to incorporate these technologies as a valid alternative sustainable management of scrub in any area, always making adjustments and corrections may be necessary depending on the features and characteristics of each area. This reproduction or use of these technologies in other areas, will allow us to determine the potential of useable biomass by them and the economic valuation of the cost. This could also be extrapolated to other areas of the EU, provided they have certain similarities to the studied areas. In addition, the methodologies developed in action B4 may be expanded to other shrub species and other European Union territories, especially to countries that present high risk for forest fires and/or large shrub areas such as the Mediterranean countries.

Regarding the replicability in other regions and activity sectors, contacts have been made with at least two companies in Spain and one in Portugal and another in Greece, where forest fires are a serious matter due to the presence of large shrub stands to launch new projects.

Concerning synergies, relevant networking is starting to be fruitful with other activity sectors such as:

Essential oils sector/industry:

Shrubs biomass and specifically rockrose (Cistus ladanifer) biomass are rich in highly valuable essential oils. An Andalusian company is interested in evaluating the viability of essential oils extraction of the rockrose harvested by means of the technologies considered in the project. The agreement with the firm envisages providing the company with the bales contemplated in action C2 immediately after harvest for the oils extraction in their facilities by means of steam dragging techniques. This company has already delivered the commitment letter for the realization of this task.

Recycling industry and waste management:

Collaboration started with a company of Castilla y León region, where large shrub lands (genus Cytisus and Genista) are present. The firm has set the first Shrub Managing Plan in Spain in order to obtain biomass from 20.000 ha in Avila province.

Beekeeping, game and mushrooms:

The apiculture, hunting and mushroom sectors are important in the study areas and can be greatly benefited by the rejuvenation of shrubs stands.

As regards mushroom production, the University of Valladolid (UVA) has extensively investigated the influence of treatments on jara (Cistus ladanifer) on the production of species of mycological interest such as Boletus sp. CIEMAT established collaboration with the UVA in the ENERBIOSCRUB project, participating its experts in a seminar held in Soria in April 2017 which showed that the rejuvenation of the rock rose stands significantly increases the production of Boletus but it is necessary to finance the clearing , being the methods developed in the ENERBIOSCRUB project important to obtain such financing. The collaboration with the UVA will be maintained and a professor (Dr Pablo Martín).

4. Best Practice lessons: briefly describe the best practice measures used and if any changes in the followed strategy could lead to possible adjustment of the best practices

Lessons have been learnt on two types of aspects:

Technical aspects:

On the technical side, the main lessons about good practices have been learnt in the actions B1, B2, B3, B4 and B6. In the action B1, there are enough hours working with the machinery in the clearing of different scrubs and in diverse situations. Consequently, conclusions on how and when the machines are operational and on the limitations and effectiveness have been drawn and are reflected in the project manuals. It has been observed that the rocky soil is a major problem, but cutting elements (hammers) have been also identified for working in soils with significant stoniness, although the biomass yield obtained is lower. A good tuning of the machines has been achieved, in order to avoid faults during the hard work they carry out and with the aim of increasing the operating productive time.

In the action B2, it has been noticed that the handling of the biomass is an important parameter to be taken into account to avoid the deterioration in the quality of the aboveground biomass when it is collected, especially if the collector driver is not careful in places where there are many stones or in soils with irregular surface. The mulcher-harvester system RETRABIO has a logistics after the harvest with a higher risk of contaminants, such as soil or stones, because it is carried out by loaders. In this sense, the baling system is cleaner in the handling after the harvest. Furthermore, handling of mulch material has many disadvantages compared to bale handling, because the bales are easy to transport and store. It is also noteworthy that the natural drying of stored bales can be very effective, as has been found in the tests carried out with broom and rockrose. This is an unquestionable advantage of the method for two reasons: (i) an important energy consumption in forced drying to produce pellets is avoided, and (ii) the dry matter losses during the storage are lower, resulting in fossil fuel saving and contribution to reduce GHG emissions related and economical losses.

Overcoming the aforementioned problem, in the action B2 it has been learnt that all the biomass materials tested can be pelletised and used as fuel in boilers of household sector, although their quality is close to the limit, in some cases, with regard to emissions and behaviour in the boilers..

Regarding the action B4, it has been learnt that the LiDAR technology for biomass estimate is not appropriate for some types of scrub. Moreover, there are other alternatives such as non-parametric interpretation using satellite imagery that have been applied in some project areas, like Fabero.

Not-technical aspects:

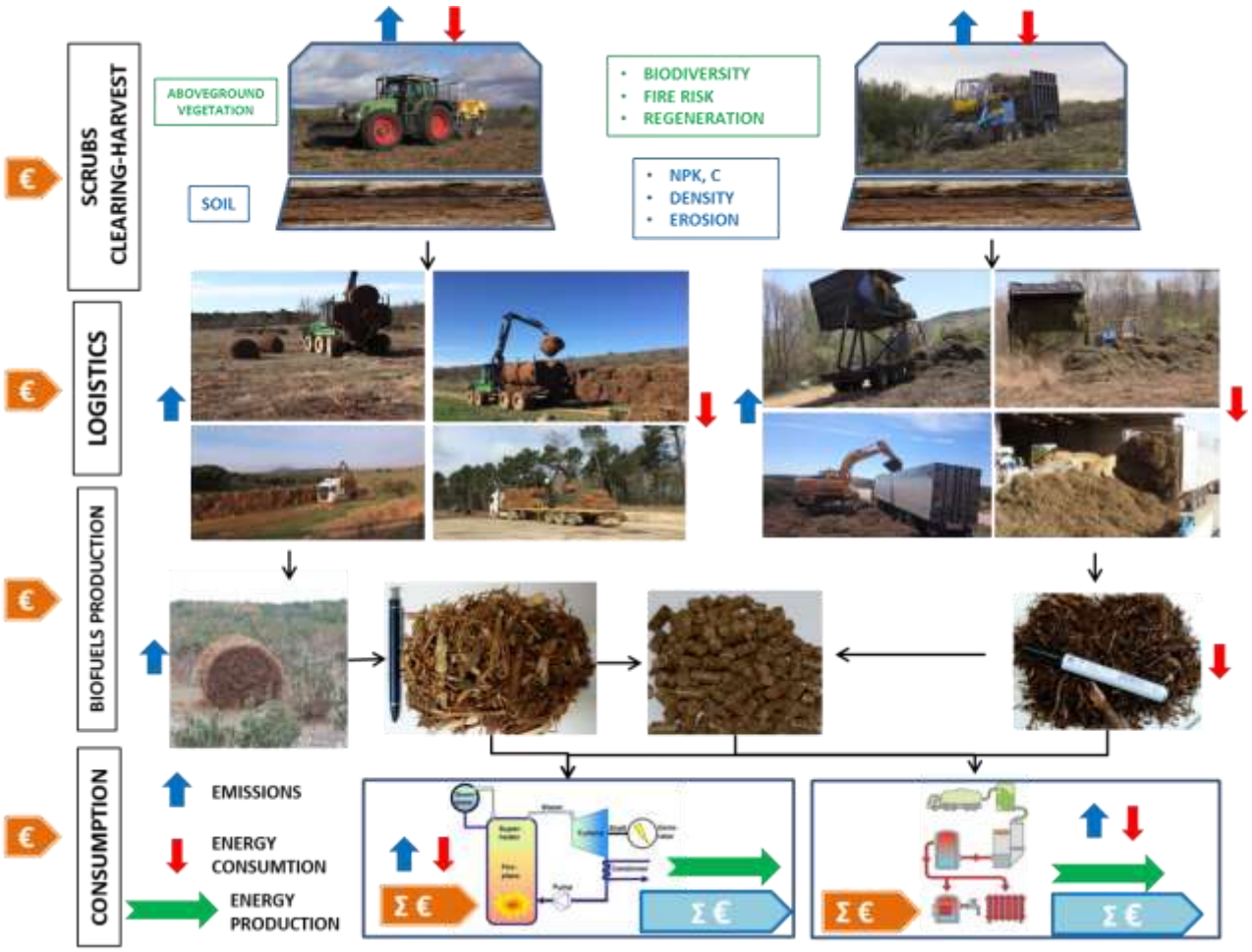
Non-technical aspects have been evaluated in the action B6. So far it has been found that the scrub is mainly located in privately owned land because the investment in the clearing of the scrub is not profitable and, in many cases, fire, as a cheap clearing method, is used to create new grazing areas.

It has been also seen that it is necessary to consider the clearings as an improvement activity and not as a lucrative biomass harvesting, if we want a replacement of the fire by the practice of mechanized clearing.

Finally, it has been found the need of establishing the figure of biomass manager and regulating the creation of logistical points where managers can store and handle small batches of biomass near the harvest areas.

5. Innovation and demonstration value: Describe the level of innovation. demonstration value added by EU funding at national and international level (including technology. processes. methods & tools. organisational & co-operational aspects);

The ENERBIOSCRUB Project combines innovation and demonstration activities using a comprehensive approach to the problem of the lack of viability of the scrub clearing, by studying the whole chain from the clearing to the thermal use of the fuel as shown in the following Figure



This approach to the problem is innovative because it has not been done before in scrub lands of the Mediterranean region and involves clearing techniques in B1 and analytical techniques of environmental parameters within the B5 that have been developed specifically for this project.

The project also addresses the problem of quantifying resources in action B4 by innovative methodologies that combine LiDAR and satellite information for fitting shrub biomass quantification models in an innovative way. This methodology may be used to detect land use changes and to have a broad spectrum of uses (carbon quantification projects, evolution of forest areas and restoration of the vegetation after forest fires among others). The methodologies developed for shrub inventories are unique and innovative for this project since traditional forest inventories focus on trees.

With regard to the dissemination activities, in addition to conventional methods, the organisation of a World Café in Expobiomasa 2017 was a successful event.

The World Café methodology was developed accidentally by American consultants Juanita Brown and David Isaacs in January 1995. It permits to discuss in depth specific issues, in order to reach new discoveries and opportunities for innovation, while consensus among participants achieved, facilitating the implementation of the decisions taken. It is based on the principle that small group there is more privacy and problems faced bluntly. The World Café method is a simple process. However, for each participant provides a maximum benefit. The basis of its philosophy is that each individual has the potential to create a great idea and sharing with others in a pleasant atmosphere, is the most powerful

way to learn. One of the main aspects of the World Café is rotation around the tables. This generates constructive exchanges of ideas, which expands the knowledge of the participants and enriches the final result.

For its organization an atmosphere like in a Café is recreated and tables are prepared for people. Cards, bookmarks and everything that encourages free discussion and documentation of the issues discussed are provided. 3 rounds of 30 minutes conversation were held at the end of which the conclusions are written on cards or sheets.

The demonstrative value of the ENERBIOSCRUB project has been high since most of the actions were carried out on full scale and involving all the stakeholders belonging to all the links of the chain. In the action of clearing, private forest owners, public managers, SMEs (livestock, forestry companies, farmers, drivers) etc, have taken part. The dissemination activities have achieved many of them to take part in the experiences from the forest to the plants where it is consumed, including the logistical operations.

6. Long term indicators of the project success: describe the quantifiable indicators to be used in future assessments of the project success. e.g. the conservation status of the habitats / species.

We can expect the consecution of the following objectives and indicators:

The key objective is to reduce shrub biomass costs below the level of current wood biomass costs, that is 45 €/t at 45 % w.b moisture content, in destination (4,5 €/GJ). Current project data indicate that this value can be reached in best places (plain terrain and high biomass density, higher than 15 green t /ha). The improvement of machinery cutting devices and operators skill will contribute to further reduce the costs up to 4 €/GJ in locations with biomass densities between 10 and 15 green t /ha

When the aforementioned objective is met, in a first approximation, it is estimated that, in thelong term, if only 2 percent (375,000 ha) of the Spanish scrub surfaces were managed annually, and even assuming a low production (<10 tons of dry matter per hectare), we would be able to generate near 3.75 million tons of biomass (dry matter) that could replace more than 1.5 million tons oil equivalent per year, assuming such a substitution of heating oil, thus avoiding the emission of 4.6 million tons of CO_2 per year. Based on these assumptions, between 3,000 and 5,000 direct jobs and 750 indirect jobs could be created, most of them in rural areas.

The possibilities of financing activities after project completion obviously depend on the goodness of the project results. The key factors are the cost and quality of biomass and the existence of demand for it.

The cost objective, as indicated above is expected to be attractive, below the market price of wood biomass. Demand in the thermal and electrical sector is abundant in Castilla y Leon and Galicia and important in the rest of Spain. The first SME was recently involved through a Joint Venture with CIEMAT and AGRESTA to perform shrub clearings using a BIOBALER machine owned by CIEMAT and adapted tractor belonging to the SME. The market activities started in Fall 2016, just after the completion of the action B1.

In June 2018, CIEMAT and AGRESTA have formed a group called GO - ESENCIAL (provisionally approved on June 21, 2018) in the framework of the program promoted by the European Association for Innovation in Agricultural Productivity and Sustainability (AEI-AGRI) and managed by the Spanish Ministry of agriculture, MAPAMA. This group, whose objective is to manage of shrub formations, extract essential oils and biomass for solid, liquid biofuels and bioproducts development, participate 10 research groups, companies and associations.

The venture capital investment is seen as interesting option for the continuation of the activities. Arranging brush land clearing contracts with forest owners and biomass supply ones with users of heating and pelletizing plants will make it an attractive investment for this type of investors. This

option will permit the acquisition of the necessary machinery by SMEs. Investment-necessary for a BIOBALER and a tractor is around 250,000 €.

Within the central Spain there are two regions (NUT-2) with good conditions for extending the project: Extremadura and Castilla La Mancha. Both are regions with large extension of scrub surfaces suffering annually important losses caused by forest fires. Some SMEs and public administrations from these regions have already established contacts with the project. We could foresee the following projects by regions and objective indicators: Castilla y Leon (2) Galicia (1), Extremadura (1) and Castilla La Mancha (1). Total 1.250.000 € capital invested in the near future.

5.4 Technical annexes

5.4.1 List of keywords and abbreviations used

C: Specific cost per unit of net energy produced

d.b.: dry basis

DM: dry matter

e: Specific energy consumed

E: Net energy obtained

Eq: equivalent

GHG: greenhouse gases emitted

MWe: electrical MW

Nm^3: m^3 calculated in normal conditions of pressure and temperature (1 atm and 0ºC)

NOx: NO + NO_2 expressed as NO_2

TOC: Total organic carbon expressed as C

Tg: tera gram = 10^{12} grams= 10^6 tonnes

w%: weight %

w.b.: wet basis

WM: wet matter

5.4.2 Technical reports. Deliverables

The updated deliverables produced are included in electronic format in the annex. The list of deliverables as foreseen in the proposal is shown in the following table:

Name of the Deliverable	Action	Deadline
Mapas temáticos de los recintos y protocolos de ensayo para la acción B1	A 2	30/09/2014
Composición y funciones del grupo de expertos para asesoramiento y seguimiento de las acciones del proyecto	D 5	15/10/2014
Creación de página web: diseño, estructura, contenido, enlaces	D 1	31/10/2014
Informe sobre el estado legal de los montes en las zonas de estudio	B 6	31/10/2014
Informe describiendo el medio natural y socioeconómico	A 1	01/03/2015
Manual técnico para divulgación sobre inventarioLIDAR	D 2	30/12/2015
Manual de buenas prácticas en el desbroce	D 2	31/12/2015
-Informe de resultados de ensayos en planta piloto con biomasas sin almacenar	B 2	01/02/2016
Informe de resultados de los trabajos para cada "Recinto de Ensayo",	B 1	01/03/2016
Informe sobre caracterización químico energética de la biomasa de matorrales	B 4	01/03/2016
Informe sobre inventario de matorrales y biomasa en las zonas seleccionadas	B 4	01/03/2016
-Informe de resultados de ensayos en planta "full scale" con biomasas sin almacena	B 3	30/06/2016
Informe sobre los actuales instrumentos de gestión de los montes y valoración técnica y jurídica	B 7	01/12/2016
-Informe de resultados de ensayos en planta piloto con biomasas almacenadas durante un año	B 2	30/04/2018
-Informe de resultados de ensayos en planta piloto con biomasas almacenadas durante un año	B 3	30/04/2018
Documento para debate sobre directrices y política forestal aplicadas a masas de matorral	C 1	30/04/2018
Dosier con informes anuales de propuestas y conclusiones del grupo de expertos	D 5	30/04/2018
Dosier con las comunicaciones científicas nacionales e internacionales publicadas por los socios del proyecto	D 3	30/04/2018
Dosier con las presentaciones orales del proyecto en jornadas de difusión, seminarios técnicos y congresos	D 4	30/04/2018
Informe Layman	D 2	30/04/2018
Informe prospectivo del potencial de generación de empleo si se emplean los recursos disponibles inventariados en las áreas de	C 2	30/04/2018

actuación. Recomendaciones. (en conjunto con el informe final)		
Informe sobre ACVs de la cadena de suministro de biomasa	B 5	30/04/2018
Informe sobre barreras no técnicas y propuesta de marco jurídico para su solución	B 6	30/04/2018
Informe sobre el el seguimiento del cumplimiento de objetivos ambientales	C 1	30/04/2018
Informe sobre la generación de empleo durante el proyecto dentro y fuera de las áreas de actuación (en conjunto con el informe final	C 2	30/04/2018
Informe sobre la huella de carbono del proyecto	B 5	30/04/2018
Informe sobre los impactos ambientales de la recolección del matorral	B 5	30/04/2018
Manual de gestión ambiental de matorrales	D 2	30/04/2018
Manual técnico para divulgación sobre biomasa del matorral	D 2	30/04/2018
Propuesta de políticas y directrices técnicas de gestion sostenible de las montes no arbolados	B 7	30/04/2018

However some of these deliverables have been split in two or more documents as indicated in section 5 in each action.