



BELENUS

**Lowering Costs by Improving Efficiencies in Biomass Fueled Boilers:
New Materials and Coatings to Reduce Corrosion**

Starting date of the project: 01/03/2019
Duration: 48 months

Deliverable: D8.1

Project website

Due date of deliverable: 31/05/2019
Actual submission date: 31/05/2019

Responsible Workpackage Leader: Víctor Encinas Sánchez, UCM
Responsible Task Leader: Víctor Encinas Sánchez, UCM
Revision: V1.0



H2020-LC-SC3-11-2018

Building a Low-Carbon, Climate Resilient Future: Secure, Clean and Efficient Energy

*"This project has received funding from the European Union's Horizon 2020
research and innovation programme under grant agreement No 815147"*

BELENUS

Dissemination level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

AUTHOR

Author	Institution	Contact (e-mail, phone)
Víctor Encinas Sánchez	UCM	vencinas@ucm.es / +34 91 394 5208

DOCUMENT CONTROL

Document version	Date	Change
V1.0	20/05/2019	

VALIDATION

	Reviewers	Validation date
Task Leader	Víctor Encinas Sánchez	20/05/2019
Work Package Leader	Víctor Encinas Sánchez	20/05/2019
Coordinator	Francisco Javier Pérez Trujillo	30/05/2019

DOCUMENT DATA

Keywords	Website; Public section
Point of Contact	Name: Víctor Encinas Sánchez Partner: UCM Address: Department of Chemical and Materials Engineering, Faculty of Chemistry, Complutense University of Madrid, Avenida Séneca s/n, 28040, Madrid Phone: +34 91 394 5208 E-mail: vencinas@ucm.es
Delivery date	31/05/2019

Executive Summary

BELENUS website www.belenus-project.eu is available since the early beginning of the project. The project website is the relevant source to show the scope and objectives of the project and outstanding results, trying to reach the targeted audiences.

Table of Contents

1. Content of Deliverable.....5

2. Website Sketches6

1. Content of Deliverable

This Deliverable contains the main information related to the BELENUS website, which will be used as dissemination and communication tool of the project's results. In the following sections, the main tabs of the project website will be presented.

2. Website Sketches

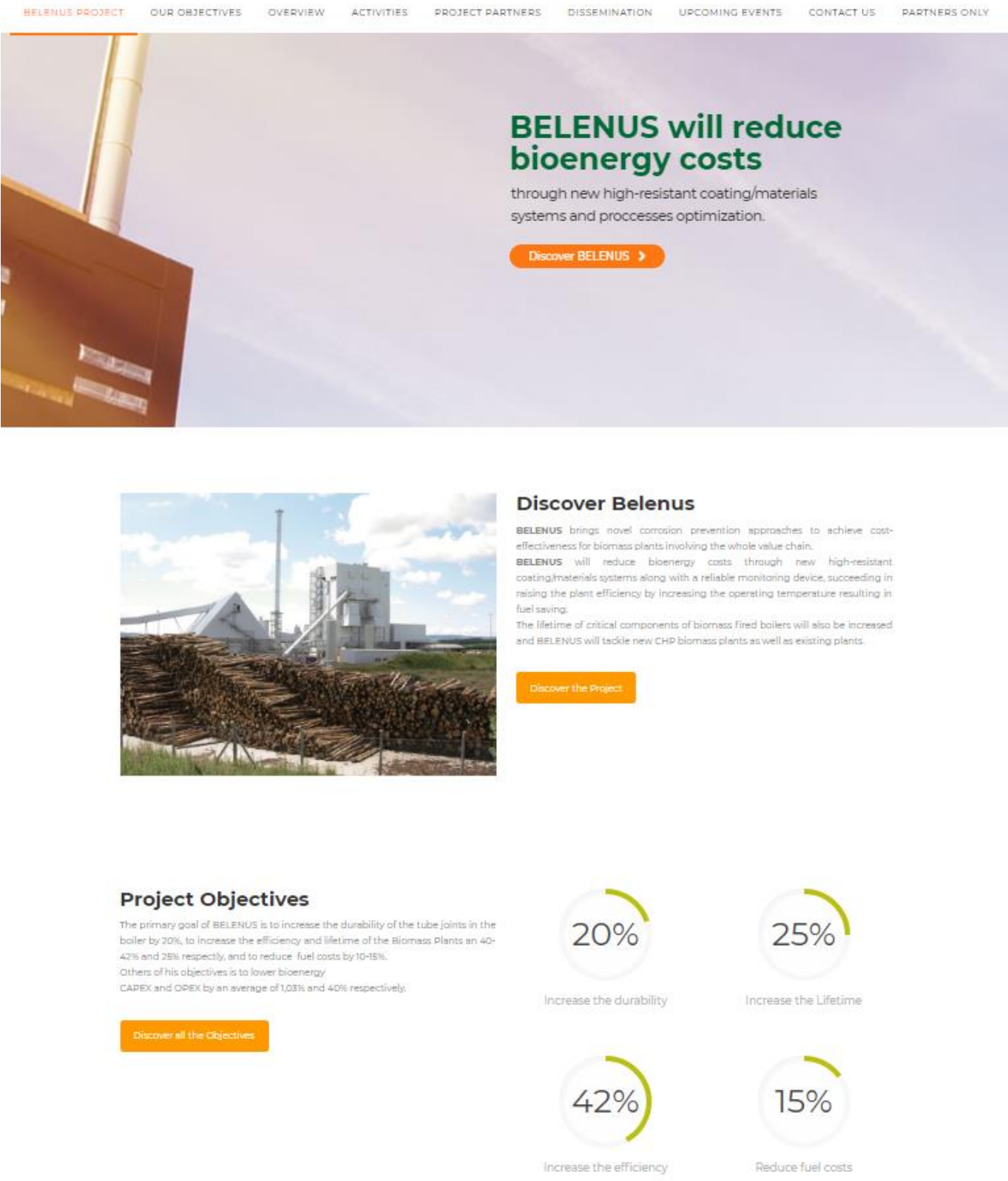


Figure 1. Home page.



This main goal will be addressed with a set of specific objectives as follows:

- 1 Develop new material systems**

To develop new material systems, based on coatings deposited on established or under development ferritic/martensitic steels and austenitic steels, with SH wall thickness losses lower than 0.1 mm per year.
- 2 Increase the durability up to 20%**

To increase the durability of the tube joints in the boiler by 20% by carrying them out through new welding strategies adapted to the new materials and coatings.
- 3 Achieve reliable monitoring**

To achieve reliable monitoring of high temperature corrosion up to 8,400 hours by developing an innovative on-line sensor to anticipate plant component failures and, thus, increasing the maintenance intervals.
- 4 Reduce CAPEX to 1.03%**

To achieve a 1.03% reduction of CAPEX by obtaining individual gains with the novel solutions proposed in the project: 0.94% with the new surface engineering: biomass corrosion highly resistant coatings on creep resistance materials and 0.09% with the new strategies of welding and bending for coated tubes.
- 5 Reduce OPEX a 40%**

To reduce the total OPEX of the plant a 40% by obtaining individual gains with the novel solutions proposed in the project: 30% with the new surface engineering: biomass corrosion highly resistant coatings on creep resistance materials, 6% with the new strategies of welding and bending for coated tubes and 4% with new online corrosion monitoring system specifically designed for biomass CHP plants.
- 6 Increase efficiency up to 40-42%**

To increase efficiency up to 40-42% in small and medium-scale CHP biomass plants by reaching super-critical conditions at 580-625°C due to the new BELENUS solution capacity in preventing or mitigating corrosion.
- 7 Raise the plant lifetime**

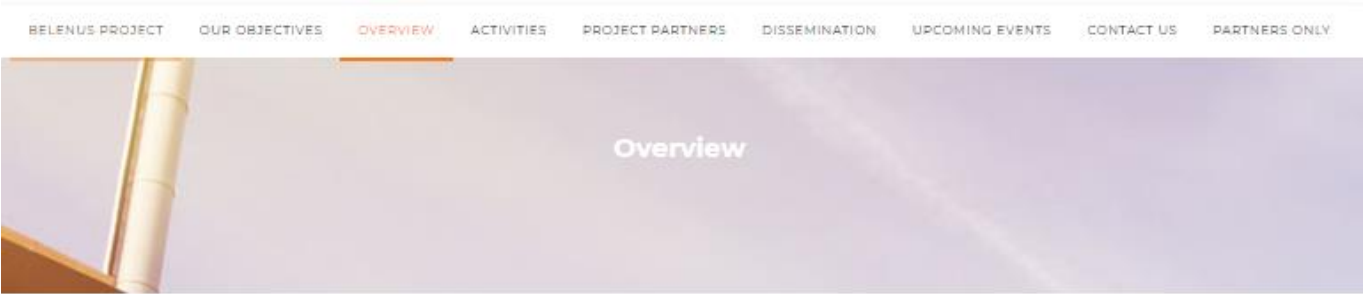
To raise the plant lifetime by:
a) increasing 5 % of the operational hours of boiler components and SH tubes, reaching more than 8,400 hours per year, saving up to 11 days of annual maintenance (meaning a potentially increase of income of approx. 1.1M€ in power generation);
b) increasing 5 years (25%) the total plant lifetime through the new corrosion protection systems.
- 8 Reduce fuel costs by 10-15%**

To reduce fuel costs by 10-15% by employing waste biomass and also consumption by increasing efficiency.
- 9 Increase the flexibility of the plant**

To increase the flexibility of the plant by allowing the use of different types of biomass.
- 10 Increase and improve co-firing of biomass and coal**

To increase and improve "co-firing" of biomass and coal in existing coal plants with some adjustments as a cost-effective option.

Figure 2. Our objectives.



CHALLENGES		BELENUS SOLUTIONS	
TECHNOLOGICAL CHALLENGES	CORROSION RESISTANCE	COATING-MATERIAL SYSTEMS RESISTANT TO A VARIETY OF HIGHLY CORROSIVE BIOMASS TYPES	
		ACCURATE AND LONG LASTING ONLINE CORROSION MONITORING SYSTEM	
	BASE MATERIALS SOLUTIONS	VALIDATION OF NEW FERRITIC-MARTENSITIC ALLOYS	NEW WELDING STRATEGIES COMBINED WITH HOT&COLD BENDING FOR COATED STRUCTURES
	VALIDATION OF SOLUTIONS	TESTING IN LAB, PILOT SCALE & OPERATING PLANT CONDITIONS	
ECONOMICAL CHALLENGES	REDUCE CAPEX & OPEX	FUEL COST REDUCTION	30% OUTAGE TIME SAVING DUE TO LOWER REPLACEMENT NEED
		HIGHER PLANT EFFICIENCY BY INCREASING OPERATING TEMPERATURES (SUPERCRITICAL CONDITIONS)	
		≥ 8400 OPERATIONAL HOURS/YEAR	INCREASE IN 1 YEARS THE LIFETIME OF THE PLANT
ENVIRONMENTAL CHALLENGES	TRANSITION TO A CIRCULAR ECONOMY	SMALL & MEDIUM-SCALE BIOMASS PLANTS IN BIOMASS RICH RURAL ZONES	
	WASTE VALORISATION	AGRICULTURAL, FORESTRY AND INDUSTRIAL WASTE WOOD TRANSFORMED TO ENERGY	
	LOWER GHG EMISSIONS	INCREASE THE SHARE OF RENEWABLE ENERGY	CO-FIRING SOLUTIONS REDUCE MATERIAL WASTAGE DUE TO CORROSION
SOCIAL CHALLENGES	RAISE RURAL POPULATION	DECENTRALISATION OF ENERGY PRODUCTION BY SMALL & MEDIUM-SCALE CHPs CONSTRUCTION	
	SOCIAL ACCEPTANCE	NON-FOOD BIOMASS FEEDSTOCK	LOWER ELECTRICITY COST ECONOMIC GROWTH
	JOB CREATION	NEW JOBS WILL ARISE IN THE BIOMASS ENERGY SECTOR	

Overall Concept
Underpinning the Project

BELENUS addresses technological, economic, environmental and social challenges for next generation biomass CHP plants, focusing in achieving sustainable and efficient renewable energy and reducing CO₂ emissions.

BELENUS aims to develop a holistic disruptive solution for corrosion prevention that will allow plant operation at 580-625°C (metal temperature), reaching efficiencies of ~40-43% while increasing the lifetime of components and plants.

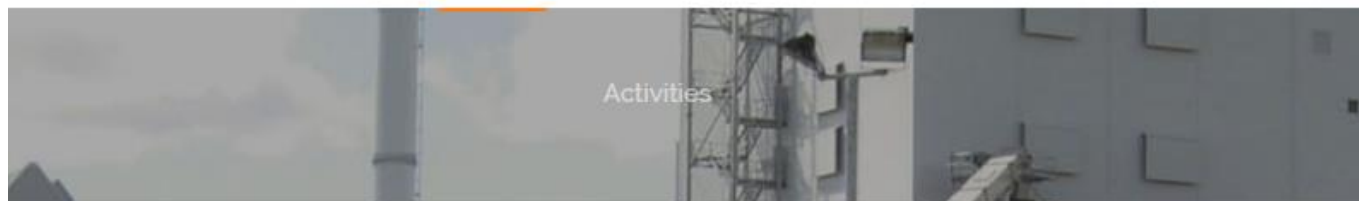
The BELENUS concept aims to validate the best TRL3 available coating/ material systems, welding strategies and on-line corrosion monitoring sensors by testing them at TRL5 (Figure 7).

The impact of BELENUS innovative corrosion solution in CAPEX and OPEX of energy generation in CHP small and medium-scale plants will be quantified. To accomplish this, BELENUS will focus on three pillars:



Figure 7. BELENUS' OVERALL CONCEPT

Figure 3. Project overview.



Brief presentation of the overall structure of the work plan

BELENUS project's Work Plan consists of 9 Work Packages (WP) (Figure 24).

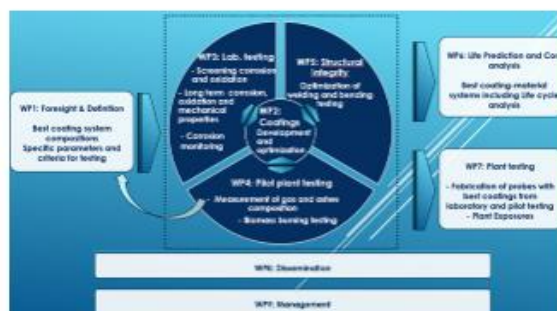


FIGURE 24. BELENUS WORK PACKAGE STRUCTURE

In WP1 the consortium will define the specifics of the project including coating composition selection, testing conditions, parameters and success criteria. The aim of WP2 is to develop and optimise the new material-coating solutions decided in WP1 and then further improve them on the basis of the results of the laboratory and pilot scale testing. WP3 and 4 are dedicated to testing in the lab and at pilot scale respectively. In fact, the initial measurements taken in the pilot scale experiments. In WP4 pilot plants that burn biomass will be employed to better select the gas and ashes composition to be used in the laboratory testing in WP3.

A screening round of short laboratory corrosion testing will be undertaken in WP3 to allow the selection of the best candidate compositions which will be optimized and:

- a) tested for longer duration in the laboratory (WP3),
- b) subjected to various mechanical tests (WP3),
- c) pilot scale tested (WP4) and
- d) subjected to bending and welding procedures (WP5).

WP5 is indeed dedicated to study coated tube welding and bending strategies. A detailed assessment of the coatings-materials system will be undertaken in terms of microstructural and mechanical stability and resistance to fire and steam-side corrosion, as well as erosive wear. Moreover, in WP3 corrosion monitoring methods will be explored and tested. Service lifetime prediction models will arise from WP6, which will in addition, perform economic and life cycle analyses of the best performing coating systems and will allow identifying opportunities for cost and environmental improvements in a holistic manner.

The coating systems exhibiting the best behaviour will be applied in specially designed probes and tubes to be exposed in operating plants in WP7 along with the corrosion monitoring probes to validate the behaviour of the proposed solutions under real conditions. As cross-cutting WPs, WP8 will ensure dissemination and communication activities as well as address the exploitation of the results to ensure market uptake, considering IP issues and social impact issues. WP9 will deal with Project Management and interactions with the EC.

Figure 4. Activities and work programme.

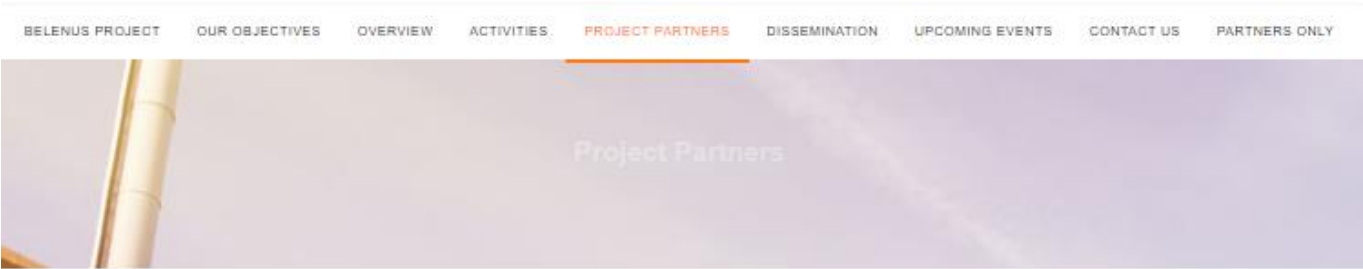


Figure 27. CONSORTIUM PARTNER MAP

Consortium as a whole

The BELENUS consortium brings together 14 partners from 6 different countries: 2 from Germany, 4 from Spain, 2 from Sweden, 1 utility from France (EDF) linked to EIFER, 2 from UK, 1 from Finland and 1 from Portugal (see Figure 27).

The consortium provides a multi-stakeholder approach, from the laboratory to the plant, as clearly emerges from the participants list, covering the whole value chain of biomass fuel plants:

- 7 R&D centres and universities, with a large multi-disciplinary expertise involved in technology development related to anticorrosion solutions, modelling and to the energy sector (UCM, INTA, CIEMAT, VTT, CTH, TUC, and EIFER).
- 2 plant owners: RWE and UNIPER bringing biomass plant operation expertise from different feedstock. EDF will also participate as plant owner under the figure of linked third party of EIFER.
- A boiler designer and manufacturer: DBL, a leader in Engineering, Procurement & Construction projects 2 material developers and production companies, specialized in tube manufacturing (SMT and VAL)
- An SME dedicated to coating development and production (TEANIM)
- A technology consulting and social innovation expert SME: ZAB



The consortium has been built with great care, looking for a group of excellent partners that brings together the necessary knowledge, competence, experience and critical mass which will ensure achievement of the objectives. Geographically speaking, the plant owners and countries provide the necessary variety of biomass types. BELENUS impact at European and international level is granted due to the previous experiences in EC projects as well as each partner's network, which will ensure the results dissemination, promotion and exploitation.

Indeed, the corresponding plans will be defined (WPs) from the beginning to guarantee that the project results are spread and reach all the stakeholders and potential end-users as well as increase biomass social acceptance. Cooperation and understanding among partners is ensured as UCM (PC) has experience in leading R&D projects at EU level and all partners have experience on working in collaborative projects, and have a strong commitment towards teamwork. In addition, many of them have also worked together in the past. In short, BELENUS is formed by a well-balanced set of partners, with proven experience and differentiated roles, which complement each other and ensures the objectives achievement as well as the impact of the project results at European level. The impact of this proposal in technology adopters, components manufacturers and end-users will be particularly important for their ability to build a research ecosystem based on the development of more cost-competitive small and medium biomass CHP plants, succeeding in reducing the cost and bringing it to a mature and competitive level compared to other energy technologies. This will lead to a relevant impact in the current and future bioenergy market.



Figure 5. Project partners.

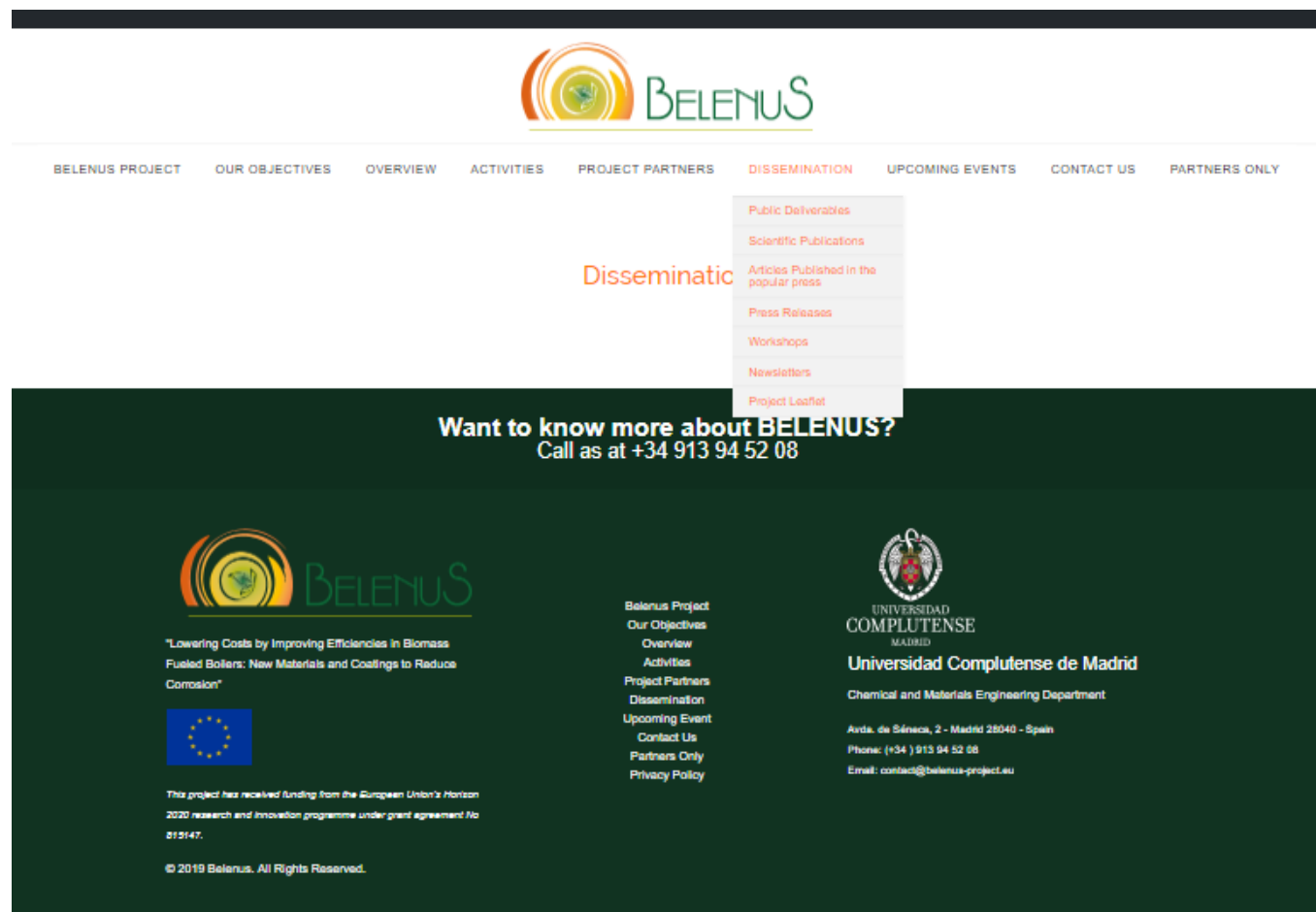
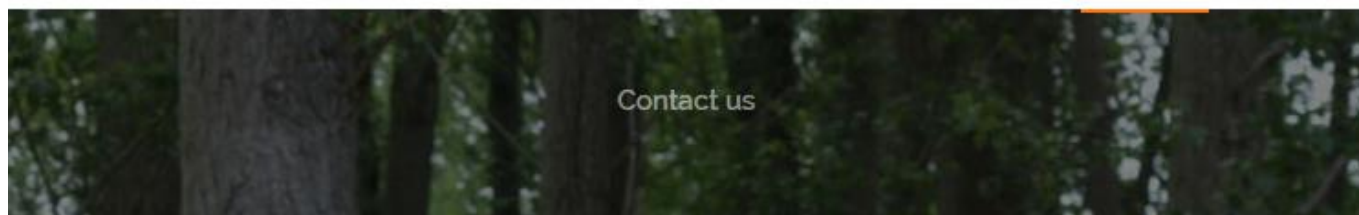


Figure 6. Dissemination and communication activities.



BELENUS PROJECT OUR OBJECTIVES OVERVIEW ACTIVITIES PROJECT PARTNERS DISSEMINATION UPCOMING EVENTS **CONTACT US** PARTNERS ONLY



Contact with us and our team answer you the soon as posible:

📍 Universidad Complutense de Madrid
Chemical and Materials Engineering Department
Avda. de Sánca, 2 - Madrid 28040 (Spain)

📞 (+34) 913 94 52 08

✉ contact@belenus-project.eu



Fill in the following contact form and our team will respond you as soon as posible

<input type="text"/>	<input type="text"/>
<input type="text"/>	
<input type="text"/>	
<input type="text"/>	

☐ I have read and accept the [The Privacy Policy](#)

SEND A MESSAGE

Figure 7. "Contact" menu.