



LIFE15 ENV/SE/000315

Final Report

Biodolomer for LIFE

Data Project

Project location:	Sweden
Project start date:	01/09/2016
Project end date:	31/12/2019
Total budget:	€ 3 147 726
EU contribution:	€ 1 431 188
(%) of eligible costs:	60 %

Data Beneficiary

Name Beneficiary:	Öresundskraft Kraft&Värme AB
Contact person:	Mrs Eva Stål
Postal address:	Box 642, 251 06 Helsingborg Sweden
Telephone:	+46 722 244083
E-mail:	Eva.stal@oresundskraft.se
Project Website:	www.biodolomerforlife.se

1 Table of contents

1	Table of contents	2
2	List of keywords and abbreviations	3
3	Executive Summary	4
4	Introduction	7
5	Administrative part.....	10
6	Technical part.....	11
6.1	Technical progress, per Action	11
	A1. Planning and preparation.....	11
	B1. Adjustment, installation, modification of core material and test.....	17
	B2. Demonstration	23
	C1. Monitoring &Evaluation.....	27
	C2. Project indicators	30
	D1. Dissemination	33
	D2. Replication and transferability	37
	E1. Project Management	39
6.2	Main deviations, problems and corrective actions implemented	40
6.3	Evaluation of Project Implementation	41
6.4	Analysis of benefits	49
	Environmental benefits	49
	Replicability, transferability, cooperation	51
	Best Practice lessons	52
	Innovation and demonstration value	52
	Policy implications.....	52
7	Key Project-level Indicators.....	53
8	Comments on the financial report	53
8.1	Summary of Costs Incurred	53
8.2	Accounting system	55
8.3	Partnership arrangements	56
8.4	Certificate on the financial statement	57
8.5	Estimation of person-days used per action	57
9	Enclosure List.....	58

2 List of keywords and abbreviations

What	Definition
Öresundskraft	Öresundskraft Kraft & Värme AB
GAIA	GAIA BioMaterials AB
NSR	NSR AB
Båstad	Båstad kommun (municipality)
GA	Grant Agreement
CB	Coordinating beneficiary
AB	Associated beneficiary
Biodolomer®	<p>A biomaterial that is renewable, biodegradable, compostable and convertible to renewable energy. Biodolomer® can replace app. 80% of volume plastics.</p> <p>Different Biodolomer® compounds:</p> <ul style="list-style-type: none"> • Biodolomer® F, for production of pouch/carrier bags/freezing bags/aprons • Biodolomer® T, for production of trays • Biodolomer® I, for production of cutlery • Biodolomer® B, for production of bottles
Fully fossil free Biodolomer®	Material containing more than 90% renewable resources
Extruder	A machine that produces unique material by mixing the various ingredients. It uses powder from the mixer, granule and oils etc. The various materials are kneaded together by a complex set of screws at a high temperature. The screw setup is a key factor to be able to generate a unique product. The other key factor is a unique recipe. The extruder has several different temperature zones.
Granules	Final product of Biodolomer®
Recycling machine	The manufacturing process will always generate waste material. Therefore the material will be recycled in this machine to be later reused.
SPCR120	Certification scheme for biofertilizer - the fragments in the digestate need to be 2 mm or less for the biofertilizer to be certified after biogas production. SPCR120 is a certification scheme owned by municipalities' industry organization for waste handling
RISE	Research Institutes of Sweden – an independent, state-owned research institute that offers unique expertise and about 100 testbeds and demonstration facilities, instrumental in future-proofing technologies, products and services
INNVENTIA AB	Research Institute, part of RISE
SIS	Swedish Institute for Standards – an international organization specialised in national and international standards. Act as project manager for Swedish and international efforts to develop standards and promote their use
	The organization issues certificate for food approval. A member organization representing the whole value chain of the Swedish industry. Today 180 members, including producers of raw material, material and products as well as the food industry in wholesale and retail. NORMPACK is part of RISE.
DIN CERTCO	DIN CERTCO is the partner to contact for all aspects of conformity assessment. DIN CERTCO assesses and registers a broad range of products, services, and certifies qualified enterprises and personnel.
AIB Vinçotte	Vinçotte offers objective and advisory services in inspection, certification, conformity assessment and training. Vinçotte is part of TÜV Austria.
TÜV Austria	Independent certification body
TÜV Rheinland	Independent certification body
GWP	Global Warming Potential
MT	Million Tons
PE	Polyethylene
LDPE	Light Density Polyethylene
PP	Polypropylene
PET	Polyethylene Terephthalate

3 Executive Summary

Reader instructions – text and enclosures

When reading the report it is important to keep in mind that not all information is found in the report itself, but more detailed information is also presented in the enclosures, i.e. to get a full understanding under each section the reader needs also to take in the information found in the enclosures. The reason for doing this is to keep the Final Report somewhat shorter than if all information would be presented in the report itself. We also have included Q&A where we answer the 26 issues to be answered by the project, Mr Salsi, 05 August 2019. This document is found under enclosure 50. Q&A.

When developing a new product in the type of industry where GAIA operates this is always done in close co-operation with the company or partner that requires the product, i.e. producers of the final product. If you develop a new product inhouse and then expect this to be sold on the market to a producer, you will not get many satisfied clients. In this type of business, you do not go from one product to another, like producing different versions of a car, one 2019 model and one 2020 model. Instead you work closely together with different clients who quite often have different requirements on how a granule should behave in their machinery and what the final result should be. Two fairly alike producers can have very different requirements, either depending on machinery or on the type of end-material that shall be produced.

We have not done more than what was defined in the Grant Agreement, but it has taken much longer time and has been much more complicated than what we had expected, even though we have more than 40 years of experience within the trade. It is the new material and the options to develop different variants of the Biodolomer® that has taken longer time and has forced GAIA to produce, deliver, test and finetune more test and demo material to clients. I.e. we have done what was planned from the beginning in the Grant Agreement but, like we say, it has required more resources, both related to manpower but also related to raw material.

Objectives

The main objective of the Biodolomer for LIFE project is to demonstrate how non-renewable and energy intensive plastic and packaging materials can be substituted with a new, highly innovative and fossil free material, Biodolomer®.

The innovative material, based on biomass, is unique in its concept by demonstrating the following four important characteristics:

- fully renewable
- fully biodegradable
- fully compostable
- fully combustible to renewable energy(heat/electricity/biogas) with hardly any fossil CO2 emissions

Fully fossil free Biodolomer®

Up until now the first fossil free versions are eight Biodolomer® T versions aimed for production of trays. The work with the other Biodolomer versions to become fossil free will continue.

When the project started in September 2016 approximately 50% of the existing versions of Biodolomer® were based on renewable material, which at the time was very competitive. During the project Biodolomer for LIFE, GAIA has continued the development of the material by working together with 283 prospects and end-producers. At project close December 2019 GAIA had developed, tested and demonstrated 101 different recipes of Biodolomer® to different prospects and customers of which the latest

8 versions are fully fossil free, meaning more than 90% renewable. Biodolomer® has achieved all necessary certificates and permits needed.

In short, the innovation can be described as a new replacement for plastics. It degrades without any industrial process. The material mainly consists of renewable sources, especially dolomite and vegetable substances. It is expected to be able to replace 80% of the volume of plastics, corresponding to 300 million tons globally on an annual basis. According to the Swedish Environmental Protection Agency, Sweden uses 1,3 million tons of fossil plastic per year. A replacement of 80% volume plastics would result in savings of about 6,9 million tons of carbon dioxide per year, corresponding to carbon dioxide emissions from about 2,3 million cars, almost half of the Swedish car fleet.

Please refer to enclosure 5. Biodolomer® versions

The development from the existing Biodolomer® versions at project start to project close for the three major product lines 1) pouch/carrier bags/freezing bags/aprons, 2) cutlery and 3) trays have gone from 50% fossil free Biodolomer® version to almost fossil free versions and for trays it has gone to more than 90% fossil free. All in all, GAIA has during the LIFE project developed 101 new recipes together with 283 clients. When developing these new versions, you take one step at the time, like improving less fossil content, material strength and better visibility, send the new version out to be tested and then change again after client's and eventual end user's response.

Pilot plant

We have installed all the machinery necessary for producing Biodolomer® granule in the pilot plant. We have also installed some end user machines to prove that based on the GAIA granules we can produce certain end products. The most challenging aspect was that key machinery needed to be made bespoke by GAIA and other suppliers/experts since none of the standard machinery on the market could work accordingly to the requirements to be able to produce Biodolomer®. The complete demonstration of operation and performance of the process concept has been successful.

Demonstrations of reference products

The result of the demonstrations for the five reference products were very good. End-users liked the products made of Biodolomer® and we have documented the result, including function and look and feel in five separate reports. When informed about that the products were made of biobased material the majority of the end users was very surprised and happy to understand that it is possible to make real products out of non-fossil plastics. One of the demonstrations was to investigate how food waste bags made of Biodolomer® fits in the circular economy by turning organic waste into biogas and biofertilizer.

Environmentally friendly Biodolomer®

To be able to find out the environmental impact by Biodolomer® an LCA was performed. We worked together with an external consultant, Profu, an independent research and consultant agency with a special focus on waste and energy. The LCA focused on GWP (Global Warming Potential), Cumulative energy use and Water usage in comparison with Bio-PE and fossil PE. The project supported Profu with facts and figures for the sourcing of the raw materials and the production of the granule and carrier bag at the GAIA plant.

The results were very positive. Biodolomer® outcompeted both the Bio-PE and the fossil PE regarding both GWP and Cumulative energy. Regarding water there is a small advantage for Biodolomer® and in total there was a minus net effect for Biodolomer® meaning that Biodolomer® is reducing the total climate impact compared to the Bio-PE and fossil PE.

To reach the many

Altogether we have reached more than 2 million people, both professionals and general public with the message about Biodolomer® and Biodolomer for LIFE. We have mainly used project website, which provides updated information of the project for stakeholders, external companies and organization. There have been many visits to the GAIA plant, and we have also reached many people via Vera Park, an industrial hub for sustainable waste handling, part of NSR. Through Swedish media (newspapers, radio, TV) we have reached more than 2 million. The project has been active at events and exhibitions; both as organizers and participants where we have used roll ups and brochures. A Layman’s report summarizing the project has been produced and an After LIFE plan is in place.

Policy influence

There is a risk that biomaterial is considered as plastics and by that throwing away the potential of biomaterial to substitute fossil plastics. Therefore, it is a big need for legislator to understand the different biomaterials on the market. The project has been proactive in influencing EU policies by different activities. We invited stakeholders for a Public Affairs event in Brussels April 2019 with app. 30 participants, among them the EU Commission (DG ENV). We have had an ongoing dialogue with the Department of Environment in Stockholm and at the same time talked to potential customers and plastics producers who wants to start using biomaterial as an alternative to fossil plastic. We wanted the EU to clarify the definition of biobased material in relation to fossil plastics and support the development of biomaterials in existing and future legislation, plus support and promote advanced biomaterial, like Biodolomer® in comparison to other biomaterials and strengthen the positive effects biobased material has in the circular economy. We need to exclude advanced biobased materials from the directive Single Use Plastics 2019/904.

The founder of GAIA, Mr. Rosén became a member of the Technical Group at SIS, Swedish Institute Standards with the opportunity to influence the standards, existing and future for plastics, including bio-based material. We were encouraged by the EU Commission to make a roll call among industry partners and clients in Europe to let the EU Commission know about the challenges the plastics industry will face when new policies for plastics will be implemented.

Please see the letter and the company list in enclosure 48.

In May 2019 GAIA BioMaterials AB successfully concluded a new round of funding of 10 million SEK, about 1 MEUR, to support its international expansion. Pepins Group acted as advisor when the company made a private placement to a selected group of individuals closely related to Investment AB Spiltan, a recognized entrepreneurial investment firm based in Stockholm, Sweden. Securing this new equity has been fundamental for GAIA to be able to expand both future production capacity in Helsingborg but also to expand its marketing activities regarding Europe and later Far East. This funding does not relate to or affect the LIFE project.

Project time plan

Action		2016				2017				2018				2019				2020			
Action Number	Name of the action	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
A. Preparatory actions (if needed)																					
A.1	Planning & preparation																				
B. Implementation actions (obligatory)																					
B.1	Adjustment, installation and test																				
B.2	Demonstration																				
C. Monitoring of the impact of the project actions (obligatory)																					
C.1	Monitoring & Evaluation																				
C.2	Project indicators																				
D. Public awareness and dissemination of results (obligatory)																					
D.1	Dissemination																				
D.2	Replication and transferability																				
E. Project management (obligatory)																					
E.1	Project Management																				

Blue = done

4 Introduction

Environmental problem

The global plastic production increased from 1,5 million tons per year from 1950 to 250 million tons in 2013 and the global plastic production is estimated to triple by 2050. Plastics are used extensively in packaging of products such as food, pharmaceuticals, cosmetics etc. the need for a new material such as the fossil free Biodolomer® is therefore immense and urgent.

The most common plastics compounds are petroleum-based polymers like PE, PS and PP. When used for disposable applications like, single use cutlery or coffee cups the waste created after use is difficult or impossible to recycle and therefore the waste goes to landfill or for incineration leading to increased fossil CO₂. Much energy and processed raw material is lost when recycled into new products. Plastics are very stable and stays in the environment a long time after being discharged, plastics also put a big chemical many times toxic burden on the environment.

Outline the hypothesis to be demonstrated/verified by the project

The main objective of the Biodolomer for LIFE project is to demonstrate how non-renewable and energy intensive plastic and packaging materials can be substituted with a highly innovative and fossil free material Biodolomer®.

Sub objectives:

- verify the production process (from raw material to end products) for cost-effective production of products based on the new renewable fossil free Biodolomer® and also demonstrate how this new material can generate more reusable waste and biogas,
- validate the market potential using commercial reference products with potential clients and actors in the value chain,
- present and disseminate the project result to problem owners in Europe and other regions. Dissemination will be a key part of the project and the project partners will use its extensive European network to ensure that the project's results are made available to all potential targets groups in the EU.

Technical/Methodological solution

The project partners, Öresundskraft (Båstad up to 30/06/2018) as coordinating beneficiary, GAIA and NSR as associated beneficiaries have followed the plan stated in the Grant Agreement with the project number LIFE15 ENV/SE/000315. The actions and means involved:

A - planning and technical preparation of the pilot plant

B1 - adjust and install a production line

B2 – complete demonstrations of operations and performance of the process concept as well as material properties

C1 – monitor and evaluate the technical part including LCA and socioeconomic impact

C2 – monitor the climate change mitigation indicators and included them together with the other KPI in EC KPI tool

D1 - ensure a wide dissemination of results and encourage an exploitation of results via various means to identify target group/end users across EU

D2 - ensure a cost-efficient replicability and transferability of the pilot/demonstration actions and results

E1 – coordinate and monitor the project with the aim to ensure efficient and successful demonstration

Expected results and environmental benefits

The project is expected to give the following results:

- 65% reduction of waste compared to plastics

- 50% less energy consumption in the production of the material
- 50% more biogas produced from waste based on the new material
- Up to 60% reduction of CO2 emissions in the complete life cycle of the new material
- Five reference products based on fossil free Biodolomer® validated by end users

The project will also include the following results: perform an LCA on the fossil free Biodolomer®, verification of the recyclability options of the material including incineration, recovery by industrial composting (EN 13432) and distribution of project results to European stakeholders, main channel via international partners and their network over the world.

Expected longer term results (as anticipated at the start of the project)

Future contribution to the implementation, updating and development of EU environmental policy and legislation, including the integration of the environment into other policies

The Biodolomer for LIFE project directly supports the objectives set out under LIFE15 priority area Waste since it will contribute to implementation of the specific objectives for waste set out in the Roadmap for a Resource-Efficient Europe and the 7th Environment Action Programme (EAP). By substituting plastic materials with Biodolomer®, waste from packaging and disposable cutlery will be easier to recycle and carbon footprint of the products reduced. The project will also demonstrate an option as to how to reduce the production of single use plastic items by substituting them with a material, which in turn will have a positive effect on the management of plastic materials in EU. The project will support the following priorities:

The project supports several EU directive and documents:

1. The Decision no 1386/2013/EU: 7th EAP
2. Directive 2012/27/EU: Energy efficiency
3. Directive 2008/98/EC: Waste framework Directive
4. Directive 2008/1/EC: Integrated Pollution Prevention Control (IPPC)
5. Directive 1999/31/EC: Waste Landfill Directive
6. Directive 94/62/EC (amended 2004/12/EC): Packaging and Packaging Waste Directive
7. BAT Reference Document (August 2006): Food, drink and milk industries (FDM)
8. Thematic Strategy COM (2005) 666: Prevention and Recycling of Waste

We would like to highlight the first three:

- Since the project aims to demonstrate how non-renewable and energy intensive packaging materials can be substituted with a new highly innovative and patented material that is renewable and biodegradable it clearly supports the 7th EAP.
- Since the project aims to demonstrate a way of reducing energy consumption compared to traditional materials, it is directly in line with the goals of the Directive 2012/27EU: Energy efficiency.
- Since the end products made of the new fossil free Biodolomer® are biodegradable increases the potential for energy recovery of the waste in the form of more climate friendly biogas production and consequently decreases the amount of waste to landfill. This will support the Directive 2008/98/EC: Waste Framework Directive.

Replicability and transferability of demonstrated technology

The overall scope of the project extends across EU and the results can easily be duplicated.

If the project would be successful GAIA had the plans to expand mainly in three ways:

1. Sell granules to existing producers of plastic material, who wants to move into more environmentally friendly products.
2. License the right to use the concept and produce material in their own premises. This was later changed and the right to produce granules will not be licensed. Regarding marketing, the strategy is to build up Europe and later market world-wide by using partners.

3. All licensing of the right to market and sell fossil free Biodolomer® and its products, will follow a franchise concept with clear documentation of all procedures. All raw materials in form of granules will be supplied by GAIA to each licensee.

Market strategy and economic feasibility

The project is performed in Helsingborg area in Sweden, but we see European stakeholders as very important for the success of the project. The involvement of stakeholders in the value chain, from suppliers, to material and converting experts as well as the industry, to end users and brand owners. The geographical scope is Europe with the aim of spreading knowledge to European companies and business worldwide.

The targets groups are numerous because the vast variety of applications and end products. From producers of food and drink products, retail producers and retailers to companies in the event business. As well as municipalities/cities, NGOs and other associations representing different sectors of society.

The dissemination to stakeholders and target groups will be of great importance for the success of the project and we will use all possible opportunities to spread the word about the new, innovative material, Biodolomer®.