PLAS-CARB

INNOVATIVE PLASMA BASED TRANSFORMATION
OF FOOD WASTE INTO HIGH VALUE GRAPHITIC
CARBON AND RENEWABLE HYDROGEN

D10.9 POLICY BRIEF

THE BOOST WITHIN: HOW FOOD WASTE CAN BECOME THE NEXT BIG ACCELERATOR OF COMPETITIVENESS

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No 603488

PROJECT DELIVERABLE

Project Number	Project Acronym	Project Title
603488	PlasCarb	"Innovative plasma based transformation of food waste into high value graphitic carbon and renewable hydrogen"

Instrument:	Thematic Priority
Collaborative Project	ENV

Title
D10.9 Policy Brief

Contractual Delivery Date:	Actual Delivery Date:
30.11.2016	18.11.2016

Start date of project:	Duration:
01.12.2013	36 months

Organisation name of lead contractor for this deliverable:	Document version:
Geonardo Ltd.	07.11.2016 Version for review by partners 15.11.2016 Final version

Dissemination level (Project co-funded by the European Commission within the Seventh Framework Programme)

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

Abstract :

This PlasCarb Policy Brief presents the innovative waste management value chain developed within the PlasCarb project and shows how this technology can contribute to enhancing the competitiveness of the EU as a single market[1]. It is aimed at policy makers at EU institutions such as the European Commission's DG Internal Market and DG Environment, stakeholders of the PlasCarb process, and the general public. Specific recommendations are laid out to support eco-innovations such as PlasCarb to enter the market more easily.

INFORMATION & CONTACT

Results, articles and publications are available for free download on:

www.plascarb.eu

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[1] Definition of the EU single market: https://ec.europa.eu/growth/single-market_en

EXECUTIVE SUMMARY

According to the 7th Environmental Action Programme and the overarching Europe 2020 Strategy of the European Union, one of the main long-term objectives of the Union is to achieve a low-carbon, resource-efficient circular economy. A circular economy is based on the concept that product cycles should be organized along a cradle-to-cradle pattern: Products do not have to be discarded or, if so, they are re- or up-cycled to useful resources for new products, energy or materials. Using waste as a resource brings not only benefits in terms of sustainability, but it also holds a massive economic potential.

Embracing this approach, the PlasCarb project has developed a groundbreaking technology which allows biogas generated from food waste to be transformed into two high-value products:

- G*raphitic carbon* (in the following called Renewable PlasCarbon – RPC), a material that is considered to be one of the most crucial industrial resources for future innovations in the electronics, printing, and automobile sector[2, 3];
- *Renewable hydrogen* (RH_2), a carbon-neutral alternative to available fuels[4].

Currently being extracted from fossil-based sources, finding a steady supply of graphitic substances is an urgent matter. As of now, the EU imports more than half of its graphite intake from China which is recently following a restrictive trade policy on the export of critical raw materials, rendering the EU vulnerable[5].

Despite the strategic importance of utilizing waste, the prevalent legislative and economic environment (e.g. high electricity demand) does not allow for an easy commercialization of eco-innovations such as PlasCarb, as missing clarifications on the treatment of bio-waste, especially food waste, the differing implementations of the Waste Directive and the lacking incentives for companies to invest in green technologies restrict the necessary large-scale application. The current Policy Brief seeks to outline the project details and the potential of PlasCarb as well as recommendations for a future market uptake of the project's results.

[2] European Commission: *Natural graphite*, in. Report on Critical Raw Materials for the EU – Critical Raw Materials Profiles, pp. 99-108.

[3] Hofet al. (2016): *Conductive inks of graphitic nanoparticles from a sustainable carbon feedstock,* in. Carbon, available at: http://dx.doi.org/10.1016/j.carbon.2016.09.052

[4] Renewable hydrogen as PlasCarb output has been deemed not financial viable at this current scale of production as it can be produced only at low mass flow rate and long payback.

[5] European Commision – Press release (2016): *EU* takes *legal action against export restrictions on Chinese raw materials.,* available at: http://europa.eu/rapid/press-release_IP-16-2581_en.htm

KEY RECOMMENDATIONS

» Rethinking the waste classification system:

Although the currently available list of waste does provide an extensive classification system, there is still a need for a clearer separation of sub-streams - such as food waste - from general bio-waste or municipal solid waste. The lack thereof proved to pose an obstacle when trying to compile data on the amount of food waste generated by the EU and the Member States individually. In failing to do so, an adequate assessment of the economical benefits of waste-based innovations becomes troublesome.

» Ensuring waste accessibility:

Agriculture, food manufacturing, the food retail sector, food services or households can be potential suppliers of food waste as the resource to PlasCarb. Such suppliers often apply internal policies for food waste availability that might create obstacles for PlasCarb users (e.g. AD plant operator) to access waste. In line with the previous recommendation, the availability of food- and bio-waste should be guided by national or regional authorities more closely to be able to serve new beneficial food waste management strategies such as PlasCarb.

» An updated bio-waste legislation:

There should be an overall improved legislative regulation of biodegradable waste as it cannot be treated in the same way as other types of municipal solid waste. As set out in the proposal for the amendment of the Waste Framework Directive (WFD), this encompasses the better enforcement of separate waste collection in order to create high standard bio-waste feed-stocks and to recognize bio-waste as a recyclable resource. Until the "decoupling of the economic growth and environmental concerns" is eventually achieved, enforcements such as these would help green technologies to penetrate the market and make "going green" an economically profitable choice instead of a burden.

» Promoting a green market:

Closely linked to the previous recommendation, it is crucial that eco-innovation and green alternatives become attractive choices next to the traditional and often cheaper competition. Although several studies underline the economic benefits of resource-efficiency and circular businesses, the main drive behind business choices remains short-term cost-efficiency and simplicity. To promote green technologies, companies need to have the necessary incentives to choose green options instead of cheaper ones. This could be enforced through heightened business responsibility schemes, financial leverages for or against technologies based on their environmental footprint (eg. taxes or subsidies), or certificates which would strengthen trust in eco-innovations.

» Easy accessibility and matchmaking:

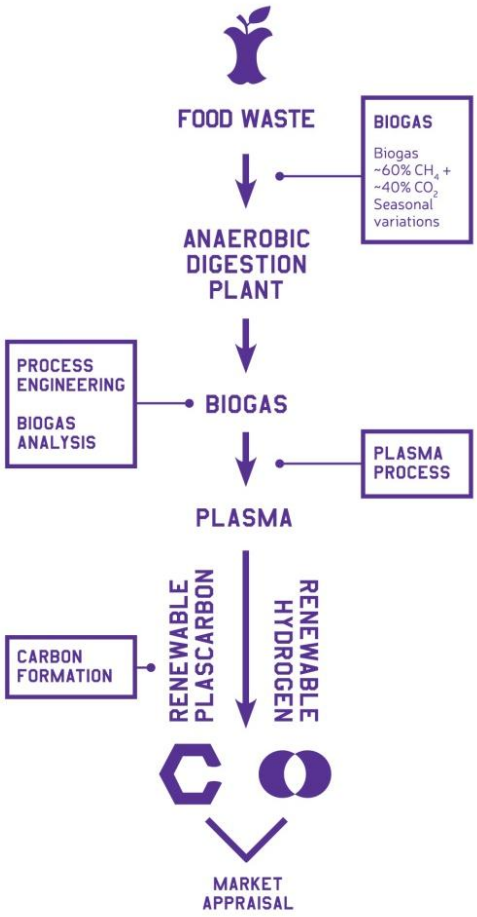
In compliance with the Commission's Action Plan for a Circular Economy, the adaptation of eco-innovations should be at the forefront of the European economy. Therefore, in order to facilitate the transfer of innovation from the research sector to the market, there should be a higher visibility of available financial instruments and a stronger support for matchmaking events between the researchers offering technologies and SMEs which would be willing to adapt and commercialize them.

BACKGROUND TO THE PLASCARB PROJECT

PlasCarb is an EU funded project that has aimed to transform biogas (consisting mainly of methane and carbon dioxide) generated by anaerobic digestion (AD) of food waste, into high value graphitic carbon (RPC) and renewable hydrogen (RH2) as displayed in **Error! Reference source not found.**. The biogas is first upgraded to high purity bio-methane and subsequently fed to an innovative low energy microwave plasma reactor and downstream separator. The bio-methane in then cracked into graphitic carbon particles (RPC) and an off-gas stream rich in hydrogen. Due to impurities in the off-gas and the difficulty to clean it, the generated hydrogen did not yet fulfil the necessary criteria in order to be considered market-ready. Therefore, the PlasCarb research team continued its exploration on RPC which, on the other hand, proved to be highly promising.

The project has been carried out by a consortium of five SMEs, a research institute and an RTO (Research and Technology Organisation) and it has been divided into ten work packages, each representing an important step in the total development of the PlasCarb process. The milestones have been:

» Perfecting microwave plasma splitting of the upgraded biogas in order to extract high standard RPC and RH_2;
» Testing and verifying the quality of RPC regarding conductivity, strength and chemical purity;
» Assessing the sustainability of the technology;
» And analyzing the business potential and possible market uptake.



The PlasCarb Process

The PlasCarb project intends this technology to be applied by waste management SMEs in order to improve their competitiveness. SMEs account for the largest share of value added (50.7%) in the waste management subsector[6]. The PlasCarb technology is likely to further expand this share and to create a significant amount of new jobs through a sustainable and economically profitable business idea.

[6] Eurostat (2012): *Sectoral analysis of value added by entreprises size class, non-financial business economy, EU-28*

Why choose Renewable PlasCarbon?

An innovative technology

The PlasCarb technology is in many ways an innovative upgrade to the current state of the art of recycling bio-waste and specifically food waste. The best available recycling method of bio-waste consists of AD for the creation of two end products: the one being biogas for the generation of fuel, electricity or heat; the other being digestate to be sold for soil improvement and fertilization. PlasCarb goes one step further: by using biogas generated by AD from the feedstock bio-waste or food waste, the project applies a microwave plasma splitting technique to create RPC, a high-value material. This graphitic substance has similar properties as the commercially available, fossil-based carbon black while being generated from a sustainable source. Acknowledged for its conductivity, lubrication capacities and strength, this material is one of the most essential components for the development of future electronic devices and conductive inks, membranes or coatings. Furthermore, the graphitic nature of RPC enables the production of graphene, the "super material" declared to be a key resource regarding future high tech research and business.

A growing graphite market

According to future global market analysis, the demand for natural and synthetic graphite is going to expand by around 5.8% annually with an expected upsurge especially in the lithium batteries sector.[7] By 2020, the batteries needed for the production of electrical vehicles and portable high tech equipment alone are going to generate a 25% increase in high purity large flake graphite demand which equals an amount of 29,600 tonnes on top of the 78,000 tonnes consumed by the EU in total.[8] Prices vary depending on the size and purity of the graphite between €1,125 to €18,000 per tonne[9]. China is with 68% the main supplier of natural graphite, with the EU importing 57% of its intake from this country.[10] As it has been recognized in the EIP Raw Materials Initiative, the dependency on imports from parts of the world that do not have a market-based system, and/or are politically and/or economically unstable poses particular risks.[11] As substitutability of natural graphite is indicated to be relatively low[12], the affected industries will be in need of a stable and secure supply of graphite and graphitic material in different forms.

[7] Donald W. Olson (August 2015): *Graphite.* In. 2013 Minerals Yearbook (2015), USGS, Ch. 32.
[8] European Commission: *Natural graphite*, in. Report on Critical Raw Materials for the EU – Critical Raw Materials Profiles, pp. 99-108.
[9] See Olson 2015
[10] COM(2014) 297 final
[11] Raw Materials Initiative COM(2008) 699 final
[12] Substitutability index: 0,72 according to COM(2014) 297 final

Food waste as an opportunity

Notwithstanding the need for the reduction of overall food waste levels, the PlasCarb project has the potential to valorise occurring food waste in a sustainable and thus circular economy-compatible manner. PlasCarb is able to provide as much as 700kg RPC out of 2,400 m^3 biogas generated from 150 tonnes of mixed food waste. According to a study by FUSIONS, the EU-28 has produced around 88 million tonnes of food waste in 2012.[13] Based on these numbers, **the PlasCarb Project could generate up to 41,000 tonnes of RPC which is equivalent to 53% of the EU-intake on natural graphite.**

PlasCarb thus re-injects waste into the economy by creating a critical raw material which could contribute to the competitiveness of major EU industries. This step would mean greater independency from import, a profitable business opportunity for SMEs and an improved comprehensive management of biodegradable waste.

A sound policy framework

Although the European Union is strongly supporting measures to achieve a zero-waste recycling economy, there are still hindrances which prevent the economy to reap the benefits of eco-innovations such as PlasCarb. One of the major obstacles of initiatives aiming at the valorisation of bio-waste is a **missing, high standard biodegradable waste stream** from the Member States. The first problems arise while trying to assess the actual amount of existing bio-waste. With the Member States applying different national methodologies when collecting data on waste flows, it is nearly impossible to create a concise study on the cumulative levels of the bio-waste stream. Moreover, **a missing common definition for food waste** (or differentiation of other sub-streams of bio-waste) further complicates the implementation of the project.[14] This also means that it is difficult to predict the exact economic benefits of the PlasCarb technology as it can only be calculated based on the available amount of biodegradable waste. Nevertheless the introduction of innovations which could turn bio-waste into a viable business opportunity could help the Member States being inclined towards the better application of the Waste Framework Directive.

[13] FUSIONS (2016): *Estimates of European food waste levels*

[14] See also Jackson, C. (2012): *EU waste law: the challenge of better compliance*, in. Directions in European Environmental Policy (5), Institute for European Environmental Policy

To facilitate the transition towards transparent and resource-efficient waste management, PlasCarb recommends **adopting the proposal by the European Commission regarding the extended Waste Framework Directive**[15] as quickly as possible. The content of the amendment is a valuable evolution of the pending waste legislation as it puts a strongly welcomed emphasis on bio-waste. However, a standalone definition of food waste is still not included, posing the difficulty of collecting consistent data of food waste. The best possible solution would be a mandatory separation of food waste from municipal waste rather than imposing general recycling targets on all types of waste.

Eco-innovation is key to the green future envisioned by the EU. These technologies receive ample financial support by the Horizon 2020 programme and embody a critical knowledge base for possible solutions to environmental challenges. However, the market for such innovations remains relatively narrow. A study on the behaviour of SMEs (which, besides being the target group of this particular project also represent 99% of European businesses) showed that more than 60% do not offer green products or services currently and are not planning on doing so in the future either. The reason for this is mainly the lack of financial incentives and assistance with finding potential markets or customers.[16] These results highlight the need for **a better promotion of eco-innovations**. They need to be exploitable and exploited. The provisions of the Small Business Act for Europe on the greening of SMEs (IXth point) already showcased a list of suitable actions to be taken by the EU and the Member States in order to create the necessary financial incentives.[17] However, as this document has been adopted in 2008, it seems that the Barometer conducted in 2015 does not reflect an entirely successful adaptation of the suggestions. Despite the wide range of financial instruments available to small businesses, the information channels seem to be too complex for SMEs to make use of them. To this end, it is crucial that SMEs become aware of the project results of various EU-funded innovations and to be eligible for assistance in how to implement them without compromising their business prospects.

Therefore it would be recommended **to organize matchmaking events more frequently** as they are an integral part of know-how transfer and inter-sectoral networking. To increase the visibility of such events it would be further favourable to compile the various interrelated channels on green funding, policy, legislation, events, and possible partners in an easily accessible, comprehensive fashion. As of today, finding the desired information requires an extensive research which some SMEs might not have the capacities for. Basically, eco-innovation-related themes and products should be redirected to the “mainstream” economy and

[15] European Commission COM(2015) 595 final

[16] Flash Eurobarometer 426 (September 2015): SMEs, resource efficiency and green markets – Summary, pp. 13-19.

[17] COM(2008) 394 final

thus target businesses which might not prioritize green technologies otherwise.

Funding for eco-innovations such as PlasCarb is needed to facilitate their market uptake. Programmes or pilots such as COSME, FTI or the SME instrument (phase 2 and 3) are suitable funding opportunities on EU level. Attracting private investment is certainly another crucial step in pursuing market entrance for eco-innovations. As most SMEs still rely on their own financial instruments, **it is advisable to create an overarching business responsibility scheme as well as to provide EU-guided mentoring (potentially in collaboration with the EIB) to private investors and innovation holders for business development** as these measures could help carve out a natural green path for businesses and strengthen trust in eco-innovations. Better yet, the funding structure could be reorganized according to an idea-to-market chain, where the development of innovations and their market uptake are integrated into a single, overarching funding and assistance mechanism. This step could be vital in fostering the various technologies to the benefit of the European economy.

Outlook and Conclusion

This policy brief introduced the PlasCarb project as a new, innovative technology that enables the valorisation of food waste. With this process, a high-value graphitic substance can be produced which would be a superior competitor to fossils-based carbon black due to (at least) similar performance yet sustainable production method. Moreover, it has the potential to warrant a reliable supply of this highly demanded critical raw material in times where export restrictions might jeopardize its inflow to the EU. Apart from the strategic importance of graphite, the PlasCarb project additionally aimed at improving the competitiveness of European waste management SMEs. By applying our technology, they would be able to create jobs, to generate profit by selling the derived graphite and to implicitly contribute to an improved municipal waste management system.

We believe that the road to a resource-efficient, circular European economy requires a detailed focus on waste legislation on the one hand and higher accessibility of eco-innovation for SMEs on the other hand. The ideal policy environment would enable the technologies to be fully exploited on a large-scale level. This would serve European competitiveness, foster strategic independence from foreign import and contribute to an environmentally more conscious society.

REFERENCES

1. European Commission (2014): *Review of the list of critical raw materials for the EU and the implementation of the Raw Materials Initiative* (COM(2014) 297 final)

2. European Commision (2016): *EU* takes *legal action against export restrictions on Chinese raw materials,* Press Release, available at: http://europa.eu/rapid/press-release_IP-16-2581_en.htm

3. European Commission (2015): *Proposal for a Directive of the European Parliament and of the Council amending Directive 2008/98/EC on waste* (COM(2015) 595 final)

4. European Commission: *Natural graphite*, in. Report on Critical Raw Materials for the EU – Critical Raw Materials Profiles, pp. 99-108.

5. Eurostat (2012): *Sectoral analysis of value added by entreprises size class, non-financial business economy, EU-28*

6. FUSIONS (2016): *Estimates of European food waste levels*

7. Jackson, C. (2012): *EU waste law: the challenge of better compliance*, in. Directions in European Environmental Policy (5), Institute for European Environmental Policy

8. European Commission (2008): *The raw Materials Initiative – meeting our critical needs for growth and jobs in Europe* (COM(2008) 699 final)

9. European Commission (2008): *"Think Small First" – A "Small Business Act" for Europe* (COM(2008) 394 final)

10. Donald W. Olson (August 2015): *Graphite.* In. 2013 Minerals Yearbook (2015), USGS, Ch. 32.

11. Flash Eurobarometer 426 (2015): *SMEs, resource efficiency and green markets – Summary*, pp. 13-19.

12. Hof et al. (2016): *Conductive inks of graphitic nanoparticles from a sustainable carbon feedstock,* in. Carbon (2016), available at: http://dx.doi.org/10.1016/j.carbon.2016.09.052