PLASCARB

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

D8.3 REPRESENTATIVE CASE STUDIES

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
D8.3 REPRESENTATAIVE CASE STUDIES

Contractual Delivery Date:	Actual Delivery Date:
Month 36	Month 36

Start date of project:	Duration:
December, 1st 2013	36 months

Organisation name of lead contractor for this deliverable:	Document version:
GAP	1.3

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

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

Contents

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

1. OBJECTIVES

1.1. Representative Case Studies to model six different end user scenarios.

2. INTRODUCTION TO CASE STUDIES

2.1. It was envisaged that the desired case studies were to match product demand with ability to supply into 6 different markets.

2.2. During the PlasCarb project it became clear to the consortium members and coordinator, that the current lack of market uptake was going to make this difficult to deliver.

2.3. It was requested that we provide case studies in three of the consortium countries, Namely UK, Germany and Hungary, looking at the two build types and challenges they faced given that there was a lack of specific take up by industry desire and no specific market. As identified in the introduction of WP10 Deliverable 10.10 "*There are no volume industrial applications of graphene yet, but a range of potential applications are being developed in labs worldwide, and the expectations based on lab results are promising.*"

2.4. We have therefore looked at the potential market applications in the three Countries and how they fit with reference to WP8 Deliverable 8.2 and WP10, Task 10.3 and provide an overview of potential application and likely interest.

2.5. Although the scenarios are based on a reactor bank of 5 PlasCarb reactors. Each reactor bank can produce enough material to satisfy the current world market, it must be mentioned that this is while the market is in its infancy and in order to the material and market to grow there will be a need for fairly rapid increase in reactor banks to match the growing supply into the market place.

2.6. In Work Package 8 Deliverable 8.1 it was identified that there were realistically only two build types that were viable in the current market. Deliverable 8.2 further investigated the funding opportunities and their portability throughout the case study countries.

2.7. Because of the funding requirements of both build options as reported in WP8 D8.2, the only realisable current funding options are by way of private Equity Funds or the preferred Industry Investment Fund Managements Companies who are able to cope with the higher risk profile and fund the working capital elements. These industry funds are currently being led by the waste sector.

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

3. CASE STUDIES 1 & 2– UK

3.1. Graphene and the UK

History:

The UK is home to The University of Manchester where in 2004 Graphene was first isolated by Prof Andre Geim and Prof Kostya Novoselov. Manchester is home to the National Graphene Institute and has been awarded the status of European City of Science 2016.

The PlasCarb Reactor was designed, built and commissioned in the UK. Additional UK trials during the PlasCarb Project using Bio Methane derived from food waste anaerobic digestion were successfully completed.

UK Market Potential and Applications:

Fuel cell commercialisation is moving forward rapidly across the world. It is estimated that the global fuel cell market could be worth over $26bn in 2020 and over $180bn in 2050. The UK share of this market could be $1bn in 2020 rising to $19bn in 2050.[1]

Although during the Plascarb Project the amount of Renewable Hydrogen was deemed to expensive to clean to an acceptable level because of the small amount being created as the reactors become more efficient this may become a viable additional revenue stream.

The UK is home to leading international hydrogen supply and storage companies. Large global players such as Air Products and BOC / Linde have particular strengths in stationary gas and liquid fuel storage and handling. Other players, such as ITM Power, are working on the integration of hydrogen systems with renewable generation, including electrolysers and fuel cells.

The WP10 documented application of Renewable PlasCarbon (RPC) also supports the potential application and uptake as a catalyst.

During the project, it was possible to perform the successful intercalation of graphitic nano carbons and its application as direct, efficient and selective reducing agent for the preparation of composite materials consisting of nano-sized graphene sheets decorated with iron oxide nanoparticles (FeNP@NCs).[2]

[1] http://www.carbontrust.co.uk/News/presscentre/091009_Polymer_fuelcell_challenge.htm
[2] PlasCarb Product Market Appraisal 4.1.7 -Abalonyx

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

This would be as a replacement for metals such as platinum for its electrocatalytic role in electrochemical reactions, its elevated price would allow the Renewable PlasCarbon (RPC) to compete and increase the value of RPC while still being a much more cost effective and environmentally replacement for Platinum .

CPI Printable Electronics are also partnering with firms to produce an Internet Of Things in packaging through RF Id Tags and similar printable circuitry. This may however be a high volume low value market chain.

3.2. Case Study 1 -UK 'Bolt On' Build:

- Funding Opportunity and Type:
    - Investment Management Fund – High Probability
- Availability of Existing Sites:
    - GAP Gateshead
    - Additional Sites Managed by Iona Capital with Excess Gas
- Potential Applications / Potential Value:
    - Printed Circuitry - RFID Tags
    - Automotive industry linked to Nissan and their fuel cell research
    - Polymer Paints and coatings for the aerospace industry

3.3. Case Study 2 - UK 'New Build'

- Funding Opportunity and Type:
    - Investment Management Fund – **Low Probability**
- Availability of Existing Sites:
    - Suitable site to be yet to be identified
- Potential Applications / Potential Value:
    - Printed Circuitry - RFID Tags
    - Automotive industry linked to Nissan and their fuel cell research
    - Polymer Paints and coatings

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

4. CASE STUDIES 3 & 4- HUNGARY

Background:

Hungary is keen to provide a competitive advantage compared to other countries in the region through the government's strong commitment to streamlining business processes and to increasing the competitiveness of both SMEs and large enterprises in Hungary through a wide range of available incentives.

Both refundable and non-refundable incentives are available to investors coming to or expanding in Hungary. The main types of incentives related to investments are cash subsidies (either from the Hungarian Government or from EU Funds), tax incentives, low-interest loans, or land available for free or at reduced prices. The regulations on incentive opportunities are in accordance with EU rules.

Hungary is situated in the heart of Europe, which makes the country optimal for the distribution of material, manufacturing, services and logistics.

They have a skilled and highly educated labour force, particularly in the engineering and IT. Who are paid 60% less than the average of the EU 27, which makes the Hungarian workforce attractive and will reduce the OPEX of both build models.

Market Potential and Applications:

There is a strong automotive and electronics industry with excellent infrastructure, ready-made industrial sites, with a good balance of labour costs and quality; and possibility of governmental and municipal incentives (cash subsidy, tax allowance) making it investment friendly.

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

4.1. CASE STUDY 3 – Hungary 'Bolt ON'

- Funding Opportunity and Type:
    - Investment Management Fund – MEDIUM Probability
- Availability of Existing Sites:
    - Low take up of Anaerobic Digestion
- Potential Applications / Potential Value:
    - Automotive industry
    - Electronics Development and New product design/innovation able to seize the potential applications of flexible electrical components

4.2. CASE STUDY 4- Hungary 'New Build'

- Funding Opportunity and Type:
    - Investment Management Fund – HIGH Probability
- Availability of Existing Sites:
    - Low take up of Anaerobic Digestion provides a higher availability of feedstock and would be designed to handle food waste at a higher level than currently required as the overflow gas can be utilised in Combined Heat and Power markets. This would allow for greater expansion as the market grows and the ability to service the local applications within industry as identified below.
- Potential Applications / Potential Value:
    - Automotive industry as a Catalyst replacement for Platinum in exhaust systems.
    - Electronics Development and New product design/innovation able to seize the potential applications of flexible electrical components

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

5. CASE STUDIES 5 & 6 - GERMANY

Background:

Bioenergy is becoming increasingly important in Germany, In 2012, the rate of energy generated from biomass increased by 8 percent compared to the previous year. In the same year, 91 percent of the heat produced by renewable energy sources came from biomass. According to Germany Trade & Invest, the industry wants to make sure that by 2030, 18 percent of electricity and 15 percent of heat used in Germany will be generated from bioenergy.

Combined heat and power

The Combined Heat and Power (CHP) industry in Germany is poised for significant growth. This is because technically, it is possible to use CHP energy to cover up to 50 percent of the electricity demand.

With the large existing supply of BioGas/Biomethane production any new technology that can improve the financial return and allow sites to be more competitive for feedstocks ensures a captive potential market for new RPC Reactors. It also stands to reason that it would place the investment route towards the 'Bolt On' approach.

Market Potential and Applications:

Germany is the fourth-largest producer of automobiles worldwide, after Japan, the US and China. Lending itself to the automotive applications of RPC and a growing Aerospace industry that has continue to grow since the mid 90's.

5.1. CASE STUDY 5 – Germany 'Bolt ON'

- Funding Opportunity and Type:
    - Investment Management Fund – HIGH Probability
- Availability of Existing Sites:
    - Large take up of Anaerobic Digestion and Biomass Facilities
- Potential Applications / Potential Value:
    - Catalyst replacement for Platinum in exhaust systems and Automotive Fuel Cell/Large Automotive in Automotive industry.
    - Conductive Composites /Coatings / Growing Aero Space Industry

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

5.2. CASE STUDY 6- Germany 'New Build'

- Funding Opportunity and Type:
    - Investment Management Fund – LOW Probability as a result of the proliferation of existing of AD Plants.
- Availability of Existing Sites:
    - Large take up of Anaerobic Digestion and Biomass Facilities
- Potential Applications / Potential Value:
    - Catalyst replacement for Platinum in exhaust systems and Automotive Fuel Cell/Large Automotive in Automotive industry.
    - Conductive Composites /Coatings / Growing Aero Space Industry

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