[LIFE15 ENV/ES/000208]

Life ECO METHY LAL

High quality methylal from non-recyclable plastic waste by an improved Catalytic Hydro-Gasification Plasma (CHG) process

***LAYMAN REPORT**/March 2021*

*The **LIFE ECOMETHYLAL project** has received funding from the LIFE Programme of the European Union.*

INTRODUCTION

THE PROBLEM

Plastic materials are essential in the reality of the EU, due to their versatility, the industry they represent and the uses of it. The use of plastic materials is extended to almost all sectors (e.g., packaging, automotive, electrical and electronic or building and construction, among other). Plastic products, at the end of their useful life, become waste.

One of the problems that must be tackled is the presence of plastic waste in the landfill. In 2018, 29.1 million tonnes of plastic waste were collected in the EU in order to be treated. Plastic waste is managed; currently 75.1% are valued to obtain new recycled materials (32.5% recycled) or energy (42.6%), with 24.9% mainly disposed of by landfill.

CHEMICAL RECYCLING

According to the current EU waste legislation (WFD, Directive 2008/98/EC, article 3.17): recycling means "any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations".

According to the waste hierarchy, recycling is preferred to energy recovery and both are above disposal.

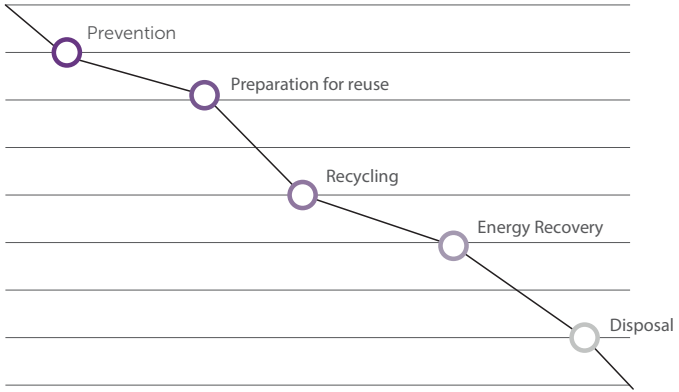


Figure 1: Waste hierarchy

It should be noted that mechanical recycling is a mature industrial process which is well established and expanding in Europe. However, three main points must be specified:

- Plastics cannot be endlessly mechanically recycled without reducing their properties and quality.
- Not all types of plastic can be mechanically recycled.
- There is a large amount of mixed waste that is difficult to separate, to be later mechanically recycled.

These limits pose challenges for plastics recycling and show the need for significant improvements in the end-of-life management of plastics. It is at this point where chemical recycling becomes important, showing its complementarity with mechanical recycling. Chemical recycling can be defined, then, as that technology, capable of converting plastics into new plastics or into chemical substances, different from fuels.

An increasing number of projects and investigations appear to be promoting chemical recycling and its technologies. These technologies can be divided into four types:

- Solvent-based purification.
- Chemical depolymerisation.
- Biological depolymerisation and cracking.
- Thermal depolymerisation and cracking (pyrolysis and gasification).

One of these investigations is the one developed in LIFE ECOMETHYLAL.

LIFE ECOMETHYLAL PROJECT

At the end of this layman as annexes, it has been collected several legislations related to the European regulations in terms of waste management, incineration legislation and landfilling. LIFE ECOMETHYLAL project will strengthen this legislation and give a solution through recycling of waste streams.

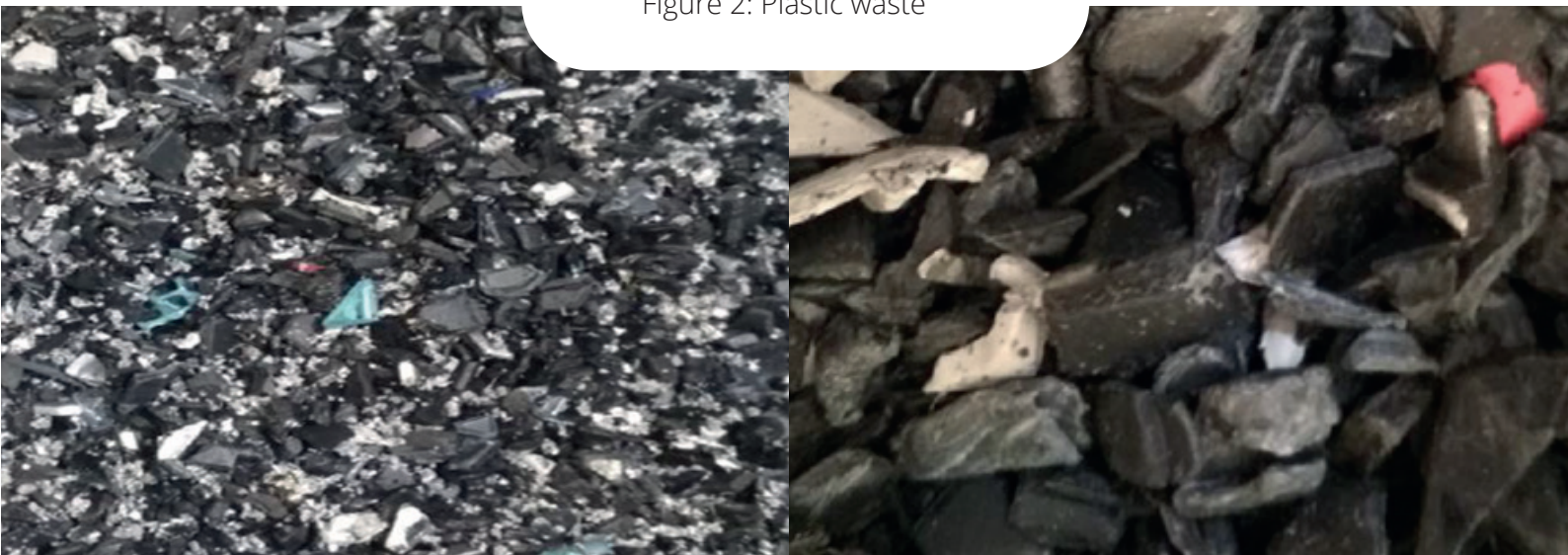
This project has demonstrated the possibility of recycling mixed waste from **non-recyclable waste** through a pyrolysis and synthesis process to obtain methylal(dimethoxymethane) as the main product, although it has also been shown that methanol can be obtained. Methylal is a chemical substance of interest to industry in numerous applications.

This technology corresponds to thermal cracking, an energy intensive process. It is considered that it is not energy recovery because from it, substances, and products of interest in the industry are obtained, not producing fuels. Therefore, it is recycling.

It is necessary to achieve the objectives related to the EU circular economy, climate and sustainable chemical polices that there is an appropriate political framework to regulate these technologies and their corresponding results.

LIFE ECOMETHYLAL implement a highly profitable technology called Catalytic Hydrogasification with Plasma (CHGP), to produce methylal using the current non-recyclable plastic waste (NRPW) from the sectors: **automotive, electric-electronic, textile and packaging**, according the waste hierarchy established by the EU policies. This should dramatically reduce the amount of landfilled NRPW and will involve producing and marketing a new eco-product made from recycled material.

Figure 2: Plastic waste



PROJECT OBJECTIVES

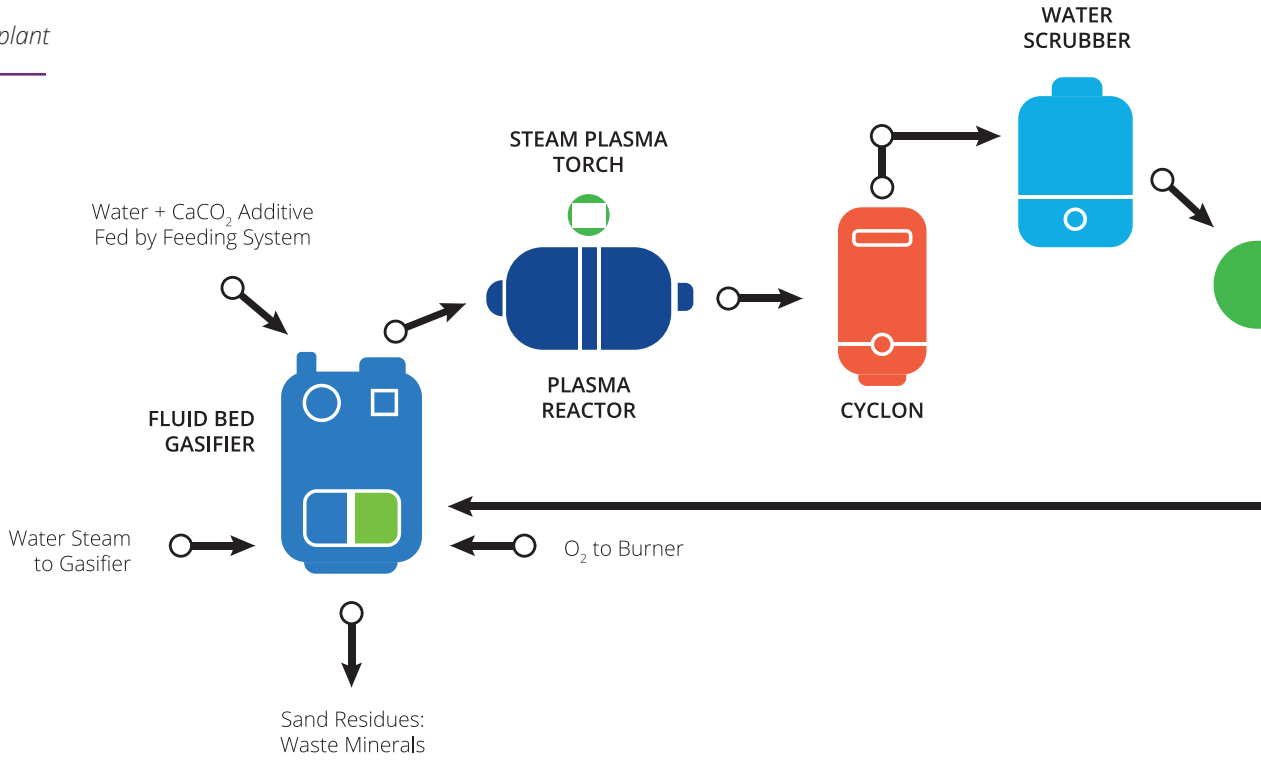
- Reduce the NRPW address to landfill and a new eco-product commercialized (by material recycling) which is a more sustainable alternative compared to the current one from fossil sources.
- It contributes to the shift towards a resource-efficient, circular economy and specifically, to the plastic waste recovery.
- Implement a mature and patented solution for homogeneous biomass.
- These plants can be installed inside/closed to the plastic treatment plants/recyclers companies to treat the non-mechanically recyclable fraction.
- The LIFE ECOMETHYLAL replicability to all EU will contribute to reduce the landfill waste.

PROJECT IMPLEMENTATION

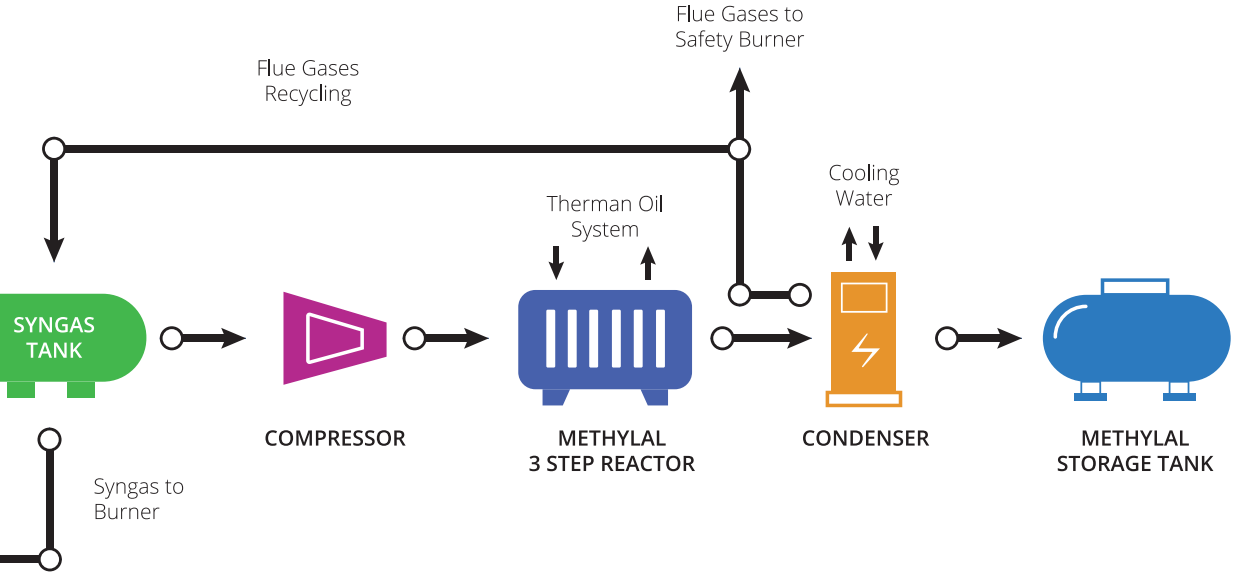
The LIFE ECOMETHYLAL Project, which will end this month, received funding from the LIFE Programme of the European Union.
[LIFE15 ENV/ES/000208].

The highlight of the project was demonstrating that waste initially considered non-recyclable for mechanical recycling can actually be recycled through chemical recycling to obtain products of interest to industry, and that the process can therefore be introduced in production cycles. This result led to the construction of a modular pilot plant consisting of two main units: a gasification unit and a synthesis unit.

Flow diagram of the plant



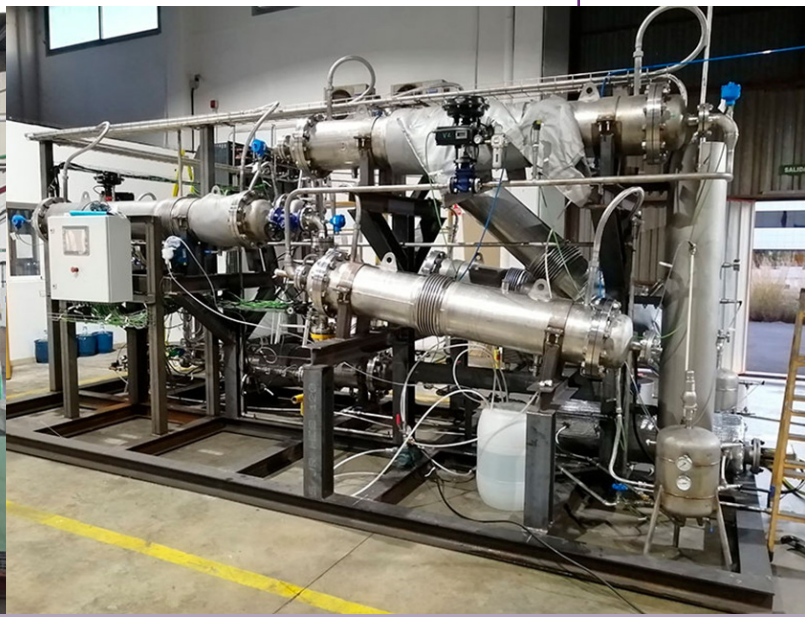
Gasification Unit



Methylal Production Unit

Figure 3:
Gasification unit

Figure 4:
Synthesis unit

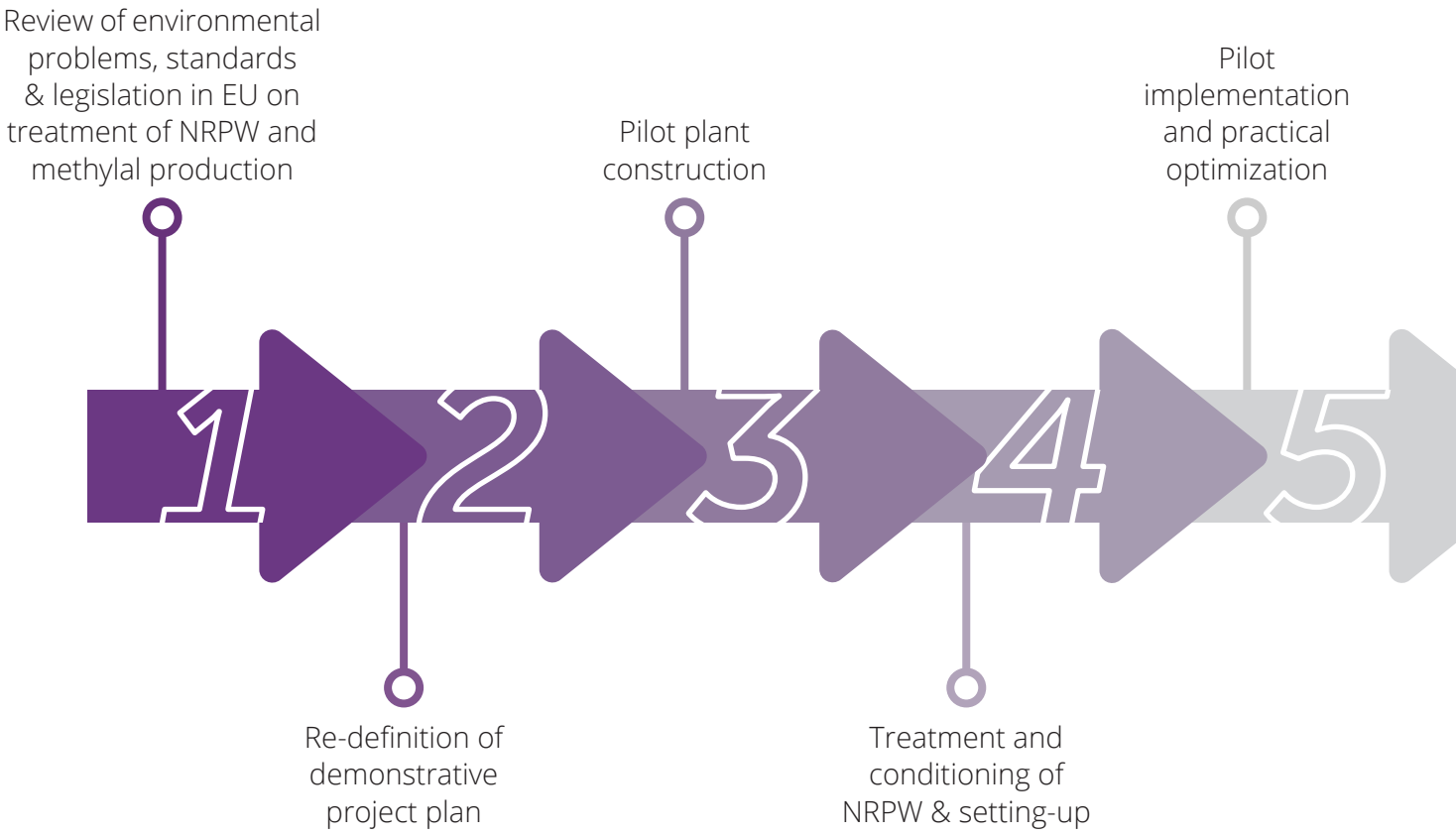


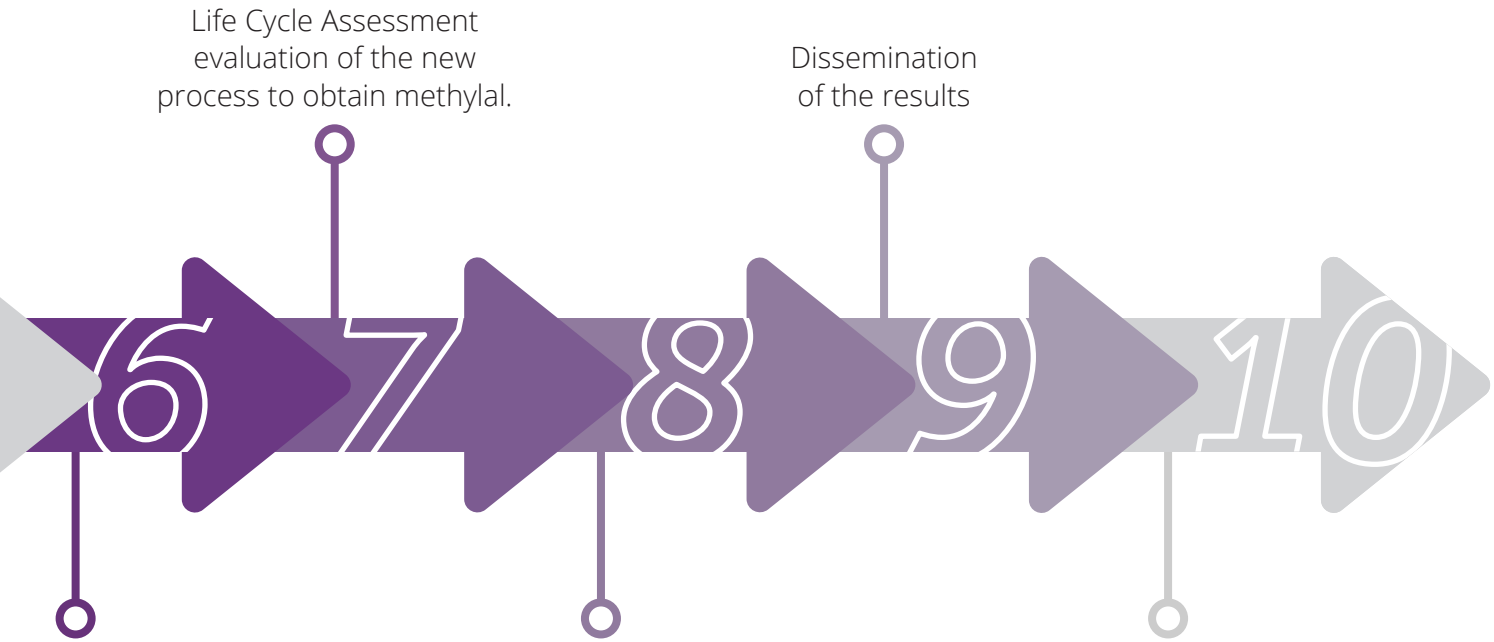
Mi-Plast Plant

Produced Methylal

The pilot plant was presented at a workshop at ***ACTECO*** *(Spain)* in September 2020 and at **MI PLAST** *(Croatia)* in November 2020.

ACTIVITIES AND MAIN OUTCOMES


Review of environmental problems, standards & legislation in EU on treatment of NRPW and methylal production
Re-definition of demonstrative project plan
Pilot plant construction
Treatment and conditioning of NRPW & setting-up
Pilot implementation and practical optimization
1
2
3
4
5


Life Cycle Assessment evaluation of the new process to obtain methylal.
Dissemination of the results
6
7
8
9
10
Characterization and comparison of methylal with commercial grades
Socio-economic, environmental, legislative & project performance indicators monitoring, including Transferability and Replicability plan to Croatia
Project Management & monitoring of action progress

RESULTS

Obtained in the pilot plant:

- Development a pilot plant with a compact and modular configuration which requires small space and low investment. It runs continuously, reducing energy consumption.
- Ecomethylal plant is able to manage heterogeneous plastic waste resulting in low humidity and some pollutants. It can be installed inside a closed plastic treatment plant / recyclers companies to treat the non-mechanically recyclable fraction.
- 3,6 tonnes of waste treated in the project.

- 36% efficiency of process (kg methylal/kg plastic waste) which could be increased to 50% by improving temperature and pressure control at the industrial plant.
- The product obtained methylal is a substance highly valued in the chemical industry as raw material, being used as additive for resins, coatings, paints and glue. It has a relevant market (estimated 5.200 M€/a).
- >80% purity of methylal.
- The LIFE ECOMETHYLAL replicability to all EU will contribute to reduce the landfill waste in line with European priorities.

RESULTS

Expected results in the transfer to future industrial plant:

- Plant emissions comply with the limits of current European environmental regulations.
- By collecting and optimizing residual heat flows from the gasification unit and the exothermic reactions of the gas to liquid reactors and the oxidation reactor in the synthesis unit, a 70% reduction of electrical power in the synthesis unit can be expected in the industrial plant compared to the pilot plant.

- The compact size of the technology allows it to be implemented at the waste manager's facilities, optimising existing resources and avoiding the transport of waste.
- The modular nature of the technology, with an annual treatment capacity of a maximum of 8,000 Tn/year of plastic waste, allows the rapid implementation with the possibility to expand the plant if necessary, to adapt to the treatment capacity of potential clients.

CONCLUSIONS

The results of the project demonstrate that the combination of gasification and synthesis is viable for recycling plastic waste from many sources and with complex compositions. In addition to these processes, products of high interest for industry can be obtained, such as methanol and methylal. These processes are expected to be implemented by industry to help meet European Union recycling targets for plastic waste and thus comply with the waste hierarchy.

- Direct decrease of the waste that are currently going to landfill.
- Production of added value Methylal.
- Creating awareness of the existence of this waste and the possibility of its good management.

RECOMMENDATIONS FOR FUTURE LEGISLATION

Chemical recycling could be a complementary solution to mechanical recycling where the latter proves to be unsuited to materially recover plastic because it is too degraded, contaminated or too complex.

Nevertheless, the best options to curb plastic pollution from environmental and economic perspective is to invest in reduction and reuse solution. If too much attention is given to a solution at the end of the process, such as recycling, this perspective can be lost.

For this reason, further work should be done on increased collection of high-quality waste and a design for reuse and recycling. Through this route, it is possible to increase the rates of recycling for plastics and ensuring no plastic escapes the material loop via plastic to fuels.

For this to happen, the following aspects are established that are considered good practices and that should be included in the waste legislation:

- Establish a clear definition of chemical recycling that excludes any operation that does not result in the production of new plastic or new chemicals that do not become fuel.
- Update the waste legislation, accordingly, introducing harmonised definitions of different chemical recycling technologies to provide clarity on the nature and outputs of different technologies covered by the term.
- Update, in the same sense, the European standards based on these definitions.

- Develop a unified quantification system recognized by all parties that includes traceability and chain of custody principles to verify the non-use of chemical recycling to obtain fuel. This system could be based on a mass balance.
- Classify as chemical recycling systems that produce chemicals and plastics with a lower carbon footprint than virgin chemicals and plastics.
- Chemical recycling should be used to deal with degraded and contaminated plastics and never with plastics coming from separate collection.

- Of value are those chemical recycling operations that recover mixed waste materials, which currently end up incinerated or deposited in landfills.
- In the interests of coherence with EU climate and Circular Economy agendas, EU funding should support mechanical and chemical recycling operations.
- Chemical recycling should be clearly accounted for in the European Union recycling targets.

Annexes

General plastic waste legislation

- Consolidated text: Commission Decision of 24 October 1994 concerning questionnaires for Member States reports on the implementation of certain Directives in the waste sector (implementation of Council Directive 91/692/EEC) (94/741/EC)

  https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:01994D0741-20070307&from=EN

- 97/622/EC: Commission Decision of 27 May 1997 concerning questionnaires for Member States reports on the implementation of certain Directives in the waste sector (implementation of Council Directive 91/692/EEC)

  https://eur-lex.europa.eu/legal-content/EN/TXT PDF/?uri=CELEX:31997D0622&from=EN

- 2000/532/EC: Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste (notified under document number C(2000) 1147) (Text with EEA relevance). Date of entry into force unknown (pending notification) or not yet in force., Date of effect: 01/01/1001: This act has been changed. Current consolidated version: 01/06/2015

  https://eur-lex.europa.eu/legal-content/EN/TXT/

PDF/?uri=CELEX:32000D0532&from=EN

- 2001/118/EC: Commission Decision of 16 January 2001 amending Decision 2000/532/EC as regards the list of wastes (Text with EEA relevance) (notified under document number C(2001) 108)

  https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001D0118&from=EN

- Regulation (EC) No 2150/2002 of the European Parliament and of the Council of 25 November 2002 on waste statistics (Text with EEA relevance)

  https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32002R2150&from=EN

- Commission Regulation (EC) No 574/2004 of 23 February 2004 amending Annexes I and III to Regulation (EC) No 2150/2002 of the European Parliament and of the Council on waste statistics (Text with EEA relevance)

  https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32004R0574&from=EN

- Commission Regulation (EC) No 782/2005 of 24 May 2005 setting out the format for the

transmission of results on waste statistics (Text with EEA relevance)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005R0782&from=EN

- Commission Regulation (EC) No 783/2005 of 24 May 2005 amending Annex II to Regulation (EC) No 2150/2002 of the European Parliament and of the Council on waste statistics (Text with EEA relevance)

  https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005R0783&from=EN

- Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste

  https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006R1013&from=EN

- Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance)

  https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN

- Commission Regulation (EU) No 849/2010 of 27 September 2010 amending Regulation (EC) No 2150/2002 of the European Parliament and of the Council on waste statistics Text with EEA relevance

Vehicle waste legislation

• Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of life vehicles - Commission Statements

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32000L0053&from=EN

• 2005/293/EC: Commission Decision of 1 April 2005 laying down detailed rules on the monitoring of the reuse/recovery and reuse/recycling targets set out in Directive 2000/53/EC of the European Parliament and of the Council on end-of-life vehicles (notified under document number C(2004) 2849) (Text with EEA relevance)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005D0293&from=EN

• 2005/437/EC: Commission Decision of 10 June 2005 repealing Decision 2005/63/EC amending Annex II to Directive 2000/53/EC of the European Parliament and of the Council on end-of life vehicles (notified under document number C(2005) 1705) (Text with EEA relevance)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005D0437&from=EN

• 2005/438/EC: Commission Decision of 10 June 2005 amending Annex II to Directive 2000/53/EC of the European Parliament and of the Council on end-of life vehicles (notified under document number C(2005) 1707) (Text with EEA relevance)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005D0438&from=EN

• 2005/618/EC: Commission Decision of 18 August 2005 amending Directive 2002/95/EC of the European Parliament and of the Council for the purpose of establishing the maximum concentration values for certain hazardous substances in electrical and electronic equipment (notified under document number C(2005) 3143)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005D0618&from=EN

• 2005/673/EC: Council Decision of 20 September 2005 amending Annex II of Directive 2000/53/EC of the European Parliament and of the Council on end-of-life vehicles (Text with EEA relevance)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005D0673&from=EN

• Directive 2008/33/EC of the European Parliament and of the Council of 11 March 2008 amending Directive 2000/53/EC on end-of-life vehicles, as regards the implementing powers conferred on the Commission

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0033&from=EN

• 2008/689/EC: Commission Decision of 1 August 2008 amending Annex II to Directive 2000/53/EC of the European Parliament and of the Council on end-of-life vehicles (notified under document number C(2008) 4017) (Text with EEA relevance)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008D0689&from=EN

• 2010/115/EU: Commission Decision of 23 February 2010 amending Annex II to Directive

Electrical and electronic equipment waste legislation

• Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment Text with EEA relevance

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011L0065&from=en

• Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE) Text with EEA relevance.

Batteries and accumulators waste legislation

• Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC (Text with EEA relevance)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006L0066&from=EN

• Directive 2008/12/EC of the European Parliament and of the Council of 11 March 2008 amending Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators, as regards the implementing powers conferred on the Commission

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0012&from=EN

• Directive 2008/103/EC of the European Parliament and of the Council of 19 November 2008 amending Directive 2006/66/EC on batteries and accumulators and waste batteries and

Batteries and accumulators waste legislation

• Commission Directive 2002/63/EC of 11 July 2002 establishing Community methods of sampling for the official control of pesticide residues in and on products of plant and animal origin and repealing Directive 79/700/EEC (Text with EEA relevance)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32002L0063&from=EN

• Regulation (EC) No 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EECText with EEA relevance.

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005R0396&from=en

• Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R1107&from=en

• Commission Implementing Regulation (EU) 2019/533 of 28 March 2019 concerning a coordinated multiannual control programme of the Union for 2020, 2021 and 2022 to ensure

Containing persistent pollutants waste

- 2006/507/EC: Council Decision of 14 October 2004 concerning the conclusion, on behalf of the European Community, of the Stockholm Convention on Persistent Organic Pollutants
  https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006D0507&from=EN
- • Regulation (EU) 2019/1021 of the European Parliament and of the Council of 20 June 2019 on

Packaging waste legislation

• European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31994L0062&from=EN

• 97/129/EC: Commission Decision of 28 January 1997 establishing the identification system for packaging materials pursuant to European Parliament and Council Directive 94/62/EC on packaging and packaging waste (Text with EEA relevance)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31997D0129&from=EN

• Directive 2004/12/EC of the European Parliament and of the Council of 11 February 2004 amending Directive 94/62/EC on packaging and packaging waste - Statement by the Council, the Commission and the European Parliament

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32004L0012&from=EN

• Directive 2005/20/EC of the European Parliament and of the Council of 9 March 2005 amending Directive 94/62/EC on packaging and packaging waste

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005L0020&from=EN

• 2005/270/EC: Commission Decision of 22 March 2005 establishing the formats relating to the database system pursuant to Directive 94/62/EC of the European Parliament and of the Council on packaging and packaging waste (notified under document number C(2005) 854) (Text with EEA relevance)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005D0270&from=EN

• 2009/292/EC: Commission Decision of 24 March 2009 establishing the conditions for a derogation for plastic crates and plastic pallets in relation to the heavy metal concentration levels established in Directive 94/62/EC of the European Parliament and of the Council on packaging and packaging waste (notified under document number C(2009) 1959) (Text with EEA relevance)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009D0292&from=EN

Incineration waste legislation

• Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) Text with EEA relevance

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0075&from=EN

• Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 2009 laying down health rules as regards animal by-products and derived products not intended for human consumption and repealing Regulation (EC) No 1774/2002 (Animal by-products Regulation)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R1069&qid=1620890570294&from=EN

• Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&rid=4

Landfill of waste legislationlegislation

• Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31999L0031&from=EN

• 2003/33/EC: Council Decision of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32003D0033&from=EN

• Commission Implementing Regulation (EU) 2019/2072 of 28 November 2019 establishing uniform conditions for the implementation of Regulation (EU) 2016/2031 of the European Parliament and the Council, as regards protective measures against pests of plants, and repealing Commission Regulation (EC) No 690/2008 and amending Commission Implementing Regulation (EU) 2018/2019

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R2072&from=EN

• Directive (EU) 2018/850 of the European Parliament and of the Council of 30 May 2018 amending Directive 1999/31/EC on the landfill of waste (Text with EEA relevance)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0850&from=EN

REACH

REGULATION (EC) No 1907/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 December 2006

concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC

Consolidated text: Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC (Text with EEA relevance)

CL2006R1907EN0180010.0001.3bi_cp 1..2 (europa.eu)

Current Legislation Act May 2021

LIFE ECOMETHYLAL PROJECT

Reference: LIFE15 ENV/ES/000208

Total Budget: 2,039,142 €

EU contribution: 1,007,464 €

Duration: 55 Months

(01/09/2016 to 31/03/2021)

Website: www.life-ecomethylal.eu
Contact info: info@life-ecomethylal.es

Coordinator:

AIMPLAS
PLASTICS TECHNOLOGY CENTRE

www.aimplas.es

Beneficiary partners:

acteco

www.acteco.es

AIRESA

www.airesa.es

BPP
TOGETHER TO RENEWABLES

www.blueplasmapower.com

mi-plast
bio-company

www.mi-plast.eu

Contact details

AIMPLAS · Instituto Tecnológico del Plástico
C/ Gustave Eiffel, 4 (València Parc Tecnológic)
46980 - PATERNA (Valencia) - SPAIN

Tel. (+34) 96 136 60 40

Contact:
https://life-ecomethylal.eu/
info@life-ecomethylal.eu