



Sun Apple Blackcurrant\*

agata

READY TO EAT NO LIQUID NO PITS

Kuchini Germolene Antiseptic Cream. Chlorhexidine Digluconate Local Anaesthetic: Numbs pain. DUAL ACTION

universal vegetable seasoning

No preservatives

Good in Sens inside me you'll find NO added sugar, salt or water NO additives or thickeners NO wheat, dairy or lactose bits and nothing artificial No preservatives or artificial colours

Y

JUICE 1908

Whisk

with Chicken in Jelly

75ml

Sachar

GARACID NEUT







# UNLOCKING POTENTIAL

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A new packaging material could dramatically increase the overall sustainability of your product, reducing raw material use, cutting transport emissions and prolonging product life. But with no recycling solution available, the consumer will be forced to send it to landfill. Do you choose it?

Enval unlocks the potential of high performance materials so you don't have to make that choice. Our microwave induced pyrolysis process is a world-first solution for recycling plastic aluminium laminates.





# PLASTIC ALUMINIUM LAMINATES: A CHALLENGE

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Advances in material science have led to the creation of high performance materials that offer significant benefits to both brands and consumers. Unfortunately it is often the most advanced materials that are also the most challenging to handle responsibly once they have served their purpose.



### An ideal packaging solution

Plastic aluminium laminates comprise a thin foil of aluminium that is sandwiched between a matrix of plastic layers. While plastic has long been chosen for its lightweight, flexible properties, the addition of aluminium provides a protective barrier against gases (including oxygen), moisture and light.

Laminate packaging has been widely adopted by fast-moving consumer goods (FMCG) companies to improve the ratio of product-to-pack weight, reduce transport costs and emissions, and reduce the weight of material that has to be disposed of after use. The product-to-pack ratio of a flexible pouch is 35 times greater than that of a glass bottle and 21 times greater than an aluminium can.

Laminates are very versatile and increasingly popular with both brands and consumers. Their use has increased considerably in recent years for everyday goods such as juices, toothpaste, cosmetics and pet food. Laminate baby food pouches did not exist a few years ago but consumer demand has encouraged many brands to convert to this new format. One of the largest baby food brands now produces around 150,000 pouches per day. In recent years, even something as quintessential as a tuna can has been converted to this new material.

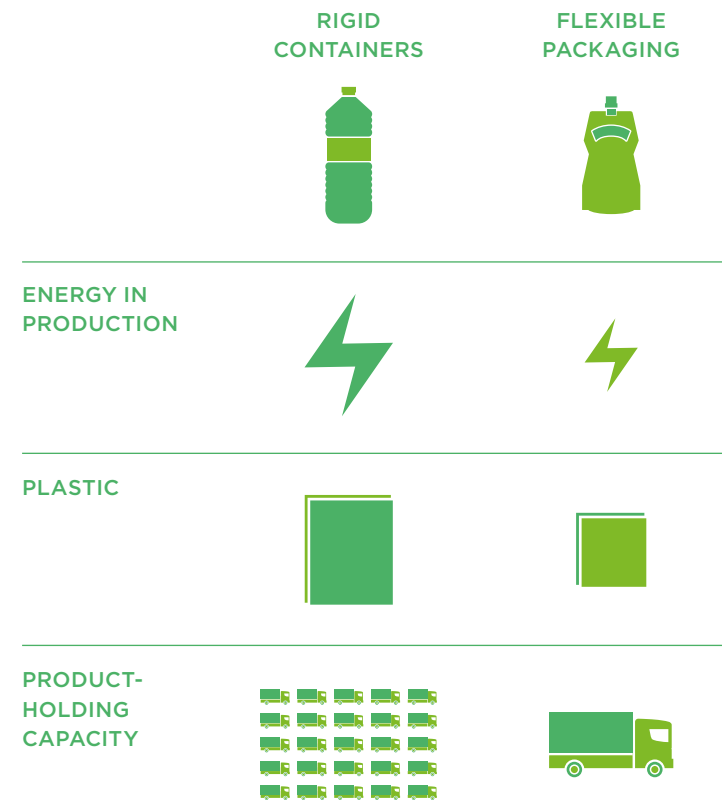
### A growing challenge

There are now more than 160,000 tonnes of flexible aluminium laminate packaging entering the UK marketplace each year.

Total global demand for plastic aluminium laminate pouches is set to increase 3.6% per year up to 2017, with even faster growth predicted through to 2022. With no recycling solution available, most of that material will be sent to landfill.

A sustainable end-of-life solution would allow brands that benefit from these materials to increase their use and start substituting other packaging systems that, although more commonly recyclable, have a greater overall environmental impact.

FLEXIBLE PACKAGING REQUIRES 50% LESS ENERGY AND 60% LESS PLASTIC TO PRODUCE. ONE TRUCKLOAD OF FLATTENED FLEXIBLE POUCHES HAS THE EQUIVALENT PRODUCT-HOLDING CAPACITY OF UP TO 25 TRUCKLOADS OF EMPTY RIGID CONTAINERS



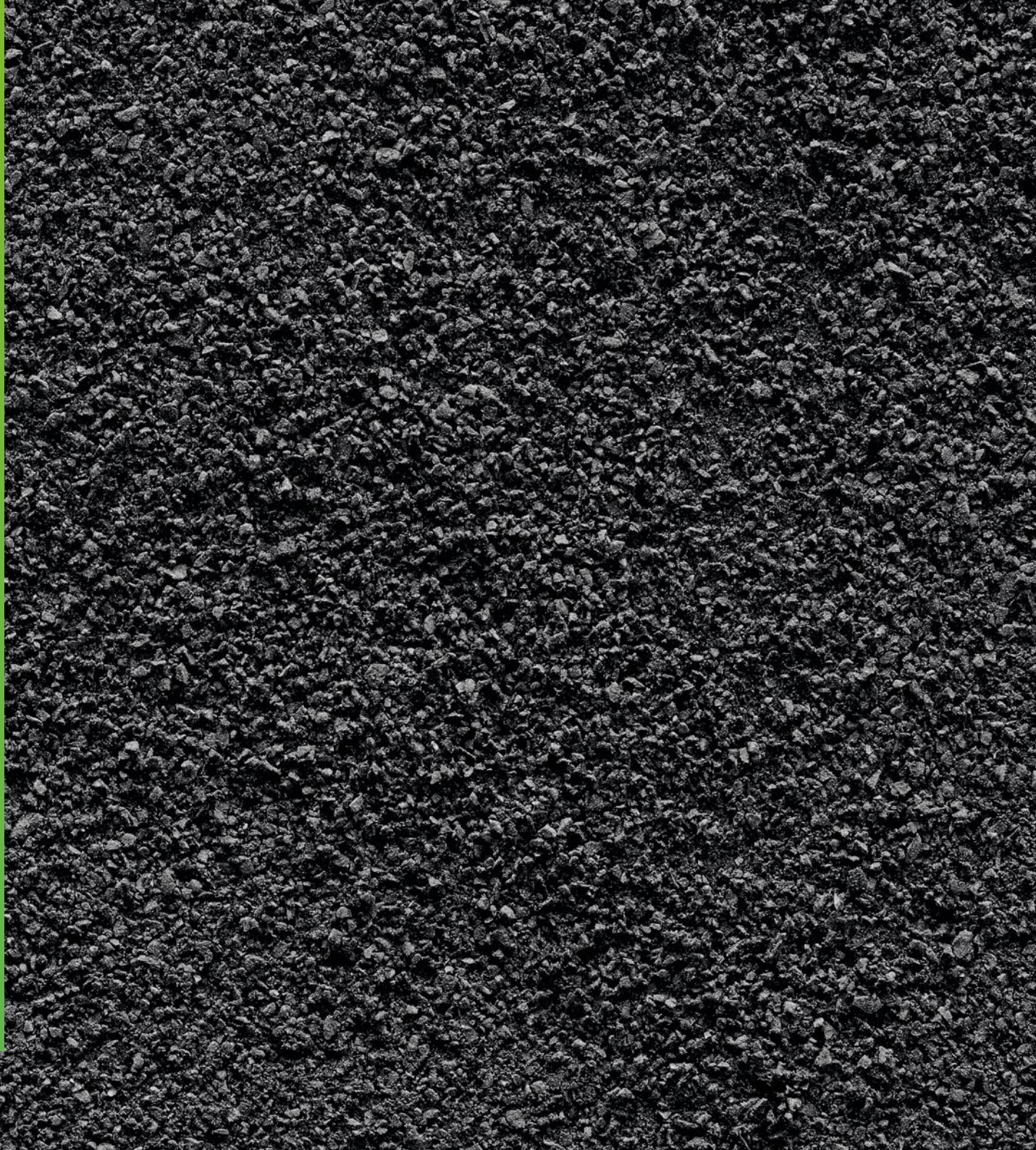




# MICROWAVE INDUCED PYROLYSIS: **A SOLUTION**

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Enval has taken the process of microwave induced pyrolysis and created a world-first solution for recycling plastic aluminium laminates. The process is clean, efficient and economical for both post-consumer and industrial waste.





## Microwave induced pyrolysis for waste management

Pyrolysis is a process in which an organic material such as paper or plastic is heated in the absence of oxygen. The high temperature causes the molecules to break down so that the material degrades without combustion or incineration. Pyrolysis has long been considered an important waste management tool because it allows for the disposal of industrial and post-consumer waste while producing valuable chemicals and energy.

With microwave induced pyrolysis, the energy required to heat up the material is provided in the form of microwaves. The process combines the advantages of microwave heating with the environmental benefits and commercial opportunities associated with pyrolysing waste. It can also be configured to operate under gentle mechanical conditions in order to extract fragile materials without damaging them.

In traditional pyrolysis processes, the energy to heat the waste is derived from burning fuel, generating emissions that require a stack on-site. By contrast, microwave induced pyrolysis is powered by electricity, eliminating the need for a stack and providing the option to use a renewable source of energy.

## Microwave induced pyrolysis for plastic aluminium laminates

When carbon is exposed to a microwave field, it can reach temperatures of up to 1,000°C in just a few minutes. If shredded plastic aluminium laminates are mixed with the carbon, the energy absorbed from the microwaves is transferred to the plastic by conduction in a quick and efficient manner.

During the process, the fragile aluminium foil remains undamaged and can be recovered still in its solid form, clean and ready for reprocessing. The plastic component of the material degrades to form a mixture of hydrocarbons ranging from  $C_3$  to  $C_{20}$ . This mixture is then cooled down and separated into two fractions: gas and oil. The gas can be used to generate the electricity required to power the process, and the condensed oils can be sold as fuel or feedstock for speciality chemicals.

THE CARBON FOOTPRINT OF THE CURRENT DISPOSAL METHODS FOR 1000 PLASTIC ALUMINIUM LAMINATE BABY FOOD POUCHES COMPARED TO THE ENVAL PROCESS (KG CO<sub>2</sub>e)



## COMPARISON TO CURRENT DISPOSAL METHODS

### LANDFILLING

Currently the vast majority of all plastic aluminium laminates are sent to landfill.

ENVIRONMENTALLY DAMAGING

LIMITED SPACE TO CONTINUE

POLITICAL PRESSURE TO CHANGE

INCREASING LANDFILL TAXES

NO RECOVERY OF ENERGY

NO RECOVERY OF CHEMICALS FROM PLASTIC

NO RECOVERY OF ALUMINIUM

### ENERGY RECOVERY

Laminates can be added to traditional energy recovery units where material is combusted to produce heat energy for electricity turbines or direct heating applications.

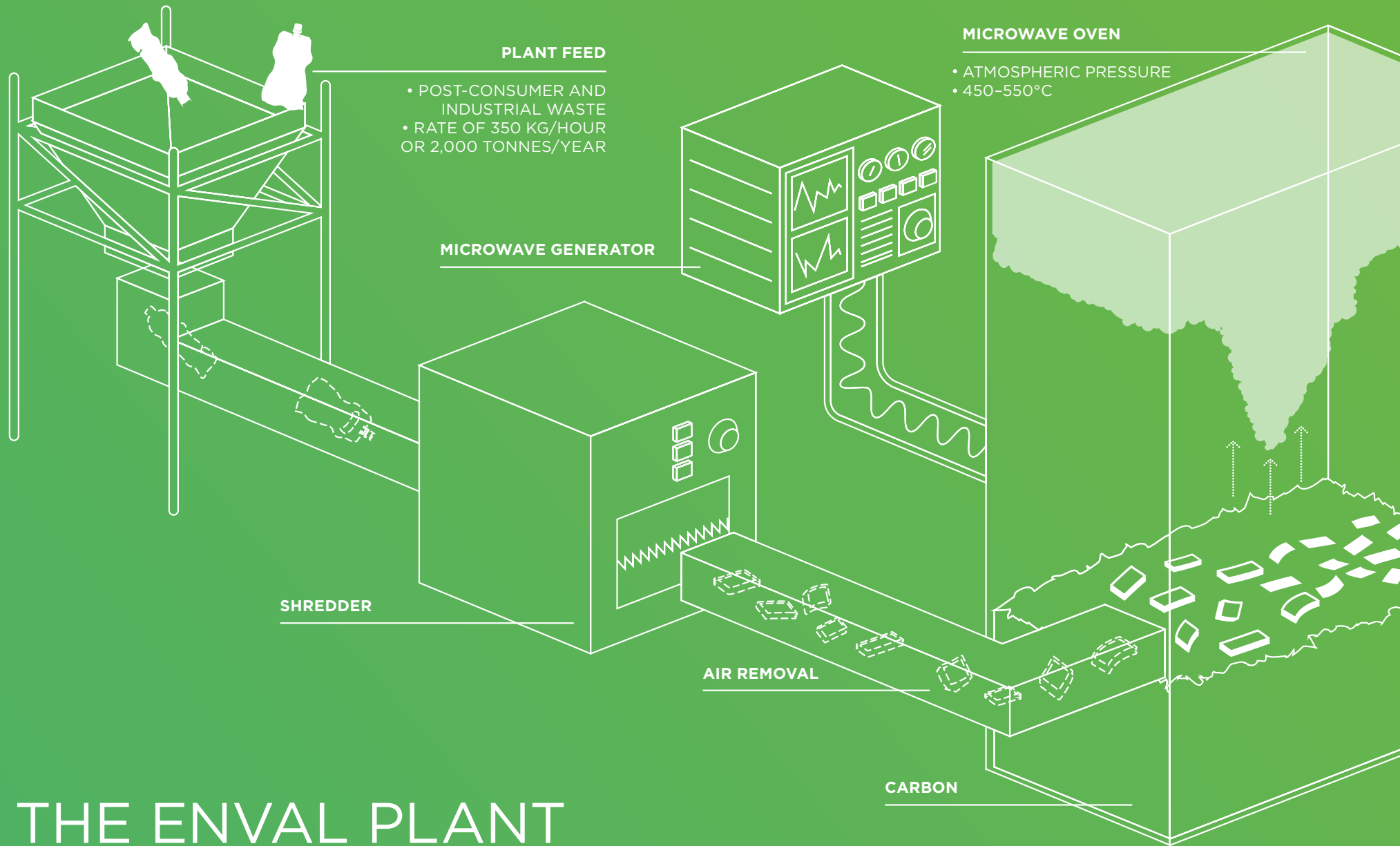
PRODUCES GREENHOUSE GAS EMISSIONS

HIGH COST OF GAS CLEANING EQUIPMENT

CAN RELEASE HIGHLY TOXIC AND CARCINOGENIC COMPOUNDS

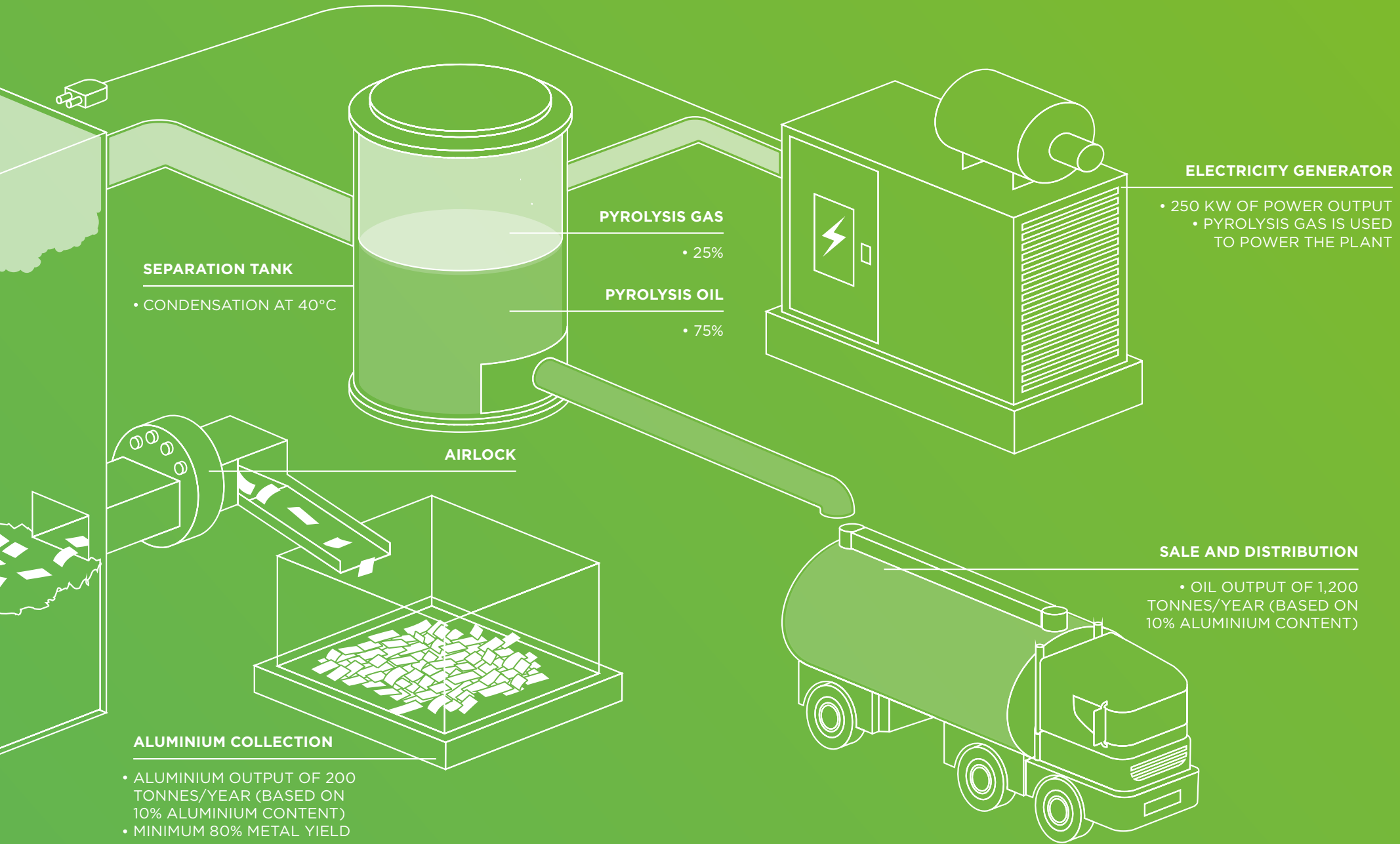
NO RECOVERY OF CHEMICALS FROM PLASTIC

NO RECOVERY OF ALUMINIUM



THE ENVAL PLANT







# THE ENVAL PROCESS: IN ACTION

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The Enval process provides a highly economical, efficient and environmentally-friendly solution for dealing with plastic aluminium laminate waste. The recovered aluminium has a carbon footprint up to 75% lower than that of primary material, while the pyrolytic oils can be sold for energy generation or chemical feedstock.





## Working with you

Working with waste handlers and large-scale laminate waste producers, Enval can design and manufacture plants according to our clients' individual requirements. As a modular process, the plant can be economically operated at a variety of scales, which allows for local treatment. A typical Enval plant operates at a feed rate of up to 350 kg per hour, which equates to a nominal capacity of 2,000 tonnes per year.

The Enval process is efficient, low-cost and requires modest levels of capital expenditure. A typical plant will pay for itself within three to four years at nominal levels of utilisation. The high efficiency and minimal emissions associated with the process mean that the plant requires minimum planning and environmental permitting.

Enval can handle assembly, installation and commissioning. Our turnkey solution includes full training to operate and maintain the equipment. Maintenance and engineering support is provided throughout the lifetime of the plant. Where required, we can also assist in identifying long-term outlets for the aluminium and hydrocarbons generated by the process.

## Valuable outputs

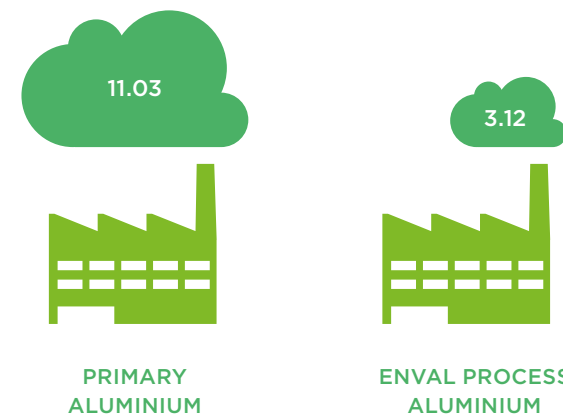
**ALUMINIUM:** The extraction of primary aluminium from bauxite is one of the most energy intensive industrial processes. Producing secondary aluminium from recycled metal significantly reduces the energy requirement. This has driven a dramatic increase in the recycling of aluminium over the last twenty years. Recycling aluminium through the Enval process leads to energy savings of up to 75%.

Aluminium extracted from the Enval process has a purity exceeding 98% and a minimum metal yield of 80%. It can be directly reintroduced to the remelting process with primary or secondary aluminium. A typical plant produces 200–400 tonnes a year at nominal operating rates.

**PYROLYSIS OILS:** The pyrolytic oils generated by the process are suitable for use as chemical feedstock or for energy generation. At sufficient scale, they could equally be used as feedstock to produce new polymers, thereby fully closing the recycling loop.

A feature of the Enval process is that it can easily be configured to adjust the balance between the gases and oils that are produced. This means that the operator can select the product mix in response to local requirements and the energy demand of their own unit.

1 KG OF ALUMINIUM PRODUCED BY THE ENVAL PROCESS HAS A CARBON FOOTPRINT OF 3.12 KG CO<sub>2</sub>e COMPARED TO 11.03 KG CO<sub>2</sub>e FOR 1 KG OF PRIMARY ALUMINIUM PRODUCED FROM BAUXITE





# THE SUPPLY CHAIN: WHO BENEFITS?

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The Enval process enables brands to unlock the benefits of plastic aluminium laminates, allowing more and more packaging to be converted to this format. It closes the loop in the life cycle of this material by ensuring an environmentally and economically sustainable recycling solution.



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## Working with waste handlers

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OPPORTUNITY TO BE AN EARLY ADOPTER OF A DISRUPTIVE TECHNOLOGY

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POTENTIAL TO CONSIDERABLY ENHANCE PROFITABILITY

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GROWTH OF MARKET SHARE AGAINST COMPETITORS

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ALTERNATIVE REVENUE OPTIONS THROUGH THE SALE OF PYROLYTIC OILS AND RECOVERED ALUMINIUM

A study by the Waste and Resources Action Program (WRAP) has demonstrated that appropriate automatic sorting equipment is readily available and often already deployed within a typical material recovery facility (MRF).



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## Working with local authorities

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ABILITY TO RESPOND TO PUBLIC PRESSURE TO FIND SOLUTIONS FOR NON-RECYCLABLE WASTE

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CONTRIBUTES TO ACHIEVING RECYCLING TARGETS

Enval is proactive in exploring the issues associated with collecting and sorting post-consumer laminate waste. Enval is conducting DEFRA-backed research in conjunction with SITA UK, Nestlé, Coca-Cola Enterprises, Tesco and LRS Consulting into the best methods of collecting plastic aluminium laminate packaging.





### Working with FMCG brands

COMPETITIVE DIFFERENTIATION THROUGH OFFERING FULLY RECYCLABLE PACKAGING

ENHANCEMENT OF GREEN CREDENTIALS IN THE EYES OF CONSUMERS

BUSINESS AS USUAL: NO NEED TO CHANGE TO DIFFERENT PACKAGING SYSTEMS

OPERATIONAL COST REDUCTION COMPARED TO LANDFILL DISPOSAL

ABILITY FOR MORE AND MORE PRODUCTS TO OFFER THE BENEFITS ASSOCIATED WITH PLASTIC ALUMINIUM LAMINATES



### Working with consumers

Consumers are now coming into daily contact with plastic aluminium laminates and are increasingly confused and concerned about what they can do with them. The vast majority of consumers consider packaging to be a major environmental problem. Negative associations with the impact of packaging still outweigh awareness of the environmental benefits it can offer.

Enval is committed to helping consumers voice their concerns about packaging that is not currently recyclable. We are also developing options to allow brands to clearly communicate that, with the Enval process in place, these materials can have a sustainable end-of-life solution.

### THE ENVAL CONSORTIUM

Enval is engaging directly with forward-thinking brands that will benefit from ensuring that the process is widely used in the waste handling industry.

The Enval Consortium is a non-competitive venture comprising leading companies from the flexible packaging supply chain.

The Consortium includes three large multinationals, Kraft Foods, Nestlé and Mondelēz International, who have supported the development of the commercial demonstration plant and are raising public and industry awareness of the Enval process.



# ABOUT US



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Enval unlocks the potential of high performance materials using a novel recycling process based on microwave induced pyrolysis. Our long-term objective is to deal with waste legacy, address the challenges presented by today's new materials, and co-create the materials of the future to ensure that recyclability is built-in.

The Enval story began when Professor Howard Chase of the Department of Chemical Engineering at the University of Cambridge started investigating potential environmental applications for the microwave heating of carbon. Joining Professor Chase for his PhD, our MD Carlos Ludlow-Palafox conducted substantial research into microwave induced pyrolysis for plastics. The next few years saw a successful worldwide patent application.

In 2005, Howard and Carlos won the Cambridge University Entrepreneurs' Business Creation Competition and founded Enval Ltd. By 2010 we had constructed a pilot plant and secured significant investment from a syndicate of investors. Following the creation of the Enval Consortium and investment from major multinational brands, we were able to begin work on the first commercial demonstration plant for the Enval process.

**If you are producing, using or trying to dispose of plastic aluminium laminate packaging and would like to see what the Enval process could do for your business, please do not hesitate to contact us.**

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## ENVAL CONSULTING

As a result of building strong in-house expertise, we are able to provide scientifically rigorous environmental consultancy services to businesses that require a clear understanding of the impact of their products, packaging and processes in order to inform their sustainability strategy.

Enval Consulting specialises in life cycle assessment and offers value and insight to our clients that go well beyond compliance. Our work has ranged from detailed comparisons of various waste handling processes to analyses of global supply chain emissions, and has included projects for several multinational brands.

[www.envalconsulting.com](http://www.envalconsulting.com)







