The Next Generation of Advanced Plastic Recycling

Mura Technology aims to be the global market-leading provider of technology to create premium, circular hydrocarbons from waste plastic.





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Our Vision

To create a net zero circular economy for plastic, where plastic pollution is eliminated and where no plastic is burned or buried.

Our Mission

To become the world's leading producer of feedstocks made from waste plastic using our breakthrough technology. Our ambition is to have 1,500,000 tonnes of annual, global advanced recycling capacity in operation or development by 2032.

Our Action

Mura Technology is:



Producing **feedstocks made from waste plastic** for the manufacture of new plastics and other materials.



Creating a truly circular economy – with no limit to the number of times plastics can be recycled using the Hydro-PRT process.



Offering an **alternative to incineration**, reducing CO₂ emissions and diverting plastic away from landfill.



Providing a **scalable solution** to eliminate plastic waste.



Decoupling the manufacture of plastic from fossil resource and providing **a sustainable alternative.**



Offering this commercially viable process to a worldwide market via our **exclusive licensing agreement with KBR.**



Pioneering research into CO₂ reduction efforts through **academic partnerships**.



Creating a global network across the **entire plastics recycling value chain** to further scale the **Hydro-PRT** technology.



Scan to watch a short overview of Mura Technology.

Challenges Posed by Plastic Waste



Over 350 million tonnes of plastic are produced globally every year¹, with half becoming waste in less than a year².



Globally, only 9% of all plastic produced has ever been recycled. The rest has been sent to incineration or landfill³.



Annual worldwide plastic production creates an estimated 390m tonnes of CO₂ every year⁴ equivalent to over 172million UK cars⁵.



The planet is on course to see 12 billion tonnes of plastic in landfills and the environment by 2050⁶.



Approximately 8 million tonnes of waste plastic enters the oceans each year⁷.

Plastic has not been recognised as a valuable, reusable material, which has led to environmental pollution. Today, most of the plastic produced worldwide is either sent to incineration or landfill, or leaks into the environment after a short, single use.

Traditional mechanical recycling methods cannot process all types of plastic, meaning many types of plastic, such as post-use, multi-layered flexible and rigid packaging, are sent to incineration, landfill or exported overseas.

A new solution is urgently needed to recycle a broader scope of plastic waste.

- Plastics: The Facts Plastics Europe (2018)
- Key Facts on Plastic Pollution Plastic Oceans UK (20
- Production, Use and Fate of All Plastics Ever Made. Science Advances Research Article. Asci.
 Adv. 2017 D. Causa J. D. Jambarda V. L. Luce
 - The New Plastics Economy: Catalysing Action - The Ellen McArthur Foundation (2017)
- Average CO2 Emissions of Newly Registered
- Cars, Great Britain OK Government (2015)
- The Ellen McArthur Foundation (2017)
- The New Plastics Economy: Catalysing Action - The Ellen McArthur Foundation (2017)

The Economic Opportunity

The **market value of global plastics** is estimated to reach



Oil demand for plastic production is

3.3 billion

barrels per year, rising to **8.4 billion by 2060**¹⁰

The value of feedstock supplied for the **manufacture of new plastic** is approximately

\$180 billion per year 5%

of material value from **plastic packaging collected globally** for recycling is retained in subsequent use¹²

\$120billion (USD)

is lost through plastic waste annually¹³

Rather than continuing to extract fossil resource to fulfil demand for new plastics, Mura's focus is on recycling a broader scope of waste plastics, converting them back into feedstocks for the manufacture of new plastics, helping to create a circular economy.

8. World Economic Forum (2018)

- 9. Statista (2019)
- 10. Statista (2019)

11. Mura Technology (2021), based on Oil Demand for Plastics Production Worldwide - Statista (2019) 12. The New Plastics Economy: Catalysing Action - The Ellen McArthur Foundation (2017)

13. World Economic Forum (2018)

Mura's Solution

Mura's proprietary process, **Hydro-PRT** (Hydrothermal Plastic Recycling Technology) is an end-to-end advanced recycling process that uses supercritical water to convert post-use, multi-layered waste plastics into industry-ready hydrocarbon products.

These products can be used as fossil-replacement feedstocks in the manufacture of new, virgin-grade plastics and other materials.

3 Key Hydro-PRT Process Advantages



Scalability

Hydro-PRT is inherently scalable - the use of supercritical water offers highly efficient, homogenous heat transfer – during the process, the supercritical water surrounds the plastic rather than heating from an external source, making scale-up a simple process. The use of supercritical water offers a source of hydrogen to saturate the broken chemical chains, with hydrogen transferring into the end products.



Plastic Scope

Hydro-PRT offers a much broader scope for recycling all types of plastic, including flexible and rigid multi-layered materials, currently considered 'unrecyclable' via traditional mechanical methods. It can process mixed, post-consumer plastics as the process is Insensitive to organic contaminants such as paper, cardboard and organic matter (e.g. food residue), meaning a wider range of recyclable waste plastics.



High Product Yields

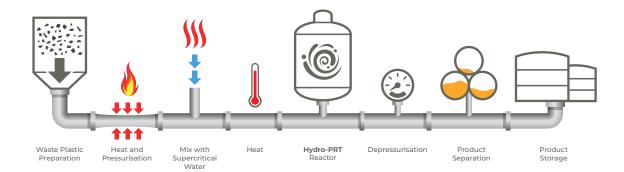
Homogeneous reaction conditions allow the cracking rate to be controlled during operation, acting as a suppressant to unwanted free radical reactions - this contributes to high yields of hydrocarbon products. Supercritical water allows for efficient heat transfer and prevents char formation.

The Hydro-PRT Process

To begin the process, mixed waste plastics are shredded and unwanted contaminants such as glass, grit, metal and stones are removed.

The mix is then heated and pressurised, mixed with supercritical water and fed into the reactor, where the supercritical water acts as 'molecular scissors' to break down the carbon bonds in the plastic, donating hydrogen to create shorter-chain hydrocarbons. The use of hydrogen in the process gives the end products increased stability.

Following conversion, the mix is depressurised and separated into liquid hydrocarbon products. These products are then stored for transport to our customers.





Target Feedstocks

Target feedstocks for **Hydro-PRT** are primarily post-use, multi-layered plastics, such as flexible films and rigid trays.

Target Feedstocks:

- Hydro-PRT can process mixed plastic waste streams
- This includes contaminated, post-consumer flexible and rigid packaging
- Laminated and metalised films

Sourced from:

- End of life, post-consumer plastics destined for incineration or landfill
- Reject materials from mechanical recycling
- Residues from the mechanical sorting of household recyclables
- Films, nets and ropes from agricultural, aquaculture and fishing industries

Mura's Hydro-PRT process will:

- Complement existing mechanical processes and infrastructure
 not compete with them
- Recycle flexible, multi-layered materials that cannot be processed via traditional, mechanical means
- Divert waste plastics that would otherwise go to landfill, incineration or leak into the environment
- Reduce the need to export plastic waste
 - Process mixed plastic waste streams (films and rigids processed together)
- Accept post-consumer plastic contaminated with organic residues and paper

Output Hydrocarbon Products

Hydro-PRT creates a range of valuable hydrocarbon products – each can be tailored to meet market requirements and conditions. These products are expected to be sold on long-term contracts.





Due to a flexible plant design, end products can be tailored to meet customer demand. The initial **Hydro-PRT** plant in Wilton, Teesside, Northeast England is producing:



Naphtha

Naphtha from Mura's **Hydro-PRT** process can be used to replace fossil naphtha as a feedstock to make new plastics.



Distillate Gas Oil

Distillate gas oil can be used to replace fossil naphtha as a feedstock to make new plastics.



Heavy Gas Oil

This product can be used as a feedstock for a range of petrochemical processes, including the production of plastics, chemicals, waxes and oils.



Heavy Wax Residue

This high-boiling hydrocarbon product can be used as an additive in the production of bitumen or asphalt, for the construction of roads.

All products are REACH¹⁴ registered.

Mura in the Plastics Recycling Value Chain

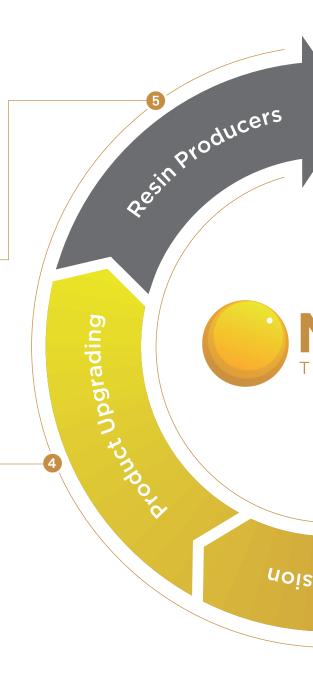
The plastics recycling value chain consists of parties who have so far mainly worked in isolation when it comes to creating advanced plastic recycling solutions. Mura intends to work closely with parties along the entire plastics recycling value chain to leverage their respective strengths and work together to accelerate the roll out of **Hydro-PRT** capacity.

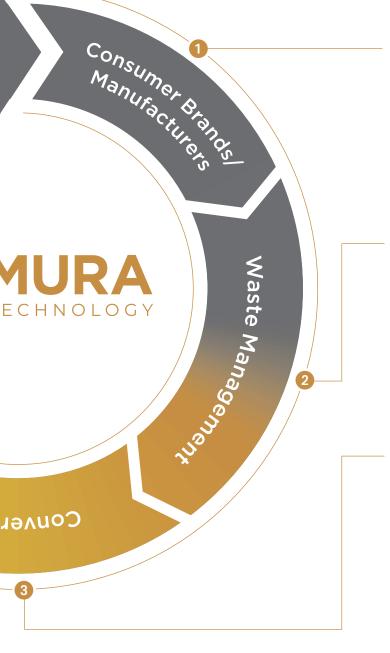
5. Resin Producers

Mura can provide sustainable feedstocks from **Hydro-PRT** as a replacement for fossil resources, for use in the manufacture of new plastics and other materials. This circular feedstock removes the reliance on fossil resources, to transition into a truly circular economy.

4. Product Upgrading

In January 2021, Mura formed an exclusive Global Licensing and Engineering Agreement with KBR, a leading international provider of science, technology and engineering solutions, to support the global roll-out of **Hydro-PRT** (see page 20). Mura is working with KBR to provide optimised product upgrading to create maximum conversion efficiency of **Hydro-PRT** feedstock to new plastics. Upgrading will be offered as an add-on option to the core process to facilitate integration into existing refineries.





1. Consumer Brands / Manufacturers

Mura's **Hydro-PRT** process enables access to recycled content for plastic packaging, alongside a recycling route for difficultto-recycle plastics, without the need for costly redesign of packaging, which may reduce performance efficiency. **Hydro-PRT** provides a pathway to net zero.

2. Waste Management

End-of-life plastics not considered recyclable via traditional mechanical means are currently sent to incineration, landfill or export. **Hydro-PRT** is a cost-competitive alternative. Global recycling partners will supply Mura with waste plastic that cannot be mechanically recycled.

3. Converters / Recyclers – Mura Technology

Mura's **Hydro-PRT** process is a complementary solution to sit alongside traditional mechanical recycling, processing waste plastics that cannot currently be recycled. A commercially viable alternative to incineration and landfill for end-of-life plastics.

Global Development

Our global technology roll-out plan is underway, with the first commercialscale recycling site set to open mid-2024.

ReNew ELP, United Kingdom

The first site to utilise **Hydro-PRT** is ReNew ELP in in Wilton, Teesside, Northeast England. This first facility will produce 20,000 tonnes of recycled, liquid hydrocarbons annually and is expected to be operational by mid-2024. The site has capacity to expand to over three times this initial size. ReNew ELP is a wholly owned subsidiary of Mura Technology. See page 18 for further details.

Europe

In September 2022, Mura Technology and Dow announced plans to construct a new facility at Dow's Böhlen site in Germany – helping to rapidly scale the advanced recycling of plastics. This is the first advanced recycling site to be based at a Dow site and has a projected production capacity of 100,000 tonnes of recycled hydrocarbons annually. The German chemical industry benefits from good infrastructure through integrated industrial sites, called chemparks, which house a high concentration of chemical industries and feedstock sorting facilities. Mura is developing feedstock supply, including discussions with incinerators to divert residual waste plastics into recycling.

USA

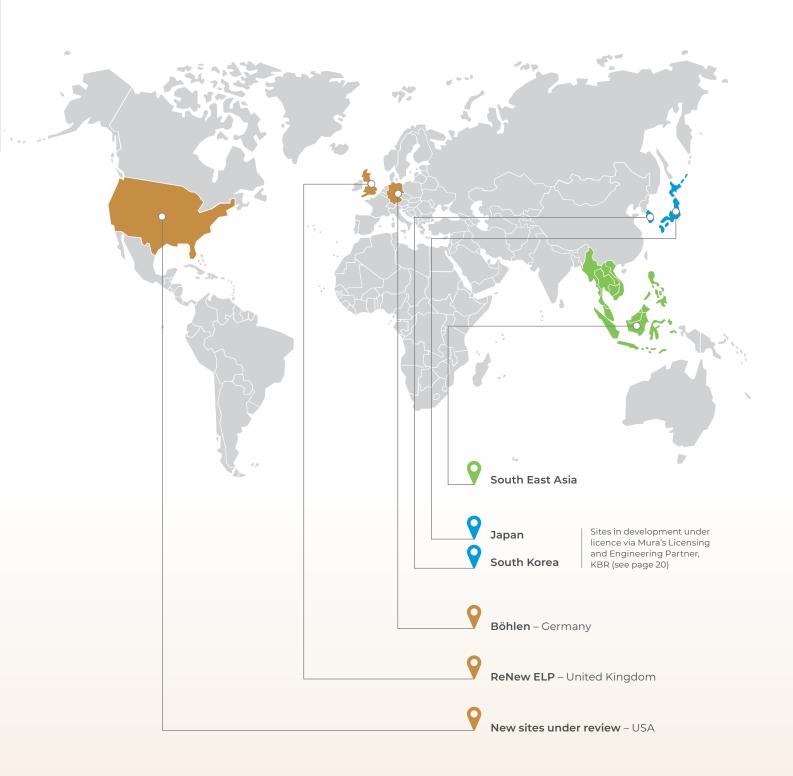
Mura is reviewing a number of new locations for construction of its first US site.

The USA generates 42 million tonnes of plastic waste annually¹⁵, with the highest per capita generation of plastic waste – over 100kg per person¹⁶. Mura is focusing on sourcing and delivering feedstock to these pre-identified sites.

Southeast Asia

Mura has identified sites in Southeast Asia with a view to developing and operating multiple **Hydro-PRT** facilities.

Southeast Asia generates 31 million tonnes of plastic waste each year¹⁷ and is home to some of the highest per capita plastic waste generating countries worldwide. Developing waste management infrastructure makes Southeast Asia a rapidly growing market for Mura.



ReNew ELP

The first site to use the **Hydro-PRT** process is under construction by ReNew ELP, a subsidiary of Mura Technology, in Teesside, North East England. This 20,000 tonne per annum capacity recycling site is located at Wilton International, an established industrial site.

The site will produce 20,000 tonnes of recycled, liquid hydrocarbons annually and is expected to be operational in mid-2024. The site has capacity to expand to over three times this initial size.

ReNew ELP has appointed Wood PLC, the global consulting and engineering company, as its Engineering, Procurement and Construction contractor (EPC) on the project and have awarded a 10 year operations and maintenance contract to px Group.

Location Benefits

- Key companies in the petrochemical industry based at Wilton
- Access to transportation infrastructure
- Skilled local workforce due to area's industrial heritage

Local Economic Benefits

- The first site will bring up to 150 jobs during construction and 50-60 direct employment jobs related to commercial operation
- High-value employment
- Local partners and resource to help with construction and operations

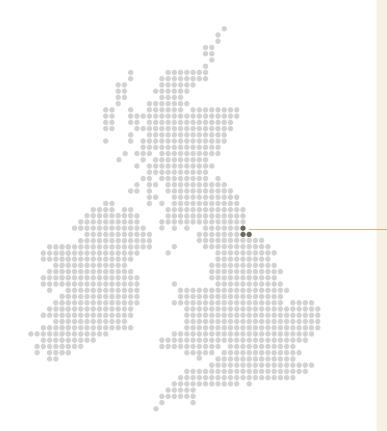
- Positive national media coverage for the North East and backing from local politicians
- Increased export trade
- Huge potential for site rejuvenation, creating a hub of new industry through innovative processes and technology

Funding

In October 2020, ReNew ELP was awarded a £4.42 million grant from Innovate UK, the UK's innovation agency, to build this world's first commercial-scale **Hydro-PRT** advanced plastic recycling plant. Focussing on the UK Government's priority to drive economic growth through new technology, the award came via the Industrial Strategy Challenge Fund's Smart Sustainable Plastic Packaging programme, recognising the commercial-scale feasibility of the technology and potential of the advanced recycling sector to help meet ambitious plastic recycling targets.

The award of the Innovate UK funding demonstrates support for the industry and confirms alignment with UK Government targets on increasing recycling capacity.





- **1** Plastic Storage
- 2 Material Preparation Plant
- 3 Clean Plastic Feed System
- **4** Hydro-PRT Core Technology
- **5** End Product Storage

ReNew ELP

Wilton Centre Redcar United Kingdom TS10 4RF

Email: info@renewelp.co.uk Phone: 01642 438 280

Exclusive Licensing and Engineering Agreement with KBR

At the start of 2021, Mura aligned with KBR, a leading international provider of science, technology and engineering solutions, to support the global roll-out of **Hydro-PRT** and the identification of new markets for the technology. KBR will provide engineering and technical services as well as equipment to develop sites for global clients.

KBR's position at the forefront in the provision of innovative, game-changing technologies offers Mura Technology world-class development opportunities and validates the technical capabilities of the **Hydro-PRT** process.

"We are extremely excited to announce that KBR will offer this innovative plastic recycling process for licence to clients so they can efficiently recycle end-of-life waste plastic and convert it into a reusable feedstock for plastics or other valuable chemicals production. This technology aligns with KBR's commitment to sustainability by reducing lifecycle greenhouse gas emissions and the volume of waste that enters landfills and the environment, whilst contributing to the growth of the plastic circular economy."

Doug Kelly, KBR President, Technology "We want to change the way the world thinks about plastics - not as a waste product, but as a valuable resource - using our technology to forge a sustainable future. KBR is the natural choice for us to achieve this vision - a global leader with the capabilities to support the licensing of our technology around the world."

Dr Steve Mahon, CEO, Mura Technology

For Licensing and Engineering, please contact:

Francis Tsang Senior Director - Plastics Recycling Technology, KBR Inc. francis.tsang@kbr.com www.kbr.com





A new partnership and license sale between Mura, KBR and leading global chemical producer LG Chem was announced in January 2022. This partnership will support the continued international roll-out of **Hydro-PRT**, with the first project in South Korea to initially recycle up to 25,000 tonnes of plastic waste annually.

South Korea is a crucial market for deploying **Hydro-PRT**, being one of the world's leaders in plastic consumption per capita. The country aims to reduce its plastic waste by 20 percent by 2025.



First Licence Agreement

In June 2021, Mura and KBR were delighted to announce the first Licensing and Engineering Agreement with Mitsubishi Chemical Corporation (MCC), which plans to deploy the **Hydro-PRT** plastic recycling system in Japan to reduce plastic waste and create a circular plastics economy.

This first project will be based at MCC's Ibaraki plant and is expected to complete construction in 2024. It will have the capacity to process 25,000 tonnes of plastic waste per year - with MCC studying the possibility of increasing capacity in the future. Initially, the project will aim to use post-industrial plastics. With 9 million tonnes of plastic waste arising annually in Japan, MCC will seek to extend the scope of the project and target these plastics as raw materials.



GS Caltex

In October 2021, Mura Technology and KBR announced a new licensing agreement with GS Caltex for their planned plastics circularity project in South Korea. The 50,000 unit will convert waste plastics into raw materials for conversion into new plastics.

"Deploying Mura's plastics recycling technology, offered in alliance with KBR, marks one of the key factors for us at GS Caltex towards meeting our circularity targets. With this contract we move a step ahead in the sustainable and green technology sector by establishing a greener facility,"

Woo Jin Choi, Vice President of GS Caltex

Partnerships

Dow

In April 2021, Mura Technology announced its partnership with Dow. The collaboration supports the rapid scaling of Mura's **Hydro-PRT** process, whilst the deal marks an important step in Dow's commitment to advance a circular economy for plastics and keep plastic waste from entering the environment.

The partnership combines Dow's materials science capabilities, global scale and financial resources with Mura's leading technology, to produce circular feedstocks, for conversion into the recycled plastics that consumers and global brands are increasingly seeking. Dow will play an important role as a global manufacturer of plastic, proving that Mura's solution can meet both the sustainability and performance needs of the industry and that the products made via **Hydro-PRT** can be employed at scale.

In addition to investing in Mura, Dow will act as offtaker for some of the recycled hydrocarbon products produced at ReNew ELP, Mura's first **Hydro-PRT** site, currently under construction in the UK (see page 18). Dow will use these materials to develop new, virgin-grade plastic for applications such as food packaging and other packaging products to be re-circulated into global supply chains, creating a true circular plastics economy. In September 2022, Mura Technology and Dow announced plans to construct a new facility at Dow's Böhlen site in Germany – helping to rapidly scale the advanced recycling of plastics. This is the first advanced recycling site to be based at a Dow site and has a projected production capacity of 100,000 tonnes of hydrocarbons annually.

"We are delighted to offer our investment and expertise to support the development of this truly game-changing recycling process. We are committed to enacting real change to stop plastic going to waste and accelerate moves towards a more circular economy. We know achieving this goal will take major innovation and investment and we can't do it alone. That's why our partnership with Mura is so exciting and why we believe it will form a key pillar of our recycling strategy going forward."

Marco ten Bruggencate, EMEA Commercial Vice President, Packaging and Specialty Plastics, Dow

www.dow.com





igus GmbH

Mura partnered with igus GmbH. in 2020 via a strategic investment to support roll-out of Mura's **Hydro-PRT** process. The family-run company based in Cologne, Germany, are global leaders in developing and producing motion plastics and have sustainability at the core.

"This could be the solution the plastics industry has been crying out for. Plastic, as a material, has many great properties and applications which make modern life possible – but it must be sustainable. We're proud to be partnering with Mura to pioneer truly recycled plastic that doesn't compromise on quality, ultimately resulting in a cleaner, greener and thriving natural environment."

Frank Blase, CEO, Igus

"We are delighted to partner with igus. Their global network and investment will accelerate our ability to deploy Mura's recycling capacity. Igus are our first strategic investor and we applaud the leadership they have shown to support Mura and in their own recycling initiatives."

Dr Steve Mahon, CEO, Mura Technology

www.igus.eu

igus

CPChem

In December 2021, Mura partnered with CPChem, following an equity investment from their subsidiary, Six Pines Investments LLC. This new agreement constitutes major development in the advanced recycling market as Mura aims to be the world's largest producer of recycled hydrocarbons, whilst CPChem has the goal of manufacturing at least 500,000 tons per year of circular polyethylene by 2030.

"CPChem and Mura believe waste plastics should not end up in landfills, as they can be circularly recycled into new plastics for use across a wide array of applications. CPChem believes that solving the global problem of plastic waste will require innovation, investment, and cooperation throughout the entire plastics value chain. Six Pines' investment advances CPChem's ambition to reduce waste and reuse as a valuable resource, accelerating change for a sustainable future."

Benny Merman, Vice President of Sustainability at CP Chem

www.cpchem.com



Partner with Mura

To support the development and global roll-out of this innovative process, we are establishing a collaborative group of international partners from the full plastic recycling value chain, including petrochemical companies, waste management firms and international consumer brands.

By becoming a Mura Partner, your company will:

Resin Producers / Petrochemical Industry

- Have access to recycled hydrocarbon feedstock
- Decouple manufacture from fossil-derived feedstocks

Consumer Brands / Manufacturers

- Be on a pathway to net zero, exhibiting significant CO₂ savings
- Have a strong message of action to communicate to consumers

Waste Management

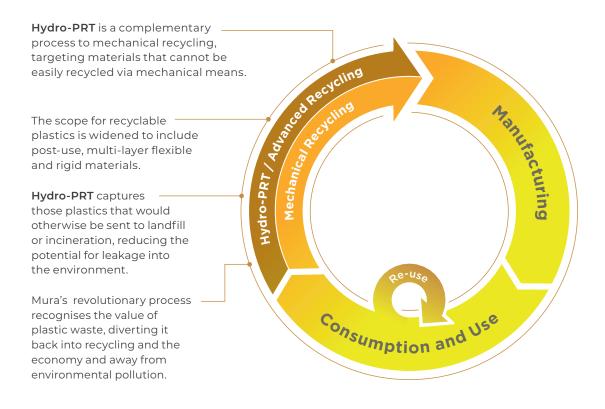
- Have a cost-competitive alternative to incinerating waste plastic
- See a reduction in requirement to export plastic waste

For partnership enquiries, please contact enquiries@muratechnology.com

Creating a Circular Economy

It is Mura's ambition to contribute towards a circular economy for plastics and a meaningful reduction in carbon emissions for the plastics industry.

Hydro-PRT – Closing the Circular Economy



Environmental Impacts

Plastic pollution and global warming are urgent environmental challenges. Mura strives to address both with **Hydro-PRT**, creating a circular economy for plastic, whilst helping to decarbonise the plastics industry and eliminate global plastic pollution.



Life Cycle Assessments

A **carbon footprint** is the total amount of greenhouse gases that are generated by our actions – from the manufacture and disposal of materials to everyday life.

A greenhouse gas is a gas in the Earth's atmosphere that traps heat.

Carbon dioxide, or CO₂, is the primary greenhouse gas emitted by human activity.

A Life Cycle Assessment (LCA) is a useful tool to understand the environmental impacts of a process or product. Independent LCAs of Mura's advanced recycling process, **Hydro-PRT**, have been performed to help better evaluate the impacts, including the carbon footprint of the process, in support of Mura's sustainability pathway to net zero.

The LCAs also support optimisation of all operations, including potential improvements to energy and resource management to further reduce environmental impacts.

Life Cycle Assessments

WMG at the University Of Warwick

The first independent LCA of **Hydro-PRT** by WMG, funded through Innovate UK's Smart Sustainable Plastic Packaging challenge (SSPP) focused on Mura's first commercial-scale site in Wilton, Teesside, showing:

- A significant c80% reduction in Clobal Warming Potential (GWP) when compared to Energy from Waste (incineration), a saving of over
 1.8 t CO₂ eq GWP per tonne of plastic processed.
- Further updates to this first report show that **Hydro-PRT** produces circular naphtha products at **lower GWP than virgin fossil equivalents** (UK and EU grid comparison) and reduces EU naphtha production GWP by 55%. This could be further improved by using renewable energy to supply the first plant in Wilton, reducing GWP by c60%.
- A new WMG study evaluated the carbon impacts of a combination of waste management approaches and found that combining advanced recycling with mechanical recycling resulted in a 42% carbon emissions saving when compared to the existing model of incineration and mechanical recycling, making incineration of plastic waste no longer the preferred option.



Read the first report



European Commission's Joint Research Centre

Conducted by the European Commission's Joint Research Centre (JRC) and Spanish consultancy AIMPLAS, this study compared data from Mura's hydrothermal process and several unnamed pyrolysis companies, showing that **Hydro-PRT**:

- Has a **50% lower Global Warming Potential than the pyrolysis processes**, making it the leading technology in the field for carbon emissions reductions.
- Has a >60% lower carbon GWP when compared to Energy from Waste (incineration), consistent with the WMG paper released in March 2023.
- Is the best performing across mechanical, advanced and energy recovery for resource use, an indication of circularity.



JOINT RESEARCH CENTRE



Read the full report

80% Carbon Emissions

saving when compared to incinerating plastic.

Leading Technology

in sector with a 50% lower GWP than pyrolysis data reviewed.

A Cleaner Equivalent

to fossil naptha. **Hydro-PRT** naphtha has a lower GWP when compared with fossil naphtha.

Impactful Partner to Mechanical Recycling

with advanced and mechanical combined saving 42% carbon emissions when compared to incineration and mechanical recycling.

Best Performing

for resource use, across mechanical recycling, advanced recyclng and energy recovery – an indication of circularity.







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