

Global Directory of Molecular Recycling Technologies

SUPPLEMENTAL RESOURCE FROM TRANSITIONING TO A CIRCULAR SYSTEM FOR PLASTICS: ASSESSING MOLECULAR RECYCLING TECHNOLOGIES IN THE UNITED STATES AND CANADA











Glossary

Companies Featured in Closed Loop Partner's Report

Molecular Recycling Innovators

These nine companies participated in the deep-dive technology due diligence and lifecycle and human health analysis, as a part of Closed Loop Partners' report on molecular recycling technologies.

Modular Technology Companies

These companies were identified by Closed Loop Partners to better understand the role that modular, small-scale molecular recycling technologies could play in a circular plastics future. The financial performance of these modular companies was evaluated compared to larger-scale facilities.

Note: The full glossary of terms is available in the report here.

Purification

These technologies distinguish themselves from other molecular recycling categories by not breaking the bonds of the plastic polymer; purification is a physical process. Purification technologies can take single-polymer feedstock or mixed plastics, and through the use of solvents, extract color and additives to produce like-virgin polymers. These processes guarantee a plastic-to-plastic, circular outcome.

Depolymerization

These technologies take single-resin feedstock and break down the polymer chains to produce a specific set of products: monomers or oligomers. Monomers are precursors to polymers and can be synthesized (i.e. "repolymerized") to produce a plastic resin (e.g. the monomers TPA and MEG can be repolymerized to make PET polymer to make PET bottles or polyester fabric). Oligomers are longer chained monomers and include products like polypropylene wax.

Conversion ⁸1

These technologies break the polymer chains to produce diverse hydrocarbon products with a relatively large range of molecular weights like naphtha, paraffin waxes, other petrochemical products, and fuels. A subset of conversion technologies completely break down the polymer to form syngas or elemental carbon products like methanol and hydrogen. This subset of technologies distinguish themselves by being able to process mixed waste with plastics commingled in it.

COMPANIES FEATURED IN CLOSED LOOP PARTNERS RESEARCH

Molecular Recycling Innovators

APK AG Brightmark Carbios Enerkem gr3n GreenMantra JEPLAN Plastic Energy PureCycle Technologie

Modular Technology Companies

Recycling Technologies Renew One Synova

GLOBAL LANDSCAPE OF MOLECULAR RECYCLING COMPANIES

This represents a snapshot in time; the molecular recycling landscape is constantly evolving.

Purification

Cadel Deinking CreaCycle Ecopek Evrnu Next Generation Group Polystyvert UMass Lowell

Depolymerization

Agilyx Aquafil Axens & The Rewind™ PET Circ Eastman Galactic Garbo Ioniqa Loop Industries NatureWorks Novoloop perPETual Poseidon Plastic Premirr Plastics
Pyrowave
Recyc'ELIT
Technisoil Industrial
Trash-2-Cash
The University of Ports
& National Renewable
Laboratory

Conversion

Agilyx Alterra Energy' Anhui Oursun Resour Technology Co., Ltd APChemi Blest Braven Environmenta Clariter CTC Foundation Eastman Eco Fuel Technology, I Encina Enval Equipolymers Fulcrum BioEnergy

	Illinois Sustainable Technology Center
	InEnTec
	Itero Technologies
	Khepra
smouth	Klean Industries
e Energy	LanzaTech
	LyondellBasell
	Nasus Labs
	New Hope Energy
	Nexus
	Pennsylvania State University
ce	The Plastics & Environment Research Lab – UMass Lowell
	Plastic2Oil
	PolyCycl
	Reclaimed EcoEnergy
	ReNew ELP
	Resynergi
	SABIC
nc	Scindo
	Sierra Energy
	Sweet Gazoil
	Valoren

Introduction

This directory is part of our 2021 report on molecular recycling, *Transitioning to a Circular System for Plastics: Assessing Molecular Recycling Technologies in the United States and Canada*, which was published under Closed Loop Partners' Advancing Circular Systems for Plastics and Packaging Initiative.

The companies featured in this directory include many of the molecular recycling solutions being explored and implemented in the market today—showcasing the range of applications that can be possible. In reading through this directory and assessing the role of different molecular recycling technologies, it is critical to note that molecular recycling is just one critical tool in the toolbox to address the plastic waste challenge. No single sector, technology or approach can solve the complex challenge. A comprehensive approach not only includes molecular recycling technologies—from purification, to depolymerization, to conversion—but also the upstream strategies that reduce the overall use of plastic through design innovation and the introduction of reuse systems at scale, as well as additional downstream strategies, including mechanical recycling, that recapture existing plastics after use. Together, these solutions can help advance a decarbonized, safe and circular future for plastics.

Thank you to all the molecular recycling technology companies around the world who have contributed to the creation of this directory.



Companies Featured in Closed Loop Partners Research Report

Molecular Recycling Innovators

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Modular Technology Companies

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Molecular Recycling Innovators in Case Study

IN THIS SECTION

APK AG

Brightmark

Carbios

Enerkem

gr3n

GreenMantra

JEPLAN

Plastic Energy

PureCycle Technologies



Overview of Company

Overview of

Technology

APK developed a proprietary, solvent-based plastics recycling technology called Newcycling® technology, pioneering a closed loop recycling system on an industrial scale. The technology has successfully processed numerous waste streams, transforming post-consumer waste, including different polymer types found in multi-layer films and mixed plastic waste fractions, into pure sorted 'virgin-like' granulates. With headquarters in Germany, APK has scaled-up their operations with feedstock supply from one of the most sophisticated waste collection and sorting markets in Europe.

The implementation of Newcycling® for post-consumer waste has substantially broadened APK's feedstock base. Multi-layer films, composite plastic waste fractions and even contaminated and odorous waste do not represent obstacles for APK's technology. From that base, APK has extended its recycling capabilities from packaging waste to other attractive waste segments, such as residues from the textile or automotive industries. APK is able to process and extract PA, PVC, LDPE, HDPE and PP-containing fractions, creating pure, sorted granules (such as PP and PE)—building the prerequisite for a fast and successful internationalization strategy. APK positions itself as a solutions provider for composite plastic closed loop recycling, combining mechanical, solvent-based and chemical processes in its integrated plants.

Since 2019, APK has operated a fully scaled-up plant with a capacity of 8,000 metric tons of post-industrial waste ('PIR') per year. This helped pave the way for testing several PCR waste streams in laboratory-, technology- and industrial-scales, since late 2019. APK was co-founded by MIG Funds and AT NewTec, both of which rank among Germany's most prominent growth investors. Hungarian chemical company, MOL Group, is the first strategic co-investment partner for APK's second full-scale plant. The strategic partnership with MOL supports APK's international roll-out strategy in Hungary, identified as a key market for feedstock supply. APK is also a member of the EU Circular Plastics Alliance, and is engaged with international projects and organizations, such as CEFLEX, the Polyolefin Circular Economy Platform ('PCEP') and the Ellen MacArthur Foundation.

Future Plans

Current

Status

The successful results of the PCR trials and the strategic partnership with MOL have contributed to APK's expansion process. A roll-out plan is underway for Q2/Q3 2021. This entails the construction of up to 10 additional plants, either fully owned or via partnerships in Europe, Asia and the Americas. The target capacity per plant will range from 20,000 to 50,000 metric tons per year.





Founded in 2016, Brightmark is a global waste solutions company that uses a proprietary pyrolysis technology to convert plastic waste into renewable fuels and wax, as well as building blocks to create new plastics. Brightmark's first commercial-scale plastics renewal facility is based in Ashley, Indiana. Once fully operational, the plant is expected to divert 100,000 tons of mixed plastic waste types 1-7 each year from landfills, waterways and incinerators, and convert it into 18 million gallons of ultra-low sulfur renewable diesel fuel, naphtha blend stocks and 6 million gallons of wax.

Overview of Technology

fuel, naphtha and wax.

Overview of

Company

Current Status Brightmark currently partners with British Petroleum (bp), with bp buying fuels produced from the plastic waste. In 2020, Brightmark launched a joint venture with Chevron USA Inc., Brightmark RNG Holdings LLC, to develop Renewable Natural Gas (RNG) projects, with initial projects in Florida, Michigan, New York and South Dakota. In early 2021, they signed a memorandum of understanding (MOU) for a partnership to construct a commercial-scale plastics renewal plant in South Korea, with Seoul-based SK Global Chemical, a subsidiary of SK Innovation.

LOCATION San Francisco, CA, USA (HQ)

TECHNOLOGY TYPE Conversion

STAGE OF MATURITY Early Commercial **SUPPLY CHAIN:** Plastics to Fuels & Petrochemicals

CAPITAL NEEDS: Data not available

LAST UPDATED: August 3, 2021 Future Plans Brightmark plans to build the world's largest molecular plastics recycling and renewal facility in Macon-Bibb County, Georgia, on a 5.3 million square-foot site. Once complete, Brightmark's second U.S. facility is expected to divert 400,000 tons of plastic waste each year from landfills and incinerators and convert it into 64 million gallons of ultra-low sulfur diesel fuel and naphtha blend stocks, and 20 million gallons of wax. By 2024, Brightmark aims to divert 8.5 million tons of plastic from landfills or the environment, and to offset 22 million tons of greenhouse gas emissions through their RNG projects. Brightmark also plans to further develop their circular plastic-to-plastic recycling processes, with goals to produce 1.7 million metric tons of feedstocks needed to remake plastics, by 2025.

Brightmark's proprietary enhanced pyrolysis technology accepts co-mingled, single-stream plastics as input, spanning plastics #1-7. Their technology first shreds waste plastic into pellets, then heats the pellets in temperatures between 400 and 650 degrees Celsius in the absence of oxygen. The polymer chains are then broken down, transforming the plastic waste into diesel





LOCATION Saint-Beauzire, France

TECHNOLOGY TYPE Depolymerization (Biological)

STAGE OF MATURITY Pilot **SUPPLY CHAIN:** Plastics to Monomers

CAPITAL NEEDS: Data not available

LAST UPDATED: March 22, 2021

Overview of Company

Established in 2011 by Truffle Capital, a French venture capital firm, Carbios is a biological depolymerization molecular recycling company. Carbios currently has 50 employees, including 25 in research & development, seven for piloting the process, and is recruiting eight additional employees to operate the demonstration plant. Carbios is headquartered in the Clermont-Ferrand region in France, and will be regrouping its teams on a single site belonging to the Michelin Group in 2022.

Overview of Technology

> Current Status

Future Plans The enzymatic recycling technology developed by Carbios deconstructs any type of PET plastic (clear, colored, opaque, complex) and textile waste into its basic components, two monomers: terephthalic acid (PTA) and ethylene glycol (EG), which can then be reused to produce new PET plastics of a quality equivalent to virgin plastic. Carbios is currently concentrating its efforts on industrial demonstration phases, to optimize the parameters of its bioprocess and ensure control of related know-how, before licensing the application bioprocess to industrial partners for the industrialization and commercialization phase. The demo plant is designed to guarantee the technology for plants up to 150 ktpa.

Carbios' enzymatic recycling technology was recognized in April 2020 by the international scientific community, with a front-page publication in the prestigious journal, Nature. The article was co-authored by Carbios' technical team and those of their academic partner, Toulouse Biotechnology Institute (TBI). Now at the pilot stage, in a 1,000-liter reactor at their headquarter in St-Beauzire, France, and preparing for industrialization, Carbios' technology has made it possible to produce the first batches of transparent PET bottles from monomers resulting from the depolymerization of PET plastic waste, but also from PET polyester textile waste. The technology has been validated by large industrial users of PET (L'Oréal, Nestlé Waters, PepsiCo and Suntory Beverage & Food Europe), each of which presented in June 2021 a packaging made with products manufactured by Carbios' technology. Currently, Carbios shares are traded on the Euronext Growth stock exchange in Paris (ticker: ALCRB), with a market capitalization of approximately €450 million.

Carbios' demonstration plant will provide technical and economic data to define all parameters for the continuous run of each step in the recycling process, and help scale-up the operation in future industrial units (estimated capacity between 50 and 100 kt per year). This will allow Carbios to establish the complete engineering documents for the process (Process Design Package), from waste to monomers, to negotiate a first industrial license by the beginning of 2023 with a partner. The company has announced that they will finance and build a first-of-a-kind unit, with a production capacity of 40 ktpa of PET, on a PET producer site, with the objective to start the plan in late 2024.

Enerkem



Overview of Company

Enerkem has developed and commercialized a disruptive technology producing advanced biofuels and renewable chemicals from non-recyclable waste. Headquartered in Montréal, Québec, Canada, Enerkem operates a full-scale commercial demonstration facility in Edmonton, Alberta, Canada as well as innovation centres in Québec and Alberta. Enerkem's technology is a prime example of how carbon in waste can be recycled into new products making everyday products greener while offering a smart, sustainable alternative to landfilling and incineration.

Overview of Technology Enerkem processes a variety of waste, including municipal solid waste-MSW and biomass into renewable chemicals and biofuels. A thermochemical process (gasification) converts the waste material to syngas, which is then cleaned and conditioned. The syngas is then converted into circular products.

Current Status Currently, Enerkem is constructing a C\$875 million biofuel plant in Varennes, Quebec, with a group of strategic partners including Shell, as lead investor, as well as Suncor and Proman, and Hydro-Québec, which will supply renewable hydrogen and oxygen, and with the support of the governments of Quebec and Canada. Varennes Carbon Recycling (VCR) will produce biofuels and renewable chemicals made from non-recyclable residual materials as well as wood waste. Commissioning is scheduled for 2023.

LOCATION

Montreal, Quebec, Canada

TECHNOLOGY TYPE Conversion (Thermal)

STAGE OF MATURITY Early Commercial **SUPPLY CHAIN:** Plastics & Biomass to Biofuels and Petrochemicals

CAPITAL NEEDS: Data not avaiable

LAST UPDATED: September 8, 2021

Future Plans

Waste-to-Jet plant in Rotterdam, Netherlands: Along with Shell and Port of Rotterdam, Enerkem's project would process up to 360,000 tonnes per annum of recycling rejects and produce up to 80,000 tonnes of renewable products, of which around 75% could be SAF and the remainder used for road fuels or to feed circular chemicals production.

Waste-to-Chemicals plant in Tarragona, Spain: Along with Agbar and Repsol, Enerkem will build the first waste to chemicals plant on the Iberian Peninsula in El Morell (Tarragona), Spain. The plant would process around 400,000 tons of non-recyclable municipal solid waste from its surrounding regions and produce 220,000 tons of methanol.

REDUCE	REUSE RECYCLE	Overview of Company	Gr3n is a Swiss high-tech company ince economically sustainable and industria and polyester plastic into its two core c assembled to obtain virgin-like plastics
<image/>		Overview of Technology	Gr3n has developed cPET, a revolutional from all types of PET products (e.g., both loop cycle, obtaining as outputs the velop roduction cycle, at a cost comparable size of a gr3n plant is around 30,000 to that is enough to process the waste PE population of 1.5 million people.
LOCATION Castagnola, Switzerland TECHNOLOGY TYPE	SUPPLY CHAIN: Plastics to Monomers CAPITAL NEEDS:	Current Status	Gr3n is now finalizing the construction
Depolymerization (Chemical) STAGE OF MATURITY Pilot	Data not available LAST UPDATED: June 1, 2021	Future Plans	Gr3n plans to have its first commercial p

incorporated in 2011 in Lugano. It has developed an strially viable process for breaking down any type of PET re components (monomers), which can then be retics, allowing endless recycling loops.

onary chemical process to recycle post-consumer waste oottles, food containers and polyester clothes) in a closedvery same pure PTA and MEG that currently feed the PET ole with that of fossil fuel-based monomers. The ideal tons per year of feedstock, to ensure a viable payback PET of a metropolitan area the size of München, with a

on of its first demonstration plant in central Italy.

al plant operational in 2023/24.





Overview of Company

GREENMANTRA Technologies is a rapidly growing company that has developed a thermocatalytic process to transform recycled plastics into specialty waxes and polymers sold under the CERANOVUS® brand name. GREENMANTRA's specialty waxes are used as processing aids to enhance industrial applications such as asphalt roofing, roads, polymer processing and plastic composites. Their styrenic polymers are used in coatings, inks and insulation.

Overview of Technology GREENMANTRA targets underutilized streams of post-consumer and post-industrial HDPE, LDPE, PP and PS. The company has partnerships with INEOS Styrolution, Crayola, Bioindustrial Innovation Canada, and Business Development Bank of Canada. In March 2021, GREENMANTRA announced a partnership with HARKE Group to distribute its products to the European market.

Current Status GREENMANTRA owns and operates its commercial manufacturing facility focused on converting PE and PP discarded plastics to specialty waxes, and a demonstration facility focused on converting discarded PS to styrenic polymers. The business has been selling commercially since 2016 and continues to expand its product portfolio and target applications. GREENMANTRA is finalizing plans to establish additional manufacturing sites in the US and EU.

TECHNOLOGY TYPE

Ontario, Canada

LOCATION

Depolymerization (Chemical)

STAGE OF MATURITY Growth **SUPPLY CHAIN:** Plastics to Polymers & Specialty Waxes

CAPITAL NEEDS: Data not available

LAST UPDATED: July 26, 2021 Future Plans In the long-term, GREENMANTRA will continue to build capacity at the Ontario facility to meet the growth in market demand. The company intends to establish additional facilities across the globe as their commercial footprint extends into new geographies.





Overview of Company

Overview of Technology

JEPLAN is pursuing multiple innovation streams in molecular recycling. A JEPLAN group company, PET Refine Technology (PRT), operates a bottle-to-bottle depolymerization process. Additionally, the Japanese molecular recycling company chemically decomposes postindustrial and post-consumer PET packaging and polyester textiles to produce PET resin and the monomer bis-2-hydroxyethyl terephthalate (BHET), for textile production at their Kitakyushu Hibikinada plant (KHP). The KHP process accepts used polyester textile feedstock collected by their own textile collection, sorting and separation program, BRING[™], which is supported by their partners. Across these two plants, the company offers expertise in PET recycling, offering not only the technology, but also operational knowhow on plants that can process bottles and textiles.

The bottle-to-bottle PRT technology utilizes a chemical depolymerization process for PET using glycolysis to produce the monomer BHET. The PRT plant accepts post-consumer PET bottles and film flakes (shredded, washed and cleaned), which may include colors, dyes and other contaminants from waste management companies and local authority recycling collections. BHET extracted in the purification process is a common substance that existing PET polymerization equipment can use as a feedstock, making it possible to introduce JEPLAN's recycling technology to conventional polymerization plants, allowing them to operate as plastic recycling plants. At their KHP plant, JEPLAN is also piloting their depolymerization process using polyester textile feedstock. The monomers are used to produce polyester textiles.

LOCATION Tokyo, Japan (HQ)	SUPPLY CHAIN: Plastics/Textiles Polymers
TECHNOLOGY TYPE Depolymerization (Chemical)	CAPITAL NEEDS: ~US\$20 million
STAGE OF MATURITY	LAST UPDATED:

Early Commercial

s to

UPDAIED: August 4, 2021

Current Status

Future Plans

JEPLAN acquired the bottle-to-bottle PET recycling plant in Kawasaki, near Tokyo, with a capacity of 22,000 tons per year, and successfully started operations this summer. The factory specializes in molecular recycling technology and polymerization equipment. JEPLAN's KHP pilot polyester textile recycling plant in Kitakyushu, Japan, has a 1,000 tpa throughput. The company also sells clothing through their collection program, BRING, where the apparel products are made of the polyester resin produced at the KHP plant. JEPLAN also sells their sustainable materials to other clothing companies.

For technology development and commercialization of depolymerization, JEPLAN announced their partnership with AXENS / IFPEN, and their plans to start their technology licence business by the end of 2022. Current partners include Muji, Starbucks and the North Face. The company seeks to expand their unique technology and business experience globally.

I PLASTIC® ENERGY



Overview of Company Plastic Energy is a privately held global recycling technology company, headquartered in the UK. Their recycling process takes contaminated post-consumer plastic waste, ranging from LDPE, HDPE, PS and PP, and produces naphtha through thermal conversion. They are currently in their growth stage, with two plants operational in Spain. In early 2021, they began building a commercial scale plant in the Netherlands.

Overview of Technology Plastic Energy uses a patented, thermal anaerobic conversion (TAC) technology to convert end-of-life mixed plastics into pyrolysis oil, branded as TACOIL™. TACOIL can be used as an alternative feedstock to virgin naphtha to create new plastics and products. Plastic Energy targets mixed and contaminated post-consumer multi-layered plastics and films, including flexible and rigid LDPE, HDPE, PP and PS, fulfilling a crucial, limited capacity gap for recycling these plastics and films mechanically, or via other purification technologies.

Current Status Plastic Energy owns and operates two commercial-scale benchmark facilities in Seville and Almeria in Spain, and sells their final TACOIL product to customers. They also have signed agreements with Viridor for feedstock supply in the UK, with global converter Sealed Air for feedstock testing and recyclability of packaging, and various brands, including Unilever and Nestlé.

Future Plans The company has also made commitments to divert plastics with organizations such as WWF Indonesia and the Ellen MacArthur Foundation. In the short term, Plastic Energy will focus on building its new plants in Europe and expanding its opportunities in the U.S., Asia and globally. Plastic Energy is currently in the process of building a new plant in the Netherlands through its joint venture with SABIC (SABIC Plastic Energy Advanced Recycling B.V.), one in France with Total, and another plant in France through a collaboration agreement with Exxon.

LOCATION London, UK

TECHNOLOGY TYPE Conversion (Thermal)

STAGE OF MATURITY Growth **SUPPLY CHAIN:** Plastics to Fuels & Petrochemicals

CAPITAL NEEDS: Data not available

LAST UPDATED: March 24, 2021


Overview of Company PureCycle Technologies (PCT) was founded in 2015 as a portfolio company of Innventure. Utilizing technology developed by the Procter & Gamble Company (P&G), the PureCycle process converts waste PP into virgin-like Ultra-Pure Recycled Polypropylene (UPRP) resin, maintaining the same physical and mechanical qualities of virgin resin.

Overview of Technology PCT utilizes a revolutionary solvent-based technology to convert PP waste streams, like cups, chip bags and carpet fibers, into UPRP resin. The process removes all contaminants, dyes and malodors, allowing for UPRP to reach its virgin-like quality. Because the process does not perform any chemical reactions to the PP, the PCT process uses dramatically less energy than virgin production.

Current Status PCT currently operates the Feedstock Evaluation Unit (FEU) in Ironton, Ohio, USA. The FEU is used to validate feedstocks and advance product development work prior to the industrial line coming online. The first industrial facility is under construction on the same Ironton, Ohio campus, and is positioned to enter operations in late 2022. PCT became a publicly traded company on the NASDAQ exchange on March 18th, 2021 (NASDAQ: PCT). The company is building their first commercial-scale plant in Ironton, Ohio, which is expected to have nameplate capacity of approximately 107 million pounds per year when fully operational.

Lawrence County, OH, USA

LOCATION

SUPPLY CHAIN: Plastics to Polymers

TECHNOLOGY TYPE Purification

STAGE OF MATURITY Early Commercial CAPITAL NEEDS:

Data not available

LAST UPDATED: March 11, 2021 Future Plans By leveraging the capital raised as part of PCT's IPO, the company is now focused on rapidly bringing additional facilities online to deliver over 1 billion pounds of UPRP to the market by 2024. Increasing access to UPRP will help PCT's strategic partners reach their sustainability goals. Modular Technology Companies in Case Study

IN THIS SECTION

Recycling Technologies

Renew One

Synova

Recycling



LOCATION Swindon, UK (HQ)

TECHNOLOGY TYPE Conversion (Thermal)

STAGE OF MATURITY Early Commercial SUPPLY CHAIN: Plastics to Chemical Feedstocks

CAPITAL NEEDS: Data not available

LAST UPDATED: April 6, 2021

Overview of Company

Overview of

Technology

Recycling Technologies Ltd is a UK-based company founded in 2011. Through a decade of research, engineering and collaboration with academia, the company has developed a proprietary, patented technology to recycle mixed plastic waste. The company is headquartered in Swindon, UK with a demonstration plant in Swindon's Recycling Centre.

The RT7000 is the proprietary pyrolysis technology that transforms plastic waste into Plaxx®, a chemical feedstock for plastic production. Plaxx is a valuable building block in the circular economy and the plastics value chain, providing post-consumer recycled content for new plastic products, in line with government targets. It is not intended for use as fuel. The company's technology uses a process called thermal-cracking, which breaks down the long chains of polymers into shorter chains through the use of heat in the absence of oxygen. The RT7000 can process most types of plastics that are not routinely recycled, such as: soft and flexible packaging (e.g., films), multi-layered and laminated plastics (e.g., crisp packets), complex or even contaminated plastic (e.g., food trays). This is a far wider variety of plastics than can be recycled through current methods. The RT7000 is modular, allowing for easy transportation and is built to integrate with existing mechanical recycling infrastructure to increase the overall recycling capacity of both methods.

In 2020, Recycling Technologies secured an important investment with two strategic industry investors, Neste and Mirova, leaders in renewable products and sustainable investments—forming valuable collaborations between the recycling industry and financial services to enable strategic and profitable circular solutions for plastic waste. Mirova's expertise as pioneers in many areas of sustainable finance supports Recycling Technologies' plans to provide a long-term solution to plastic waste. Neste's investment, technical skills and commitment to build recycling capacity provides a valuable and defined market route for Plaxx® into recycled plastic.

Recycling Technologies, INEOS Styrolution and Trinseo have plans to build commercial polystyrene (PS) recycling plants in Europe. Prior to this, a PS recycling pilot plant will be built in the UK in 2022, and the technology will be further developed jointly by the three companies involved. Recycling Technology has also partnered with Circulor and TotalEnergies to develop TRACKCYCLE, a blockchain-enabled traceability solution for hard-to-recycle plastics. Recycling Technologies also received a £3.1 million grant from UK Research and Innovation for a three-year project with Neste and Unilever, to further develop their technology to recycle plastic packaging that is currently incinerated, landfilled or exported.

Future Plans

Current Status

RENEW ONE



Overview of Company Founded at MIT, Renew One aims to be a technology leader in developing solutions for landfill-bound waste. The company operates a research & demonstration facility in Salt Lake City, Utah, which converts low-value plastics into petrochemical products, and demonstrates innovative pre-processing for mixed plastic waste.

Overview of Technology Renew One's proprietary molecular recycling process, which allows the company to reverse plastic back into its basic molecular structure, converts non-recycled plastic waste into new valuable products such as high-value petrochemical feedstocks. Their process is continuous, automated and able to accept contaminated, mixed streams of plastics.

Current Status Renew One's Salt Lake City facility was financed by public and private partners through grants, awards and debt capital. The company has been awarded grant funding from Utah Governor's Office of Economic Development, as well as low interest debt from Salt Lake City's Economic Development Loan Fund and Enhanced Capital. Renew One's founders are the recipient of awards from the leading silicon valley VC firm, Lightspeed Venture Partners and Steve Case (former CEO and founder of AOL).

Future Plans Renew One began construction of equipment for its City of Phoenix plastics renewal project in 2020, and is working closely with the City on launching the first phase of the project in 2021. The project is in support of the city's "Reimagine Phoenix" initiative to increase its landfill diversion rate to 40% in the near-term, and ultimately reach zero waste by 2050. Renew One has previously successfully tested the City of Phoenix's plastic waste at its Salt Lake City facility, and will be deploying its equipment at Reimagine Phoenix's Resource Innovation Campus (RIC).

LOCATION Salt Lake City, UT, USA

TECHNOLOGY TYPE Conversion (Thermal)

STAGE OF MATURITY Early Commercial **SUPPLY CHAIN:** Plastics to Fuels & Petrochemicals

CAPITAL NEEDS: Raising Series A

LAST UPDATED: September 1, 2021

SYNOVA Renewable technology



LOCATION Massluis, The Netherlands

TECHNOLOGY TYPE Conversion (Thermal)

STAGE OF MATURITY Early Commercial **SUPPLY CHAIN:** Plastics & Biomass to Monomers, Polymers, Aromatics

CAPITAL NEEDS: \$15 - 50 million

LAST UPDATED: September 1, 2021

Overview of Company

Synova was founded in California in 2012 and is now headquartered in the Netherlands with a U.S. subsidiary (Delaware Corp.) and a team in Bangkok to serve the Asian market. Synova's technology and team are a spin-out of Royal Dahlman, an expert in gas cleaning, and the Netherlands Organization for Applied Scientific Research (TNO), with deep expertise in waste processing that is also providing ongoing R&D and support. Caterpillar Ventures in San Francisco is an investor/partner.

Overview of Technology Synova's patented process converts dirty, mixed, multi-material plastics and biomass in a single step, into a gas rich in plastic feedstocks (monomers, aromatics). This can meaningfully reduce the production cost compared to virgin inputs, and the CO2 footprint compared to landfill or incineration. Commercial refuse-derived fuel (RDF) can be enriched with waste plastics, since the process accepts paper, textiles, food, moisture, wood, sand, rubber, cardboard, etc. This minimizes sorting and cleaning costs, complexity and losses to landfill or incineration. The modular design allows for a range of sizes, from larger scale (~150 tpd or more) to smaller prefabricated (~30 tpd) options that can be built in 12 months.

Current Status Synova's process, which converts solid waste, closely mirrors the virgin polymer production process using naphtha; multiple petrochemical companies have evaluated their process. Like the virgin system, Synova's process runs at temperatures around 750°C, with ~75% efficiency, and takes only a few seconds of residence time to produce similar molecules including: ethylene, propylene, benzene and C4 olefins. Their outputs can then leverage existing, commercially available downstream technologies. Synova has two small commercial units, with a capacity of ~25 tpd in Portugal and India, a long-running process demonstration unit (PDU)-scale facility in the Netherlands, with a capacity of ~4 tpd, and a pilot-scale facility

Future Plans Synova's recent announcement with Technip Energies, a leader in building plastic manufacturing infrastructure, enables rapid go-to-market globally, Strategic Partnership in Advanced Plastic Recycling Technology. Synova continues to engage around project and partnership opportunities to develop "green" chemicals, and biomass-to-fuels (e.g., RNG or renewable natural gas), which would be aimed to meet plastics circularity and sustainability objectives across sectors. Synova's investor, FullCycle Fund, is also actively developing Synova projects.



Global Landscape of Molecular Recycling Companies

Purification

These technologies distinguish themselves from other molecular recycling categories by not breaking the bonds of the plastic polymer; purification is a physical process. Purification techologies can take single-polymer feedstock or mixed plastics, and through the use of solvents, extract color and additives to produce like-virgin polymers. These processes guarantee a plastic-to-plastic, circular outcome.

IN THIS SECTION

Cadel Deinking

CreaCycle

Ecopek

Evrnu

Next Generation Group

Polystyvert

UMass Lowell

Worn Again Technologies

CADEL DEINKING	Description	Cadel Deinking uses water-based purification to remove printed ink from plastic surfaces, without requiring solvents. The company is also developing other technologies like delamination, and is working to get the first "food approval certificate" for rLDPE on the market.	CreaCycle GmbH Innovative Plastic Recycling Technologies	Description	The CreaSolv® Process developed by CreaCycle and Fraunhofer Institute IVV changes the physical state (solid- liquid-solid) of polymers, without changing composition, to separate them from imbedded impurities for re-use in original applications. HBCD, a brominated flame retardant, is destroyed, while the valuable bromine component and PS are recovered
LOCATION Alicante, Spain		Cadel Deinking targets post-	LOCATION Grevenbroich, Germany		CreaCycle uses post-consumer
TECHNOLOGY TYPE Purification	Feedstock	edstock and households) and post-industrial plastics. This includes all types of plastics (e.g., HDPE, LDPE, PP, PET) and any inks (e.g., water-based, solvent-based, UV, electron beam). TECHNOLOGY TYPE	TECHNOLOGY TYPE Purification	Feedstock	thermoplastic waste (e.g., multilayer packaging, waste electrical and elecrtonic equpment (WEEE), automotive ELV, flame-retarded polymers. PE, PP, PS, EPS, XPS, ABS, HIPS, PET, PA, PLA).
STAGE OF MATURITY			STAGE OF MATURITY		
Growth	Eacilities	Cadel Deinking has a facility in Alicante,	Pilot		In 2021, the PolyStyreneLoop cooperation will start up a 3,000 metric ton CreaSolv® Demoplant to recycle PS foam from construction, which is polluted with HBCD, a persistent organic pollutant. In 2021, Fraunhofer
SUPPLY CHAIN: Plastics to Polymers	Facilities	of 450 kg per hour	SUPPLY CHAIN: Plastics to Polymers	Facilities	
CAPITAL NEEDS: €3 million	Partners	Cadel Deinking has sold five plants to different converting companies in Italy, Brazil, France, UK and EEUU. To develop the business, they partnered with a	CAPITAL NEEDS: Data not available		hour CreaSolv® Pilot plant in Bavaria, Germany to recycle PVC flooring, removing restricted plasticizers (phthalic acid esters).
LAST UPDATED:		plastic recycling machine manufacturer leader and a first-class chemical	LAST UPDATED:		CrosCycle partners with EDC Croup
January 29, 2021		company.	January 29, 2021	Partners	for PS, and LOEMI for polyolefins, to support CreaSolv® Process licensees.
*Based on research and profile submitted by Cadel Deinking sl.	Business Model	Cadel Deinking owns and operates their facility in Spain. In the short term, they work in collaboration with a recycling machine manufacturer to provide turnkey Deinking plants for converters. In the middle-term, they aim to establish in the U.S Capital is being raised to build a deinking center and R&D laboratory in US.	*Based on research and profile submitted by CreaCycle GmbH	Business Model	Fraunhofer IVV adapts the CreaSolv® Process to different waste streams based on customer needs. CreaCycle develops tailored CreaSolv® Formulations. Fraunhofer IVV or engineering partners license the CreaSolv® Process with CreaCycle supplying the specified formulations. The company intends to scale up from pilot stage to commercial stage before 2025.



ECOPEK	Description	Ecopek (formerly CabelmaPET S.A.) produces food-grade rPET from PET bottles. The PET bottles are first mechanically processed into rPET flakes, followed by chemical upgrading processes which turns the flakes into rPET pellets.	EVZNU
LOCATION Pacheco, Buenos Aires,			LOCATION Seattle, WA, USA
TECHNOLOGY TYPE Purification	Feedstock	Ecopek targets post-consumer PET.	TECHNOLOGY TYPE Purification and Depolymerization
STAGE OF MATURITY Early Commercial	Facilities	Ecopek's facility in Pacheco, Buenos Aires, Argentina has a production capacity of 16,000 tons of rPET per year.	STAGE OF MATURITY Early Commercial
SUPPLY CHAIN: Plastics to Polymers			SUPPLY CHAIN: Textile Plastics
CAPITAL NEEDS: Data not available	Partners	DAK Americas Argentina S.A. (virgin PET producer) acquired Ecopek	(Cellulose Polymer) to Polymer
LAST UPDATED:		(formerly CabelmaPET S.A.) in 2014.	CAPITAL NEEDS: US\$5 million
February 24, 2021		Currently, a portion of Ecopek's post-	convertible note in preparation for Series B in 2022
	Business Model	Americas' virgin PET production at its manufacturing facility in Zarate, Argentina. Ecopek also sells directly to merchants.	LAST UPDATED: March 19, 2021
*Based on research and validated with DAK Americas.			*Based on research and validated with Evrnu.

Description	Evrnu is a textile innovations company and inventor of NuCycl technologies. They are creating a circular ecosystem specializing in regenerative fiber technologies made from discarded clothing that can be disassembled to the molecular level and regenerated over and over again.
Feedstock	Evrnu works with multiple waste partners to supply feedstock for pulp production, linking the existing waste supply chain to the apparel supply chain.
Facilities	Evrnu has a pilot facility in South Carolina, USA as well as labs in Seattle and New Jersey, USA.
Partners	Adidas, Levi's, Stella McCartney and Target are all early adopters of Evrnu. Several other confidential brands and supply chain partners are under NDA, but are planning to launch NuCycl to consumers in 2022.
Business Model	Evrnu partners with forward thinking brands and retailers to develop circular prototype textiles in their labs and on their pilot lines. NuCycl by Evrnu technologies are then licensed to commercial producers to scale. NuCycl is a consumer-facing co-brand signifying that the garment is made from waste and recyclable. Additional financing will likely be needed to expand scaling in 2021.



LOCATION

Feldkirchen,

Austria (HQ)

Purification

SUPPLY CHAIN:

CAPITAL NEEDS:

LAST UPDATED:

February 24, 2021

Data not available

Pilot

TECHNOLOGY TYPE

STAGE OF MATURITY

Plastics to Polymers

Description

Feedstock

Facilities

Partners

Business

Model

Next Generation Group is an established mechanical PET recycling equipment provider. Since 2015, Next Generation Group has also been developing a PET-recycling technology called Liquid State Polycondensation (LSP) to produce food-grade rPET. With LSP, decontamination and rebuilding of the molecular chain takes place in the liquid phase.

The LSP technology targets PET. Established initially for fibers only, LSP can now allow mixed PET feedstock, including bottles, flakes, sheets, strapping and thermoforms. LSP can also process co-polymers of PET such as PETG and streams with polyolefin content (e.g., PE, PP).

Next Generation Group demonstrated the LSP technology at its facility in Feldkirchen, Austria in November 2018.

Next Generation Group is partnered with Ingka Group (parent company of IKEA) in this venture.

Data not available.

Polystyvert

LOCATION Montreal, Quebec, Canada **TECHNOLOGY TYPE** Purification **STAGE OF MATURITY** Pilot **SUPPLY CHAIN:** Plastics to Polymers **CAPITAL NEEDS:** Data not available LAST UPDATED: February 25, 2021

*Based on research only.

*Based on research and validated with Next Generation Group.

Description	Polystyvert uses a mix of filtration, dissolution and purification to recycle PS back into PS pellets. A coarse filtration process removes large contaminants (e.g., paper, other plastics, cardboard, metals, etc.). The dissolution and purification occur in an essential oil, which acts as the solvent and is recovered.
Feedstock	Polystvert processes all forms of PS, including expanded PS, extruded PS and high-impact PS.
Facilities	In 2018, Polystvert opened a continuous industrial pilot operating at 125 kg per hour. The estimated output is 600 metric tons per year.
Partners	Polystvert has many investors and financing partners, including capital from grants, equity from seed shareholders, and loans. Polystvert also has an industrial partnership with TOTAL Group. In 2021, they partnered with Ineos Styrolution to convert post- consumer PS into high-quality PS raw material.
Business Model	In the short term, Polystvert will begin commercial deployment through a licensing system in Europe and North America. In the long term, Polystvert will continue commercialization through licenses on a worldwide scale.

UMASS	Description	The Plastics & Environment Research Lab (PERL) at UMass Lowell uses a selectively solvent dissolution and precipitation technique to reclaim and purify polymers.	worn again technologies	Description	Worn Again Technologies uses a patented solvent-based polymer recycling technology to separate, decontaminate and recapture PET pellets and cellulose pulp from pure polyester and blends of poly-cotton/ cellulose. They raised €8 million in June
LOCATION			LOCATION		2020.
Lowell, MA, USA			Nottingham, UK (Lab) Redcar, UK (Pilot Plant)		Worn Again Technologies processes
TECHNOLOGY TYPE Purification	Feedstock	Istock The technology uses feedstock such as electronic waste and post-consumer plastics including PE, PP, PS and Acrylonitrile butadiene styrene (ABS).	Feedstock	pure and blended non-reusable polyester and poly-cotton/cellulose textiles, post-consumer PET bottles and plastic packaging.	
STAGE OF MATURITY Lab			STAGE OF MATURITY		
SUPPLY CHAIN: Plastics to Polymers	Facilities	Data not available.	Pilot SUPPLY CHAIN: Plastics to Polymers	Facilities	Worn Again Technologies commissioned their pilot facility in Redcar, UK in January 2020.
CAPITAL NEEDS: Data not available		The selective solvent dissolution and	CAPITAL NEEDS: Data not available	Partners	Worn Again Technologies has H&M Group and Sulzer–Chemtech as investors and the support of leading
February 7, 2021	Partners	precipitation technique is part of the REMADE Institutes Project Call 2.0.	LAST UPDATED: February 7, 2021		Asics, Sympatex, Dibella, Himes Wear and Directex.
*Based on research and profile submitted by UMass Lowell.	Business Model	Currently, UMass Lowell is developing a techno-economic analysis for the selective solvent and dissolution technology.	*Based on research and profile submitted by Worn Again Technologies	Business Model	Worn Again Technologies expects its demonstration plant to be operational in 2021, in Europe. In the long- term, Worn Again Technologies will offer licenses of the technology to commercial plant operators globally.

Depolymerization ⊞

Depolymerization processes take single-resin feedstock and break down the polymer chains to produce a specific set of products: monomers or oligomers. Monomers are precursors to polymers and can be synthesized (i.e. "repolymerized") to produce a plastic resin (e.g. the monomers TPA and MEG can be repolymerized to make PET polymer to make PET bottles or polyester fabric). Oligomers are longer chained monomers and include products like polypropylene wax.

IN THIS SECTION

Agilyx

Aquafil

Axens & The Rewind™ PET

Circ

Eastman

Galactic

Garbo

Ioniqa

Loop Industries

NatureWorks

Novoloop

perPETual

Poseidon Plastic

Premirr Plastics

Pyrowave

Recyc'ELIT

Technisoil Industrial

Trash-2-Cash

The University of Portsmouth & National Renewable Energy Laboratory



LOCATION

(Thermal)

Tigard, OR, USA

TECHNOLOGY TYPE

Depolymerization

STAGE OF MATURITY

Early Commercial

Plastics to Monomers

SUPPLY CHAIN:

CAPITAL NEEDS:

LAST UPDATED:

February 25, 2021

Data not available

Description

Feedstock

Facilities

Partners

Business

Model

Agilyx creates circular recycling pathways for plastics through their single polymer pathway such as the Polystyrene-to-Styrene Monomer (PSM) System, which produces styrene oil.

Agilyx processes both post-consumer and post-industrial mixed plastics. The company performs physical and chemical characterization to understand the feedstock composition before selecting the optimal platform, and generates feedstock recipes suitable for the value chain.

Agilyx owns and operates one facility in Tigard, Oregon, USA, with a capacity of 10 tons of PS per day. Agilyx has shipped 800,000+ gallons (processing 8,000,000+ lbs of mixed plastics) of Agilyx Synthetic Crude Oil (ASCO) from prior systems.

Agilyx works with members in the entire value chain, from brand owners and retail to chemical manufacturers, polymer producers, waste industry and municipal governments. For the PSM Platform, Agilyx has collaborations with Americas Styrenics, INEOS Styrolution, Trinseo and others to develop 50-ton per day PS recycling facilities.

Agilyx has three business pillars: 1) conversion facilities that employ pyrolysis technology to process plastics; 2) research and development that generates new circular pathways; and 3) 'Cyclyx,' a feedstock logistics division that aggregates and prepares feedstock for the purpose of chemical and circular recycling.



LOCATION

Arco, Italy

TECHNOLOGY TYPE Depolymerization (Thermal)

STAGE OF MATURITY Growth

SUPPLY CHAIN: Plastics to Fuels

CAPITAL NEEDS: Data not available

LAST UPDATED: February 23, 2021

*Based on research and validated with Aquafil.

*Based on research and an

interview. Validated with Agilyx.

Description	Aquafil's ECONYL® Regeneration System depolymerizes PA6 to its monomer: caprolactam. The monomers are polymerized to produce two kind of yarns: ECONYL® nylon yarns for textile applications and ECONYL® nylon yarns for carpet applications.
Feedstock	Aquafil processes pre- and post- consumer PA6 products. The three main sources include PA6 fishnets (collected worldwide), PA6 carpets and oligomers/other plastic waste generated by polymer industries.
Facilities	Aquafil has 16 facilities operating in seven countries over three continents. The group's headquarter is located in Arco, Italy, while the ECONYL® Regeneration System is located in Ljubljana, Slovenia. Linked sites are located in Ajdovščina, Slovenia (PA6 waste storage and preparation) and Phoenix, Arizona, USA (Aquafil Carpet Recycling #1 - ACR #1). ACR#1 is able to recycle 16,000 tons per year of used carpet.
Partners	Aquafil has strong relationships with all players along the value chain, from PA6 waste providers to clothing brands (e.g., Adidas, Volcom, Stella McCartney) and carpet manufacturers (e.g., Interface, Milliken, Mannington, Tarkett Group).
Business Model	Aquafil is a leading supplier for carpet manufacturers in the following markets: contract (hotels, offices and public buildings), automotive (car mats and upholstery) and residential. They are the primary supplier to some of Europe's leading manufacturers of clothing, swimwear and sportswear. Aquafil Engineering's core business is the supply of polyamide and polyester polymer plants.

Axens Powering integrated solutions Rewind PET	Description	Axens (a company of the IFP Energies Nouvelles group), develops Rewind [™] PET, a Polyethylene terephthalate (PET) monomer recycling solution that produces high-quality clear and food- grade PET for packaging, from any type of waste PET.	(irc
LOCATION Rueil-Malmaison, France TECHNOLOGY TYPE Depolymerization	Feedstock	The Rewind [™] PET process targets any type of waste PET: colored and opaque PET bottles and trays, films, multi layers trays and polyester fibers.	LOCATION Danville, VA, USA TECHNOLOGY TYPE Depolymerization (Chemical)
(Chemical) STAGE OF MATURITY Pilot	Facilities	Axens has a pilot plant in IFPEN, in Solaize, France and a 2 KTA demonstration plant in JEPLAN, Kitakyushu Hibikinada, Japan	SUPPLY CHAIN:
SUPPLY CHAIN: Plastics to Monomers CAPITAL NEEDS: Data not available LAST UPDATED:	Partners	Rewind [™] PET is the result of a partnership between JEPLAN, a disruptive circular economy startup, IFPEN, a recognized R&D center, and Axens, a process developer and licensor, catalyst manufacturer & engineering company.	Plastics to Monomers CAPITAL NEEDS: Series B in 2021 LAST UPDATED: February 7, 2021
*Based on research and profile submitted by Axens	Business Model	Beyond licensing, Axens will propose a global offer to Rewind™ PET customers, from the delivery of turn-key modular units to full support for the operation of the process.	*Based on research and profile submitted by Circ^. ^Formerly Tyton BioSciences

Description	Circ has developed a low-impact hydrothermal technology to (re)source nature's raw ingredients from global textile waste. Outputs include virgin- grade regenerated cellulose, Purified Terephthalic Acid (PTA) and ethylene glycol (EG).
Feedstock	Circ accepts both pre- and post- consumer polyester, cotton and poly- cotton textiles.
Facilities	Circ is currently operating at a pilot scale with contract manufacturers throughout the eastern U.S.
Partners	Circ's publicly announced brand partnerships include Patagonia, Marubeni Corporation and the stakeholders at Fashion for Good, where Circ is a scaling program member.
Business Model	Circ will continue to establish long-term partnerships with forward-thinking brands to deploy its technology on a global scale. In the next three years, Circ aims to commercialize a zero-waste, continuous process commercial plant, which will enable rapid expansion to new geographies and increased production volumes.

EASTMAN		Glycolysis, one of Eastman's polyester renewal technologies, unzips polyesters to convert them back to their basic monomers which are used to create new polymers like Tritan™ Renew, Cristal™ Renew and others. The materials produced are	EASTMAN
LOCATION Kingsport, TN, USA	Description	indistinguishable from those made with virgin or non-recycled content. Glycolysis will produce monomers with 20-30% greenhouse gas reductions compared to processes using fossil feedstocks. Third-party critical review	LOCATION Kingsport, TN, USA
TECHNOLOGY TYPE Depolymerization		of the LCA study is expected in the first quarter of 2021.	TECHNOLOGY TYPE Depolymerization
(Chemical) STAGE OF MATURITY Early Commercial	Feedstock	Polyester renewal technology uses a family of polyester material as the process input. Glycolysis utilizes rPET from existing collection streams.	(Chemical) STAGE OF MATURITY Pilot
SUPPLY CHAIN: Plastics to Monomers	Facilities	Commercial operation began in the fourth quarter of 2019.	SUPPLY CHAIN: Plastics to Monomers
CAPITAL NEEDS: Data not available			CAPITAL NEEDS: Data not available
LAST UPDATED: February 7, 2021	Partners	Data not available.	LAST UPDATED: February 3, 2021
	Business Model	Eastman is dedicated to building a circular economy that creates value from material waste. They are advancing innovative recycling technologies and utilizing waste plastics to manufacture existing products in their portfolio.	

*Based on research and validated with Eastman

*Based on research and validated with Eastman

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Description	Methanolysis, one of Eastman's polyester renewal technologies, breaks down polyester-based products into their polymer building blocks, which are then reintroduced to the production of new polyester-based polymers. A pioneer in methanolysis, Eastman has more than three decades of expertise in this innovative recycling process. Methanolysis will produce monomers with 20-30% greenhouse gas reductions compared to processes using fossil feedstocks. Third-party critical review of the LCA study is expected in the first quarter of 2021.
Feedstock	Methanolysis recycles a range of polyester plastic waste that is not valued by mechanical recyclers, like colored PET packaging, PET thermoforms, polyester carpet fiber, or even polyester-based clothing from landfills and incinerators. Eastman will have the capacity to recycle 110 KMT per year.
Facilities	The facility is to be mechanically completed by the end of 2022.
Partners	Eastman launched a partnership with Circular Polymers for polyester based carpet feedstocks in 2019.
Business Model	Eastman is dedicated to building a circular economy that creates value from material waste. They are advancing innovative recycling technologies and utilizing waste plastics to manufacture existing products in their portfolio. Eastman announced the two-year investment of approximately US\$250 million in January 2021.



Escanaffles, Belgium

TECHNOLOGY TYPE

Depolymerization

STAGE OF MATURITY

Early Commercial

Plastics to Polymers

SUPPLY CHAIN:

CAPITAL NEEDS:

US\$10 million

LAST UPDATED:

February 24, 2021

LOCATION

(Chemical)

Description

Feedstock

Facilities

Partners

Business

Model

Galactic is a PLA producer and the company operates its own LOOPLA® PLA feedstock recovery scheme, a new recycling process for converting PLA back into lactic acid, using the technology provided by Futerro, a subsidiary of the Belgian Galactic group.

Futerro's technology targets PLA.

Futerro's in-house LOOPLA® feedstock recovery scheme supports Galactic's

first fully integrated PLA plant in China with a capacity of 30,000 tons per year, supplied by a lactic acid unit with a

operation in Escanaffles, Belgium. In October 2020, Futerro launched the

Galactic has partnerships with other

including NatureWorks. Futerro built the plant in China in partnership with

Futerro and BBCA plan to bring the lactic acid production in China to 180,000 tons per year and that of PLA

to 100,000 tons per year. Futerro offers

licenses for the production of lactic acid by fermentation monomer, PLA

major players in the PLA industry,

capacity of 80,000 tons.

BBCA Biochemical.

and LOOPLA.



LOCATION Cerano, Italy TECHNOLOGY TYPE Depolymerization (Chemical) STAGE OF MATURITY
Cerano, Italy TECHNOLOGY TYPE Depolymerization (Chemical) STAGE OF MATURITY
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Pilot
SUPPLY CHAIN:
Plastics to Monomer
CAPITAL NEEDS:
Data not available
LAST UPDATED:
February 24, 2021

*Based on research and validated by Galactic.

Description	Garbo developed ChemPET®, a depolymerization process which uses glycolysis to produce a monomer: BHET. After the chemical reaction, Garbo purifies the monomers. The entire process takes less than six hours.
Feedstock	Garbo uses PET feedstock, including PET sourced from packaging, fabrics and fine waste from mechanical recycling processes.
Facilities	Garbo has validated the technology at a lab scale of 10 kg per day. The company is currently starting up and validating a pre-industrial production line with a capacity of three tons per day.
Partners	Garbo's partners include Indorama, Plastipak, IKEA and Ester (India) to support the company with recycled PET outlets and quality assessment methods. ChemPET® was developed in collaboration with the University of Modena and Bologna.
Business Model	Currently, Garbo is validating scaled up production. In the short term, Garbo will be building and operating their own recycling line and selling purified BHET. In the long term, Garbo plans to polymerize the BHET and to sell polymers.

ioniqa	Description	loniqa uses a glycolysis reaction with magnetic metal particles as a catalyst to produce a monomer: BHET. This process can separate out colorants and other contaminants.	
LOCATION Eindhoven, Netherlands	Feedstock	loniqa accepts all types and colors of PET feedstocks.	LOCATION Terrebonne, Quebec, Canada
TECHNOLOGY TYPE Depolymerization (Chemical)	Facilities	Ioniqa is building its first PET plastic upcycling factory in the Netherlands, with a capacity of 10,000 tons. The PET plastic waste will be converted into high-grade, pure PET raw material, used to produce new food packaging.	TECHNOLOGY TYPE Depolymerization (Chemical)
STAGE OF MATURITY Early Commercial			STAGE OF MATURITY Pilot
SUPPLY CHAIN: Plastics to Monomers	Partners	loniqa is a spin-off from the Eindhoven University of Technology. The company is in a partnership with Unilever and Indorama Ventures. Coca-Cola has extended a loan to Ioniqa to accelerate the development of the technology.	SUPPLY CHAIN: Plastics to Monomers
CAPITAL NEEDS: €2 million			CAPITAL NEEDS: Data not available
LAST UPDATED: February 25, 2021	Business Model	Once the technology has been proven in loniqa's 10,000-ton capacity plant, they plan to sell licenses around the world for the production of monomers, on an estimated 50,000-ton scale. loniqa is researching more applications of the technology, with polyester fibers. Their capital needs are to enable	LAST UPDATED: April 19, 2021
*Based on research and an interview. Validated with Ioniqa Technologies.		recycling of polyester textiles.	*Based on research and profile submitted by Loop Industries.

Description	Loop Industries' low-energy methanolysis breaks down waste PET plastic and polyester fiber into its monomers: dimethyl terephthalate (DMT) and monoethylene glycol (MEG). The monomers are filtered, purified and polymerized into virgin-quality PET resin made from 100% recycled content—verified by Kemitek.
Feedstock	Loop can process PET plastic (clear, opaque, colored, soiled, damaged) and polyester fiber textiles (e.g., apparel, carpet fiber, etc.) of all types and degrees of contamination.
Facilities	Loop operates an innovation center and pilot plant in Terrebonne Québec, Canada, and is currently developing plans for the industrial commercialization of its technology.
Partners	Loop's partners include Indorama Ventures (joint venture for retrofit), SUEZ (for the development of the first Infinite Loop™ facility in Europe), Worley (for engineering, procurement and construction) & INVISTA/ Chemtex (for polymerization). Loop has supply agreements with brand owners PepsiCo, Danone, L'Oréal and L'Occitane.
Business Model	Loop's commercialization strategy is focused on the development of fully-integrated greenfield Infinite Loop™ manufacturing facilities, the first of which will be built in Europe, in partnership with SUEZ, and is expected to be commissioned in 2023. Plans for expansion of Loop's technology in different parts of the world are currently in discussion.

NatureWorks	Description	NatureWorks depolymerizes polylactic acid (PLA) via a hydrolysis reaction to recover lactic acid monomers. PLA is heated at 120-1600C and the process takes approximately one to eight hours. The monomers are used to manufacture the company's Ingeo	Novoloop
LOCATION Minnetonka, MN, USA		brand PLA and lactides, which are used to make plastics and fibers.	LOCATION Menlo Park, CA, USA
TECHNOLOGY TYPE Depolymerization (Chemical)	Feedstock	NatureWorks utilizes internally generated pre-consumer PLA waste streams.	TECHNOLOGY TYPE Depolymerization (Chemical)
STAGE OF MATURITY Early Commercial	Facilities	NatureWorks operates a commercial Ingeo polylactide facility in Nebraska, USA, with a capacity of 150,000 metric tons per year.	STAGE OF MATURITY Pilot
SUPPLY CHAIN: Plastics to Polymers		NatureWorks is jointly owned by	SUPPLY CHAIN: Plastics to Monomers and Polymers
CAPITAL NEEDS: Data not available	Partners	PTT Global Chemical and Cargill. The company has business in North America, Europe, Japan and Asia Pacific. Partners include the Ellen MacArthur Foundation, Etimex, Taghleef Industries, Sidaplax, Constantia Flexibles, See Box Corp. and Synerlink. Envirogreen has toll-converted PLA to lactic acid for NatureWorks.	CAPITAL NEEDS: US\$12 million Series A
January 29, 2021			LAST UPDATED: March 8, 2021
*Based on research and profile submitted by NatureWorks.	Business Model	Currently, NatureWorks owns and operates their Nebraska facility and sells Ingeo brand PLA and lactides.	*Based on research and profile submitted by Novoloop (previously BioCellection).

Description	Novoloop uses Accelerated Thermal Oxidative Decomposition (ATOD™) to convert PE into proprietary building blocks, and make performance materials that offer brands and manufacturers sustainable products without compromise in product quality.
Feedstock	Novoloop uses post-consumer LDPE, HDPE, combination.
Facilities	Novoloop's R&D is headquartered in Menlo Park, California and is piloting production at the 100kg scale, with plans to exceed 25MT in 2023.
Partners	Novoloop has announced feedstock partnerships with GreenWaste Recovery, Inc. and the City of San José. The company also has >20 confidential product partnerships in development.
Business Model	Novoloop is commercializing its first product, a thermoplastic polyurethane (TPU) with up to 50% PCR content and 45% CO2e reduction compared to virgin TPU. Novoloop is currently monetizing through joint development partnerships and sample sales with plans to start supply agreements in 2022.



Feedstock

Facilities

Partners

Business

Model

perPETual has commercialized a low temperature glycolysis process with depth filtration to recycle PET plastics into an ester, which is used to make polyester applications, such as filament yarns, unsaturated polyesters, PET bottles & packaging.

perPETual uses post-consumer PET bottles, and can also process polyester textiles (textile-to-textile) and PET packaging.

perPETual has a fully operational and profitable plant in Nashik, India currently processing 3 million plastic bottles per day (circa 12,000 metric tons continuous production per year).

perPETual's products are used regularly by many global brands, such as Decathlon, Adidas, The North Face, Zara, H&M and more. perPETual has also partners for texturizing and yarn spinning in over seven countries globally.

perPETual has started to build its second plant of 30,000 metric tons per year. They are also in discussions to establish further facilities in the U.S and Asia, with local partners. perPETual aims to produce the highest quality chemically recycled polyester products with the lowest CO2 footprint. They are currently raising debt for new plants & seeking joint venture partners for expansion. POSEIDON PLASTICS

LOCATION The Wilton Centre, Redcar, UK

TECHNOLOGY TYPE Depolymerization (Chemical)

STAGE OF MATURITY Pilot

SUPPLY CHAIN: Plastics to Monomers

CAPITAL NEEDS: Data not available

LAST UPDATED: February 23, 2021

*Based on research and profile submitted by Poseidon Plastics.

SUPPLY CHAIN:

LOCATION

Germany (HQ)

India (Operations)

TECHNOLOGY TYPE

Depolymerization

STAGE OF MATURITY

(Chemical)

Growth

Plastics to Monomers and Polymers

CAPITAL NEEDS:

Data not available

LAST UPDATED:

February 7, 2021

*Based on research and profile submitted by perPETual.

Description	Poseidon Plastics' proprietary waste- to-polyester technology breaks down waste PET into rBHET™, a low-cost, sustainable feedstock. The rBHET™ is then remanufactured into virgin-grade PET for food-grade plastic packaging, bottles and containers.
Feedstock	Poseidon targets both post-consumer and post-industrial waste, focusing on previously difficult-to-recycle mixed PET waste streams, including textiles, carpets and films.
Facilities	Poseidon has successfully tested and demonstrated its technology in a pilot plant. Construction of the company's first commercial 10 kilo-tonnes per year facility is due to start in the second quarter of 2021.
Partners	Poseidon received multi-million pound funding from UK Research and Innovation in October 2020. The company's commercial partners include Alpek Polyester UK, DuPont Teijin Films, Biffa Polymers and Presca Sportswear.
Business Model	Using its technology as a platform, Poseidon will look to develop its recycling infrastructure on an industrial scale. In 2022, the company will open its first commercial facility, initially capable of processing 10kpta of waste PET. It will then work toward rapidly increasing scale in the UK and internationally.

PREMIRR ·PLASTICS·	Description	Premirr Plastics uses an innovative process and system to continuously convert waste PET back to monomer. The optimized process operates at very high efficiencies, and produces high purity BHET monomers in minutes.	PYROI//A\/E
LOCATION Chapel Hill, NC, USA TECHNOLOGY TYPE Depolymerization	Feedstock	Waste PET feedstocks are amenable with the Premirr process and system, including many sources that are considered unrecyclable.	LOCATION Montréal, Canada TECHNOLOGY TYPE Depolymerization
(Chemical) STAGE OF MATURITY Pilot	Facilities	Premirr Plastics has an operational pilot plant in Garner, North Carolina. This pilot plant is capable of continuously depolymerizing 120 kilograms (265 pounds) of PET per hour.	(Chemical) STAGE OF MATURITY Early Commercial
SUPPLY CHAIN: Plastics to Monomers CAPITAL NEEDS: Series A LAST UPDATED: July 15, 2021	Partners	Premirr Plastics partners with University of North Carolina (Chapel Hill, North Carolina) and Laitram (New Orleans, Louisiana). Additional collaborations with global chemical companies are focused on supplying high quality BHET at an industrial scale.	SUPPLY CHAIN: Plastics to Monomers CAPITAL NEEDS: Data not available LAST UPDATED: January 29, 2021
*Based on research and profile submitted by Premirr Plastics.	Business Model	Currently, Premirr is enhancing their continuous process to manufacture BHET monomer at an industrial scale. Long-term goals include producing resin from 100% recycled content, thereby redefining PET plastic away from a single-use plastic, into a reusable and renewable resource.	*Based on research and profile submitted by Pyrowave.

Description	Pyrowave uses a modular Catalytic Microwave Depolymerization (CMD) technology, an electric platform using microwave to initiate the depolymerization of plastics to monomers (primarily), waxes and oil. Its primary application recovers styrene monomer from PS.
Feedstock	Pyrowave uses PS, including General Purpose Polystyrene (GPPS), High Impact Polystyrene (HIPS) and Expanded Polystyrene (EPS).
Facilities	Pyrowave has one commercial-size unit in operation in Montreal along with full- scale purification equipment to form >99.8% styrene monomers.
Partners	Pyrowave collaborates with major styrenics producers and consumers. Pyrowave collaborates actively with Styrenics Circular Solution, a consortium of styrenics in Europe, and recently received funding from Michelin.
Business Model	Pyrowave operates a hybrid OEM licensing model. The company sells its core patented reactor skids to licensees and licenses the process book.

RecyćElt	Description	An eco-efficient, truly circular and easy-to-implement technology which selectively depolymerizes PET plastic at a very moderate temperature and atmospheric pressure to recover dimethyl terephthalate DMT and Ethylene glycol EG, enabling infinite recycling toward any grade of PET.	TechniSoil
LOCATION Chasse sur Rhône, France TECHNOLOGY TYPE	Feedstock	Recyc'ELIT's process works on every PET type. They are focused on difficult PET plastics such as food containers, colored, transparent and opaques films, and are continuously iterating their process.	LOCATION Redding, CA, USA TECHNOLOGY TYPE Depolymerization
Depolymerization (Chemical) STAGE OF MATURITY	Facilities	Recyc'ELIT is finalizing a pilot lab scale stage, and tackling a 150 liter pilot reactor stage, with the goal of 1 ton per day by 2023.	(Chemical) STAGE OF MATURITY Early Commercial
Lab SUPPLY CHAIN: Plastics to Monomers CAPITAL NEEDS: \$1-3 million	Partners	Recyc'ELIT coordinates an industrial R&D program in collaboration with INSA Lyon and IVA Essex, a leader in insulating resins, in order to scale up the technology into a 150 liter reactor scale. They also collaborate with Valorplast and a renowned mechanical recycler to test the molecular recycling of food containers.	SUPPLY CHAIN: Plastics to Monomers and Polymers CAPITAL NEEDS: Data not available
*Based on research and validated with Recyc'FLIT	Business Model	Currently, Recyc'ELIT is working to scale up and reach the demonstrator stage. They have a hybrid mode for DMT end-users (<1000 tons per year), and envision providing modular units as turnkey technology with licensing fees. For larger users, they aim to form joint ventures to process 100% recycled PET. Capital needs for 2021-2023 are to develop an industrial demonstrator with a 1.5 ton-per day capacity	LAST UPDATED: February 23, 2021 *Based on research and validated with Technisoil

Industrial.

Description	Technisoil Industrial uses polymer chemistry, including recycled polyester polyol in a patented road recycling technology. This technology recycles 100% of the existing roadway into a stronger, longer lasting pavement.
Feedstock	Technisoil Industrial targets post- consumer and post-industrial PET plastics. #2-7 plastics can also be incorporated to create the company's G5 and G5-P polymers that have been engineered specifically for road recycling applications.
Facilities	Technisoil Industrial utilizes long- term partnerships with global scale suppliers in the Americas, Europe and Asia.
Partners	Technisoil Industrial is announcing a joint partnership with the City of Los Angeles and Caltrans to revamp California road networks. Negotiations with other U.S. states and foreign countries are ongoing.
Business Model	Technisoil Industrial is commercializing its technology through supply agreements to road building companies and agencies globally. Third party partnerships for polymer and machinery suppliers are in place.



Description	The University of Portsmouth (UoP) and the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) determined two synergistic enzymes—PETase and MHETase—that work in tandem to break down PET. For this research, MHETase has not been studied as extensively as PETase has. The new research combined structural, computational, biochemical and bioinformatics approaches to reveal molecular insights into its structure and functionality. Additional research discovered two other bacteria that contain enzymes like MHETase, bringing the total known enzymes that act on this synthetic substrate to three.
Feedstock	UoP and NREL target PET plastics.
Facilities	Data not available.
Partners	The U.S. Department of Energy's Advanced Manufacturing Office and its Bioenergy Technologies Office funded the research. The work was performed as part of the Bio-Optimized Technologies to keep Thermoplastics out of Landfills and the Environment (BOTTLE) Consortium.
Business Model	Data not available.

Conversion &

These technologies break the polymer chains to produce diverse hydrocarbon products with a relatively large range of molecular weights like naphtha, paraffin waxes, other petrochemical products, and fuels. A subset of conversion technologies completely break down the polymer to form syngas or elemental carbon products like methanol and hydrogen. This subset of technologies distinguish themselves by being able to process mixed waste with plastics commingled in it.

IN THIS SECTION

Agilyx

Alterra Energy'

Anhui Oursun Resource Technology Co., Ltd

APChemi

Blest

Braven Environmental

Clariter

CTC Foundation

Eastman

Eco Fuel Technology, Inc

Encina

Enval

Equipolymers

Fulcrum BioEnergy

Illinois Sustainable Technology Center

InEnTec

Itero Technologies

Khepra

Klean Industries

LanzaTech LyondellBasell Nasus Labs New Hope Energy Nexus Pennsylvania State University The Plastics & Environment Research Lab -UMass Lowell Plastic2Oil PolyCycl Reclaimed EcoEnergy ReNew ELP Resynergi SABIC

Scindo

Sierra Energy

Sweet Gazoil

Valoren

agilyx Reduces. Produces. Creates.	Description	Agilyx creates circular recycling pathways for plastics through their Mixed Plastics-to-Crude (MPC) System, which produces lower-carbon crude oil for fuel production, naphtha cracker feed.	ALTERRA ENERGY
LOCATION Tigard, OR, USA TECHNOLOGY TYPE	Feedstock	Agilyx processes both post-consumer and post-industrial mixed plastics. The company performs physical and chemical characterization to understand the feedstock composition before selecting the optimal platform, and generates feedstock recipes suitable for the value chain.	LOCATION Akron, OH, USA TECHNOLOGY TYPE
Conversion (Thermal) STAGE OF MATURITY Early Commercial SUPPLY CHAIN:	Facilities	Agilyx owns and operates one facility in Tigard, Oregon, USA, with a capacity of 10 tons of PS per day. Agilyx has shipped 800,000+ gallons (processing 8,000,000+ Ibs of mixed plastics) of Agilyx Synthetic Crude Oil (ASCO) from prior systems.	Conversion (Thermal) STAGE OF MATURITY Growth SUPPLY CHAIN:
Plastics to Fuels CAPITAL NEEDS: Data not available LAST UPDATED: February 25, 2021	Partners	Agilyx works with stakeholders across the entire value chain, from brand owners and retail to chemical manufacturers, polymer producers, waste industry and municipal governments. For the MPC Platform, Agilyx is partnered with Delta Air Lines and Monroe Energy, a wholly owned subsidiary of Delta Air Lines, to take up to 2,500 bbl per day of ASCO and has an ongoing existing relationship with U.S. Oil.	Plastics to Monomers/ Polymers CAPITAL NEEDS: Data not available LAST UPDATED: June 28, 2021
*Based on research and an interview. Validated with Agilyx.	Business Model	Agilyx has three business pillars: 1) conversion facilities that employ pyrolysis technology to process plastics; 2) research and development that generates new circular pathways; and 3) 'Cyclyx,' a feedstock logistics division that aggregates and prepares feedstock for the purpose of chemical and circular recycling.	*Based on research and validated with Alterra Energy.



ANHUI OURSUN RESOURCE TECHNOLOGY	Description	Anhui Oursun Resource Technology Co., Ltd (Oursun Resources) converts plastic waste into diesel oil, gasoline oil, gas and slag. The company's machine system is continuous and automatic, using computer-controlled equipment. The company has patents on its constant-temperature slagging device, its batch-type mixer, its gas recovery and voltage stabilizing supply device, its plastic cracking catalyst formulation and its plastic cracking process.	Leaders in Pyrolysis APChemi We recycle plastics, transparently.
LOCATION Hefei, Anhui, China			LOCATION Navi Mumbai, India
TECHNOLOGY TYPE Conversion (Thermal)	Feedstock	Oursun Resources targets waste PE, PP, and PS (#2, 4, 5, 6).	TECHNOLOGY TYPE Conversion (Thermal)
STAGE OF MATURITY Growth SUPPLY CHAIN: Plastics to Fuels CAPITAL NEEDS:	Facilities	Oursun Resources' facilities can process between 10 to 500 tons per day of plastic and can yield between 50-90% of oil, depending on the feedstock. The facilities require approximately 280 kWh of electricity for every ton of plastic processed.	STAGE OF MATURITY Growth SUPPLY CHAIN: Plastics to Fuels, Petrochemicals and Chemicals
LAST UPDATED: February 23, 2021	Partners	Oursun Resources was established as a joint venture between China, America and Taiwan. The company's scientific research team relies on the expertise and human resources advantage of Hefei, the scientific and technological city of China.	CAPITAL NEEDS: US\$7.5 million LAST UPDATED: March 17, 2021
*Based on research only.	Business Model	Currently, Oursun Resources is a manufacturer and exporter of pyrolysis technology.	*Based on research and profile submitted by Agile Process Chemicals (APChemi).

Description	Over the last 12 years, APChemi has offered commercially proven technology and plants to convert mechanically non-recyclable plastics into pyrolysis oil. APChemi has commissioned 30 plants of capacity up to 12 metric tons per day and has published seven patents.
Feedstock	APChemi uses mixed-multilayer packaging waste—PET containing plastic waste, mixed plastic waste and municipal solid waste segregated plastic waste.
Facilities	APChemi has over 15 commercially operational pyrolysis plants with capacities of up to 12 metric tons per day, located mostly in India and Africa. They also have a research laboratory and machinery fabrication facility. Capital is needed to deploy 50 metric ton per day plastic pyrolysis plants.
Partners	APChemi is supported by Royal Dutch Shell as part of the Shell E4 program. They are part of the Singapore startup accelerator program of PNP, Alliance to End Plastic Waste. Their 30+ global clients include Equate, Shell, Uflex, Greenjoules and CPE.
Business Model	APChemi has interest in co-owning and operating pyrolysis plants. They also offer engineering, equipment manufacturing, consulting and technology licensing solutions in domain of plastic pyrolysis. The company has interest in the pyrolysis oil offtake.

Protect earth from contamination	Description	Blest manufactures three different levels of plastic to oil pyrolysis technology, operating between 400- 450°C. The technology produces a mixed synthetic light sweet crude composed of diesel, gasoline, kerosene and heavy oils.	Braven, Environmental
LOCATION Kanagawa, Japan			LOCATION Yonkers, NY, USA (HQ)
TECHNOLOGY TYPE Conversion (Thermal)	Feedstock	Blest targets PE, PP and PS feedstock. Blest machines do not accept PET or PVC.	TECHNOLOGY TYPE Conversion (Thermal)
STAGE OF MATURITY Growth			STAGE OF MATURITY Early Commercial
SUPPLY CHAIN: Plastics to Fuels	Facilities	Blest offers both batch type machines and continuous system machines. The highest capacity model processes 2,000 kg per day.	SUPPLY CHAIN: Plastics to Fuels
CAPITAL NEEDS: Data not available LAST UPDATED: February 23, 2021	Partners	Blest has sold over 100 machines in more than 30 countries. Countries using machines with higher capacities include Japan, Palau, Iceland and Canada. Blest's customers include a mix of governments and recycling companies (e.g., Nagatashigyo Co., Ltd. and P&M Recycling Center).	CAPITAL NEEDS: US\$120 million in equity LAST UPDATED: March 4, 2021
*Based on research only.	Business Model	Currently, Blest is a manufacturer and distributor of pyrolysis technology.	*Based on research and an interview. Validated with Braven Environmental.

Description	Braven Environmental (formerly Golden Renewable Energy) uses pyrolysis technology to produce chemical feedstocks that can be recycled into new plastic products, or liquid or gas fuels for transportation, electric power production or heating oil. PyChem is their liquid petroleum product, comparable to low sulfur ASTM D396.		
Feedstock	Braven's Recycled Fuel Production (RFP) Unit can accept almost all types of post-consumer plastic and film, including plastic bags.		
Facilities	Braven owns and operates a facility in Zebulon, North Carolina, USA. Each RFP Unit is capable of processing 30 to 36 tons of waste plastic in a 24 hour period.		
Partners	Multiple plant sites are currently being developed in the U.S. and abroad with design work being done by Ford, Bacon and Davis.		
Business Model	Each plant intends to benefit tipping fees to take the waste plastics or feedstock from waste management companies, municipalities and industrial waste plastic producers; and PyChem sales, sold at a premium under spot and long-term offtake contracts. Braven plans to install waste plastic processing units within large and small processing facilities around the world.		

bclariter

Description

Feedstock

Facilities

Partners

Business

Model

Clariter created a unique process of continuous thermal cracking, hydrotreatment and separation that produces industrial snow-white waxes, pure oils and aliphatic solvent products from end-of-life plastic waste, instead of from fossil feedstocks. In addition to over 17 years of R&D and technology development, the company conducted its own LCA, which indicated positive results with regard to the technology's carbon footprint.

Clariter's raw material consists mostly of a mix of various streams of PE and PP, with limited amounts of PS.

Clariter has a 300m² Research & Development Plant in Gliwice, Poland and a 15,000m² Industrial-scale Plant (1,000 mtpa) in East London, South Africa.

Partnerships include the Solar Impulse Foundation, Count, Kerax, Industrial Development Corporation of SA, EIB, South African BRICS. Other partners are under NDA.

Clariter is pursuing building two fullscale (50 ktpa) plants by the end of 2023, and two more in a second wave. Clariter will complement this "Build, Own and Operate" JV route with a licensing model. Product sales are ongoing.

Foundatio

LOCATION
Gillette, WY, USA
Conversion (Thermal)
STAGE OF MATURITY
Concept
SUPPLY CHAIN:
Plastics to
Petrochemicals
CAPITAL NEEDS:
US\$250,000+
LAST UPDATED:
February 23, 2021
*Based on research and
profile submitted by CTC Foundation

TECHNOLOGY TYPE Conversion (Chemical)

STAGE OF MATURITY Early Commercial

LOCATION

Africa

Warsaw, Poland

Tel-Aviv, Israel

Netherlands

East London, South

SUPPLY CHAIN: Plastics to Chemicals

CAPITAL NEEDS: Convertible Loan Agreement Round

LAST UPDATED: February 23, 2021

*Based on research and profile submitted by Clariter.

Description	CTC Foundation has developed technology that gasifies the plastic polymer material used for wind blades to produce a synthetic gas that can be used to make new plastics and/ or electricity. There is no waste stream from the process.
Feedstock	CTC Foundation's technology concept processes municipal solid waste, single- use plastic bags, wind turbine blades and coal fly ash to produce a synthetic gas.
Facilities	With 17 patents, CTC Foundation's gasification system reverse engineers steelmaking, using electric arc furnace technology to achieve high temperatures of about +/-2912° F.
Partners	CTC Foundation is identifying potential partnerships with domestic de-manufacturers of wind turbine assemblies that recover the rare earth element (REE) permanent magnets, and then manufacture new assemblies.
Business Model	CTC Foundation is still in concept stage of the technology.

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EASTMAN LOCATION Kingsport, TN, USA	Description	Eastman's carbon renewal technology (CRT) breaks down waste plastics into molecular building blocks like carbon, oxygen and hydrogen. These building blocks are used to produce materials like Naia™ Renew, Acetate Renew and Treva™ Renew. Eastman's carbon renewal technology's LCA shows a 20- 50% greenhouse gas reduction over traditional manufacturing. This study has been critically reviewed by CE Delft and verified to conform with ISO 14040 and 14044 LCA standards.	Livonia, MI, USA
TECHNOLOGY TYPE Conversion (Chemical)		Carbon renewal technology gives	TECHNOLOGY TYPE Conversion (Thermal)
STAGE OF MATURITY Early Commercial	Feedstock	new life to the most complex waste plastic by recycling all types of plastic, except PVC. CRT can recycle complex articles like carpet fiber and textiles, in addition to more traditional plastics, many of which cannot be recycled via traditional technologies. CRT does not recycle mixed waste streams.	STAGE OF MATURITY Early Commercial
SUPPLY CHAIN: Plastics to Chemicals			SUPPLY CHAIN: Plastics to Fuels and
CAPITAL NEEDS: Data not available	Facilities	Commercial operation began in the fourth quarter of 2019.	CAPITAL NEEDS:
LAST UPDATED: February 7, 2021	Partners	Eastman launched a partnership with Circular Polymers for polyester-based carpet feedstocks in 2019.	LAST UPDATED: January 29, 2021
*Based on research and validated with Eastman.	Business Model	Eastman is dedicated to building a circular economy that creates value from material waste. They are advancing innovative recycling technologies and utilizing waste plastics to manufacture existing products in their portfolio.	*Based on research and profile submitted by Eco Fuel Technology, Inc.

Description	Eco Fuel Technology, Inc (EFT), is a waste-to-products technology company that uses advanced thermal catalytic decomposition (ATCD) to turn waste plastic into products that are ready-to-use in engines (e.g., lubricating fluids, diesel, gasoline, aviation fuel). Technology operates at low temperatures (350°C-450°C) and uses a nano-engineered catalyst.
Feedstock	While the technology can deal with all kinds of plastic (#1-7), EFT strongly recommends use of all types of PE (#2,4 and some 7), PP (#5) and PS (#6) for >80% conversion to fuel.
Facilities	EFT has R&D units in Livonia, Michigan; Santa Cruz, California; University of Illinois at Urbana-Champaign; and Chennai, India. Larger units are being built for Vancouver, Canada and Australia. Starting in 2021, capacity of the first plant in the Philippines is 20 metric tons per day (operational by Q3). It will be followed by four more plants with similar capacity, all to be completed by 2022. In 2021, a 20 metric ton per day plant is proposed for BC, Canada, scalable to 60 metric tons per day by 2022.
Partners	In Canada, EFT is working with Eco- Options Cooperative. In the Philippines, EFT works with Knewtech. In Ghana, they work with Sunyanienergy, Inc. Eco Fuel Technology also partners with Ocean Guardian and Ocean Recovery Systems to recover plastics from the mid-depths of the ocean and convert them to fuel.
Business Model	In North America, EFT aims to sell its continuous Plastic-to-Fuel (PTF) units, by supplying the catalyst and service. Abroad (mainly in Southeast Asia and Australia), it has licensed its technology to build units for local sales and services, for a fee and stack in equity.

ENCINA	Description	Encina processes waste plastics with a catalytic pyrolysis technology to manufacture ASTM-grade ~99% BTX, fuels and propylene.	<pre>enva</pre>
LOCATION Houston, TX, USA TECHNOLOGY TYPE	Feedstock	Encina receives all forms of waste plastics, with preference to process #3-7 feedstock provided by industrial and post-consumer processors.	LOCATION England, UK TECHNOLOGY TYPE
Conversion (Thermal) STAGE OF MATURITY Early Commercial SUPPLY CHAIN:	Facilities	Encina operates a facility in San Antonio, Texas, and is now finalizing pre-construction activities for a 20-ton per hour facility with their EPC and full slate of technology partners.	SUPPLY CHAIN:
Plastics to Fuels, Petrochemicals, & Chemicals CAPITAL NEEDS: Data not available	Partners	Encina's partnerships include: Worley Parsons, GTC Technology; Particulate Solid Research, Inc.; Southwest Research Institute, Hazen Research, CPFD Software, LLC (Computational Particle Fluid Dynamics) and a multitude of feedstock suppliers.	Plastics to Fuels CAPITAL NEEDS: Data not available LAST UPDATED: February 24, 2021
LAST UPDATED: February 23, 2021 *Based on research and profile submitted by Encina Development Group, LLC.	Business Model	Encina builds, owns and operates their own facilities, as well as enters into partnerships with companies where Encina's technologies can serve as a benefit to their partners who seek a flexible industry solution. Encina holds term sheets for ~\$960 million of project financing for their project portfolio build out.	*Based on research only.

Description	Enval utilizes microwave-induced pyrolysis, powered by electricity, to convert pouches and plastic aluminum laminates into low-carbon aluminum and hydrocarbons. The hydrocarbons are separated into high value gas and oil for fuel or specialty chemicals.
Feedstock	Enval processes multilayer packaging/ film, such as pouches and plastic aluminium laminates (e.g., aluminium foil sandwiched between plastic layers).
Facilities	Enval's typical plant operates at a nominal capacity of 2,000 metric tons per year. The pyrolysis gas generated by the process is used to produce the electricity required to operate the plant.
Partners	Enval has partnered with Little Freddie, an organic baby food company, for a zero waste to landfill solution for their pouches. Other partners include Kraft Heinz Co., SAIREM, Sonoco and Nestlé.
Business Model	Currently, Enval offers a modular, turnkey solution which includes full training to operate and maintain the equipment, as well as engineering support throughout the lifetime of the plant.

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equipolymers™

Feedstock

Facilities

Partners

Business

Model

Equipolymers is producing 'Viridis 25': a food-grade PET made with 25% recycled content. In 2009, Equipolymers also launched Viridis 10, a PET containing up to 10% recycled content.

Equipolymers processes PET

feedstocks.



Schkopau, Germany				
TECHNOLOGY TYPE				

LOCATION

Data not available

STAGE OF MATURITY

Early Commercial

SUPPLY CHAIN:

Plastics to Polymers

CAPITAL NEEDS:

Data not available

LAST UPDATED:

March 4, 2021

per year and the PET 2 facility has a capacity of 175 metrics tons per year. Equipolymers is a wholly owned subsidiary of the EQUATE Petrochemical Company (EQUATE),

Equipolymers' current production

per year. They have two production

capacity of PET is about 335 metric tons

plant in Schkopau, Germany; the PET 1 facility has a capacity of 160 metric tons

which is part of the EQUATE Group. Coca-Cola has played a strong role supporting the development of the material ,and partook in the launch of Viridis 25.

Equipolymers supplies their PET products to brand owners and converters, throughout Europe.

Description	Fulcrum BioEnergy converts municipal solid waste into low-carbon transportation fuels. Fulcrum uses gasification to produce syngas, followed by purification and a Fischer-Tropsch process to convert syngas into syncrude. The syncrude is upgraded to products such as jet fuel and diesel.
Feedstock	Fulcrum's feedstock is MSW that has been pre-processed to extract commercially recyclable material and inorganic waste.
Facilities	The Sierra Biofuels Plant is being constructed in Storey County, Nevada, USA, with an expected capacity of 175,000 tons per year of MSW once it is complete. Fulcrum has built the Feedstock Processing Facility at the plant, which has been in operation since 2016.
Partners	Fulcrum's product offtake customers are Cathay Pacific, United Airlines, Andeavor, BP and World Fuels Services. The gasification system was developed by ThermoChem Recovery International. Other partners include the U.S. Navy and Air Force.
Business Model	Currently, Fulcrum is building the Biorefinery at the Sierra Biofuels Plant, expected to begin operations in early 2021.

ILLINOIS SUSTAINABLE TECHNOLOGY CENTER PRAIRIE RESEARCH INSTITUTE	Description	Illinois Sustainable Technology Center (ISTC) is developing two technologies for plastics. One employs a solvent extraction process to produce pure polycarbonate. The solvent used is N-methyl-2-pyrrolidone (NMP). The second pathway uses pyrolysis to convert complex mixtures of plastics to fuel.	INENTEC® LOCATION OR and MI, USA
TECHNOLOGY TYPE Purification Conversion (Thermal) STAGE OF MATURITY	Feedstock	ISTC processes plastic feedstocks from e-waste, including simple mixtures such as PC/PA (via solvent extraction) and complex mixtures such as PC/PA/ ABS/PMMA (via pyrolysis).	Taiwan, Japan, Malaysia TECHNOLOGY TYPE Conversion (Thermal) STAGE OF MATURITY
Lab SUPPLY CHAIN: Plastics to Polymers Plastics to Fuels CAPITAL NEEDS: Data not available	Facilities	ISTC has proven the purification and thermal conversion processes at the lab scale using plastics #7 (other). ISTC has also conducted pilot scale testing for the thermal conversion of plastics #5 (PP), which is representative of thermal conversion applications to plastics #2, 4 and 6 (HDPE, LDPE, PS).	Growth SUPPLY CHAIN: Plastics to Fuels CAPITAL NEEDS: Data not available
LAST UPDATED: February 23, 2021	Partners	Data not available.	February 25, 2021
*Based on research and validated by Illinois Sustainable Technology Center.	Business Model	Data not available.	*Based on research.

Description	InEnTec developed a patented Plasma Enhanced Melter (PEM) technology, using gasification to produce ultra- clean syngas.	
Feedstock	The PEM technology can process municipal solid waste, industrial byproducts, medical waste, PCB, asbestos, electronic waste, batteries and others.	
Facilities	The technology is used in InEnTec Columbia Ridge's facility in Oregon to process 25 tons per day of solid and liquid feedstock, as well as by Dow Corning Corporation in Michigan, by Global Plasma Technology Limited in Taiwan, by Kawasaki Plant systems and Fuji Kaihatsu Ltd in Japan and by The Boeing Company facility in Malaysia.	
Partners	The technology was developed in coordination with MIT and the Department of Energy's National Laboratories. InEnTec announced a partnership with Sims Resource Renewal, as the prefered technology for their resource renewal facility in Australia.	
Business Model	InEnTec deploys their technologies to help clients turn waste into valuable products such as bioreactor feedstock, renewable energy, clean fuels, industrial gases and chemicals and building & industrial materials.	

Ó ITERO	Description	Itero Technologies (formerly CGC Technologies) uses pyrolysis technology to convert waste plastics into recycled naphtha, waxes and oils. Their novel hydrocarbon recovery system and multiple adjustable process parameters guarantees maximum product yields & revenues.	KHEPRA 😂
LOCATION London, UK TECHNOLOGY TYPE Conversion (Thermal)	Feedstock	Feedstock includes post-consumer and commercial/industrial waste plastics not accepted by mechanical recycling (e.g., contaminated films, mixed polymers). Target polymers include PP, HDPE, LDPE, PS.	LOCATION San Francisco, CA, USA TECHNOLOGY TYPE Conversion [Cavitation]
STAGE OF MATURITY Pilot/Early Commercial SUPPLY CHAIN: Plastics to	Facilities	Itero has a pilot-scale R&D facility in the UK, which has a demonstrated capacity of 1.5 metric tons per day. A commercial-scale 27,000 metric tons per year plant in the Netherlands is in development.	STAGE OF MATURITY Lab SUPPLY CHAIN: Plastics and Biomass
Petrochemicals/ Chemicals CAPITAL NEEDS: €15 million	Partners	Itero partners with global EPC company IHI E&C to engineer, build, commission and warranty their plant in the Netherlands. Infinity Recycling is a commercial advisor. Commercial partners include COUNT Energy Trading and Kerax.	to Fuels and Petrochemicals CAPITAL NEEDS: Seed Round in 2020/2021
LAST UPDATED: February 23, 2021 *Based on research and profile submitted by Itero Technologies.	Business Model	Itero is initially focused on building and operating its first commercial-scale plant in the Netherlands, followed by commercial partnerships to build and operate plants across the EU. Globally, Itero will focus on licensing its technology. They will continue to develop and commercialize new technologies.	LAST UPDATED: February 23, 2021 *Based on research and profile submitted by Khepra.



Klean Industries

Feedstock

Facilities

Partners

Klean Industries (Klean) uses pyrolysis, liquefaction and gasification systems to produce refined fuels, recovered carbon black and nano carbon filler compounds from various petroleumbased feedstocks.

Klean targets all types of postconsumer and post-industrial plastics (e.g., agricultural plastics, films, automotive shredder residues, e-Waste) and can handle high volumes of undesirable plastics such as PVC and PET, with the ideal feedstock of HDPE, LDPE, PP, PS, and "mixed" 3-7.

Klean currently has 17 operational plastics recycling facilities globally. The Sapporo Plastic Recycling (SPR) plant in Hokkaido, Japan, was built to process 15,000 metric tons per year and was installed in 1999. The facility was designed as a commercial-scale flagship facility and has led to Klean's commercial success for the last two decades.

Klean provides their technology and expertise to the Sapporo Plastic Recycling facility and to Greenfuels AG. Organizations involved with Klean's projects include Dow Chemical, Bayer, BASF, Toshiba Corp., Sapporo City Government, Mitsui & Co. Ltd., Sacre-Davey, BDC, EDC and Newalta.

Klean has 15+ active projects for new plastics recycling facilities. KleanFuels in Vancouver, Canada will process 5,000 metric tons per year, GreenFuels in Germany will process over 35,000 metric tons per year, and a 20,000 tons per year facility in Malta will also incorporate the new KleanLoop blockchain technology that will bring in additional operational transparency. Klean will roll out more facilities in North America and Europe that incorporate new advancements to the SPR technology that is used in Japan.

LanzaTech

LOCATION
Chicago, IL, USA
TECHNOLOGY TYPE
Conversion (Chemical)
STAGE OF MATURITY
Early Commercial
SUPPLY CHAIN:
Plastics to Fuels and
Petrochemicals
CAPITAL NEEDS:
Data not available
LAST UPDATED:
February 23, 2021
-

*Based on research and profile submitted by LanzaTech.

Vancouver, British Columbia, Canada (HQ)

TECHNOLOGY TYPE Conversion (Thermal)

STAGE OF MATURITY

Growth

LOCATION

SUPPLY CHAIN: Plastics to Fuels

CAPITAL NEEDS:

Data not available

LAST UPDATED:

February 24, 2021

Business Model

*Based on research and an interview. Validated with Klean Industries.

Description	LanzaTech uses a biocatalyst to convert waste carbon into sustainable fuels and chemicals. Through a process of gas fermentation, the process captures and recycles carbon into over 30 chemical building blocks.
Feedstock	LanzaTech uses feedstock containing CO2 & H2 and/or CO, including waste industrial emissions, gasified unsorted unrecyclable municipal solid waste or agricultural waste.
Facilities	LanzaTech operates a 16M gpa commercial facility in China, with seven other facilities in design or construction globally. In the U.S., they have a pilot facility in Georgia and a lab facility in Illinois.
Partners	LanzaTech partners across the supply chain. For feedstock, they partner with ArcelorMittal, NextChem, MRPL, IndianOil, Sekisui; for fuels, with ANA, Virgin Atlantic; for products, with BASF, Migros/Mibelle and other consumer brands.
Business Model	LanzaTech employs a licensing model. Their customers fund plant development, construction, and operations, with LanzaTech providing technology for licensing fees. This allows them to remain "capital light" and build multiple units in parallel globally, with different sectors.

Iyondellbasell Advancing Possible	Description	LyondellBasell's proprietary molecular recycling technology, known as MoReTec, uses a proprietary catalyst- based approach to convert plastics into their molecular state, to be used as feedstock to produce new plastic for all applications including food contact and healthcare items.	
LOCATION Ferrara, Italy			LOCATION South Jordan, UT, USA
TECHNOLOGY TYPE Conversion (Thermal)	Feedstock	LyondellBasell's MoReTec technology targets difficult-to-recycle plastic waste such as multilayer film.	TECHNOLOGY TYPE Conversion (Thermal)
STAGE OF MATURITY Pilot			STAGE OF MATURITY Growth
SUPPLY CHAIN: Plastics to Petrochemicals	Facilities	The small-scale pilot facility is in Ferrara, Italy, building on the site's long history of research and development, including catalyst development.	SUPPLY CHAIN: Plastics to Fuels
CAPITAL NEEDS:			CAPITAL NEEDS: Data not available
LAST UPDATED: February 24, 2021	Partners	The technology was developed in collaboration with the Karlsruhe Institute of Technology (KIT).	LAST UPDATED: February 23, 2021
*Based on research only.	Business Model	LyondellBasell will continue construction of its pilot facility, while focusing on the interaction of various waste types on the molecular recycling process, catalyst selection and process conditions.	*Based on research and profile submitted by Nasus Labs.





Feedstock

Facilities

Partners

Business

Model

New Hope Energy (NHE) uses a pyrolysis process to convert plastics into high-quality petroleum products (e.g., bunker 2 and 4, marine gasoil, home heating oil, fuel oil 2 and 4, naphtha, paraffin, asphalt). NHE completes all fabrication in-house, which includes building their patented heat exchange vessels.

NHE accepts all post-consumer and post-industrial waste plastics, including plastics of mixed colors. NHE prefers HDPE, LDPE, PP and PS.

In early 2017, NHE commissioned the Trinity Oaks facility in Tyler, Texas, USA, which holds the first of several plastic conversion facilities (PCFs).

NHE is a member of the American Chemistry Council's Plastics-to-Fuel & Petrochemistry Alliance. Previously, NHE sold their renewable oil product to a refinery in Texas and has relationships with several other buyers. Recently, NHE signed an agreement with Chevron Phillips Chemical to provide ISCC PLUS certified renewable chemical feedstock produced through pyrolysis.

NHE is working on phase II of the Trinity Oaks facility. Their next plant will be the core of a Sustainable Trade Zone. Growth in their technology's manufacturing capacity is set to be announced soon.



LOCATION Atlanta, GA, USA

TECHNOLOGY TYPE Conversion (Thermal)

STAGE OF MATURITY Early Commercial

SUPPLY CHAIN: Plastics to Fuels and Petrochemicals

CAPITAL NEEDS: Data not available

LAST UPDATED: March 17, 2021

*Based on research and profile submitted by Nexus.

LOCATION Tyler, TX, USA

Conversion (Thermal)

STAGE OF MATURITY Early Commercial

TECHNOLOGY TYPE

SUPPLY CHAIN:

Plastics to Fuels & Petrochemicals

CAPITAL NEEDS:

Data not available

LAST UPDATED:

February 25, 2021

*Based on research and an interview.

Description	Nexus is an ISCC+ certified commercialized business using a modern molecular pyrolysis technology to convert waste plastics into high-grade liquid feedstocks, which in turn are converted to virgin plastic precursors, in a 100% circular. process.
Feedstock	Nexus uses post-industrial or commercial plastics (HDPE, LDPE, PP, PS) with reasonable contaminant levels, optimized for films, coupled with front- end sortation systems and artificial intelligence automation. Nexus also utilizes port-consumer material from a Dow Energy program and a local community recycling center.
Facilities	Nexus operates a commercial-scale, 50 metric ton per day facility in Atlanta, Georgia, with all Federal/State approvals, certification, infrastructure, engineering and logistics. To date, 0.8+MM liters have been sold.
Partners	Nexus has off-take agreements with waste-to-virgin global clients like Royal Dutch Shell and Chevron Phillips Chemical. Further agreements are underway to meet significant demand. Investors include a US\$21 billion cleantech-focused conglomerate outside of the chemical/oil/gas space. Other partners include Cox Enterprises, Dow and Leidos.
Business Model	Nexus uses an accelerated JV owner/ operator model to scale knowledge, followed by licensing at an appropriate time, since pyrolysis is too complex to license immediately. They are targeting co-located sites with strategic partnerships in North America, Europe and Asia to scale and deploy business and technology. Capital is needed to scale globally.

	Description	The Pennsylvania State University developed a process to densify waste plastic into fuel nuggets called Plastofuel™. The technology works by forcing film or rigid plastics through a heated extrusion die.	LOCATION
Harrisburg, PA, USA			Lowell, MA, USA
TECHNOLOGY TYPE Conversion (Thermal)	Feedstock	Plastofuel can process all plastics but targets non-recyclable plastics, with a focus on agricultural and household waste.	TECHNOLOGY TYPE Conversion (Thermal)
STAGE OF MATURITY Lab			STAGE OF MATURITY Lab
SUPPLY CHAIN: Plastics to Fuels	Facilities	The scaled-up prototype at the Pennsylvania State University produces 500 lbs per hour of Plastofuel™.	SUPPLY CHAIN: Plastics to Fuels and
CAPITAL NEEDS:			Petrochemicals
LAST UPDATED:			CAPITAL NEEDS: Data not available
February 25, 2021	Partners	The technology was developed in the school's Department of Agricultural and Biological Engineering.	LAST UPDATED: February 7, 2021
*Based on research and validated with The Pennsylvania State University.	Business Model	Data not available.	*Based on research and profile submitted by UMass Lowell.



Plastic20il	Description	JBI, Inc. developed the Plastic2Oil (P2O) technology which transforms unsorted, unwashed waste plastic into ultra- clean, ultra-low sulphur fuel without the need for refinement. Fuel products include naphtha, fuel #2 (such as furnace oil or diesel) and fuel #6 (such as heavy fuel for industrial boilers and ships).
Niagara Falls, NY, USA HQ) T ECHNOLOGY TYPE Conversion (Thermal)	Feedstock	The P2O technology targets HDPE, LDPE, PP and other plastics (#2, 4, 5, 7) and does not accept PET and PVC (#1, 3).
STAGE OF MATURITY Early Commercial SUPPLY CHAIN: Plastics to Fuels	Facilities	The P2O process is permitted by the New York State Department of Environmental Conservation for up to 4,000 lbs of plastic feedstock per machine per hour at the company's Niagara Falls, NY, USA facility.
CAPITAL NEEDS: Data not available AST UPDATED: February 24, 2021	Partners	JBI has a 20-year master agreement with Veridisyn, who has agreed to license the P2O technology and purchase P2O processors. Other partners include GTI, Indigo Energy, RockTenn, XTR Energy and Coco Paving.

Business

Model

P2O offers opportunities to sell its fuel products through three channels: fuel brokers, fuel retailers and direct to endusers.



LOCATION Kalka, Haryana, India (HQ)

TECHNOLOGY TYPE Conversion (Thermal)

STAGE OF MATURITY Pilot

SUPPLY CHAIN: Plastics to Fuels and Petrochemicals

CAPITAL NEEDS: Data not available

LAST UPDATED: February 24, 2021

*Based on research and validated with PolyCycl.

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*Based on research only.

Description	PolyCycl offers Contiflow Cracker™, a patented technology that converts waste plastics to high- value petrochemical feedstock and industrial fuels using a next-generation continuous process.
Feedstock	PolyCycl processes post-consumer and post-industrial plastics, including HDPE, LDPE, PP, PS and multilayer packaging/ film.
Facilities	In 2016-2017, PolyCycl setup India's first continuous process demonstration plant for conversion of municipal waste plastics to industrial middle distillate fuels.
Partners	PolyCycl has a joint venture with Ramky Environment, India's largest waste management company. The company's demonstration plant has been audited by Mott MacDonald for product yield and fuel quality. PolyCycl has also established product market offtake acceptance and retails fuel generated from the plant to its industrial clients. PolyCycl was previously Ventana Cleantech.
Business Model	Currently, PolyCycl sells fuel generated from its demonstration plant to several industrial customers. In the short term, PolyCycl will be setting up its first plant in Hyderabad, India with Ramky Group. In the long term, PolyCycl will license its technology to waste management companies globally. PolyCycl also plans to form joint ventures with selective Tier-1 waste management companies to build and operate plastic-to-fuel facilities globally.

Reclaimed EcoEnergy LOCATION Newport Beach, CA, USA	Description	Reclaimed EcoEnergy (REE) processes feedstocks into lubricants via EcoCavitation™, a physical process that requires no added heat. The process can be described as millions of tiny micro-bubbles that attach to the surface and act as very tiny 'hammers,' destroying the weak carbon bonds. The output is pure carbon, which is combined with hydrogen to form pure organic lubricants.	LOCATION Redcar, UK
TECHNOLOGY TYPE Conversion [Cavitation]		REE's technology accepts any organic material source, including plastics PET, HDPE, PVC, LDPE, PP, PS, "mixed" 3-7 and multilayer packaging/film.	TECHNOLOGY TYPE Conversion (Chemical)
STAGE OF MATURITY Pilot	Feedstock		STAGE OF MATURITY Early Commercial
SUPPLY CHAIN: Plastics to Chemicals	Facilities	Data not available.	SUPPLY CHAIN: Plastics to Petrochemicals and Chemicals
CAPITAL NEEDS: US\$5-10 million LAST UPDATED: February 23, 2021	Partners	REE was offered a Purchase and Sale Agreement for five units and a territorial license from an investment group out of Southern California, USA, with a background in the O&G sector.	CAPITAL NEEDS: Data not available
			LAST UPDATED: February 7, 2021
*Based on research only.	Business Model	Currently, REE is building out their first commercial project and looking to bring to market small-scale integration with MRF facilities.	*Based on research and profile submitted by UMass Lowell.

Description	ReNew ELP uses a patented hydrothermal upgrading platform called Cat-HTR™ to convert end- of-life waste plastics into a range of hydrocarbon feedstocks, for processing into new materials such as plastics and chemicals.
Feedstock	ReNew ELP can recycle residual post- consumer plastics, including all types of plastics (e.g., HDPE, LDPE, PP, PET) and complex multi-layer materials.
Facilities	ReNew ELP's first commercial-scale site is in development in Teesside, UK. On completion, the facility will be able to process 80,000 metric tons of plastic per year.
Partners	Currently, ReNew ELP is developing strategic partnerships with industrial partners in the waste plastic and chemical industry to facilitate the wider development and roll-out of the Cat- HTR technology.
Business Model	ReNew ELP is working with a number of industry and financial investors and recently secured £4.42 million of UK Government funding towards the construction of its first modular operating line. There is a project pipeline for the Cat-HTR technology; focus markets of Central Europe, North America and Asia are in development. They are currently fundraising for a global roll-out.

Resynergi evolutionary energy recovery systems	Description	Resynergi provides pyrolysis and gasification systems for converting plastics to low-carbon and low-sulfur fuels. The system's outputs are 70- 75% ASTM-grade gasoline (which is generally sulfur-free) and 15-20% char and syngas.	سابک عاداه
LOCATION			LOCATION
Santa Rosa, CA, USA			Houston, TX, USA
TECHNOLOGY TYPE Conversion (Thermal)	Feedstock	Resynergi processes HDPE, LDPE, PP and PS.	TECHNOLOGY TYPE Depolymerization (Chemical)
STAGE OF MATURITY			
Pilot		Resynergi is currently operating out of Washington and California, USA.	STAGE OF MATURITY Growth
SUPPLY CHAIN:	Facilities	The company's Evolucient Continuous Microwave Assisted Pyrolysis (CMAP) system is modular, compact and portable, with a per-unit capacity to process one to five metric tons per day of feedstock.	
Plastics to Fuels and Petrochemicals			SUPPLY CHAIN: Plastics to Polymers
CAPITAL NEEDS:			CAPITAL NEEDS:
Data not available		Resynergi has partnered with the University of Minnesota to develop this microwave-based technology.	Data not available
LAST UPDATED: February 25, 2021	Partners		LAST UPDATED: February 7, 2021
	Business Model	In the long-term, Resynergi aims to sell its modular microwave system to a range of buyers, such as big box stores and manufacturers.	

*Based on research and profile submitted by SABIC



SCIND¢	Description	Scindo uses novel enzyme functionality to breakdown vinyl plastics and polyolefins into short-chain molecular aldehydes. The enzymes are engineered and optimized to specifically target PVC, PE, PP and PS, together accounting for more than 70% of the global plastic production.	SIERRA ENERGY
LOCATION London, UK TECHNOLOGY TYPE Conversion (Biological)	Feedstock	Scindo focuses on the development of recycling solutions for mixed plastic waste containing PVC, PE, PP and PS that otherwise would be incinerated or landfilled.	LOCATION Davis, CA, USA TECHNOLOGY TYPE Conversion (Thermal)
Lab SUPPLY CHAIN: Plastics to Chemicals	Facilities	Scindo has a developmental lab in London, UK, and has demonstrated breakdown of vinyl plastics at lab scale.	STAGE OF MATURITY Early Commercial SUPPLY CHAIN: Plastics to Fuels
CAPITAL NEEDS: \$1.5 million Seed Round LAST UPDATED: February 23, 2021	Partners	Scindo is currently exploring a number of partnerships, both with recycling companies, as well as with specialty chemicals companies for the product output.	CAPITAL NEEDS: Series B in 2021 LAST UPDATED: January 29, 2021
*Based on research and	Business Model	Scindo is working on scaling up their technology for pilot studies, and will be generating revenue through the disposal of mixed plastic waste for recycling companies, and sale of output molecules to specialty chemicals companies to create a more circular economy for industries dependent on petrochemicals.	*Based on research and profile submitted by Sierra

profile submitted by Scindo.

Energy.

Description	Sierra Energy's FastOx® gasification system converts waste to clean syngas that can subsequently be upgraded to hydrogen, electricity and other end-products. It is based on blast furnace technology and operates at 4,000°F. Using computer-controlled injection nozzles, Sierra Energy can obtain consistent gas outputs despite inconsistent feedstocks.
Feedstock	Due to high temperature, FastOx® gasification is suitable for converting nearly all waste types including municipal solid waste, biomass, tires, plastics, medical waste, batteries and certain hazardous wastes.
Facilities	Sierra Energy has its commercial-scale demonstration facility commissioned and in operation for biomass and municipal solid waste at Fort Hunter Liggett, in Monterey County, California.
Partners	Sierra Energy's partners at the Fort Hunter Liggett facility include the California Energy Commission and the U.S. Army. Sierra Energy has several other partners tied to various aspects of the technology, including a specialist in value-added end-products from syngas.
Business Model	Sierra Energy plans to license its gasification technology and provide engineering services and monitoring of projects using FastOx® gasification. The company does not plan to build, own and operate systems in a majority of markets. The company will focus on gasification technology and partner with EPC firms to build the balance of the plant.

sweet gazoil	Description	Sweet Gazoil has a continuous anti- fouling ultra-fast pyrolysis technology called Surface Flash Cracking (SFC) that converts dirty mixed waste plastics into readily saleable diesel and/or specialty products without further refining.	Valoren
LOCATION Montreal, Canada	Feedstock	Sweet Gazoil targets post-consumer #2, #4, #5 and #6 plastics, including multi- layered, with some #1, #3, #7.	LOCATION Indaiatuba, São Paulo Brazil
TECHNOLOGY TYPE Conversion (Thermal) STAGE OF MATURITY Early Commercial SUPPLY CHAIN: Plastics to Fuels and	Facilities	Sweet Gazoil is building their first commercial-scale SFC demonstration plant in Quebec that will intake 15,000 metric tons per year of contaminated mixed plastics, with an average of 15% contamination. The unit transforms 12,750 mixed waste plastics into good quality ultra-low sulfur diesel (USLD) or naphtha.	TECHNOLOGY TYPE Conversion (Chemical) STAGE OF MATURITY Pilot SUPPLY CHAIN:
Petrochemicals CAPITAL NEEDS: US\$9.7 million for the SFC demonstration plant	Partners	Sweet Gazoil has partnered with Soleco Energy and Canada STDC to build the SFC demonstration plant. Sweet Gazoil is upgrading Soleco's batch plastic pyrolysis unit in Quebec and has performed R&D for the design of the SFC plant.	Plastics to Petrochemicals CAPITAL NEEDS: US\$5 million (for expansion in Brazil) and
LAST UPDATED: February 23, 2021 *Based on research and profile submitted by Sweet Gazoil.	Business Model	Sweet Gazoil is working with Soleco Energy who will build, own and operate the SFC demonstration unit. In the long term, Sweet Gazoil will work with Soleco Energy to build SFC plants throughout Canada and will continue to commercialize the technology worldwide through licensing agreements.	US\$4 million (for first operation in Europe) LAST UPDATED: February 23, 2021 *Based on research and profile submitted by Valoren.

Description	Valoren has developed a low-cost technology to produce naphtha- like specifications and other petrochemicals without requiring additional distillation. The company operates integrated plants (mechanical and chemical recycling).
Feedstock	Valoren focuses on post-consumer plastic films from landfills, although the process also works with a variety of plastics with low concentrations of PVC and PET.
Facilities	Valoren currently has two sites: mechanical recycling PCR-oriented (18,000 metric tons per year) and chemical recycling (1,800 metric tons per year).
Partners	Valoren has worked closely with international and local universities to develop its own technology. The products have been tested and approved by petrochemical companies such as Braskem.
Business Model	Valoren designs, constructs, owns and operates its plants. Besides the plant in Brazil, Valoren has agreements to build new plants in Europe with local partners. Their intended expansion in Brazil will be a co-located plant at a landfill, to help divert plastic waste from landfill.



CONTACT

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Learn more about molecular recycling in our report, *Transitioning to a Circular System for Plastics: Assessing Molecular Recycling Technologies in the United States and Canada*.

This directory was created by Bea Miñana and designed by Emily Mills.