Regulatory Treatment of Manufacturing Facilities that Convert Post-Use Plastics to Fuels, Chemical Feedstocks and other Petroleum Products

This document was developed by the American Chemistry Council's Plastics-to-Fuel & Petrochemistry Alliance (PFPA). It provides guidelines for how state policymakers and regulators should classify and regulate facilities that convert post-use plastics into oil, fuels, chemical feedstocks, monomers and other useful products such as waxes and lubricants. It also provides a checklist of typical federal, state, and local permits required to operate such facilities.

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Introduction: Plastics-to-Fuel and Petrochemistry (PTFP) Manufacturing Facilities

Intent

Technological innovation is enabling non-recycled plastics[1] to be diverted from landfills and converted via pyrolysis to useful fuels and chemical products. This helps move us closer to a circular economy and the U.S. Environmental Protection Agency's goal of sustainable materials management.[2] Because commercialization of these technologies is relatively new, states are seeking reliable information to better understand how they work in order to effectively regulate them and to answer questions about their impacts. To date only a few states have developed permitting frameworks to address pyrolysis. States should therefore consider new legislation or reform to existing regulations to ensure their permitting frameworks enable the deployment of PTFP facilities and other conversion technologies. This document identifies and explains the inputs, the process and the products, and shares why existing regulations for manufacturing facilities are the most appropriate for these facilities.

Manufacturing Process and Products

A PTFP facility is a manufacturing plant that takes non-recycled plastics (NRP) and converts them into petroleum-based products via a thermochemical process in an oxygen-free environment. This process is sometimes called pyrolysis. A PTFP facility first receives pre-processed plastic feedstock that has been shredded, dried, and cleared of most non-plastic contamination. Next, the PTFP facility heats this NRP feedstock *in the absence of oxygen* until it melts and forms gas vapors. Some of these gases are then cooled and condensed into synthetic crude oil and/or other petroleum-based products. The condensed product can subsequently be refined into the following types of products: heating and transportation fuels and blendstocks, waxes and lubricants, and feedstocks to produce new chemicals and plastic resins. Two other co-products are created at a PTFP facility: (1) non-condensable gases (including propane) which are usually captured for use as process energy, reducing the need for energy inputs, and (2) carbon, sometimes called "char," which can be sold as carbon black or a low-grade boiler fuel.

Regulatory Guidance for PTFP Manufacturing Facilities

Standalone PTFP facilities should be regulated as manufacturing because these facilities receive a feedstock and produce valuable commodities for sale in commercial markets. However, since it's a relatively new and innovative technology many regulators have questions about the process, the feedstocks and if PTFP facilities are accepting materials that

[1] Non-Recycled Plastics are defined as post-use plastics that are not recycled in commercial markets.
[2] Sustainable Materials Management is defined as a "systematic approach to using and reusing materials more productively over their entire life cycles" U.S. EPA. https://www.epa.gov/smm

ideally should be mechanically recycled. A PTFP facility does not receive mixed solid waste (MSW) nor does it burn or combust plastic or waste. Instead, a PTFP facility receives feedstocks (rigid, flexible, and mixed plastics) that are converted into valuable petroleum products via an oxygen-free environment to prevent material from becoming waste. The process and product outputs are already addressed under regulatory frameworks set at the local, state, and federal level. These are addressed in the *Federal, State, and Local Permit Considerations of this FAQ*. These frameworks may include those governing air, wastewater, and sometimes hazardous materials.

The following points address some of the more common misunderstandings about regulating new PTFP manufacturing facilities:

- PTFP feedstock is not solid waste
- PTFP facilities are neither landfills nor "waste-to-energy" facilities
- Recyclers should determine whether there is a viable market for the plastics
- Storage of plastics feedstock should be allowed onsite
- Off-spec feedstocks and by-products will need to be safely disposed of offsite because contaminated material is not suited for PTFP manufacturing.

PTFP feedstock is not solid waste.

Even though PTFP facilities generally receive plastics that have very low value in commercial markets, relevant definitions should treat the primary PTFP feedstock as *feedstocks* or *materials for manufacturing, and not as MSW or solid waste*. Solid waste facility definitions should focus on the mixed types of material that are unsuitable for manufacturing feedstock, are contaminated and create risks and hazards if improperly managed. Sorted and graded materials that meet the specifications of the PTFP manufacturer as *feedstocks* are not waste. Solid waste should only describe those materials that cannot be sorted and upgraded for reuse or conversion into higher value commodities.

PTFP facilities are neither landfills nor "waste-to-energy" facilities.

Landfills and waste-to-energy facilities receive a tipping fee for receiving mixed solid waste. However, in some cases, generators of mixed plastics that do not have commercial buyers for these materials are willing to pay a fee so the PTFP will take these materials at a lower cost. Some regulators have suggested that a PTFP facility should not be able to charge a tip fee because it may induce haulers of solid waste to tip at the facility instead of a landfill. However, a PTFP facility works to enforce its feedstock specifications so that it does not receive mixed materials. It is in the PTFP facility's best interest to ensure the composition and consistency of the plastic feedstock. The acceptance of a fee, however, does not make the feedstock a waste, nor does it change the physical operations or the environmental considerations associated with the process. Another example of a tip fee facility that is not a disposal facility is a materials recovery facility (MRF). While they sell the recyclable commodities for much of their profit, the tip fees add security to cash flow that a daily-price, commodity business does not.

Recyclers should determine whether there is a viable market for the plastics.

Banning materials from use in PTFP because of the *technical possibility* that such materials may be recycled or once were recycled will result in large volumes of material being landfilled. Plastics recyclers have every incentive to sell their material to the highest value use. However, commodity markets change daily and the inventory a facility can stockpile for later sale is limited by the space of its facility. Large volumes of material likely would be sent to landfills during periods when there are, for example, no commercial buyers for the material. We have seen this in recent years with drastic changes to the import policies of China for scrap commodities. Additionally, non-market based restrictions or bans on technically recyclable material at a PTFP facility could result in plastics being landfilled. A free, open and competitive marketplace will most efficiently control the best use of the material at a given time.

Storage of plastics feedstock should be allowed onsite.

To operate efficiently, PTFP operators need a minimum supply of non-recycled plastics onsite in case of a feedstock supply disruption. A typical PTFP facility shouldn't need more than approximately one to three weeks of supply onsite. Like most other manufacturing facilities, feedstocks for PTFP facilities are usually contained in a covered place. One concern of regulators is that PTFP facilities may choose to leave considerable amounts of waste behind in the event of facility closure. We believe this scenario is highly unlikely because of existing manufacturing facility permitting requirements, potential financial penalties, and the millions of dollars of investment in equipment. Additionally, this implies leaving dirty contaminants when these facilities require clean, pre-processed material as feedstock. Because a PTFP facility is not a permitted solid waste facility, it can only convert plastic feedstocks to a marketable commodity. It must dispose of other materials offsite. A PTFP facility loses money on materials it receives which cannot be converted to saleable commodities. This is because the PTFP facility must pay for disposal of those materials. PTFP process wastes or other wastes are sent to regulated landfills or disposed at regulated disposal facilities offsite. Those offsite facilities are required, as appropriate, to make necessary financial assurances or guarantees for cleanup.

Because contaminated material is not suited for PTFP manufacturing, off-spec feedstock and by-products will need to be safely disposed offsite.

Not every material delivered to a PTFP facility can be used. Like other manufacturers, PTFP operators sometimes receive feedstock that does not meet the needed specifications. Therefore, some materials delivered to a PTFP facility need to be disposed of properly along with by-products of the PTFP process. Some have suggested that conversion technologies should only exist if they are at least 80% efficient or more. While this is a worthy goal, setting arbitrary conversion percentages without reference to actual operating conditions can hinder achieving a more circular economy where all materials are captured for their best use. Until we have a fully circular system, net energy and material recovery is an important leap forward compared to disposal.

Federal, State, and Local Permit Considerations

Existing local, state, and federal regulations for manufacturing can adequately address and permit for PTFP standalone facilities. The following section provides guidance on suggested permitting approaches and zoning, inputs, and outputs of a typical operation that may be regulated by local, state, and federal regulations.

Siting and Local Zoning

PTFP as a standalone facility
If the PTFP facilities are standalone, and do not have a plastics recycling facility co-located, the facility can be sited in areas designated for light industrial activity.

PTFP co-located with recycling
In this business arrangement, the recycling facility would require a property designated for heavy industrial use based on the operations of the recycling facility.

Some states may additionally impose land use siting or authorization requirements that specifically apply to facilities.

Inputs

Non-Recycled Plastics

Generally speaking, sorted mixed plastics that are used as feedstock for a PTFP system are culled up to three times to remove recyclables for sale. These steps include:

- At the curb by residents who want the material to be recycled or by the commercial or industrial generator;
- At the materials recovery facility, after determining what materials can be sold into commercial materials markets; and/or
- By the recycling center or PTFP operator with the intent to reduce specific plastics types, such as polyethylene terephthalate (PET) and polyvinyl chloride (PVC) that have lower conversion rates to useful petroleum products. Large volumes of clean, high value plastics such as PET, high density polyethylene (HDPE) and polypropylene (PP) bottles and containers will likely be removed and sold into materials markets. These resins consistently command higher value than fuels or petrochemical feedstocks when markets are functioning normally.

The remaining plastics still have value and thus should be treated as feedstocks or the primary “ingredients” for production and not classified as wastes.

Outputs – Products, Co-Products and Wastes

Fuels

Operators may need to comply with a range of regulations, depending on the use that will be made of the product produced. For example, if the product is to be sold as feedstock for a finished fuel product or as a final finished product, the PTFP operator may be required by one or more of the following:

- **Federal:**
  - U.S. Environmental Protection Agency (EPA) Toxic Substances Control Act (TSCA) Pre-Manufacturing Notice (40 CFR 720)
  - U.S. EPA Registration of Fuels and Fuel Additives (40 CFR 79)
  - Spill Prevention Control and Countermeasure (SPCC) Plan (40 CFR 112)
  - Occupational Safety and Health Administration (OSHA)

- **State:** State fire code may also require permits for or controls due to the storage of flammable materials

- **Local:** Local fire code may also require permits for or controls due to the storage of flammable materials

Monomers and Chemical Products

One of the outputs of a PTFP facility, depending on its configuration and technology, are monomers or feedstocks for chemicals and plastic resins. For example, a PTFP facility can produce styrene monomer via the pyrolysis process. The process chemically recycles polystyrene back to styrene monomer. A used polystyrene foam coffee cup can be taken back to its basic chemical.

Carbon/Char/Carbon Black

If the char/carbon black is pure, then this becomes a product that can be used as carbon black for rubber manufacturing, ink production, or as an ignition fuel for industrial boilers such as steel furnaces. If the char is contaminated as a result of off-specification feedstock such that it becomes hazardous, then:

- **Federal:** Under the Resource Conservation and Recovery Act (RCRA) (40 CFR 260-299), the char must be disposed of as a hazardous waste. If the amount of hazardous waste generated is below the threshold of 100 kg/month, then the facility is regulated as a Conditionally Exempt Small Quantity Generator of hazardous waste and must meet certain labeling, storage, and reporting requirements. If it generates between 100 kg and 1,000 kg per month, then the facility is a Small Quantity Generator, and must obtain a generator identification number, and meet inspection and training requirements. If the facility generates more than 1,000 kg per month, then the facility is a Large Quantity Generator and is subject to additional requirements.

- **State:** Often the enforcement of the federal regulations is delegated to the state's environmental agencies.

- **Local:** Local agencies, such as counties, tend to be the waste system operators yet do not necessarily exert regulatory authority over the private sector haulers and processors. In some counties and cities there may be unique local legislation, such as toxic right to know laws that may require disclosure and reporting. Therefore, the local agencies may set more strict standards by contract than the federal or state government.

Contaminated or Unwanted Materials from Feedstocks. A PTFP facility utilizes plastics as its feedstock for conversion to marketable fuels and other petroleum products. However, materials such as paper, metal, and other small-unidentified material may show up in the feedstocks. This material is not used as energy or converted to a product. Rather, it is generally recycled or disposed of as regular solid waste. However, while rare, if the contaminants exhibit characteristics of hazardous waste, they must be handled and disposed of as hazardous waste.

Salts

Plastic resins containing chlorine are undesirable in the process because they yield low quantities of oil. These resins are generally removed or excluded from the raw material streams, to the extent possible. However, some chlorinated plastics may find their way into the process. Because the chlorine can cause corrosion of the equipment and deterioration of product quality, chlorine is often combined with additives and reacted in-situ to form salts.

Air – Natural Gas and Fuel Gas Combustion

Data show that emissions from PTFP technologies are lower when compared to many other industrial facilities found in communities across the nation. The pyrolysis process is a much lower emitter compared to a waste-to-energy facility because it does *not* directly combust non-recycled plastic. Further, the by-products of the pyrolysis process include non-condensable gasses such as propane. These "fuel" gasses are a useful energy source and are combusted for heat to reduce the need for virgin natural gas as an energy source. The production of non-condensable gases represents a loss of yield of saleable commodity products. Therefore, it is prudent and environmentally beneficial according to the U.S. Department of Energy's Argonne National Laboratory, to use these fuels gasses as an energy source.[3] For a comparison of emissions from a PTFP facility to other commercial facilities such as food processing or hospitals and universities please see: *Comparison of Plastics-to-Fuel and Petrochemistry Manufacturing Emissions to Common Manufacturing Emissions* at the following link: https://plastics.americanchemistry.com/Plastics-to-Fuel-Manufacturing-Emissions-Study.pdf

Air emissions from the process of converting non-recycled plastics to petroleum products mainly come from two sources: (1) combustion of natural gas for process heat for the pyrolysis vessels (if electricity is not used); (2) combustion of any vaporized portion of the plastics that cannot be condensed into liquid petroleum products; and (3) combustion to supply electricity. These light “fuel gases” or non-condensable gases (e.g., propane, ethane, methane, and butadiene) represent up to 10-15% of the mass of the vaporized plastics and can be combusted like natural gas in commercial scale PTFP systems to provide process energy.

Alternately, these gases may be fully combusted without energy recapture to destroy certain compounds. Note that this is *not* combustion of the plastics feedstock, but efficient and environmentally sound handling. PTFP facilities will vary in scale and the types of plastics they receive may vary, so air emissions will have to be determined on a facility-by-facility basis. However, the combustion of the non-condensable gasses typically produce (in descending order): carbon dioxide, particulate matter (PM 10 and 2.5), carbon monoxide, nitrogen oxide, and organic carbon well below permitting thresholds. Other non-process emissions sources from PTFP, such as CO_2, are similar to many manufacturing facilities (e.g., combustion of propane used as fuel for forklifts or methane combustion to produce heat and steam). PTFP facility operators recognize that despite their low emissions, the following federal, state, and local air permits may be required depending on the scale and throughput of the operations.

- **Federal:** Federal air permit requirements are triggered if a facility’s potential air emissions exceed certain thresholds. Applicable thresholds for criteria pollutants (particulate, VOCs, SO_x, NO_x, CO and lead) vary between 10 and 250 tons per year depending on the air quality of the area in which the facility is located. For hazardous air pollutants (HAPs), federal air permitting requirements are triggered if the facility has the potential to emit 10 tons/year for a single HAP or 25 tons/year for any combination of HAPs per section 112 of the Clean Air Act (CAA). Depending on the precise feedstocks, equipment, and operations present at the facility, federal regulations may additionally impose emission limits or other operational requirements on the facility’s operations under the New Source Performance Standards (NSPS) and/or the National Emission Standards for Hazardous Air Pollutants (NESHAP) programs.

[3] Benavides, Sun, Han, Dunn, and Wang. (2017). *Life-cycle analysis of fuels from post-use non-recycled plastics.* Fuel 203 (2017) 11–22.

- **State:** Even if the facility does not trigger federal permitting requirements, it may still need a state air construction and/or operating permit, depending on the state and the local air emissions permitting requirements. In addition, it may be subject to state-imposed emission limits and/or operational requirements.

- **Regional:** Federal air quality enforcement authority is traditionally delegated to the state for enforcement. In turn, some states delegate the authority for enforcement to local air quality authorities that are usually air shed based in their reach. For example, in California, Air Quality Management Districts (AQMD) enforce the federal, state, and/or other more stringent standards, depending on air quality concerns.

Water

Process Water. Depending on the technology, process water is likely to be treated, recirculated, and periodically purged, usually to a liquid waste company.

- **Federal:** Under the Clean Water Act (CWA), a facility's discharge of process water to waters of the United States requires authorization. A facility may choose to discharge process water directly, pursuant to a National Pollutant Discharge Eliminations System (NPDES) permit obtained by the facility, or indirectly via discharge to a Publicly Owned Treatment Works (POTW). Prior to discharge, the facility may be required to treat it on-site to meet certain criteria including categorical pre-treatment standards. *See* 40 CFR Part 403, *et seq*.

- **State:** Each state typically implements the NPDES permit program and will issue NPDES permits. A facility's NPDES permit will include discharge limits, sampling, and reporting requirements. If a facility discharges indirectly to a POTW, the POTW will hold an NPDES permit and may, in turn, impose requirements on the facility to obtain a discharge authorization and/or ensure that its discharges do not prevent the POTW from meeting the POTW's NPDES permit requirements.

- **Local:** A discharge permit from the local wastewater authority may be required if process water meets local specifications.

Stormwater. The CWA also regulates discharges of surface water drainage (stormwater) through its NPDES and General Permit programs. PTFP equipment is typically indoors, so the requirements regarding storm water would likely be limited to construction, parking, and loading and unloading areas for inbound feedstocks and outbound products. If the correct physical controls are in place (e.g., cover and controlled drainage basins) then a PTFP facility may be able to obtain a "No Exposure Certification," which effectively exempts the facility from the need for additional permits.

- **Federal:** *See* 40 CFR 122.26(b) (14) and (15) for a list of industrial facilities that are required to obtain a permit for storm water discharges.

- **State:** Similar to discharges of process water, stormwater discharges are typically implemented by the states through their NPDES programs and state-specific General Stormwater Permits.

- **Local:** Though not typical, states may delegate enforcement authority under the relevant NPDES programs to local agencies.

Frequently Asked Questions (FAQs)

1. Why should PTFP facilities be regulated as manufacturing and not as solid waste disposal facilities?

Because these facilities receive a feedstock and produce a valuable commodity for sale. That is the definition of manufacturing. Additionally, the non-recycled plastic feedstocks at a PTFP facility are not mixed solid waste. The plastics are *not putrescible, nor are they mixed materials* of all different types. In most cases, plastics that are brought to a PTFP facility have been sorted at the curb, sorted at a recycling center, and/or sorted for preparation as a manufacturing feedstock. Non-recycled plastics have been finding their way into landfills as a means of disposal. This is the result of a lack of options for public and private recyclers to convert these materials to higher value end products. Definitions in the existing solid waste code are not typically written for the technologies of today and may be outdated. Outdated regulatory definitions create a significant barrier for new innovations, such as PTFP facilities.

2. Will plastics-to-fuel facilities discourage recycling?

No, these facilities complement existing recycling and provide an opportunity for converting even greater amounts of plastics back to chemical feedstocks and monomers as well as conversion to fuels and other products. PTFP operators depend on an already-sorted supply of non-recycled plastics coming from recyclers that otherwise would be going to landfills. Plastics such as polyethylene terephthalate (PET) soda and water bottles, high-density polyethylene (HDPE) milk jugs and detergent bottles, and many rigid plastic containers such as HDPE, and polypropylene (PP) yogurt tubs and containers have strong end markets and are commonly recycled. Growing markets also exist for laundry baskets and buckets, as well as clean, dry HDPE and low-density polyethylene (LDPE) films such as bubble wrap, plastic bags, and dry-cleaning film. Generally, these materials are more valuable when recycled than converted to fuels or other chemistry products. PTFP was developed for plastics without a higher use. Market demands favor the highest and best use for materials. PTFP technology is for the plastics that are generally not mechanically recycled such as food-contaminated plastics, co-mingled mixed plastics, agricultural plastics, multi-layered flexible packaging, some plastic toys, and some engineered resins that do not have robust recycling markets. PTFP is a great option for converting post-use polystyrene back to styrene monomer for closed loop recycling. Therefore, PTFP will complement mechanical recycling and help make plastics recycling back to its base chemicals a reality.

3. Are PTFP facilities energy facilities?

No, they are manufacturing facilities. PTFP facilities are not combusting the oil, chemical feedstocks or petroleum-based products that they produce and *are not* combusting plastic or mixed solid waste to generate electricity. A PTFP facility recaptures energy from non-recycled plastic feedstock and converts it into a variety of products including heating and transportation fuels and blendstocks, waxes and lubricants, and feedstocks for chemicals and plastic resins. PTFP technologies induce a thermo-chemical conversion of the plastic molecules in an oxygen-starved environment, to make new vapors. These vapors are then condensed into crude oil and or distilled into other marketable petroleum products such as diesel fuel, naphtha or polymer feedstocks such as styrene. The products are sold to refiners or manufacturers to produce products such as boiler and transportation fuels, lubricants, new resins (monomers), chemicals or plastics. PTFP facilities do combust some fuels, usually natural gas, for process energy. Non-condensable gases produced via the pyrolysis process can be combusted for process energy. However, the use of such process energy should not be equated with combustion used in energy facilities to generate electricity and export power, as PTFP facilities are not energy providers.

4. Why is PTFP technology good for the environment?

Because PTFP complement existing mechanical recycling, keep valuable resources out of landfill and produce fuels and chemical feedstocks with a lower environmental footprint than virgin fuels and feedstocks.[4] Advances in engineering, design, and material innovation have resulted in plastic packaging that uses less material, preserves products longer, reduces food waste, reduces the use of fresh water resources, and reduces energy and greenhouse gases (GHGs) across the product life-cycle. And while these packaging materials have many desirable environmental attributes, their complexly engineered structure and use of several layers of materials require innovations in recycling technology. PTFP facilities would enhance recovery of these packages and similar plastic materials by effectively converting them into useful products or feedstocks for industry.

Argonne National Laboratory 2017 study, *Life-cycle analysis of fuels from post-use non-recycled plastics*, evaluated the life-cycle emissions of a PTFP manufacturing facility. Argonne evaluated the GHG emissions, water usage, and energy use of ultra-low sulfur diesel (ULSD) derived from post-use plastics at PTFP facilities. The analysis concluded that

[4] Benavides, Sun, Han, Dunn, and Wang. (2017). *Life-cycle analysis of fuels from post-use non-recycled plastics*. Fuel 203 (2017) 11–22.

compared to virgin ULSD, PTFP derived ULSD reduced: (1) GHG emissions by up to 14%, (2) water consumption by up to 58%, and (3) fossil fuel consumption (i.e. life-cycle processes including extraction) by up to 96%.

5. Can PTFP help get us closer to sending zero plastics to landfill?

Yes, it can. Today, we generally have four choices for managing difficult to recycle post-use plastics: convert to fuel or other products, waste-to-energy, landfill, or have the public sector subsidize non-economical recycling. PTFP has been shown to recover chemical mass and embodied energy better than the alternatives. It also keeps these valuable plastics out of landfill and gets us closer to a more circular system of recovery.

6. How efficient are PTFP facilities in recovering embodied energy in plastics?

PTFP is currently the most efficient technology at recovering energy embodied in plastics (compared to traditional energy recovery) and puts this energy into a storable medium. The following table and chart illustrate the comparison Energy Return on Energy Invested (EROEI) and GHG intensity when comparing PTFP fuel and styrene production to virgin extraction and production. For a fuel product, PTFP is more efficient in its ability to produce the same equivalent product with a range of EROEI of three to seven. From a GHG perspective, PTFP derived fuels produce 1/3 to 1/6th the GHG emissions in comparison to the extraction and refining of crude oil. As for styrene monomers, similarly PTFP styrene production is more efficient and results in fewer GHG emissions (described in the next section).

Table 1. Environmental Comparison of Non-Recycling Post-Use Options for Plastics

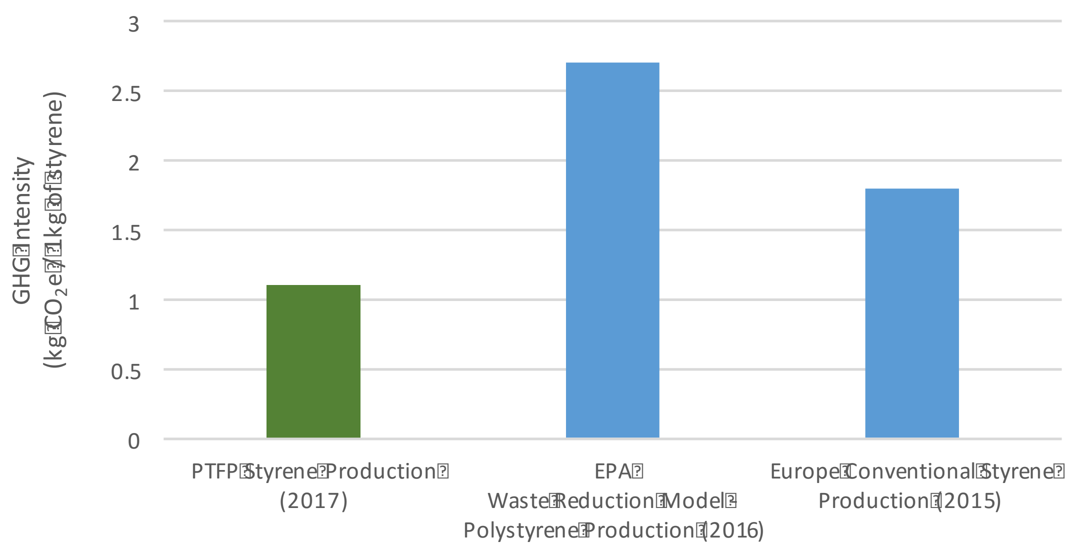
Management Options	Feedstock (Mixed Municipal Solid Waste (MSW) or Sorted Material)	Currently Counts toward diversion and recovery goals	Energy Returned on Energy Invested (EROEI)	Avoided Greenhouse Gases	Avoided Virgin Extraction
Plastics-to-Fuel	Sorted twice	No	~3-8x	1/3 to 1/6th of GHGs compared to virgin crude*	Crude oil
Waste-to-Energy	Mixed Solid Waste (MSW)	Depends on the state	~0.6-1.6x	Depends on electrical grid's carbon intensity	Coal or natural gas
Landfill with Flare	MSW	No	~0x	Reduced from fugitive methane	None

Source: Good Company Analysis, 2018
Integrated Pollution Prevention and Control Reference Document on the Best Available Techniques for Waste Incineration, 2006 http://eippcb.jrc.ec.europa.eu/reference/BREF/wi_bref_0806.pdf
** Note: the assumptions of this study and results per Argonne optimized operating conditions are based on the facility using landfill gas (LFG) for thermal energy in addition to the process gas and that if grid natural or electricity were used to power the facility the results would look very different.*

7. Will deployment of PTFP facilities lead to more recycling of plastics back to monomers, base chemicals and other plastic feedstocks?

Yes. Beyond producing transportation fuels such as diesel or crude oil, a PTFP facility can currently produce materials and raw ingredients for plastic resins such as polystyrene. Similar to emissions for fuel production, PTFP facilities are capable of reducing the GHG emissions associated with producing styrene from post-use expanded polystyrene (EPS) and high impact polystyrene (HIPS). Figure 1 shows the GHG intensity differences between a PTFP facility and virgin styrene based on EPA and European data points.

Figure 1. Comparison of GHG Intensity of PTFP with Virgin Styrene Production



Source: Good Company Analysis, 2018

8. How does a PTFP facility get decommissioned?

The operator will choose whether to continue in the business with new equipment or to de-commission the facility when the equipment comes to the end of its useful life. The operator will have to purge the facility of products and sell or dispose of the outputs and equipment. The operator will taper the volumes of feedstocks inbound to the facility and send any remaining feedstocks to another PTFP facility or for disposal before de-commissioning the equipment.

9. Who are the main customers of PTFP products?

The primary customers for the products produced by PTFP technologies are fuel refineries, lubricant manufacturers, and chemical and plastics manufacturing facilities. These customers value the purity of the PTFP products and the opportunity to utilize recycled inputs into their manufacturing process. Final products purchased from PTFP facilities and customers include heating and transportation fuels and blendstocks, waxes and lubricants, and feedstocks for chemicals and plastic resins. Additionally, local blenders, as well as refineries, can target customers for PTFP facilities that elect to distill crude oil into blendstocks such as naphtha and diesel.

10. How does a PTFP facility relate to renewable and low carbon fuel standards rules on the national and state level?

A fuel qualifies for the Renewable Fuel Standard (RFS) if it has a biogenic feedstock and reduces carbon compared to conventional fuels. The RFS is a federal program administered by the EPA. Plastics are still mostly fossil fuel based and currently do not qualify. If the bio-preference is eventually removed to allow for alternative fuels that demonstrate performance in reducing overall GHGs and energy consumption, PTFP and other alternatives may eventually qualify. Seven states (Louisiana, Minnesota, Missouri, Montana, Oregon, Pennsylvania, and Washington) have renewable fuels mandates. The European Commission also has a low-carbon fuels regulation in place.[5] In its most recent working document on impacts of varying fuels, the use of plastics as feedstocks to alternative fuels is assigned an upstream unit carbon intensity value of zero (this is not to say that PTFP products have a value of zero). See page 76 of the 125-page Annex VIII: Estimated GHG emission associated with fossil and biofuels.[6]

At the state level, California Air Resource Board's (CARB) Low Carbon Fuel Standard (http://www.arb.ca.gov/fuels/lcfs/lcfs.htm) encourages any fuel that has reduced carbon intensity compared to traditional fuels such as gasoline and diesel. CARB has not mandated a way to reduce the carbon intensity of vehicles fuels; it merely rewards fuel producers, importers and blenders for reducing carbon intensity and documenting performance. This program is open to any version of technology and is not limited to biogenic feedstocks. PTFP may be an important part of producing vehicle fuels of the future. Currently, California and Oregon in the United States are the only states to have a Low Carbon Fuels law in place.[7] British Columbia, Canada is the only province in Canada with a low carbon fuels standard; however, in late 2016 Canada announced that it would be adopting a national LCFS.[8]

11. What are states doing to address PTFP facilities more effectively with policy?

Many states are beginning to recognize that outdated waste and recycling laws and regulations need to be kept current with the latest technology. State regulatory contexts vary in how they address PTFP facilities and many are developing different approaches to more accurately and effectively regulate and deploy this production technology. States,

[5] Official Journal of the European Union. (2009) Directive 2009/30/EC of the European Parliament and of the Council http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0088:0113:EN:PDF
[6] European Commission. (2014) Commission Staff Working Document Impact Assessment. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0296&from=EN
[7] Center for Climate and Energy Solutions. (2017) Low Carbon Fuel Standard. https://www.c2es.org/us-states-regions/policy-maps/low-carbon-fuel-standard
[8] Government of Canada. (2017) "Clean Fuel Standard: Discussion paper" https://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=D7C913BB-1

such as Florida, Wisconsin and Georgia, via legislation have adopted specific language that provides a more welcoming and appropriate regulatory environment to develop PTFP manufacturing facilities. Florida's HB 335: Resource Recovery and Management, which became law in 2017, defines certain terms such as "pyrolysis," "pyrolysis facility," and "post-use plastics" and exempts PTFP facilities from certain resource recovery regulations. HB 335 also counts all the products of pyrolysis including crude oil, fuels and fuel substitutes as "recycling." Another approach, employed by Ohio is to grant a state waiver from regulation as a solid waste facility for the development and use of a PTFP facility. Other states, such as Michigan and Oregon have developed either Conversion Technology Rules or identified the need for tailored or regulatory exemption options for new and innovative technologies such as pyrolysis. The state of Oregon has established a definition for conversion technology facilities: "a conversion technology facility is one that primarily uses chemical or thermal processes to produce fuels, chemicals or other useful products from separated solid waste such as waste plastic or rubber. These chemical or thermal processes include but are not limited to: distillation, gasification, hydrolysis, pyrolysis, thermal depolymerization, transesterification[9] and animal rendering. These processes do not include melting (changing from solid to liquid through heating without changing chemical composition), direct combustion, composting, anaerobic digestion or mechanical recycling".[10] Other states, such as Pennsylvania, determine facility category via feedstock definition and the difference between waste and non-waste.

12. What are the useful approaches to attract these facilities?

States should consider reform to existing statutes and regulations to ensure their permitting frameworks are transparent and properly regulate PTFP facilities and other conversion technologies as manufacturing. Two general suggestions for reform are below:

Regulate PTFP facilities as a manufacturer utilizing raw materials for a manufacturing process. Existing laws provide adequate basis for the safety of the public and the environment for all the inputs and outputs of a PTFP facility. Making a clear distinction between PTFP operations and the operations of solid waste disposal facility is vitally important. A PTFP facility which uses difficult or non-recycled plastics as a feedstock is not that much different from many other manufacturing operations that use recycled plastics.

Count plastics converted to fuels, feedstocks or other petroleum products as diversion or recycling. PTFP facilities help avoid GHGs and support more circularity in our economy by returning non-recycled plastics to a valuable next use. While the materials change chemically, most of the mass of the material is recovered. Public waste managers and recyclers will be more likely to support PTFP if they are rewarded with diversion or recovery credits. Let the systems that prepare feedstocks for PTFP

[9] This the process of exchanging the organic group of an ester with the organic group of an alcohol.
[10] Oregon Department of Environmental Quality. (2014) Permit Exemptions for Conversion Technology Facilities http://www.oregon.gov/deq/FilterDocs/ConTechExemptFS.pdf

facilities get credit for its benefits.

Disclaimer

This document ("Regulatory Treatment of Manufacturing Facilities that Convert Post-Use Plastics to Fuels, Chemical Feedstocks and Other Petroleum Products") has been prepared to provide useful information to parties interested in the conversion of non-recycled plastics to oil, fuels, and chemical feedstocks. Different jurisdictions may vary their approach with respect to particular regulations, permits, and policies. Further, operations and conditions may vary between PTFP facilities. This FAQ is not designed or intended to define or create legal rights or obligations. ACC does not make any warranty or representation, either express or implied, with respect to the completeness of the information contained in this report; nor does ACC assume any liability of any kind whatsoever resulting from the use of or reliance upon any information, conclusion, or options contained herein. ACC's Plastics-to-Fuel & Petrochemistry Alliance sponsored this FAQ. This work is protected by copyright. ACC, which is the owner of the copyright, hereby grants a nonexclusive royalty-free license to reproduce and distribute this work, subject to the following limitations: (1) the work must be reproduced in its entirety, without alterations; and (2) copies of the work may not be sold.

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