Regulatory Treatment of Plastics-to-Fuel Facilities

This document provides guidelines for how state policymakers and regulators should classify and regulate new Plastics-to-Fuel Facilities. 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 (PTF) Facilities

Technological innovation is enabling non-recycled plastics[1] to be diverted from landfills and converted to useful fuels and chemical feedstocks. This has led to increasing interest from state and local governments. States are raising important questions about how to regulate these technologies and this document seeks to answer those questions. A plastics-to-fuel (PTF) facility is a manufacturing plant that takes non-recycled plastics and converts them into petroleum based products via a thermochemical process in an oxygen-starved environment, sometimes called pyrolysis. A PTF facility first receives pre-processed plastic feedstock that has been shredded, dried, and cleared of most non-plastic contamination. Next, the PTF facility heats this non-recycled plastic feedstock in the absence of oxygen until it melts and eventually cracks the polymer molecules to form gas vapors. The condensable gases are then converted to synthetic crude oil and/or other petroleum based products. The low-sulfur crude oil can subsequently be refined into fuels for transportation or boilers, lubricants, waxes, or even feedstocks (such as naphtha) for new chemicals and plastics. Two other co-products are created at a PTF facility. Non-condensable gases (including propane) are usually captured for use as process energy – thus reducing the need for energy inputs – or are sometimes safely flared. A carbon, sometimes called "char" is also produced. It can be sold as carbon black or a low-grade boiler fuel. Or, it can be disposed as non-hazardous; however, if there are certain impurities in the char, it may need to be disposed of as hazardous waste.

Regulatory Guidance for PTF Facilities

Standalone PTF facilities should be regulated as any manufacturer would be regulated. A PTF facility receives feedstocks (rigid, flexible, and mixed plastics) that are converted into valuable petroleum products via an oxygen-starved environment. A PTF facility does not receive mixed solid waste nor does it burn the plastic or waste. Below are some guidelines for regulating new PTF facilities.

PTF Feedstock is not "solid waste."

Relevant definitions should treat the primary PTF feedstock (post-recycled material) as *feedstocks* or *materials, and not as municipal solid waste*. Solid waste definitions should focus on the mixed types of material that are contaminated and create risks and hazards. Sorted and graded materials of a similar type that meet the specifications of a manufacturer are *feedstocks*, not waste. Solid waste should only describe those materials that cannot be sorted and upgraded for re-use.

[1] Non-Recycled Plastics are defined as post-use plastics that, for whatever reason, are not recycled in commercial markets.

PTF facilities are neither landfills nor "waste-to-energy" facilities, and charging a "tip fee" does not change the nature of the PTF facility.

Some regulators have suggested that a PTF 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 PTF facility works to enforce its feedstock specifications so that it does not receive mixed materials with its plastic feedstock. The acceptance of a fee does not make the feedstock a waste, nor does it change the physical operations or the environmental issues associated with the process.

Let recyclers determine whether there is a viable market for the plastics.

Banning materials from use in PTF - because of the technical possibility that such materials may be recycled - will result in large volumes of material being wasted to disposal. Plastics recyclers have every incentive to sell their material to the highest value use (e.g., recycling). However, commodity markets change daily and the amount a facility can stockpile inventory for later sale is limited by the space of their facility. Large volumes of material might be wasted to disposal during periods when there are, for example, no end recycling markets for the material. This could be the result of bans or regulations that prevent use of technically recyclable material at a PTF facility. The market should efficiently control the best use of the material.

Allow storage of plastics onsite.

Generally, large supplies of non-recycled plastics are available. However, PTF operators need a minimum supply in case of a feedstock supply disruption due to events outside their control (such as labor disruption, severe weather). Typically a PTF facility shouldn't need more than approximately one to three weeks of supply onsite. Like any other manufacturing facility, the feedstocks should be in a contained and covered place.

Allow for disposal of off-spec feedstocks and by-products; these products would have been in the disposal system anyway.

Not every material delivered to a PTF facility can be used. Some material does not meet the relevant specifications. Inevitably there will be some materials delivered to a PTF facility that need to be disposed of properly along with by-products of the process. Some have suggested that conversion technologies should only exist if they are at least 80% efficient or more. This does not fully support the goals of recycling and reuse – which still have some waste as well. The ultimate goal is a closed-loop system where all materials are recycled perpetually with no waste. However, until we get there, net energy and material recovery is a far preferable outcome than disposal.

Unnecessary financial guarantees discourage investment.

Because a PTF facility is not a permitted solid waste facility, it can only convert non-recycled plastic feedstocks to a marketable commodity. It must dispose of other materials offsite. A PTF facility loses money on materials it receives which cannot be used as feedstock. This is

because the PTF facility must then pay for disposal. Therefore, a PTF facility is incentivized to only accept the material it can use. Waste to landfill and other process wastes are disposed at regulated disposal facilities offsite. Those offsite facilities are required, as appropriate, to make necessary financial assurances/guarantees for cleanup.

Federal, State, and Local Permit Considerations

The following section helps determine which permits may be required. It details zoning, inputs, and outputs of a typical operation that may be regulated by federal, state, and local regulations.

Siting and Local Zoning

Plastics-to-Fuel as a stand-alone facility
If the PTF facilities are stand alone, and do not have a plastics recycling facility co-located, the facility can be sited in areas designated for light industrial activity.

Plastics-to-Fuel co-located with recycling
In this business arrangement, the recycling facility would require a property designated for heavy industrial use.

Some states may additionally impose land use siting/authorization requirements that specifically apply to facilities conducting waste treatment (e.g., converting wastes to fuel) activities.

Inputs

Non-Recycled Plastics

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

a. At the curb by residents who want the material to be recycled or by the commercial or industrial generator;

b. At the materials recycling center, after determining what materials can be sold to materials markets; and/or

c. By the recycling center or PTF operator with the intent to reduce specific plastics types that are low oil yields (such as PET and PVC). Large volumes of clean, high value plastics will likely be removed and sold into materials markets.

These remaining plastics should be treated as feedstocks or the primary "ingredients" for production and not classified as wastes.

Outputs - Products, Co-Products, and Wastes

Oil

Operators may need to comply with a range of regulations, depending on the use that will be made of the energy 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 PTF operator may require one or more of the following:

a. Federal:
   i. U.S. Environmental Protection Agency (EPA) Toxic Substances Control Act (TSCA) Pre-Manufacturing Notice (40 CFR 720)
   ii. U.S. EPA Registration of Fuels and Fuel Additives (40 CFR 79)
   iii. Spill Prevention Control and Countermeasure (SPCC) Plan (40 CFR 112)

b. State: State fire code may also require permits for or controls due to the storage oil/flammable materials

c. Local: State fire code may also require permits for or controls due to the storage of flammable materials

Soil

Char/Carbon Black. If the char/carbon black is pure with no ash, then this becomes a product that can be used as carbon black for tire 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:

a. 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 1000 kg per month, then the facility is a Small Quantity Generator, must obtain a generator identification number, and must meet inspection and training requirements. If the facility generates more than 1000 kg per month, then the facility is a Large Quantity Generator and is subject to additional requirements as well.

b. State: Often the enforcement of the federal regulations is delegated to the state's

environmental agencies.

c. 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/reporting. Therefore, the local agencies may set more strict standards by contract than the federal or state government.

Feedstocks. A plastics-to-fuel facility utilizes non-recycled 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 and are 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 it is buffered with salts. Depending on test results of the salts post-use, the salt can be disposed of as non-hazardous or hazardous waste.

Air

The PTF manufacturing process is a low emitter because it does *not* incinerate non-recycled plastic. It converts the plastics to petroleum products in an oxygen starved environment and these petroleum products are used at refineries, vehicles, or boilers. These petroleum products are not combusted onsite at the PTF facility. 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); and (2) combustion of any vaporized portion of the plastics that cannot be condensed into liquid petroleum products. These light "fuel gases" or non-condensable gases (e.g., propane, ethane, methane, and butadiene) represent only about 10% - 15% of the mass of the vaporized plastics and are combusted like natural gas in commercial scale PTF systems to provide process energy for the pyrolysis vessels. Alternately, these gases may be flared (combusted) without energy recapture to destroy certain compounds. Note that this is *not* incineration of the plastics feedstock, but incineration of the non-condensable gases, similar to natural gas, to offset some virgin energy requirements. This is done via a negative pressure line into an environmental control device that combusts the gasses. PTF 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, post destruction, these gasses typically produce in descending order: carbon dioxide, particulate matter (10 and 2.5), carbon monoxide, nitrogen oxide and organic carbon well below any permitting threshold. Other non-process emissions from PTF, such as CO_2, are similar to any manufacturing footprint where heavy machinery is

operated (e.g., combustion of propane used as fuel for forklifts or methane combustion to produce heat and steam). Plastics-to-fuel facility operators recognize that despite their low emissions, they could need the following federal, state, and local air permits – depending on the scale and throughput of the operations.

a. Federal: Federal air permit requirements are triggered if a facility's potential air emissions exceed certain thresholds. Applicable triggering 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.

b. 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.

c. 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, they are called Air Quality Management Districts (AQMD) and they 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.

a. 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*.

b. 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.

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

Storm Water. The CWA also regulates discharges of surface water drainage (storm water) through its NPDES and General Permit programs. PTF 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 - such as cover and controlled drainage basins - then a PTF facility may be able to obtain a "No Exposure Certification," which effectively exempts the facility from the need for a permit.

a. 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.

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

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

FAQs

1. **Why should plastics-to-fuel facilities be regulated as manufacturing and not as solid waste disposal facilities?**
   In most cases the plastics that are brought to a PTF facility have been sorted at the curb, sorted at a recycling center, and/or sorted for preparation as a manufacturing feedstock. While 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 written for the technologies of today and may be outdated. Outdated regulatory definitions create a significant barrier for new innovations, such as plastics to oil technologies. Quite simply, the non-recycled plastic feedstocks at a PTF facility are not mixed solid waste - they are not putrescible, mixed materials of all different types.

2. **Will plastics-to-fuel facilities discourage recycling?**
   PTF 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 oil. PTF technology is for the plastics that cannot be economically recycled such as food-contaminated plastics, agricultural plastics, multi-layered flexible packaging, some plastic toys, and some engineered resins that do not have robust recycling markets. Therefore, PTF will not disrupt recycling operations.

3. **Are plastics-to-fuel facilities energy facilities?**
No. PTF facilities are not combusting the oil or petroleum based products that they produce and *are not* burning plastic or volumes of trash to generate electricity. A PTF facility recaptures energy from non-recycled plastic feedstock and converts it into low sulfur crude oil, diesel fuel and other petroleum products. PTF 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 or naphtha. The crude oil is sold to a refiner to produce products such as boiler and transportation fuels, lubricants, new resins, chemicals or plastics. PTF 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.

4. **Why are plastics-to-fuel facilities good for the environment?**
Advances in engineering, design and material innovation have resulted in plastic packaging that uses less material, preserves products longer, reduces food waste, and reduces energy and greenhouse gases across the product life-cycle when compared to alternative materials. And while these packaging materials have many desirable environmental attributes, because they are complexly engineered and use several layers of materials, they cannot always be economically recycled. PTF facilities would further improve the environmental attributes of these packages and similar plastic materials by converting them to useful feedstocks for industry.

   PTF is efficient in recovering embodied energy.
   PTF is currently the most efficient technology at recovering energy embodied in plastics for use and puts this energy into a storable medium. PTF can also reduce the use of fuel needed to transport plastics to a landfill and compact them.

   PTF displaces the need for some virgin crude oil extraction.
   PTF has roughly 1/3 of the carbon intensity of traditional crude extraction and is roughly 1/6 of the carbon intensity of certain new sources of crude oil, such as oil sands or shale oil. *See e.g.*, http://agilyx.com/images/Agilyx-Life-Cycle-Analysis.pdf.

PTF is the best solution we have today to get closer to zero waste for plastics.
Until there is global alignment among product manufacturers, retailers, consumers, packaging manufacturers, and waste system managers on standards for material types and closed loop systems for those materials, we have a challenge. Today, we have four choices for managing difficult to recycle post-use plastics: convert to oil, waste-to-energy, landfill, or have the public sector subsidize non-economical recycling. PTF recovers chemical mass and embodied energy better than the alternatives.

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	Avoided Greenhouse Gases	Avoided Virgin Extraction
Plastics to Fuel	Sorted twice	No	~16x	1/3 to 1/6th of GHGs compared to virgin crude	Crude oil
Waste-to-Energy	MSW	Depends on the state	~3x	Depends on electrical grid's carbon intensity	Coal or natural gas
Landfill with Flare	MSW	No	~0x	Reduced from fugitive methane	None

Source: http://agilyx.com/images/Agilyx-Life-Cycle-Analysis.pdf

5. **How does a plastics-to-fuel facility get de-commissioned?**
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 system of residual outputs 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 PTF facility or for disposal before de-commissioning the equipment.

6. **Who are the main customers of the oil from plastics-to-fuel facilities?**
The primary customers for the fuels and other petroleum products produced by PTF technologies are fuel refineries, lubricant manufacturers, and chemical manufacturing facilities. These customers value the purity of the products. These final products include transportation fuels, petroleum based waxes, and fuel oil with reduced contaminants. While the end markets for fuel, naphtha, and petroleum waxes and lubes are strong, it is possible that heat-intense industries might switch from co-firing with alternative fuels to PTF crude for air quality reasons. Local blenders as well as refineries are the target customers for PTF facilities that elect to distill crude oil into blendstocks such as naphtha and diesel.

7. **How does plastics-to-fuel 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 fossil fuel based and currently do not qualify. If the bio-preference is eventually removed to allow for alternative fuels that demonstrate promise in reducing overall greenhouse gases and energy consumption, PTF and other alternatives may eventually qualify. The European Commission also has a low-carbon fuels regulation in place (Fuel Quality Directive 2009). In its most recent working document on impacts of varying fuels, the use of plastics as feedstocks to alternative fuels is assigned a an upstream unit carbon intensity value of zero. *See page 76 of the 125-page pdf Annex VIII: Estimated GHG emission associated with fossil and biofuels; available at* http://ec.europa.eu/clima/policies/transport/fuel/docs/swd_2014_296_en.pdf

   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 carbon intensity; it merely rewards fuel producers, importers and blenders for reducing carbon intensity. This program is open to any version of technology and is not limited to biogenic feedstocks. PTF may be an important part of producing the fuels of the future. Currently California and British Columbia, Canada are the only two states/provinces to have a Low Carbon Fuels law in place. Several other states are in the rulemaking process including Oregon and Washington. In the Northeast and Mid-Atlantic there is a regional effort to develop a low carbon fuel standard. Participants include: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island and Vermont.

8. **What incentives could be offered to attract these facilities?**
   Because PTF technologies have not been widely deployed, few states have developed permitting frameworks that address their unique needs. States should reform their existing regulations to ensure their permitting frameworks enable the deployment of PTF and other conversion technologies. Two general suggestions for reform are below:

   Regulate PTF facilities as a manufacturer utilizing raw materials for a manufacturing process. Existing laws ensure the safety of the public and the environment for all the inputs and outputs of a PTF facility. Making a clear distinction between PTF operations and the operations of solid waste disposal is vitally important.

   Reward public waste system operators with diversion credits for use of PTF.
   PTF facilities help avoid greenhouse gas emissions and support a circular 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 PTF if they are rewarded with diversion or

recovery credits. Let the systems that prepare feedstocks for PTF facilities get credit for its benefits.

Disclaimer

This document ("Regulatory Treatment of Plastics-to-Fuel Facilities") 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 PTF 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. The American Chemistry Council's Plastics to Oil Technologies Alliance sponsored this FAQ. This work is protected by copyright. The American Chemistry Council, 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.