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Testimony on 2017 Senate Bill 646

Senator Robert Cowles
Senate Committee on Natural Resources and Energy - January 4, 2018

Thank you, committee members, for allowing me to testify on 2017 Senate Bill 646. This bill presents Wisconsin with a pro-business and pro-environment opportunity by defining the proper regulatory structure for the pyrolysis and gasification of post-use, non-recycled plastics.

As defined in this bill, pyrolysis and gasification facilities convert post-use, non-recycled plastics in an oxygen-free or oxygen-deficient environment into valuable commodities such as oils, fuels, waxes, lubricants, or chemicals. While pyrolysis and gasification facilities would divert plastics from landfills, the process of pyrolysis and gasification is much more reflective of the process that is currently done by hundreds of Wisconsin manufacturers. Senate Bill 646 clarifies that pyrolysis and gasification facilities are defined and regulated as manufacturing facilities and not as solid waste disposal facilities. This bill also ensures that post-use, non-recycled plastics that are converted via pyrolysis or gasification are not misclassified as solid waste, and that post-use plastics that are destined for a landfill are not prohibited from pyrolysis or gasification. Without this bill, these facilities would have to go through the timely, costly, burdensome and unnecessary process of solid waste facility citing with the DNR that other manufactures do not have to endure.

This bill does not interfere with the regulation of existing materials recovery facilities, mixed waste processing facilities, transfer stations, waste-to-energy facilities, or landfills, nor does it interfere with any current waste or recycling hauling, routes, or contracts. Pyrolysis and gasification are also different from the often-contentious waste-to-energy facilities that burn garbage. Finally, pyrolysis and gasification facilities would still be subject to other environmental regulations, including air and water permitting. According to a study done by Oregon-based consulting firm Good Company, air emissions from a typical pyrolysis facility are much lower than other manufacturing processes, largely because lost emissions are attributable to lost product and lost profit.

According to the DNR, Wisconsin recycles over 20,000 tons of plastics each year. Pyrolysis and gasification would complement this plastics recycling by converting the plastics that are not recycled in commercial markets to valuable fuels and chemical feedstocks. According to the American Chemistry Council, if all the non-recycled plastics in Wisconsin were instead converted to fuel, we could power over 150,000 cars each year! Additionally, putting post-use, non-recycled plastics into pyrolysis and gasification can sustain multiple facilities that would generate jobs and tens of millions of dollars in annual economic output.

Pyrolysis and gasification are already happening in the United States and Europe. In 2015, United Airlines announced an investment of $30 million in Fulcrum BioEnergy to build a gasification facility in Nevada to produce millions of gallons of cost-competitive and low-emission jet fuel. In Ohio, Vadxx is presently commissioning a new, commercial-scale pyrolysis facility. The European Union, a leader in waste diversion technologies, already regulates the pyrolysis and gasification of post-use, non-recycled plastics as manufacturing. Last year, a bill similar to Senate Bill 646 unanimously passed the Florida legislature, and other states, including Illinois, are looking to pass similar legislation.

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In summation, this bill opens the door for a new pro-business and pro-environment manufacturing industry in Wisconsin. The pyrolysis and gasification of post-use, non-recycled plastics is truly a beneficial industry, as this process creates new, stable and long-term markets for non-recycled plastics which benefits businesses and consumers, and an increased diversion of materials from our landfills which benefits local governments and communities.

Increasingly, creating value from non-recycled materials is a priority of consumer product companies and municipalities. New technologies like pyrolysis and gasification are key to this transformation. Through new technologies like pyrolysis and gasification, we will complement the current plastics recycling industry by transforming non-recycled plastics that would otherwise go to landfills into valuable commodities. Wisconsin has the opportunity to be on the cutting edge of this new industry, and Senate Bill 646 will ensure that Wisconsin continues to lead the nation in sustainably managing our waste and manufacturing innovation.

PAUL TITTL

STATE REPRESENTATIVE • 25TH ASSEMBLY DISTRICT

Senate Committee on Natural Resources and Energy
Senate Bill 646
January 4, 2018

Committee members, I appreciate this opportunity to testify before you today concerning Senate Bill 646.

I agree with the testimony Senator Cowles has just presented, and I will not repeat the comments he has already made. However, I would particularly like to express my support for this bill on account of the economic opportunity it presents.

When first approached about the bill, I immediately thought about how it would be good not only for people in my area of the state but for the rest of the state as well.

First, because pyrolysis is an entirely new industry and does not currently exist in Wisconsin, it presents additional job opportunities for Wisconsin workers and their families.

These opportunities extend not only to people who engage in the actual pyrolysis work but also to other workers. In another state, construction of a pyrolysis facility cost $30 million. That translates into local construction related jobs that are important for our economy. In addition, the growth in pyrolysis can have an indirect, positive effect on other businesses in our communities.

Second, companies that currently pay to have their plastics deposited in landfills can save money and reinvest it in what they do best: running their businesses, creating jobs and producing goods and services.

Pyrolysis could reduce our dependence on fossil fuels and foreign oil, providing fuel for 150,000 cars per year, which amounts to 7% of registered vehicles in Wisconsin.

Finally, local communities can more efficiently use their landfills to manage waste that cannot be recycled. That result is good for our communities, because they can save money and landfill space in the long-term.

Other speakers will touch upon the economic benefits of this bill, so I will conclude my remarks at this point. This bill is good for our environment and our economy, and I ask for your support.

Thank you for providing this opportunity to testify before you today.

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American Chemistry Council

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.

   <u>PTF is efficient in recovering embodied energy.</u>
   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.

   <u>PTF displaces the need for some virgin crude oil extraction.</u>
   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.

American Chemistry Council | Plastics-to-Fuel & Petrochemistry Alliance

Comparison of Plastics-to-Fuel and Petrochemistry Manufacturing Emissions to Common Manufacturing Emissions

July 24, 2017

Prepared by:

good company

Plastics-to-Fuel and Petrochemistry (PTFP) facilities produce fuels and chemistry products from post-use plastics that are not traditionally recycled in commercial markets. PTFP technologies are a new generation of a manufacturing process known as pyrolysis.

PTFP technologies can complement the traditional recycling of post-use plastics and enable communities and businesses to divert greater quantities of valuable plastics from landfill. The production of fuels, chemical feedstocks, and monomers from post-use, non-recycled plastics can offset the need for some virgin material extraction and production. The U.S. Department of Energy's Argonne National Laboratory has determined that there are quantifiable environmental benefits to converting post-use, non-recycled plastics to fuels instead of sending these plastics to landfill.[1]

Pyrolysis: How does it work?

A PTFP facility first receives plastic feedstock that has been shredded, dried, and cleared of most non-plastic contamination. Next, this "post-processed" feedstock is heated in the absence of oxygen and halogen until it melts and the polymer molecules break down to form gaseous vapors. The condensable gases are converted to fuel and chemistry products while the non-condensable gases are collected separately and either combusted for process energy, or flared. Some of the products the technology can make include: fuels for transportation or boilers/furnaces, lubricants, waxes, or even feedstocks (such as naphtha or monomers) to produce new chemicals and plastics.

The ideal plastic resin feedstock depends on the intended end product. Generally speaking, resins that yield greater amounts of useful end products include high density polyethylene (HDPE), low density polyethylene (LDPE), linear low density polyethylene (LLDPE), polypropylene (PP), polystyrene (PS), and some engineered resins labeled as #7 Other via the Resin Identification Code (RIC). By contrast, polyethylene terephthalate (PET) has lower yields, and more importantly generally has strong traditional material-recycling markets. Polyvinyl chloride (PVC) also yields low amounts of marketable liquid hydrocarbon product because a large percentage of the weight of PVC is chlorine, which does not give rise to a combustible product such as a fuel. The presence of elements other than carbon, hydrogen, and oxygen is not generally desirable in the resultant pyrolysis products.

1 "Life-cycle analysis of fuels from post-use, non-recycled plastics." Fuel. Volume 203, 1 September 2017. Pahola Thathiana Benavides, Pingping Sun, Jeongwoo Han, Jennifer B. Dunn, Michael Wang.

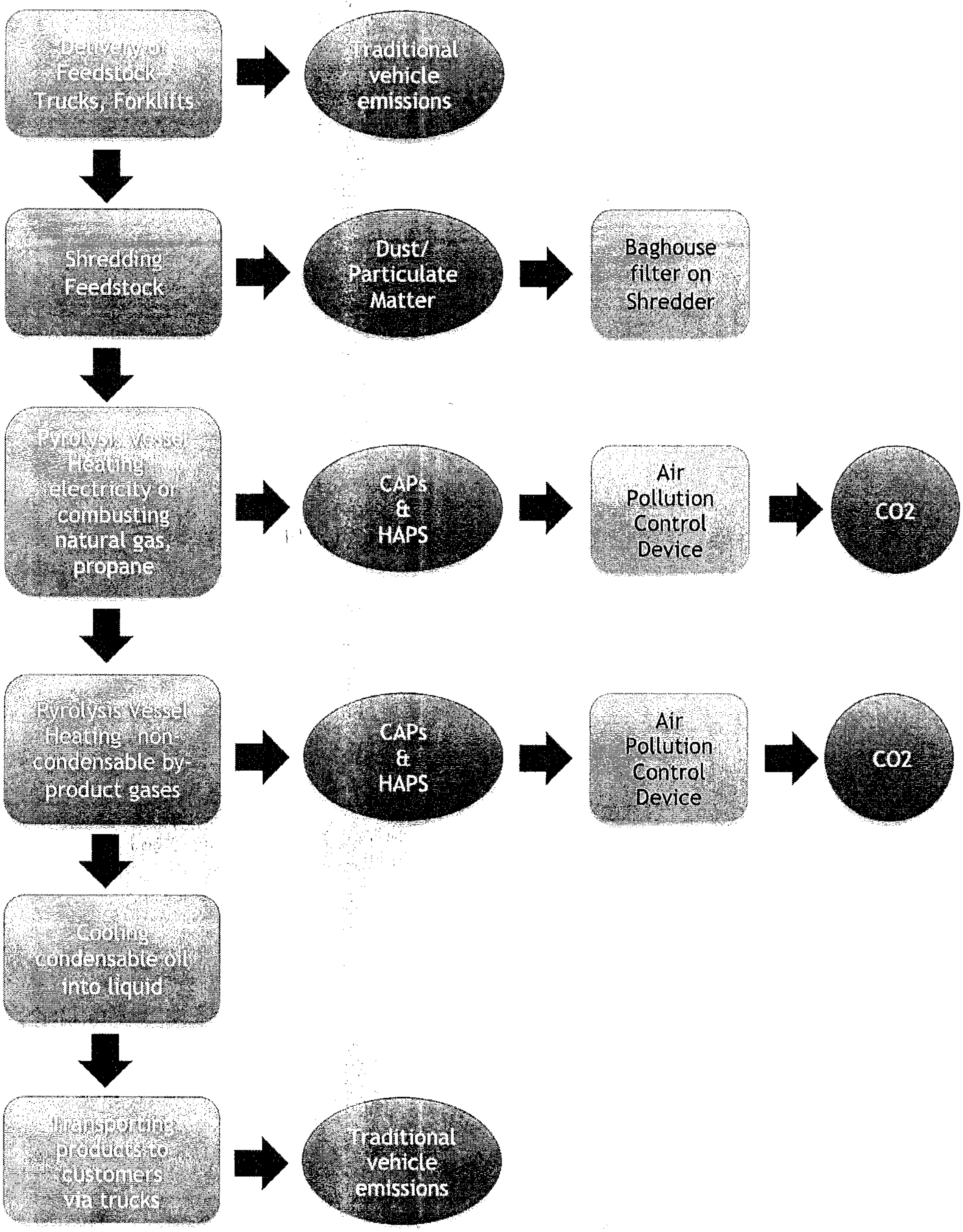
Plastics to Fuel: What are the primary steps and sources of PTFP emissions?

This paper explains what PTFP technology is and provides emissions data to help evaluate the safety of these operations. To put the data into context, we have provided emissions from several manufacturing industries. The data demonstrate that the emissions produced by PTFP technologies are lower when compared to many other industrial facilities found in communities across the country. This paper diagrams all the sources and types of emissions from a PTFP operation.

Importantly, pyrolysis is not the same as solid waste combustion. Instead, non-recycled plastics which have been sorted/separated three times (at the curb, at the recycling facility and once more to remove non-plastic contamination) are processed in a closed system that is heated in the absence of oxygen. The primary steps in the PTFP process include:

1. The site is visited by trucks delivering post-use plastic feedstocks. These materials are unloaded by a forklift that could be powered by gasoline, diesel, propane or electricity.
2. The feedstocks are shredded to reduce the size and densified in some cases. A filter collects the dust and contains it in a baghouse for disposal.
3. The pyrolysis vessels are sealed and starved of oxygen, then heated with electricity, natural gas, or propane. Because air pollution control devices are employed, the external emissions from heating pyrolysis vessels tend to be the same as a home stove or water heater on a per unit basis.
4. The newly formed vapors/gases are then cooled and condensed, and air pollution control devices are used to prevent additional emissions at this stage.
5. The non-condensable gases such as methane and hydrogen are generally co-fired with natural gas or propane to heat the vessels. This produces CO2 and water. Alternately, these gases are combusted with natural gas to destroy the emissions and produce CO2 and water. In the European Union, the non-condensable gases may not be co-fired to heat the vessels, so they are combusted directly.
6. After the gaseous vapors are condensed into the desired end products including crude oil, liquid fuels, fuel blendstocks or chemical feedstocks, the products are shipped offsite via rail, trucks, or barge that are most likely running on diesel fuel with emissions typical of that fuel.

Generalized Process Flow Diagram to Show Emission Sources and Types:



What PTFP emissions are regulated by the U.S. EPA?

There are both Federal and State programs designed to monitor emissions and protect communities' safety and well-being. The U.S. Environmental Protection Agency regulates both Criteria Air Pollutants (CAPs), and Hazardous Air Pollutants (HAPs). CAP emissions exceeding 100 tons per year are subject to federal regulation and require a Title V Permit. However, sources of any significant amount of CAP emissions must report the emission levels. In addition, CAPs may also be reportable under various state, regional, and other local air quality regulations (referred to as "local" regulations). Local jurisdictions (Departments of Environment, Air Quality Management Districts, etc.) are responsible for enforcement and often require more stringent reporting and limits on emissions than the EPA. CAPs are commonly found pollutants that are detrimental to human health, and include these 6 compounds:

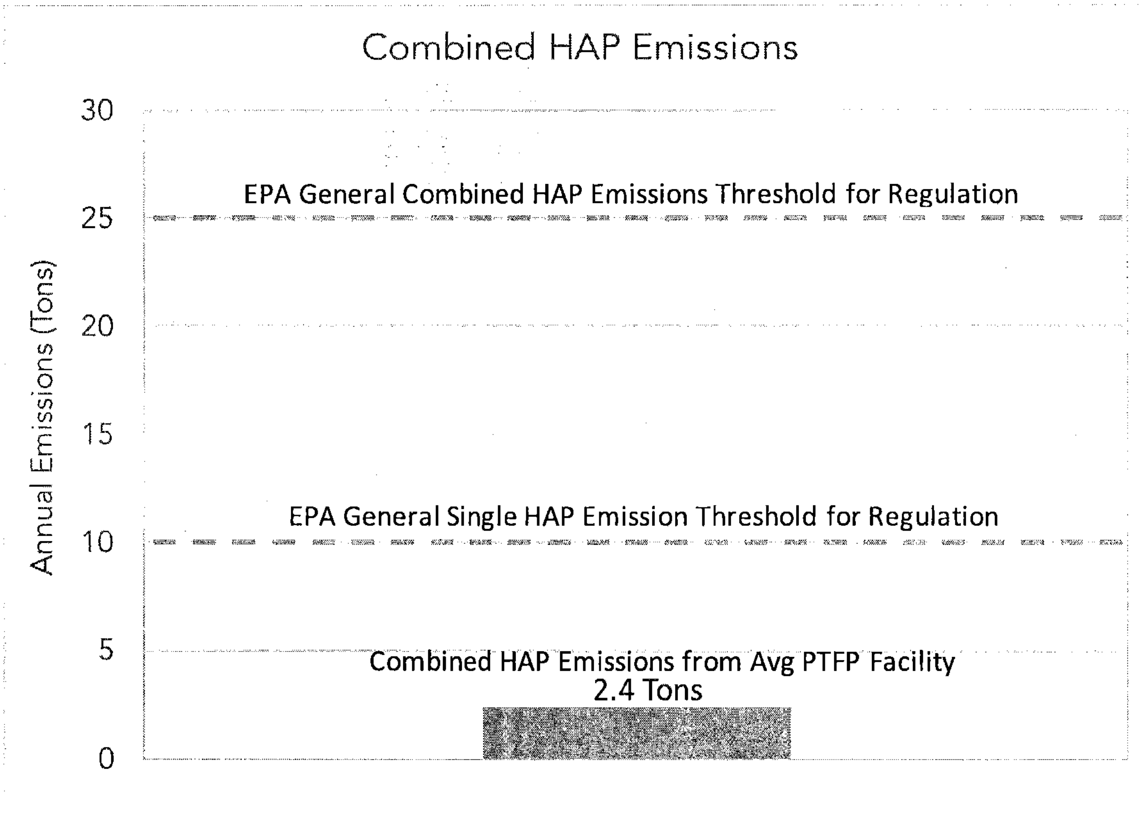
- Surface Ozone (O_3) / Volatile Organic Compounds (VOCs)
- Particulate Matter (PM)
- Sulfur Dioxide (SO_2)
- Nitrogen Dioxide (NO_2)
- Carbon Monoxide (CO)
- Lead (Pb)

The EPA also lists and regulates 187 HAPs under the Clean Air Act. HAPs are toxic air pollutants that cause or may cause serious harm to human and environment health. The EPA regulates these pollutants from general industrial sources at levels of 10 tons per individual HAP and 25 tons of combined HAPs per 12-month period. The following is a list of the primary contributing HAPs that could be produced by PTFP facilities:

1. Benzene
2. Toluene
3. Ethyl benzene
4. Xylenes

Combined HAP Emissions

Permitting data indicates that PTFP facilities are expected to create very few HAP emissions and are likely to be well below federal permitting requirements. In fact, at some PTFP facilities with lower scales of production, very little to no HAP emissions are expected.



What are the emissions of PTFP facilities and what are they comparable to?

A PTFP facility generates CAPs, and this paper provides context for these emissions by benchmarking them to other common manufacturing activities. For this paper we have modeled the "Typical PTFP Facility" as one that processes 15,000 tons per year of inbound plastics. This "Typical Facility" represents an average size for facilities that provided data for this paper. A typical PTFP facility is not required to have a Title V Permit under the Clean Air Act because its emissions would fall below the emissions levels which trigger need for a permit.

A typical PTFP facility's CAP emissions as a group are not comparable to any single industry. However, several of its individual CAP emissions are comparable to those of numerous specific, well-regulated facilities that are required to report to the EPA under the Clean Air Act.

VOC (Volatile Organic Compounds) and PM_{10} (Particulate Matter under 10 microns) emissions from a typical PTFP facility are roughly comparable to those from smaller than average Food and Snack Processing Plants;

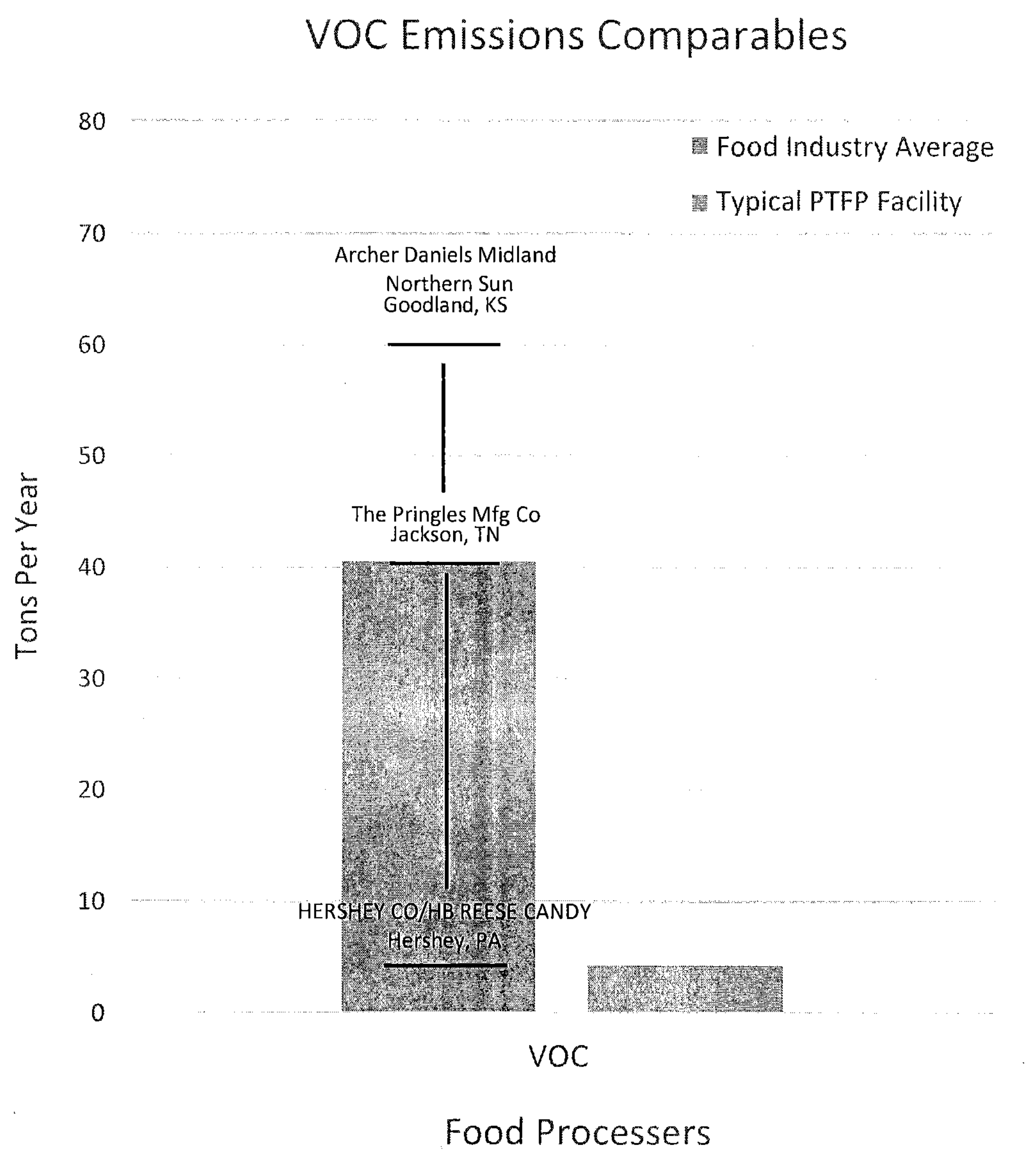
SO_2 (Sulfur Dioxide) emissions are roughly comparable those from smaller than average Institutions (Hospitals, Universities, and Prisons);

NO_2 (Nitrogen dioxide) emissions are roughly comparable to those from average Institutions (Hospitals, Universities, and Prisons); and,

CO (Carbon Monoxide) emissions are comparable to those from average Auto Manufacturing Operations.

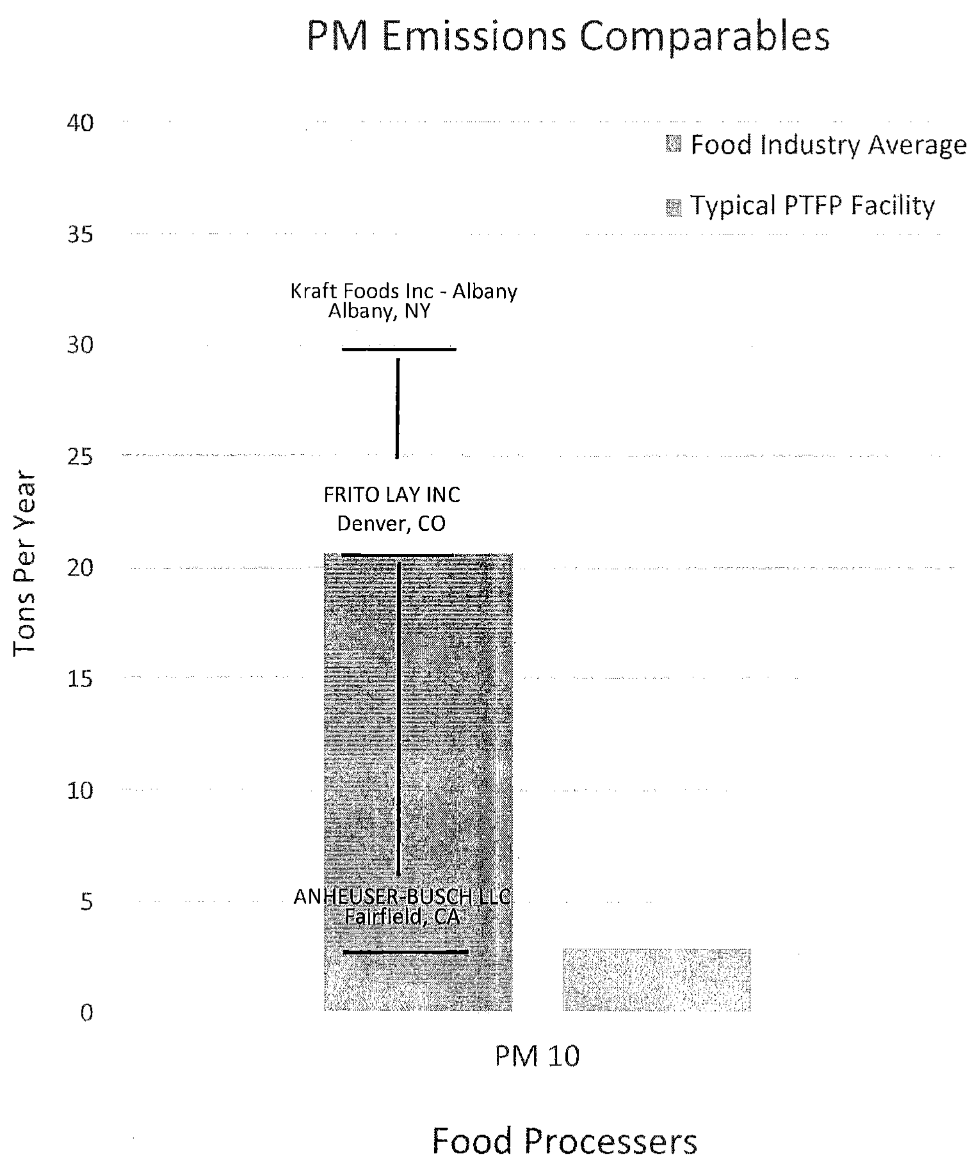
While Lead is also a CAP, there are no measurable Lead emissions from PTFP facilities and so it is omitted from this paper.

Volatile Organic Compounds (VOCs)



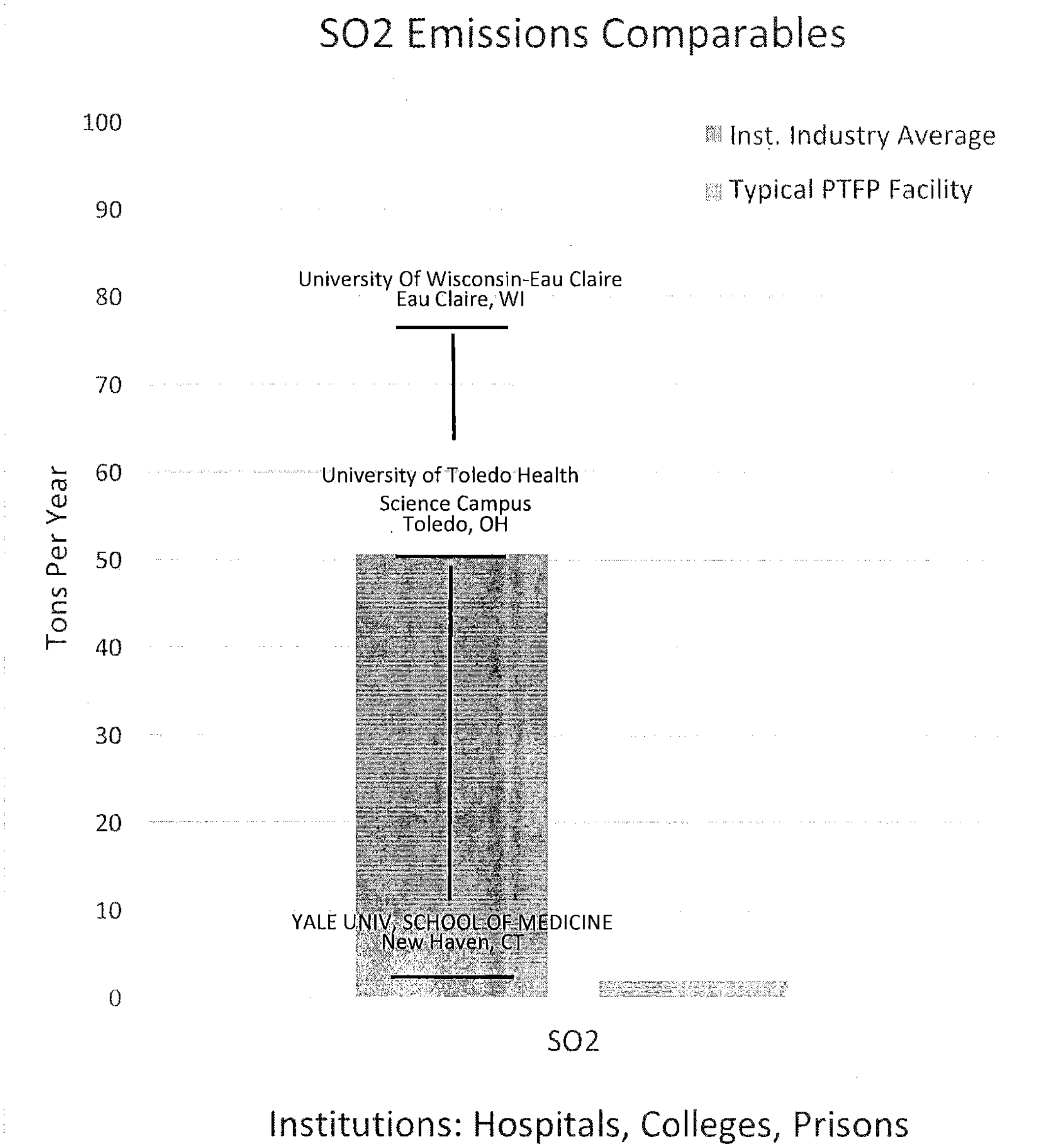
The Typical PTFP Facility will emit less than 5 tons of VOCs annually. For comparison, the average reporting food processing facility in the U.S. (excluding those facilities with less than 1/10 of a ton of emissions) reports 40 tons of VOCs emitted annually. For comparison, the Typical PTFP Facility emits roughly as much as the Hershey/HB Reese candy production facility in Hershey, PA.

Particulate Matter, under 10 microns (PM_{10})



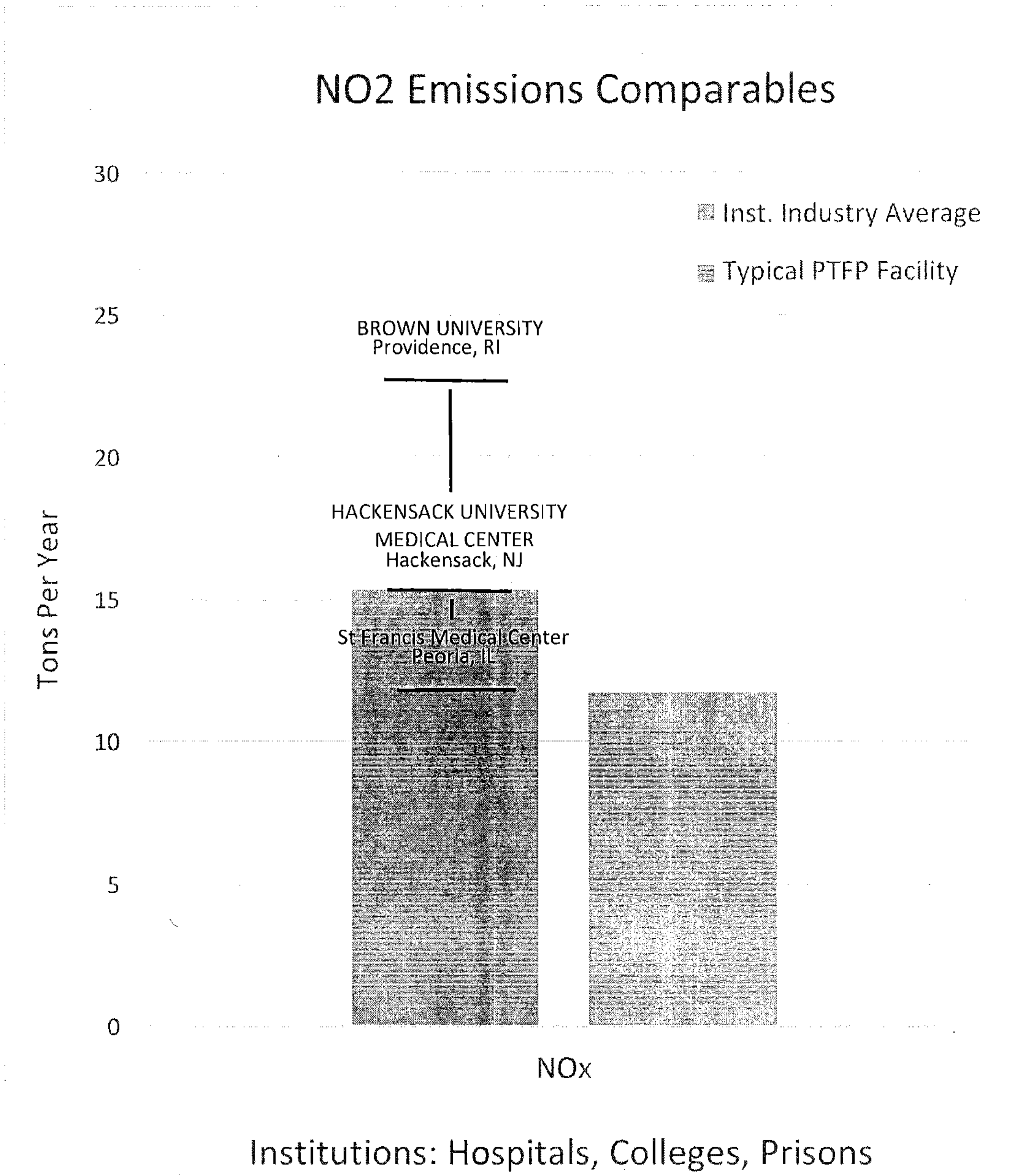
The Typical PTFP Facility will emit less than 5 tons of PM_{10} annually. For comparison, the average reporting food processing facility in the U.S. (excluding those facilities with less than 1/10 of a ton of emissions) reports 20 tons of PM_{10} emitted annually. For comparison, the Typical PTFP Facility emits roughly as much as the Anheuser-Busch Brewery in Fairfield, CA.

Sulfur Dioxide (SO_2)



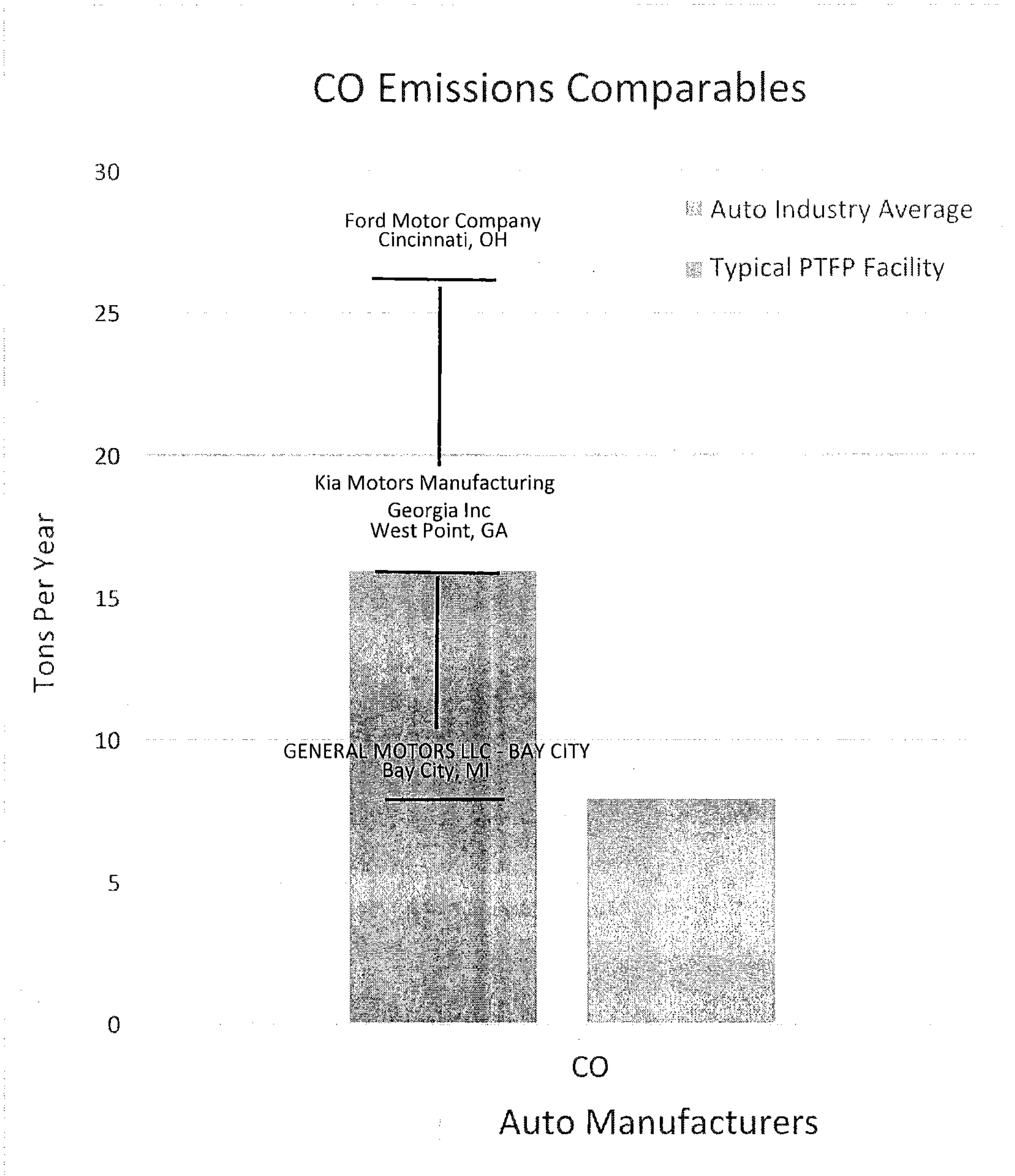
The Typical PTFP Facility will emit less than 5 tons of SO_2 annually. For comparison, the average reporting institutional campus in the U.S. (excluding those facilities with less than 1/10 of a ton of emissions) reports 50 tons of SO_2 emitted annually. These emissions typically come from an onsite power plant or generator. For comparison, the Typical PTFP facility emits roughly as much as the 15 megawatt combined heat & power (CHP) power plant providing energy to the Yale School of Medicine.

Nitrogen Oxides (including NO_2)



The Typical PTFP Facility will emit less than 12 tons of NO_2 annually. For comparison, the average reporting institutional campus in the U.S. (excluding those facilities with less than 1/10 of a ton of emissions) reports 15 tons of NO_2 emitted annually. These emissions typically come from an onsite power plant or generator. For comparison, the Typical PTFP Facility emits roughly as much as the power plant providing energy to the St. Francis Medical Center in Peoria, IL.

Carbon Monoxide (CO)



The Typical PTFP Facility will emit less than 10 tons of CO annually. For comparison, the average reporting Auto Manufacturer/Assembler in the U.S. (excluding those facilities with less than 1/10 of a ton of emissions) reports 15 tons of CO emitted annually. For comparison, the Typical PTFP Facility emits roughly as much as the General Motors (GM) transmission and engine parts manufacturing plant in Bay City, Michigan.

Why Dioxin is not a concern for PTFP facilities

Where do dioxins come from?
For forty years, it has been known that poorly controlled combustion of waste gives rise to dioxins, furans, and other products of incomplete combustion. Most dioxins found in the environment today are man-made and were created before 1990. Historically, incinerators, the manufacture of certain herbicides, and pulp and paper bleaching were among the largest industrial sources of dioxins.

Since then, regulation and subsequent technical advances have led to drastic decreases in dioxin emissions. Between 1987 and 2000, for example, dioxin emissions declined 90% in the U.S.[2] As dioxin emissions from industry declined, unregulated sources such as forest fires, backyard barrel burning of garbage and residential wood burning have risen in significance as contributors to dioxin emissions. In fact, backyard burning of waste is currently the largest source of dioxins at 35% of the U.S. total.

For more information, please see dioxinfacts.org and World Health Organization: http://www.who.int/ipcs/assessment/public_health/dioxins/en/

How do Plastics-to-Fuel and Petrochemistry technologies prevent dioxin formation?
Proper operation of a PTFP facility will not result in the production of dioxins primarily because the material is heated in a closed, oxygen-deprived environment that causes a thermo-chemical reaction *that is not combustion*. However, if the technologies are operated incorrectly - in a way that damages the equipment and makes the products unsaleable, then it's possible to produce dioxins. Given that PTFP technology is designed to recover valuable products, not to destroy itself and produce liabilities, these technologies are designed and operated to prevent dioxins!

Based on operating and lab data from 6 companies, dioxins are not produced during pyrolysis because:

- There is no atmospheric oxygen or halogen in the pyrolysis chamber
- The products of pyrolysis spend virtually no time at the dioxin formation temperature
- Vapors resulting from pyrolysis are combusted at temperatures well above the total destruction temperature of dioxins and furans

[2] U.S. Environmental Protection Agency (EPA), 2006. An inventory of sources and environmental releases of dioxin-like compounds in the United States for the years 1987, 1995, and 2000. National Center for Environmental Assessment.

Detailed Practices for dioxin prevention in operations of PTFP facilities.

Feedstock Controls:

1. **Specifications Enforced with Scanners and Contractual Penalties** – Plant operators sort the inbound material to ensure a feedstock predominantly composed of carbon and hydrogen. Chlorinated plastics are generally excluded from PTFP technologies because those resins have very low yields of marketable petroleum products and can produce acidic byproducts that corrode the equipment and cause the marketable products to fail to meet strict customer specifications. For these reasons, feedstock specifications are strictly enforced using optical scanners and hand held scanners to determine the makeup of the inbound plastic materials. Further, contracts with the feedstock provider often require the specification to be met or they are subject to fines and penalties from both the PTFP operating companies and purchasers of the final product.
2. **Additional Quality Controls** – Many operators randomly spot check the purveyors of the feedstocks at the source (usually plastics recyclers). Finally, some of the technology operators pay their staff a bounty on off-spec material and reward them for reducing contamination.

Vessel Controls to Ensure Pyrolysis, not Combustion:
The vessels where the primary thermal reaction occurs is flushed with nitrogen to eliminate oxygen or halogen and not only prevent combustion, but also dioxin and furan formation.

Temperature Controls:
Pyrolyzing plastics without oxygen does not create dioxins and is different than combustion in incinerators. Pyrolyzing plastics yields new gases that can be condensed into fuels and non-condensable gases that may contain chlorine. The cooling of these gases or the destruction of these gases is controlled to prevent dioxin formation.

1. **Controlled Cooling** – The condensable gases are rapidly cooled to prevent the formation of dioxins that could occur if they were to sit for an extended period in the temperature range of 200°C - 400°C (392°F - 752°F).
2. **Controlled Destruction** – The non-condensable gases are destroyed through a high temperature destruction device that uses methane to ensure complete combustion at approximately 600°C - 800°C (1,202°F - 1,472°F)[3]. Similarly, when the non-condensable gases are used instead for thermal energy to heat the pyrolytic vessels, they are also co-fired with methane at the same temperatures to prevent dioxin formation.

[3] Aurell, J. and S. Marklund. 2009. Effects of Varying Combustion Conditions on PCDD/F Emissions and Formation During MSW Incineration.

Conclusion

The data illustrate that Plastics-to-Fuel and Petrochemistry technologies are expected to have air emissions that are well below regulated levels, below well-known industries in every category of emissions, or in most cases both. These technologies offer a unique way to recover mass, energy and polymer feedstocks from plastics that are not recycled in commercial markets and are currently being landfilled.

References

U.S. Environmental Protection Agency. (2015). 2011 National Emissions Inventory. https://www.epa.gov/air-emissions-inventories/2011-national-emissions-inventory-nei-data.

U.S. Environmental Protection Agency. (2006). An inventory of sources and environmental releases of dioxin-like compounds in the United States for the years 1987, 1995, and 2000. National Center for Environmental Assessment, Washington, DC; EPA/600/P-03/002F. Available from: National Technical Information Service, Springfield, VA, and online at http://epa.gov/ncea.

U.S. EPA. Update to An Inventory of Sources and Environmental Releases of Dioxin-Like Compounds in the United States for the Years 1987, 1995, and 2000 (2013, External Review Draft). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-11/005A, 2013.

Schecter, A., Cramer, P., Boggess, K., Stanley, J., Päpke, O., Olson, J.Schmitz, M. (2001). Intake of Dioxins and Related Compounds from Food in the U.S. Population. Journal of Toxicology and Environmental Health, Part A, 63(1), 1-18. doi:10.1080/152873901750128326.

Confidential Interviews with Plastics-to-Fuel Technology Companies.

World Health Organization (WHO). (Updated June 2014). Dioxins and their effects on human health. http://www.who.int/mediacentre/factsheets/fs225/en.

Aurell, J. and S. Marklund. (2009). Effects of Varying Combustion Conditions on PCDD/F Emissions and Formation During MSW Incineration. Chemosphere. 2009 May; 75(5):667-73. doi: 10.1016/j.chemosphere.2008.12.038. Epub 2009 Jan 25.

Appendix - Methodology

Normalizing Emissions Data

Data from permits have been scaled to incoming feedstock (which is reported in permitting applications). This allows for a calculation to normalize emissions per ton of incoming feedstock. Further, we set the capacity of the facilities at a near average capacity of 15,000 tons of inbound feedstock per year.

Conservative Overestimation

At the time of this paper, only a few of the PTFP facilities have commercial run data. The others have data from bench trials. Good Company conservatively estimated scaled up bench trials and commercial run data. Therefore, PTFP facility emissions were overestimated by using publicly available permit limits approved by local regulators. Permit limits are approved by local regulators based on bench trial (lab) data, test runs of operating equipment and required air pollution control devices. These limits represent the top end of possible emissions, which may lead to an overstatement of PTFP facility emissions.

Industry Emissions Data

Industry emissions data are sourced from the EPA's 2011 National Emissions Inventory—the most recent at the time of this analysis. EPA's inventory is a database made up of an aggregation of locally and federally reported CAP emissions. Any facility required to report any single CAP emissions at either level is included in this database. This leads to some facilities having near zero emissions of a single CAP because that facility is required to report substantial emissions in another CAP (and therefore all its CAP emissions). Additionally, reporting thresholds (bottom of permit range) vary between local regulators, leading to possible inclusions of some facilities and exclusions of others, even if they have similar emissions profiles (this occurs when emissions fall beneath federal Title V permitting).

The average emissions per industry reported in this paper is a straight average of emissions excluding facilities that reported under 1/10th of a ton of CAP emissions in that category. This exclusion is an attempt to remove "incidental" emissions that are included in the database as described in the above paragraph.

Disclaimer

This Report, titled, *Comparison of Plastics-to-Fuel and Petrochemisty Manufacturing Emissions to Common Manufacturing Emissions* has been prepared to provide information to parties interested in the recycling and recovery of plastics and other materials. Plastics-to-Fuel and Petrochemical facilities may vary their approach with respect to particular operations, products, or locations based on specific factual circumstances, the practicality and effectiveness of particular actions and economic and technological feasibilities. This report 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 accuracy

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your environmental voice since 1970

January 4, 2018

To: Senate Committee on Natural Resources and Energy Members
From: Amber Meyer Smith
Vice President of Programs and Government Relations
Subject: Senate Bill 646

We appreciate the efforts of Senator Cowles to bring together many voices to discuss this bill early in the process, and appreciate some changes that have been made. The intention to remove additional plastics from landfills and use them to create fuel is certainly a laudable goal.

Further changes we suggest to SB 646 include:

1. **Limiting the bill to only pyrolysis facilities.** Gasification facilities are included in the exemptions in SB 646, but the environmental concerns are different. Pyrolysis does not use oxygen, and therefore has limited emissions of many pollutants of concern. Gasification, however, does use amounts of oxygen and has related emissions concerns including dioxins and furans that are extremely toxic. While we have seen data about emissions related to pyrolysis facilities to demonstrate their safety, we have not seen comparable data for gasification facilities.
2. **Limiting the bill to non-recyclable plastics that have no current recycling market.** While it is certainly true that converting plastics to fuel rather than landfilling them is preferable, SB 646 does not limit the feedstock for a pyrolysis/gasification facility to only non-recyclable plastics. Recycling is still the preferable method of dealing with plastics, and "recycling" ranks above "energy recovery" on the waste management hierarchy because of increased sustainability and reduced pollution. Furthermore, the bill allows an unspecified number of materials other than plastics to be used at gasification plants, including "other post-industrial waste containing post-use plastics." It is hard to evaluate the environmental impacts from that unknown universe of base materials.
3. **Prohibiting the use of halogenated plastics like PVC as a feedstock for these facilities.** Halogenated plastics are most likely to produce dioxins and furan emissions, which are extremely toxic. While we understand these halogenated plastics are not likely to be used as feedstock in pyrolysis facilities because they damage equipment, the potentially toxic emissions make it important to ensure they **can't** be used in the future and won't be a problem for communities that host a facility. In fact, adding that level of comfort in SB 646 might help alleviate some of the arguments about toxic emissions that are sometimes associated with these kinds of facilities by opponents.

We remain available to continue the productive discussions with the author and supporters of this bill.

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Action Network