Advocacy Brief

PLASTIC-TO-FUEL: A LOSING PROPOSITION

Plastic production and waste generation are doubling every twenty years.[1] In light of the global plastic crisis, technologies such as turning plastic waste into fuel and burning it are being falsely marketed as circular, climate-friendly, and sustainable. Such incineration technologies — including gasification and pyrolysis — are popping up across the globe, both as large-scale industrial investments and small-scale, backyard projects.

Despite the industry hype, the environmental and health drawbacks from these processes outweigh any supposed benefits, for the following five reasons:

1. Plastic-to-fuel produces poor-quality fuels
2. Plastic-to-fuel exacerbates climate change
3. Plastic-to-fuel produces toxic air emissions and byproducts
4. Plastic-to-fuel has wasted billions of dollars
5. Plastic-to-fuel perpetuates overproduction of plastic

What technologies are behind plastic-to-fuel?

This briefing will address issues and concerns on plastic-to-fuel technologies such as gasification and pyrolysis incineration, which are often promoted as "chemical recycling" or "advanced recycling" by the plastic and waste industry. As certain terms are used interchangeably, potentially misleading the public, the definitions below offer useful clarification.

- **Chemical recycling**: an industry greenwash term used to refer to various plastic-to-fuel and plastic-to-plastic technologies. Although these processes aim to turn plastic into liquids or gases which could be used to make new plastic, the end products are usually burned in practice. Technological variants of this process include pyrolysis, solvolysis, and depolymerization. However, regardless of the label, the technology is plastic-to-fuel, aka plastic incineration, if the end products are burned.

- **Pyrolysis**: the process of heating waste in the absence of oxygen to produce a liquid or gas fuel.

- **Gasification**: similar to pyrolysis, heating waste in a low-oxygen environment.

1

Plastic-to-fuel produces poor quality fuels

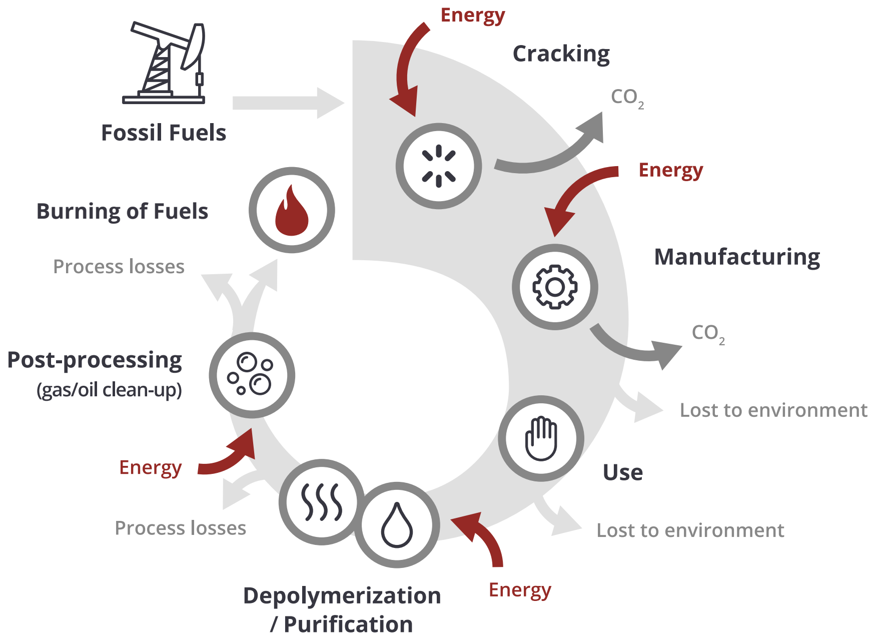
- **Gasification and pyrolysis produce a highly contaminated hydrocarbon mix that does not meet specifications for transportation fuels, the quality of which largely depends on the composition of feedstock, and complex chemical, physical and thermal inter-relations.[2]**
    - As acknowledged in a report commissioned by the American Chemistry Council, a major chemical industry lobby group in the U.S, fuel quality is "one of the most salient challenges" in the plastic-derived fuel production and marketing.[3] High levels of nitrogen, sulfur, chlorines, and halogens in the plastic feedstock can result in lower yields and lower quality products.[4]
- **Due to low quality and high levels of contamination, the fuel products require extensive decontamination and enrichment to meet industrial standards.[5]**
    - The products are subject to high quality standards to be able to use in internal combustion engines.[6] Especially, jet fuels must meet the highest and the latest standards in order to avoid problems associated with handling multiple fuel types.[7] Despite three decades of continued efforts and wasted investments, meeting these rigid specifications is nowhere in sight for waste-derived fuel production.
    - Fuels derived from plastic waste are not suitable for long-term running of diesel engines due to long ignition delay periods; fuels will have to be blended with conventional fuel at a ratio higher than 25 percent.[8]
- **Plastic-derived fuel produces higher exhaust emissions compared to diesel,[9] which leads to high pollution levels and potentially long-term damage to the engine. The emissions from fuels are often inadequately regulated when burned in off-site industries and vehicles.**
    - Pyrolysis oil is far more contaminated with solid residue, dioxins, and polycyclic aromatic hydrocarbons (PAHs) than regular diesel, and produces greater quantities of sulphuric content, unburned hydrocarbons (UHC), oxides of nitrogen (NO_x), soot, carbon monoxide (CO) and carbon dioxide (CO_2) emissions compared to diesel in a standard engine.[10, 11, 12, 13, 14] High concentrations of alkanes in the fuel[15] can result in deadly explosions and accidents in contact with oxygen and flammable substances.[16]

2

Plastic-to-fuel exacerbates climate change

- Turning plastic to fuel and then burning it releases the carbon in the plastic as CO_2.[17] Looking at the whole life cycle of a fuel made from plastic, greenhouse gas emissions occur in several stages from the point of extracting fossil fuel resources through burning of the fuel and final disposal of residue waste.[18, 19]

- Gasification and pyrolysis are high-temperature thermal processes which require heavy energy input during pretreatment, processing, and post-processing.[20]
    - Feedstocks for pyrolysis often require pretreatment processes, which can consume significant quantities of energy.
    - The endothermic nature of pyrolysis inevitably makes it an energy-intensive process.[21] Starved-oxygen environments used in these technologies require additional input of energy to maintain the process.
    - The shredding and drying of the plastic waste, high-temperature thermal processing, and the starved-oxygen environments that pyrolysis demands take a significant amount of energy to sustain.
    - The decontamination and enrichment required prior to using fuel products incur excessive energy consumption.
    - No chemical recycling technology can currently offer a net-positive energy balance, and there is no evidence to predict that this can improve in the foreseeable future.[22]



3

Plastic-to-fuel produces toxic air emissions and byproducts

- **Pyrolysis and gasification of plastic waste and the final combustion of produced fuel release toxic substances.[23] In addition to toxic additives and contaminants in plastic including bisphenol-A (BPA), cadmium, benzene, brominated compounds, phthalates, lead, tin, antimony, and volatile organic compounds (VOCs), toxic chemicals are newly formed during high-heat processes, including dioxines and furans, benzene, toluene, formaldehyde, vinyl chloride, hydrogen cyanide, PBDEs, PAHs, and high-temperature tars, among many others.[24] Uncontrolled pollution from such processes could pose significant health and safety risks for local populations and place a heavy toxic burden on workers, especially in countries with less stringent emission standards and communities.**
    - This is particularly the case with the small-scale pyrolysis initiatives that are appearing across Africa, Asia and Latin America.
    - In the U.S., a pyrolysis facility in Oregon sent over 49,000 tons of waste styrene to burn in cement kilns located in marginalized communities in 2018.
- **Even if those pollutants are successfully captured or neutralized, they remain in the product itself or in byproducts such as fly ash, char, slag, and wastewater. Cleaning the toxicants from plastic-to-fuel products is extremely difficult, expensive, and creates additional toxic waste streams.[25]**
    - The American Chemistry Council recognized residual waste from plastic-to-fuel as a major problem— approximately 15 to 20 percent of the overall feedstock used in the process.[26]
    - Because aromatic molecules do not oxidize easily,[27] plastic-to-fuel processes release particulate emissions which form soots that increase emissions and reduce combustion efficiency.[28]
    - Some processes use catalysts, and both toxins from the plastic and newly created toxins can remain in the spent solvent.[29] For example, a 100,000 tonne-per-year plant would produce 2.5 million cubic meters of post-processing n-hexane, a substance known to cause neurotoxicity and respiratory diseases.[30]
    - Condensation, cooling, and liquefaction of gases require water, which needs to be treated before being discharged into local sewage systems. According to one source, 34 gallons of water is used per ton of feedstock processed.[31]

4

Plastic-to-fuel has wasted billions of dollars

- Due to the low and unpredictable quality of the end products, many academic and industry sources have acknowledged the lack of potential for economic operation of chemical recycling and plastic-to-fuel technologies.[32] These approaches have a track record of high-profile failures, fires, explosions, and financial losses. GAIA's 2017 publication, Waste Gasification & Pyrolysis: High Risk, Low Yield Processes for Waste Management[33] found that USD 2 billion has been invested in projects which were either closed or canceled.

- As an energy source, plastic-to-fuel is cost-prohibitive and has weak market competitiveness.
  - Capital costs for pyrolysis facilities with 15 megawatt output range from USD 8,000 to USD 11,500.[34]
  - As plastic-to-fuel facilities produce relatively small quantities of liquid fuel compared with refineries, and the product quality varies by system and changes in feedstock, the fuel products are not competitive in the market.[35]

- Building infrastructure for cleaning, sorting, shredding, and removal of dyes, stabilizers, and other additives and contaminants would mean billions of dollars of investment, all to justify the existence of cheap plastic packaging and products. Mixed plastic waste can be four times as slow to process compared to pre-treated reagent grade feedstock.[36]

- Some methods also require rare elements such as ruthenium (Ru) and platinum (Pt) as catalysts, and the amount required to process hundreds of thousands tonnes of plastic waste is simply far more than what we currently have on Earth.[37]

5

Plastic-to-fuel perpetuates overproduction of plastic

- Burning plastic is equivalent to burning fossil fuels. In essence, plastic-to-fuel provides a more complicated way to extract and burn fossil fuels that take a brief sojourn as a piece of plastic.

- Plastic-to-fuel enables further overproduction of junk plastic and distracts from real solutions.
  - In order to operate, facilities need a steady stream of plastic, necessitating further extraction and production of low-quality plastic. This blocks important recycling opportunities (and the greenhouse gas savings associated with them) and locks communities in the linear plastic economy.
  - Unlike recycling, plastic-to-fuel fails to capture the material to feed back into a closed loop system that would prevent further extraction; the European Union's Waste Framework Directive stipulates that producing fuels from waste cannot be labeled or counted as "recycling."
  - The entities most responsible for plastic production, certain members of the American Chemistry Council, Chevron Phillips Chemical, Dow Chemical and Procter & Gamble, are particularly vocal supporters of plastic-to-fuel.

Conflict map: ongoing battles against plastic-to-fuel projects and proposals

US (Wisconsin): Waukesha County Environmental Action League (WEAL) and its allies have been filing public comments to oppose exemptions to air emissions rules applied to mobile gasification units.

US (Idaho): GAIA has been organizing campaigns against Hefty Energy Bags, an initiative run by Dow Chemical, which collects waste plastic to send to a plastic-to-fuel plant named Renewlogy; now the waste is sent to a cement kiln in Boise after the plant was shut down due to technical issues.

US (Georgia): Environment Georgia is working with Macon residents and other allies to fight the construction of Brightmark's proposed plastics-to-fuel plant in Macon, Georgia by organizing against a decision to give Brightmark USD500 million in bonds. The Georgia Water Coalition has also put the proposed Brightmark plant on their Dirty Dozen list for 2021.

New Zealand: Aotearoa Plastic Pollution Alliance has been working to stop a pyrolysis plant proposal.

Pakistan: The government demolished thirteen pyrolysis plants in the Lahore district, as the plants released hundreds of tons of carbon powder on a daily basis.

Latin America: Local groups are monitoring a proposal from a US-based company named Plastikgas, which plans to build over ten plants in Ecuador and the Galapagos islands.

Italy: Many groups in Livorno including Rifiuti Zero Livorno are working together to debunk Ente Nazionale Idrocarburi's "advanced recycling" plant and other false solutions that the global fossil fuel company is putting forward.

What do we do with all the plastic waste in our communities?

Plastic-derived fuel is a fossil fuel and therefore not compatible with the real zero emissions future we need. Even if these fuels were to succeed technologically and economically, they are still going to have a massive carbon footprint which should be avoided in the first place. In any case, waste gasification and pyrolysis have failed for over three decades due to high energy demands and low financial viability, so it is highly unlikely that attempts to produce waste-derived fuels will suddenly succeed, let alone low-carbon fuels.[38]

There is no one size fits all solution to the plastic pollution crisis and climate change, but decision-makers and investors must support country-wide and community-based approaches of waste prevention, plastic reduction, separation and collection, reuse, and recycling — also referred to as zero waste. Unnecessary plastic packaging and products can be eliminated through redesign, innovation, and supportive policies such as bans on single-use plastics, extended producer responsibility, and deposit-return schemes.

Acknowledgements

- Written by: Doun Moon, Shanar Tabrizi
- Reviewed and edited by: Claire Arkin, Miriam Azurin, Alejandra Parra, Yobel Novian Putra, Neil Tangri, Janek Vähk, Lauriane Veillard, Mariel Vilella, Jonathan Weissglass, Monica Wilson
- Designed by: Doun Moon (vector sources provided by: Yippa, Francesca Tabasso, Freepik)

This publication has been made possible in part through funding from the Plastic Solutions Fund (PSF). The views expressed in this publication do not necessarily reflect those of PSF. This report or its parts may be reproduced for non-commercial purposes provided the source is fully acknowledged. Reproduction for sale or commercial purposes is prohibited without written permission of the copyright holder.

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Eight questions you should ask when confronted with a plastic-to-fuel projects

1. What is the type of technology used in the facility? Has it been proven to work under real-world operating conditions, or just in a laboratory? Has this process been employed at this scale elsewhere?
2. What is the energy balance of the process and how will it be measured and tracked? What is the carbon balance and how will it be monitored?
3. What are expected emissions and how will they be monitored and reported?
4. Which types of feedstock has it been tested on? How much feedstock will be sourced, from which communities?
5. What are the outputs of the process, including main products and byproducts? How will the ash, wastewater, spent solvent, and residual waste be managed? Will any residual waste be sent to incinerators or cement kilns?
6. Are the products to be burned on-site or transported to a different location? How will the emissions be monitored off-site?
7. How will the project be funded? If through public funds, are there other projects that could have been funded for the community to move toward zero waste?
8. How close is the facility location to marginalized communities or populated neighborhoods? Are there any concerns about causing disproportionate harm to environmental justice communities?[39]

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