



Chemical recycling of plastic and health concerns

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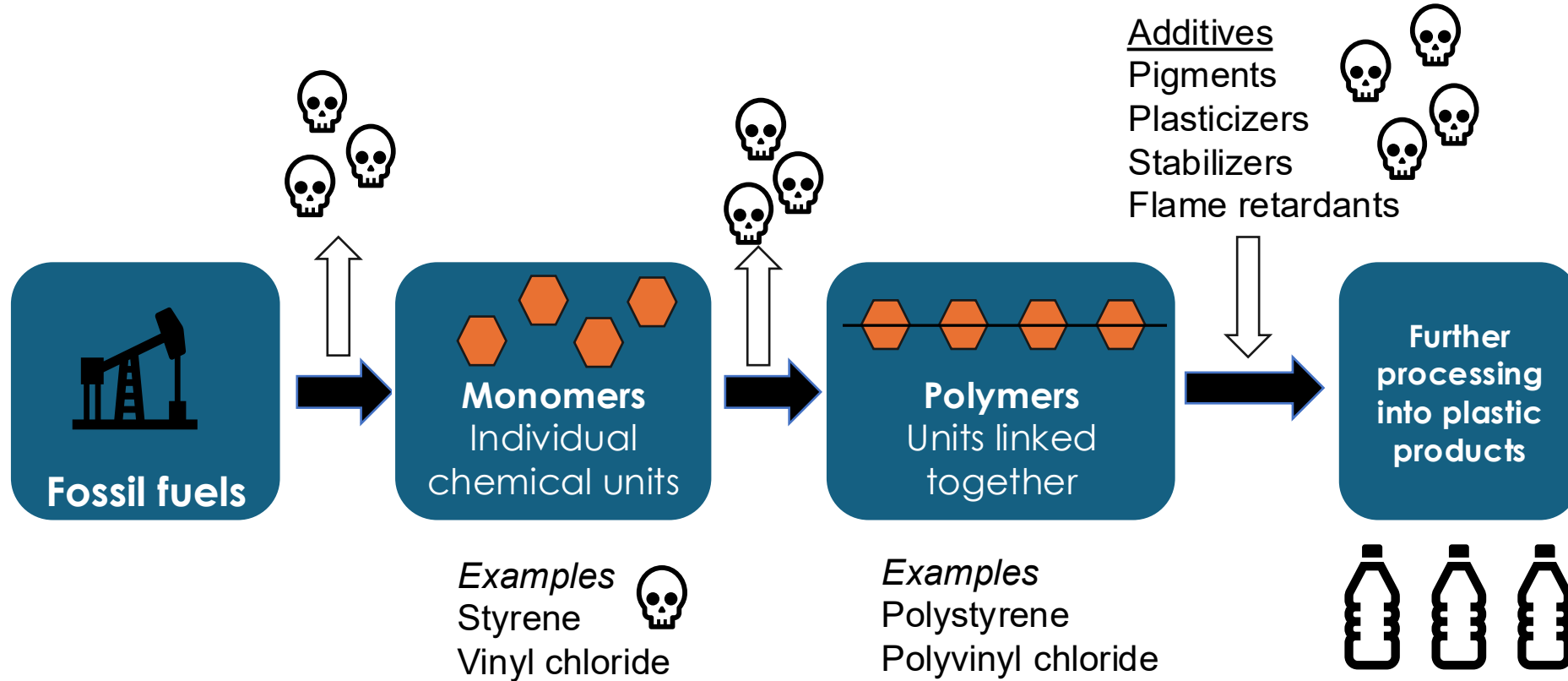
I have no conflicts to disclose.



Trail map

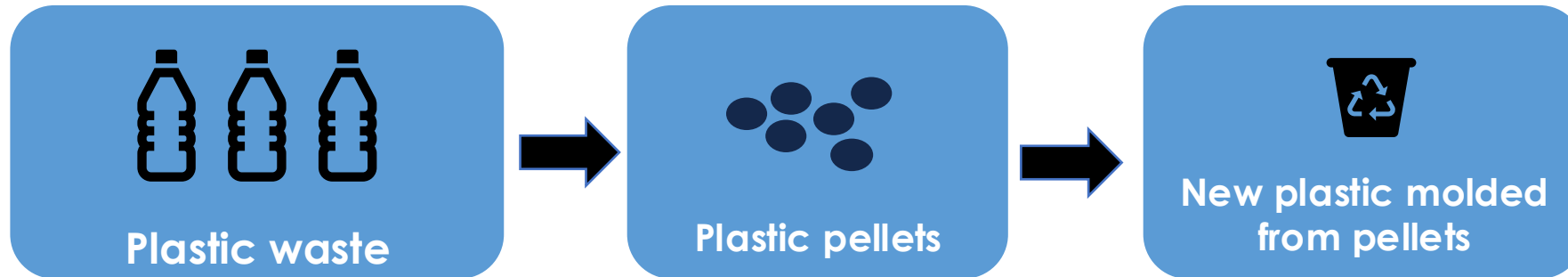
- Plastic life cycle and recycling
- Basics of chemical recycling
- Health concerns with different types of chemical recycling

Plastics are made from fossil fuels and petrochemicals



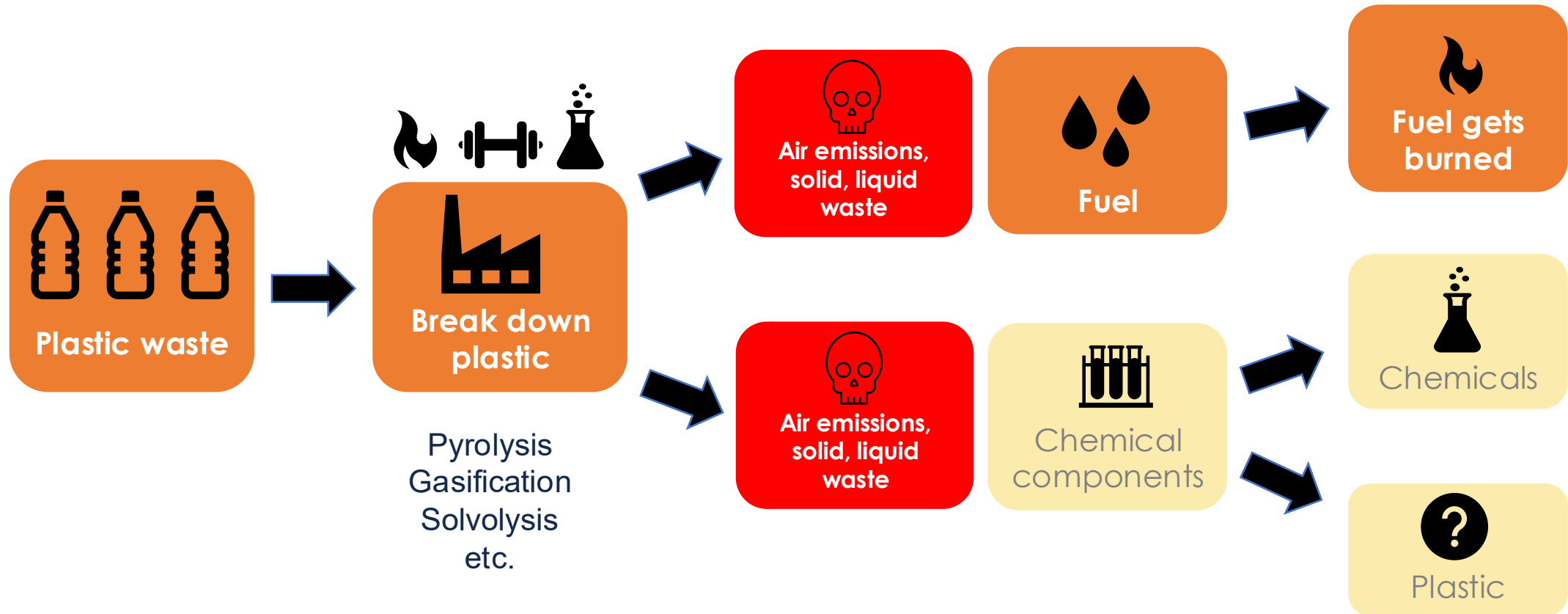
Conventional (mechanical) recycling

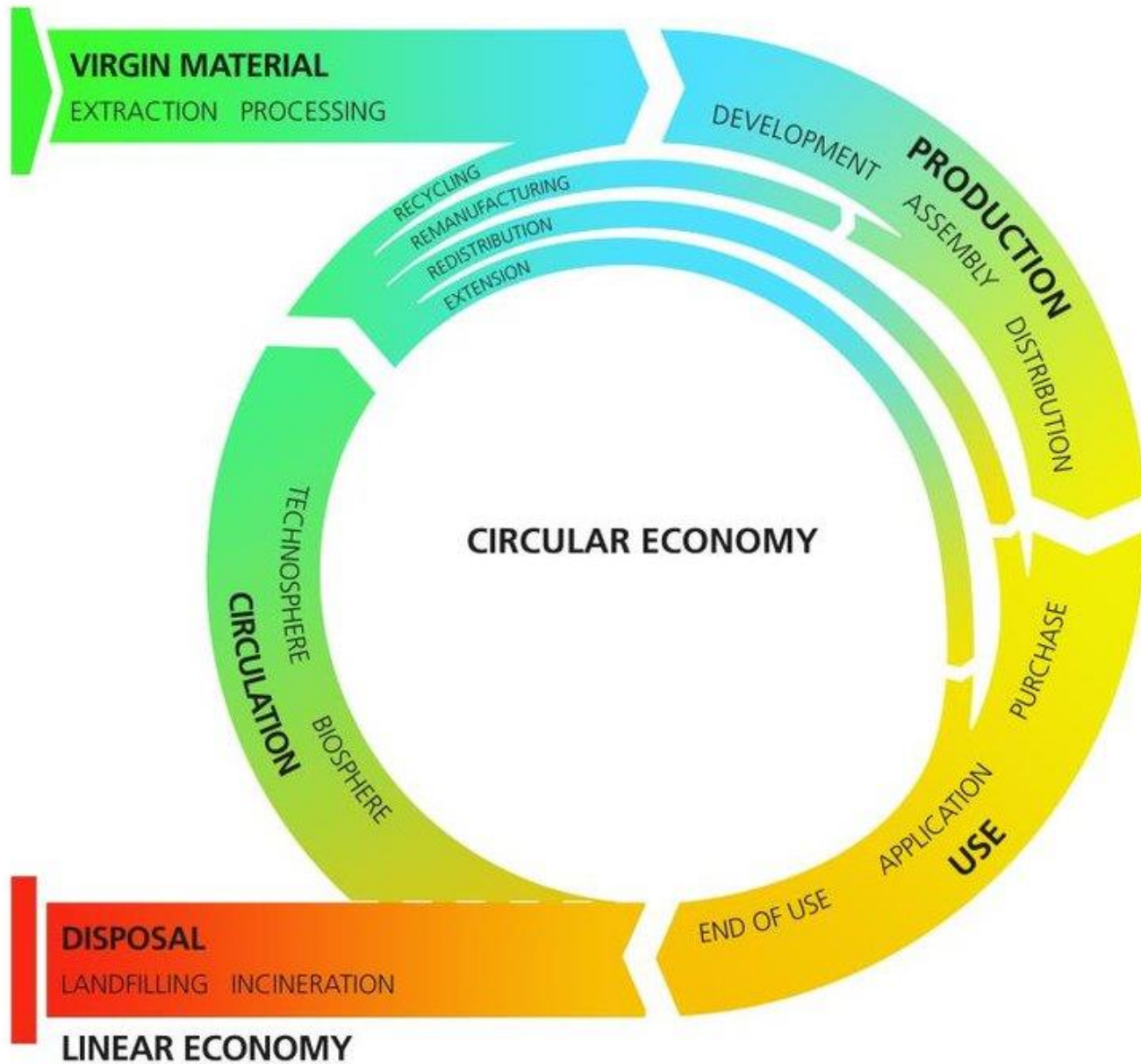
Plastic → plastic



“Chemical recycling”

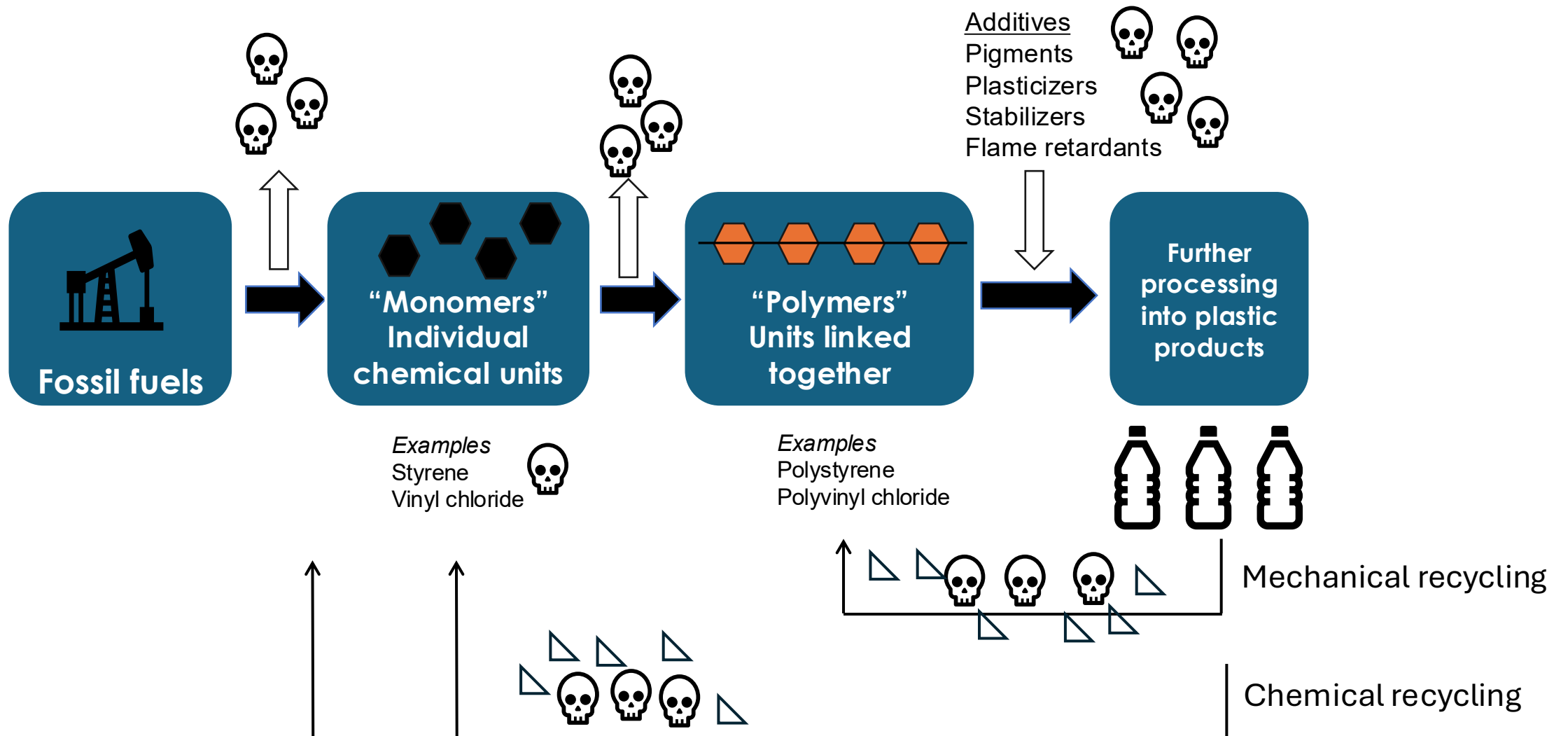
Plastic → fuel, chemicals, waste



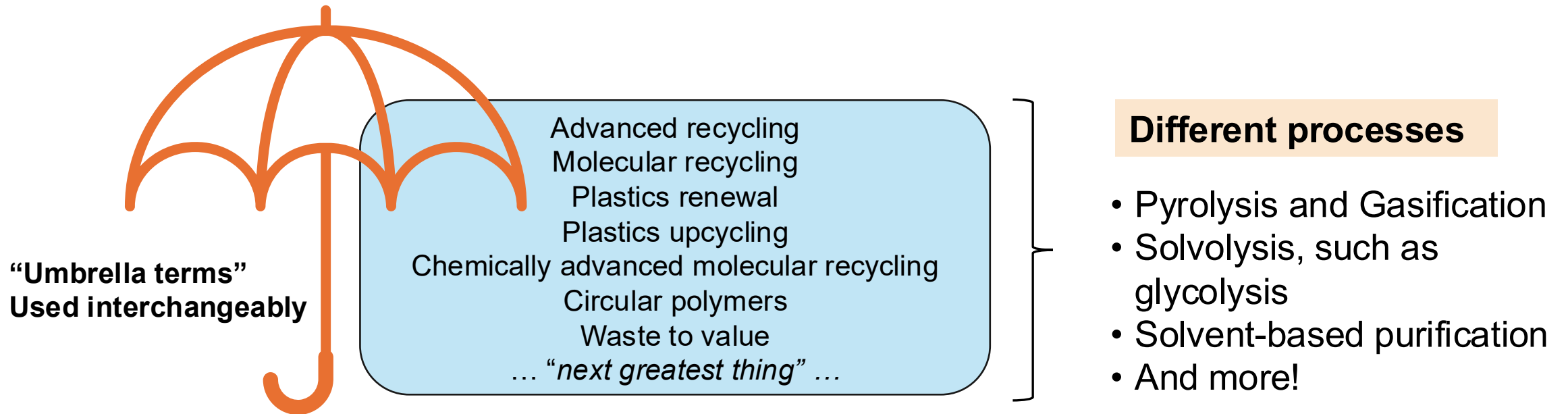


- Turning plastic into fuel is not recycling
- Burning materials at any point = need for more resource extraction

Microplastics and toxic emissions, additives concerns with mechanical AND chemical recycling



“Chemical recycling” terminology part 1



“Chemical recycling” terminology part 2



Thermal conversion= incineration

Pyrolysis

Gasification

Plasma arc pyrolysis

Microwave pyrolysis

Etc

etc

Solvent based= not incineration

Solvent-based purification

Solvolysis (Depolymerization)

Methanolysis

Glycolysis

Etc

etc



These terms can be used differently by different sources.
Example: Pyrolysis = “thermal depolymerization”

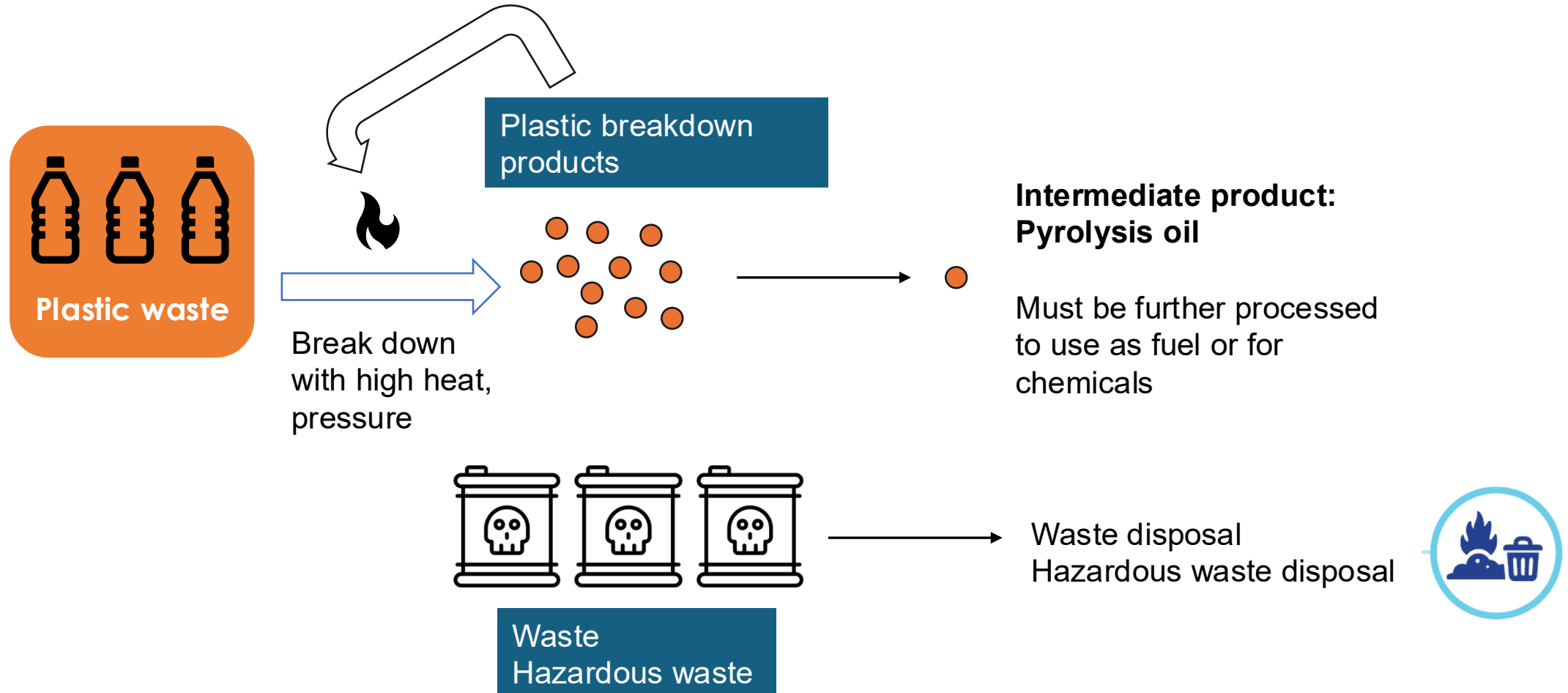
Closer look at each technology



- Pyrolysis/ gasification (incineration)
- Solvolysis (not incineration)
- Solvent purification (not incineration)

Pyrolysis: plastic to fuel, chemicals

Generally takes: polyethylene, polypropylene



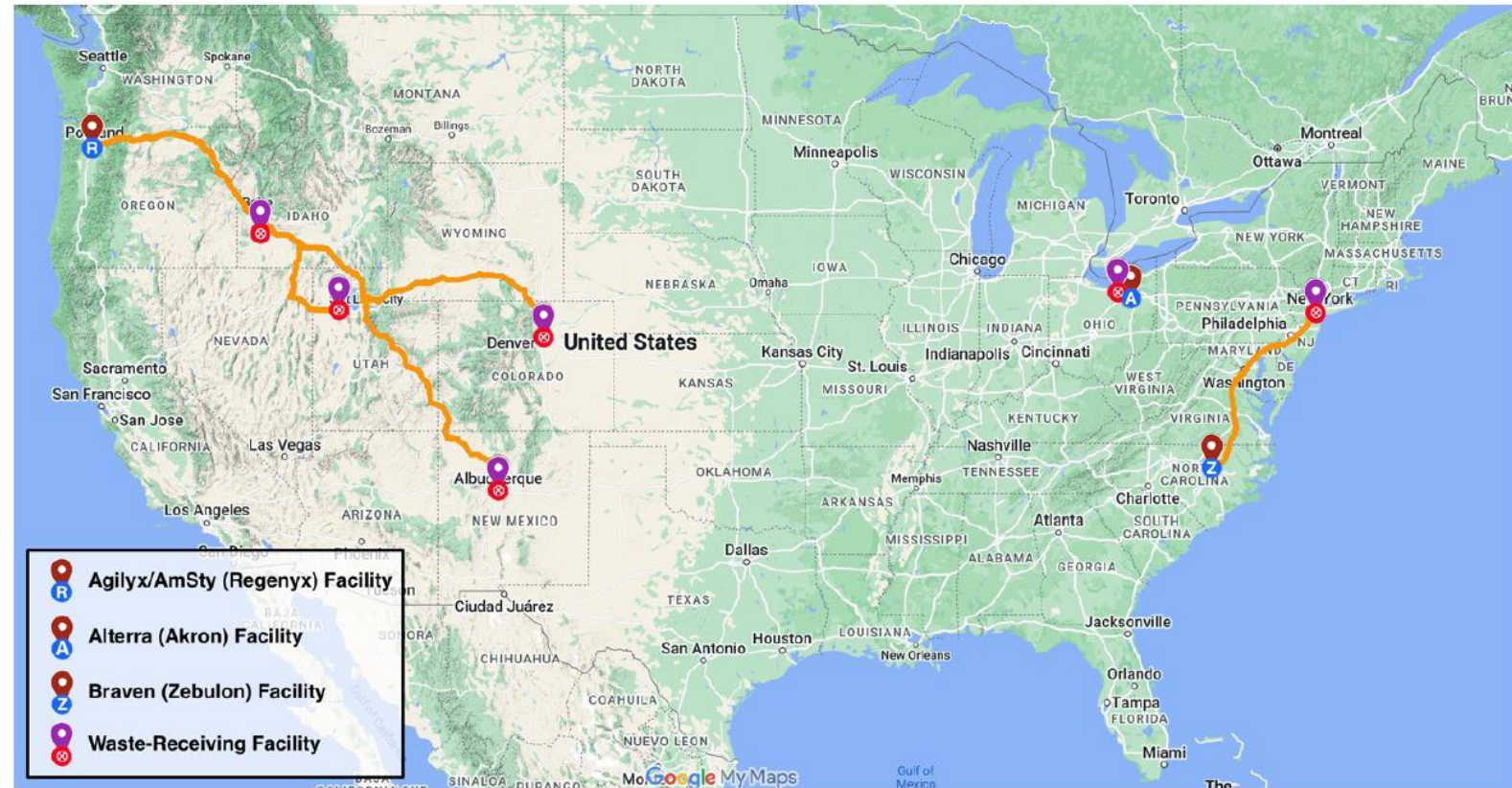
Large quantities of hazardous waste...

TABLE 3: JUST THREE PYROLYSIS FACILITIES GENERATED MORE THAN 2 MILLION POUNDS OF HAZARDOUS WASTE IN LESS THAN FOUR YEARS

Reflects hazardous waste that was produced by the Agilyx/AmSty (Regenyx), Alterra (Akron), and Braven (Zebulon) facilities and shipped off-site, according to the EPA's ECHO database.²¹ At the time of this writing, the 2024 data were available through October 12, 2024.

Company/Facility Name	Pounds of Hazardous Waste Produced and Shipped Off-Site (by year)			
	2021	2022	2023	2024 (through October 12, 2024)
Agilyx/AmSty (Regenyx) ²²	416,766	326,564	224,723	113,547
Alterra (Akron) ²³	65,609	80,384	113,337	172,653
Braven (Zebulon) ²⁴	23,895	48,506	115,072	384,962
Total	506,270	455,454	453,132	671,162

...threatens communities where it is generated, transported through, and disposed



Pyrolysis facilities: health harming air pollution

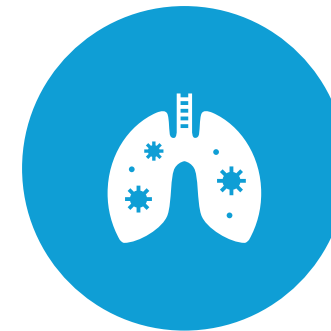
	Carcinogen	Reproductive toxicant	Developmental toxicant	Neurotoxicant	Persistent	Bioaccumulative	Liver toxicant	Cardiovascular toxicant	Respiratory toxicant	Kidney toxicant	Skin toxicant	Eye toxicant
Hazardous Air Pollutants												
Acetaldehyde*	X			X					X		X	X
Acetophenone*									X		X	X
Benzene*	X	X	X	X				X	X			
Cadmium**	X	X	X		X	X			X	X		
Chlorine*									X			X



30+ TOXIC CHEMICALS



BENZENE, LEAD,
PARTICULATE MATTER AND
MORE



LINKED TO INCREASED RISKS
FOR CANCERS, ASTHMA,
HEART DISEASE AND MORE

Pyrolysis units present fire and explosion risks

Inside Climate News

Pulitzer Prize-winning, nonpartisan journalism on the biggest crisis facing our planet.

Fossil Fuels

Inside Indiana's 'Advanced' Plastics Recycling Plant: Dangerous Vapors, Oil Spills and Life-Threatening Fires

The Brightmark "plastics renewal" plant can't get past the startup phase, as former employees raise environmental, health and safety concerns.



By James Bruggers
June 16, 2023

Brightmark- Ashley, IN
Pyrolysis of mixed plastic → fuel



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Inherent Hazards and Limited Regulatory Oversight in the Waste Plastic Recycling Sector – Repeat Explosion at Pyrolysis Plant

Frank Huess Hedlund

Fire and Explosion Hazards and Safety Management Measures of Waste Plastic-to-Pyrolysis Oil Conversion Process

Dong-Hyun Seo^{1*} · Yi-Rac Choi² · Jin-Ho Lim² · Ou-Sup Han²

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ABSTRACT The number of fire and explosion accidents caused by pyrolysis oil and gas at waste plastic pyrolysis plants is increasing, but accident status and safety conditions have not been clearly identified. Therefore, the aim of the study was to identify the risks of the waste plastic pyrolysis process and suggest appropriate safety management measures. We collected information on 19 cases of fire and explosion accidents that occurred between 2010 and 2021 at 26 waste plastic pyrolysis plants using the Korea

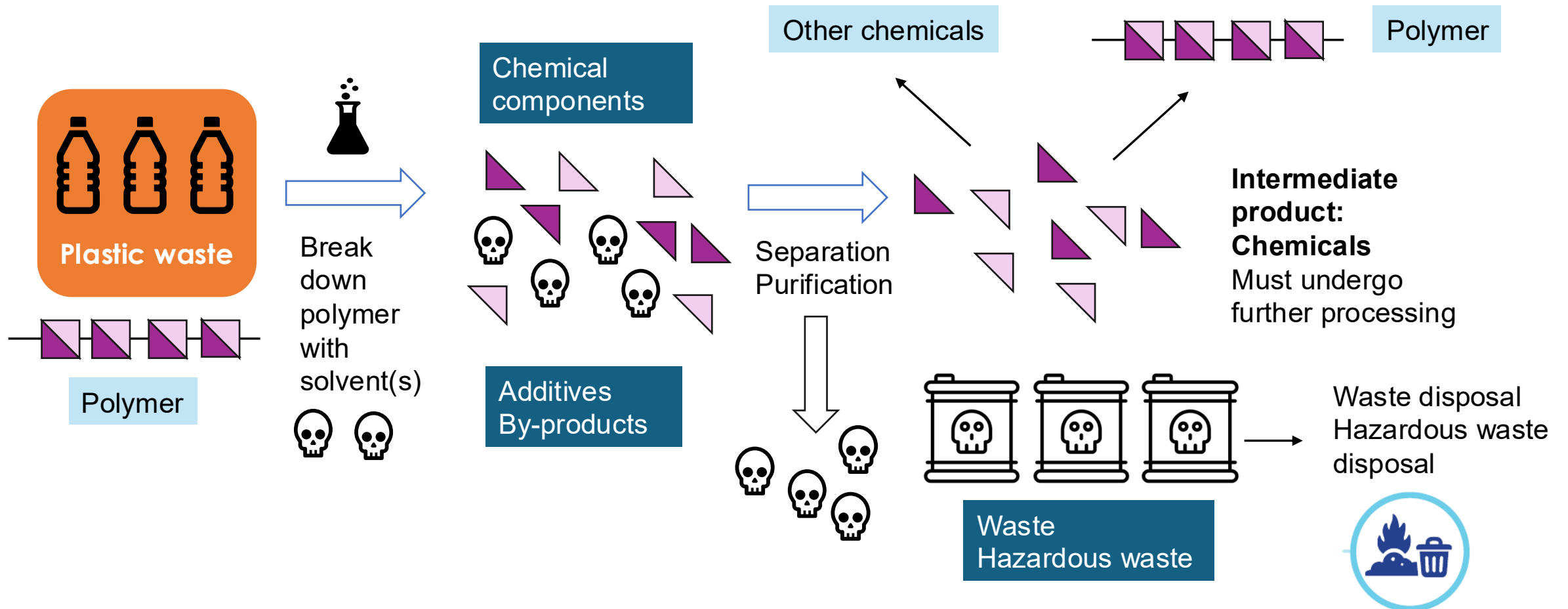
	Carcinogen	Reproductive toxicant	Developmental toxicant	Neurotoxicant	Liver/digestive toxicant	Cardiovascular toxicant	Respiratory toxicant	Kidney toxicant	Skin toxicant	Eye toxicant
Solvent-based purification										
Benzene	X	X	X	X		X	X			
Butane	X									
Cymene		X					X		X	X
Dichloromethane	X			X	X	X	X			
Hexane		X		X						
Methanol			X	X						
Methyl ethyl ketone			X	X			X		X	X
N-methylpyrrolidone		X	X							
Tetrachloroethylene	X			X	X	X	X	X		
Toluene			X	X	X	X	X			X
Xylene				X			X			X
Alkaline hydrolysis										
Ethylene glycol			X	X			X	X		X
Sodium hydroxide							X		X	X
Sulfuric acid	X						X			
Methanolysis										
Dichloromethane	X			X	X	X	X			
Methanol			X	X						
Glycolysis										
Ethylene glycol			X	X			X	X		X

Solvent-based technologies use hazardous solvents

- Emissions
- Worker exposures
- Hazardous waste

Solvolysis: Plastic to chemicals

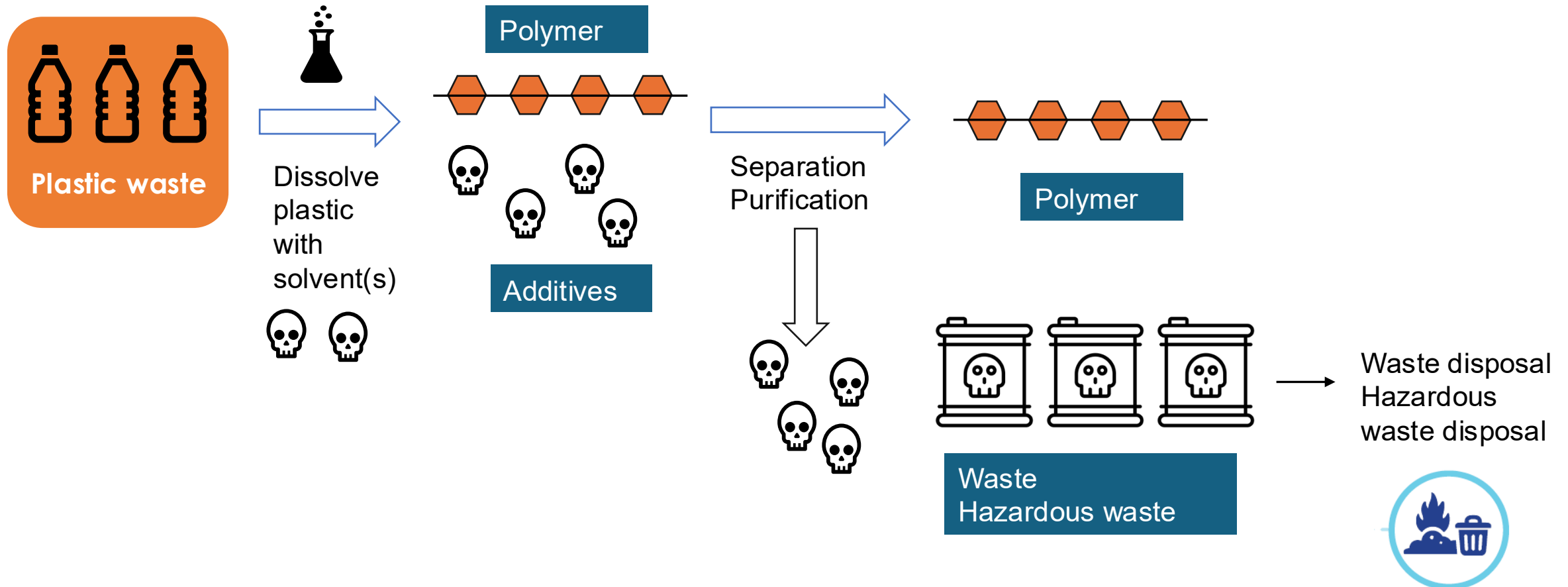
Generally takes: polyethylene terephthalate (PET or polyester)



Solvent-based purification: “plastic to plastic”

(Also called physical recycling or dissolution-precipitation)

Input must be single polymer type, i.e. polypropylene



Solvent-based purification facility generates air pollution and hazardous waste

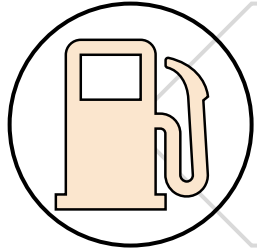


- PureCycle- Ironton, OH
- Polypropylene waste → polypropylene
- Permitted to release VOCs
- Required to “flare” (burn off) excess VOCs
- Generates hazardous waste

Facilities are disproportionately sited in low income, communities of color

Operating Status	Percentage of facilities in areas with above-average populations of people of color	Percentage of facilities in areas with above-average low-income population
Currently operating or partially operating	45%	100%
Proposed or under construction	55%	72%

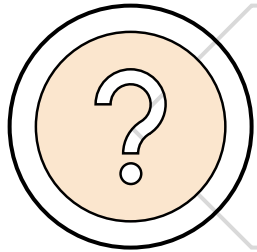
“Chemical recycling” summary



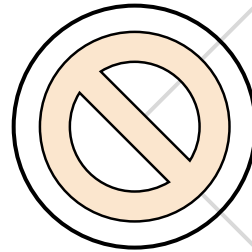
Mostly used to make fuels, not recycle



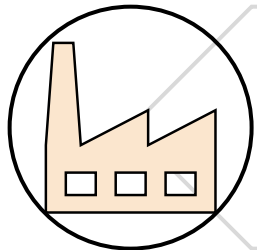
Does one or more of: (1) Uses hazardous chemicals, (2) produces hazardous chemicals, and/ or (3) generates hazardous waste



Lacks transparency



Not operating at scale (process and product problems)



Generates harmful air pollution



Generally sited in communities that are disproportionately low income, people of color, or both

Thank you!

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