Worker and Community Exposure to Ethylene Oxide, Benzene and other Toxic Chemicals on the Frontlines of Plastics Production

Plastics and Human Health Symposium presented by

New York University Langone Health Center for the Investigation of Environmental Hazards

23 September 2024

By Mike Belliveau, Director and Founder

Assess the Hazards of the Full Plastics Lifecycle

Not just chemical additives and microplastics from use and disposal

- **EXTRACTION:** Plastics production consumes 12% of crude oil and 8.5% of fossil gas globally (and some coal in China)
- **PRODUCTION:** Hazards exist at every stage of plastics production:
  - Fossil feedstock fraction (from oil refining and natural gas processing)
  - Production of primary petrochemicals *and* chemical intermediates
  - Production of monomers *and* final polymers
  - Production of processing aids *and* additives, and their supply chains
  - Shaping and processing of final polymers

More research is needed on the upstream health impacts of plastics

Bend the Curve
HEALTH • CLIMATE • JUSTICE

The Material Hazards and Human Health Risks

Chemical exposure from plastics production is marked by:

- Higher exposure levels (than population exposure to additives)
- Exposure to plant workers, nearby workers, and communities
- Cumulative impacts from multiple chemicals and sources
- Environmental injustice: racial/ethnic and other disparities

Let's review examples for just three common plastics:

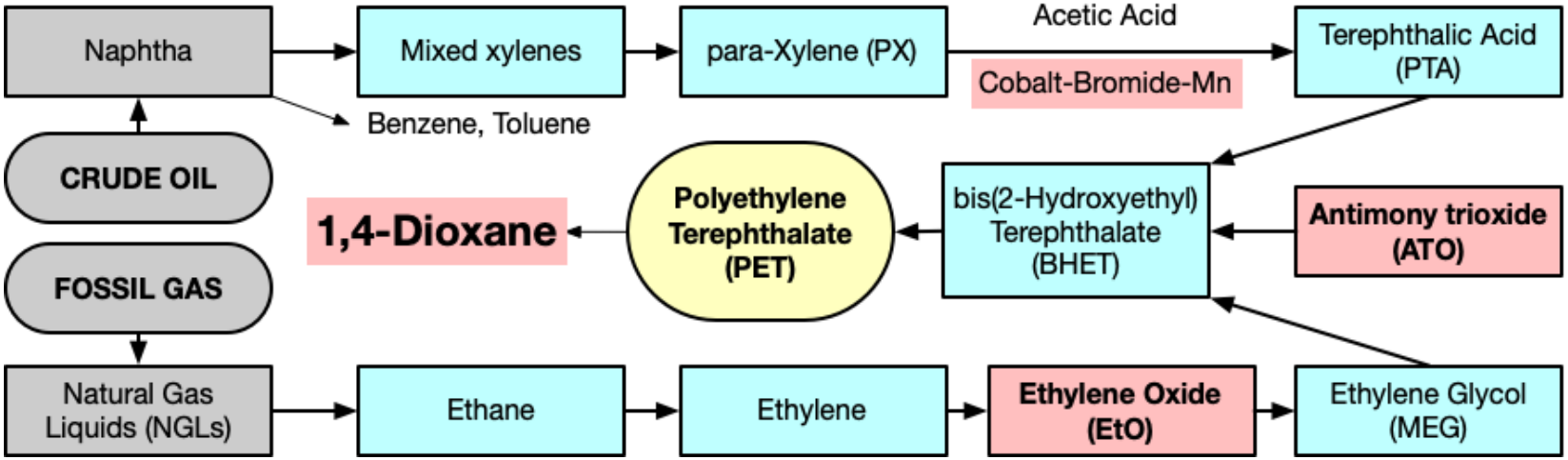
- Polyethylene terephthalate (PET and polyester)
- Polystyrene (PS) and expanded polystyrene (EPS) foam
- Polyvinyl chloride (PVC or vinyl)

Bend the Curve
HEALTH · CLIMATE · JUSTICE

Production & Use of PET Plastic & Polyester

Typical PET Production Process

High hazards highlighted in RED



81 million metric tons produced globally in 2019

More than any other plastic

Bend the Curve
HEALTH • CLIMATE • JUSTICE

MAJOR DEMAND DRIVERS:

- 25% for Plastic Bottles
- 25% for Polyester Clothing
- 11% for Home Furnishings
- 9% for Carpets & Rugs

Chemical Exposures from PET Polyester

USEPA: Air emissions of ethylene oxide (EtO) from chemical manufacturing poses an unacceptable risk to human health

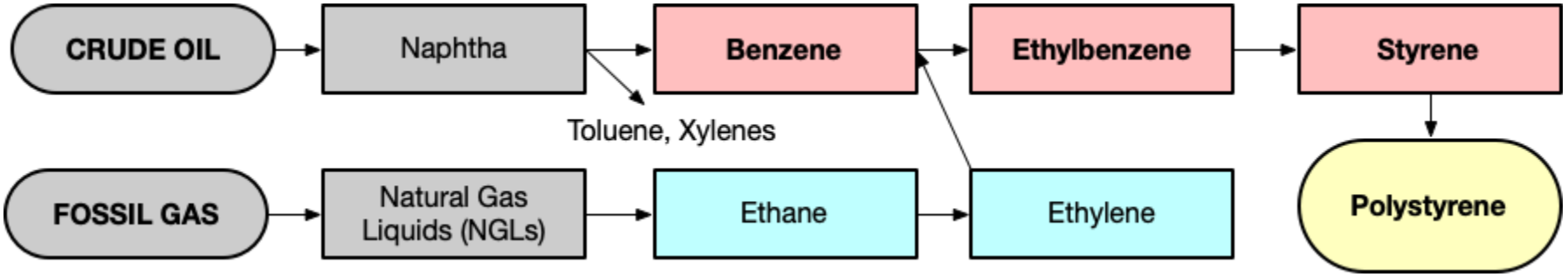
- About 54% of EtO is used to supply the production of PET polyester
- NESHAP rule would leave more than 3 million mostly Brown and Black residents at serious risk of cancer (lymphoma, leukemia, breast)
- EtO air emissions are under-estimated by a factor of up to tenfold (Robinson et al. *Env. Sci. Technol.* 2024, 58:11084-11095)

USEPA: 1,4-dioxane released by PET polyester production plants poses an unreasonable risk to human health for some workers and downstream drinking water consumers

- PET polyester plants are the largest source of air & water releases
- Risk management action still years away under TSCA

Bend the Curve
HEALTH · CLIMATE · JUSTICE

Production & Use of Polystyrene (PS) Plastic



Typical production process for General Purpose Polystyrene (GPPS). High hazard chemicals highlighted in RED. High Impact Polystyrene (HIPS) adds polybutadiene from hazardous **1,3-butadiene**. Expanded polystyrene (EPS) foam uses blowing agents.

Polystyrene drives the production of:

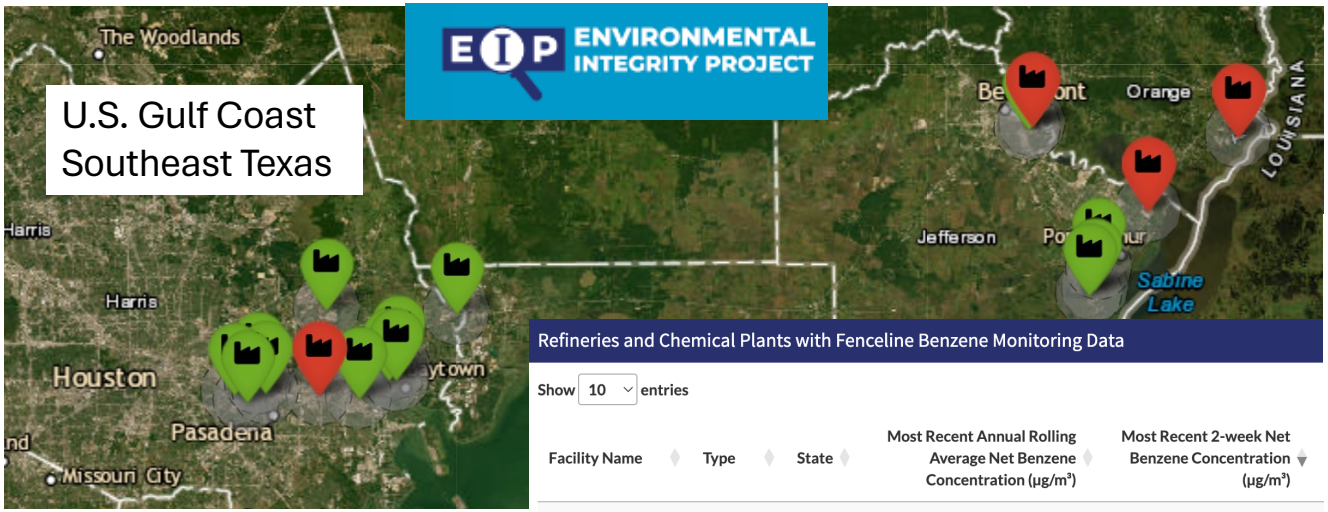
- 60 % of all Styrene
- 30 % of all Benzene

Bend the Curve
HEALTH • CLIMATE • JUSTICE

MAJOR DEMAND DRIVERS

- 64% of PS for Food Service and Food Packaging
- 12% PS for Electronic Cases
- 48% of EPS for Building Prod.
- 20% of EPS for Packaging

Benzene Exposures Driven by Polystyrene



Refineries and Chemical Plants with Fenceline Benzene Monitoring Data

Show 10 entries

Facility Name	Type	State	Most Recent Annual Rolling Average Net Benzene Concentration (µg/m³)	Most Recent 2-week Net Benzene Concentration (µg/m³)
LyondellBasell Clinton Plant	Chemical Plant	IA	3.71	31.53
Dow Chemical Orange Plant	Chemical Plant	TX	17.21	29.80
Beaumont Refinery	Refinery	TX	7.30	27.60
Pascagoula Refinery	Refinery	MS	8.07	20.00
Exxon Baton Rouge Chemical Plant	Chemical Plant	LA	6.43	19.40
Exxon Beaumont Chemical Plant	Chemical Plant	TX	9.59	17.50
Motiva - Port Arthur Refinery	Refinery	TX	6.19	10.35
Deer Park Refinery	Refinery	TX	18.70	10.30

Fenceline Monitoring

136 oil refineries & petro-chemical plants since 2018

218 chemical plants in 2026

Bend the Curve
HEALTH • CLIMATE • JUSTICE

Excessive benzene emissions from a styrene plan in Chemical Valley of Sarnia, Ontario, Canada

Aamjiwnaang First Nation says high chemical levels making members sick, calls for Sarnia facility shutdown

Company says it's reviewing the data and concerns over high chemical levels

Jennifer La Grassa · CBC News · Posted: Apr 17, 2024 5:01 PM EDT | Last Updated: April 17

Aamjiwnaang First Nation still on edge as chemical plant temporarily shuts doors

Provincial government orders company to cut benzene emissions

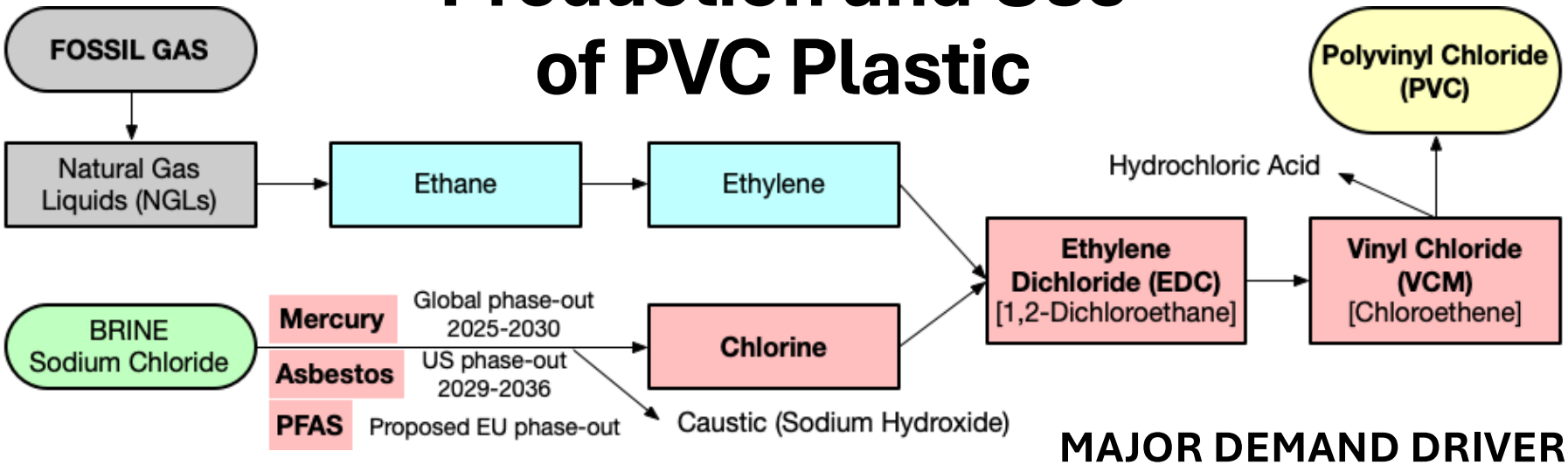
CBC News · Posted: Apr 22, 2024 7:01 PM EDT | Last Updated: April 22

CANADA'S NATIONAL OBSERVER

Ontario suspends Sarnia chemical plant approval over benzene emissions

By Allison Jones | News, Politics | May 2nd 2024

Production and Use of PVC Plastic



PVC plastic drives the production of:

- 96 % of all EDC
- 35 % of all Chlorine

Bend the Curve
HEALTH • CLIMATE • JUSTICE

MAJOR DEMAND DRIVERS

- 48% for Pipes and Tubing
- 9% for Vinyl Siding
- 7% for Windows & Doors
- 5% for Films & Sheet
- 3% *each* for Fencing & Decking, Packaging, Wire & Cable, and Flooring

Chemical Exposures from PVC Plastic

In 2022, U.S. chemical plants emitted into the air about:

- ✓ 332,000 pounds of **ethylene dichloride (EDC)** from 34 plants
- ✓ 268,000 pounds of **vinyl chloride (VCM)** from 28 plants
- ✓ 246,000 pounds of **chlorine** from 72 plants

After the EPA air toxics regulation takes full effect in 2026 (assuming it survives legal and political challenges), EDC and VCM emissions will:

* Still pose serious **cancer risks** at the 1-in-1-million level to nearly 300,000 people who live within 50 kilometers (31 miles) of each plant
* Account for 5% of **cancer incidence** attributed to all chemical plants
* Three chlorine sources may cause **acute & chronic non-cancer effects**

Bend the Curve
HEALTH • CLIMATE • JUSTICE

Research and Policy Implications & Priorities

- ❑ The human health impacts of plastics may be significantly affected by exposures that occur in the chemical manufacturing supply chain
- ❑ More research is needed on health hazards and risks to workers and community residents in and around plastics-related chemical plants
- ❑ More research is needed on the cumulative impacts of plastics-related chemical manufacturing, including racial/ethnic and other disparities
- ❑ Available technologies should be deployed to further reduce fugitive air emissions, including leakless connectors and high-tech leak monitoring
- ❑ Corporate and institutional consumers of plastics should eliminate unnecessary uses, and choose safer plastics & more sustainable materials
- ❑ A Global Plastics Treaty should reduce production and toxicity of plastics

Bend the Curve
HEALTH • CLIMATE • JUSTICE