coming clean

# THE CHEMICAL INDUSTRY: AN OVERLOOKED DRIVER of CLIMATE CHANGE

## The Problem and Policy Solutions

## POLICY PAPER # 1

### for the LOUISVILLE CHARTER

Prepared by Darya Minovi
Center for Progressive Reform

With contributions by Al Huang
Coming Clean & NRDC

# SUMMARY


The chemical sector—which includes the production of oil-, coal-, and natural gas-derived products, such as plastic, rubber, pesticides, and other industrial chemicals—is inextricably linked to fossil fuels, from extraction to processing, use, and waste disposal. In all, chemicals account for roughly seven percent of global greenhouse gas (GHG) emissions, yet they continue to be overlooked in efforts to mitigate climate change.[1]

Chemical production and use entrenches fossil fuel extraction and production, contributes to GHG emissions, and ultimately drives the climate crisis in three primary ways:

1) The use of fossil fuels for energy production to manufacture chemicals;
2) The use of fossil fuels as feedstock for products such as plastics and pesticides, and
3) The production of chemicals that are potent greenhouse gases.

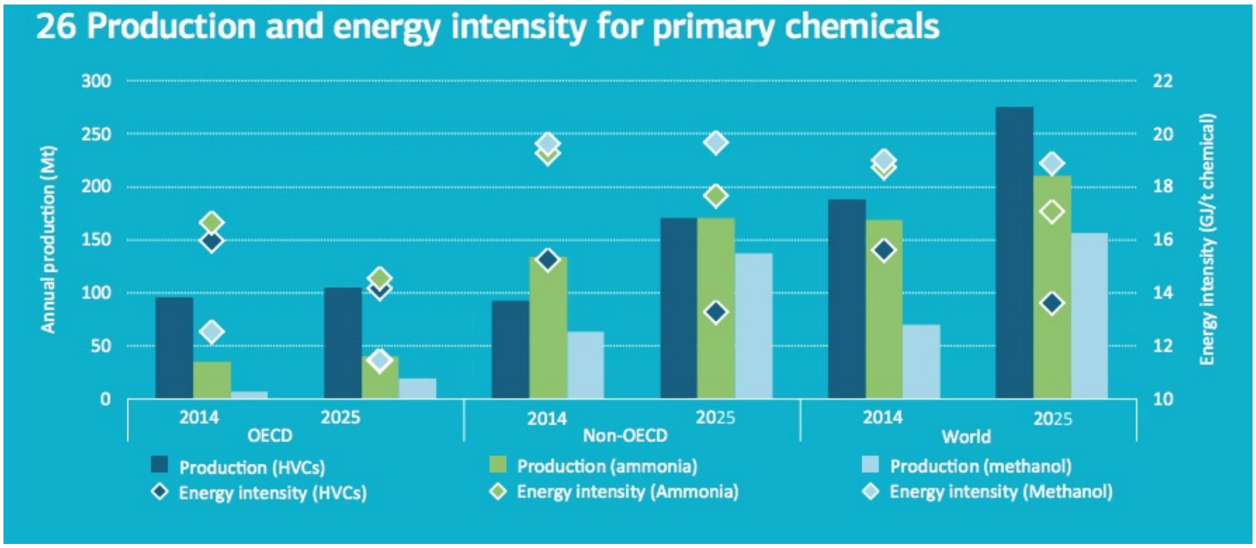
Failing to keep global temperature increases below 1.5°C will result in more extreme and frequent weather events, such as flooding, storms, heatwaves, fires, and drought. These climate impacts will in turn increase the risk of chemical disasters, resulting in additional GHG emissions and hazardous pollutants released to air and waterways.

Chemical and petrochemical operations are also largely concentrated in low-income communities and communities of color. Therefore, people and families who may already be overburdened by social and economic stressors are also being exposed to toxic emissions that harm their health. Furthermore, because these communities face a disproportionately higher risk of being impacted by climate change, in the event of a climate-fueled chemical disaster, they are hurt first and worst.[2]

To mitigate the worst impacts of climate change, limit the risk of chemical disasters, and begin to remedy a legacy of environmental injustice, we must significantly reduce and replace the use of fossil fuels in every part of the chemical industry, slow plastic production, and end the production of harmful and potent GHGs.

# THE CHEMICAL SECTOR IS ONE OF THE MAIN DRIVERS OF CLIMATE CHANGE

The vast majority of chemicals and petrochemicals are derived from three groups of "primary chemicals," which are produced directly from fossil fuels. These primary chemicals are: high-value chemicals (HVCs, which are used to produce most of the world's plastics) like light olefins (ethylene and propylene) and BTX aromatics (benzene, toluene, and xylene); ammonia (largely used to produce nitrogen fertilizers); and methanol (mainly used for formaldehyde). Production of primary chemicals has steadily increased, particularly in recent years. Between 2009 and 2014, in spite of the global financial crisis, production of HVCs increased by 19 percent, ammonia by 13 percent, and methanol by 51 percent.[3] By mass, fertilizers and plastics account for roughly 70 percent of petrochemical production.[4]




Source: OECD/IEA[5]

The chemical and petrochemical sector is the largest industrial energy consumer worldwide, accounting for approximately 28 percent of industrial and 10 percent of overall energy use.[6] Most of the sector's energy inputs are from oil and natural gas, which are either used to generate industrial processing energy or as carbon feedstock. The chemical and petrochemical industry accounts for 18 percent (nearly one-fifth) of global direct industrial carbon dioxide emissions.[7]

Over the last several decades, the sector's share of global energy consumption has steadily increased. In the United States, GHG emissions from petrochemical production alone increased by nearly 43 percent between 1990 and 2019.[8] Ninety percent of the sector's emissions in 2018 were from facilities along the Texas and Louisiana Gulf Coast, many of which are sited in largely Black, Latino, and low-income communities.[9]

By 2030, petrochemicals are set to account for more than a third of the growth in oil demand, and nearly half by 2050, ahead of freight, aviation, and shipping.[10] This is largely due to a projected 40 percent increase in plastic production over the next decade, particularly in lower-income countries.[11]

If global demand for petrochemicals reaches the levels seen in higher-income countries, petrochemicals could use nearly 30 percent of current annual oil production, and 20 percent of natural gas production.[12] This shift, which oil and gas producers are driving to shield themselves from the impending energy transition away from fossil fuels, will undercut global efforts to meet climate change goals. Already, the projected growth of the sector in the United States is in direct opposition to the U.S. Nationally Determined Contributions commitments to decrease GHG emissions by 50 to 52 percent by 2030.[13]

Global GHG emissions are already driving more intense hurricanes, flooding, and wildfires. One study found that hazardous substance releases due to natural hazards increased between 1990 and 2008.[14] Hurricane-related releases in particular increased fifteen-fold between 2005 and 2008. Another analysis found that at least 3,856 (one third of) facilities regulated under the federal Risk Management Program—which covers industrial facilities that use, store and/or manage highly hazardous chemicals—are at risk of being impacted by wildfires, flooding, hurricane storm surge, and/or coastal flooding.[15] While it will take decades, perhaps centuries, to reverse the worst effects of climate change, bold actions, including adoption of the Equitable & Just Climate Platform, must be taken now to limit the compounding hazards of climate-driven chemical disasters at petrochemical facilities, and continued emissions from this growing industry.

A significant reduction in global GHG emissions will require a transformation in how chemicals are manufactured and used. This paper discusses the three primary ways that the chemical sector drives the climate crisis: 1) the use of fossil fuels for energy production to manufacture chemicals; 2) the use of fossil fuels as feedstock for products such as plastics and pesticides; and 3) the production of chemicals that are potent greenhouse gases. The paper also details the public health and environmental justice implications of the chemical and petrochemical industry and offers policy solutions and industry practices that will help end global reliance on fossil fuels.

# USE OF FOSSIL FUELS AS PROCESS ENERGY FOR CHEMICAL MANUFACTURING

Roughly 42 percent of the chemical and petrochemical industry's fossil fuel needs are for process energy (i.e. for the manufacturing of chemicals).[16] The primary fuel source used to power chemical production processes is natural gas, followed by coal.[17] GHG emissions may arise from both the use of energy in chemical production and from venting byproducts, such as carbon dioxide, from manufacturing processes. Manufacturing of just 26 basic chemicals accounts for three-quarters of the sector's energy use and more than 90 percent of emissions.[18]

Some of the most commonly manufactured chemicals are also the most energy intensive. Steam cracking for the production of ethylene—a chemical used to manufacture plastics, textiles, antifreeze, vinyl, and synthetic rubber—is the most energy intensive process in the industry. The pyrolysis process in steam cracking alone consumes roughly 65 percent of process energy.[19] One analysis of ethylene production found that fuel burning to produce energy at a power plant contributed between 78 to 93 percent of the cumulative adverse environmental impacts, which include GHG emissions.[20] While the industry has implemented some energy efficiency measures and low-carbon technology, direct carbon dioxide emissions from primary chemical production have continued to increase alongside demand for these materials.[21]

In addition to producing GHGs, chemical manufacturing also generates emissions of toxic air pollutants that can harm workers and communities living adjacent to these facilities. These may include heavy metals, organic compounds, and other chemicals. Chemical and petrochemical manufacturing is largely concentrated in the Gulf Coast, and many of these facilities are disproportionately clustered in communities of color and low-income communities.[22] For example, the Harrisburg/Manchester community in East Houston, Texas, which is predominantly Latino, is home to a slew of facilities that contribute to toxic air concentrations of chemicals like chromium, 1,3-Butadiene, and hydrogen cyanide.[23] Ninety percent of the community's residents live within one mile of a high-risk industrial facility.[24] One citywide assessment found that air pollution in the Harrisburg/Manchester community exceeded safe levels for seven out of 12 pollutants.[25] Furthermore, the cancer risk and respiratory hazard index (indicates whether residents face a greater risk of developing lung diseases such as asthma or chronic bronchitis) are 22 percent greater for Harrisburg/Manchester than for Houston's urban area overall.[26]

Moreover, due to inadequate federal regulations and rollbacks of the Obama-era Chemical Disaster Rule, which covers facilities using extremely hazardous substances, many high-risk facilities are unprepared for the worsening impacts of climate change, such as sea level rise, flooding, and wildfires, that can contribute to catastrophic chemical releases.[27] For example, during Hurricane Harvey in 2017, forty-six industrial facilities in and around Houston, including the Arkema chemical plant, released approximately 4.6 million pounds of hazardous air emissions from pre-emptive shutdowns and startups, leaks, and explosions.[28] Many people were injured and hundreds were forced to evacuate their homes.

Beyond the climate impacts of chemical manufacturing, the burden of "business as usual" emissions are disproportionately felt by communities of color and low-income communities nationwide. This is largely the result of redlining, discriminatory housing and zoning policies, and systemic exclusion of Black, Latino, Indigenous, and other people of color from public processes and decision-making. Furthermore, as the impacts of climate change intensify, these communities and workers will be hit hardest by chemical releases at these facilities. Any efforts to mitigate GHG emissions from the chemical and petrochemical sector must also be rooted in eliminating the environmental racism upon which the industry was built and relies on.

## INDUSTRIAL AGRICULTURE, THE SILENT DRIVER OF GHG EMISSIONS FROM THE PETROCHEMICAL SECTOR

About 23 percent of global GHG emissions are from agriculture, forestry, and other land uses.[29] Agricultural emissions are largely from industrial practices (such as soil management and fossil fuel-powered equipment) and monoculture production dependent on the intensive use of synthetic chemical fertilizers and pesticides.[30] Ammonia—the basic component of ammonium nitrate fertilizer—is the second most commonly produced chemical worldwide.[31] Roughly half of ammonia production in the United States is concentrated in Louisiana, Oklahoma, and Texas. [32] Ammonia manufacturing alone is responsible for two percent of anthropogenic carbon dioxide emissions.[33] Furthermore, since fertilizers are often applied to land in excess amounts, they can run off into waterways or are broken down by soil microbes, which can release nitrous oxide, a potent GHG, into the atmosphere. [34]

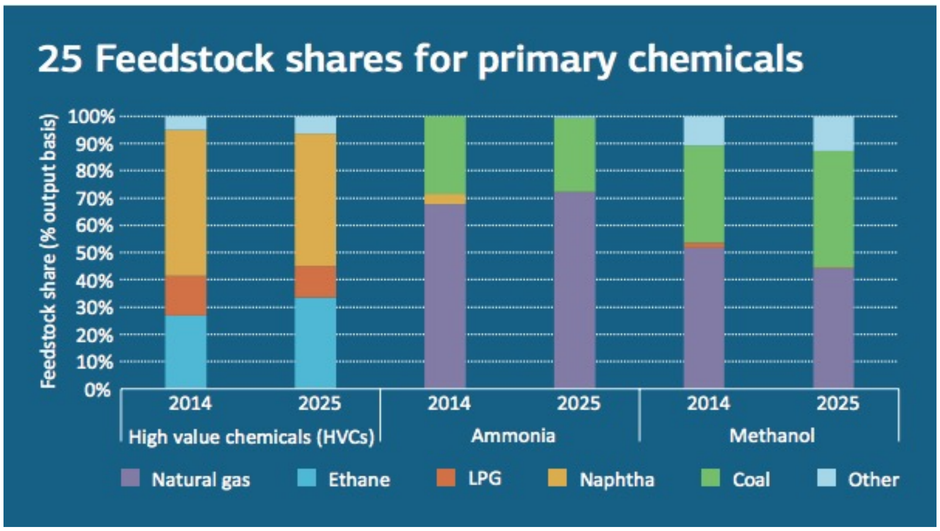
Many pesticides are also produced from petroleum-based chemicals such as ethylene, propylene, and methane.[35] While manufacturing of pesticides consumes a smaller share of energy inputs in the agricultural sector, some pesticides can require two to five times more energy to produce per pound than nitrogen fertilizer. [36]

Some pesticides are also greenhouses gases on their own. For example, methyl bromide is a highly toxic odorless and colorless gas that is used as a pesticide and fumigant.[37] Methyl bromide is also a significant contributor to ozone layer depletion. While the substance has been largely phased out of use in the U.S. under the Montreal Protocol, the EPA has granted some "critical exemptions."[38] For example, in Wilmington, North Carolina, residents have fought to oppose a permit for a facility that uses methyl bromide to fumigate logs.[39] The facility is located in a community largely made up of low-income families and people of color, with 18 other air pollution sources within a one-mile radius.[40] Continued use of the health- and climate-harming chemical in overburdened communities further entrenches environmental injustice and reliance on these chemicals.

Transitioning to sustainable practices, such as regenerative agriculture, which do not rely on the use of petroleum-derived pesticides and fertilizers, can not only reduce GHG emissions, but also limit toxic pollution in communities and mitigate climate change through carbon sequestration.[41] These practices may also produce alternative biofuel feedstocks.

# USE OF FOSSIL FUELS AS FEEDSTOCKS

Fossil fuel feedstocks—oil, natural gas, or coal used as raw material inputs, rather than as an energy source—account for roughly 58 percent of the chemical and petrochemical sector's energy inputs.[42] Energy use from petrochemical feedstock has steadily increased, with a growth rate of roughly 2.3 percent per year between 2000 and 2014.[43] Much of this growth is driven by increasing demand for and production of plastic. Naphtha and ethane are the primary feedstocks for the production of HVCs, while ammonia and methanol largely rely on natural gas and coal feedstocks.[44]




Source: OECD/IEA[45]

While feedstocks are the chemical and petrochemical sector's primary energy input, they contribute to just 19 percent (nearly one-fifth) of the chemical and petrochemical sector's direct carbon dioxide emissions.[46] This is because while some of the inputs are released as emissions during manufacturing, the majority of carbon stays within the products. The U.S. Environmental Protection Agency (EPA) estimates that between 1990 and 2016, up to 38 percent of potential carbon was released during production of non-fuel petrochemical products, leaving at least 62 percent stored within the products themselves.[47]

A significant source of feedstock-related emissions relates to how the products are disposed of. Waste incineration, for example, is the most significant source of GHG emissions compared to other disposal methods, such as landfilling and recycling, and is the predominant form of waste management in many countries.[48] Waste incinerators are typically used to generate electricity and heat, and when products like plastics are incinerated, the carbon atoms stored within are released as carbon dioxide emissions.[49]

Waste incinerators and landfills, where petrochemical products are often disposed of, are disproportionately located near communities of color and low-income communities.[50] Similar to chemical and petrochemical facilities, waste incineration can result in emissions of metals, acid gases, and organic compounds.[51] Workers and communities near waste incinerators are more likely to report having poor mental and physical health, and may be at a greater risk of cancer and adverse birth and neonatal outcomes.[52]

The city of Baltimore has maintained a reliance on waste-to-energy incineration for over 30 years, burning the region's waste at the Wheelabrator Baltimore trash incinerator (formerly the Baltimore Refuse Energy Systems Company incinerator) and imposing health and environmental burdens on neighboring Black and low-income communities. According to a 2011 report, the Wheelabrator incinerator produced more mercury, lead, and GHGs per hour of energy than each of the state's four largest coal-fired power plants.[53] In response, the South Baltimore Community Land Trust secured real commitments from city leadership to prioritize a just transition to zero waste in Baltimore.

## PLASTICS ARE A GROWING AND SIGNIFICANT CONTRIBUTOR TO THE PETROCHEMICAL SECTOR'S GHG EMISSIONS

Around 98 percent of single-use plastic (one third of annual plastic production) is derived from fossil fuels, and in every stage of the life cycle, plastics release GHGs, from fossil fuel extraction and transport, to refining and manufacture, and finally disposal and incineration.[54] Even when plastic products are recycled, most end up in landfills, and roughly 24 percent are incinerated to produce energy.[55] In 2015, plastic incineration alone resulted in an additional 5.9 million metric tons of carbon dioxide equivalents (CO2e).[56]

Plastic that is not incinerated often ends up in our oceans. Ocean plastic, particularly microplastics (tiny, broken-down pieces of plastic), can be toxic to marine life and humans, and contribute to GHG emissions. Research suggests that sunlight can cause ocean plastic to break down and release methane and ethylene, two potent GHGs.[57] With projected increases in plastic production, experts predict that GHG emissions from degradation of surface ocean plastic will be up to 103 megatons (Mt) per year for methane and up to 70 Mt per year for ethylene by 2025.[58]

Plastic production has increased precipitously over the last several years as oil and gas producers have attempted to offset losses from the ongoing transition to renewables and electric cars. Between 2012 and 2018, GHG emissions from the plastics sector increased by 15 percent.[59] As of 2020, the U.S. plastics industry, from creation and usage to disposal, contributed to at least 232 million tons of CO2e each year.[60] This is equivalent to the average emissions from 116 coal-fired power plants.

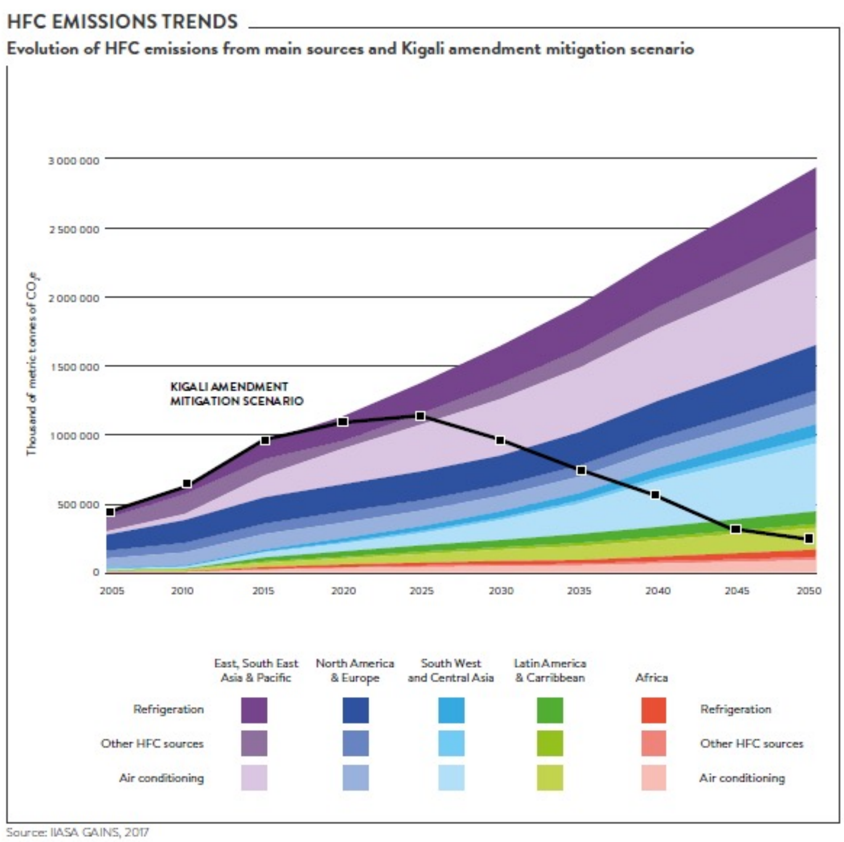
Plastic production is projected to grow, and as a result, so will demand for fossil fuels. At the current rate of growth, by 2030, emissions from the plastic production and incineration could reach 1.34 gigatons per year, equivalent to 295 coal plants.[61] By 2050, GHG emissions could reach more than 56 gigatons, which is 10 to 13 percent of the remaining carbon budget.[62]

Unfortunately, so-called "chemical recycling" (referring to both plastic-to-plastic, and plastic-to-fuel recycling) is not an effective method for managing plastic waste.[63] While plastic-to-plastic recycling does result in "avoided" carbon dioxide emissions, only about nine percent of global annual plastic waste is currently being recycled.[64] More often than plastic-to-plastic recycling, the industry transforms plastic products into fossil fuels (often through incineration) – a process that also generates toxic air emissions that disproportionately harm overburdened communities.[65] To add insult to injury, "chemical recycling" processes like pyrolysis and gasification are not defined under the Clean Air Act, and different classifications of these facilities may allow them to shirk regulation.[66] If all of the plastic industry's proposed "chemical recycling" facilities are built, they will emit upwards of 18 million tons of GHGs per year.[67]

# PRODUCTION OF CHEMICALS THAT ARE POTENT GREENHOUSE GASES

In addition to the use of fossil fuels for process energy and as feedstock, many manufactured chemicals are also significant contributors to climate change themselves. For example, fluorinated gases (such as hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride) are synthetic, powerful GHGs that are emitted from a variety of industrial processes.[68] These gases are typically emitted in smaller quantities, but because they are potent GHGs, they are sometimes referred to as High Global Warming Potential gases with a global warming effect up to 23,000 times greater than carbon dioxide.[69] In 2019, fluorinated gases represented three percent of GHG emissions in the United States.[70] They are used in several types of products, such as refrigeration, air conditioning, and heat pump equipment, and are ideal for widespread use over natural-occurring gases because of their durability, non-flammability, and stability.[71]

Though hydrofluorocarbons (HFCs, used as refrigerants and foam-blowing agents) are relatively short-lived in the atmosphere, they are the most widely produced fluorinated gases and have significant implications for climate change. HFCs are roughly 3,800 times more damaging to the climate than carbon dioxide over a 20-year period, and emissions of HFCs are growing at a rate of 10 to 15 percent per year.[72] Under the Kigali Amendment of the Montreal Protocol, countries have committed to cut production and consumption of HFCs by at least 80 percent by 2047. [73]




Source: CCA Coalition.[74]

Other fluorinated gases, like perfluorocarbons (PFCs) and sulphur hexafluoride (SF6), can remain in the atmosphere for thousands of years (up to 50,000) and their effects cannot be controlled. PFCs are typically emitted during the manufacture of aluminum, and SF6 is used in the electronics industry.[75]

The Chemours Louisville Works facility in Louisville, Kentucky is the largest emitter of hydrofluorocarbon-23 (HFC-23) in the United States.[76] HFC-23 is a "super-pollutant" byproduct from the production of hydrochlorofluorocarbon-22 (HCFC-22), which is often used in refrigeration and air conditioning. HFC-23 emissions from venting at the facility in 2019 were equivalent to the annual GHG emissions from 671,000 vehicles.[77] The Chemours facility is also located in Rubbertown – a highly industrial complex that is adjacent to lower-income residents of Louisville.

In 2021, the U.S. EPA set a goal of reducing HFC production and import by 85 percent over the next 15 years.[78] The agency estimates that this new regulation could reduce GHGs by an amount equivalent to three years of carbon dioxide emissions from U.S. power plants.[79] Under the new rule, the Chemours facility will be required to use or destroy 99.9 percent of the HFC-23 that it produces, however, it is not required to reduce emissions of HCFC-22, which is also a potent pollutant.[80] Regulatory loopholes for HCFC-22 remain a concern. For example, in 2019, the Daikin America plant in Decatur, Alabama released HCFC-22 emissions equivalent to those from 125,000 cars.[81] The Decatur facility produces per- and polyfluoroalkyl substances (PFAS) for use in food packaging.

# THE PATH TOWARD A CARBON-FREE AND LOW HAZARD CHEMICAL INDUSTRY

The chemical and petrochemical sector, the most energy-intensive industry, is driving the climate crisis, and projections indicate that petrochemical demand and production will only increase over the coming decades. While the industry has implemented some partial measures like energy efficient technology and process intensification, these efforts alone are not remotely enough.[82] Aggressive and multi-pronged strategies are needed to transform the industry and drastically reduce or eliminate its carbon and chemical footprint. Solutions must also remedy the legacy environmental, health, and economic impacts of the chemical industry on fenceline communities. Moreover, strategies to address climate change must benefit, rather than continue to burden, communities who have borne disproportionate harm from the industry.

To solve the climate crisis and eliminate environmental and public health harm by the chemical sector, we must:

**Pursue aggressive energy efficiency measures and scale up the use of renewable energy as a process energy source for the chemical and petrochemical industry, ultimately phasing out the use of fossil fuels for energy generation.**

- EPA must require facilities to continue pursuing and aggressively expand energy efficiency measures. For example, upgrading all steam cracking plants (the most energy intensive process in the chemical industry) would reduce energy intensity by 23 percent.[83]

- The chemical and petrochemical industry must invest in renewable energy technology and infrastructure.[84] One 2019 study found that running the global chemical industry on renewables requires more than 18 petawatt hours of electricity per year, which is 55 percent of total electricity expected from all sources in 2030.[85]

**Eliminate the use of fossil fuels as feedstock for chemical manufacturing and shift towards low hazard, renewable and/or recycled materials.**

- The chemical and petrochemical industry must incorporate the 12 Principles of Green Chemistry to reduce the inherent hazards of chemical products.[86] Innovation is needed to scale the development of new feedstock chemicals with low hazards. Replacing the production of highly hazardous feedstock chemicals such as benzene, toluene, and xylene with biobased carbon, for example, will perpetuate the ongoing problem of hazardous chemical releases into fenceline communities. This combination of low hazard and renewable materials and energy is key to a sustainable transformation of the chemical sector.

- Policymakers must tax fossil fuel producers (ie. a carbon tax) on the full amount of embedded carbon to drive the industry away from incineration and landfills.[87]

- Policymakers must invest in renewable energy-powered plastic-to-plastic recycling infrastructure to make this a viable approach for managing plastic waste.

**Stop the expansion of plastic production.**

- Policymakers must halt production of single-use plastics, particularly luxury items, to ensure that the burden of this transition does not fall on communities that may not yet have access to affordable plastic-free products.[88]

- EPA must suspend permits for new plastics production and infrastructure projects, including so-called "chemical recycling" and waste incineration facilities.[89]

- States have already begun to pass laws that exempt "chemical recycling" processes from solid waste regulations. EPA should define these processes under the Clean Air Act to ensure that emissions from existing facilities are regulated.[90]

- EPA must update Clean Air Act and Clean Water Act regulations for plastics facilities to ensure that they use zero-emissions technology and prevent discharge of plastics to waterways.[91]

- EPA must issue rules under the Resource Conservation and Recovery Act to ensure proper disposal of plastic hazardous waste that does not include incineration, and require best management practices for plastics disposal in state and regional solid waste plans.[92]

- EPA must regulate plastics that pose an unreasonable risk to public health under the Toxic Substances Control Act, particularly ensuring that manufacturers track and ensure proper disposal and recycling of those plastics.[93]

**Phase out manufacturing of chemicals that are significant GHGs on their own.**

- The chemical and petrochemical industry must invest in technology to recycle and reclaim fluorinated gases.[94]

- EPA and industry must ensure that HFC phase-out does not result in regrettable substitution with other super-pollutants.

- Alongside the phase-down of HFCs, EPA must set aggressive reduction goals for other fluorinated gases and High Global Warming Potential chemicals. The European Union— which has set restrictions on the sale and use of and emissions from fluorinated gases— may provide a model.[95]

**Eliminate the disproportionate burden of environmental and public health harm of the petrochemical industry on fenceline communities.**

- EPA must require emissions and fenceline monitoring of pollutants for all chemical and petrochemical facilities. See Equitable & Just Climate Platform.

- EPA must conduct cumulative impact assessments to human health for all chemical and disposal industry permitting decisions.

- The national climate policy agenda must reduce the disproportionate amount of pollution in environmental justice communities and that is associated with cumulative impacts, public health risks, and other persistent challenges. See proposed legislation in the EJ for All Act, EJ Act of 2021 and EJ Legacy Pollution Act. Also see Equitable & Just Climate Platform.

- EPA must require all chemical facilities, including those regulated under the Risk Management Program, to assess and plan for climate- and natural disaster-related hazards and expand community-level emergency response planning.

- Congress must codify President Bill Clinton's standing Executive Order 12898 on Environmental Justice to ensure that environmental justice considered in all actions by all federal agencies. See proposed legislation in the EJ for All Act and EJ Act of 2021.

- Congress must pass legislation that corrects Title VI of the Civil Rights Act of 1964 to allow communities to challenge discriminatory practice. See proposed legislation in the EJ for All Act and EJ Act of 2021.

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