



# Houston's Dirty Dozen:

A REPORT ON THE TOP INDUSTRIAL AIR POLLUTERS



# ACKNOWLEDGMENTS

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## GLOSSARY

### **TOXIC RELEASE INVENTORY (TRI):**

A database managed by the EPA that tracks the management of certain toxic chemicals that may threaten human health and the environment. U.S. facilities in different industry sectors must report annually how much of each chemical is released to the environment and/or managed through recycling, energy recovery, and treatment.

### **EPA ENFORCEMENT AND COMPLIANCE HISTORY ONLINE (ECHO):**

A public tool maintained by the EPA that provides integrated compliance and enforcement information for more than one million regulated facilities nationwide. The site also provides dashboards with views of overall enforcement and compliance status trends and some bulk datasets for downloading.

### **TCEQ ENFORCEMENT DATA:**

Statewide data compiled by the TCEQ Office of Compliance and Enforcement that provides information on investigations resulting in a Notice of Enforcement (NOE) and the details associated with each violation.

### **EPA FACILITY LEVEL INFORMATION ON GREENHOUSE GASES TOOL (FLIGHT):**

The EPA's FLIGHT provides maps, charts, and tables to quickly and easily filter data from the Greenhouse Gas Reporting Program (GHGRP) in a variety of ways, including by facility, industry, location, or gas. The GHGRP requires reporting greenhouse gas (GHG) data and other relevant information from large GHG emission sources, fuel and industrial gas suppliers, and CO<sub>2</sub> injection sites in the United States.

### **RISK SCREENING ENVIRONMENTAL INDICATORS (RSEI):**

EPA's Risk-Screening Environmental Indicators (RSEI) is a screening-level model that incorporates over 30 years of TRI chemical reporting data, three U.S. decennial Censuses, toxicity, and physicochemical properties for more than 400 chemicals, and geographical information for more than 100,000 facilities to model each chemical release through the environment and the potential human exposure and relative impacts that may result.



## EXECUTIVE SUMMARY

With Houston being the petrochemical capital of the world, industrial emissions continue to contribute significantly to the air pollution in the Houston area. Some major hazardous air pollutants released from these point sources include Ethylene oxide, 1,3 Butadiene, Propylene, and Nitrous oxide.

In this study, we utilized multiple publicly available data sources, including the Toxic Release Inventory (TRI), Enforcement and Compliance History Online (ECHO) data, Facility Level Information on Greenhouse Gases Tool (FLIGHT), Risk Screening Environmental Indicators (RSEI), all from the US Environmental Protection Agency (EPA). We also used the Enforcement and Violation data from the Texas Commission for Environmental Quality (TCEQ). This information was used to identify the industrial facilities that contributed the most to air pollution in Houston, particularly with our severe nonattainment status of the National Ambient Air Quality Standards (NAAQS) for ozone, which pollutants from these facilities contribute to.

The TRI data showed that most petrochemical facilities were in Pasadena, Deer Park, Channel View, and Baytown. The top three compounds most emitted were Ethylene, Propylene, and Ammonia. The TRI data also revealed that the facility with the most emissions out of over 300 facilities was ExxonMobil Baytown, releasing over 8 million pounds of petroleum products, closely followed by LyondellBasell's Channelview plant with Chevron Phillips Baytown facility as third. These three facilities account for 60% of the chemical releases in Harris County.

The chemical with the highest RSEI hazard score was Ethylene oxide, a known human carcinogen, and the facility that released the most Ethylene oxide was LyondellBasell. From the FLIGHT data, ExxonMobil Baytown was again at the top of greenhouse gas emitters. These greenhouse gases, like Carbon dioxide and Nitrous oxide from petrochemical plants and refineries, continue to drive the climate crisis.

The ECHO data identified the facilities that paid the most in penalties and had the most violations. Altivia Oxide Chemicals and Chevron Phillips Cedar Bayou were first and second regarding the most penalties paid as well as most high-priority violations.

We found it necessary to identify the most polluting facilities to call attention to the amount of emissions released by the same facilities and to be cognizant of the cumulative impact of their emissions on the surrounding communities.

## INTRODUCTION

Industrial activity and petrochemical production often cause various forms of environmental pollution, impacting the air, water, land, and public health. The datasets used in this project provide multiple perspectives on these industrial activities, with data on releases of hazardous substances, environmental violations, and risk indicators. The Dirty Dozen Project uses data analytics, cross-referencing techniques, and data visualization to discover patterns and correlations to identify the industrial entities and sectors with the most significant contributions to air pollution, the most violations of their permits, and environmental regulations in Houston.

In 2005, Houston's mayor, Bill White, commissioned a study examining air pollution in the Greater Houston area. A year later, the results from the report ranked 12 major pollutants that pose the most health risks to city residents according to their respective impact. These included chromium, butadiene, and benzene, with the highest levels recorded in East side neighborhoods of the City. This research seeks to augment those findings by ranking the region's highest industrial sources of air pollution.

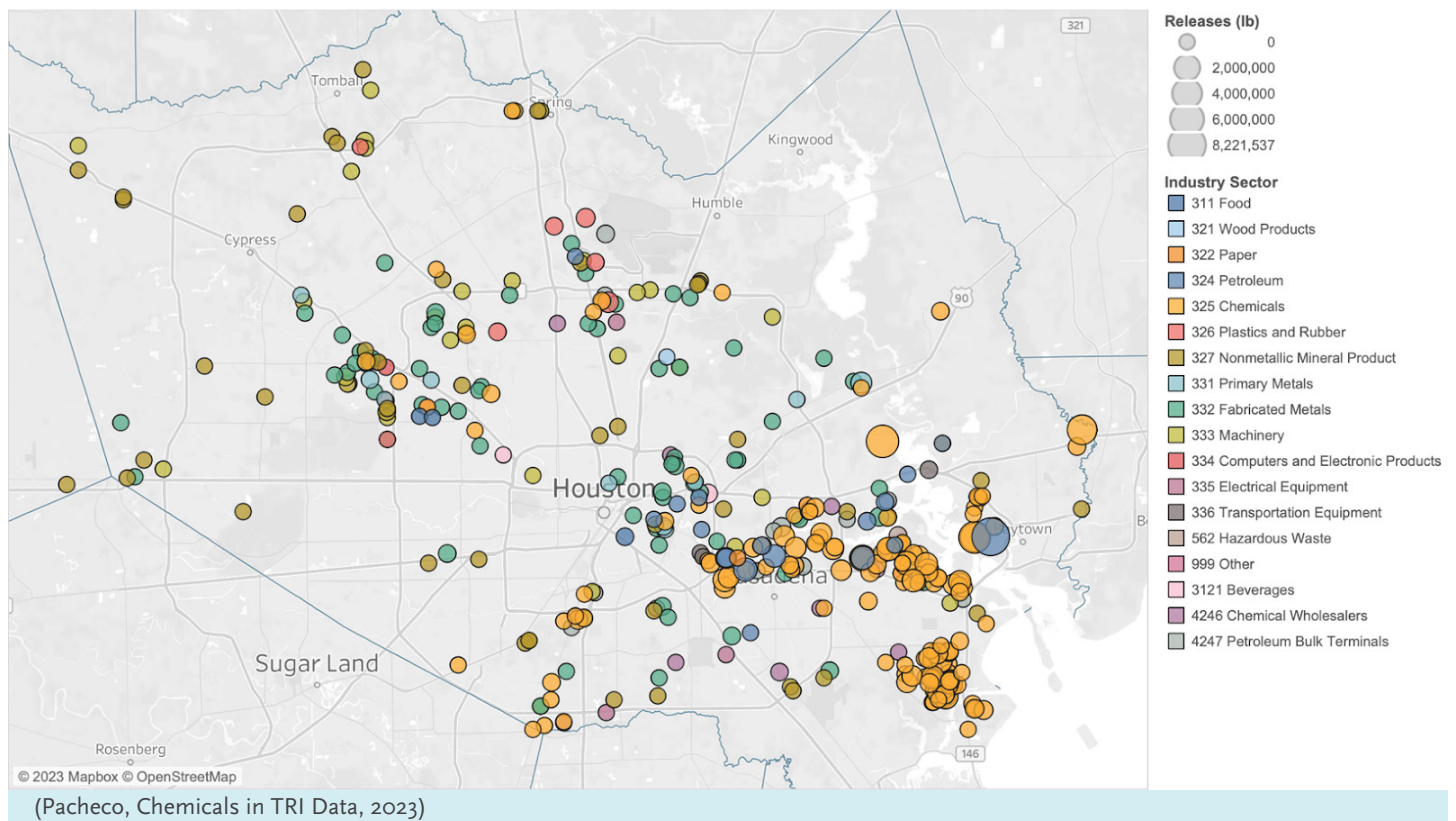


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# TOXIC RELEASE INVENTORY (TRI)

The Toxic Release Inventory (TRI) is a database for learning about toxic chemical releases, management, and pollution prevention activities reported by industrial and federal facilities. It is administered by the Environmental Protection Agency (EPA). The TRI was established under the Emergency Planning and Community Right-to-Know Act (EPCRA) and later expanded by the Pollution Prevention Act.

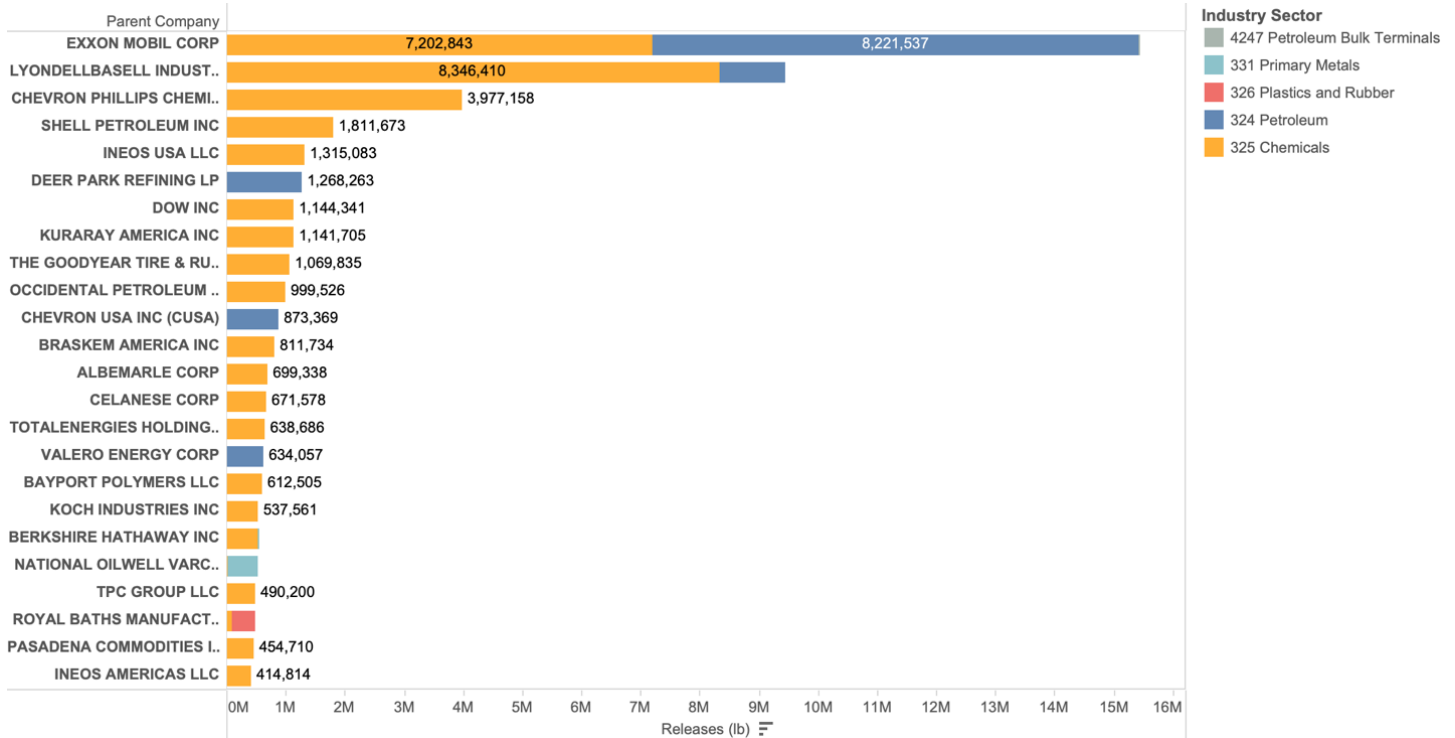
Using TRI data from 2018 to 2022, we gained meaningful insights into the industries contributing to the greatest chemical releases. “Release” refers to how toxic chemicals from industrial facilities enter the air. Releases include spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment.



The most predominant industry in Harris County, according to releases of toxic chemicals, is the petrochemical industry, as highlighted by the map above. This visualization allows us to identify clusters of these industrial polluters and the quantities of chemicals released over the time period studied. Most of these petrochemical facilities are located in the eastern and southeastern regions of the city and county and include areas like Pasadena, Deer Park, Channelview, La Porte, and Baytown.

Next is a closer look at the top 25 out of 350 companies, sorted by the amount of chemicals released from 2018 to 2022.



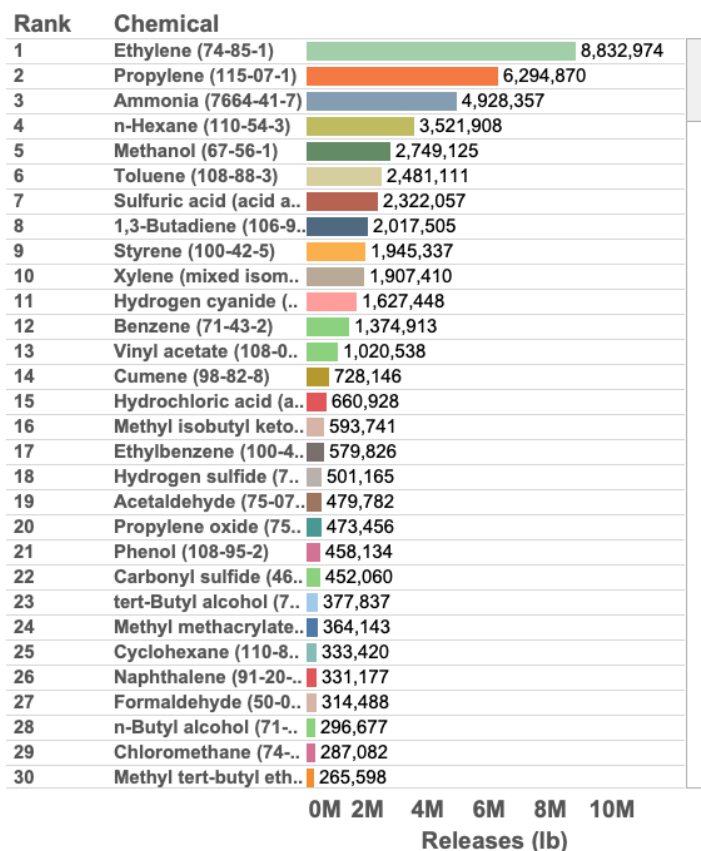


- ExxonMobil Corporation:** One of the largest international oil & gas companies and one of the largest refiners and marketers of petrochemicals, topped the list.
  - ExxonMobil's emissions come from its Baytown Complex - a sprawling 3,400-acre industrial site that includes a refinery, a chemical plant, and an Olefins unit.
- LyondellBasell Industries:** This chemical company that manufactures and sells plastics and petrochemicals and refines crude oil to convert it into products such as diesel, gasoline, and jet fuel was second.
  - LyondellBasell owns several facilities in the Houston area; however, its largest source of emissions comes from its 4,000-acre Channelview Complex, which includes two manufacturing facilities and is one of the most extensive Gulf Coast petrochemical facilities.
- Chevron Phillips Chemical:** This petrochemical company that produces chemicals used in manufacturing industrial products such as polyolefins, aromatics, styrene, specialty chemicals, and plastics was third on the list.
  - Chevron Phillips Chemical's emissions come from its Cedar Bayou facility in Baytown, a 1,800-acre petrochemical manufacturing complex that produces Ethylene, polyethylene, hexene, and olefins.

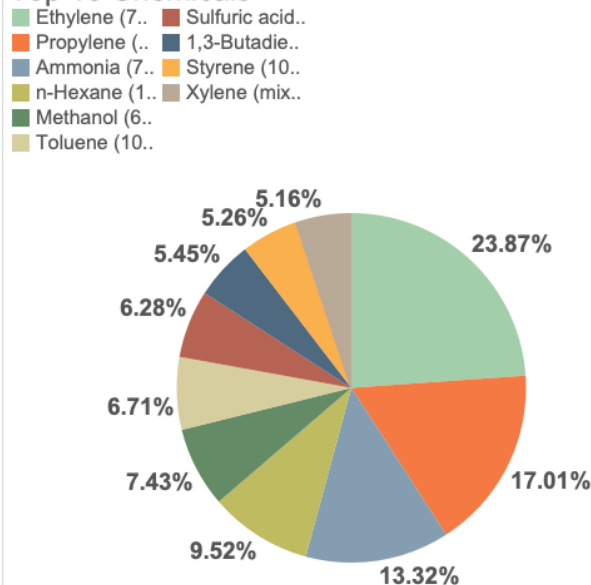
These three petrochemical companies and their facilities alone are responsible for 60% of the chemical releases in Harris County.

## TRI - Chemicals Releases

The TRI dataset also provided information about the different chemicals released into the air by these industrial facilities. In total, there were 272 different chemicals in our dataset.



Top 10 Chemicals



We explored a few of the chemicals that appeared at the top of this graph more in-depth:

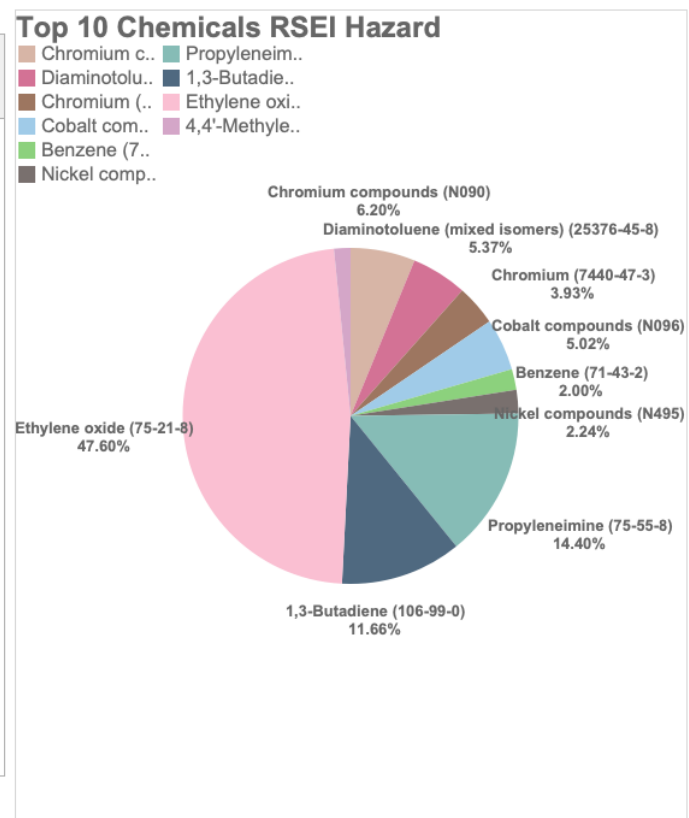
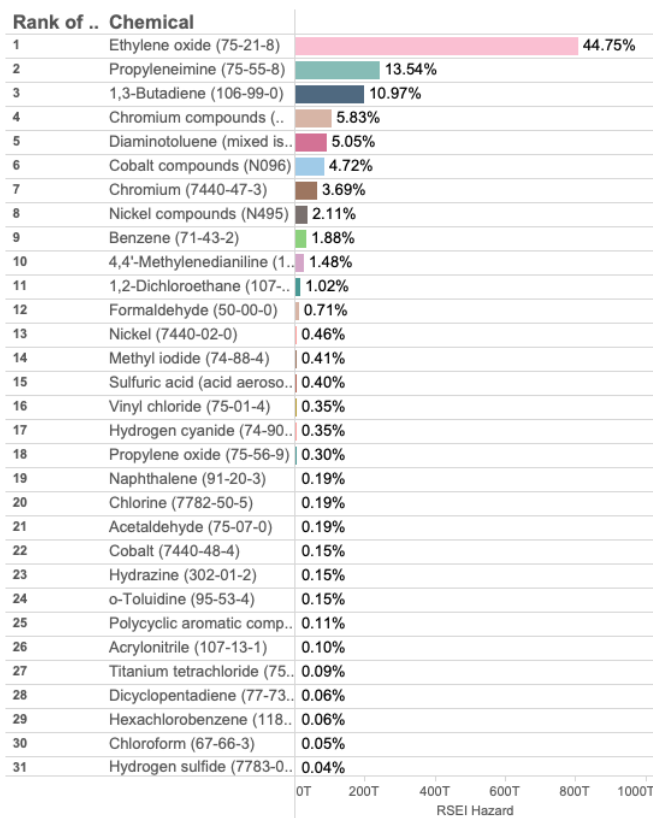
- **Ethylene:** This is widely used in the chemical industry, and much of this production goes toward creating polyethylene, a plastic containing polymer chains of ethylene units in various chain lengths. Ethylene is also an important natural plant hormone used in agriculture to accelerate the ripening of fruits. Metabolic studies in animals and humans have revealed that ethylene is metabolized to ethylene oxide, which has carcinogenic and mutagenic effects. ((IARC), n.d.)
- **Propylene:** This compound is used to produce many organic chemicals, including resins, plastics, synthetic rubber, and gasoline. The primary human exposure to propylene is in the occupational setting. Consumer exposure to propylene is only likely from the low levels of heating gasses and some anthropogenic sources such as combustion products of organic matter, motor vehicle exhaust, and cigarette smoke. ((IARC), n.d.)
- **1,3-Butadiene:** This is produced through the processing of petroleum and is mainly used in the production of synthetic rubber but is also found in smaller amounts in plastics and fuel. Acute low exposures may irritate the eyes, throat, nose, and lungs. Based on human and animal studies, the EPA has classified 1,3-butadiene as a known human carcinogen. ((IARC), n.d.)

# TRI - CHEMICALS RELEASES & RSEI HAZARD SCORE

The RSEI Hazard Score is the quantity of waste management activity (e.g., chemical quantity released to the environment or transferred off-site for further waste management) in pounds per year (TRI Pounds), multiplied by a chemical- and exposure route-specific toxicity weight ((EPA) E. P., Understanding RSEI Results, n.d.).

RSEI Hazard score can be calculated for any waste management activity reported to TRI. These scores account for the size of a chemical release, the size and locations of potentially exposed populations, and the relative toxicity.

Our graph below shows us the chemical with the highest RSEI Hazard score.



When comparing the results from the chemicals weighted by the TRI release in pounds and the chemicals by the RSEI Hazard score, the chemicals shown change. For example, in the RSEI Hazard score, Ethylene oxide is ranked number 1. This chemical has been scientifically proven to be highly associated with the occurrence of cancer, reproductive effects, neurotoxicity, and mutagenic changes following chronic exposure.

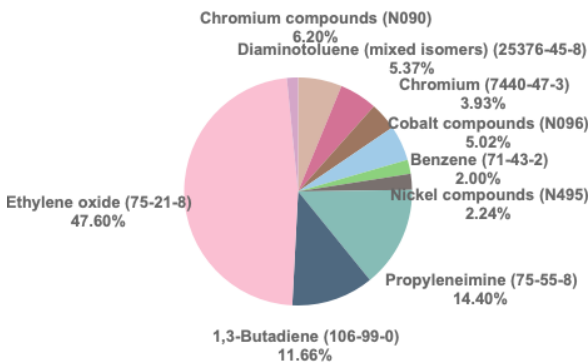
Propyleneimine, ranked number 2, is a potential occupational carcinogen. 1,3-Butadiene, a known human carcinogen, which repeats in both graphs, is number 3 and therefore occupies a higher position in the RSEI Hazard score.



Here are the top companies and their percentages on emissions of the top hazardous chemicals. Some of these names repeat in our graph of the top companies by number of releases, showing that they release multiple hazardous pollutants.

### Top 10 Chemicals R..

- Chromium compounds (N090)
- Diaminotoluene (mixed isome..)
- Chromium (7440-47-3)
- Cobalt compounds (N096)
- Benzene (71-43-2)
- Nickel compounds (N495)
- Propyleneimine (75-55-8)
- 1,3-Butadiene (106-99-0)
- Ethylene oxide (75-21-8)
- 4,4'-Methylenedianiline (101-7..)



| Parent Company                 | Chemical                       | Percentage |
|--------------------------------|--------------------------------|------------|
| LYONDELLBASELL INDUSTRIES      | Ethylene oxide (75-21-8)       | 44.01%     |
|                                | 1,3-Butadiene (106-99-0)       | 6.29%      |
|                                | Chromium compounds (N090)      | 0.12%      |
| DIXIE HOLDINGS INC             | Propyleneimine (75-55-8)       | 17.28%     |
|                                | 1,3-Butadiene (106-99-0)       | 0.32%      |
| CELANESE CORP                  | Ethylene oxide (75-21-8)       | 9.19%      |
| EXXON MOBIL CORP               | Chromium compounds (N090)      | 4.71%      |
|                                | 1,3-Butadiene (106-99-0)       | 2.19%      |
| FUTURE PIPE IND..              | Diaminotoluene (mixed isomers) | 4.74%      |
| ALBEMARLE CORP                 | Diaminotoluene (mixed isomers) | 1.71%      |
| SHELL PETROLEUM CORP           | 1,3-Butadiene (106-99-0)       | 1.24%      |
| CLARIANT CORP                  | Ethylene oxide (75-21-8)       | 1.21%      |
| INNOVEX DOWNH..                | Chromium compounds (N090)      | 1.05%      |
| NOURYON CHEMICALS              | Ethylene oxide (75-21-8)       | 1.04%      |
| TPC GROUP LLC                  | 1,3-Butadiene (106-99-0)       | 0.86%      |
| CHEVRON                        | 1,3-Butadiene (106-99-0)       | 0.73%      |
| PHILLIPS CHEMICALS             | Chromium compounds (N090)      | 0.00%      |
| THE GOODYEAR TIRE & RUBBER CO. | 1,3-Butadiene (106-99-0)       | 0.62%      |
| TARGA RESOURCES                | 1,3-Butadiene (106-99-0)       | 0.52%      |
| INDORAMA VENTURES              | Ethylene oxide (75-21-8)       | 0.49%      |
| DEER PARK REFINERY             | 1,3-Butadiene (106-99-0)       | 0.43%      |
| DOW INC                        | Ethylene oxide (75-21-8)       | 0.42%      |
| SOLVAY HOLDING                 | Ethylene oxide (75-21-8)       | 0.40%      |
| KANEKA AMERICA                 | 1,3-Butadiene (106-99-0)       | 0.33%      |
| BERKSHIRE HATHAWAY             | 1,3-Butadiene (106-99-0)       | 0.06%      |
| HALDOR TOPSOE                  | Chromium compounds (N090)      | 0.05%      |

Ultimately, the TRI data allows us to explore the different facilities and provides information about the industry type, the number of pounds released in a period, the RSEI Hazard score, and the list of chemicals emitted by these companies.

The most important part of the TRI dataset is the differences in results when comparing the compounds released versus their RSEI Hazard score. According to the EPA, the RSEI “scores” results are not to be judged only by high or low; however, in this data set, most of the top 10 chemicals by RSEI Hazard score are primarily human carcinogens.

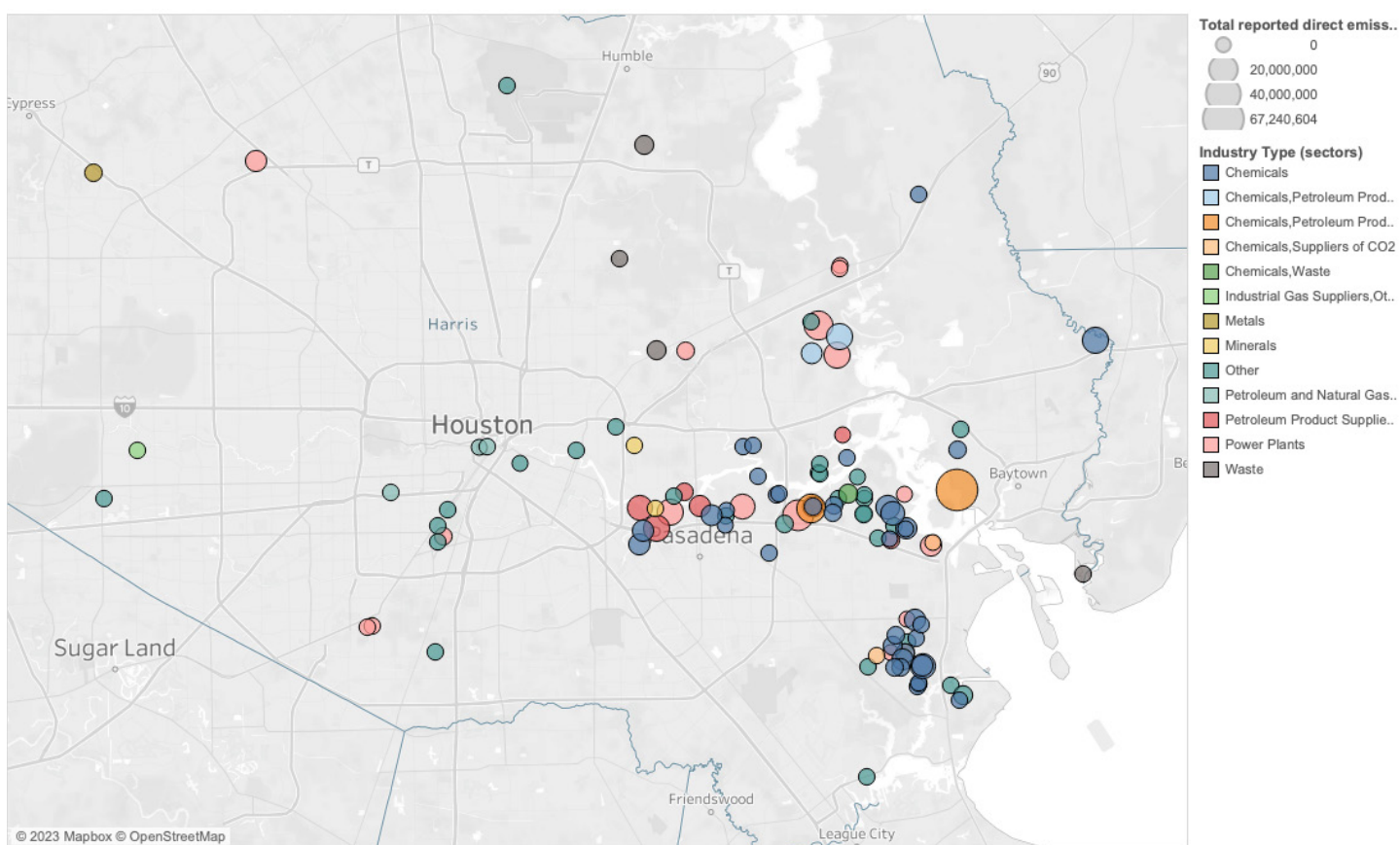
The TRI data set provides enough variables to visualize and understand cluster points, the companies’ size, the industry type, and the most released chemical. This information makes it easier to distinguish mega-polluters from smaller companies.

## EPA GREENHOUSE GASES

Greenhouse gases are gases that trap heat in the atmosphere.

Transportation, electricity production, industry, commercial, residential, and agriculture are the sectors that contribute the most to greenhouse gases. In industry, the gases are produced by burning fossil fuels for energy and are released from chemical reactions when producing goods from raw materials.

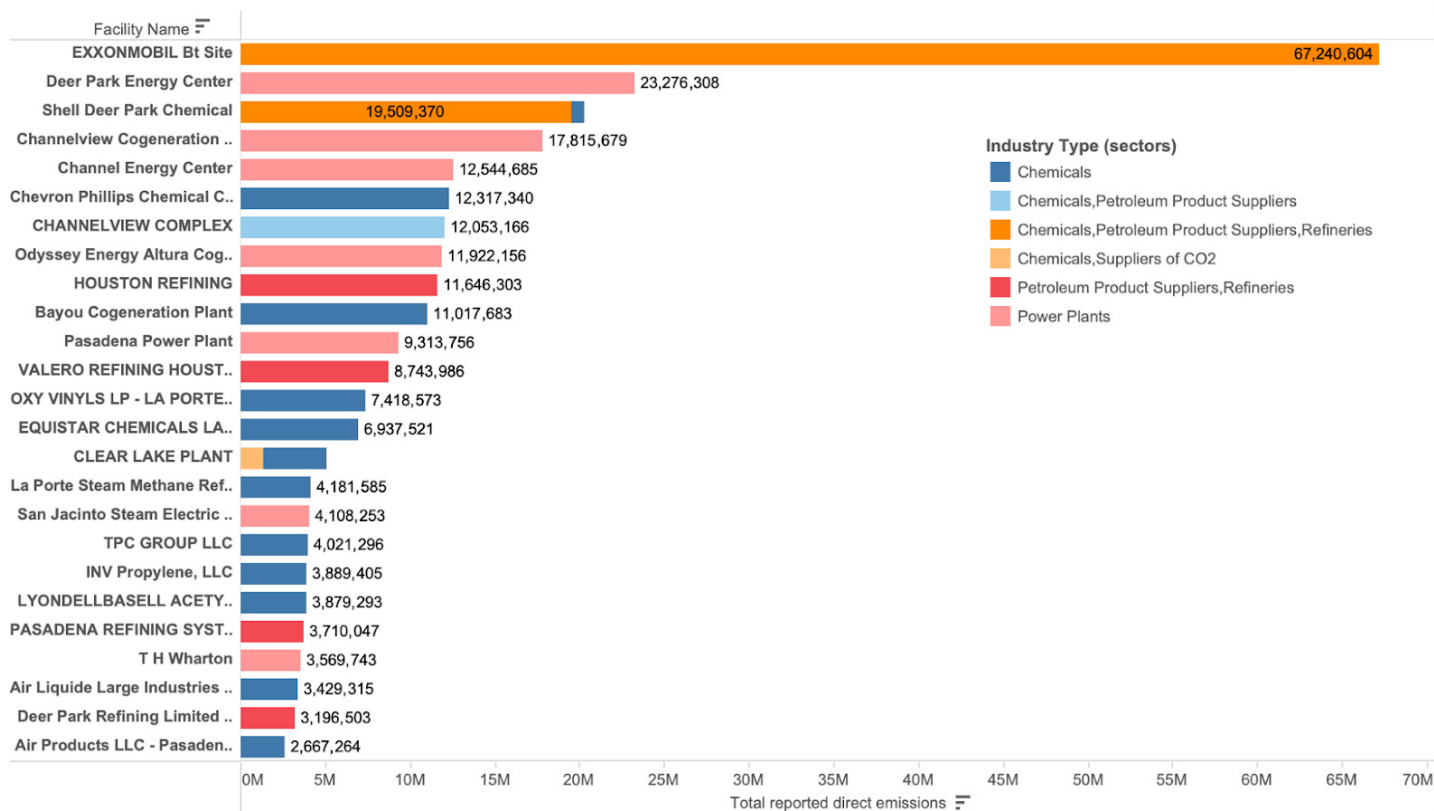
We used the EPA FLIGHT (Facility Level Information on Greenhouse Gases Tool) to explore the industry type. ((EPA) U. E., n.d.) This tool provides information about greenhouse gas emissions from facilities in the U.S., focusing on specific types of gases.



(Pacheco, Greenhouse Gases Visualization, 2023)

We gathered data from the 108 facilities in Harris County from 2018 to 2022. The dashboard enabled us to locate the companies with the most direct greenhouse gas emissions. Pasadena and Baytown had the most noticeable cluster of points because most of the facilities there were in the petrochemical industry (petroleum product suppliers, refineries, suppliers of CO<sub>2</sub>, and waste).

Below are the top 25 out of 108 companies, sorted by their number of direct emissions from 2018-2022.



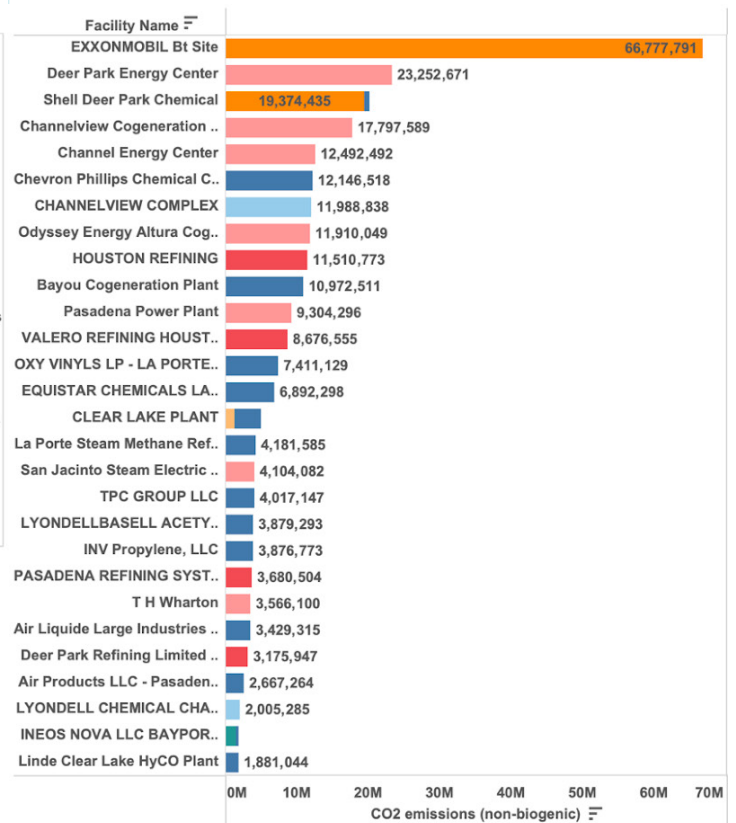
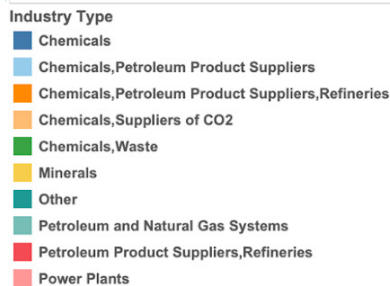
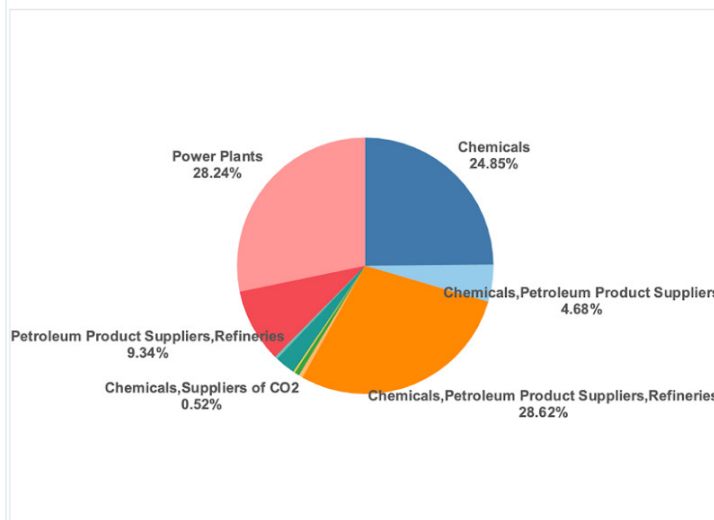
- **ExxonMobil Bt (Baytown) Site:** This ExxonMobil plant manufactures approximately 10 billion pounds of petrochemical products each year, shipped via pipeline. Baytown operates eleven natural gas cogeneration units to generate electricity and high-pressure steam across the Baytown Complex. (ExxonMobil, 2022)
- **Deer Park Energy Center:** This is the largest power plant in Calpine’s fleet (America’s largest generator of electricity from natural gas and geothermal resources). The plant captures CO<sub>2</sub>, supplies steam to Shell Chemical Company, and generates electric power sold into the wholesale market. (Corporation, n.d.)
- **Shell Deer Park Chemical:** It manufactures base chemicals or raw material chemicals and sells them to other chemical companies that turn them into thousands of consumer products. Most chemicals from Deer Park are shipped via pipelines, but the site also uses ships, barges, rail cars, and trucks to supply customers in the U.S. and foreign countries (Shell).



## Carbon Dioxide (CO2)

Carbon dioxide (CO2) is the primary greenhouse gas emitted. It enters the atmosphere through burning fossil fuels (coal, natural gas, and oil), solid waste, trees, and other biological materials, and specific chemical reactions (e.g., cement production) (Agency, Overview of Greenhouse Gases, n.d.).

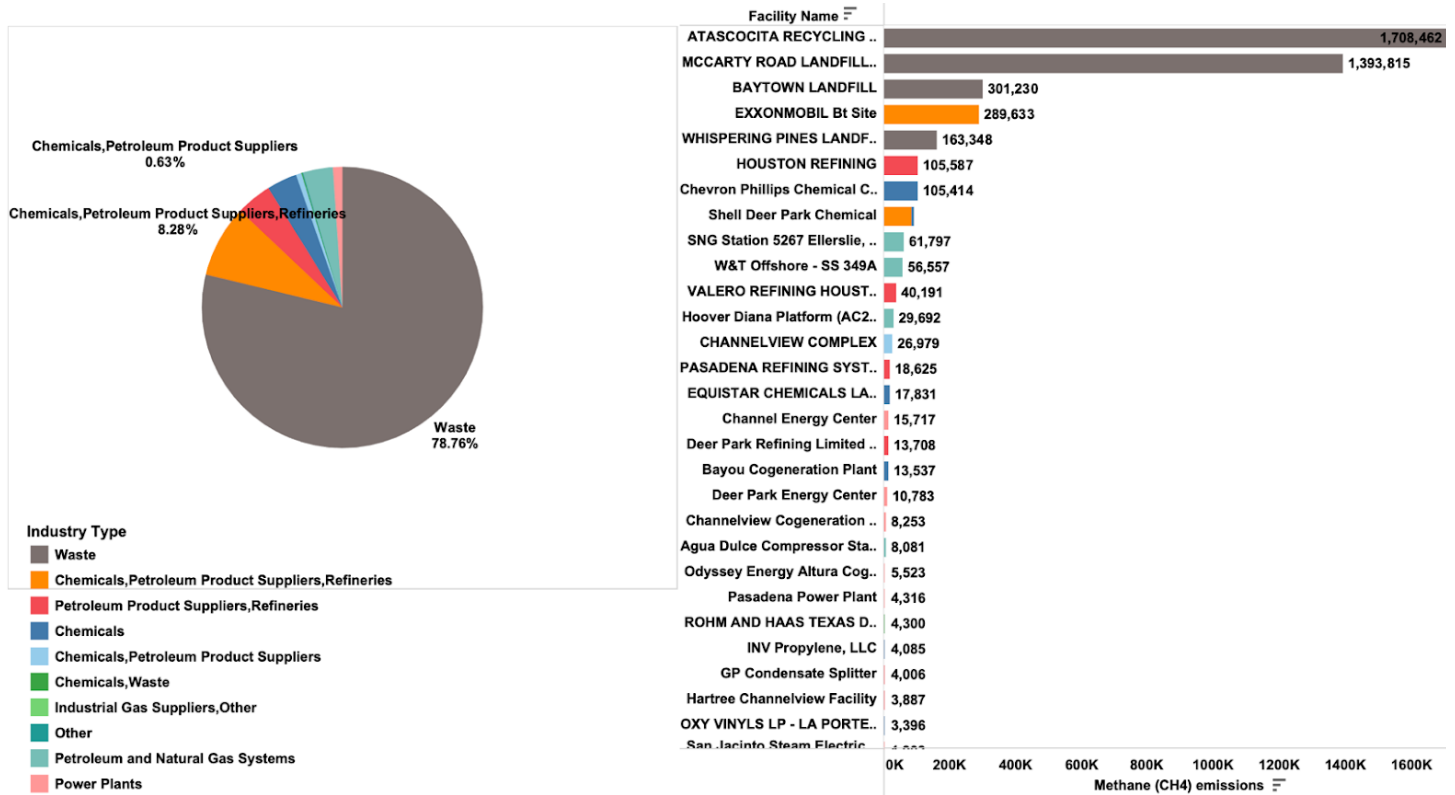
Below are the top companies are the top companies with direct emissions of CO2 and their industry type. The companies that contribute the most to the direct emissions of CO2 are mainly the Chemical and Power Plants industries. CO2 can produce adverse effects in humans, such as headaches, dizziness, restlessness, difficulty breathing, tiredness, elevated blood pressure, and increased heart rate. (Power, n.d.)



## Methane (CH<sub>4</sub>)

Methane is emitted during coal, natural gas, and oil production and transport. Methane emissions also result from livestock and other agricultural practices, land use, and the decay of organic waste in municipal solid waste landfills.

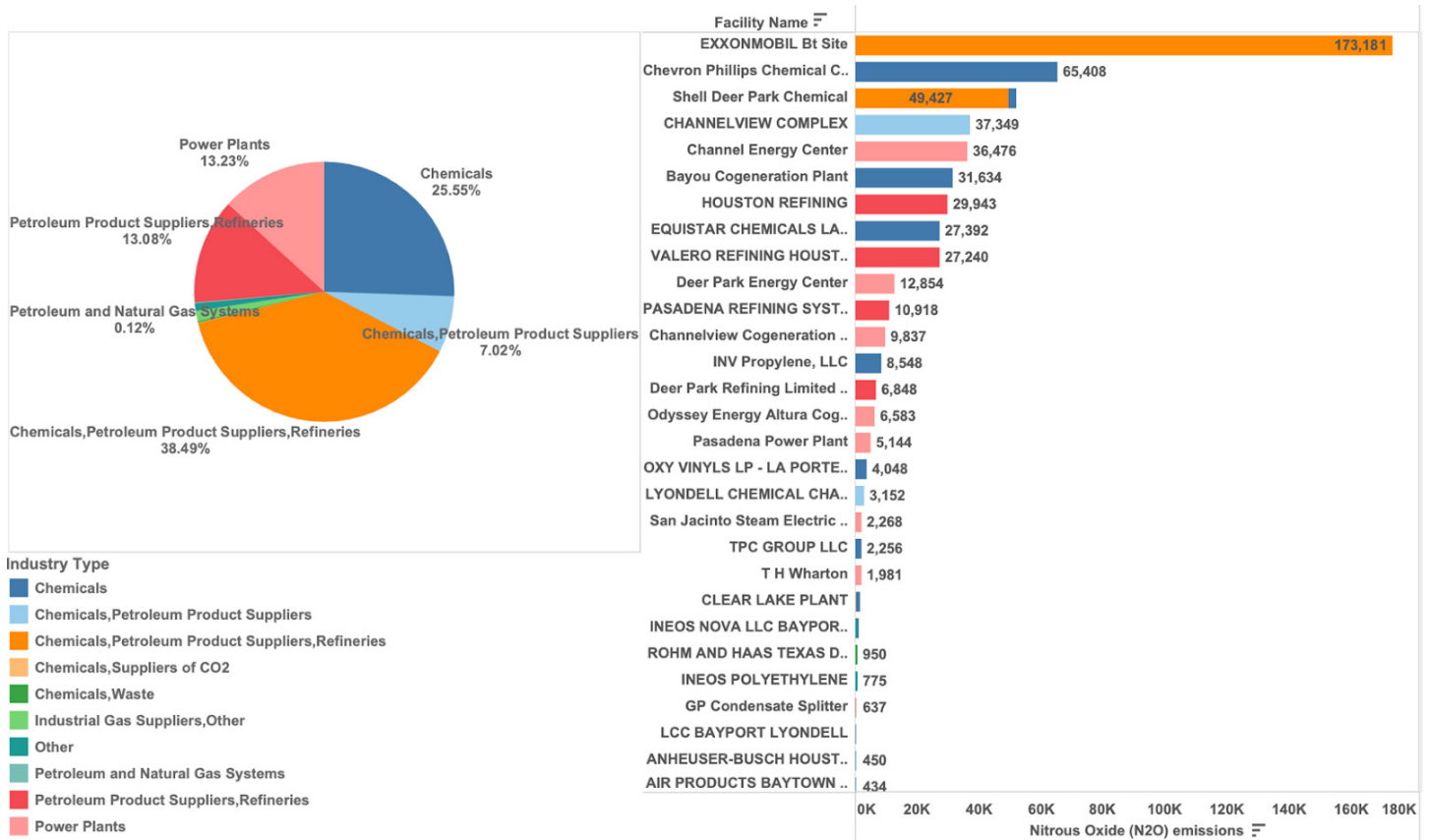
Methane’s lifetime in the atmosphere is much shorter than that of carbon dioxide (CO<sub>2</sub>), but CH<sub>4</sub> is more efficient at trapping radiation than CO<sub>2</sub>. Pound for pound, the comparative impact of CH<sub>4</sub> is 28 times greater than CO<sub>2</sub> over 100 years. (Agency, Overview of Greenhouse Gases, n.d.)



The industry type changes regarding methane emissions; in this case, the “waste” industry is in the first place by a significant difference, contributing to 78% of the total methane emissions in Harris County.

## Nitrous Oxide (N<sub>2</sub>O)

Nitrous oxide (N<sub>2</sub>O) is released during agricultural, land use, and industrial activities; combustion of fossil fuels and solid waste; and wastewater treatment. It is worthy of note that the impact of 1 pound of N<sub>2</sub>O on warming the atmosphere is 265 times that of 1 pound of CO<sub>2</sub>. (Agency, Overview of Greenhouse Gases, n.d.)



During our study period (2018 - 2022), petrochemical product suppliers and refineries were the highest contributors to direct emissions of N<sub>2</sub>O in Harris County. The ExxonMobil Bt (Baytown) location was in the lead again for CO<sub>2</sub> and N<sub>2</sub>O emissions.

# EPA ENFORCEMENT AND COMPLIANCE

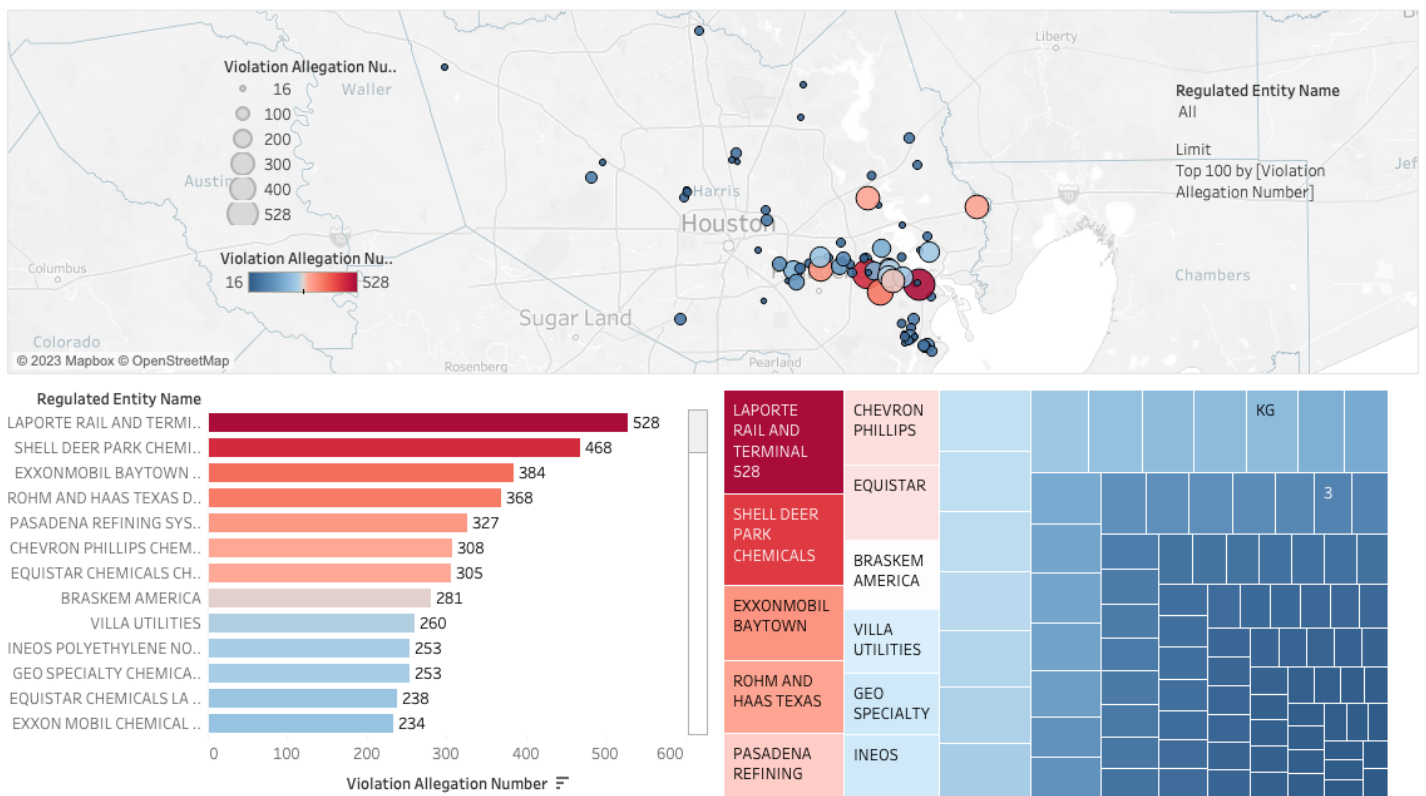
We used the Enforcement and Compliance History Online (ECHO) tool from the EPA to obtain and assess historical data regarding compliance with environmental regulations. We streamlined facilities through the media program “Air (CAA-Clean Air Act),” where we obtained data of the TRI facilities with enforcement and compliance data. (Agency, Environmental Compliance History Online (ECHO), n.d.)

## Penalties

We obtained data from 108 companies that shared their reports with the TRI and were in the ECHO database. The dashboard below shows five years (2018-2022) compliance historical data.

The visualization identifies the companies that have paid the most in penalties.

The clusters were again in the Pasadena and Baytown areas, with Altivia Oxide Chemicals and Chevron Phillips Chemical leading the charts.

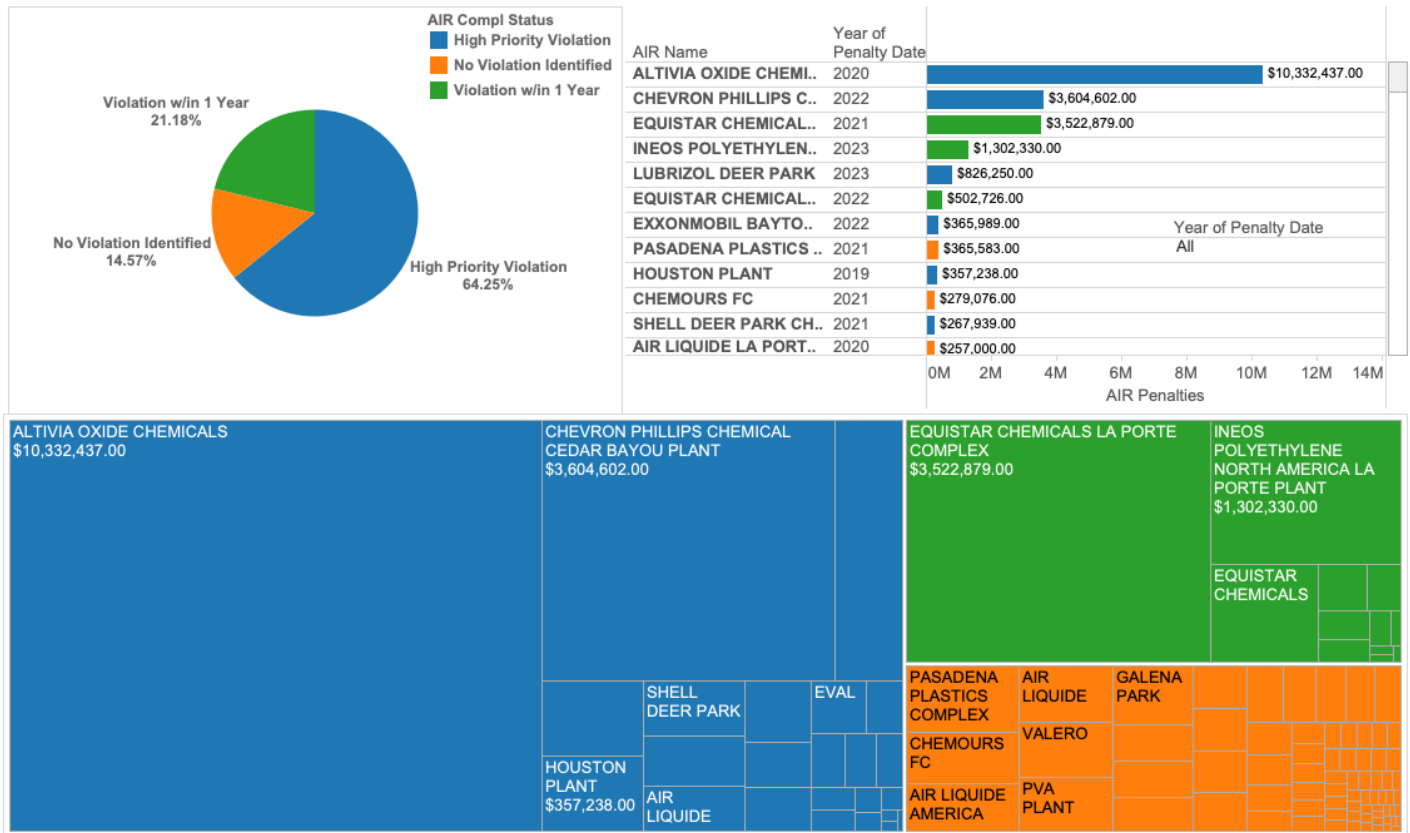


(Pacheco, EPA Penalties Data Visualization, 2023)



## Compliance Status

The EPA enforcement and compliance data also categorizes the violations facilities have committed. The following graph reveals that the status of these violations impacted the amount of money the facilities were fined.



Most violations (64.25%) in the five years we studied were “High Priority.”

- Exceedance of a major stationary source annual emission threshold, as defined in the New Source Review (NSR) regulations, by a synthetic minor stationary source.
- Failure to obtain a New Source Review (NSR) permit and install the Best Available Control Technology or Lowest Available Emission Reductions for any new primary stationary source or major modifications at a major stationary source.
- Violations of federally enforceable work practices, testing requirements, monitoring requirements, recordkeeping, or reporting that substantially interferes with enforcement or determination of a facility’s compliance requirements. (Agency, DFR Data Dictionary, n.d.)

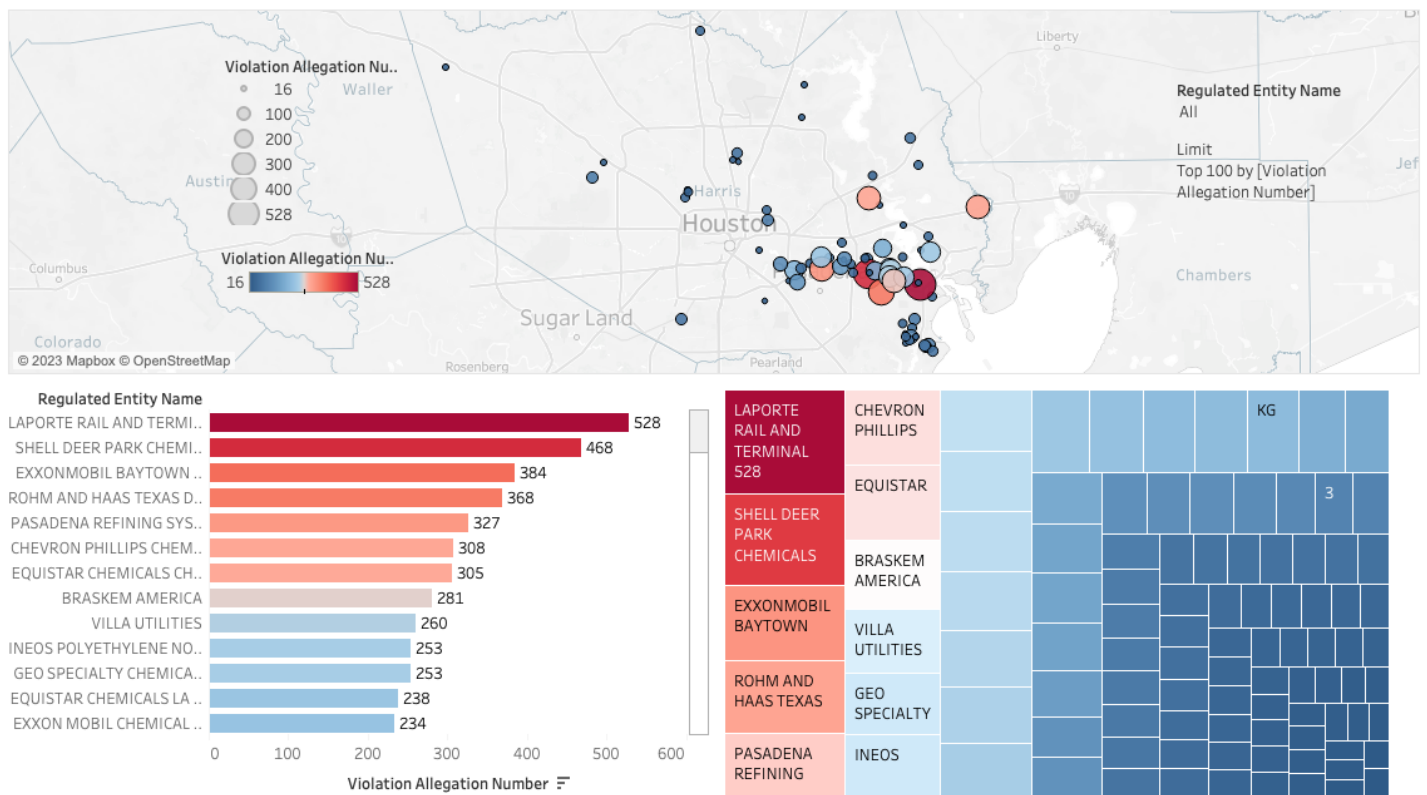
The second was 21.18% for violations within one year and 14.57% where no violation was identified. However, even with no violation, some facilities still received monetary penalty fines, which could be due to remaining unsolved fines from penalties of past years. Further, most of the fines imposed by the EPA are due to high-priority violations, and considering the number of releases the top facilities have, it is alarming to see most of the same companies at the top of all the databases explored.

# TEXAS COMMISSION ON ENVIRONMENTAL QUALITY (TCEQ) –NOTICES OF ENFORCEMENT (NOE)

Next, we utilized the Texas Commission on Environmental Quality’s (TCEQ) records of investigations resulting in a Notice of Enforcement (NOE) and the details associated with each violation from the different facilities.

This database was the least user-friendly; accessing options were too narrow, and searches for data of specific years and counties were not in plain sight. We utilized a query-building option to obtain the data needed. (Quality, n.d.) Another limitation was that this data set contained only text.

To extract the relevant information, we counted the number of violations the facilities had during our study years (2018 - 2022) and represented them in the dashboard.



(Pacheco, EPA Penalties Data Visualization, 2023)

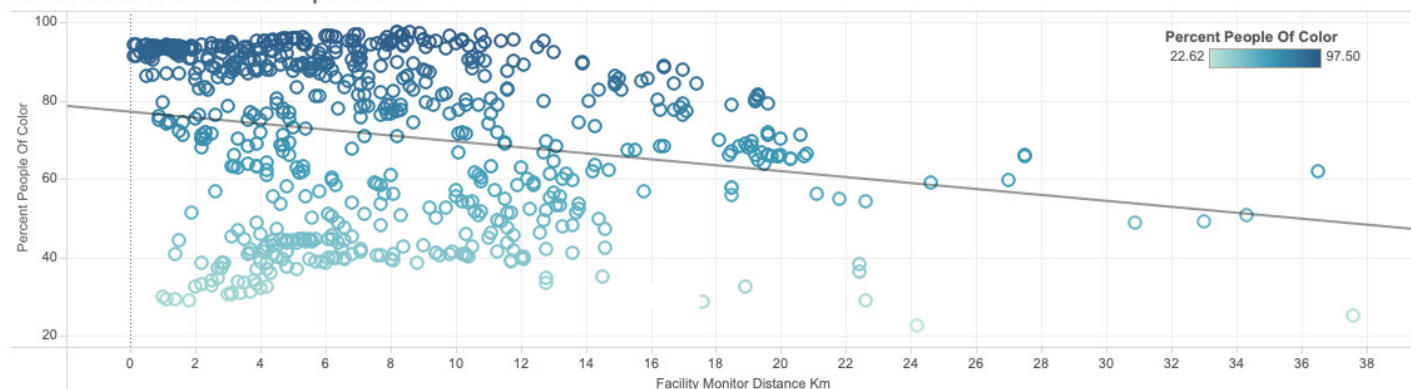
Laporte Rail and Terminal, an industrial complex along the Houston Ship Channel near the Fred Hartman Bridge, was top of the list. The facility offers chemical and industrial manufacturers leased land with access to numerous services. In addition, they offer rail car storage inside and outside the secure facility. (LPR) Shell Deer Park Chemicals and ExxonMobil Baytown were second and third, respectively.



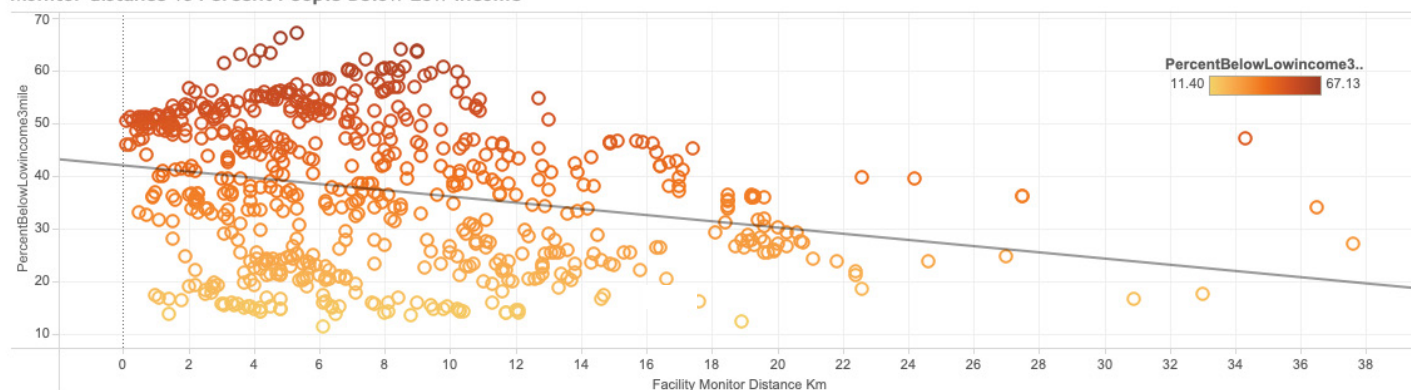
## DEMOGRAPHICS

One of the most concerning elements of air pollution in Harris County is that most industrial facilities are situated around communities with high percentages of Hispanic, African American, low-income, and elderly populations (Agency, n.d.). As a result, local and state air monitoring stations are also concentrated in high-pollution regions. The following graph examines this correlation by plotting the facilities' distance from a regulatory air monitor distance in kilometers versus the percentage of people of color and the percentage of people of low income in the surrounding communities.

Monitor distance vs Percent People of Color



Monitor distance vs Percent People Below Low Income



These factors show a negative correlation, with a downhill trend line observed in both correlation plots. The p-value was below 0.05, and the R-square values were 0.045 (people of color) and 0.065 (people of low income), which is statistically significant. This negative correlation means that when a facility's distance from the nearest regulatory air monitor increases, the percentage of people of color and those below income decreases. It underscores the conclusion that the areas with relatively greater monitoring due to a higher threat of air pollution are predominantly communities of color and low income.



## CONCLUSION

Here are the “dirty dozen” industrial polluters (in no particular order), according to the findings and patterns from the five datasets utilized:

- ExxonMobil Baytown Site
- Chevron Phillips Chemical
- Shell Deer Park Chemical
- LyondellBasell Industry
- Altivia Oxide Chemicals
- Equistar Chemicals Channelview
- Atascocita Recycling Center
- McCarty Road Landfill
- Deerpark Energy Center
- Dixie Holdings Inc
- Ineos Oxide
- Celanese Clearlake

These companies were at the top of one or multiple dashboards created with the data from the five resources. These facilities contribute the most to Harris County air pollution, with hazardous chemical releases, greenhouse gases, waste, and climate injustice.

Most of the data is self-reported by the facilities, and no third-party or regulatory entity ensures the validity and integrity of the data reported. Regardless of this limitation, a trend is apparent with the same group of companies always at the top of the metrics, fines, and releases/emissions.



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**Everyone has a right to breathe clean air.**



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