

Pollution Prevention and Waste Management

Each year, the Toxics Release Inventory (TRI) collects information from more than 21,000 facilities on the quantities of TRI-listed chemicals they recycle, combust for energy recovery, treat for destruction, and dispose of or otherwise release both on and off site as part of their normal operations. These quantities are collectively referred to as the quantity of [production-related waste managed](#).

Looking at production-related waste managed over time helps track facilities' progress in reducing the amount of chemical waste generated and in adopting waste management practices that are preferable to disposing of or otherwise releasing waste into the environment.

Pollution prevention is an essential component of sustainable manufacturing practices. EPA encourages facilities to first to reduce or eliminate the use of TRI-listed chemicals and the creation of chemical waste through source reduction activities such as material substitutions and process modifications. For waste that is generated, the preferred management method is recycling, followed by combusting for energy recovery, treatment, and, as a last resort, disposing of or otherwise releasing the chemical waste into the environment in a safe manner. This order of preference is consistent with the national policy established by the [Pollution Prevention Act \(PPA\) of 1990](#). This waste management hierarchy is illustrated in the graphic above. While not specifically mentioned in the PPA of 1990, energy recovery is a preferred practice over treatment and disposal and is included in the hierarchy.



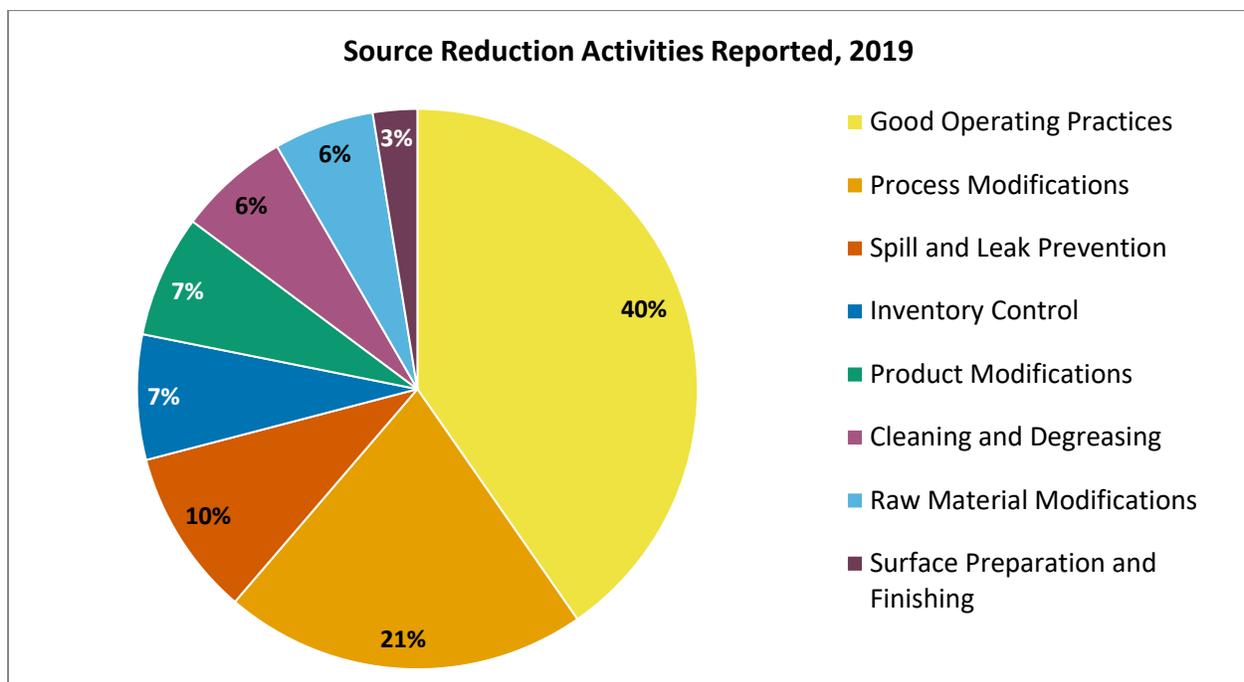
TRI Data Considerations

As with any dataset, there are several factors to consider when using the TRI data. Key factors associated with data used in the National Analysis are summarized in the [Introduction](#). For more information see [Factors to Consider When Using Toxics Release Inventory Data](#).

Source Reduction Activities Reported

Facilities are required to report new source reduction activities that they initiated or fully implemented during the year. Source reduction (also referred to as pollution prevention) includes activities that eliminate or reduce the use of TRI-listed chemicals and the generation of chemical waste. Other waste management practices, such as recycling and treatment, refer to how chemical waste is managed after it is generated and are not considered source reduction activities. The source reduction information the TRI Program collects can help facilities learn from each other's best practices and potentially reduce their own chemical releases.

For more information, see the [TRI Source Reduction Reporting Fact Sheet](#).



Note: Facilities report their source reduction activities by selecting codes that describe their activities. These codes are organized into eight categories listed in the graph legend and are defined in the [TRI Reporting Forms and Instructions](#).

- In 2019, 1,325 facilities (6% of all facilities that reported to TRI) implemented a combined 3,285 new source reduction activities.
- On their reporting forms, facilities select from 49 types of source reduction activities across the 8 categories shown in the graph. The most reported source reduction category is Good Operating Practices.
 - For example, a fabricated metal parts manufacturer used an automated system for applying sulfuric acid which improved operating efficiency and minimized sulfuric acid usage in the plating process. [\[Click to view facility details in the TRI P2 Search Tool\]](#)

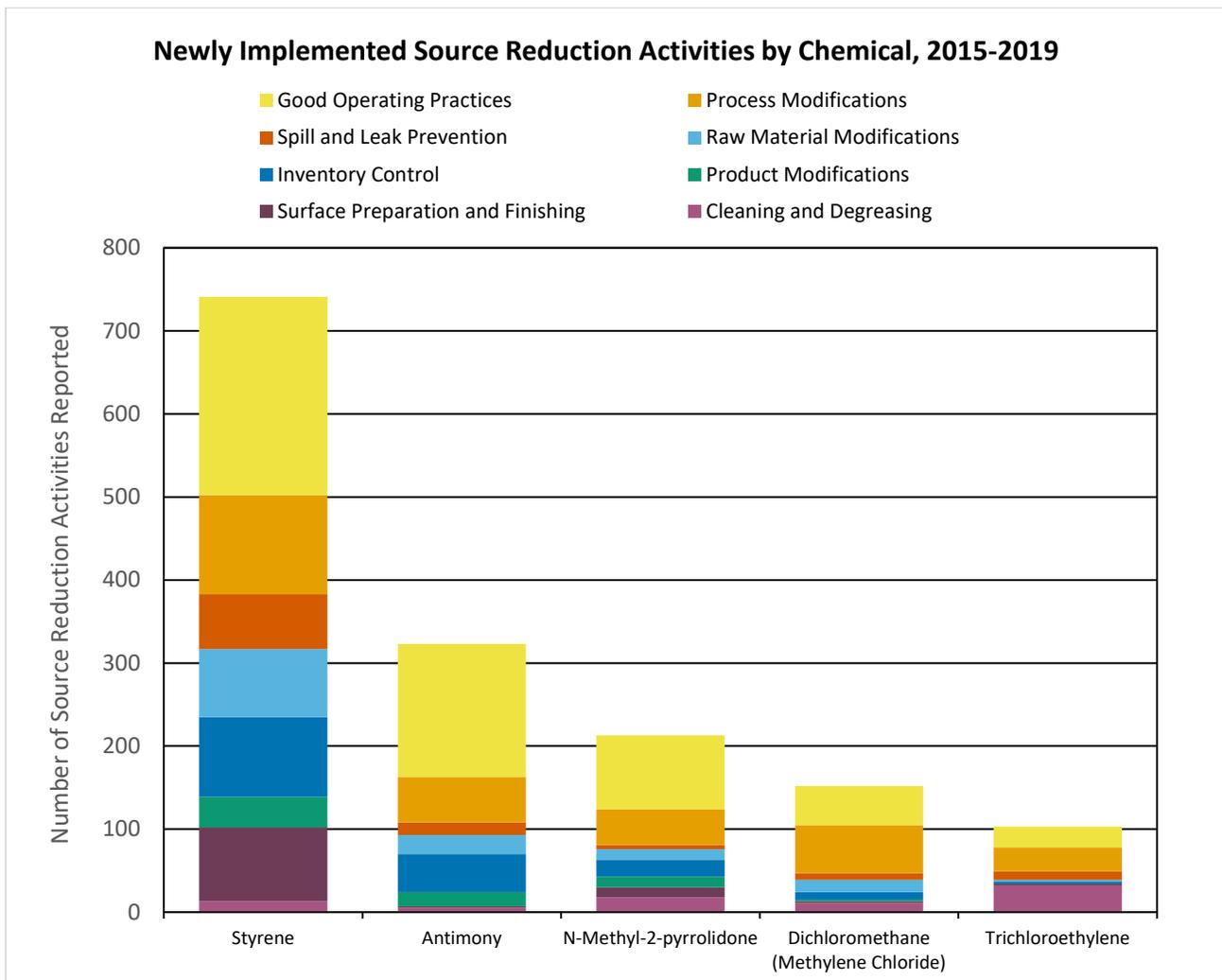
- Facilities also report the methods by which source reduction activities are identified. In 2019, the most commonly reported method for identifying source reduction opportunities was participative team management. Internal pollution prevention audits and vendor assistance were also commonly reported.

Additional Resources

- See the TRI [P2 Data Overview Factsheet](#) for more information on source reduction reporting in recent years.
- Note that facilities may have implemented source reduction activities in earlier years which are ongoing or completed projects. To see details of source reduction activities implemented for this year or in previous years, [use the TRI P2 Search Tool](#).

Source Reduction Activities by Chemical

For the chemicals with the highest source reduction reporting rates over the last 5 years, this figure shows the number and types of activities implemented.



Note: 1) Limited to chemicals with at least 100 reports of source reduction activities from 2015-2019. 2) In this figure, metals are combined with their metal compounds, although metals and compounds of the same metal are listed separately on the TRI list (e.g. antimony is listed separately from antimony compounds). 3) Facilities report their source reduction activities by selecting codes that describe their activities from among eight categories, which are listed in the graph and are defined in the [TRI Reporting Forms and Instructions](#).

From 2015 to 2019:

- TRI facilities reported 23,871 source reduction activities for more than 250 chemicals and chemical categories.

- Chemicals with the highest source reduction reporting rates were styrene, antimony and antimony compounds, N-methyl-2-pyrrolidone (NMP), dichloromethane (DCM, also known as methylene chloride), and trichloroethylene (TCE).
- The type of source reduction activities implemented for these chemicals varied depending on their use in industrial operations and the chemical's characteristics. For example:
 - **Raw material modifications** include the use of alternative materials in the manufacturing process, such as replacing styrene, a chemical used to make plastics such as polystyrene, and antimony compounds, which are used in electronics, batteries, and as a component of fire retardants.
 - **Cleaning and degreasing activities**, including changing to water-based cleaners, are implemented to reduce wastes of industrial solvents, such as trichloroethylene (TCE).
 - **Process modifications**, including optimizing reaction conditions and modifying equipment, layout, or piping, can help reduce the amount of solvents such as dichloromethane (DCM) needed for a process.

Facilities may also report additional details about their source reduction activities in an optional text field of the TRI reporting form.

Examples of optional source reduction information for 2019:

- **Styrene:** With supplier assistance, a fiberglass manufacturing facility began using gel coats with lower styrene content which reduced the facility's overall usage of styrene. [[Click to view facility details in the TRI P2 Search Tool](#)]
- **Antimony and antimony compounds:** A ceramic tile manufacturer added dry cutting lines so that antimony compounds which would otherwise be handled as waste could be recirculated within the system, reducing material usage. [[Click to view facility details in the TRI P2 Search Tool](#)]
- **N-Methyl-2-pyrrolidone:** A paint and coating manufacturing facility implemented better monitoring of shelf life and improved its "first-in, first-out" inventory method, which reduced the quantity of N-methyl-2-pyrrolidone waste generated. The facility also began manufacturing some products on demand rather than stocking inventory. [[Click to view facility details in the TRI P2 Search Tool](#)]

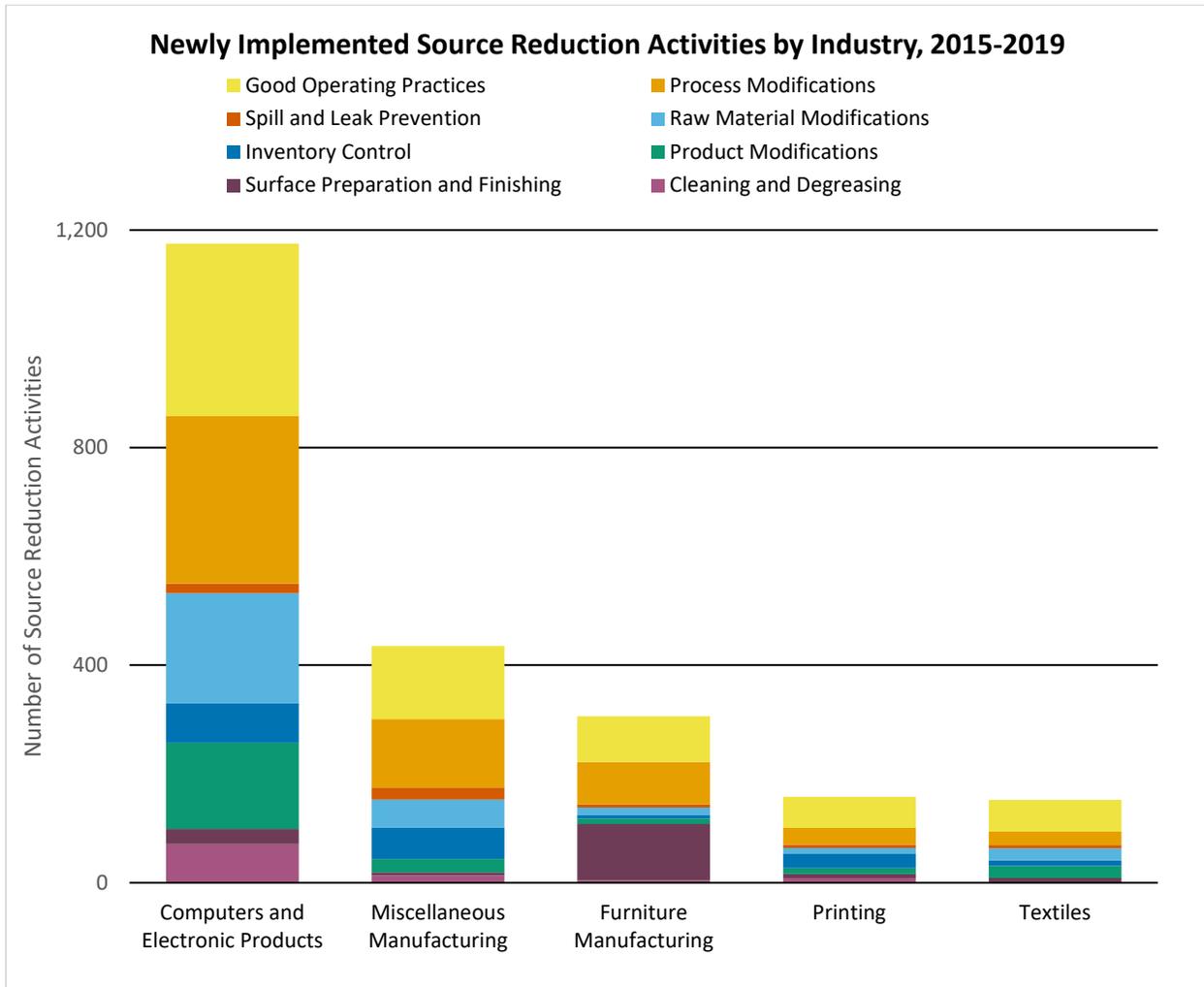


- **Dichloromethane:** A laboratory instrument manufacturing facility revised its rinse procedures to reduce waste and replaced dichloromethane with hexane, a less toxic chemical, in some processes. [[Click to view facility details in the TRI P2 Search Tool](#)]
- **Trichloroethylene:** A metal heat treating facility installed a newer degreaser with a lower temperature surface vapor control and a smaller surface which reduced trichloroethylene waste. [[Click to view facility details in the TRI P2 Search Tool](#)]

You can [compare facilities' waste management methods and trends for any TRI chemical by using the TRI P2 Search Tool](#).

Source Reduction Activities by Industry

For the industries with the highest source reduction reporting rates over the last 5 years, this figure shows the number and types of activities these sectors implemented.



Note: 1) Limited to industries with at least 100 source reduction activities reported from 2015-2019. 2) Facilities report their source reduction activities by selecting codes that describe their activities. These codes fall into one of eight categories listed in the graph legend and are defined in the [TRI Reporting Forms and Instructions](#).

From 2015 to 2019:

- The five industry sectors with the highest source reduction reporting rates were computers and electronic products, miscellaneous manufacturing (e.g., medical equipment), furniture manufacturing, textiles, and textile products.
- For most sectors, “Good operating practices” was the most frequently reported type of source reduction activity. Other commonly reported source reduction activities varied by

sector. For example, computers and electronic products manufacturers frequently reported modifications to their raw materials and products, often associated with the elimination of lead-based solder.

Facilities may also report additional details to TRI about their source reduction activities, as shown in the following examples.

Examples of optional source reduction information for 2019:

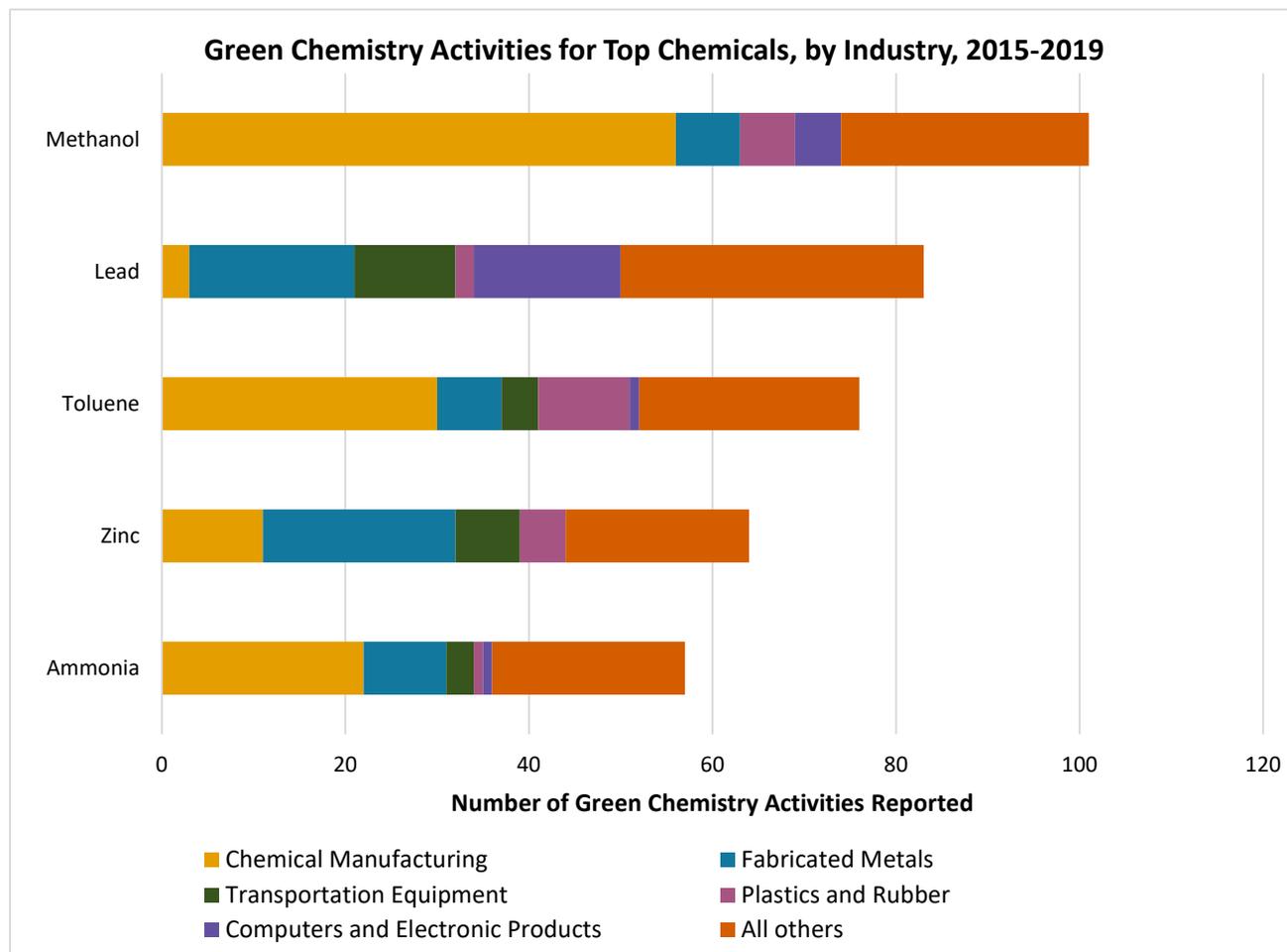
- **Computers and Electronic Products:** A printed circuit board manufacturer switched from a spray application, which generated an aerosol, to a flooded application of hydrochloric acid which flows solution on the product and reduces emissions. [[Click to view facility details in the TRI P2 Search Tool](#)]
- **Miscellaneous Manufacturing:** A casket manufacturing facility reduced its usage of certain glycol ethers by reducing the number of times clear coat is applied during the rerun process. [[Click to view facility details in the TRI P2 Search Tool](#)]
- **Furniture Manufacturing:** A wood cabinet manufacturer installed a point-of-use injection system which uses less 1,2,4-trimethylbenzene in their process. [[Click to view facility details in the TRI P2 Search Tool](#)]
- **Printing:** A printing facility focused on running similar jobs on the press to minimize downtime and reduce toluene waste. [[Click to view facility details in the TRI P2 Search Tool](#)]
- **Textiles:** A fabric coating mill reduced antimony usage by re-evaluating product specifications and removing antimony from products that were initially over-engineered. [[Click to view facility details in the TRI P2 Search Tool](#)]

You can [view all reported pollution prevention activities and compare facilities' waste management methods and trends for any TRI chemical by using the TRI P2 Search Tool](#).

Green Chemistry Activities

Green chemistry is the design of chemical products and processes that use safer inputs and minimal energy while preventing the generation of waste. In the pollution prevention hierarchy, green chemistry is a way to achieve source reduction. Advancements in green chemistry allow industry to prevent pollution at its source by, for example, designing manufacturing processes that reduce or eliminate the use of TRI chemicals.

Six of the TRI source reduction codes facilities can choose from are specific to green chemistry activities, although green chemistry practices may also fit under other codes. This figure shows the chemicals for which the highest number of green chemistry activities were implemented over the last 5 years and the sectors that reported those activities.



Note: In this figure, metals are combined with their metal compounds, although metals and compounds of the same metal are listed separately on the TRI list (e.g. lead is listed separately from lead compounds).

- Since 2015, facilities have reported 1,233 green chemistry activities for 115 TRI chemicals and chemical categories.
 - Green chemistry activities were reported most frequently for methanol, lead and lead compounds, toluene, zinc and zinc compounds, and ammonia.
 - The chemical manufacturing, fabricated metals, and transportation equipment manufacturing sectors reported the highest number of green chemistry activities.
- Chemical manufacturers used green chemistry to reduce or eliminate their use of TRI solvent and reagent chemicals, such as methanol, toluene, and ammonia. For example:
 - An organic chemical manufacturing facility installed catalyst reduction equipment which decreased methanol usage. [[Click to view facility details in the TRI P2 Search Tool](#)]
- Fabricated metal producers and transportation equipment manufacturers applied green chemistry techniques to reduce or eliminate their usage of metals such as lead and zinc. For example:
 - A fabricated metal product manufacturer enhanced process monitoring and quality control which improved resource utilization and decreased waste generation, including metal waste. [[Click to view facility details in the TRI P2 Search Tool](#)]

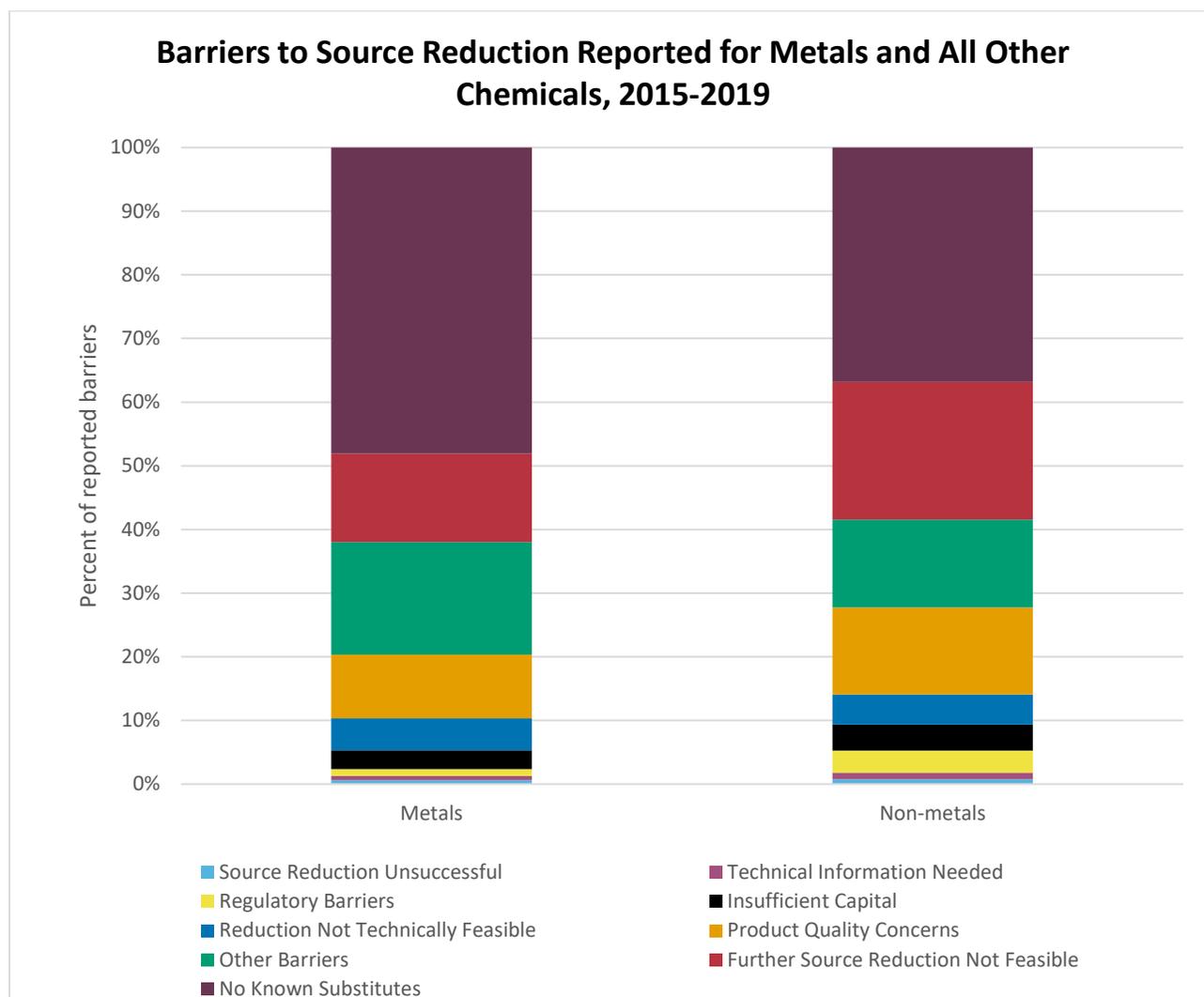
Additional Resources

Source reduction activities such as green chemistry are the preferred way to reduce the creation of chemical wastes. Find more information on green chemistry using these resources:

- [EPA's TRI P2 Industry Profile Dashboard](#): green chemistry examples for a specific chemical and/or industry.
- [EPA's Green Chemistry program](#): information about green chemistry and EPA's efforts to facilitate its adoption.
- [EPA's Safer Choice program](#): information about consumer products with lower hazard.
- For more details on the types of green chemistry activities reported to TRI and trends in green chemistry reporting, see [*The Utility of the Toxics Release Inventory \(TRI\) in Tracking Implementation and Environmental Impact of Industrial Green Chemistry Practices in the United States*](#).

Reported Barriers to Source Reduction

Facilities that did not implement new source reduction activities for a TRI chemical have the option to tell EPA about any barriers that prevented them from doing so. Analyzing the source reduction barriers reported to TRI helps identify where more research is needed, for example, to address technological challenges or promote development of viable alternatives. It may also allow for better communication between those that have knowledge of source reduction practices and those that are seeking additional help. This figure shows the types of barriers that facilities reported for metals and for all other (non-metal) TRI chemicals.



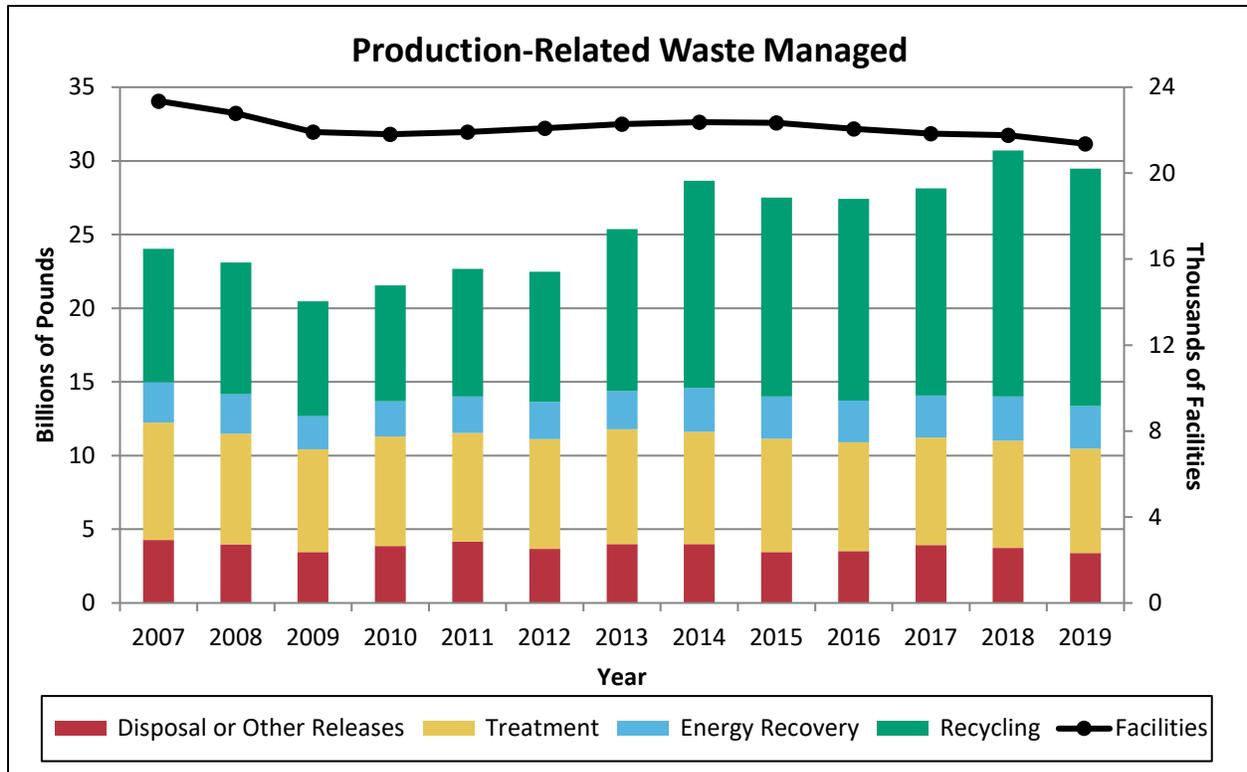
Note: Facilities report barriers to source reduction by selecting from nine codes. These codes are defined in the [TRI Reporting Forms and Instructions](#).

From 2015 to 2019:

- Facilities reported barriers to source reduction for 321 chemicals and chemical categories.
- While *no known substitutes* was the most frequently reported barrier for both metals and non-metals, it accounted for almost half (48%) of the barriers reported for metals but made up a smaller portion (37%) of barriers reported for non-metals.
- For the *no known substitutes* barrier for metals, many facilities reported the presence of the TRI metal in their raw materials (e.g., metal alloys) as the reason they did not implement source reduction activities. Examples include:
 - A nonferrous metal forge reported that lead is present as a trace contaminant in the raw aluminum and there are no known alternatives for purchasing aluminum without the lead. [[Click to view facility details in the TRI P2 Search Tool](#)]
 - A printing facility reported that it continues to consider alternatives to lead anodes for hard chrome plating, but feasibility, testing, and quality standards would need to be met prior to implementation. [[Click to view facility details in the TRI P2 Search Tool](#)]
- *Further source reduction not feasible* was the next most commonly reported barrier for both metals and non-metals. Facilities select this barrier code when additional reductions do not appear feasible. For example:
 - A powder metallurgy part manufacturing facility previously implemented practices to minimize the use of bulk ammonia in furnace operations. The facility reported that further source reduction is not feasible because the alternative to ammonia requires the storage of hydrogen gas, an extremely flammable material. [[Click to view facility details in the TRI P2 Search Tool](#)]
- You can [view source reduction barriers for any TRI chemical by using the TRI P2 Search Tool](#).

Waste Management Trends

Facilities report the quantities of TRI-listed chemicals that they dispose of or otherwise release into the environment as a result of normal industrial operations. In addition, facilities report the quantities of these chemicals that they manage through preferred methods including recycling, combusting for energy recovery, and treating for destruction. This figure shows the trend in these quantities, collectively referred to as [production-related waste managed](#).



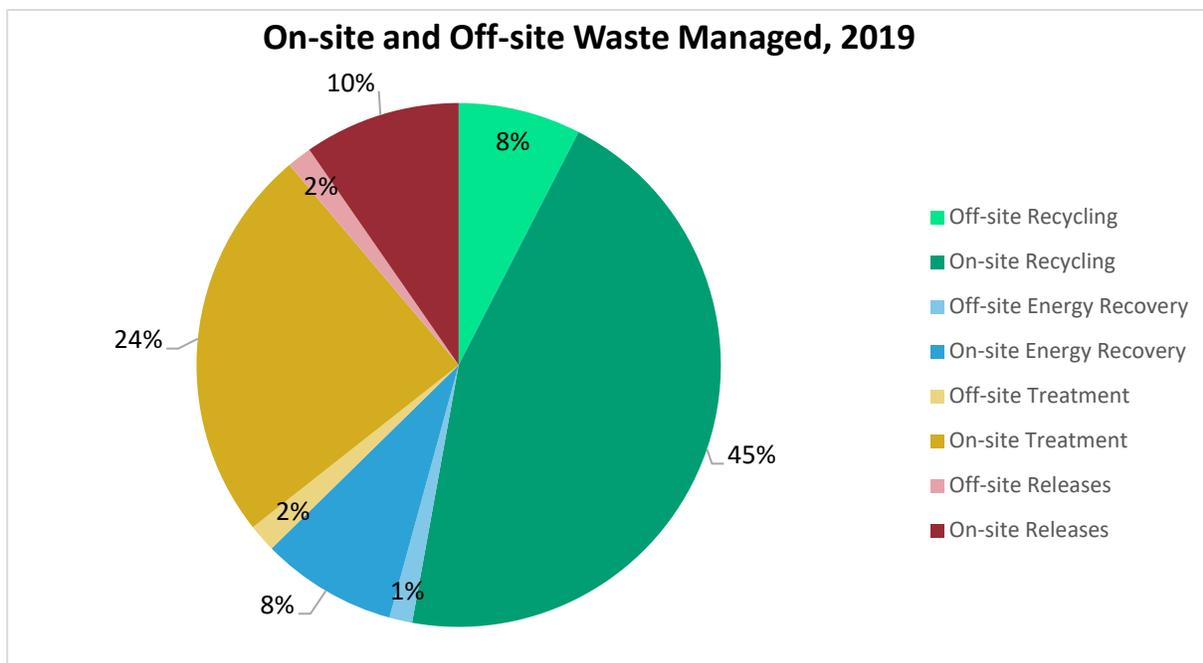
Note: For comparability, trend graphs include only those chemicals that were reportable to TRI for all years presented.

From 2007 to 2019:

- Production-related waste managed decreased during the recession from 2007 to 2009. Since 2009, production-related waste managed has generally increased as the U.S. economy has improved.
- Since 2007, production-related waste managed increased by 5.4 billion pounds (23%), driven by increased recycling.
 - Disposal and other releases decreased by 874 million pounds (-20%).
 - Treatment decreased by 887 million pounds (-11%).
 - Energy recovery increased by 124 million pounds (5%).

- Recycling increased by 7.1 billion pounds (78%), a trend largely driven by three facilities in the chemical manufacturing sector that each reported recycling one billion pounds or more annually in recent years.
- The number of facilities that report to TRI has declined by 9% since 2007. Reasons for this decrease include facility closures, outsourcing of operations to other countries, and facilities reducing their manufacture, processing, or other use of TRI-listed chemicals to below the reporting thresholds.
- Please note that the most recent TRI dataset reflects chemical waste management activities that occurred during calendar year 2019, and therefore does not indicate any potential impacts of the COVID-19 pandemic, which began in the U.S. in early 2020.

Facilities report both on- and off-site waste management. The following chart shows the relative quantities of on-site and off-site waste management methods for 2019.

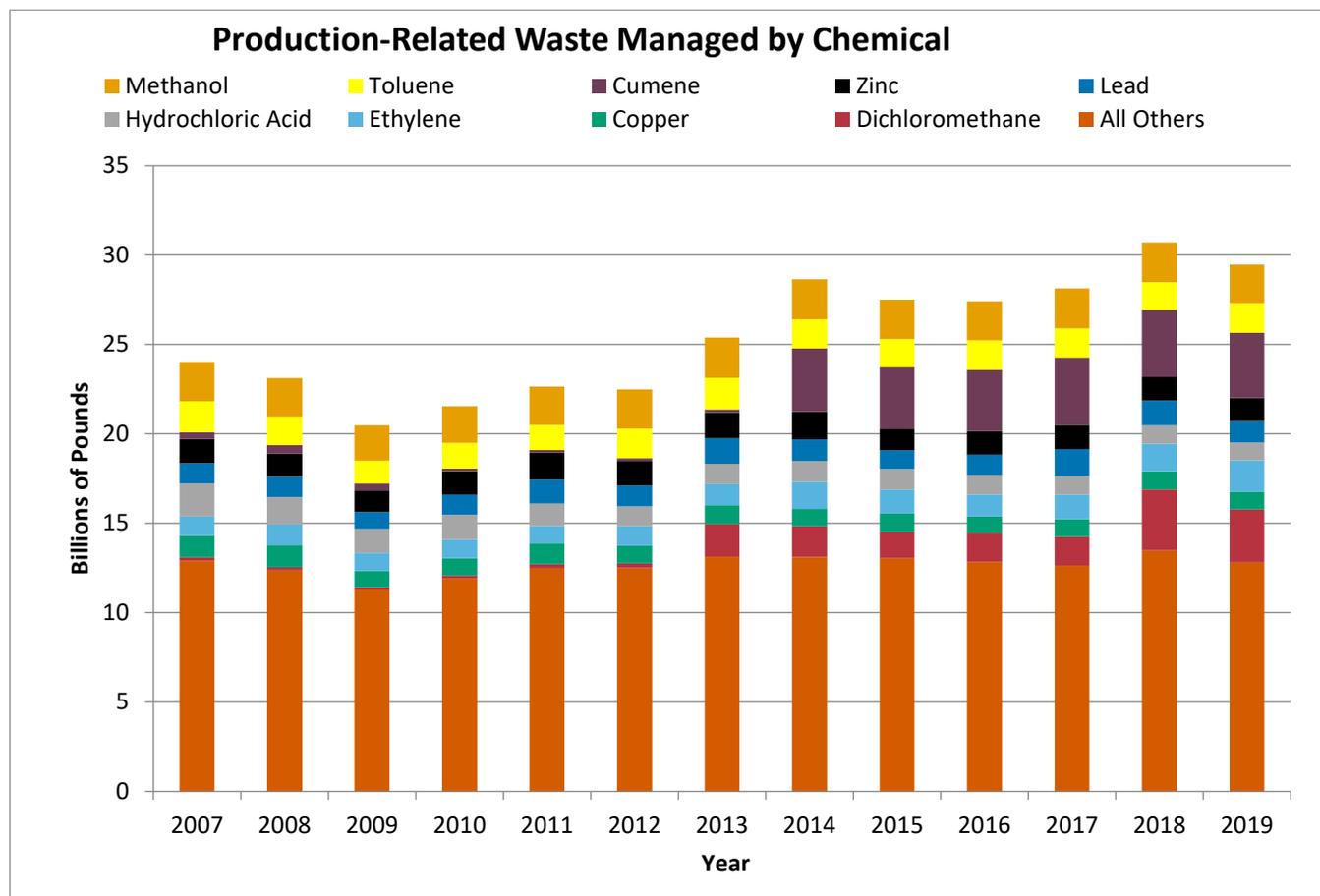


For 2019, 88% of production-related waste was managed on site.

- Most production-related waste managed off site is recycled. Most of this recycling is reported by the primary and fabricated metals sectors. Facilities in these sectors often send scrap metal off site for recycling.
- The 2019 distribution of waste managed on site and off site is similar to previous years.

Production-Related Waste Managed by Chemical

This figure shows the chemicals that were managed as waste in the greatest quantities from 2007 to 2019.



Note: 1) For comparability, trend graphs include only those chemicals that were reportable to TRI for all years presented. 2) In this figure, metals are combined with their metal compounds, although metals and compounds of the same metal are listed separately on the TRI list (e.g. lead is listed separately from lead compounds).

From 2007 to 2019:

- Facilities reported production-related waste managed for more than 500 chemicals and chemical categories from 2007 to 2019. The nine chemicals for which facilities reported the most production-related waste managed, shown above, represent 50% of the total production-related waste reported.
- Of the chemicals shown above, facilities reported increased quantities of waste managed for: dichloromethane (methylene chloride), lead and lead compounds, cumene, and ethylene.
 - Waste managed of ethylene increased by 701 million pounds (66%).

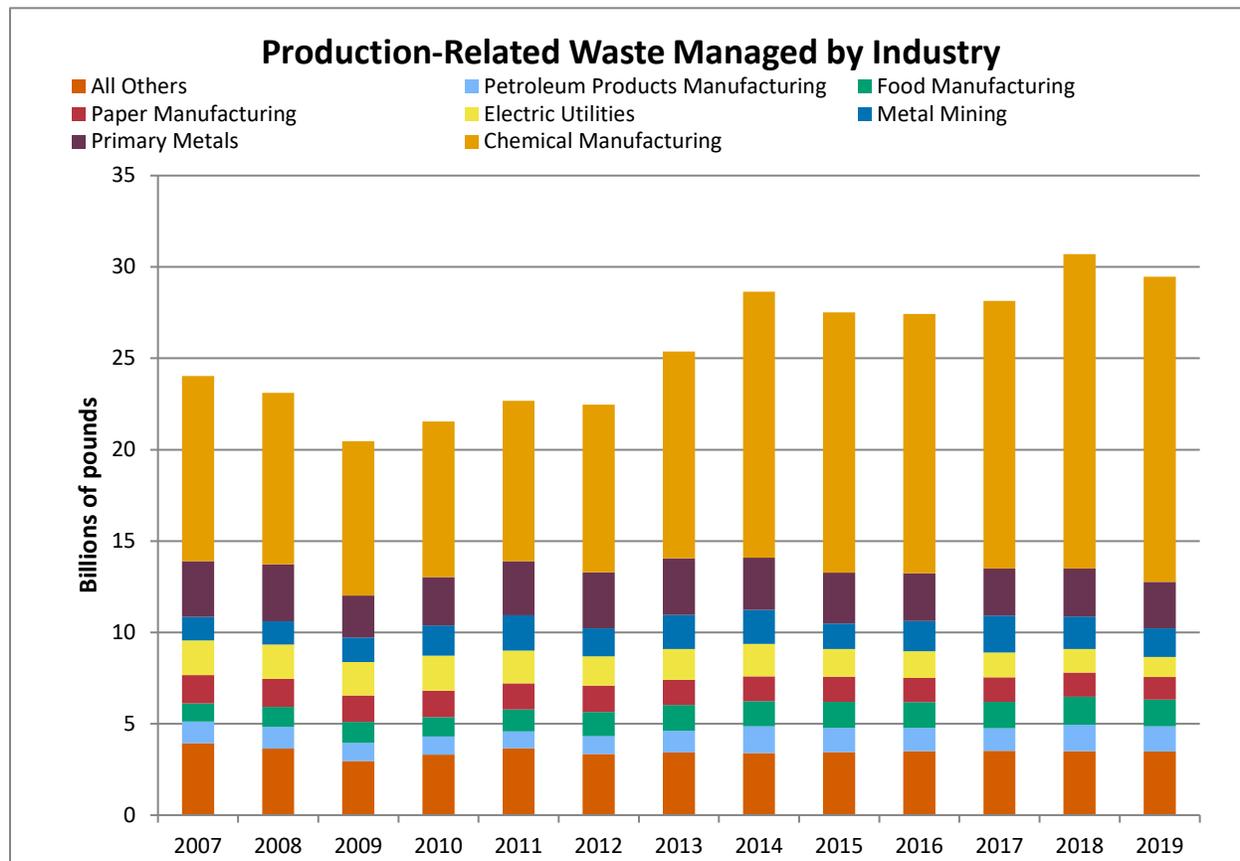
- Dichloromethane waste managed increased over 10-fold, due to 2 facilities that started recycling large quantities of the chemical, one starting in 2013 and the other starting in 2018.
- Cumene recycling increased eight-fold, mostly driven by one facility reporting recycling over 3.4 billion pounds of cumene annually from 2014 to 2019. [[Click to view facility details in the TRI P2 Search Tool](#)]

From 2018 to 2019:

- Quantities of TRI chemical waste decreased for numerous chemicals, including:
 - Lead and lead compounds decreased by 186.4 million pounds (-14%)
 - Methanol decreased by 58.8 million pounds (-3%)
 - Hydrochloric acid decreased by 26.4 million pounds (-3%)
 - Copper and copper compounds decreased by 26.4 million pounds (-3%)
- Dichloromethane waste managed decreased by 475 million pounds (-14%), mostly driven by one plastic manufacturing facility reporting a decrease of 367 million pounds of dichloromethane recycling from 2018 to 2019. [[Click to view facility details in the TRI P2 Search Tool](#)]
- Quantities of TRI chemical waste managed increased for other chemicals including:
 - Toluene increased by 95 million pounds (6%)
 - Ethylene waste managed increased by 232 million pounds (15%)

Production-Related Waste Managed by Industry

This figure shows the industry sectors that managed the most TRI chemical waste from 2007 to 2019.



Note: For comparability, trend graphs include only those chemicals that were reportable to TRI for all years presented.

From 2007 to 2019:

- The percent contribution of each of the top sectors to production-related waste managed has remained relatively constant since 2007.
- Of the sectors shown in the graph, four increased their quantity of waste managed:
 - Chemical manufacturing increased by 6.6 billion pounds (65%)
 - Metal mining increased by 291 million pounds (23%)
 - Food manufacturing increased by 456 million pounds (46%)
 - Petroleum products manufacturing increased by 185 million pounds (16%)
- The quantity of waste generated in some industries fluctuates considerably from year to year, due to changes in production or other factors. For example, quantities of waste

managed reported by metal mining facilities can change significantly based on differences in the composition of waste rock.

From 2018 to 2019:

- Industry sectors with the greatest reported changes in waste management quantities were:
 - Chemical manufacturing decreased by 501 million pounds (-3%)
 - Petroleum products manufacturing decreased by 260 million pounds (-11%)
 - Metal mining decreased by 226 million pounds (-13%)

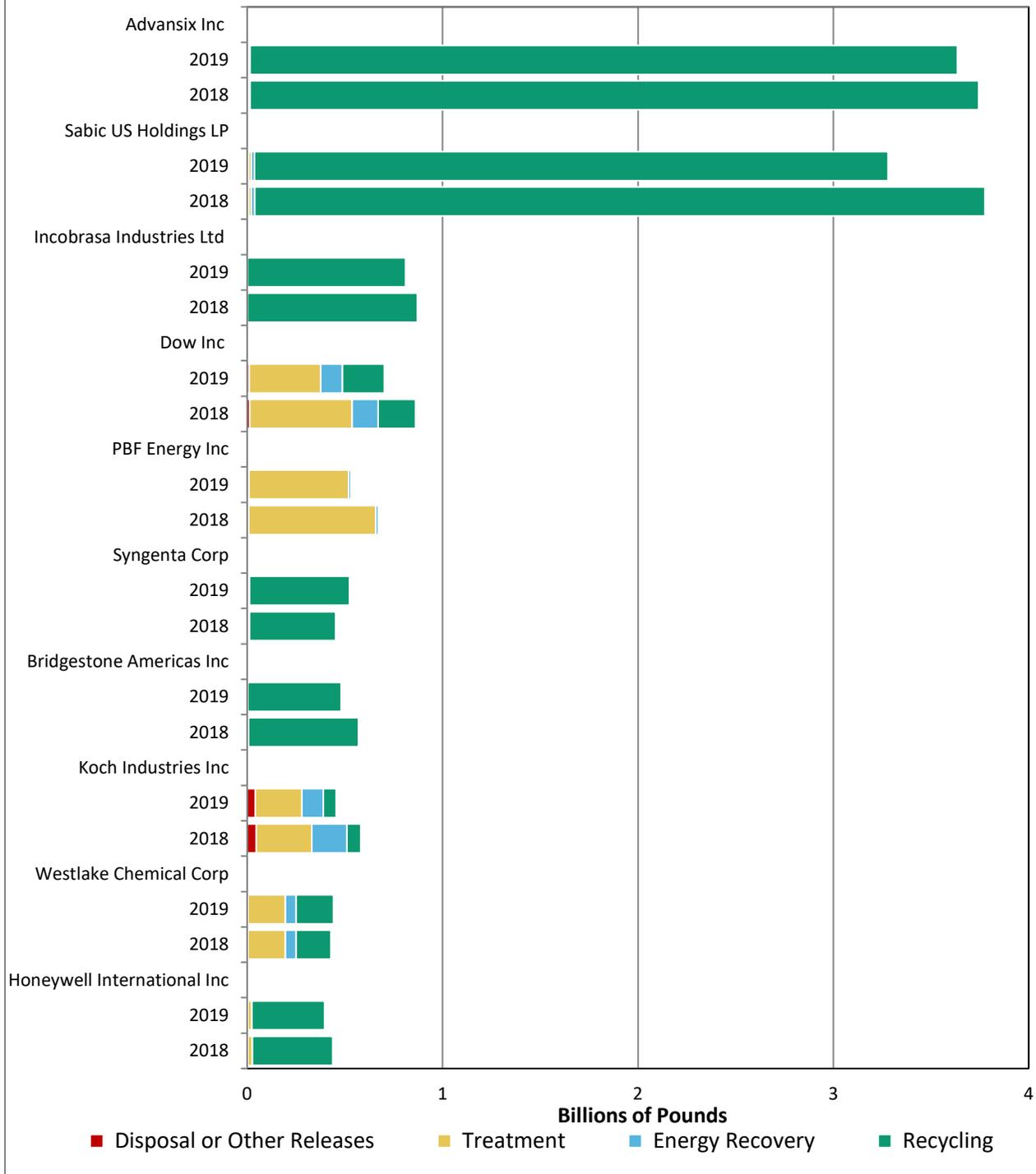


Waste Management by Parent Company

Facilities that report to the Toxics Release Inventory (TRI) provide information on their parent company. For TRI reporting purposes, the parent company is the highest-level company located in the United States. This figure shows the parent companies whose facilities reported the most production-related waste managed for 2019. Facilities outside of the manufacturing sector, such as electric utilities and coal and metal mines, are not included in this chart because those sectors' activities do not lend themselves to the same types or degree of source reduction opportunities as the activities at manufacturing facilities.

Note that these manufacturing facilities manage the majority of their waste through EPA's preferred waste management methods—recycling, energy recovery, or treatment—rather than releasing it into the environment.

Production-Related Waste Managed by Parent Company



Notes: 1) This figure uses EPA’s standardized parent company names. 2) To view facility counts by parent company in 2018 or 2019, mouse over the bar graph. 3) One facility, Incobrassa Industries Ltd, does not report a parent company but it is included in this figure because it has a comparable quantity of production-related waste managed. 4) Thirty of the facilities that submitted “Dow Inc” as their parent company name for 2019 submitted “DowDuPont Inc” as their parent company for 2018. Production-related waste for 2018 from these facilities is included in the figure above under “Dow Inc.”

These parent companies' TRI-reporting facilities operate in the following industry sectors:

- **Chemical manufacturing:** Advansix Inc, Dow Inc, Syngenta Corp, Honeywell International Inc, Sabic US Holdings LP, Westlake Chemical Corp
- **Soybean processing:** Incobrasa Industries Ltd
- **Multiple sectors**, e.g. pulp and paper, petroleum refining, and chemicals: Koch Industries Inc
- **Tires and rubber products:** Bridgestone Americas Inc
- **Petroleum refining:** PBF Energy Inc

Five of these top parent companies reported implementing new source reduction activities in 2019. Some of these companies reported additional (optional) descriptive information about their pollution prevention activities.

Examples of additional pollution prevention-related information for 2019:

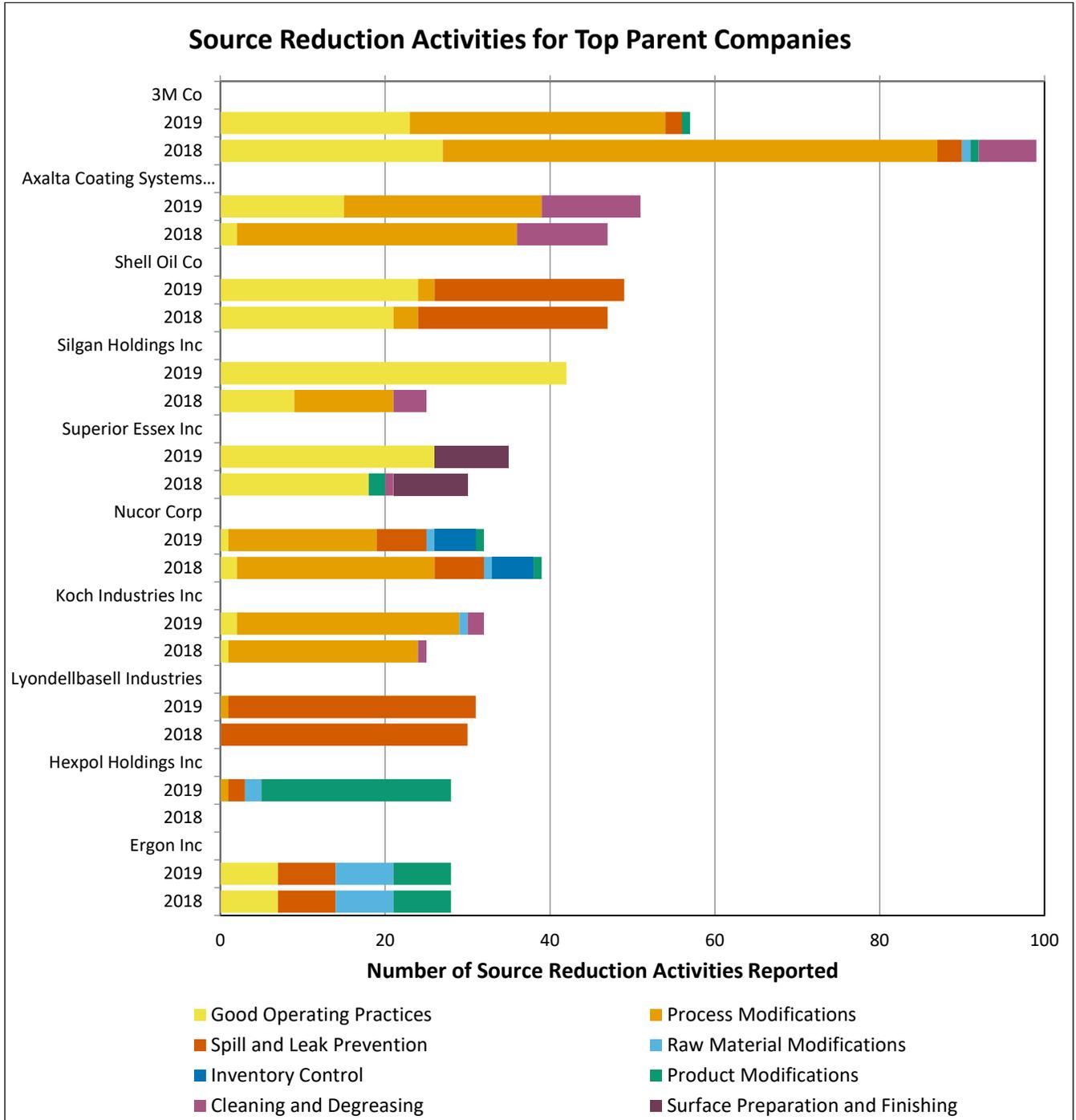
- A Koch Industries chemical manufacturing facility implemented process modifications that resulted in a 64% reduction in the site's air emissions of methanol. [[Click to view facility details in the TRI P2 Search Tool](#)]
- A plastic products manufacturing facility owned by Westlake Chemical Corporation reduced its usage of chromium compounds through reformulation and substitution of the products they use. [[Click to view facility details in the TRI P2 Search Tool](#)]

[To conduct a similar type of parent company comparison for a given sector, chemical, or geographic location, use the TRI P2 Search Tool.](#)

Source Reduction Activities by Parent Company

This figure shows the parent companies whose facilities implemented the most source reduction activities during 2019. Facilities outside of the manufacturing sector, such as electric utilities and coal and metal mines, are not included in this chart because those sectors' activities do not lend themselves to the same source reduction opportunities as the activities at manufacturing facilities. For example, metal mining involves dislodging and moving large volumes of earth that contain metals included on the TRI chemical list from below ground or from a mining pit to the surface to get to the target metal ore. This activity, which metal mines report as a release of the TRI chemicals, is inherent in mining operations.

Facilities report their source reduction activities by selecting codes that describe their activities. These codes fall into one of eight categories listed in the graph legend and are defined in the [TRI Reporting Forms and Instructions](#).



Notes: 1) This figure uses EPA's standardized parent company names. 2) To view facility counts by parent company in 2018 or 2019, mouse over the bar graph.

These parent companies' facilities primarily operate in the following industries:

- **Chemical manufacturing:** 3M Co, Axalta Coating Systems LLC, Lyondellbasell Industries
- **Steel manufacturing:** Nucor Corp
- **Plastics and rubber manufacturing:** Hexpol Holdings Inc
- **Fabricated metals manufacturing:** Silgan Holdings Inc
- **Wire and cable manufacturing:** Superior Essex Inc
- **Petroleum products manufacturing:** Shell Oil Co
- **Multiple sectors**, e.g. pulp and paper, petroleum refining, and chemicals: Koch Industries Inc, Ergon Inc

Good operating practices, such as improving maintenance scheduling and installation of quality monitoring systems, are the most commonly reported types of source reduction activities for these parent companies. Spill and leak prevention and process modifications are also commonly reported.

Some of these parent companies submitted additional optional text on their TRI reporting forms describing their pollution prevention activities.

Examples of additional pollution prevention-related information for 2019:

- A chemical manufacturing facility owned by Koch Industries Inc. began collecting styrene from line breaks, sampling activities, or line bleedings to use as feedstock in other processes. The styrene collected from these activities would have historically been treated as waste. [[Click to view facility details in the TRI P2 Search Tool](#)]
- A 3M facility participated in a water waste reduction project which resulted in fewer changeovers and cleanings between products. This reduced the amount of barium compounds landfilled. [[Click to view facility details in the TRI P2 Search Tool](#)]

You can [find P2 activities reported by a specific parent company and compare facilities' waste management methods and trends for any TRI chemical by using the TRI P2 Search Tool.](#)