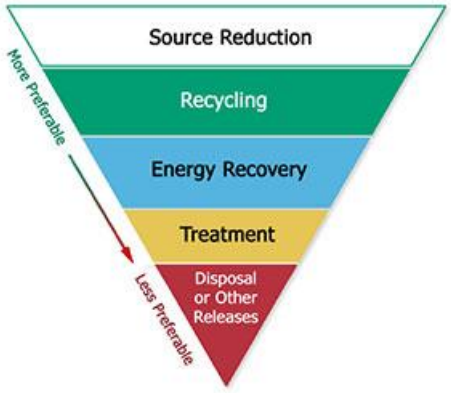
Pollution Prevention and Waste Management

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, in total, are collectively referred to as the quantity of production-related waste managed.

Waste Management Hierarchy



Looking at production-related waste managed over time helps track progress made by industrial facilities 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.

EPA encourages facilities to first eliminate the creation of chemical waste through source reduction activities. For wastes that are generated, the most 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 an environmentally safe manner. This order of preference is established in the Pollution Prevention Act (PPA) of 1990 and illustrated by the waste management hierarchy graphic above. One goal of the PPA is that over time facilities will shift from disposal or other releases toward the more preferred techniques in the waste management hierarchy that do not result in releases to the environment.

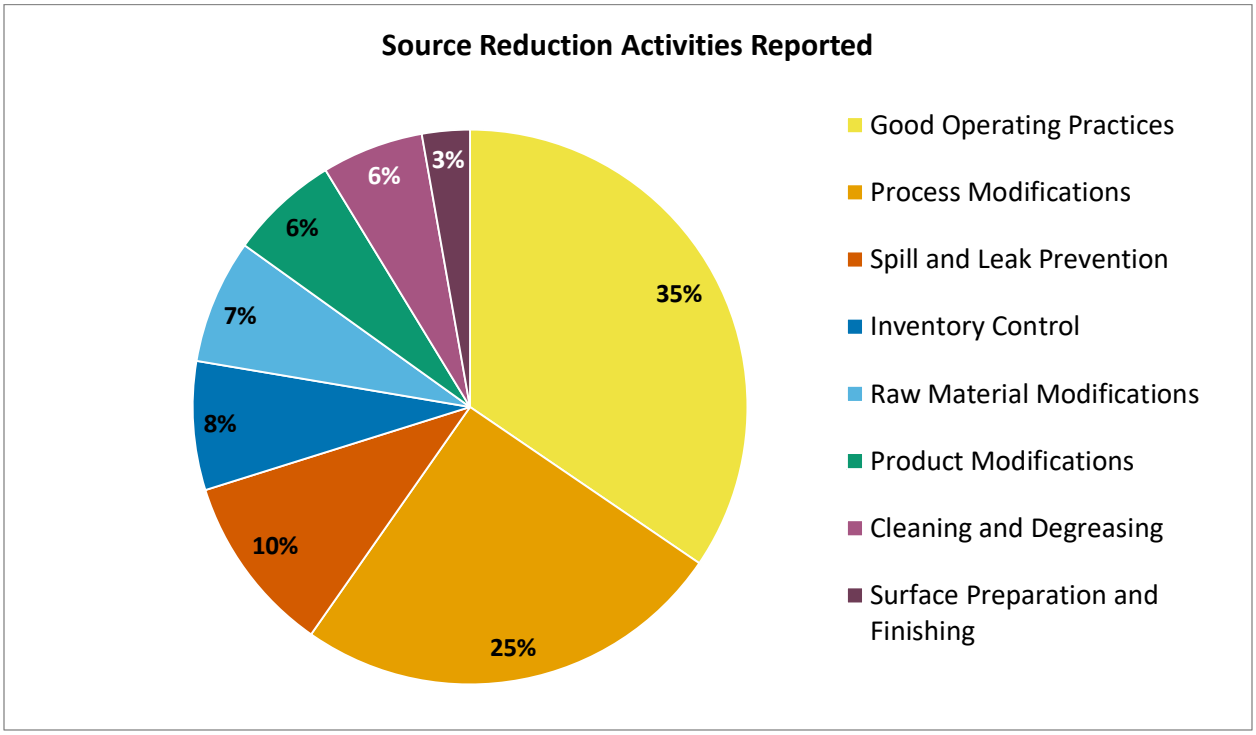
As with any dataset, there are several factors to consider when using the TRI data. Key factors associated with data used in the National Analysis are summarized in the Introduction. For more information see Factors to Consider When Using Toxics Release Inventory Data.

Also note that the list of TRI chemicals has changed over the years. For comparability, trend graphs include only those chemicals that were reportable for all years presented. Figures that focus only on the year 2018 include all chemicals reportable for 2018, therefore, values for a 2018-only analysis may differ slightly from results for 2018 in a trend analysis.

Source Reduction Activities Reported

Facilities are required to report to TRI new source reduction activities that they initiated or fully implemented during the year. Source reduction includes activities that eliminate or reduce 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 fall into one of eight categories listed in the graph legend and are defined in the TRI Reporting Forms and Instructions.

- In 2018, a total of 3,120 new source reduction activities were implemented by 1,270 facilities (6% of all facilities that reported to TRI).
- Facilities select from 49 types of source reduction activities that fall under the 8 categories shown in the graph. The most commonly reported source reduction category is Good Operating Practices.

- For example, a printed circuit board manufacturing facility reported periodic maintenance of equipment that helps minimize overdosing ammonia into the process. [Click to view facility details in the Pollution Prevention (P2) tool]

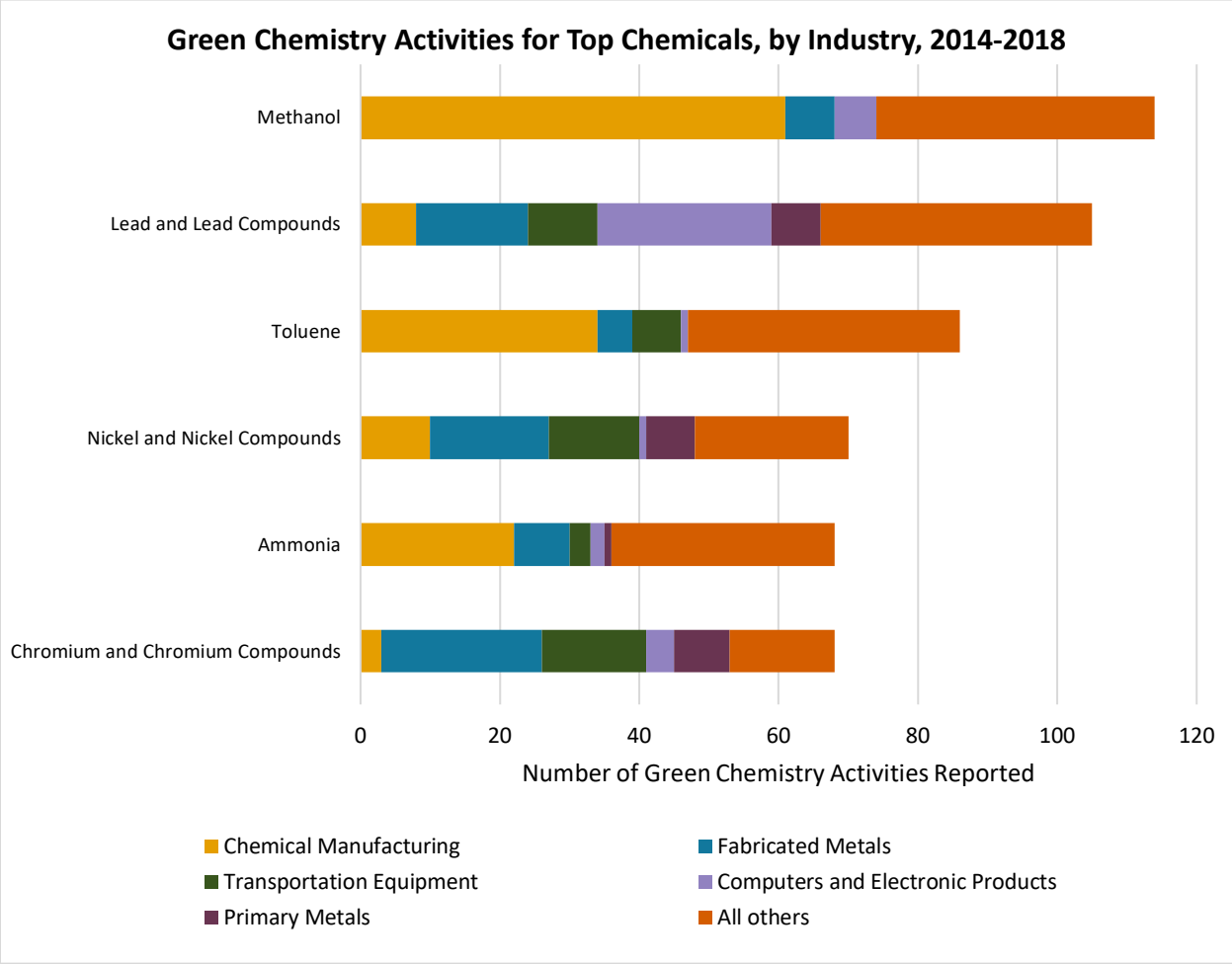
Additional Resources

- 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 Pollution Prevention (P2) Search Tool.

Green Chemistry Activities

Green chemistry is a discipline within the field of chemistry which seeks to prevent formation of pollution through the design and implementation of manufacturing syntheses that use safer reagents (e.g., green solvents) or feedstocks, use minimal energy, and produce the desired product in high yield without forming unwanted byproducts or wastes. In the pollution prevention hierarchy green chemistry is a means to achieve source reduction. Advancements in green chemistry allow industry to reduce or even prevent pollution at its source by, for example, designing manufacturing processes that use or produce fewer quantities of TRI chemicals, or no TRI chemicals at all.

Six of the source reduction codes 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, based on the six green chemistry codes, were implemented over the last five years and the sectors that reported those activities.



- Since 2014, facilities have reported 1,496 green chemistry activities for 130 TRI chemicals and chemical categories.
    - Green chemistry activities were reported most frequently for methanol, lead and lead compounds, toluene, nickel and nickel compounds, ammonia, and chromium and chromium compounds.
    - The chemical manufacturing, fabricated metals, and transportation equipment 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:
    - Based on an employee recommendation, a paint and coating manufacturing facility reformulated a number of products to reduce its toluene usage. [Click to view facility details in the Pollution Prevention (P2) Tool]
- Fabricated metal producers applied green chemistry techniques to reduce their usage of metals including lead, nickel, and chromium. For example:
    - A metal forming and laser cutting facility used enhanced process monitoring and quality control to improve its resource utilization and reduce the scrap metal (containing nickel) generated. [Click to view facility details in the P2 Tool]
- Transportation equipment manufacturers used green chemistry to reduce or eliminate their usage of chromium, nickel, and lead. For example:
    - A motor vehicle electronics manufacturer replaced leaded product lines with non-leaded lines, reducing its amount of lead waste managed. [Click to view facility details in the P2 Tool]

Additional Resources

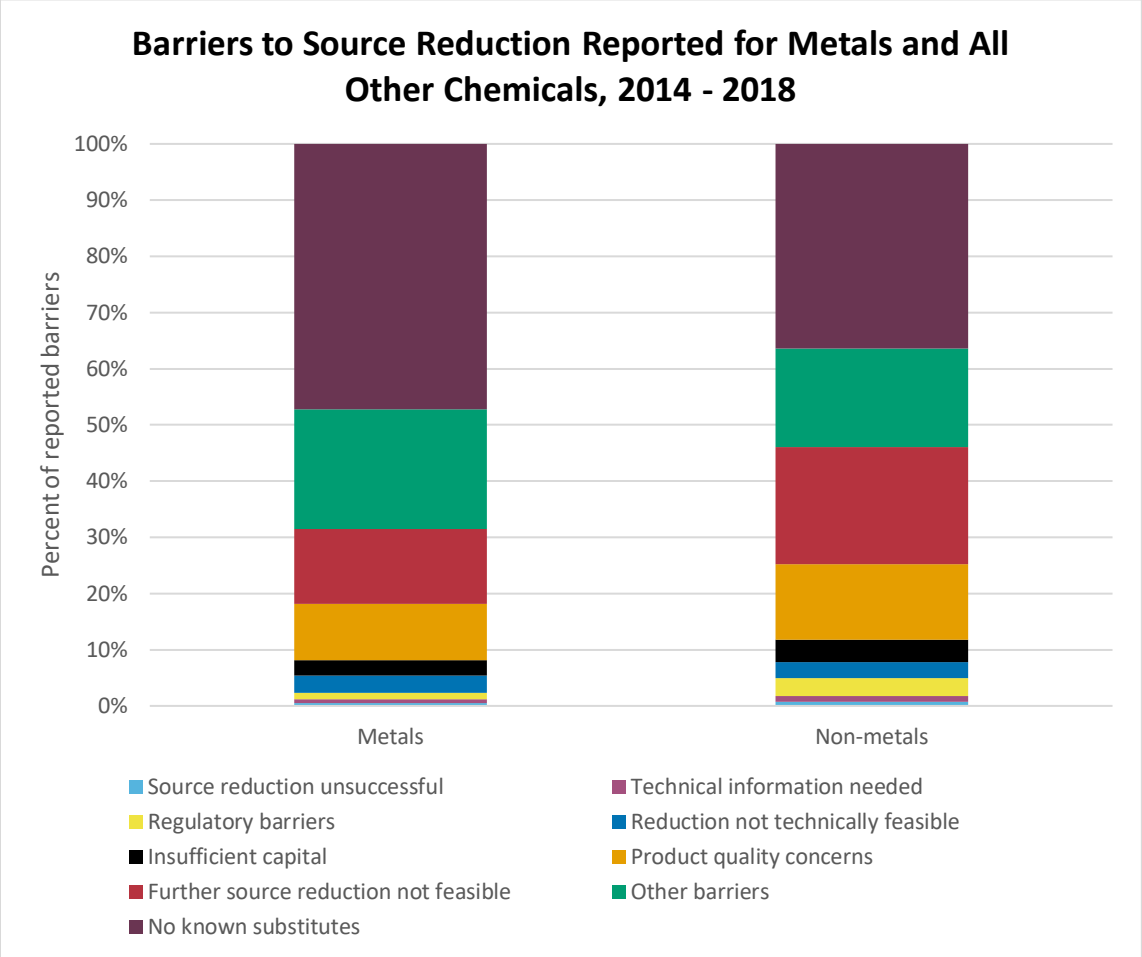
Source reduction activities such as green chemistry are the preferred way to reduce formation of chemical wastes. Find more information on green chemistry using these resources:

- EPA's TRI Pollution Prevention (P2) Qlik Dashboard to find green chemistry examples for a specific chemical and/or industry.
- EPA's Green Chemistry program for information about green chemistry and EPA's efforts to facilitate its adoption.
- EPA's Safer Choice program for 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*. EXIT

Reported Barriers to Source Reduction

Facilities that did not implement new source reduction activities for a TRI chemical have the option to disclose any barriers that prevented them from implementing source reduction. Since 2014, TRI reporting forms include barrier codes, which enable reporting and analysis of obstacles that facilities may be experiencing. 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 that describe possible barriers. These codes are defined in the TRI Reporting Forms and Instructions.

From 2014 to 2018:

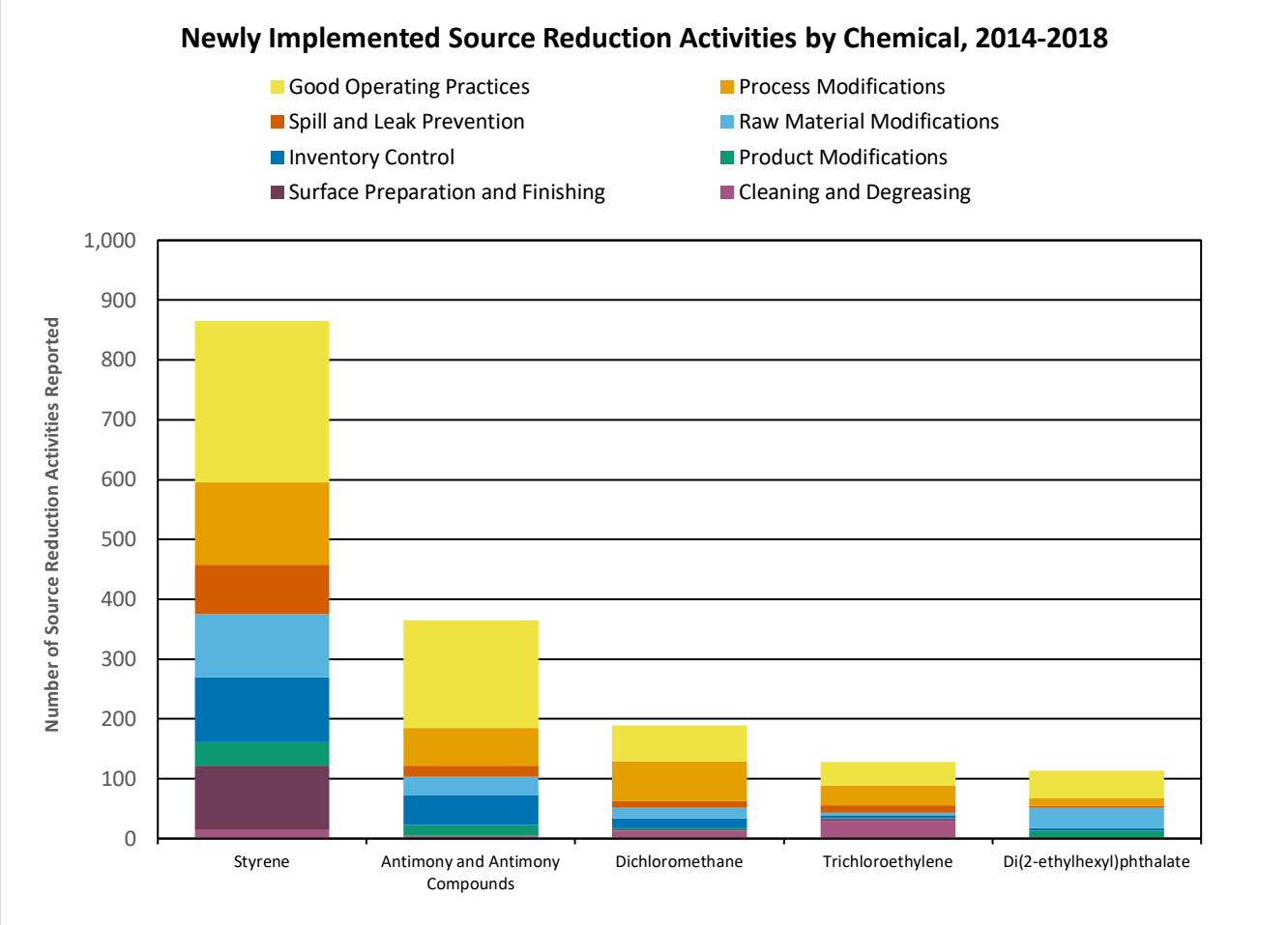
- Facilities reported barriers to source reduction for 333 chemicals and chemical categories. Analyzing the source reduction barriers reported to TRI helps identify where more research is needed, for example, to address technological challenges or promote development of viable alternatives. It may also allow for better communication between

those that have knowledge of source reduction practices and those that are seeking additional help.

- The most frequently reported barriers for both metals and non-metals were *no known substitutes or alternative technologies* and *further source reduction not feasible*. This excludes *other barriers*, a catch-all category available to facilities.
- While *no known substitutes* was the most frequently reported barrier for both metals and non-metals, it accounted for almost half (47%) 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 sign manufacturer reported that the prime aluminum and magnesium they use in production contains trace amounts of lead as an undesirable impurity. [Click to view facility details in the Pollution Prevention (P2) Tool]
    - An iron and steel mill noted that manganese is used in steel production to comply with American Society for Testing and Materials (ASTM) standards, so they are unable to reduce their use of this chemical. [Click to view facility details in the P2 Tool]
- *Further source reduction not feasible* was another commonly reported barrier, especially for non-metals. Facilities select this barrier code when additional reductions do not appear feasible. For example:
    - A plastic product manufacturing facility implemented a recirculation system for bulk storage and an accurate metering system related to its styrene usage. Further reductions could be realized with the implementation of a robotic application process, but the facility reported insufficient capital to install such equipment. [Click to view facility details in the P2 Tool]
- You can view barriers reported for any TRI chemical by using 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 2014-2018. 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 and are defined in the TRI Reporting Forms and Instructions.

From 2014 to 2018:

- TRI facilities reported 28,951 source reduction activities for 267 chemicals and chemical categories.
- Chemicals with the highest source reduction reporting rates were: styrene, antimony and antimony compounds, dichloromethane (DCM, also known as methylene chloride), trichloroethylene, and di(2-ethylhexyl)phthalate.

- The type of source reduction activity implemented for these chemicals varied depending on their use in industrial operations and the chemical's characteristics. For example:
    - **Raw material modifications** is commonly reported as a source reduction activity to reduce waste of di(2-ethylhexyl)phthalate (DEHP), a plasticizer; 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**, including changing to aqueous cleaners, is implemented for 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 to TRI about their source reduction, recycling, or pollution control activities in an optional text field of the TRI reporting form.

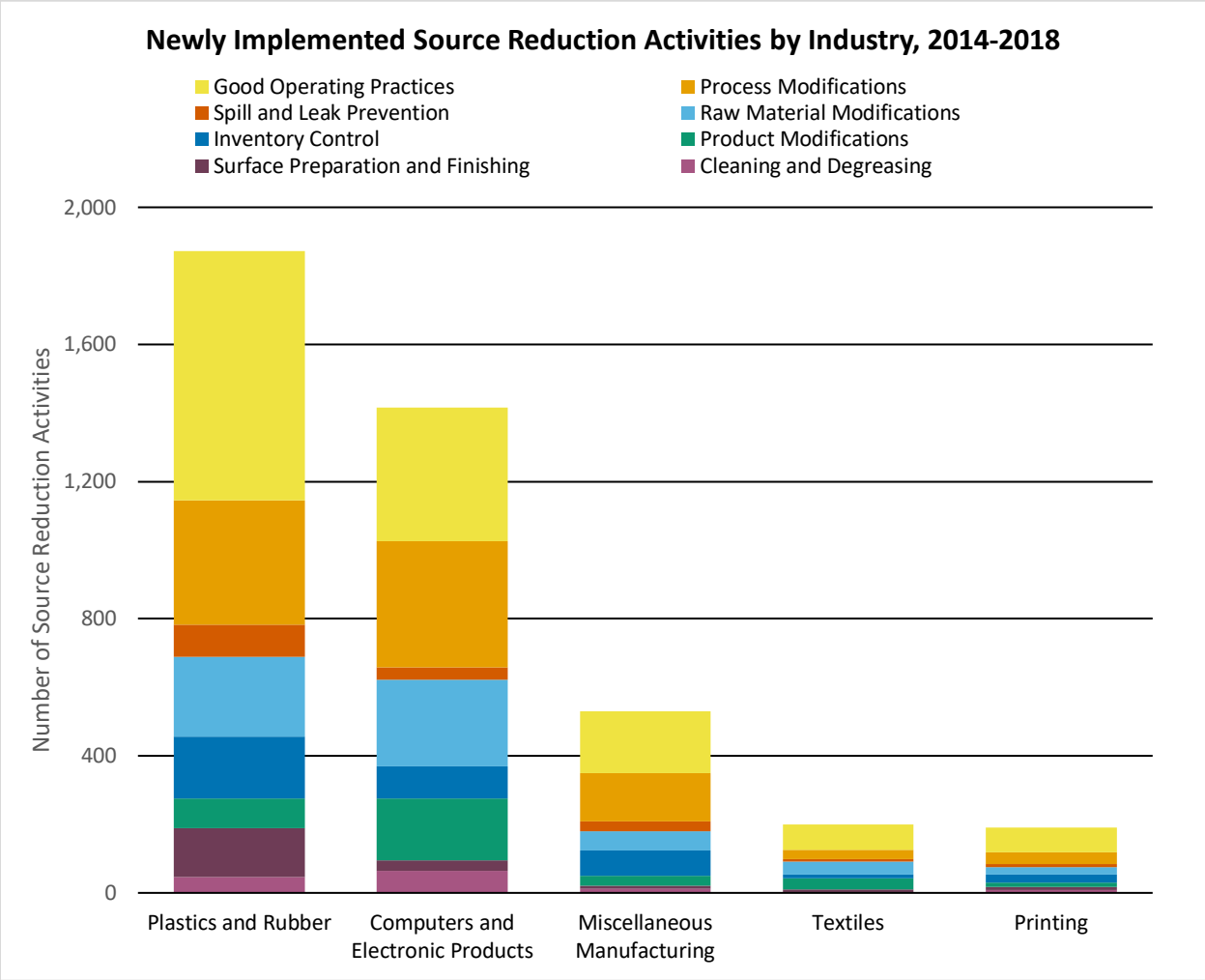
Examples of optional source reduction information for 2018:

- Styrene: A boat manufacturer optimized the efficient use of styrene by adding equipment to conduct some molding operations under closed conditions. [Click to view facility details in the Pollution Prevention (P2) Tool]
- Dichloromethane: A paint and coating manufacturer was able to reduce its releases of dichloromethane by implementing product reformulation identified through participative team management. [Click to view facility details in the P2 Tool]
- Trichloroethylene: A metal stamping facility purchased and installed a new vacuum vapor degreaser to reduce its trichloroethylene releases. [Click to view facility details in the P2 Tool]
- Di(2-ethylhexyl)phthalate: A resin compounding facility substituted DEHP with other plasticizer(s). [Click to view facility details in the P2 Tool]
- Antimony Compounds: An automobile parts manufacturer is moving away from PVC materials which use antimony trioxide as a fire retardant to thermoplastic polyolefin (TPO)-type materials to meet customer demands. The facility continues to test alternative fire retardants to use in its products. [Click to view facility details in the P2 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: 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 2014 to 2018:

- The five industry sectors with the highest source reduction reporting rates were plastics and rubber, computers and electronic products, miscellaneous manufacturing (e.g., medical equipment), textiles, and printing.
- 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 or waste management activities, as shown in the following examples.

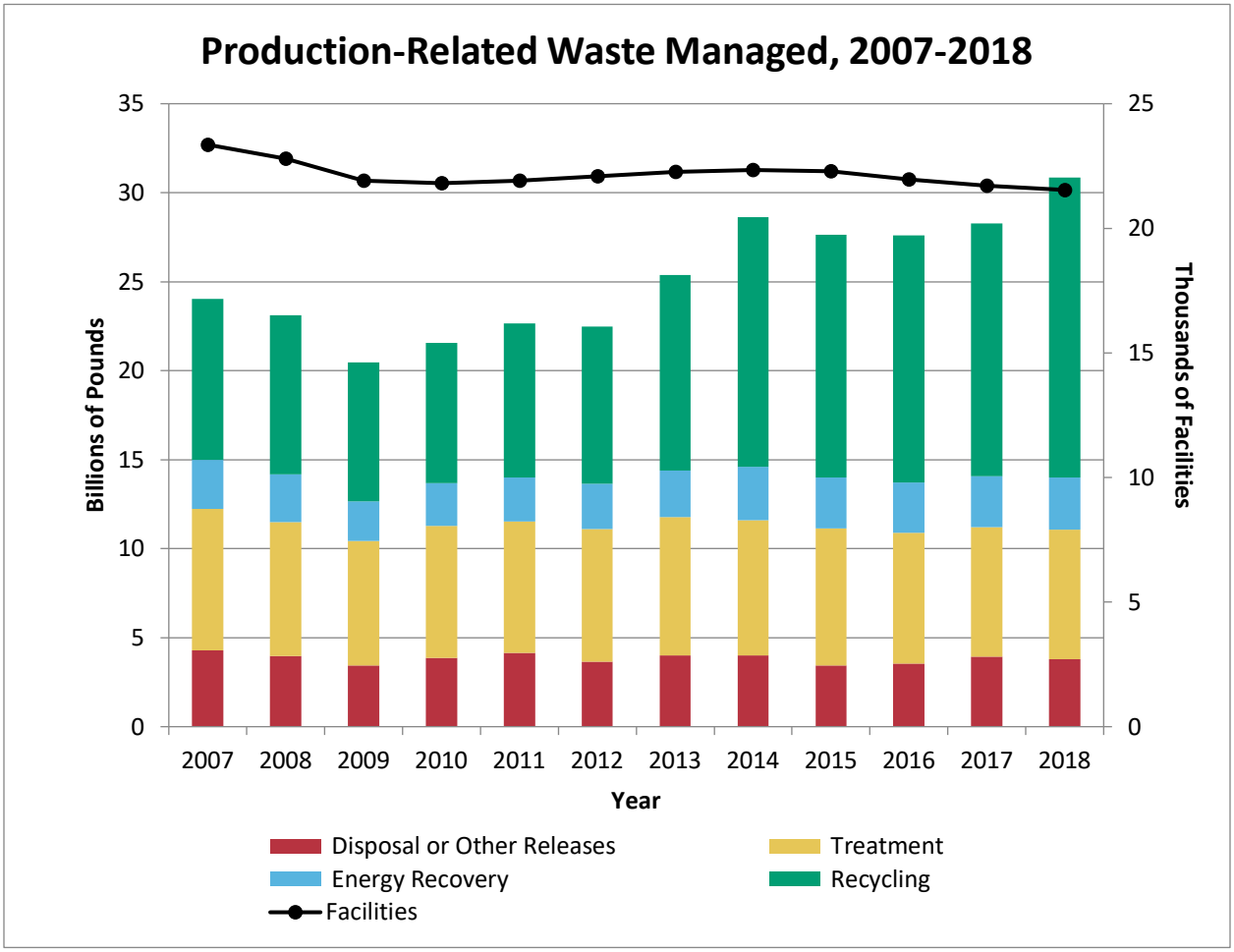
Examples of optional source reduction information for 2018:

- **Plastics and Rubber**: A plastics and resin manufacturing facility reformulated its liquid polyester resin to a zero-styrene alternative resin, and reformulated its sheet molding compounds resin to use raw materials with lower quantities of styrene. [Click to view facility details in the P2 Tool]
- **Computers and Electronic Products**: A printed circuit board manufacturing facility began offering alternative product finishes to customers in order to offset the use of lead finish in its product. The facility also changed product specifications to minimize the amount of rework required in production, further reducing unnecessary use of lead for metal coating. [Click to view facility details in the P2 Tool]
- **Miscellaneous Manufacturing**: A surgical and medical instrument manufacturing facility purchased raw materials shaped more similarly to final products to reduce its chromium-containing stainless steel scrap. [Click to view facility details in the P2 Tool]
- **Printing**: A gravure printer reduced toluene use through paint scrap tracking and paint reuse programs. [Click to view facility details in the P2 Tool]
- **Textiles**: A carpet and rug mill implemented raw material modifications and reduced its cobalt and copper compounds releases by using a different type of yarn. [Click to view facility details in the P2 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.

Waste Management Trends

Facilities report to TRI the quantities of TRI-listed chemicals that they dispose of or otherwise release to 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 2018:

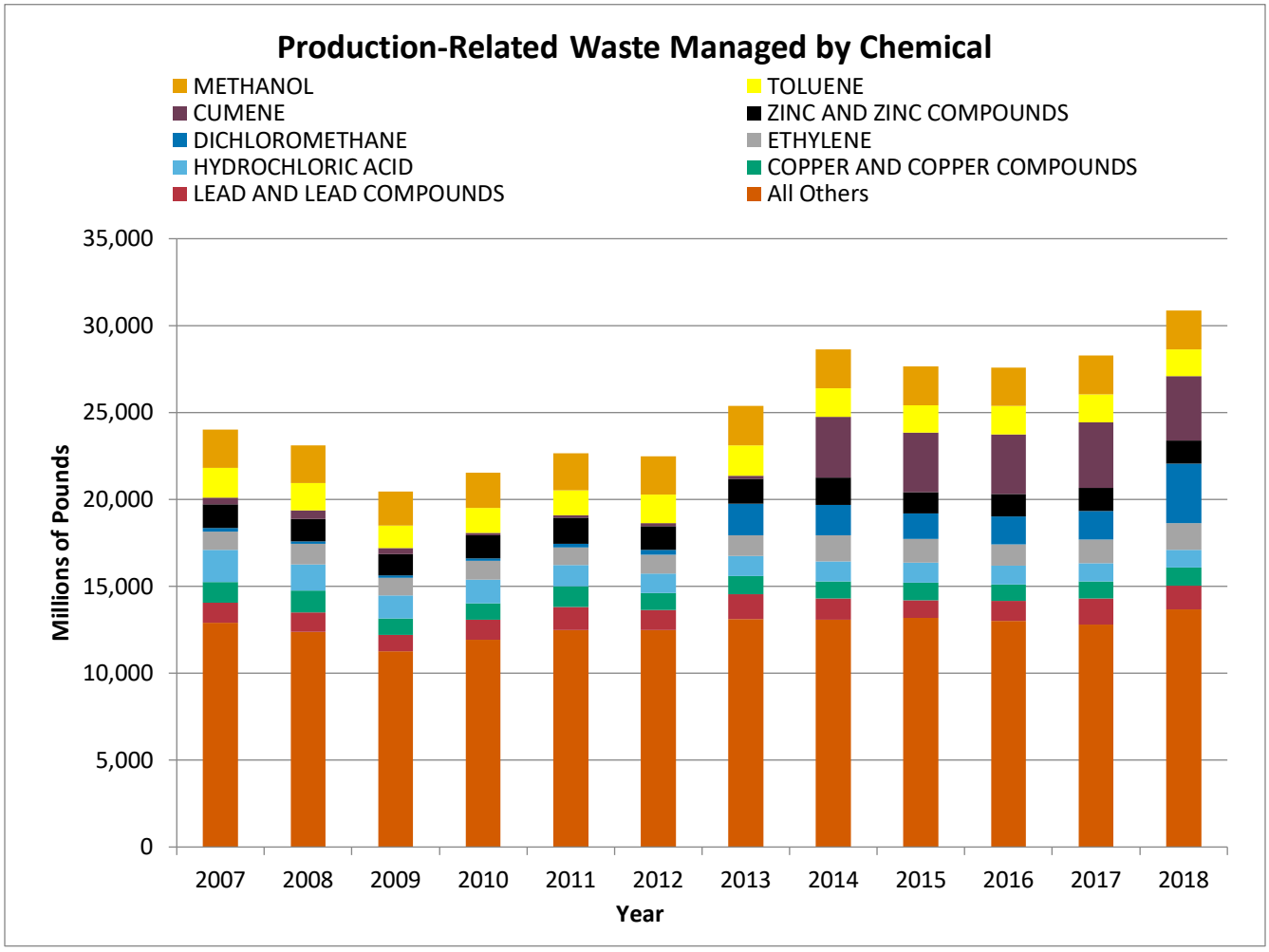
- Production-related waste managed decreased during the recession. Since 2009, production-related waste managed has generally been increasing as the U.S. economy has improved.
- Since 2007, production-related waste managed increased by 6.8 billion pounds (28%).

  - Disposal and other releases decreased by 466 million pounds (-11%).
  - Treatment decreased by 707 million pounds (-9%).
  - Energy recovery increased by 194 million pounds (7%).
  - Recycling increased by 7.8 billion pounds (86%), a trend largely driven by two plastics manufacturing facilities reporting billions of pounds of dichloromethane recycled and one petrochemical manufacturing facility reporting over 3.4 billion pounds of cumene recycled each year from 2014-2018.

- The number of facilities that report to TRI has declined by 8% 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 below the reporting thresholds.

Production-Related Waste Managed by Chemical

This figure shows the chemicals that were managed as waste in the greatest quantities from 2007 to 2018.



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

From 2007 to 2018:

- Facilities reported production-related waste managed for 546 chemicals and chemical categories from 2007 to 2018. The nine chemicals for which facilities reported the most production-related waste managed, shown above, represent 50% of the total production-related waste reported.
- The reported quantities of most of the top chemicals contributing to production-related waste managed have remained relatively constant since 2007.

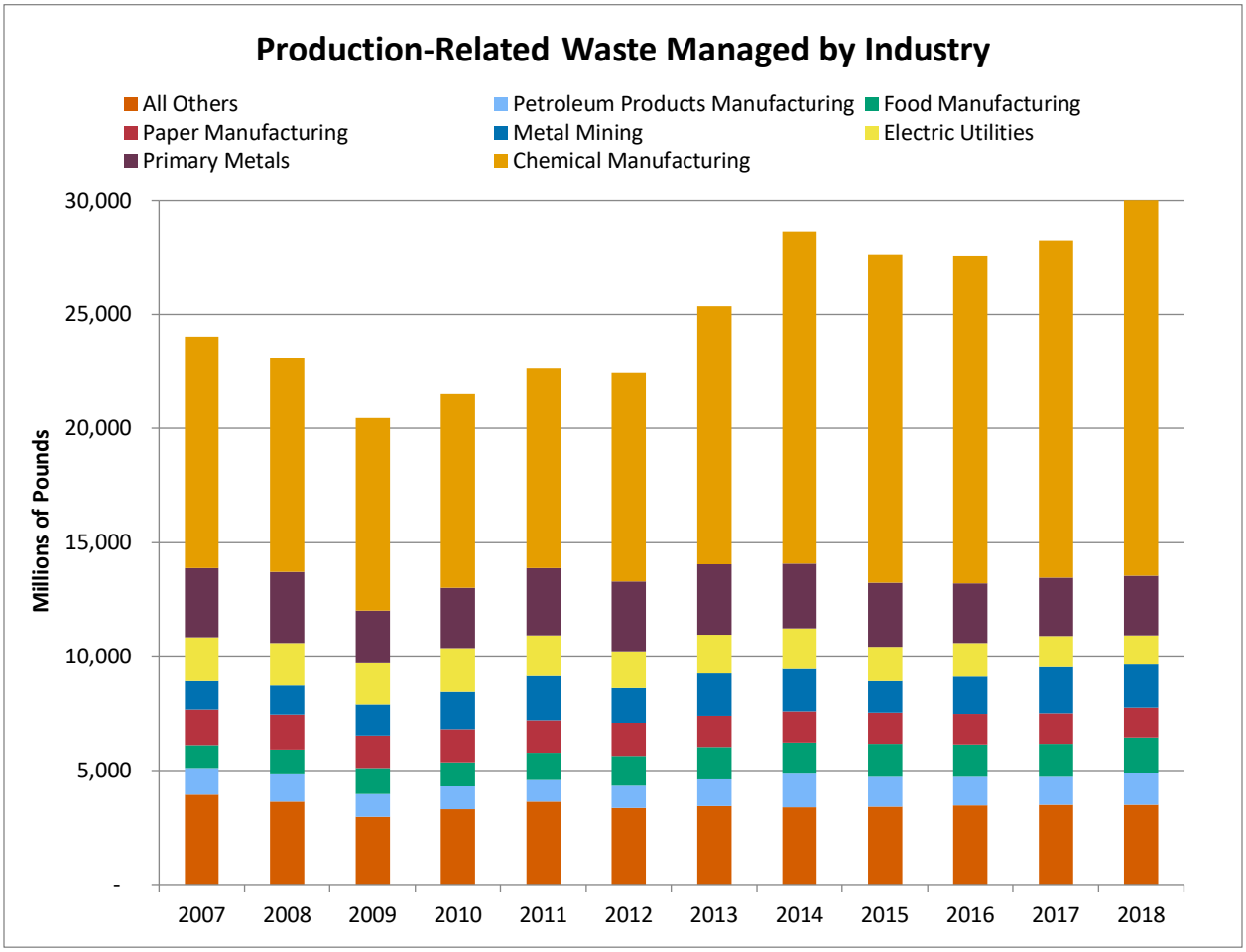
- Of the chemicals shown above, facilities reported increased quantities of waste managed for: dichloromethane, lead and lead compounds, cumene, and ethylene.
    - Production-related waste of lead and lead compounds increased by 21%.
    - Cumene waste managed increased eight-fold, mostly driven by one facility reporting over 3.4 billion pounds of cumene recycled annually during 2014-2018. [Click to view facility details in the Pollution Prevention (P2) Tool]

From 2017 to 2018:

- Facilities reported decreases in waste management quantities for these chemicals:
    - Lead and lead compounds decreased by 117 million pounds (-8%)
    - Toluene decreased by 70.0 million pounds (-4%)
    - Hydrochloric acid decreased by 42.2 million pounds (-4%)
    - Cumene decreased by 37.8 million pounds (-1%)
    - Zinc and zinc compounds decreased by 27.4 million pounds (-2%)
- Dichloromethane waste managed increased by 1.8 billion pounds (112%), mostly driven by one plastic manufacturing facility reporting 2.0 billion pounds of the chemical recycled in 2018 and no recycling of dichloromethane in prior years. [Click to view facility details in the Pollution Prevention (P2) Tool]

Production-Related Waste Managed by Industry

This figure shows the industry sectors that managed the most waste from 2007 to 2018.



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

From 2007 to 2018:

- 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 7 billion pounds (71%)
  - Metal mining increased by 601 million pounds (47%)
  - Food manufacturing increased by 553 million pounds (55%)
  - Petroleum products manufacturing increased by 203 million pounds (17%)

- 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.

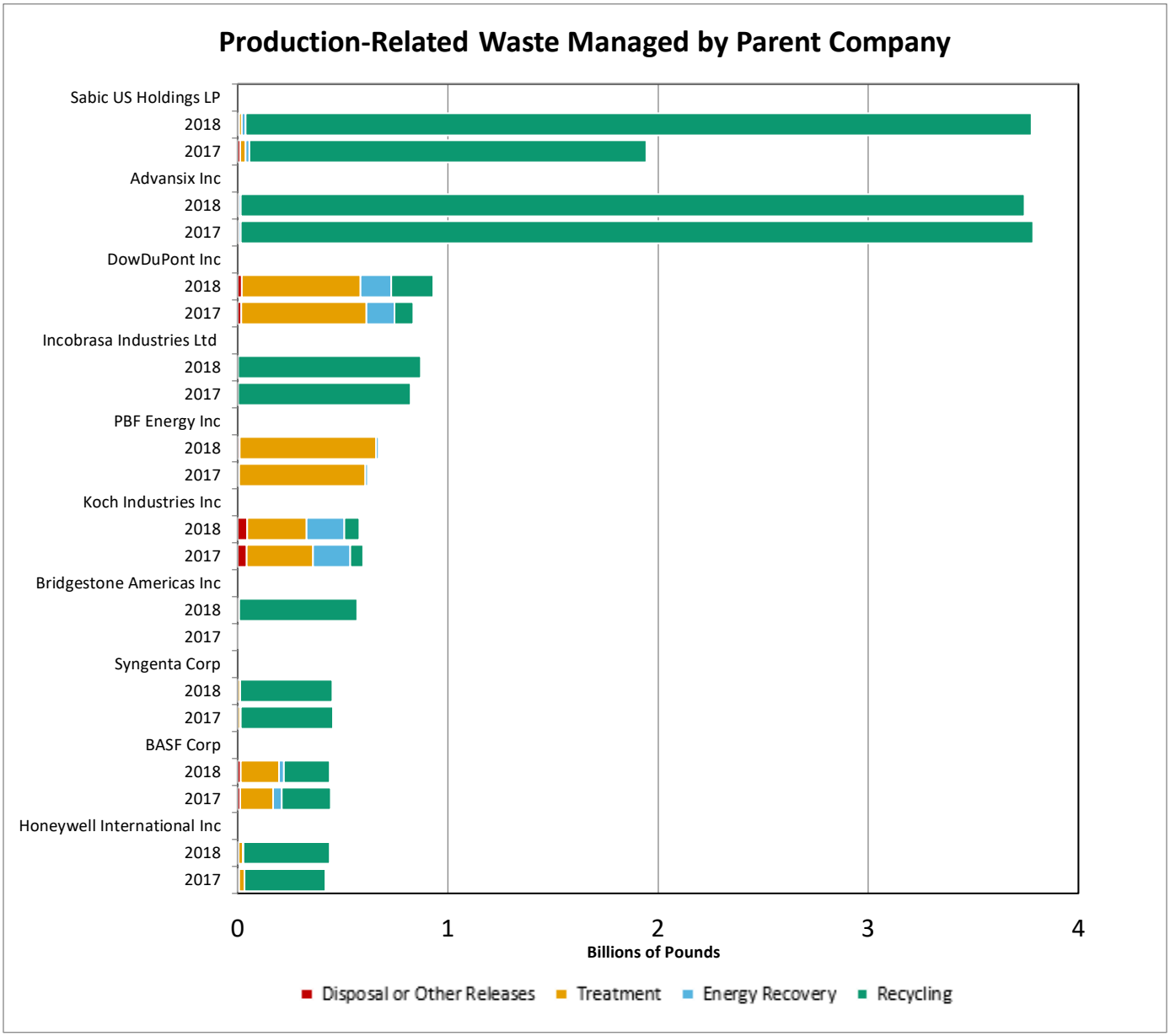
From 2017 to 2018:

- Industry sectors with the greatest reported changes in waste management quantities were:
    - Chemical manufacturing increased by 2.5 billion pounds (16%)
    - Petroleum products manufacturing increased by 175 million pounds (8%)

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 2018. 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 almost all of these companies are largely managing their waste through EPA's preferred waste management methods–recycling, energy recovery, or treatment–rather than releasing it to the environment.



Notes: 1) This figure uses EPA's standardized parent name. 2) To view facility counts by parent in 2017 or 2018, mouse over the bar graph. 3) One facility, Incobrasa 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) For 2017, ten facilities submitted subsidiaries or variations of Bridgestone Americas, Inc. as their parent company and for 2018, these facilities were standardized under the Bridgestone Americas parent company.

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

- **Chemical manufacturing:** Advansix Inc, DowDuPont Inc, BASF Corp, Syngenta Corp, Honeywell International Inc, Sabic US Holdings LP
- **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

Six of these top parent companies reported implementing new source reduction activities in 2018. Some of these companies reported additional (optional) descriptive information to TRI about their pollution prevention or waste management activities.

Examples of additional pollution prevention-related information for 2018:

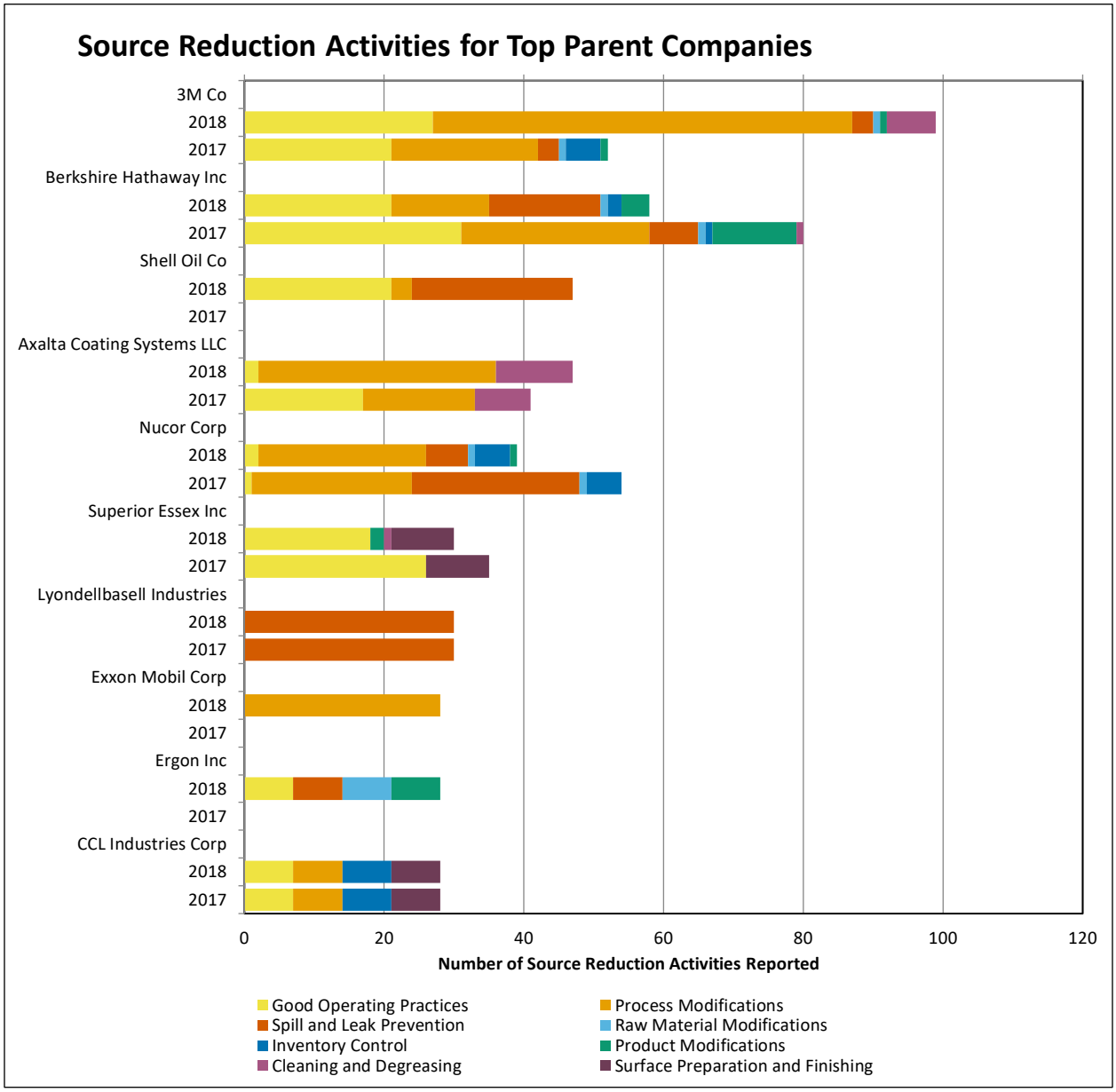
- A DowDuPont plastics and resin manufacturing facility replaced a process tank and connected the new tank to an air pollution control device to reduce releases of chemicals including acrylonitrile. [Click to view facility details in the Pollution Prevention (P2) Tool]
- A wood product manufacturing facility owned by Koch Industries upgraded a wastewater treatment system to reduce releases of ammonia in wastewater, and diverted a portion of the previously treated wastewater for energy recovery. [Click to view facility details in the P2 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 2018. 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 moving large volumes of earth 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 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) The increases by Ergon, Inc are driven by the acquisition of two facilities whose source reduction activities for 2017 are under their former parent company. 3) For 2017, 13 facilities reported subsidiaries of Shell Oil Company as their parent companies; for 2018 the parent company for these facilities was standardized to Shell Oil Company. 4) To view facility counts by parent in 2017 or 2018, mouse over the bar graph.

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

- **Chemical manufacturing**: 3M Co, Axalta Coating Systems, Lyondellbasell Industries
- **Multiple sectors**: Berkshire Hathaway Inc, Ergon Inc
- **Steel manufacturing**: Nucor Corp

- **Wire and cable manufacturing**: Superior Essex Inc
- **Metal containers**: CCL Industries Corp
- **Petroleum products manufacturing**: Shell Oil Co, Exxon Mobil Corp

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 or waste management activities.

Examples of additional pollution prevention-related information for 2018:

- A Nucor facility began using a new primer paint coating containing less certain glycol ethers to reduce its releases of the chemical. [Click to view facility details in the Pollution Prevention (P2) Tool]
- A 3M facility implemented procedures to prevent spilling or leakage of boron trifluoride by improving maintenance and inspection requirements for its outdoor storage tanks. [Click to view facility details in the P2 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.