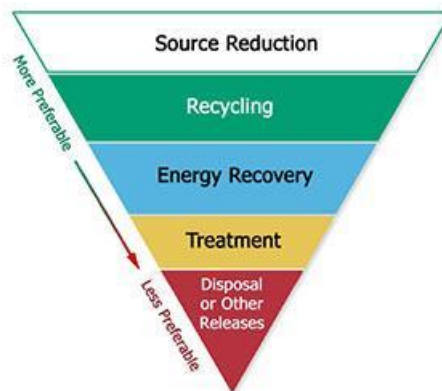


Pollution Prevention and Waste Management

Each year, the Toxics Release Inventory (TRI) collects information from more than 20,000 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. These quantities, in aggregate, are collectively referred to as the quantity of production-related waste managed.

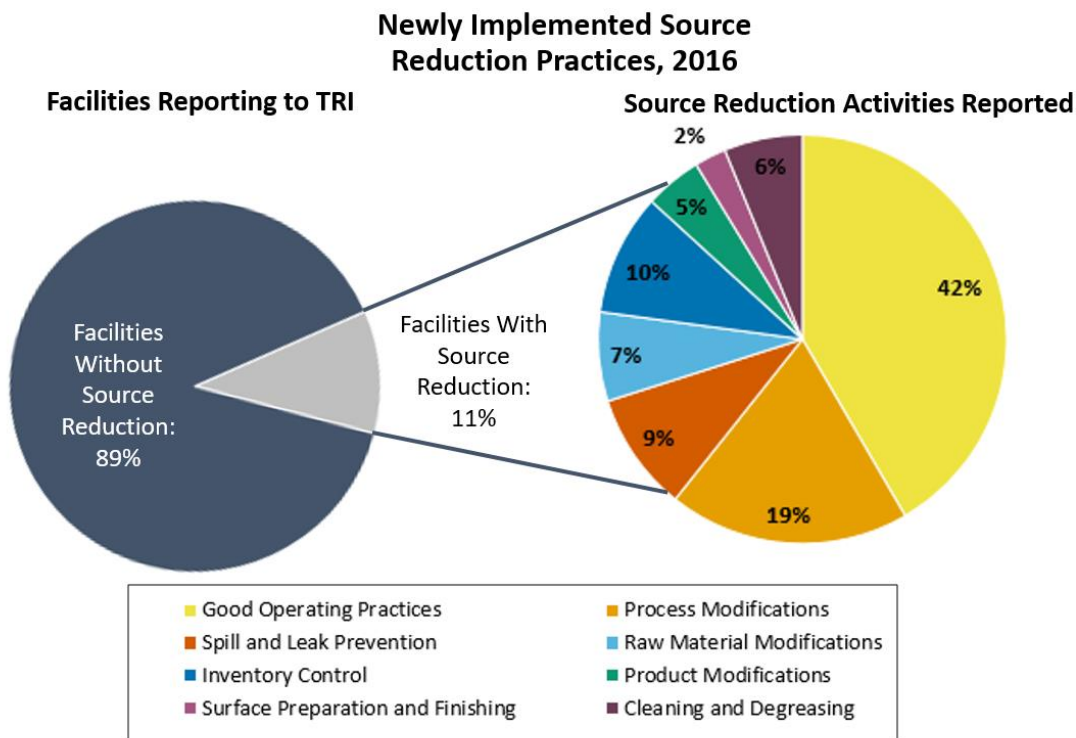
Looking at production-related waste managed over time helps track progress in reducing the amount of chemical waste generated and in adopting waste management practices that are more preferable than disposing of or otherwise releasing waste to the environment. EPA encourages facilities to first eliminate the creation of chemical waste through source reduction activities. For wastes that are generated, the most preferred management method



is recycling, followed by burning for energy recovery, treatment, and, as a last resort, disposing of or otherwise releasing the chemical waste into the environment. These waste management practices are illustrated in the waste management hierarchy image shown here, and discussed in the Pollution Prevention Act (PPA) of 1990. 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.

Source Reduction Activities Reported

Facilities report new source reduction activities that they implemented during the year to the Toxics Release Inventory (TRI). Source reduction includes activities that eliminate or reduce the generation of chemical waste in the first place. Other waste management practices, such as recycling, refer to how chemical waste is managed after it is generated.



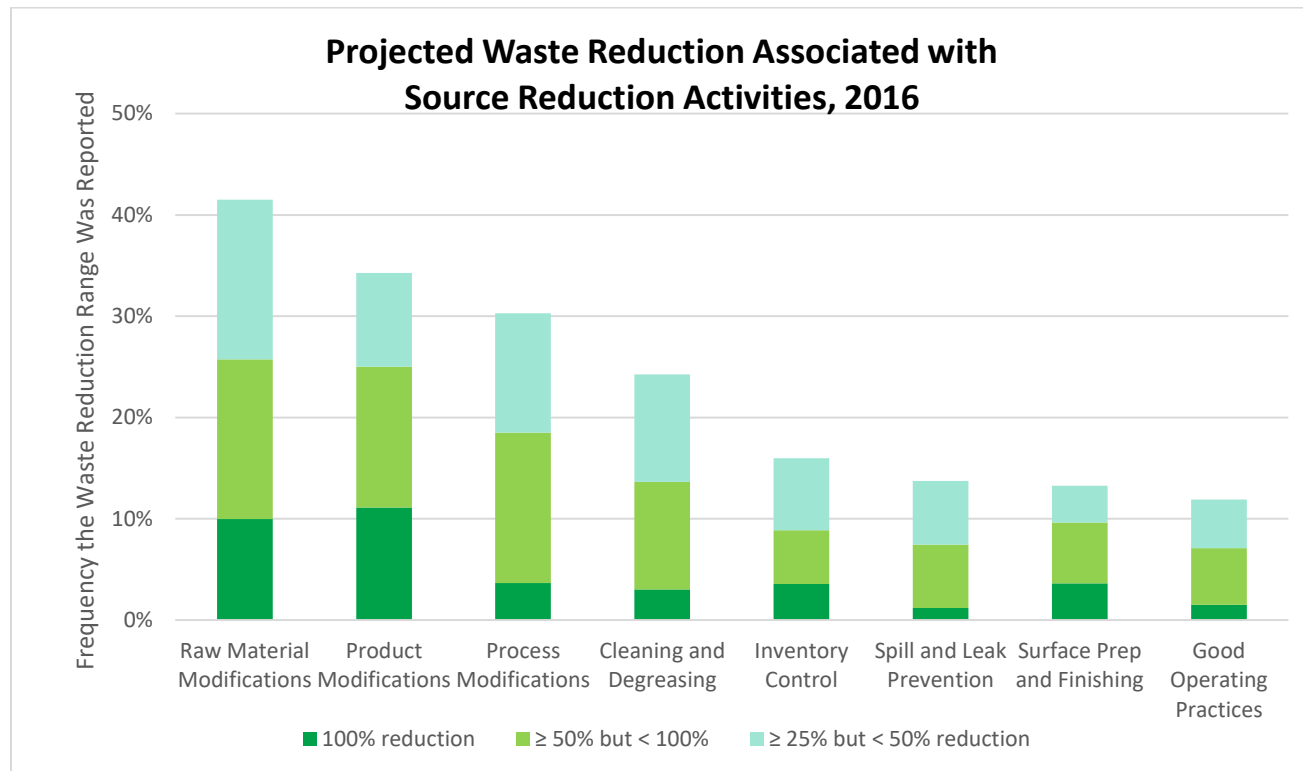
Note: Facilities report their source reduction activities by selecting codes that describe their activities. These codes fall into one of eight categories listed in the graph legend and are defined in the [TRI Reporting Forms and Instructions](#).

In 2016:

- 2,306 facilities (11% of all facilities that reported to TRI) reported initiating a total of 5,868 new source reduction activities.
- Note that facilities may have ongoing source reduction activities initiated in previous years that are not included in the figure. You can [find information on previously implemented source reduction activities by using the TRI Pollution Prevention \(P2\) Search Tool](#).

Anticipated Benefits of Source Reduction

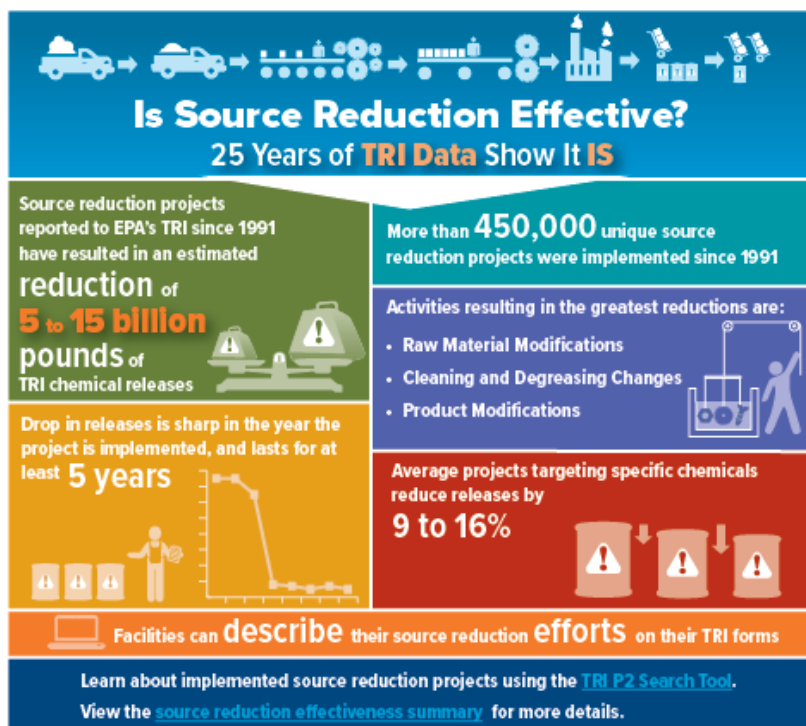
For each source reduction activity implemented, facilities may provide an estimate of the expected reduction in the amount of chemical waste generated. This figure shows the association between specific source reduction activities implemented in 2016 and the estimated reductions in chemical waste that facilities expect to achieve in the coming year.



- Facilities implementing Raw Material Modifications expected to see the greatest waste reductions; 41% of these facilities expected to cut waste by more than one-quarter, including 10% of facilities that anticipated eliminating the chemical. The other 59% of facilities implementing Raw Material Modifications (not shown in the figure) expect waste reductions of up to 25%.
- Among the categories of source reduction activities, facilities implementing Good Operating Practices expected to see the least reduction in waste.

Is Source Reduction Effective?

EPA and many other stakeholders are interested in knowing how effective source reduction is in reducing waste. To quantify the impacts of source reduction activities following implementation, EPA analyzed the source reduction data submitted to TRI over the past 25 years. By applying a statistical approach to this large dataset, the study isolated source reduction impacts from the many other factors that influence the quantities of chemicals released over time.



- The study suggests that source reduction projects implemented by industry have prevented 5 to 15 billion pounds of TRI-listed chemical releases since 1991.
- Raw material modifications, cleaning and degreasing changes, and product modifications have resulted in the greatest release reductions.
- Search for [examples of source reduction projects for a specific chemical and/or industry using the TRI Pollution Prevention \(P2\) Search Tool](#).
- [For details on the study, see the published article](#).

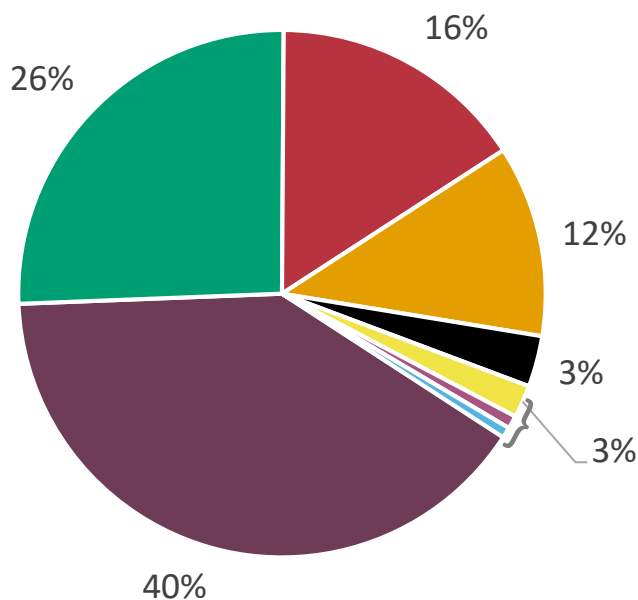
Reported Barriers to Source Reduction

If a facility did not implement new source reduction activities, they can optionally provide information about barriers they faced to source reduction.

In 2016:

- Barriers were reported for 243 chemicals.
- The most common specific barriers were:
 - No known substitute or alternative technology for a chemical or process; and
 - Pollution prevention was previously implemented – additional reduction does not appear technically or economically feasible.

Reported Barriers of Source Reduction, 2016



To see examples of reported barriers to source reduction, click on the color-coded legend.

■ No known substitutes or alternative technologies (41%)

Example:

An explosives manufacturing facility is unable to eliminate lead from the manufacturing process because lead is an essential constituent in producing delay components for non-electric and electric. [[Click to view facility details in the Pollution Prevention \(P2\) Tool](#)]

■ Pollution prevention previously implemented - additional reduction does not appear technically or economically feasible (16%)

Example:

A pharmaceutical manufacturing facility had previously implemented source reduction activities to reduce methanol including eliminating the use of methanol in formulations and changing to dry formulations where possible, but current batches that use methanol cannot be changed. [[Click to view facility details in the P2 Tool](#)]

■ Concern that product quality may decline as a result of source reduction (12%)

Example:

An organic chemical manufacturing facility utilizes methanol in its cleaning process and found that other solvents could not be substituted due to product contamination. [[Click to view facility details in the P2 Tool](#)]

■ Insufficient capital to install new source reduction equipment or implement new source reduction activities/initiatives (3%)

Example:

A leather, hide tanning, and finishing facility releases chromium compounds. The facility is exploring new filtration equipment to recycle chrome even though it's currently too expensive. [[Click to view facility details in the P2 Tool](#)]

■ Specific regulatory/permit burdens (2%)

Example:

A pharmaceutical facility's FDA-qualified process determines the amount of phenol required and therefore the amount of waste generated. [[Click to view facility details in the P2 Tool](#)]

Require technical information on pollution prevention techniques applicable to specific production processes (1%)

Example:

A resin compounding facility is currently searching for a substitute for di(2-ethylhexyl) phthalate that will provide the same product performance. [[Click to view facility details in the P2 Tool](#)]

Source reduction activities were implemented but were unsuccessful (1%)

Example:

An antenna manufacturer attempted implementing a resin infusion (closed molding) process to reduce styrene use but so far cannot duplicate previous quality. [[Click to view facility details in the P2 Tool](#)]

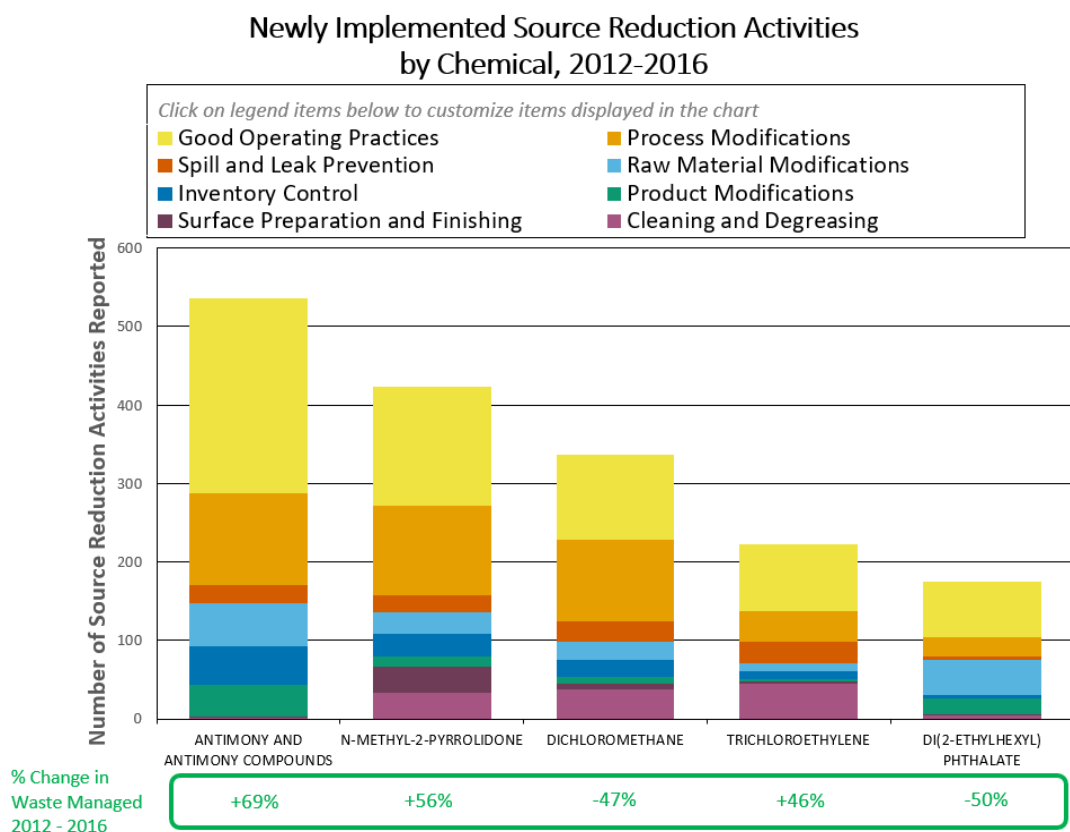
Other, including customer demand (26%)

Example:

A spring manufacturer uses steel which contains manganese and chromium but the steel used in the product is specified by their customers. [[Click to view facility details in the P2 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 types of activities implemented, and the percent change in the quantity of waste managed.



Note: 1) Limited to chemicals with at least 250 total forms from 2012-2016.
 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 2012 to 2016:

- Chemicals with the highest source reduction reporting rate were: antimony, N-methyl-2-pyrrolidone, dichloromethane (DCM, also known as methylene chloride), trichloroethylene, and di(2-ethylhexyl) phthalate.
- The type of source reduction activity implemented for these chemicals varies depending on their use in industrial operations and the chemical's characteristics. For example:
 - Raw material modification** is commonly reported as a source reduction activity to reduce waste of [di \(2-ethylhexyl\) phthalate](#) (DEHP), a plasticizer, and antimony compounds, used in electronics, batteries, and as a component of

fire retardants. Many facilities report that they are replacing these chemicals with environmentally preferable alternatives.

- **Cleaning and degreasing**, including changing to aqueous cleaners, is implemented for common industrial solvents such as [trichloroethylene](#) (TCE), [dichloromethane](#) (DCM, also known as methylene chloride), and [N-methyl-2-pyrrolidone](#) (NMP).
- The quantity of waste managed over the last 5 years decreased considerably for DCM and DEHP. For the other chemicals shown in the figure, waste quantities have increased. While quantities of waste managed overall increased by 18% over this post-recession time period, the increases in quantities of antimony, NMP, and TCE waste managed exceeded this average increase. Use of NMP expanded in recent years as a substitute for chlorinated solvents such as DCM.

Facilities may also report additional details to TRI about their source reduction, recycling, or pollution control activities.

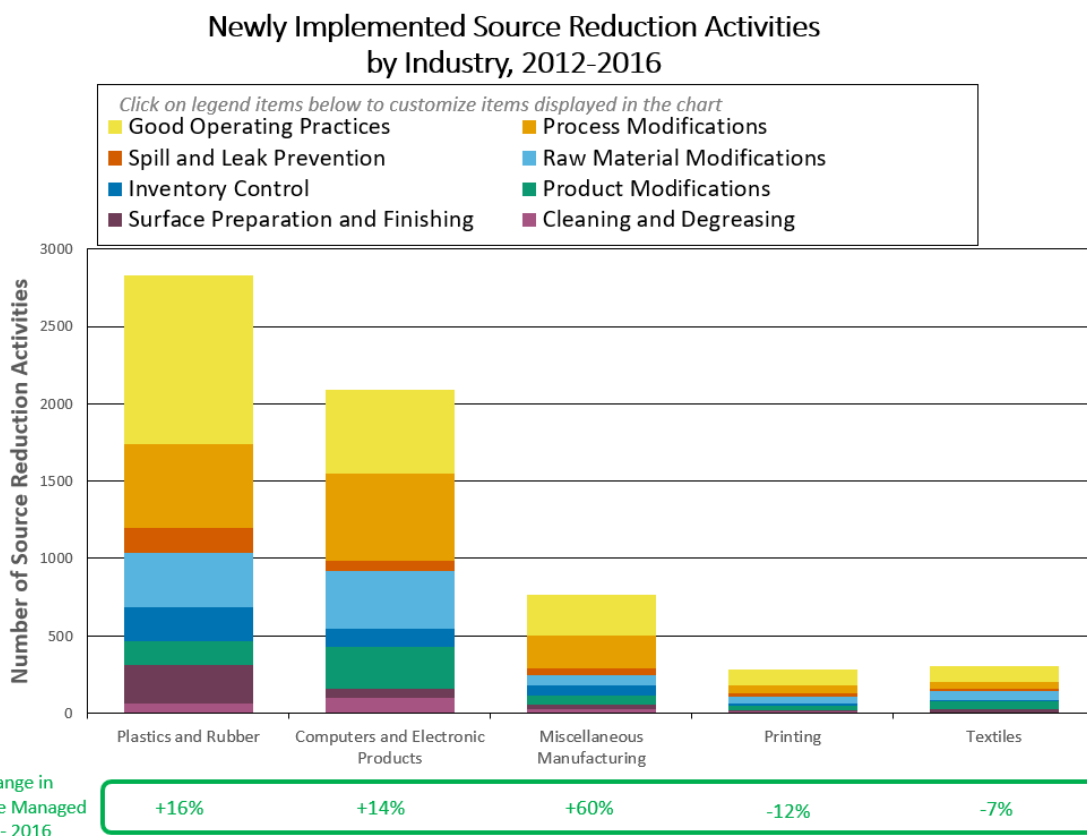
Examples of additional pollution prevention-related information for 2016:

- [N-methyl-2-pyrrolidone](#): A semiconductor manufacturer replaced N-methyl-2-pyrrolidone with de-ionized water for the cleaning processes of certain tools. [[Click to view facility details in the Pollution Prevention \(P2\) Tool](#)]
- [Dichloromethane](#): A maintenance products manufacturer is phasing out the use of dichloromethane as a solvent, reducing its use by 64% in 2016. [[Click to view facility details in the P2 Tool](#)]
- [Trichloroethylene](#): A precision machining facility started using a vacuum vapor degreasing system which will eliminate the use of trichloroethylene as a solvent. [[Click to view facility details in the P2 Tool](#)]
- [Di \(2-ethylhexyl\) phthalate](#): A rubber product manufacturer has been replacing di(2-ethylhexyl) phthalate with a new chemical in existing formulations, and excluding the chemical from use in new formulations. [[Click to view facility details in the P2 Tool](#)]
- [Antimony Compounds](#): A resins manufacturer changed from using antimony trioxide powder to propylene pellets with antimony trioxide incorporated into the pellet resulting in less waste than the powder. [[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 industry sectors with the highest source reduction reporting rates over the last 5 years, this figure shows the types of activities implemented, and the percent change in the quantity of waste managed.



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 in the [TRI Reporting Forms and Instructions](#).

From 2012 to 2016:

- The five industry sectors with highest source reduction reporting rates are plastics and rubber, computers and electronic products, miscellaneous manufacturing (e.g., medical equipment), textiles, and printing.
- For most sectors, “Good operating practices” is the most frequently reported type of source reduction activity. Other commonly reported source reduction activities vary 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, recycling, or pollution control activities.

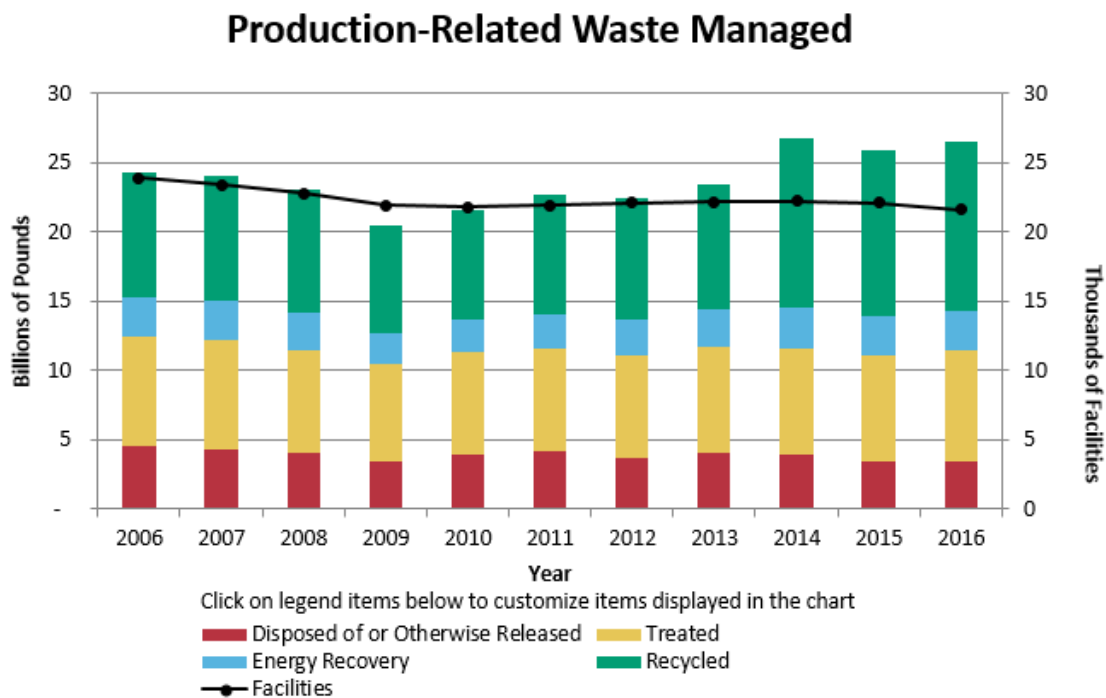
Examples of additional pollution prevention-related information for 2016

- **Plastics and Rubber:** A garden tools manufacturer improved the recovery process for scrap hose from 50% recovery (by weight) to 75%. [[Click to view facility details in the Pollution Prevention \(P2\) Tool](#)]
- **Computers and Electronic Products:** A printed circuit board assembly facility designs most new products as lead-free assemblies reducing the overall use of lead. [[Click to view facility details in the P2 Tool](#)]
- **Miscellaneous Manufacturing:** A medical instrument manufacturer began using chemical totes rather than drums to minimize generation of empty containers for disposal. [[Click to view facility details in the P2 Tool](#)]
- **Textiles:** A fabric coating manufacturer minimized adhesive usage while maintaining good adhesion and flame test results to reduce the amount of antimony in waste [[Click to view facility details in the P2 Tool](#)]
- **Printing:** A printer reduced glycol ether air emissions by replacing one solvent based ink containing 90% glycol ether compounds with a UV ink containing little or no glycol ethers. [[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

In addition to reporting the quantities of chemical waste that they dispose of or otherwise release to the environment to the Toxics Release Inventory (TRI), facilities also report the quantities of TRI-listed chemicals 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 the production-related waste managed.



From 2006 to 2016:

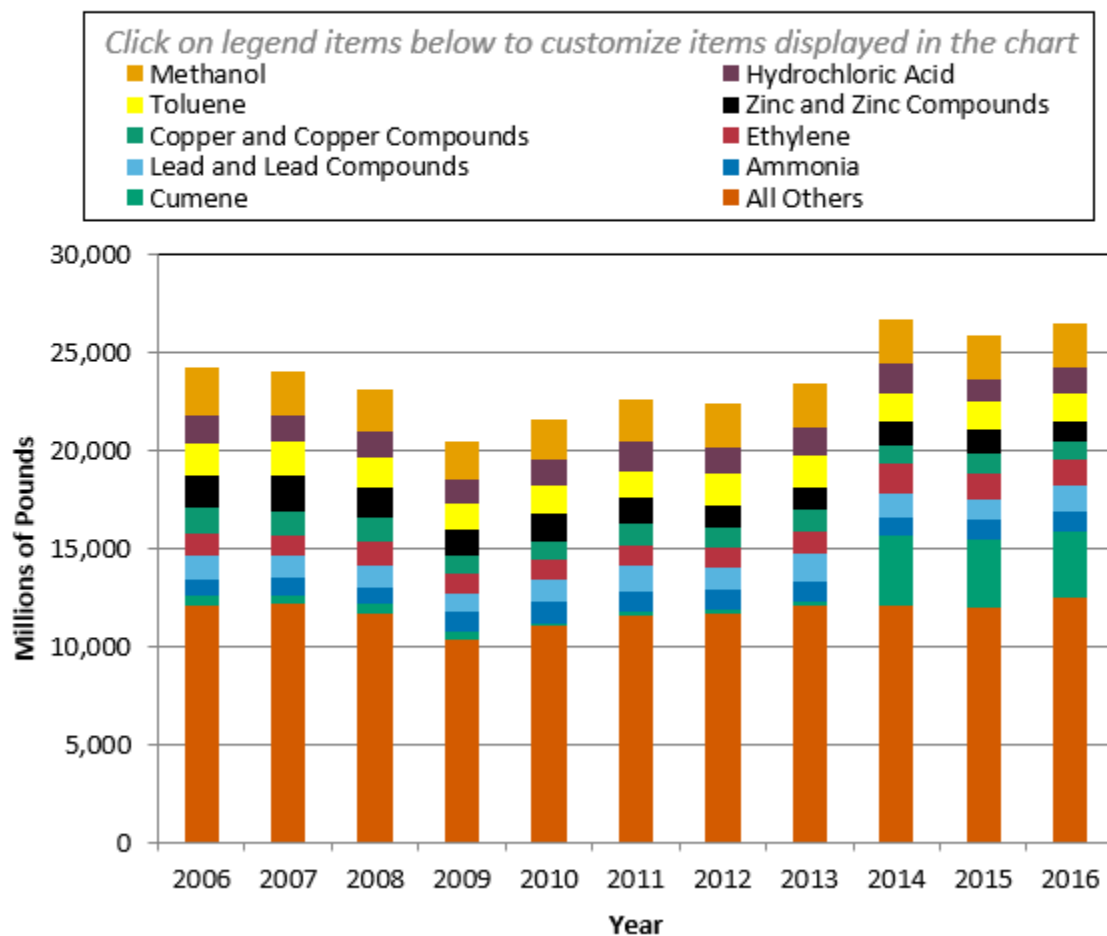
- Since 2009, production-related waste managed has generally been increasing as the U.S. economy has improved.
- Production-related waste managed increased by 2.2 billion pounds (9%).
 - Disposal and other releases decreased by 1.0 billion pounds (-23%).
 - Treatment increased by 40.3 million pounds (1%).
 - Energy recovery increased by 44.3 million pounds (2%).

- Recycling increased by 3.1 billion pounds (35%), a trend mostly driven by one facility reporting over 3.4 billion pounds of cumene recycled in 2014 – 2016.
[\[Click to view facility details in the Pollution Prevention \(P2\) Tool\]](#)
- The number of facilities that report to TRI has declined by 9% since 2006, with 21,629 facilities reporting for 2016.

Production-Related Waste Managed by Chemical

This figure shows the chemicals that were managed as waste in the greatest quantities from 2006 - 2016.

Production-Related Waste Managed by Chemical



From 2006 to 2016:

- Most of the top chemicals contributing to production-related waste managed have remained relatively constant since 2006.
- Of the chemicals shown above, facilities reported increased quantities of waste managed for four: lead and lead compounds, cumene, ethylene, ammonia.

- Production-related waste of lead and lead compounds increased by 19%.
- Cumene increased six-fold, mostly driven by one facility reporting over 3.4 billion pounds of cumene recycled in 2014 – 2016. [[Click to view facility details in the Pollution Prevention \(P2\) Tool](#)]
- Ethylene increased by 17% and ammonia increased by 10%.

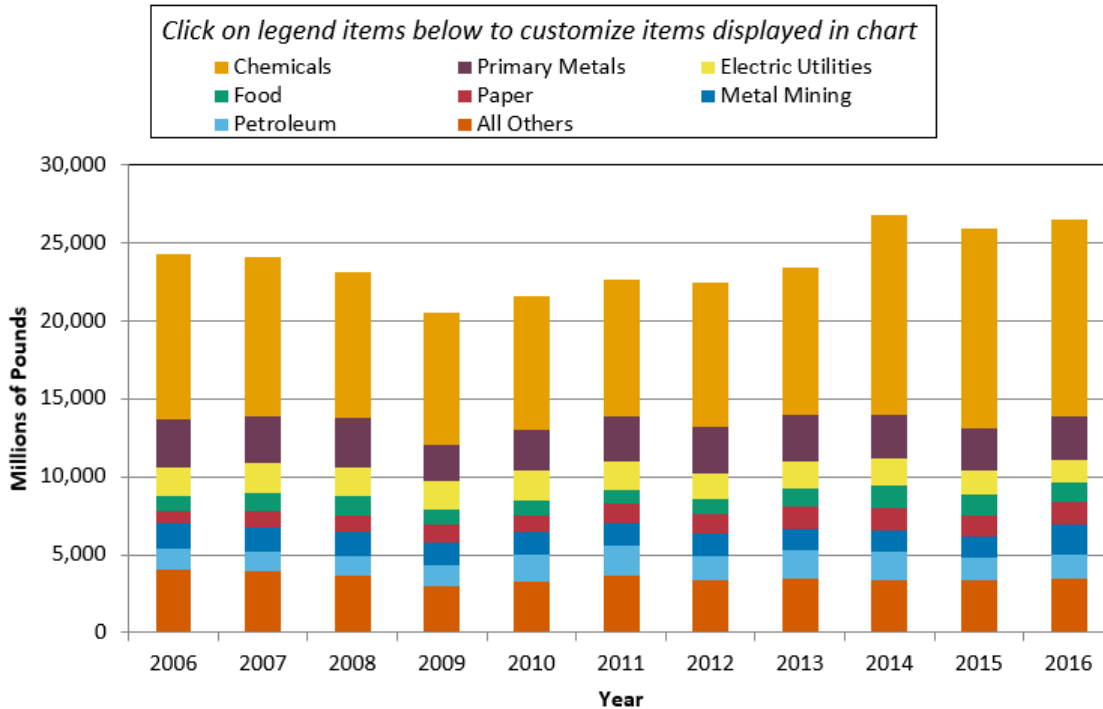
From 2015 to 2016:

- Facilities reported the greatest decreases in overall waste quantities for these chemicals:
 - Zinc and zinc compounds, decreased by 114 million pounds (-10%)
 - Copper and copper compounds, decreased by 94 million pounds (-9%)
- Lead and lead compounds, increased by 316 million pounds (30%)

Production-Related Waste Managed by Industry

This figure shows the industry sectors that managed the most waste from 2006-2016.

Production-Related Waste Managed by Sector



From 2006 to 2016:

- The contribution of each of the top sectors to production-related waste managed has remained relatively constant since 2006.
- Of the sectors shown in the graph, five increased their quantity of waste managed:
 - Chemicals increased by 2.1 billion pounds (20%)
 - Food increased by 664 million pounds (89%)
 - Petroleum increased by 312 million pounds (33%)
 - Paper increased by 281 million pounds (18%)
 - Metal Mining increased by 252 million pounds (18%)
- The quantity of waste generated in some industries fluctuates considerably from year to year, due to changes in production or other factors (e.g., quantities reported by metal

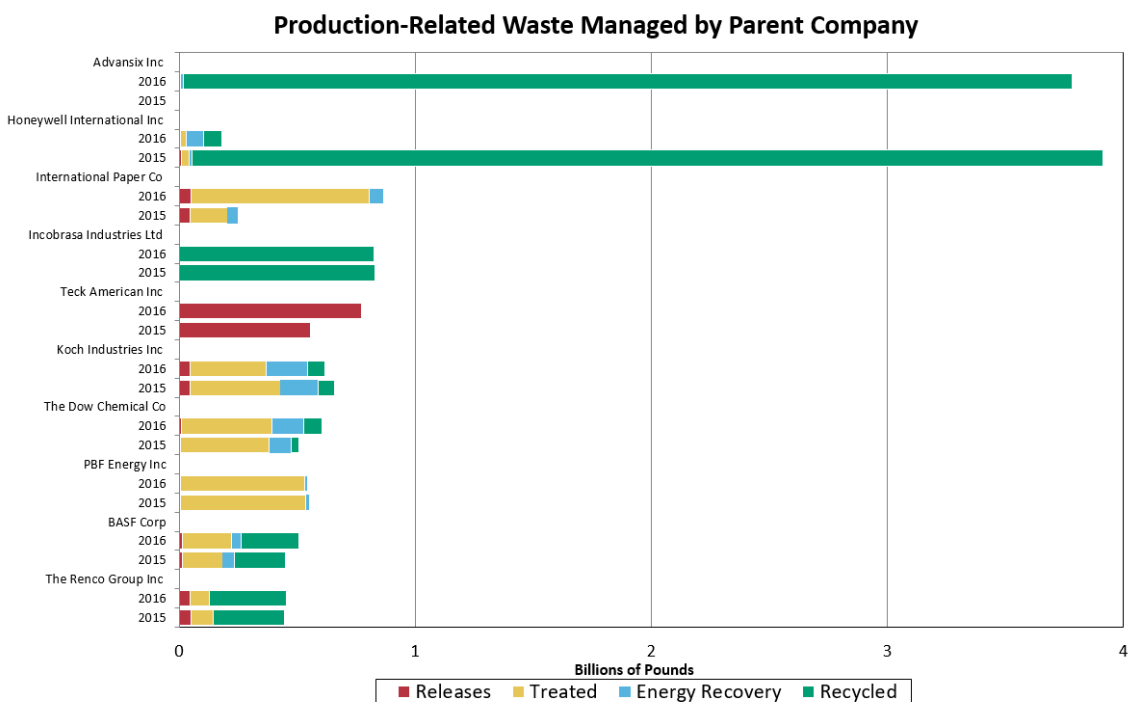
mining facilities can change significantly based on changes in the composition of waste rock).

From 2015 to 2016:

- Industry sectors with the greatest reported changes in overall waste quantities are:
 - Paper increased by 521 million pounds (38%)
 - Metal Mining increased by 248 million pounds (18%)

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 for 2015 - 2016. 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) For TRI reporting, the parent company is the highest-level U.S. company which directly owns at least 50% of the voting stock of the company. This figure uses EPA's standardized parent name. 2) To view facility counts by parent in 2015 or 2016, 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) In 2016, Honeywell spun-off its resins and chemicals business into a separate company named AdvanSix Inc. Production-related waste associated with these operations appear in the graph under the parent company Honeywell in 2015 and under the parent AdvanSix Inc in 2016.

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

- Chemical manufacturing: AdvanSix Inc, Honeywell International, Dow Chemical, BASF
- Paper: International Paper
- Soybean processing: Incobrasa
- Metal mining: Teck American
- Multiple sectors, e.g. pulp and paper, petroleum refining, and chemicals: Koch Industries

- Petroleum refining: PBF Energy
- Metal Smelting: The Renco Group

The quantity reported by AdvanSix for 2016 can be ascribed primarily to cumene recycling at a facility that was owned by Honeywell International in 2015. This facility uses cumene as a feedstock to manufacture phenol, a widely used TRI-covered chemical that is produced in very large quantities. This facility is among the largest manufacturers of phenol in North America and has implemented a number of steps to increase its recovery and recycling of cumene.

Most of these top parent companies reported implementing one or more new source reduction activities in 2016. Some of these companies also reported additional (optional) information to TRI about their pollution prevention or waste management activities.

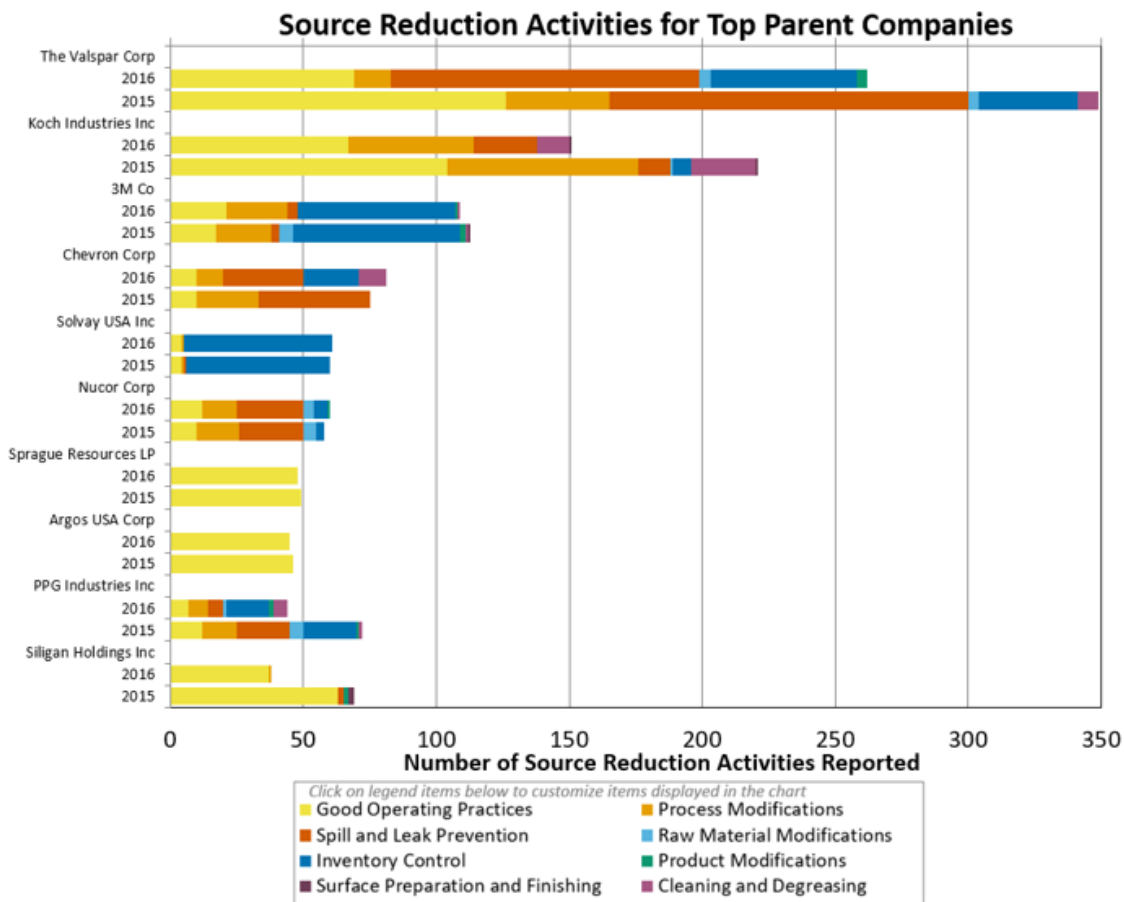
Examples of additional pollution prevention-related information for 2016:

- An International Paper facility implemented a comprehensive chemical screening program for new products purchased or used on the site to help minimize or eliminate the use of lead and other PBTs when suitable alternatives are available. [[Click to view facility details in the Pollution Prevention \(P2\) Tool](#)]
- A Dow Chemical facility instituted a clearinghouse to exchange materials that would otherwise be discarded and utilizes a program to allow employees to take product that would otherwise be discarded to minimize the release of diisocyanates. [[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 for 2015 - 2016. The number of source reduction activities reported in 2015 is also shown for reference.



Notes: 1) For TRI reporting, the parent company is the highest level U.S. company which directly owns at least 50% of the voting stock of the company. This figure uses EPA's standardized parent company names. 2) Facilities report their source reduction activities by selected 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 3) To view facility counts by parent in 2015 or 2016, mouse over the bar graph.

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

- Chemical manufacturing sector: Valspar, 3M, Solvay, PPG Industries
- Multiple sectors, e.g. pulp and paper, petroleum refining, and chemicals: Koch Industries

- Multiple petroleum-related sectors, e.g. petroleum refining, bulk petroleum, chemicals: Chevron
- Steel manufacturing: Nucor
- Bulk petroleum industry (store and distribute crude petroleum and petroleum products): Sprague Resources
- Cement manufacturing: Argos
- Metal containers: Silgan Holdings

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 text to EPA with their TRI reports describing their pollution prevention or waste management activities.

Examples of additional pollution prevention-related information for 2016:

- A 3M facility reduced releases of numerous chemicals by sequencing changeovers to reduce the need to perform a clean-up. This reduces the amount of cleaning solution used in the processes as well as waste generated. More processes in the plant have started using this technique. [[Click to view facility details in the Pollution Prevention \(P2\) Tool](#)]
- A Koch Industries paperboard facility modified a recovery boiler from bark burning to natural gas and no longer burns bark at the facility. [[Click to view facility details in the P2 Tool](#)]
- PPG Industries chemists are reformulating products to eliminate lead. The process will take multiple years as customers will need to approve the changes. [[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.](#)



Transfers Off-site for Waste Management

Toxics Release Inventory (TRI) facilities report the quantities of chemicals that they transfer off-site for waste management. Chemicals may be sent off-site for treatment, recycling, energy recover, or disposal. Use the interactive tool to explore where TRI chemicals in waste were sent in 2016, and explore off-site transfers for any chemical or sector of interest.