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FRAMEWORK ON THE ROLE OF POLLUTANT RELEASE AND TRANSFER REGISTERS (PRTRs) IN GLOBAL SUSTAINABILITY ANALYSES

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FRAMEWORK ON THE ROLE OF POLLUTANT RELEASE AND TRANSFER REGISTERS (PRTRs) IN GLOBAL SUSTAINABILITY ANALYSES

IOMC
INTER-ORGANIZATION PROGRAMME FOR THE SOUND MANAGEMENT OF CHEMICALS
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FOREWORD

Pollutant Release and Transfer Registers (PRTRs) have been established throughout the world to track emissions and other waste management quantities (e.g. quantities recycled or used for energy recovery) of potentially harmful chemicals. PRTRs are practical and powerful pollution prevention tools. Many countries have either established their own PRTR or started a pilot PRTR, and many more countries plan to implement their own PRTRs in the coming years. Since the 1990s, the OECD has been supporting the design and implementation of PRTRs through the development of guidance documents and manuals.

As a result of the ever increasing emphasis on sustainability as an international priority, there is a growing need to evaluate progress towards reducing emissions and other waste management quantities of harmful chemicals at the global level, not just at the country-specific, regional, or continental levels. Hence, more attention is being placed on the use of information collected and made available by PRTRs to assess progress towards pollution prevention and worldwide sustainability.

While demands on the use of information collected and made available by PRTRs to assess progress towards sustainability are growing, there is little documentation on how PRTR data can be used as a tool within the realm of sustainability. In fact, the term “PRTR” is rarely associated or used with the terms “sustainability” or “sustainable development” in the same publications.

To this end, the OECD Working Group on PRTRs (former Task Force on PRTRs) agreed at its 15th meeting (held in 2011) to pursue the development of a framework that defines the role of PRTRs in sustainable development, and illustrates how PRTR data and information can be used to assess progress towards global sustainability. This work was led by the United States.

This document is the above-mentioned framework. This document was prepared by the United States Environmental Protection Agency (US EPA), with the support of Rebecca Fink, Cheryl Keenan, and Lawrence Reichle of Abt Associates, located in Cambridge, Massachusetts, United States of America. The US EPA would like to acknowledge the tremendous efforts of these individuals, and the enormously valuable input put forth by the members of the OECD Working Group on PRTRs throughout the development of this document. The final draft version of the document was approved by the Working Group on PRTRs in December2016.

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ABBREVIATIONS

ANZSIC	Australian and New Zealand Standard Industrial Classification
CAS Number	Chemical Abstracts Service number
CEC	Commission for Environmental Cooperation
CEPA	Canadian Environmental Protection Act
EU	European Union
EEA	European Environment Agency
E-PRTR	European Pollutant Release and Transfer Register (also known as EU PRTR)
GDP	Gross Domestic Product
Hg	Mercury
ISIC	International Standard Industrial Classification of All Economic Activities
kg	Kilogram
Mfg.	Manufacturing
MW	Megawatt
MWh	Megawatt-hour
NAICS	North American Industry Classification System
N.E.C.	Not Elsewhere Classified
NGO	Non-Governmental Organisation
NPI	National Pollutant Inventory (Australia)
NPRI	National Pollutant Release Inventory (Canada)
OECD	Organisation for Economic Co-Operation and Development
P2	Pollution Prevention
PBT	Persistent, Bioaccumulative and Toxic
POTW	Publicly Owned Treatment Works
PRTR	Pollutant Release and Transfer Register

RCRA	Resource Conservation and Recovery Act
RETC	Registro de Emisiones y Transferencia de Contaminantes (Pollutant Release and Transfer Register) (Mexico)
RSEI	Risk-Screening Environmental Indicators model
SDGs	Sustainable Development Goals
SI	Système International (International System of Units)
SLAB	Spent Lead-acid Batteries
TRI	Toxics Release Inventory (U.S.)
U.S.	United States
U.S. EPA	United States Environmental Protection Agency
UNECE	United Nations Economic Commission for Europe
WHO	World Health Organisation
WWAP	United Nations World Water Assessment Programme

EXECUTIVE SUMMARY

Introduction

A Pollutant Release and Transfer Register (PRTR) is an inventory of data and other information submitted by facilities on the amount of toxic chemicals they released on-site to air, water, and land; recycled; burned for energy recovery; and transferred off-site for recycling, energy recovery, treatment, or disposal. Often PRTRs also collect information on facilities' pollution prevention-related activities, making these inventories powerful tools as a source of pollution prevention information. Among the most important applications of PRTRs is their use to inform decisions, gain insight, identify opportunities, and assess progress related to sustainability. Although sustainability is a global issue, most applications of PRTR data use information from a single PRTR system and are limited to a national or subnational scale.

In recent years, several organisations have been working to promote the harmonisation of different PRTR datasets for use in international-scale analysis. This report builds upon these efforts by providing a framework for using PRTR data to assess and promote progress in global sustainability. The framework highlights opportunities for using PRTR data for international-scale sustainability analyses, presents limitations and factors to consider in international-scale applications of PRTR data, and discusses improving harmonisation of PRTR data to facilitate international-scale analyses.

Opportunities for using PRTR data in global sustainability analyses

PRTRs contain a wealth of information applicable to sustainability analysis. With this information, it is possible to identify: 1) chemicals that are being released from facilities to the environment; 2) sources of chemical releases; 3) the specific locations of those sources; and 4) patterns in release and transfer quantities of chemicals. Also, PRTR information enables comparison and evaluation of pollution prevention activities implemented by facilities, parent companies or industry sectors, and the environmental impact of such practices. In addition, combining data from multiple PRTRs allows for the possibility of conducting analyses at an international scale.

The potential global sustainability analyses using PRTR data presented in this framework illustrate how PRTR data might be used to;

1) evaluate global trends,
2) evaluate impacts of environmental policies and programmes,
3) gain insight into human and ecosystem health issues,
4) characterize transboundary movements of wastes,
5) identify pollution prevention opportunities, and
6) review environmental performance and efficiency.

In addition, there are three UN Sustainable Development Goals (SDGs) where PRTR data are directly relevant to measuring progress and several other SDGs where PRTR data may also prove to be useful in measuring progress. The potential applications of PRTR data are presented to assess progress toward SDGs.

Limitations of PRTR data in global sustainability analyses

PRTR data are useful for a broad range of applications but, as with all information sources, PRTRs have limitations. Some limitations are related to the scope of information collected by PRTRs. For example, not all facilities that release and transfer chemicals report to PRTRs, and not all chemicals are reported to PRTRs. In addition, differences among PRTRs in chemical coverage, industry sector coverage (facility universe), reported data, timeframe, and format of published data complicate comparison and integration of PRTR data in international-scale analyses. Information from other data sources will be needed to fill in data gaps and provide context to facilitate interpretation of analyses involving PRTR information.

Limitations of using PRTR data may change in the future. PRTRs are dynamic; the application of PRTR data in global-scale analyses is expected to increase as the need to track progress in sustainable development at the global level increases.

Factors to Consider in analyses

When designing analyses, it is important to consider factors and techniques that facilitate international-scale analysis of PRTR data, such as:

- Focusing analyses on chemicals and sectors that are most consistently reported across PRTRs;
- Deciding whether to integrate PRTR data or conduct separate analogous analyses to compare patterns across PRTRs; and
- Considering whether data could be adjusted to improve data comparability among PRTRs (e.g., if PRTRs use different units of measure for quantitative values, converting data to consistent units using conversion factors).

Additional factors to consider for some of the potential global sustainability analyses highlighted in this framework include opportunities for combining PRTR data with data from other sources and considering a chemical comparability approach when global PRTR chemicals differ.

Recommendations: Improving Harmonisation for international-scale analyses

The use of PRTR data in international-scale analysis is complicated by differences among PRTRs. To meet the growing need for using PRTR data, it is recommended that countries consider taking steps to improve harmonisation of their PRTR data with other PRTR systems. International organisations are taking actions to improve harmonisation of PRTR data and facilitate international-scale sustainability analyses. These include designing key features of PRTR systems (e.g., reporting universe, release estimation techniques) to improve consistency among PRTRs. PRTR programs are also taking steps to enable harmonisation of PRTR data for international-scale analysis. Examples of such steps include developing compatible data systems for PRTR data collection, compilation, and storage; publishing key data elements and complete documentation so that PRTR data are available to international stakeholders; and developing reference materials to assist emerging and established PRTR programs in implementing actions that make their respective PRTR data more comparable with that of other PRTRs.

1 INTRODUCTION

1.1 Sustainability

In recent years, there has been an increased emphasis on global sustainability. Throughout the world, national governments are incorporating sustainable development into their planning and policies, local efforts are encouraging citizens to participate in sustainability programs (e.g., waste reduction), and businesses are developing sustainable products and processes (OECD, 2008a). Each of these efforts is a means to achieve a common goal, to meet "the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987).

Three key dimensions of sustainability include:

- **Economic sustainability:** Allows for strong and durable economic growth by preserving financial stability, a low and stable inflationary environment, and capacities to invest and innovate (OECD, 2001a).

- **Environmental sustainability:** Focuses on maintaining the integrity, productivity, and resilience of biological and physical systems, and preserving access to a healthy environment (OECD, 2001a).

- **Social sustainability:** Emphasizes the importance of high employment, of safety nets capable to adapt to major demographic and structural changes, of equity, and of democratic participation in decision making (OECD, 2001a).

These economic, environmental, and social dimensions of sustainability are interrelated, and there are often trade-offs among these dimensions (OECD, 2001a; OECD, 2008a). For example, increasing industrial activity may improve employment and social sustainability, but may require resource use that negatively impacts environmental sustainability. The strongest sustainable solutions consider the connections and interdependence between these dimensions and allow for long-term balance between the economy, the environment, and society (OECD, 2001a; OECD, 2008a).

1.2 The Importance of Addressing Sustainability on a Global Level

Economic, environmental, and social sustainability are global issues. National economies have become integrated on a global scale; during the 20th century, international trade and financial flows grew, and multinational enterprises increased in importance (OECD, 2001a). With better communication tools and falling transport costs, economic globalization continues to increase (OECD, 2008a). Environmental issues also span political borders (e.g., pollutants released in one location may be transported via air or water to another location; the health of migratory animal populations depends on environmental conditions in multiple locations). In addition, some of today's most important environmental challenges are global in scale (e.g., climate change) (OECD, 2001a). As a result, processes and policies that affect economic, environmental, or social sustainability in one nation can have impacts throughout the world (OECD, 2003a).

Sustainability requires developing in a way that benefits the widest possible range of sectors, across borders and between generations (OECD, 2008a). Decisions should consider potential impacts on society, the environment, and the economy, while keeping in mind that actions can have impacts elsewhere and in the future (OECD 2008a). Political will and co-operation on a global scale are necessary to establish coherent policies that support each other in moving towards sustainability (OECD 2008a).

The necessity of a global focus on sustainability was further emphasized in 2015 when the United Nations (UN) adopted an ambitious sustainability agenda called *Transforming Our World: The 2030 Agenda for Sustainable Development* (UN, 2015). This plan is comprised of a series of Sustainable Development Goals (SDGs) designed to "shift the world on to a sustainable and resilient path" over the next 15 years. To achieve the goals, the intention is that all countries and all stakeholders, acting in collaborative partnership, will implement the plan.

1.2.1 Need for Sustainability Analyses

Due to the global nature of sustainability issues and the interdependencies among economic, environmental, and social sustainability, it can be challenging to discern whether a practice is sustainable or how sustainability could be improved. Exploratory analyses can be performed to gain insight into the factors that influence the economy, society, and the environment and to identify opportunities to improve sustainability.

Available analytic tools relevant to sustainability include impact assessments and indicators:

- **Sustainability impact assessments** can be conducted to evaluate the long-term economic, social, and environmental impacts of policies and programs (OECD, 2010). Results from these assessments help inform policy makers' decisions on effective policies.

- **Indicators** can be developed to monitor and communicate progress towards sustainability goals (United Nations Economic Commission for Europe (UNECE) et al., 2008). Results from indicator analyses can be used to assess the current situation, make comparisons across geographic areas, and review trends over time.

1.2.2 Types of Industry Practices That Are Directed at Sustainability

Many industries are implementing sustainable practices to minimize negative environmental, economic, and societal impacts of their activities. Opportunities for improving the sustainability of industrial practices include:

- Reducing use and emissions of toxic chemicals or other pollutants, through:

    - **Green chemistry/sustainable chemistry,** the design, manufacture and use of efficient, effective, safe, and more environmentally benign chemical products and processes (OECD, 2014a).

    - **Green engineering:** designing processes that use safe inputs, prevent waste generation, and avoid depletion of natural resources and engineering processes and products using systems analysis, environmental impact assessment tools, and life-cycle thinking (U.S. EPA, 2014a).

- **Reducing energy consumption** by improving energy management and energy efficiency, and by fostering innovation to develop green energy technologies (OECD, 2012).

- **Reducing use of water** by improving water use efficiency through technological innovation, water management practices, and conversion of wastewater streams into useful inputs for industrial processes (WWAP, 2012).

- **Reducing the use of non-renewable materials** through greater and more efficient utilisation of renewable resources (e.g., feedstocks) (OECD, 2001b).

1.3 Pollutant Release and Transfer Registries (PRTRs)

A Pollutant Release and Transfer Register (PRTR) is a system to collect and disseminate information on environmental releases and transfers of toxic chemicals from industrial and other facilities, usually annually. In addition to facility releases, many collect pollution prevention-related information on the toxic chemicals, and some PRTR systems include estimates of releases from diffuse sources (e.g., from vehicles or agriculture). Through the PRTR, the public can access these data to learn of the chemicals that are being released, where, how much, and by whom.

PRTRs differ from other types of pollutant inventories in that their data are self-reported, multimedia in scope, and publicly available:

- **Self-reported:** When reporting PRTR data, facilities must review the chemicals present in their industrial processes and determine the quantities they release and transfer off-site. Through this process, facilities can recognize their own contributions to global emissions.

- **Multimedia:** PRTRs include measures of pollutant emissions to air, water, and land as well as off-site waste transfers. With this information, it is possible to use a single data source to consider the impacts of chemical releases across environmental media.

- **Public:** PRTR data are made publicly available. Therefore, it may be used by any interested party, including communities, governments, industry, non-governmental organisations (NGOs), the news media, and academics. These stakeholders use PRTR data for a broad range of applications. For example,

    - **The public and NGOs** use PRTR data to learn about the sources and potential effects of pollution in communities, partner with industry and government to improve facility performance and government policies, and evaluate environmental justice issues.

    - **Industry** uses PRTR data to investigate sources of pollution, identify opportunities for pollution prevention (e.g., in the United States, using the Toxics Release Inventory (TRI) Pollution Prevention Search Tool (U.S. EPA, 2014c)), identify opportunities for cost reductions, disclose environmental data to the public, compare their organisation's environmental performance with that of other industrial organisations, and incorporate plant level release and transfer data into their Environmental Management Systems.

    - **Government agencies** use PRTR data to assess regulatory compliance, inform development of policies and regulations, evaluate environmental programs, perform risk assessments, educate the public, and bring about environmental awareness and improvements.

    - **The investment community** uses PRTR data to assess and track environmental performance of companies.

- **Academic research institutions** use PRTR data in classrooms and to perform research (OECD, 2005a).

1.3.1 PRTR Data and Sustainability

Among the most important applications of PRTRs is their use to inform decisions, gain insight, identify opportunities, and assess progress related to sustainability. PRTRs are a powerful tool for promoting pollution prevention; they can be used to identify opportunities for improving the environmental performance of industrial practices and encourage the minimization of pollutant releases and waste disposal, or even prevent pollution at its source. In addition, PRTR data can be applied in benchmarking and trend analyses to identify opportunities for pollution prevention at facilities and corporations and within industrial sectors covered by PRTRs (OECD, 2013a). PRTR data can also be applied to assess sustainability impacts of policies and programs; to measure progress towards sustainability goals; to understand the current state of the economy, society, and the environment; and to explore factors that influence sustainability.

The 1996 Recommendation of the Council on Implementing Pollutant Release and Transfer Registers [C(96)41/FINAL] amended on 28 May 2003 [C(2003)87] recommends that member countries establish PRTRs and take into account a set of principles concerning establishment of PRTR systems. Two of these principles highlight the importance of PRTR data for analysis related to sustainability:

- PRTR systems should provide data to support the identification and assessment of possible risks to humans and the environment by identifying sources and amounts of potentially harmful releases and transfers to all environmental media.

- The PRTR data should be used to promote prevention of pollution at source (e.g., by encouraging implementation of cleaner technologies). National governments might use PRTR data to evaluate the progress of environmental policies and to assess to what extent national environmental goals are or can be achieved.

(Source: OECD, 2003b)

Current examples of PRTR data use related to sustainability include:

- **Evaluating environmental programs and policies** (e.g., data from the U.S. TRI have been used to track progress made towards national goals under the U.S. EPA's National Waste Minimization Program).

- **Investigating relationships between toxic chemical releases and public health** (e.g., data from the European Pollutant Release and Transfer Register (E-PRTR) have been used to explore relationships between industrial pollution and cancer mortality) (Ramis et al., 2012; Fernández-Navarroa et al., 2012).

- **Reviewing corporate environmental performance** (e.g., data from Australia's National Pollutant Inventory (NPI) have been used to review companies' initiatives to reduce pollutant emissions) (Australian Government Department of the Environment, 2014a).

- **Performing community outreach** (e.g., the Commission for Environmental Cooperation (CEC) works with communities to use North American PRTR data to support community environmental health and green economy initiatives) (OECD, 2013a).

- **Developing environmental indicators** (e.g., air release data from Canada's National Pollutant Release Inventory (NPRI) are incorporated into Canadian Environmental Sustainability Indicators that measure the progress of the Federal Sustainable Development Strategy, report on the state of the environment, and describe progress on key environmental sustainability issues) (OECD, 2013a; Environment Canada, 2014a).

- **Identifying successful pollution prevention practices** (e.g., by using an online pollution prevention (P2) Search Tool (U.S. EPA, 2014c), users can identify effective pollution prevention practices corresponding with measurable decreases in toxic chemical releases).

1.3.2 Current Activities for Using PRTR Data at Continental or Regional Levels

Although PRTR data are commonly used for applications related to sustainability, it is currently uncommon for PRTR data to be used to assess and promote sustainability at a global level. Today, most applications of PRTR data use information from a single PRTR system and are limited to a national or subnational scale.

In recent years, several organisations have been working to promote the harmonisation of PRTR data for use in international-scale analysis. Efforts to enhance the use of PRTR data at a regional or global scale include:

- **Kiev Protocol on PRTRs** (UNECE, 2011). The Kiev Protocol promotes the use of PRTR data on an international scale in that it sets minimum, consistent PRTR requirements for all Parties, resulting in harmonisation of the Parties' PRTRs. The Protocol sets minimum requirements for PRTRs including the chemicals reported (86 chemicals are identified in the Protocol), the sectors reporting, how often reporting occurs, and how data are disseminated. The Protocol also requires its Parties to strive to achieve convergence among PRTRs. Adopted as a protocol to the Aarhus Convention in 2003, the Protocol has been ratified by 34 countries and the European Union as of May 2016.

- **E-PRTR** (EEA, 2012). The European Pollutant Release and Transfer Register (E-PRTR) combines PRTR data from the 27 EU Member States as well as Iceland, Liechtenstein, Norway, Serbia, and Switzerland. Data are reported annually by individual facilities to the relevant authorities. The data are then provided to the European Commission and the European Environment Agency (EEA) for compilation and dissemination on the E-PRTR website.

- **Taking Stock Online** (CEC, 2013a). The Commission for Environmental Cooperation (CEC) combines PRTR data from Canada's NPRI, Mexico's Registro de Emisiones y Transferencia de Contaminantes (RETC), and the United States' TRI to create the North American PRTR database. These data are available online through the CEC's Taking Stock Online Tool, which provides summary charts and enables custom analytical queries and downloads, so that users may explore information on pollution from industrial facilities within and across North America.

- **OECD Centre for PRTR Data** (OECD, 2013b). The OECD's Working Group on PRTRs developed the Centre for PRTR Data to share PRTR data as widely as possible within the OECD area. It includes PRTR data from 39 countries compiled on a national or regional level. Users can create a report of PRTR data according to years, countries, regions, industry sectors, chemicals, types of release sources, and types of releases and transfers.

- **Action Plan to Enhance the Comparability of Pollution Release and Transfer Registers** (CEC, 2014 update). This CEC Action Plan puts forth recommendations to enhance the comparability of North American countries' PRTR data. It serves as a framework for the countries to address differences between the national PRTR programs and to take steps to increase comparability and integration of PRTR data collected by Canada, Mexico, and the United States.

- Other Activities Undertaken by OECD's Working Group on PRTRs:

  - **Harmonised List of Pollutants and Harmonised List of Industry Sectors.** In an effort to improve the consistency of chemical and reporting (industry) sectors' coverage among PRTRs, OECD compared chemical and reporting sector coverage among five national and regional PRTR systems[1] and the UNECE Kiev Protocol on PRTRs. Two documents were developed outlining results from the comparison. The first document compares covered chemicals and their reporting thresholds among PRTRs, and proposes a harmonised list of chemicals (OECD, 2014b). The second document compares covered reporting sectors and their reporting thresholds among PRTRs and proposes a harmonised list of sectors (OECD, 2013c).

  - **Guidance Document on Elements of a PRTR** (OECD, 2014c; OECD, 2015). OECD developed a *Guidance Document on Elements of a PRTR* that outlines the design of a PRTR, and focuses on common elements among different PRTRs. This guidance document is composed of two parts; Part I provides elements that may be included in the design of a PRTR, and Part II focuses on PRTR initiation, operation, and long term success. This document serves as a framework from which emerging or future PRTRs can be designed so that the data collected are harmonisable with data collected from other PRTRs.

  - **Resource Compendium for Release Estimation Techniques** (OECD, 2003c; OECD, 2005b; OECD, 2011; OECD, 2013d). OECD has developed a compendium of technical documents that provide governments, industry, and other interested parties with information and practical guidance for identifying, selecting, and applying different techniques for estimating pollutant release quantities from point and diffuse sources, and quantities that are transferred, released or disposed.

1.3.3 Structure of the document

This report builds upon the above mentioned efforts and materials to expand the use of PRTR data on an international scale by providing a framework on how PRTR data and information can be used to assess and promote progress in global sustainability. Its contents are organised as follows:

- **Chapter 2** reviews opportunities for using PRTR data in international-scale sustainability analyses.

- **Chapter 3** presents limitations of PRTR data relevant to assessing and promoting progress in global sustainability.

[1] Australia's NPI (National Pollutant Inventory), Canada's NPRI (National Pollutant Release Inventory), the EU's E-PRTR (European Pollutant Release and Transfer Register), Japan's PRTR (Pollutant Release and Transfer Register), and the U.S.'s TRI (Toxics Release Inventory).

- **Chapter 4** discusses factors to consider when designing, conducting, and interpreting analyses of PRTR data related to sustainability.

- **Chapter 5** highlights opportunities for improving harmonisation of PRTR to facilitate global-scale analyses.

In addition, resources for sustainability analyses (Annex A) and a case study on a multinational PRTR analysis (Annex B) are provided. Annex C demonstrates how PRTR data can be used to assess implementation of pollution prevention practices in an industry sector.

2 OPPORTUNITIES FOR USING PRTR DATA IN SUSTAINABILITY ANALYSES

2.1 Introduction

This Chapter presents opportunities for using PRTR data in international-scale analyses of environmental, economic, and social sustainability. It discusses PRTR data useful for sustainability analysis and lists potential international-scale analyses of PRTR data that might be conducted to inform decisions, gain insight, identify opportunities, and assess progress related to sustainability. Note that like any dataset, PRTR data are limited in scope of application. These limitations are discussed in Chapter 3.

2.2 PRTR Data Useful for Sustainability Analysis

2.2.1 Key PRTR Data

Key data elements that are useful in sustainability analyses and are found in most PRTRs include:

- Facility identification (name, address)
- Industry classification
- Chemical identification (CAS number, chemical name)
- Releases by environmental media (air, water, and land)
- Transfers off-site for waste management, including disposal or other releases (OECD, 2014c).

With this information, it is possible to identify which PRTR chemicals are being released to the environment, identify sources of PRTR chemical releases, pinpoint the locations of those sources, review patterns in release and transfer quantities, and compare or evaluate industrial sectors.

2.2.2 Additional Data under PRTR system

Many PRTRs require or encourage submission of additional information from reporting facilities that are relevant to sustainability. For example, a PRTR may contain details on the following:

- Waste management details (e.g., recycling, treatment)
- Pollution prevention and source reduction activities
- Production information
- Quantities of chemicals manufactured, processed, and used at the facility
- Quantities of chemicals incorporated into products

- Reasons for changes in quantities reported (e.g., production changes, calculation method changes, pollution prevention)

- Freeform text (e.g., optional additional information about pollution prevention activities, public statements) (OECD, 2014c).

This information provides a contextual basis for interpreting patterns in PRTR release and transfer data. For example, production information can be used to determine whether a decrease in releases at a facility indicates improved environmental performance or is merely the result of a decrease in production. These additional data may also provide a more complete picture of industrial facilities' impacts, including downstream releases from products and off-site waste management activities.

2.2.3 Other Available Information

For some analyses, opportunities may exist where PRTR data can be combined with data from other sources (e.g., demographic information; ambient conditions, health indicators, economic trends) to further analyse aspects of sustainability. Utilizing data with data from other sources, along with PRTR data, can be particularly useful for economic and social sustainability analyses. Non-PRTR data can help tie PRTR data to social issues relevant to the communities surrounding industrial facilities and to economic issues relevant to industrial facilities, their investors, and consumers of their products. Non-PRTR data can also be used to provide a more complete picture of releases with supplementary data on emissions from sources beyond the scope of a given PRTR. For example, Norway's PRTR provides information on emissions from industry as well as from activities that are not typically covered in a PRTR such as transportation and agriculture.

2.3 Global-Scale Sustainability Analyses and Case Studies

This section presents potential analyses that use PRTR data to evaluate and promote progress in global sustainability. As PRTRs primarily contain environmental data, the majority of these potential analyses are relevant to environmental sustainability. PRTR data can also be used for analyses relevant to social and economic issues; examples of potential analyses described herein pertain to social sustainability (e.g., analyses of environmental justice and human health) or economic sustainability (e.g., analyses estimating economic costs and benefits; analyses for informing consumers and investors).

Other potential analyses discussed here focus on using PRTR data to address or understand sustainability issues at a global level. Some use PRTR data from multiple countries to gain insight at the national or local level, so that local sustainability efforts can contribute to global sustainability.

The potential analyses presented in this section are grouped into the following categories based on their anticipated outcomes:

1) Evaluate Global Trends

2) Evaluate Impacts of Environmental Policies and Programmes

3) Gain Insight into Human and Ecosystem Health Issues

4) Characterize Transboundary Movements of Wastes

5) Identify Pollution Prevention Opportunities

6) Review Environmental Performance and Efficiency.

The potential analyses are presented to illustrate the types of international-scale sustainability analyses that might be undertaken using PRTR data. The exact analytical methods, data sources, and resources used to conduct any one of the analyses would need to be determined by the analyst, who would consider the scope of the analysis, intended uses of analytical results, and the data available. Data availability may be a key limiting factor for conducting these analyse at present in some countries, although as PRTRs expand their scope as part of global PRTR harmonisation efforts, analyse that are not currently possible in some locations, may be feasible in the future.

Note that each of the potential analyses has associated limitations. For example, all analyses will be limited to the chemicals and sectors covered by PRTRs. Differences in the timeframes covered by each PRTR will affect the years that can be included in trend analyses. These limitations, potential impacts on analytical results, and possible adjustment to PRTR data for each analysis in the global sustainability framework are discussed further in Chapter 3. In addition, factors to consider in international-scale sustainability analyses of PRTR data are discussed in Chapter 4.

2.3.1 Evaluate Global Trends

Global-scale trends in releases, transfers, and other waste management quantities provide insight into progress made (or lack thereof) towards global sustainability goals for reducing pollution. Basic steps in evaluating global trends include:

i. *Review trends* in releases and transfers of PRTR covered chemicals totalled across all countries

ii. *Summarize* all PRTR reported releases and transfers or focus on a selected industry sector, chemical, chemical group (e.g., carcinogens, metals), or release media (e.g., air releases, water releases)

iii. *Compare trends* against trends in global economic measures (e.g., production, value added)

iv. *Conduct further research* to identify the factors driving the change in releases within countries (e.g., environmental policies, emerging technologies, changes in industry mix/production, outsourcing, economic factors, increased production within a country, change in industrial mix, changes in availability of fuels and raw materials).

Disaggregation of global-scale quantities by specific waste management practice may provide additional insight into progress made towards global sustainability goals. Review global trends in transfers of PRTR covered chemicals by waste management technique (e.g., disposal, recovery). Summarize all PRTR reported transfers or focus on a selected industry sector, chemical, or chemical group (e.g., carcinogens, greenhouse gases).

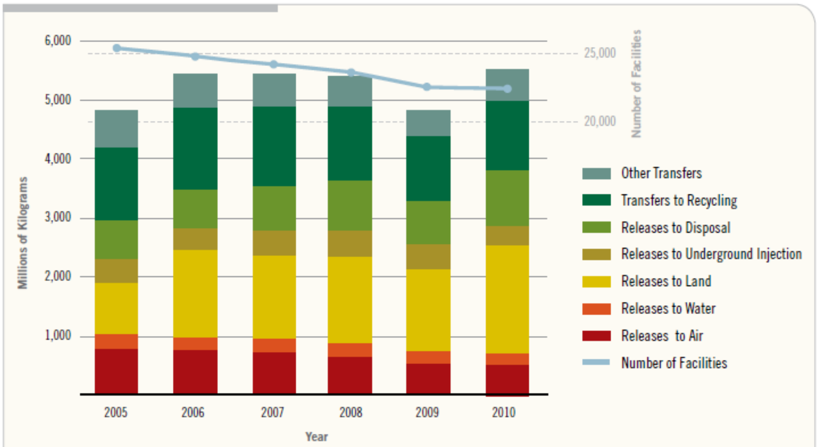
Indicators may be useful in planning, clarifying policy objectives, and setting priorities related to sustainability. Develop indicators that can be used to measure environmental performance and progress towards sustainability goals at an international or national level.[2] Indicators may include totals or averages of release and transfers of PRTR covered chemicals or comparisons of PRTR data against other available information (e.g., ratios between releases of PRTR covered chemicals and production levels).

[2] For resources on developing indicators, see Annex A.

Case Study – Aggregating Global Total Releases from North American PRTRs

This example from the CEC's Taking Stock (CEC, 2013a) takes a big picture look at trends of absolute (not adjusted for Gross Domestic Product (GDP)) releases of the United States, Canada, and Mexico between 2005 and 2010. High-level trend information can identify topics for further investigation. When aggregating large amounts of data such as these, it is important for the analyst to be cognizant of differences in reporting time periods between PRTRs, units (SI units vs. U.S. customary units), and differences in reporting thresholds, for example. In addition, certain PRTRs do not report recycling or treatment, which limits the ability to compare production-related waste among PRTRs.

Figure 1. Releases and Transfers Reported to the North American PRTRs, 2005-2010



	Total Releases and Transfers (kg)	Releases to Air (kg)	Releases to Water (kg)	Releases to Underground Injection (kg)	Releases to Land (kg)	Releases to Disposal (kg)	Transfers to Recycling (kg)	All Other Transfers (kg)
2005	4,833,498,433	807,172,052	234,003,770	412,296,802	866,151,548	653,288,663	1,259,727,734	600,652,254
2010	5,530,710,253	514,173,851	221,806,836	340,822,984	1,802,531,538	930,493,737	1,182,757,774	536,970,141
Difference	697,211,821	-292,998,200	-12,196,935	-71,473,819	936,379,989	277,205,074	-76,969,961	-63,682,114
Change (%)	14	-36	-5	-17	108	42	-6	-11

Source: (CEC, 2013a)

2.3.2 Evaluate Impacts of Environmental Policies and Programmes

Identifying and researching successful policies or programmes may help identify good practices for policy makers aiming to reduce release and other waste management quantities of toxic chemicals. Review changes in releases of PRTR covered chemicals at facilities subject to a policy or programme before and after its implementation to determine whether the policy or programme may have led to the reduced releases or other waste management quantities. Conduct further research to rule out confounding factors (e.g., changes in production at facilities resulting from changes in economic conditions).

Results from sustainability impact assessments may be used to inform decisions and strategic planning related to the policy or programme. Perform a sustainability impact assessment.[3] Depending on the policy or programme being assessed, PRTR data might be used to analyse economic impacts (e.g., reductions in

[3] For resources on sustainability impact assessments, see Annex A.

waste management costs), environmental impacts (e.g., improved air, water, or soil quality) or social impacts (e.g., reduced health risks associated with PRTR covered chemicals).

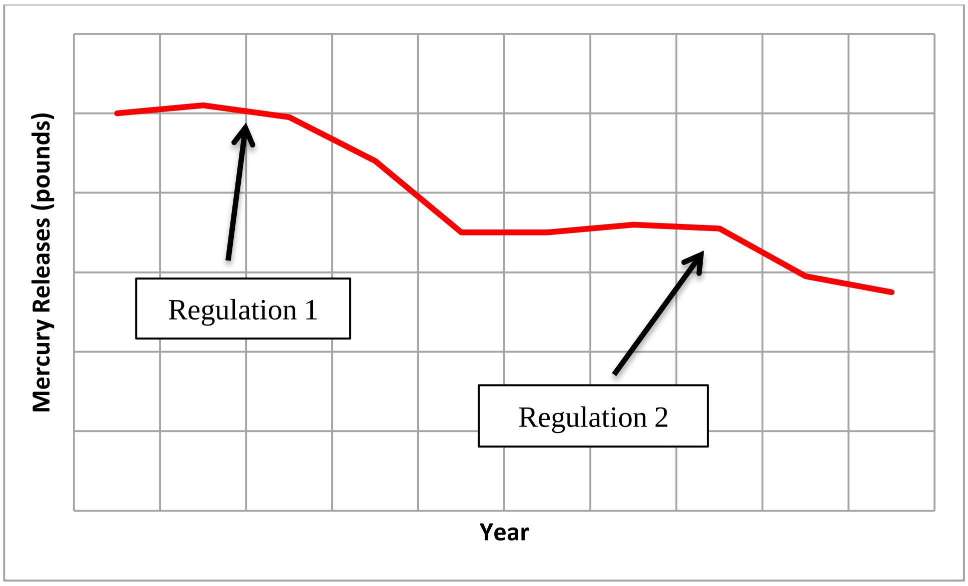
Results from cost-benefit analyses can inform policy and programme development. Perform a cost-benefit analysis[4] for a proposed policy or programme. How PRTR data may be used to estimate costs or benefits depends on the policy. Typical uses of PRTR data in cost-benefit analyses include identifying the universe of facilities that will incur costs under the policy and predicting the reductions in release and other waste management quantities of PRTR chemicals and the resultant human and ecosystem health benefits expected to be achieved under the policy. PRTR data might also be used to review cost reductions associated with moving away from toxic solvents or other listed compounds (i.e., reduced waste disposal costs, reduced purchasing of expensive solvents, reduced liability).

Knowledge of how releases compare among chemicals may be used to set priorities for environmental programmes. Identify PRTR covered chemicals with the highest toxicity-weighted releases, the highest toxicity-weighted releases in population-dense areas, or releases that are increasing on a global scale.

Case Study – Changes in Chemical Releases Influenced by Environmental Policy

In this hypothetical example, there have been two regulatory actions to lower point source emissions of mercury. While these rules were enacted to lower mercury emissions in the targeted sector, PRTR can be used to determine the impact of environmental policies on the emissions. If pursuing this type of analysis, be sure to note other national or international policies or GDP changes which may have an effect on the emissions.

Figure 2. Mercury Releases from the Targeted Sector



2.3.3 Gain Insight into Human and Ecosystem Health Issues

Research on changes in chemical releases of toxic chemicals from industrial facilities may be used to gain insight into changes in potential exposures of humans and ecological receptors (e.g., birds, fish) to the

4 For resources on cost-benefit analysis, see Annex A.

toxic chemicals and corresponding changes in risks and the identification of priority industries and chemicals for pollution prevention. Review trends in releases of PRTR covered chemicals to identify industrial sectors that have shifted to using chemicals with lower toxicity or ecotoxicity in their manufacturing processes. Conduct research to understand factors driving shifts to lower toxicity or ecotoxicity chemicals (e.g., environmental policies, availability and performance of material substitutes).

Patterns in population density may be considered when developing policies to limit residents' exposure to chemical releases from industrial facilities. Review population density in areas surrounding PRTR reporters to characterize the population that may have the greatest potential to be exposed to chemicals released from facilities. Identify industries typically located in population-dense areas and chemicals frequently released near people.

Relationships between releases and public health may be used to identify pollution prevention priorities. Assess whether associations exist between releases of PRTR covered chemicals from facilities with local measures of disease prevalence to evaluate potential health risks from industrial activity. Conduct further research to identify possible confounding factors (e.g., comorbidities, other emission sources).

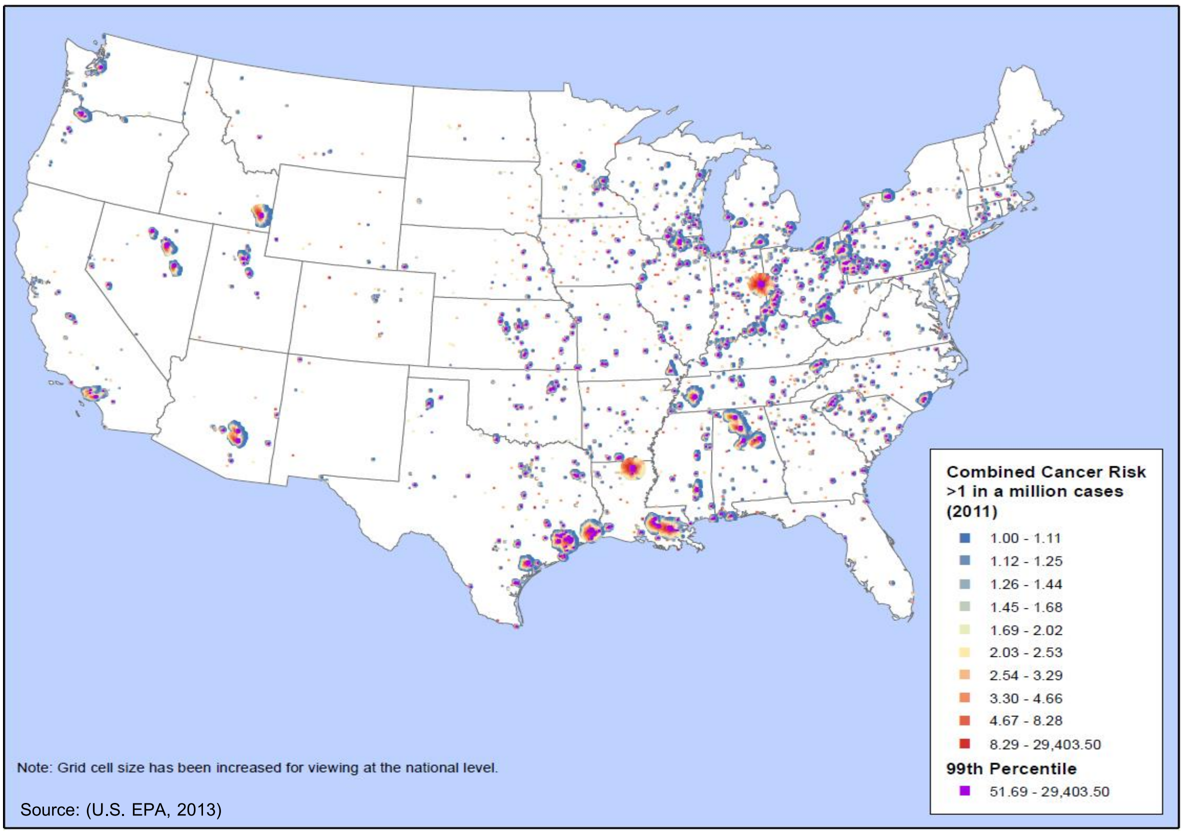
Results from risk assessments may be used to gain insight into the environmental performance characteristics of facilities, parent companies, or industry sectors, and to inform development of policies related to environmental health safety issues. Perform risk assessments[5] to evaluate the potential for adverse health effects from exposure to PRTR covered chemicals. PRTR data may be used to identify chemicals released in an area and possible exposure routes (e.g., air emissions of a chemical may indicate the potential for inhalation exposure). Data from additional sources will be needed to characterize and evaluate hazard and risk.

5 For resources on conducting risk assessments, see Annex A.

Case Study – Cancer Risk Screening in the United States Using TRI

The risk from air releases of carcinogens was mapped with EPA's Risk-Screening Environmental Indicators (RSEI) model using cancer toxicity weights and 2011 TRI data.

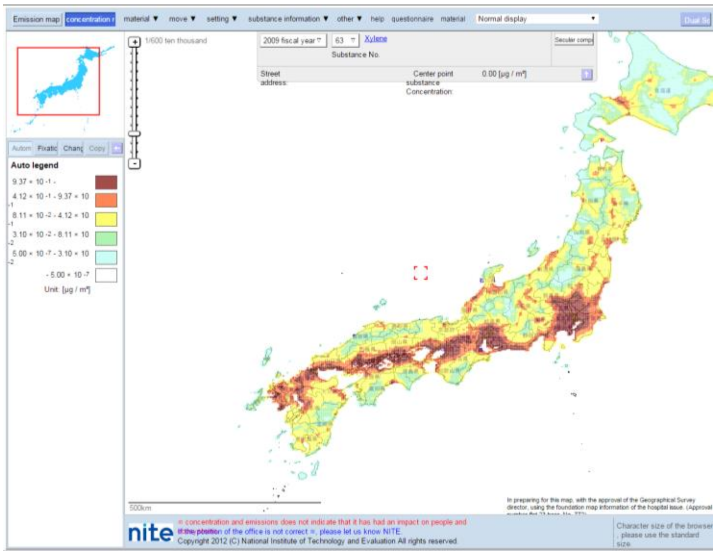
Figure 3. Combined Cancer Risk of TRI Releases in the U.S., 2011



Case Study – Visualizing Potential Exposure Based on Pollutant Concentrations and Population Density in Japan

Japan's National Institute of Technology and Evaluation (NITE) has created a PRTR map of emission concentrations from reporting sources (Government of Japan: National Institute of Technology and Evaluation, 2012). The atmospheric concentrations displayed in the figure below are the estimated annual average in a 5 x 5 km grid for xylene in 2009. Population density could be overlaid with this map, and chemical exposures could be considered to gain insight into human health.

Figure 4. Estimated Atmospheric Concentrations of Xylene in Japan, 2009



Source: (Government of Japan: National Institute of Technology and Evaluation, 2012)

2.3.4 Characterize Transboundary Movements of Wastes

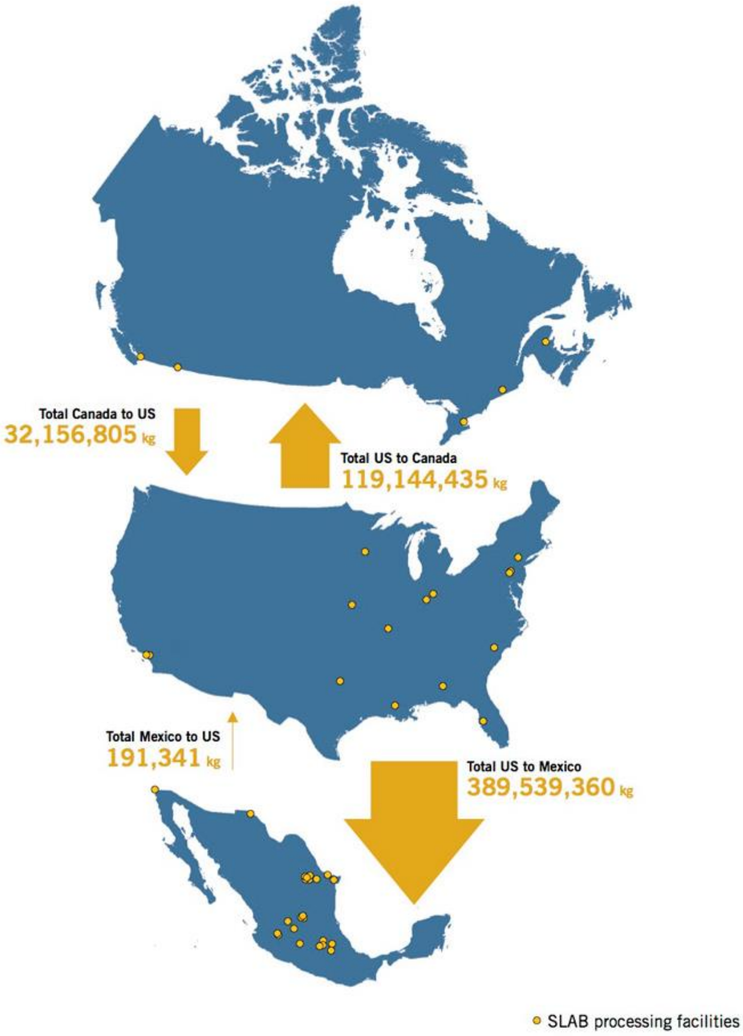
Research on transboundary movements of wastes may be used to inform decisions regarding waste management policy in countries receiving and transferring wastes. Identify hotspots for receiving transfers of PRTR covered chemicals (e.g., countries receiving transboundary movements of wastes, cities receiving domestic and transboundary movements of wastes). Conduct research to understand factors driving transfers of pollutants to these areas (e.g., better technologies for recycling or treating waste, less stringent waste management regulations, expense).

Identify the countries with the highest percentage of waste transfers of PRTR covered chemicals that are sent to locations outside the country. Conduct research to understand factors driving transfers of pollutants outside these countries (e.g., availability and expense of waste management within the country, opportunities for recycling or reuse of waste outside the country).

Case Study –Transborder Lead Battery Recycling in North America

In 2013, the North American Commission for Environmental Cooperation (CEC) released a report highlighting transboundary movements of wastes of lead between the U.S., Canada, and Mexico (CEC, 2013b). PRTRs from these countries were used to study trends in lead transfers between the countries. The figure displays a summary of the PRTR information CEC used in their report (CEC, 2013b).

Figure 5. North American Imports and Exports of Spent Lead-acid Batteries (SLABs), 2011



Source: (CEC, 2013b)

2.3.5 Identify Pollution Prevention Opportunities

Releases at facilities owned by multinational corporations can be reviewed to identify priority corporations for engagement; if facilities within a single corporation release a large portion of the releases by all facilities within an industry sector, it may be more efficient to engage with that single corporation than engaging with many smaller corporations in the sector. Identify corporations with the largest share of releases of PRTR covered chemicals in a sector by totalling releases across facilities owned by the corporation.

Lessons learned from researching corporations with decreasing releases may be used to identify opportunities for pollution prevention at similar corporations. Identify corporations in a sector with decreasing releases of PRTR covered chemicals or low releases relative to production. Conduct further analysis to identify the factors driving low releases (e.g., corporate policies, environmental policies in the locations where corporations do business, resources available to invest in more efficient technologies, availability of raw materials to corporations).

Results from comparisons of emerging, existing, and closed facilities may be used to inform policies concerning new industrial facilities. Identify emerging and closed facilities. Compare releases of PRTR covered chemicals per unit production at emerging facilities, existing facilities, and recently closed facilities to determine whether new facilities are more efficient than closed facilities. Also, compare releases per unit production of PRTR covered chemicals at emerging facilities against expected releases under the best available P2 technology to determine whether new facilities are implementing P2 practices. These comparisons should consider both PRTR data (e.g., releases from facilities) and data from other sources (e.g., production levels, efficiency of P2 technologies).

Studying how migration of industry among countries affects releases of chemicals in those countries may provide insight into drivers of country-level trends in releases. Identify migration of industry among countries using global economic data. Use PRTR data to review resulting changes in releases of PRTR covered chemicals.

Identifying the impacts of a chemical phase-out in one industry or country may inform programme and policy decisions regarding phase-out of the chemical in other industries or countries. Review changes in releases of PRTR covered chemicals in response to the phase-out of a chemical from an industrial process. Review changes in releases or other waste management quantities of the chemical at facilities that perform the process to monitor elimination of the chemical from the process. In addition, review chemicals with increasing releases and newly reported chemicals at these facilities to identify possible chemicals substitutions.

> The U.S. Environmental Protection Agency developed a public online P2 Search Tool (http://www2.epa.gov/toxics-release-inventory-tri-program/pollution-prevention-p2-and-tri) where users can search for the pollution prevention practices reported to TRI that have been implemented for a user-selected chemical and/or industry sector. Through the tool, users can find details on the most effective pollution prevention practices and see the impact of those practices on facilities' toxic chemical releases. If other countries make this type of tool available for their PRTRs, it will enhance the ability to identify and analyse pollution prevention information on a global scale (U.S. EPA 2014c).

Case Study – Has Pollution Prevention Led to Release Reductions in the Pharmaceutical Sector?

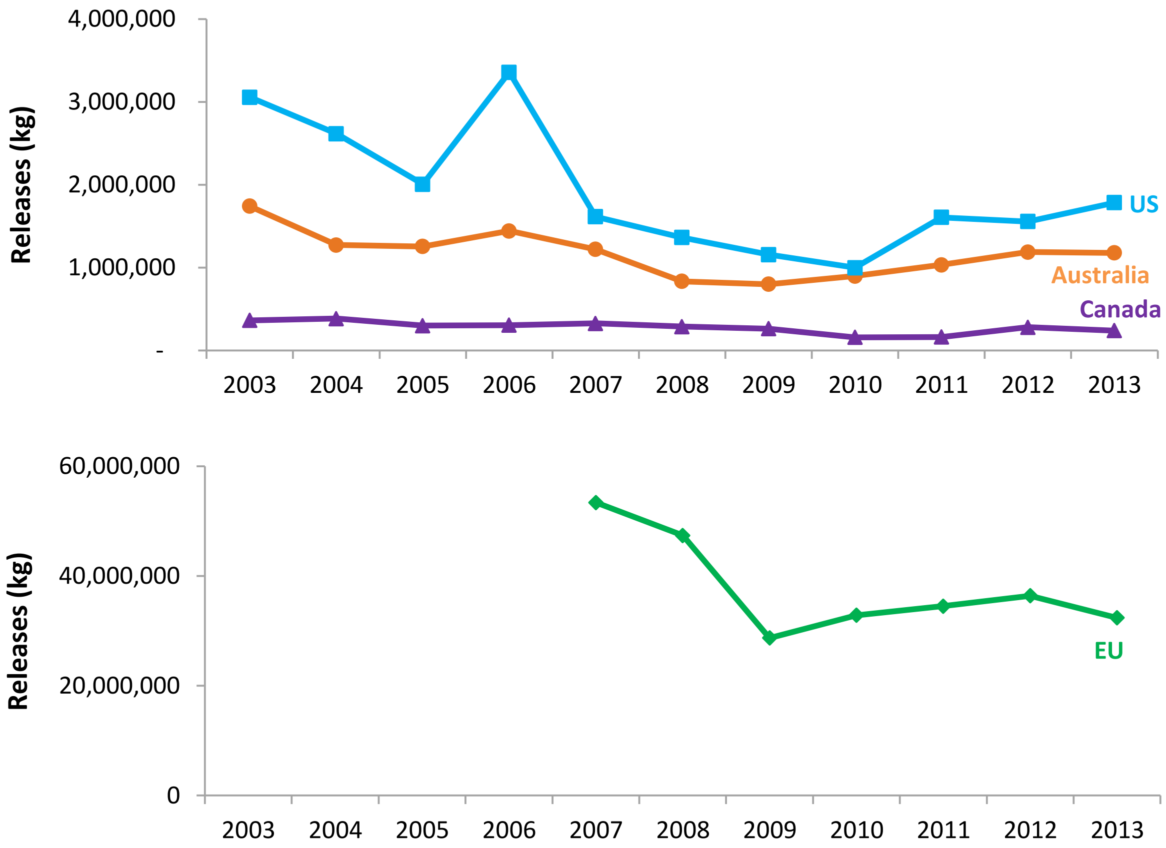
This analysis presents the trends in toxic chemical releases by facilities in the pharmaceutical sector including trends in reporting to their respective PRTR in the United States, Canada, Australia, and European Union (EU). Toxic chemical releases have declined in all countries over the time period examined, as shown in Figure 6. Note that data were limited to toxic chemicals only (e.g., GHG emissions were not included), and that the EU results are displayed on a separate graph because of differences in scale. Next, the PRTR data were used to examine what factors were driving the observed release reductions; *why* did these declines occur? Based on a literature review of the sector's actions to reduce releases, there was evidence that numerous pollution prevention activities, including advances in green chemistry, had been implemented. If facilities throughout the pharmaceutical sector had implemented pollution prevention activities focused on reducing toxic chemicals releases, as was indicated in the literature, these reductions should be apparent in the PRTR data.

The analysis investigated if indeed pollution prevention was a driver in the sector's declining releases by looking at the role of numerous other possible drivers. For example, one potential driver investigated was production levels. Decreased production can lead to decreases in releases, as less manufacturing requires less raw materials and results in reduced releases. To assess the impact of production levels on the releases trend, data on the annual value added for the pharmaceutical sector was compiled. Value added is a measure of the contribution of the sector to the country's Gross Domestic Product.

Figure 7 shows the value added for the sector, by country. Note that the value added data were not available at the sector level for a consistent timeframe for all countries. This illustrates the difficulty in identifying consistent, comparable data when performing multi-country analyses. While more comprehensive data on value added is required for a complete analysis, with the data available, it appears that production levels generally remained steady over the timeframe examined, and therefore production changes are not a driving factor in the pharmaceutical sector's reductions in releases of toxic chemicals.

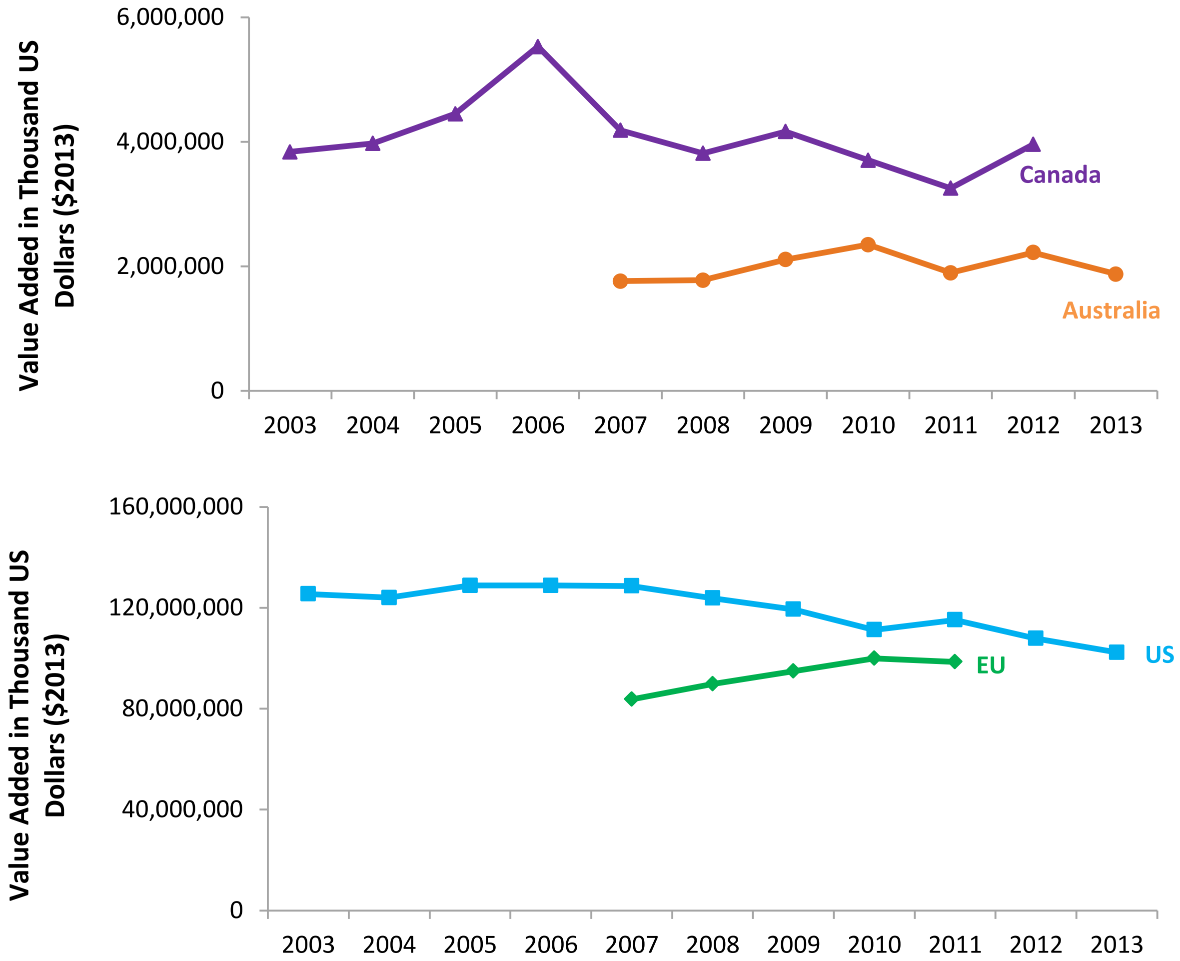
As noted previously, it is important to consider the limitations of this type of analysis, including varying reporting periods and requirements for each PRTR. For example, the U.S. TRI includes more toxic chemicals than the EU's E-PRTR (e.g., among key solvents used in the pharmaceutical sector, methanol is reported in all programs displayed below except E-PRTR). On the other hand, there are more pharmaceutical manufacturers in the EU than there are in the U.S. While differences in PRTR requirements mean that direct comparisons cannot be made between countries' PRTR data, the data can be used to investigate each country's trends over time for a better understanding of global trends. This analysis was completed for a single-country (U.S.) and indicated that pollution prevention played a significant role in the country's reduced toxic chemical releases from the pharmaceutical sector (DeVito et al., 2015).

Figure 6. PRTR Toxic Chemical Releases from the Pharmaceutical Sector



Sources: (U.S. EPA, 2014d) (Environment Canada, 2014b) (Australian Government Department of the Environment, 2014c) (EEA, 2012)

Figure 7. Economic Value Added for the Pharmaceutical Sector ($2013 USD)



Sources: (U.S. BEA, 2015) (U.S. Census Bureau, 2013) (Eurostat, 2014) (World Bank, 2015) (Statistics Canada, 2014) (ABS, 2014) (UNIDO, 2014)

2.3.6 Review Environmental Performance and Efficiency

Corporate environmental profiles may be developed to inform consumers and investors, whose choices can influence global corporations' efforts to improve environmental performance. For each country where the company of interest has operations, use the PRTR data to compile current or trend data on the releases and transfers for the individual facilities owned by the company. Compile the data across all countries where the company has operations to create a profile of the company's global environmental performance.

Evaluating the sustainability of environmentally friendly and traditional products can help inform consumers' choices, which in turn may influence corporations' environmental performance. Compare releases and transfers of PRTR covered chemicals per unit production between facilities that produce environmentally friendly products and those that produce traditional products.

Results from life cycle assessments may be used to identify opportunities for reducing environmental impacts associated with a product and to inform consumer and investor choices. Perform life cycle assessments for a product.[6] PRTR data may be used to estimate releases and waste generation of PRTR covered chemicals generated during raw material extraction, materials processing, and product manufacture. Data from other sources are needed for other aspects of the assessment (e.g., measuring energy use during product manufacture; measuring chemical releases during product use).

2.4 Using PRTR Data to Assess Progress toward Sustainable Development Goals

2.4.1 Sustainable Development Goals

In 2015, the United Nations (UN) published *Transforming Our World: The 2030 Agenda for Sustainable Development*[7]. This ambitious Agenda sets forth a plan to "shift the world on to a sustainable and resilient path" by setting 17 Sustainable Development Goals (SDGs) that encompass the economic, environmental, and social dimensions of sustainability. To achieve the goals, the intention is that all countries and all stakeholders, acting in collaborative partnership, will implement the plan. While the SDGs are far-reaching in scope, each one is supported by multiple associated targets that are more specific and actionable. For example, Goal 3 is stated as "Ensure healthy lives and promote well-being for all at all ages." While the Goal itself is broad, it is supported by nine associated targets that provide specific actions such as "By 2030, reduce the global maternal mortality to less than 70 per 100,000 live births."

As countries and stakeholders take action toward achieving the SDGs, the plan emphasizes that it will be necessary to measure progress toward the Goals. While recognizing that countries have varying capacity to measure progress, the plan stresses that "data and information from existing reporting mechanisms should be used where possible." One such existing data source for many countries may be found in their established PRTR data. This section describes how PRTR data may be used to measure progress for specific targets listed in the UN's plan.

Of the 17 SDGs shown in the box below and the 169 associated targets, there are three goals where PRTR data are directly relevant to measuring progress. These three goals are Goals 3, 6, and 12, as described in the sections 2.4.2 - 2.4.4. PRTR data may also prove to be useful in measuring progress in several other areas, although less directly. Examples of where PRTR data are more tangentially related to measuring progress are described in Section2.4.5.

While it is possible to name specific targets where PRTR data can be used in assessing progress in achieving them, a multitude of SDGs and their targets are simply more likely to be achieved if a PRTR has been implemented in a country. This is based on the fact that (a) the establishment of PRTRs follows the overall objective to reduce pollution; and (b) to reach this aim, PRTRs link environmental welfare with industrial and social development. The same principle as applied within the 2030 Agenda. Implementing new PRTRs and adapting existing PRTRs with a view to support the achievement of the SDGs will hence facilitate to achieve most of the SDGs, including many of their specific targets – addressing all of these targets in detail, however, would clearly exceed the scope of this document.

In January 2017, the first UN World Data Forum will convene to discuss data and indicators for sustainable development.[8] To date, numerous indicators have been compiled for SDGs which are available through the SDG Indicators Global Database housed by the UN's Statistics Division.[9] As of August 2016,

[6] For resources on conducting life cycle assessments, see Annex A.

[7] https://sustainabledevelopment.un.org/post2015/transformingourworld

[8] http://unstats.un.org/sdgs/#

[9] http://unstats.un.org/sdgs/indicators/database/

the initial indicators do not include measures directly related to the targets described below, nor do they mention PRTR as a potential source of measurement information.

The UN's *2030 Agenda for Sustainable Development*: Sustainable Development Goals

1. End poverty in all its forms everywhere
2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture
3. Ensure healthy lives and promote well-being for all at all ages
4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
5. Achieve gender equality and empower all women and girls
6. Ensure availability and sustainable management of water and sanitation for all
7. Ensure access to affordable, reliable, sustainable and modern energy for all
8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
10. Reduce inequality within and among countries
11. Make cities and human settlements inclusive, safe, resilient and sustainable
12. Ensure sustainable consumption and production patterns
13. Take urgent action to combat climate change and its impacts
14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

2.4.2 Assessing Progress toward Goal 3: Ensure healthy lives and promote well-being for all at all ages

Under Goal 3, there are 13 associated targets focused achieving universal access to health care and on reducing mortality rates due to disease, accidents, substance abuse, and hazardous chemicals. PRTR data may be applicable to measuring progress toward Target 3.9 which states: "By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination."

Target 3.9
By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination.

While PRTRs do not track deaths or illnesses resulting from exposure to hazardous chemicals, pollution and contamination, PRTR data may be used as an indicator if direct measures of chemical/pollution-related deaths and illnesses are not available. For example, a country or partner could use PRTR data to track the annual quantity of chemicals released to air, water, and soil as an indicator of the trend in the potential for chemical exposure. If available, these quantity data should further be utilized or analysed with corresponding chemical toxicity and exposure data as described in Section 2.2.3 (*Gain Insight into Human and Ecosystem Health Issues*). Consideration of toxicity and exposure data (e.g., population density, chemical fate and transport) will produce a trend that is more relevant than just quantity values to the potential for human impacts from the releases. As with all PRTR data analyses, consider the impact of the data limitations (see Chapter 3) on the trend.

2.4.3 Assessing Progress toward Goal 6: Ensure availability and sustainable management of water and sanitation for all

Goal 6 includes eight targets focused on access to drinking water and sanitation, improving water quality and water use efficiency, and protecting water-related ecosystems. PRTR data may be applicable to measuring progress toward Target 6.3 which is: "By 2030, improve water quality by reducing pollution, eliminating dumping, and minimizing release of hazardous chemicals and materials, halving the proportion of untreated waste water and substantially increasing recycling and safe reuse globally."

Target 6.3
By 2030, improve water quality by reducing pollution, eliminating dumping, and minimizing release of hazardous chemicals and materials, halving the proportion of untreated waste water and substantially increasing recycling and safe reuse globally.

Using PRTR data, a country or partner can directly track the annual trend in the quantity of chemicals released to water to track progress toward "minimizing release of hazardous chemicals and materials." As with all PRTR data analyses, consider the impact of the data limitations (see Chapter 3) on the trend. For example, consider the impact of chemicals that are not included in PRTRs and sources of water pollution that are not covered (e.g., chemicals discharged from agricultural land in stormwater run-off and wastewater treatment facilities' discharges are not included in some PRTRs).

2.4.4 Assessing Progress toward Goal 12: Ensure sustainable production and consumption patterns

Goal 12 includes 11 targets focused on efficient use of resources. PRTRs contribute to progress toward this goal by encouraging companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting. Additionally, by ensuring that people have access to relevant information on emissions of toxic substances and transport of waste, PRTRs play a role in disseminating information on sustainable production practices and achievements. Governments can also make use of PRTR data to identify and promote sound chemicals management practices. For measuring progress toward this goal, PRTR data could be for Target 12.4 and 12.5, which are shown in the text box.

For Target 12.4, PRTR data could be used to measure progress toward "more environmentally sound management of chemicals" if the PRTR collects data on waste management methods. For example, the U.S. and Canadian PRTRs collect data on quantities of toxic chemicals recycled, combusted for energy recovery, treated for destruction, and disposed or released. Examining these waste management quantities over time helps track progress in reducing waste generation and moving toward preferred waste management practices. For waste that is generated, the preferred management method is recycling, followed by burning for energy recovery, treating, and, as a last resort, disposing of or releasing the waste into the environment. These waste management priorities can be illustrated as shown in the *waste management hierarchy* figure. Progress toward the "sound management of chemicals" would be achieved if the PRTR data show a shift over time from disposal or releases toward the preferred techniques in the waste management hierarchy. To measure progress toward the later part of Target 12.4, "significantly reduce their release to air, water and soil," PRTR data could be used to track the country's releases to air, water, and soil over time. This measurement could be consolidated with the measurement described above in support of Target 3.9 to minimize the number of distinct metrics required.

For Target 12.5, trends in waste generation rely on the same waste management trend data from PRTRs as is described above for measuring progress toward Target 12.4. This waste management trend could be supplemented with PRTR data on source reduction activities implemented, as is collected by some PRTRs. Trends in source reduction reporting rates give some context on "prevention" and "reduction" activities, as stated in Target 12.5. Measuring the impact on releases of those source reduction activities are more complicated because any given reporter's trend in releases can be influenced by both source reduction activities as well as other factors such as production levels. Methods have been implemented to measure the impact of source reduction activities on releases such as a recently published study that estimated how source reduction activities affect toxic releases reported by facilities that report to the U.S. PRTR (Ranson et al., 2015).

Target 12.4
By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.

Target 12.5
By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.

2.4.5 Assessing Other SDGs Using PRTR Data

As mentioned above, there are numerous additional SDG targets that are also related to PRTRs, although more tangentially. For these targets, PRTR data may play a role in assessing progress, although PRTR data would likely be used to supplement to other primary data sources. For example, Goal 9 is to "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation." PRTRs play a role in making progress toward this goal in that they stimulate improved environmental management at different levels. In the case of the reporting entities, the PRTR exercise of monitoring or estimating pollution levels, as well as their mandatory publication, encourages efforts to improve efficiency and reduce pollution levels, a step toward sustainable industrialization.

Examples of additional targets where PRTRs contribute to achieving or tracking progress toward the target include:

- **Target 9.2:** Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries.

- **Target 9.4:** By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.

- **Target 12.2:** By 2030, achieve the sustainable management and efficient use of natural resources.

- **Target 16.10:** Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements.

These targets focus, at least in part, on resource efficiency. Waste management trends from PRTR data could be used, as described in Section 2.3.3, to measure progress toward resource efficiency by combining the quantity on the quantity of waste generated with a measure of economic output to produce efficiency metric, such as kg of waste produced per Euro of product generated.

3 LIMITATIONS OF PRTR DATA IN GLOBAL-SCALE SUSTAINABILITY ANALYSIS

This Chapter presents limitations of PRTR data in international-scale sustainability analyses. It discusses limitations inherent to all PRTR data, limitations due to differences among PRTRs, and potential analytical impacts of these limitations.

3.1 Limitations Inherent to PRTR Data

PRTR data are useful for a broad range of applications, but, as with all information sources, PRTRs have limitations in regard to their breadth and scope:

- **Not all facilities that release and transfer chemicals report to PRTRs.** The universe of facilities that actually report is limited to those that meet reporting requirements; typically, this includes facilities that exceed reporting thresholds, meet employee thresholds, and are categorized in an industry sector that is subject to the reporting requirements established for the PRTR. For example, in regard to employee thresholds, in the U.S. and Canada only facilities with an equivalent of 10 or more full-time employees must report (with certain exceptions) to either the Toxic Release Inventory (for facilities in the U.S.) or the National Pollutant Release Inventory (for facilities in Canada) , assuming other requirements are met.

- **Not all chemicals are reported to PRTRs.** PRTR reporting is typically limited to a set list of chemicals of concern to a country (e.g., those known to have the potential to cause adverse environmental or human health effects). These set lists vary among PRTR systems, although there is overlap of chemicals among the systems. (This variation is discussed in the Section 3.2.)

- **Additional information may be needed to contextualize PRTR data**. For example, it may be necessary to use other data sources[10] to determine processes containing chemicals at facilities, the quantity of chemicals incorporated into products, changes in production at facilities, toxicity of chemicals, and populations that may be exposed to chemicals.

- **The quality of PRTR data depends on the techniques used to determine release and transfer quantities.** Most PRTR data that pertain to mass quantities are estimated. Most PRTR systems perform data quality assurance to identify and resolve data quality issues and reporting errors; however, there is some uncertainty inherent in the release estimation techniques that facilities use for estimating releases of emissions and other reportable quantities of substances (OECD, 2008b). For example, Japan collects data for two categories of transfers (transfers to sewerage and other transfers outside the business establishment) (Government of Japan: Ministry of the Environment, 2004), whereas Canada collects data for more than 20 categories of transfers (e.g., transfers to underground injection, transfers to physical treatment) (Environment Canada, 2013).

[10] Potential additional data sources may include Material Safety Data Sheets; ToxFAQs from the U.S. Agency for Toxic Substances and Disease Registry (www.atsdr.cdc.gov/toxfaqs/index.asp); State of New Jersey, Department of Health, Right-to- Know Hazardous Substance Fact Sheets (http://web.doh.state.nj.us/rtkhsfs/indexFs.aspx).

3.2 Limitations for Global-Scale Analyses Due to Differences Among PRTRs

3.2.1 Differences Among PRTRs

There is considerable variation in PRTR programs throughout the world due to many factors that influence how a given country has designed and implements its PRTR (e.g., available resources, types of industrial sectors it covers, national policy priorities, and environmental needs) (OECD, 2001c). This variation complicates comparison and integration of data from different PRTRs in international-scale analyses, although there are ways to address or normalize many of the differences. Differences that impact the comparability of data among PRTRs include:

- **Chemical coverage**. The chemicals that are reportable to each PRTR vary among PRTRs. For example, the U.S. TRI covers 683 chemicals and chemical categories, while Australia's NPI covers 93 substances (Australian Government: Department of the Environment, 2014b; U.S. EPA, 2014b). PRTRs may also define what is actually reported for a given chemical differently. For example, aniline is covered as an individual chemical under the U.S. TRI (U.S. EPA, 2014b). In contrast, Canada's NPRI covers aniline and aniline salts (e.g., aniline sulphate, aniline hydrochloride) as a chemical group (Environment Canada, 2012).

- **Facility universe.** The facilities that are required to report to each PRTR vary due to differences in:

  - **Reporting unit definition**: Most, if not all, PRTR programs are empowered to regulate facilities. Different PRTR programs adhere to different statutory definitions of the term 'facility' and therefore regulate facilities differently. These definitional differences affect reporting of PRTR data. The reporting unit definition determines the types of entities that must report to a PRTR. Typically, this definition limits entities that report to PRTRs to specific sources; however, there are subtle differences between the types of facilities, industrial processes, and equipment that are subject to reporting under each PRTR. For example, Canada's NPRI includes portable facilities (e.g., portable concrete batching plants), while the U.S. TRI includes only stationary sites (Environment Canada, 2012; U.S. EPA, 2014b).

  - **Reporting thresholds:** PRTRs differ in their reporting thresholds, which determine: (1) when facilities are required to report; and (2) and for which chemicals they must report. For example, pentachlorobenzene is reported to the EU's E-PRTR if a covered facility releases more than 1 kilogram of the chemical to air, water, or land in a year (European Commission, 2006). In contrast, pentachlorobenzene is reported to the U.S. TRI if a covered facility has 10 or more employees and manufactures, processes, or otherwise uses more than 10 pounds (4.55 kilograms) of the chemical in one year (U.S. EPA, 2014b).

  - **Sector coverage:** Sectors that are subject to reporting to a given PRTR may not necessarily be covered by other PRTRs. For example, Australia's NPI covers facilities in 215 industrial sectors, while the EU's E-PRTR covers facilities that undertake any one of 65 industrial activities (Australian Government: Department of the Environment, 2006; European Commission, 2006).

- **Reported data.** The data elements collected by each PRTR, the units of measure for quantitative values, and reporting requirements vary across PRTRs:

- **Data elements:** Typically, PRTRs collect the key data elements discussed in Section 2.2.1; however, the level of detail and definitions of these data elements vary among PRTRs. For example, the EU's E-PRTR collects a single (aggregated) data element for all releases to land, while the U.S. TRI collects distinct details on releases to landfills as defined under Resource Conservation and Recovery Act (RCRA) Subtitle C ; other landfills; land treatment; RCRA Subtitle C surface impoundments; other surface impoundments; and other land disposal (European Commission, 2006; U.S. EPA, 2014b). In addition, each PRTR also collects a unique set of additional data elements (OECD, 2014c).
- **Units of measure:** The units used to measure release and transfer quantities vary across PRTRs. For example, in the EU's E-PRTR release and transfer quantities are expressed in kilograms, while the U.S. TRI expresses such quantities in pounds (European Commission, 2006; U.S. EPA, 2014b)
- **Optional reporting:** PRTRs differ in whether they require or allow optional reporting for each data element. For example, Australia's NPI allows facilities to voluntarily report on transfers destined for recycling, while reporting on transfers to recycling is mandatory for the U.S. TRI (Australian Government: Department of Sustainability, Environment, Water, Population and Communities, 2012; U.S. EPA, 2014b).

- **Timeframe.** The available years of PRTR data and the reporting period for which data are reported vary across PRTRs:
  - **Available Years: :** The years for which PRTR data are available varies across PRTRs. For example, the EU's E-PRTR contains data for each year since 2007, while Canada's NPRI data date back to 1993 (EEA, 2013; Environment Canada 2014b).
  - **Reporting Period:** Typically, PRTRs collect data annually. Annual releases and transfers quantities reported to a PRTR may correspond to a calendar year (e.g., Canada's NPRI collects data for the annual period starting on January 1st and ending on December 31st) or to another annual period (e.g., Japan's PRTR collect release and transfer data for the federal fiscal year from April 1st to March 31st) (Environment Canada, 2012; Government of Japan, 2004).
- **Format of published data.** Published PRTR data vary in: file format (e.g., XML, CSV, Microsoft® Access); language of publication; and level of granularity (e.g., records for each facility and chemical, aggregate records with totals by chemical and sector).

3.2.2 Potential Impacts of Differences on International-Scale Analyses

Each of the differences presented above affects what international analyses are possible using PRTR data. In addition, these differences among PRTRs may impact analytical results. Differences among PRTRs may result in:

- Values for quantitative data elements (e.g., release and transfer quantities, counts of reporters, counts of reports) being higher under one PRTR than they would be under another PRTR:
  - A PRTR with broader chemical coverage might collect a greater number of reports and have higher release and transfer totals across those reports than a PRTR that covers fewer chemicals.

  - Facilities might report higher release and transfer quantities to a PRTR with a broader definition for a chemical than a PRTR with a narrower definition. For example, release and transfer quantities for mercury compounds from a PRTR that cover the mass of mercury compounds may be higher than quantities from a PRTR that covers only the mass of the mercury element within mercury compounds.
  - A PRTR that covers a broader reporting universe (e.g., covers numerous sectors, a broad reporting unit definition, and low reporting thresholds) might collect data from a greater number of facilities and have higher release and transfer quantities across facilities than a PRTR with a narrower reporting universe.
  - A PRTR that limits its reporting universe to large facilities (e.g., has high reporting thresholds) may have higher average releases and transfers per facility than a PRTR that incorporates smaller entities.
  - Values reported may appear higher in one PRTR than another due to differences in unit of measure (e.g., quantities reported in pounds would be 2.2 times higher than quantities reported in kilograms).
  - A PRTR that requires mandatory reporting for all data elements may have higher release and transfer quantities than a PRTR that allows optional reporting; optional data elements may not include releases and transfers from all facilities.
  - A release or transfer quantity may be higher in a PRTR with a broader definition of a data element (e.g., transfers include recycling, recovery, treatment, or disposal) than in a PRTR with a narrower definition of a data element (e.g., transfers include only transfers to municipal sewage treatment plants).

- Data gaps that limit the scope of an analysis or prevent inclusion of data from one or more PRTRs:

  - Data for a chemical or industry sector of interest will be absent from a PRTR if the PRTR does not cover the chemical or sector.
  - Data will be absent from a PRTR for the years before the PRTR was implemented. The most recent year may also be absent if the PRTR has not completed the data processing steps or data quality assurance checks needed to publish PRTR data.
  - Granular data (e.g., records for individual facilities and chemicals) may not be available if a PRTR only publishes aggregated data.

- A need for data processing to allow for analysis at an international scale:

  - It may be necessary to aggregate transfer and release data across data elements if one PRTR collects more detailed release or transfer data than another.
  - Differences in file format used to publish PRTR data complicate the mechanics of compiling and integrating PRTR data; it may be necessary to translate data to a common language, transfer data into a common file type, and restructure data.

- Difficulty identifying a uniform subset of PRTR records:
  - When PRTRs use different industry classification systems, it may be difficult to consistently identify facilities in an industrial sector.
  - When CAS numbers are not available for chemicals or chemical categories, it may be difficult to consistently identify records for a chemical or set of chemicals, as the same chemical or groups of chemicals may be known by many different names.

3.3 Limitations May Change over Time

Limitations of using PRTR data in global-scale sustainability analysis may become less of an impediment in the future. PRTRs are dynamic; they can be (and often are) modified to collect new or different information needed to better meet national and international goals. As PRTRs around the world continue to evolve, use of PRTR data in global-scale sustainability analyses is expected to increase. For example, current harmonisation efforts may reduce differences among PRTRs and ease integration and analysis of PRTR data on an international scale. In addition, the scope of data collected by PRTRs may expand to capture information on emerging chemicals and industrial sectors that may impact global sustainability.

4 FACTORS TO CONSIDER IN INTERNATIONAL-SCALE SUSTAINABILITY ANALYSES OF PRTR DATA

This Chapter presents factors to consider when PRTR data are used in international-scale sustainability analyses. It includes factors to consider when designing analyses; adjusting PRTR data to address differences among PRTRs; and performing the analyses discussed in Section 2.3.

4.1 Designing Analyses

Factors to consider when designing international analyses of PRTR data to avoid impacts from differences among PRTRs on analytical results include:

- whether to focus analyses on chemicals and sectors that are most consistently reported across PRTRs; and
- whether to integrate PRTR data or to conduct separate analogous analyses to compare patterns across PRTRs.

4.1.1 Focusing Analyses on Chemicals and Sectors

Although there is considerable variation in the chemicals and sectors covered by each PRTR, most PRTRs have some overlap in the chemicals and sectors they cover. When international-scale analyses of PRTR data are focused on the chemicals and sectors most consistently covered across PRTRs, potential impacts on analytical results due to the differences in chemical and sector coverage are minimized. In addition, the chemicals and sectors covered by multiple PRTRs generally represent those that are identified by numerous countries to be of greater importance due to their potential to impact human and environmental health.

In an effort to improve the consistency of sector coverage among PRTRs, OECD compared chemical and reporting sector coverage among five PRTR systems[11] and the UNECE Kiev Protocol on PRTRs (OECD, 2014b; OECD, 2013c). Outputs from these comparisons identify chemicals and sectors that are consistently covered by the PRTRs:

- OECD's "Short Chemical List" included 126 chemicals - Persistent Organic Pollutants, Greenhouse Gases, chemicals covered under the Kiev Protocol, and other chemicals covered by four or more of the studied PRTRs (OECD, 2014b).
- OECD's "Short Reporting Sector List" included 152 International Standard Industrial Classification of All Economic Activities (ISIC) sectors covered by four or more of the studied PRTRs (OECD, 2013c).

These lists are useful starting points for identifying those consistently covered sectors and chemicals that may serve as the focus of an international-scale analysis of PRTR data.

4.1.2 Integrating PRTR Data vs. Conducting Separate Analogous Analyses

[11] Australia's NPI, Canada's NPRI, EU's E-PRTR, Japan's PRTR, and U.S.'s TRI.

When designing international analyses of PRTR data, it is important to consider two main approaches:

- **Integrating PRTR data.** This approach integrates data from multiple PRTRs into a single dataset for analysis. Outputs from this type of analysis utilize data from multiple PRTRs. For example, an analysis might sum release quantities to produce an international-scale trend in releases (Figure 8).

- **Conducting Separate Analogous Analyses.** This approach analyses data from each PRTR separately, and then compares patterns across PRTRs. Outputs from this type of analysis include a separate analytical result for each PRTR. For example, an analysis reviewing changes in releases over time will yield a series of trend lines indicating any changes in releases that occurred within individual countries. These trend lines can be compared to see whether observed patterns in releases over time are consistent on an international scale (Figure 9).

Figure 8. Trend in Releases: Total Across Countries

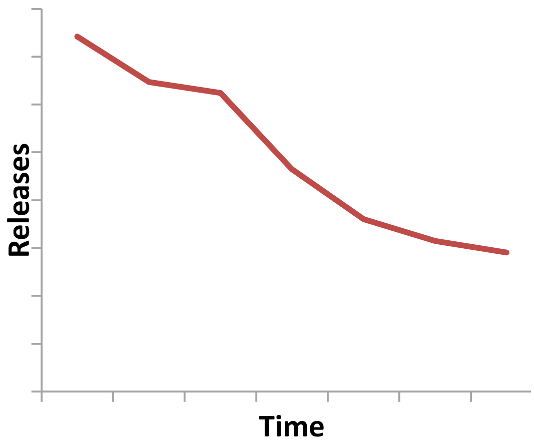
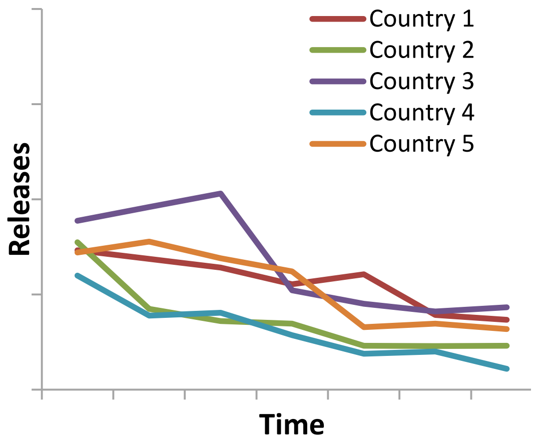


Figure 9. Trend in Releases by Country



These approaches allow for flexibility in how PRTR data are analysed at an international scale. For example, if differences in the format of published data prohibit integrating PRTR data, it may still be possible to conduct separate analogous analyses that provide insightful results, as illustrated in Figure 9..

4.2 Adjusting PRTR Data to Address Differences Among PRTRs

As discussed in Section 3.2, there are numerous differences among the PRTRs that might impact international-scale analysis of PRTR data. Chemical coverage, facility universe, reported data, timeframe, and format of published data often varies among PRTRs.

In some cases adjustments can be made that account for these differences and enable comparisons among PRTRs. For example, it is straightforward to convert release and transfer quantities to the same unit of measure. For other differences, adjusting data may not be feasible (e.g., data cannot be obtained for years prior to the implementation of a PRTR) or may require considerable effort (e.g., limiting an analysis to the types of facilities that would be covered by every PRTR in the analysis).

4.2.1 Selecting What Adjustments to Make in an Analysis

To determine whether to adjust PRTR data for an international-scale analysis, it is important to consider:

- **What is the intended use of the analysis?** For example, analyses conducted to inform policy decisions may require high data comparability to withstand political rigor and allow policy decisions to be made with the best available data. Alternatively, exploratory analyses used to obtain a general idea about an issue may require less effort in validating comparability between datasets.

- **What type of analysis is being conducted?** For example, when comparing one country's releases to another country's releases, differences in the countries' reporting requirements can have a significant influence on the comparison. When comparing the trend over time (e.g., the slope of the line) of one country to that of another, however, the differences in the PRTRs are less of a factor, as long as there is consistency within each individual country.

- **What assumptions would need to be made to use unadjusted data?** If an assumption is unreasonable, it will be necessary to adjust data so that results do not depend on that assumption. Consider if the assumptions needed to use unadjusted data are reasonable for the analysis and how they will impact results (e.g., overestimating or underestimating).

- **How might using adjusted data impact results?** For example, limiting an analysis to consistently covered chemicals may improve the comparability of data, but considerably reduce the number of records that are included in the analysis, which may increase the uncertainty in analytic results.

- **How feasible is it to make adjustments?** Feasibility varies across analyses. For example, it may not be feasible to redistribute release and transfer data from fiscal years to calendar years; this adjustment could be made only if every facility included in the analysis reported in every year.

4.2.2 Feasibility of Adjustments

1. As discussed above, in some cases it is possible to make adjustments to improve the comparability or even miscibility of PRTR data for international-scale analyses. Table 1 lists potential adjustments for each of the differences among PRTRs discussed in Section 2.3 and discusses the feasibility of each potential adjustment.

Table 1. Feasibility of Adjustments

Difference	Potential Adjustment	Feasibility
Chemical Coverage		
List of Chemicals Covered	If PRTRs cover some of the same chemicals, analyses should be limited to just those chemicals covered by each PRTR.	This adjustment is straightforward; consistently covered chemicals can typically be identified using CAS number or existing chemical crosswalks (e.g., OECD's Long Chemical List (OECD, 2014b)).

Table 1. Feasibility of Adjustments

Difference	Potential Adjustment	Feasibility
Definitions for a Chemical or Chemical Groups	If PRTRs have different definitions of what is reported for a given chemical, release and transfer quantities may be adjusted to reflect a consistent definition. For example, one PRTR may cover the full mass of mercury compounds while another covers only the portion associated with the mercury element found in mercury compounds. To harmonise the definition of mercury compounds in this situation, the release and transfer data that includes the full mass of mercury compounds could be adjusted to include only the elemental mass of mercury.	To make this adjustment, the proportion of each release and transfer quantity associated with a consistent definition (in this example, the mercury element in mercury compounds) would need to be identified. Precisely identifying this proportion is challenging; the proportion is likely process specific and varies among facilities. In this example an assumption could be made that all mercury compounds are in the form of mercury (II) oxide (HgO). Regardless, it is important to communicate the uncertainties and confounding factors when interpreting or communicating the results of such analyses.
Facility Universe		
Reporting Unit Definition	When PRTRs have different reporting unit definitions, the universe of facilities could be limited to the facilities in each PRTR that meet the reporting unit definition for every PRTR included in the analysis.	Creating a dataset in which reporting units are equivalent would entail conducting detailed research and analysis of every facility in each PRTR. This may only be feasible for analyses that focus on a subset of facilities (e.g., facilities in a specific industrial sector).
Reporting Thresholds	To improve comparability in analyses, the universe of facilities could be limited to only those facilities that exceed all reporting thresholds used across all PRTRs.	The feasibility of this adjustment depends on the types of reporting thresholds used by each PRTR. If thresholds are based on quantities released, it is straightforward to identify which facilities have exceeded release thresholds based on their PRTR reporting. Considerably more effort would be needed to identify facilities that exceed other thresholds. Data are often limited or unavailable for facility information on number of employees, or on quantities of chemical used.
Sector Coverage	If PRTRs cover a different set of sectors, analysis can be limited to just those sectors covered by each PRTR.	The feasibility of this adjustment depends on how sectors are identified in each PRTR. If each PRTR uses the same industry classification system, it is straightforward to identify records that correspond to the industries covered by both PRTRs. If PRTRs use different industry classification systems, it will be necessary to use industry classification crosswalks to identify common sectors. As there is not always a 1:1 relationship between industry classification codes used by different classification systems, research may be required to determine whether facilities are in an industry covered by both PRTRs.
Reported Data		
Data Elements – Differences in Coverage	If one PRTR includes a data element that is not included in another PRTR, data may be adjusted by removing the data element from the analysis.	This adjustment is straightforward; data elements not covered by a PRTR are readily identified.

Table 1. Feasibility of Adjustments

Difference	Potential Adjustment	Feasibility
Data Elements – Differences in Level of Detail	If one PRTR collects more detailed data than another, the more detailed data may be aggregated to match the less detailed data. For example, one PRTR may collect total off-site transfers while another PRTR collects transfers to recycling, energy recovery, treatment, and other disposal; transfers from the second PRTR may be summed across waste management techniques to produce a transfer total analogous to the first PRTR's total transfer data element.	This adjustment is straightforward; however, care should be taken to review the definition of both the aggregate and detailed data elements to identify which detailed data elements correspond to the aggregate data element.
Unit of Measure	If PRTRs use different units of measure for quantitative values, data can be converted to consistent units using conversion factors.	This adjustment is straightforward; unit conversion factors are readily available.
Optional Reporting	If one PRTR requires reporting for a data element and another allows optional reporting for the data element, data may be adjusted by removing the data element from the analysis.	This adjustment is straightforward; optional reporting data elements are readily identified.
Timeframe		
Available Years	If PRTRs cover different years, analysis can be limited to just those years covered by each PRTR.	This adjustment is straightforward; years covered by a PRTR and data reported in each year are readily identified.
Reporting Period	If different reporting periods are used to collect data (e.g., fiscal year vs. calendar year), annual release and transfer quantities may be made more consistent across PRTRs by redistributing data to better reflect calendar years. For example, fiscal year release and transfer data might be averaged between fiscal year 2012 and fiscal year 2011 to produce data for calendar year 2011.	Redistributing release and transfer data is impractical for many applications; release and transfer quantities for each facility are not readily disaggregated by month, and not all facilities report the same chemicals to a PRTR in every year. This type of adjustment would be most useful for analyses focusing on a small set of facilities that report the same chemicals every year.
Format of Published Data		
File Format	If PRTR data are published in different formats, data can be transferred to a common file type and restructured using consistent table structures.	PRTR data are readily transferred to common file types and data structures; however, the transfers may require technical knowledge. In addition, specific software may be needed to open and manipulate datasets, depending on the file type of published data.
Language	If PRTR data are published in different languages, data element names and data may need to be translated to a consistent language. In cases where identification codes accompany description data elements (e.g., chemical names correspond to CAS number, industry name corresponds to an industry code), data may be translated using existing crosswalks.	It is straightforward to translate data using a crosswalk; however, crosswalks are only available for a limited number of data elements. If a crosswalk is not available, knowledge of multiple languages is needed to translate PRTR data.
Level of Granularity	If PRTR data are published using different levels of granularity, data from more granular PRTRs may be aggregated to match less granular PRTRs. For example, if one PRTR publishes facility-level information and another publishes industry-level information, release and waste transfer quantities can be summed across facilities to produce industry totals. In some cases, it may also be possible to request more granular data from the agency responsible for PRTR data dissemination.	It is straightforward to aggregate granular data, provided that the granular dataset contains the data element by which data are to be aggregated (e.g., chemical name or CAS number are needed to aggregate PRTR data to the chemical level).

4.3 Performing the Potential International-Scale Sustainability Analyses

This section presents factors to consider relevant to common analytical methods for the potential international-scale sustainability analyses discussed in Section 2.3, including combining PRTR data with non-PRTR data sources as well as trend analysis of PRTR data.

4.3.1 Using Contextual Data with PRTR Data

For several of the potential international-scale sustainability analyses, it is necessary to utilize other data sources in combination with PRTR data. For example, analysts may use production data to contextualize trends in PRTR data, or population and epidemiological data to study potential health impacts of releases.

The feasibility of analyses requiring contextual data from non-PRTR sources depends on:

- **The availability of contextual data.** Is an international-scale dataset with the contextual data needed for the analysis readily available? Are sources available for the data for each country in the analysis?

- **The consistency of data across counties.** Are there differences in contextual data sources among countries that might influence analytical results?

- **How other data will be linked to PRTR data.** Are there identifiers that can be used to link contextual data to PRTR data (e.g., CAS number for chemical-specific information)? Do data need to be aggregated (e.g., aggregating monthly production data to annual totals) before they can be utilized with PRTR data?

It is important to keep in mind that combining PRTR data with other data can increase the complexity of an analysis and the resources required to conduct the analysis.

4.3.2 Trend Analysis of PRTR Data

When interpreting year-to-year comparisons of PRTR data, it is important to consider the reasons why release and transfer quantities may have changed over time. Reasons for changes in release and transfer quantities may include changes in:

- **Pollution prevention:** Facilities that report to a PRTR may take actions to reduce the quantities of chemicals they release to the environment and the quantities of waste they generate.

- **Technology:** Facilities that report to a PRTR may change the methods they use in an industrial process (e.g., use new technology in a manufacturing process), substitute the chemicals they use in an industrial process, or make other changes in response to government regulations.

- **Facility activity:** There may be changes in production levels or product lines at facilities that report to a PRTR.

- **Outsourcing:** Facilities may outsource a process that was previously conducted on-site. This change may result in reduced releases for the facility, although the overall releases associated with producing the product may not have changed.

- **Estimation methodology:** Facilities that report to a PRTR may change the release estimation techniques they use to estimate release and transfer quantities; for example, to reflect updated emission factors or to take into account new information from sampling.

- **Reporting requirements:** A PRTR may adjust its reporting requirements or implement new requirements for a given chemical, some chemicals, or all chemicals; facilities; or sectors. Adjustments may result in a change in the universe of facilities that report to a PRTR, a change in the chemicals that must be reported, or a change in the data elements reported by facilities.

When interpreting trends in PRTR data, additional investigation may be useful to identify possible reasons for changes in PRTR data. For example, trends in PRTR data may be compared against trends in production measures to identify how changes in activity may have affected release and transfer quantities. Similarly, trends in PRTR releases may be reviewed against trends in releases for an index chemical where changes in releases over time are well understood. In addition, PRTR data may be validated against measures of ambient conditions when studying trends in PRTR reported releases and their environmental impacts. Furthermore, reporting requirements under PRTRs included in an analysis may be reviewed to identify changes that could have affected reported release and transfer quantities.

4.4 The Role of Equivalency in Comparability: Are We There Yet?

As discussed in Sections 3.2 and 4.2 of this document, many of the specific chemicals that are covered under a given PRTR system are often not covered under other PRTR systems. From strictly a chemical identity standpoint, such differences confound and limit comparative analyses of release and other waste management quantities reported under different PRTR systems. There may be ways, however, to circumvent such challenges if one were to consider the properties that are shared among different chemicals. That is, base the comparison on a common, relevant characteristic of two or more chemicals, rather than limiting the comparisons to only those chemicals that are identical in chemical structure.

For example, many toxic chemicals, especially those that are structurally similar, often cause the same toxic effect(s) through the same biochemical mechanism(s). What may differ among the chemicals is the dose or level and duration of exposure required to cause the toxicity (i.e., their relative toxic potencies). In such instances exposure of an individual to a greater quantity of a less potent chemical is, at least in theory, toxicologically equivalent to being exposed to a less of a quantity of a more potent chemical in the group. From a practical standpoint, most people are probably more concerned with the toxic effect a chemical being released into their community may cause, rather than the specific chemical.

If sufficient information is available from which relative toxic potencies can be quantified or even semi-quantified, comparative analyses can be made on such chemicals. This type of information exists for some chemicals where relative potencies in causing the same toxic effects have been derived. Well known examples are with dioxins and dibenzofurans, the latter being a class of chemicals that are structurally similar to dioxins. These chemicals all cause the same toxic effects through the same or essentially the same biochemical mechanisms, but differ in their potencies in causing the effects. Their relative toxic potencies are often expressed as a “Toxic Equivalency Factor” or “TEF”, relative to 2,3,7,8-tetrachlorodibenzo-*p*-doxin (TCDD), the dioxin that has the greatest toxic potency. In fact, the U.S. EPA’s TRI list of toxic chemicals includes a chemical category known as “Dioxin and Dioxin-Like Compounds”, which consists of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans. The U.S. EPA has enabled facilities to report releases and other waste management quantities on these chemicals in terms of mass and TEFs.

As the role of PRTR data in global sustainability continues to evolve and take hold, there will no doubt be greater emphasis on comparing the data collected by different PRTRs systems. Analysts should not conclude that comparisons cannot be made unless chemical coverage is identical among PRTRs. Analysts should take advantage of common properties different chemicals often have, and be receptive to employing innovative ways to base their analyses and comparisons on what is common.

5 RECOMMENDATIONS; IMPROVING HARMONISATION OF PRTR DATA

As discussed throughout this framework, it is anticipated that PRTR data will increasingly be used to assess progress towards global sustainability. However, as discussed in the previous Chapters, the use of PRTR data in international-scale analysis is complicated by differences among PRTRs. To meet the growing need for using PRTR data for global analyses, it is recommended that countries consider taking steps to improve harmonisation of their PRTR data with other PRTR systems when designing new PRTR systems, or modifying existing ones. More consistent (harmonised) data allow for more straightforward international-scale sustainability analyses.

> The 1996 Recommendation of the Council on Implementing Pollutant Release and Transfer Registers [amended on 28 May 2003 - C(2003)87] recommends that member countries take into account the principle that PRTR systems should allow as far as possible comparison and co-operation with other national PRTR systems and possible harmonisation with similar international databases.
>
> Source: OECD, 2003b

Features of a PRTR system that can be designed or modified to facilitate international-scale analysis are detailed in OECD's *Guidance Document on Elements of a PRTR: Part I and Part II* (OECD, 2014c; OECD 2015). The key features that can be harmonised among PRTRs include:

- **Reporting universe:** The information collected by PRTRs (e.g., reporting unit; reporting sectors; chemicals; activity thresholds; data elements; and reporting period)
- **Release estimation techniques:** The techniques used to estimate PRTR data and the mechanisms for documenting these techniques
- **Efficient system development:** Mechanisms for balancing the costs of data collection with the value of data collected and for protecting sensitive information.

In addition, PRTR programs can take steps during initiation and operation of a PRTR system to improve harmonisation of PRTR data for international-scale analysis. These steps include:

- Identifying harmonisation goals for a PRTR
- During PRTR pilots, testing the compatibility of PRTR data for use with data from other PRTR systems
- Developing compatible data systems for PRTR data collection, compilation, and storage
- Performing compliance assurance and data quality assurance to maintain high quality data
- Publishing key data elements and complete documentation so that PRTR data are available to international stakeholders
- Collaborating with international organizations, other countries, and NGOs to promote harmonisation of PRTR data and application of PRTR data in international-scale analysis (OECD, 2015).

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ANNEX A. RESOURCES FOR SUSTAINABILITY ANALYSIS

Type of Analysis	Resource
Cost-Benefit Analysis	OECD (2006), *Cost-Benefit Analysis and The Environment: Recent Development*, OECD, Paris, *www.oecd.org/env/tools-evaluation/cost-benefitanalysisandtheenvironmentrecentdevelopments.htm.*
Cost-Benefit Analysis	UNEP (2009), *Supplemental Cost-Benefit Economic Analysis Guide*, UNEP, *www.chem.unep.ch/unepsaicm/mainstreaming/Documents/UNDP-UNEP%20PI_Economic%20Analysis%20Supplement_Revised%20draft.pdf.*
Developing Indicators	OECD (2003d), *OECD Environmental Indicators: Development, Measurement, and Use*, OECD, Paris, *www.oecd.org/environment/indicators-modelling-outlooks/24993546.pdf*.
Developing Indicators	UNECE, OECD, and Eurostat Working Group on Statistics for Sustainable Development (2008), *Measuring Sustainable Development,* United Nations, Geneva, *www.oecd.org/greengrowth/41414440.pdf.*
Developing Indicators	UNECE, Eurostat, and OECD Task Force on Measuring Sustainable Development (2013), *Framework and suggested indicators to measure sustainable development*, UNECE, Geneva, *www.unece.org/fileadmin/DAM/stats/documents/ece/ces/2013/SD_framework_and_indicators_final.pdf*.
Life Cycle Assessment	OECD (2005c), *Environment and the OECD Guidelines for Multinational Enterprises: Corporate Tools and Approaches*, OECD, Paris, *http://images2.ehaus2.co.uk/oecd/pdfs/free/9705041e.pdf*.
Life Cycle Assessment	UNEP and SETAC (2011), *Toward a Life Cycle Sustainability Assessment: Making informed choices on products*, UNEP/SETAC Life Cycle Initiative, *www.unep.fr/shared/publications/pdf/DTIx1412xPA-Towards%20a%20LCSAMakingInformedChoice.pdf*
Risk Assessment	OECD (2014d), The OECD Environmental Risk Assessment Toolkit: Tools for Environmental Risk Assessment and Management, *www.oecd.org/chemicalsafety/risk-assessment/theoecdenvironmentalriskassessmenttoolkittoolsforenvironmentalriskassessmentandmanagement.htm*, accessed 1 December 2014.
Risk Assessment	WHO (2010), *WHO Human Health Risk Assessment Toolkit: Chemical Hazards*, WHO, the International Labour Organisation (ILO) and UNEP, *www.who.int/ipcs/publications/methods/harmonization/toolkit.pdf?ua=1*.
Sustainability Impact Assessment	OECD (2010), Guidance on Sustainability Impact Assessment, OECD, Paris, www.oecd.org/greengrowth/46530443.pdf.

ANNEX B. CASE STUDY: DATA INTEGRATION PILOT ANALYSIS

A pilot analysis was conducted by the U.S. EPA and Abt Associates in March of 2013 to explore the feasibility of integrating data from multiple PRTRs to perform international-scale analyses. The pilot analysis integrated release and transfer quantities reported for selected chemicals (i.e., aniline, benzene, mercury and mercury compounds) by facilities in specific sectors (i.e. chemicals, waste management services, electric power generation, fossil fuel refining) covered by five PRTRs, and assessed trends in these quantities among the five PRTRs.

This case study: 1) describes the methods and results from the pilot analysis; 2) highlights some of the challenges to integrating PRTR data that were identified; 3) discusses adjustments that were made to PRTR data for the purposes of the pilot analysis; and 4) presents mechanisms that might be used to address these differences in future analyses.

Key findings from the pilot analysis include:

- The frequency of reporting and reported release and transfer quantities varied among chemicals, industry sectors, and the five PRTRs. Of the chemicals and industries studied in the pilot analysis, data were most frequently reported to the five PRTRs for:

– Air releases and transfers of benzene from chemicals and chemical products manufacturers and coke and refined petroleum products manufacturers; and

– Air releases and transfers of mercury and compounds from chemicals and chemical products manufacturers and electric power generation, transmission and distribution facilities.

- Differences among the PRTRs were identified that complicate international-scale analysis of PRTR data, including inconsistencies in:

– Chemical coverage;

– Facility universe (reporting unit definition, reporting thresholds, sector coverage, and industry classification system useful for identifying facilities within a sector);

– Reported Data (data elements and unit of measure);

– Timeframe (available years and reporting period); and

– Format of published data.

- Despite the differences among PRTRs studied in this analysis, it was possible to identify similar trends in releases among the five PRTRs. Releases decreased during 2002-2011 for:

– Benzene from chemical and chemical products manufacturing facilities in five PRTRs;

– Benzene from coke and refined petroleum products manufacturing facilities in five PRTRs;

– Mercury and compounds from chemical and chemical products manufacturing facilities in four PRTRs; and

– Mercury and compounds from electric power generation, transmission and distribution facilities in four PRTRs.

It is possible that these consistent trends in air releases among PRTRs indicate a common factor is driving international decreases in air releases of benzene and mercury compounds.

B.1 Methods

This pilot analysis attempted to integrate release and transfer quantities[12] reported for three chemicals by facilities in selected sectors, and across five PRTRs:

- Australia's National Pollutant Inventory (NPI)
- Canada's National Pollutant Release Inventory (NPRI)
- The EU's European Pollutant Release and Transfer Register (E-PRTR)
- Japan's Pollutant Release and Transfer Register (Japan PRTR)
- The U.S.'s Toxics Release Inventory (TRI).

This integration was followed by an analysis and comparison of the trends for the reported quantities for the chemicals among the five PRTRs.

To select chemicals with data in multiple PRTRs, the chemicals that were included on OECD's Short Chemicals List and covered by at least four of the above PRTRs were identified. Three chemicals with different chemical properties and industrial applications for the pilot analysis were then identified:

- Aniline (an aromatic amine)
- Benzene (an aromatic hydrocarbon)
- Mercury metal (Hg^0) and compounds that contain mercury. (Mercury metal and compounds that contain mercury are regarded by many PRTR systems as persistent, bioaccumulative, and toxic (PBT) chemicals.)

Next, two International Standard Industrial Classification of All Economic Activities (ISIC) industry sectors were selected to focus the analysis for each chemical. To select industry sectors that would have data from multiple PRTRs, sectors from the OECD Short Reporting Sector List that frequently reported each chemical were identified. Following this approach, two sectors of interest were identified for each chemical (Table 2).

12 Note that all five PRTRs collect quantitative release and transfer information while only the U.S. and Canada collect quantitative information on other waste management activities (e.g., burned on-site for energy recovery), so it was determined that studying release and transfer quantities would be more fruitful than studying other waste management quantities. For details, see the section *Release, Transfer and Other Waste Management Data Elements*.

Table 2. Chemicals and Industry Sectors of Interest

Chemical	Industry Sector
Aniline	Manufacture of chemicals and chemical products Waste collection, treatment, and disposal activities
Benzene	Manufacture of chemicals and chemical products Manufacture of coke and refined petroleum products
Mercury and Compounds	Manufacture of chemicals and chemical products Electric power generation, transmission and distribution

After identifying the sectors and chemicals to be included in the analysis, PRTR data were gathered for each sector and chemical from the five PRTRs. The records from these PRTRs were combined into a common dataset, and the dataset was then used to generate trends over time for each industry and chemical.

In the process of gathering, combining, and analysing data from the five PRTRs, differences among the PRTRs that might impact the analysis were identified. For example, differences across the PRTR systems included inconsistencies in:

- Chemical coverage
- Facility universe (reporting unit definition, reporting thresholds, sector coverage, and industry classification system useful for identifying facilities within a sector)
- Reported Data (data elements and unit of measure)
- Timeframe (available years and reporting period)
- Format of published data.

The following sections discuss each of these differences, any adjustments that were made to PRTR data for this analysis, and mechanisms that might be used to address the differences in future analyses.

B.1.1 Chemical Coverage

The first step in identifying any differences in coverage of aniline, benzene, and mercury and mercury compounds across PRTRs was determining whether each of these chemicals is reportable under all of the five PRTRs. In addition, the forms of the chemicals that are included in release and transfer quantities were identified. Benzene was covered consistently across all five PRTRs. Coverage of aniline and mercury and compounds varied as described in Table 3.

Table 3. Chemical Coverage

PRTR	Chemical Coverage		
	Aniline	**Benzene**	**Mercury and Compounds**
Australia NPI	Reported as aniline	Reported as benzene	Reported as mercury and compounds (refers to the total amount of the metal and its compounds used).
Canada NPRI	Reported as aniline (and its salts)	Reported as benzene	Reported as mercury (and its compounds) (total of the pure element and the equivalent weight of the element contained in any compound, alloy or mixture).
EU E-PRTR	Not Covered	Reported as benzene	Reported as mercury and compounds. For metal compounds, the mass of the elemental metal present in the compound is reported.
Japan PRTR	Reported as aniline	Reported as benzene	Reported as mercury and its compounds. For metal compounds, the mass of the elemental metal present in the compound is reported.
U.S. TRI	Reported as aniline	Reported as benzene	Reported as mercury. Also reported as mercury compounds (includes any unique chemical substance that contains mercury as part of that chemical's infrastructure; only the mass of the metal (mercury) portion of a mercury compound is reported as released or otherwise managed as waste.

Aniline. Four of the five PRTRs cover some form of aniline. Australia, Japan, and the U.S. PRTRs cover aniline (in its free base or un-ionized), whereas Canada's PRTR coverage of aniline is broader; it includes aniline and aniline salts (e.g., aniline sulphate, aniline hydrochloride). For the purposes of this pilot analysis, aniline release and transfer quantities were included as they were reported, regardless of whether they were reported as aniline or aniline and salts. Note that E-PRTR does not cover aniline, so no aniline records from the EU were included in the combined dataset.

To improve the comparability of aniline data in future analyses, release and transfer quantities of aniline and its salts from Canada's NPRI could be adjusted; the amount of aniline salts in each release and transfer could be removed so that releases and transfer quantities reflect only aniline. For this pilot analysis, no straightforward method or information sources were identified to make this adjustment.

Benzene. All five PRTRs covered benzene consistently.

Mercury and Compounds. Each PRTR covered some combination of mercury metal and mercury compounds. Most PRTRs included mercury and compounds in a single chemical category, whereas the U.S. TRI Program covers mercury and mercury compounds separately. In the U.S. PRTR system, determinations as to whether a reporting threshold was exceeded are made separately for mercury (using the weight of the metal) and for mercury compounds (using the weight of the entire compound). In either case, if a reporting threshold is exceeded, facilities are required to report the mass of mercury. To adjust for this difference, TRI records for both mercury and mercury compounds were combined in this analysis; the union of the quantities of mercury and mercury compounds compiled in the TRI is comparable to the quantities of mercury and mercury compounds compiled in the other four PRTRs.

In addition, PRTRs varied in whether the full mass of mercury compounds or only the portion associated with the mercury element found in mercury compounds is reported in release and transfer quantities (Table 3). For the purposes of this pilot analysis, release and transfer quantities were included as they were reported, regardless of whether they reflected the full mass of mercury compounds or only the portion associated with the mercury element.

To improve the comparability of mercury data in future analyses, PRTR reporting that includes the full mass of mercury compounds could be adjusted by removing the quantity of mercury compounds that do not correspond to the mercury element. To make this adjustment, the proportion of each release and transfer quantity associated with the mercury element in mercury compounds would need to be identified. Precisely identifying this proportion is challenging because the specific compound released or transferred (e.g., HgO vs. HgS) is not reported; the proportion is likely process specific and varies among facilities. For this pilot analysis, no straightforward method or information sources were identified for estimating the proportion.

B.1.2 Facility Universe

The universe of facilities available from each PRTR is determined by the PRTRs' reporting unit definitions, reporting thresholds, and sector coverage. In addition, the PRTRs' industry classifications were used to identify facilities within the industry sectors of interest to be included in this pilot analysis.

B.1.2.1 Reporting Unit Definition

The reporting unit definition determines the types of entities that must report to a PRTR. The reporting unit definition is fairly consistent across all five PRTRs; each PRTR collects information from point sources as shown in Table 4. However, there are subtle differences between the types of facilities, industrial processes, and equipment that are subject to reporting under each PRTR. For example, Canada's NPRI includes portable facilities (e.g., portable concrete batching plants) while the U.S. TRI includes only stationary sites. As a result, some PRTRs may contain data for facilities that would be absent from other PRTRs due to differences in reporting unit definitions.

For the purposes of this pilot, all facilities were included in the analysis under the assumption that the reporting unit definitions from each PRTR are similar enough to compare data reported by all facilities.

To improve comparability for future analyses, the universe of facilities could be limited to the facilities in each PRTR that meet the reporting unit definition for all five PRTRs. However, creating a dataset in which reporting units are equivalent would entail conducting detailed research and analysis of every facility in the PRTRs.

Table 4. Reporting Unit Definitions

PRTR System	Reporting Unit Definition
Australia NPI	Any building, land or offshore site from which an NPI substance may be emitted, together with any machinery, plant, appliance, equipment, implement, tool or other item used in connection with any activity carried out.
Canada NPRI	A contiguous facility, a portable facility, a pipeline installation or an offshore installation.
EU E-PRTR	One or more installations on the same site that are operated by the same natural or legal person.
Japan PRTR	A unit place where a business activity that falls under a designated business category is run. In principle, it continuously runs the business activity within the same or adjacent premises under a unit administrative body (such as an enterprise).
U.S. TRI	All buildings, equipment, structures, and other stationary items which are located on a single site or on contiguous or adjacent sites and which are owned or operated by the same person (or by any person which controls, is controlled by, or under common control with such person). A facility may contain more than one establishment.

B.1.2.2 Reporting Thresholds

The types of reporting thresholds and the threshold values vary considerably among the five PRTRs as shown in Table 5 and Table 6. The most common reporting thresholds are employee thresholds and chemical specific thresholds. Additional sector-specific thresholds may also apply; for example, thermal power stations are required to report to E-PRTR only if they exceed a heat input threshold of 50 megawatts (MW).

Differences in reporting thresholds impact the comparability of the reporting universes under each PRTR; a facility that exceeds the employee and a chemical specific threshold established for one PRTR may not meet the reporting requirements under one or more of the other PRTRs. For this pilot analysis, all facilities that reported under each sector were included.

To improve comparability in future analyses, the universe of facilities could be limited to only those facilities that exceed all reporting thresholds used across all PRTRs. It is straightforward to identify which facilities have exceeded release thresholds; PRTRs collect release data from each facility. For example, to identify facilities that exceed the E-PRTR threshold for mercury releases to air, it would be possible to select each facility in the other PRTRs that reported air releases greater than 10 kg (22 lbs). However, considerably more effort would be needed to identify facilities that exceed other thresholds. Detailed research would be needed to gather, for example, the employee data and chemical manufacture, process, use, and concentration data that would be compared to employment and chemical activity reporting thresholds; these data are not readily available from most PRTRs.

Table 5. Employee Thresholds

PRTR	Employee Threshold
Australia NPI	No employee threshold
Canada NPRI	20 000 employee hours
EU E-PRTR	No employee threshold
Japan PRTR	21 employees
U.S. TRI	10 full-time equivalent employees

Table 6. Chemical Specific Thresholds

PRTR	Chemical Specific Thresholds	Aniline	Benzene	Mercury and Compounds
Australia: NPI	Usage (kg/year)	10,000	10,000	5
	Fuel Combusted: Annual (kg/year)	NA	NA	2,000,000
	Energy Use (MWh)	NA	NA	60,000
	Power Rating (MW)	NA	NA	20
Canada: NPRI	Manufacture, Process, or Otherwise Use (kg/year)	10,000	10,000	5
	Concentration	1.0%	1.0%	0.0%
EU: E-PRTR	Release to Air (kg/year)	NA	1,000	10
	Release to Water (kg/year)	NA	200	1
	Release to Land (kg/year)	NA	200	1
Japan: PRTR	Usage (kg/year)	1,000	500	1,000
	Concentration	1%	0%	1%
U.S.: TRI	Manufacture (kg/year)*	11,340	11,340	5
	Process (kg/year)*	11,340	11,340	5
	Otherwise Use (kg/year)*	4,536	4,536	5
	De Minimis % Limit	1.0%	0.1%	NA

NA = Not Applicable * quantities converted from pounds to kilograms

B.1.2.3 Sector Coverage

Four sectors were selected for inclusion in this analysis based on the frequency of reporting for aniline, benzene, or mercury and compounds by facilities in the sector:

- Manufacture of coke and refined petroleum products;
- Manufacture of chemicals and chemical products;
- Electric power generation, transmission and distribution; and
- Waste collection, treatment, and disposal activities.

To identify differences in coverage of the sectors across PRTRs, whether the sectors are reportable under each PRTR was reviewed.

Manufacture of coke and refined petroleum products was fully covered by all five PRTRs. Coverage varied for manufacture of chemicals and chemical products; electric power generation, transmission and distribution; and waste collection, treatment, and disposal activities as shown in Table 7. For example, waste treatment and disposal is only partially covered by the U.S. TRI; facilities must report only if they are regulated under the Resource Conservation and Recovery Act, subtitle C, 42 U.S.C. 6921 et seq. Similarly, electric power generation, transmission and distribution is only partially covered by the EU; facilities are required to report only if they qualify as thermal power stations or house combustion installations.

Differences in sector coverage affect the universe and comparability of facilities reporting to each PRTR under the selected sectors. For the purposes of this pilot analysis, all facilities in the sectors were included under the assumption that the overlap in sector coverage across PRTRs was similar enough to compare data reported by facilities in the sectors.

To improve universe comparability in future analyses, facilities whose industrial activity would not be covered by all five PRTRs might be excluded from analysis. However, considerable effort would be required to identify whether the facilities in a PRTR are in the subset of an industrial sector that is covered by all five PRTRs; this would entail conducting detailed research on the industrial activities at every facility in sectors that are partially covered by one or more PRTR.

Table 7. Sector Coverage

ISIC Class		Coverage
	Manufacture of coke and refined petroleum products	
1910	Manufacture of coke oven products	Fully covered by all five PRTRs
1920	Manufacture of refined petroleum products	Fully covered by all five PRTRs
	Manufacture of chemicals and chemical products	
2011	Manufacture of basic chemicals	Fully covered by all five PRTRs
2012	Manufacture of fertilizers and nitrogen compounds	Fully covered by all five PRTRs
2013	Manufacture of plastics and synthetic rubber in primary forms	Fully covered by all five PRTRs
2021	Manufacture of pesticides and other agrochemical products	Fully covered by all five PRTRs

Table 7. Sector Coverage

ISIC Class		Coverage
2022	Manufacture of paints, varnishes and coatings, printing ink and mastics	Fully covered by all five PRTRs
2023	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	Fully covered by all five PRTRs
2029	Manufacture of other chemical products not elsewhere classified	Fully covered by all Australia, Canada, Japan, and the U.S. Partially Covered by the EU
2030	Manufacture of man-made fibres	Fully covered by all five PRTRs
Electric power generation, transmission and distribution		
3510	Electric power generation, transmission and distribution	Fully covered by all Australia, Canada, and Japan Partially Covered by the EU and the U.S.
Waste collection, treatment, and disposal activities		
3812	Collection of hazardous waste	Fully covered by all Australia, Canada, the EU, and Japan Partially Covered by the U.S.
3821	Treatment and disposal of non-hazardous waste	Fully covered by all Australia, Canada, the EU, and Japan Partially Covered by the U.S.
3822	Treatment and disposal of hazardous waste	Fully covered by all Australia, Canada, the EU, and Japan Partially Covered by the U.S.

B.1.2.4 Industry Classification

Each PRTR uses a different system to classify facilities' industry sectors. To be consistent when selecting facilities, the International Standard Industrial Classification of All Economic Activities (ISIC) system was used to define the four sectors of interest. The ISIC classes in each sector were cross-walked to the industry classification codes used by each PRTR (Table 8). Facilities were then selected from each PRTR if their industry classification codes corresponded to an ISIC class in the sector of interest.

The industry classification systems used by each PRTR varied in hierarchical organisation of industries. In addition, ISIC classes and PRTRs' industry codes rarely had a 1:1 relationship. Some PRTR industry codes only partially overlap with ISIC classes in the sectors of interest (partial overlap is designated with a "P" in Table 8). For example, Australian and New Zealand Standard Industrial Classification (ANZSIC) code 1311 (wool scouring) partially overlaps with ISIC class 2023 (manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations); ANZSIC code 1311 and ISIC class 2023 both include the industrial activity lanolin manufacturing. However, ANZSIC 1311 also includes other industrial activities (e.g., slag wool manufacturing) that correspond to another ISIC class outside of manufacture of chemicals and chemical products.

In using industry codes cross-walked to ISIC classes to identify facilities in the four sectors of interest, facilities may have been over included; for example, Australian slag wool manufacturers were included in the manufacture of chemicals and chemical products sector, because ANZSIC code 1311 partially overlaps with ISIC class 2023. The industry classification system used by EU E-PRTR is the abbreviated as NACE[13], and the system used by the U.S. TRI and the Canadian NPRI is NAICS[14]. For the purposes of this pilot analysis, all facilities were included that reported under partially overlapping codes, assuming that the universes captured using each PRTR's industry codes were similar enough to compare the data.

To improve universe comparability in future analyses, ISIC classes for facilities with partially overlapping industry classifications could be verified to remove facilities outside the scope of the analysis. However, this would entail conducting detailed research on the industrial activities at every facility with partially overlapping industry classifications.

[13] NACE is derived from the French Nomenclature des Activités Économiques dans la Communauté Européenne.

[14] North American Industry Classification System.

Table 8. Crosswalk Between ISIC Classes and PRTRs' Industry Classification Codes

ISIC Class	Corresponding Industry Codes				
	ANZSIC (Australia)	NACE (EU)	NAICS (U.S.)	NAICS (Canada)	Japan
Manufacture of coke and refined petroleum products					
					2100 Manufacture of petroleum and coal products
1910 Manufacture of Coke Oven Products	1709 Other Petroleum and Coal Product Manufacturing (Mfg.) P 1811 Industrial Gas Mfg. P 1812 Basic Organic Chemical Mfg. P	19.10 Manufacture of Coke Oven Products □	324199 All Other Petroleum and Coal Products Mfg. P 325192 Cyclic Crude and Intermediate Mfg. P	324190 Other Petroleum and Coal Product Mfg. P 325190 Other Basic Organic Chemical Mfg. P	
1920 Manufacture of Refined Petroleum Products	1701 Petroleum Refining and Petroleum Fuel Mfg. □ 1709 Other Petroleum and Coal Product Mfg. P 1811 Industrial Gas Mfg. P	19.20 Manufacture of Refined Petroleum Products □	324110 Petroleum Refineries □ 324191 Petroleum Lubricating Oil and Grease Mfg. □ 324199 All Other Petroleum and Coal Products Mfg. P 325110 Petrochemical Mfg. P	324110 Petroleum Refineries □ 324190 Other Petroleum and Coal Product Mfg. P 325110 Petrochemical Mfg. P	

Table 8. Crosswalk Between ISIC Classes and PRTRs' Industry Classification Codes

ISIC Class	Corresponding Industry Codes				
	ANZSIC (Australia)	NACE (EU)	NAICS (U.S.)	NAICS (Canada)	Japan
Manufacture of chemicals and chemical products					
					2000 Manufacture of chemical and allied products
2011 Manufacture of Basic Chemicals	1709 Other Petroleum and Coal Product Mfg. P	20.11 Manufacture of Industrial Gases □	312140 Distilleries P	312140 Distilleries P	
	1811 Industrial Gas Mfg. P	20.12 Manufacture of Dyes and Pigments □	325110 Petrochemical Mfg. P	325110 Petrochemical Mfg. P	
	1812 Basic Organic Chemical Mfg. P	20.13 Manufacture of Other Inorganic Basic Chemicals □	325120 Industrial Gas Mfg. □	325120 Industrial Gas Mfg. □	
	1813 Basic Inorganic Chemical Mfg. P	20.14 Manufacture of Other Organic Basic Chemicals □	325131 Inorganic Dye and Pigment Mfg. □	325130 Synthetic Dye and Pigment Mfg. □	
	1891 Photographic Chemical Product Mfg. P		325132 Synthetic Organic Dye and Pigment Mfg. □	325181 Alkali and Chlorine Mfg. □	
	1892 Explosive Mfg. P		325181 Alkalies and Chlorine Mfg. □	325189 All Other Basic Inorganic Chemical Mfg. P	
	1899 Other Basic Chemical Product Mfg. Not Elsewhere Classified (N.E.C.) P		325182 Carbon Black Mfg. □	325190 Other Basic Organic Chemical Mfg. P	
	1916 Paint and Coatings Mfg. P		325188 All Other Basic Inorganic Chemical Mfg. P	325313 Chemical Fertilizer (except Potash) Mfg. P	

Table 8. Crosswalk Between ISIC Classes and PRTRs' Industry Classification Codes

ISIC Class	Corresponding Industry Codes				
	ANZSIC (Australia)	NACE (EU)	NAICS (U.S.)	NAICS (Canada)	Japan
			325191 Gum and Wood Chemical Mfg. P 325192 Cyclic Crude and Intermediate Mfg. P 325193 Ethyl Alcohol Mfg. □ 325199 All Other Basic Organic Chemical Mfg. P 325312 Phosphatic Fertilizer Mfg. P 325612 Polish and Other Sanitation Good Mfg. P 325998 All Other Miscellaneous Chemical Product and Preparation Mfg. P	325610 Soap and Cleaning Compound Mfg. P 325999 All Other Miscellaneous Chemical Product Mfg. P	
2012 Manufacture of Fertilizers and Nitrogen Compounds	1813 Basic Inorganic Chemical Mfg. P 1831 Fertiliser Mfg. P	20.15 Manufacture of Fertilisers and Nitrogen Compounds □	325188 All Other Basic Inorganic Chemical Mfg. P 325311 Nitrogenous. Fertilizer Mfg. □	325189 All Other Basic Inorganic Chemical Mfg. P 325313 Chemical Fertilizer (except Potash) Mfg. P	

Table 8. Crosswalk Between ISIC Classes and PRTRs' Industry Classification Codes

ISIC Class	Corresponding Industry Codes				
	ANZSIC (Australia)	NACE (EU)	NAICS (U.S.)	NAICS (Canada)	Japan
	1892 Explosive Mfg. P		325312 Phosphatic Fertilizer Mfg. P 325314 Fertilizer (Mixing Only) Mfg. □	325314 Mixed Fertilizer Mfg. □	
2013 Manufacture of Plastics and Synthetic Rubber in Primary Forms	1821 Synthetic Resin and Synthetic Rubber Mfg. □ 1829 Other Basic Polymer Mfg. P	20.16 Manufacture of Plastics in Primary Forms □ 20.17 Manufacture of Synthetic Rubber in Primary Forms □	325211 Plastics Material and Resin Mfg. □ 325212 Synthetic Rubber Mfg. □ 325991 Custom Compounding of Purchased Resins □	325210 Resin and Synthetic Rubber Mfg. □ 325991 Custom Compounding of Purchased Resins □	2200 Manufacture of plastic products 2300 Manufacture of rubber products
2021 Manufacture of Pesticides and Other Agrochemical Products	1832 Pesticide Mfg. □	20.20 Manufacture of Pesticides and Other Agrochemical Products □	325320 Pesticide and Other Agricultural Chemical Mfg. □ 325612 Polish and Other Sanitation Good Mfg. P	325320 Pesticide and Other Agricultural Chemical Mfg. □ 325610 Soap and Cleaning Compound Mfg. P	
2022 Manufacture of Paints, Varnishes and Similar Coatings, Printing Ink and Mastics	1916 Paint and Coatings Mfg. P	20.30 Manufacture of Paints, Varnishes and Similar Coatings, Printing Ink and Mastics □	325191 Gum and Wood Chemical Mfg. P 325510 Paint and Coating Mfg. □	325190 Other Basic Organic Chemical Mfg. P 325510 Paint and Coating Mfg. □	

Table 8. Crosswalk Between ISIC Classes and PRTRs' Industry Classification Codes

ISIC Class	Corresponding Industry Codes				
	ANZSIC (Australia)	NACE (EU)	NAICS (U.S.)	NAICS (Canada)	Japan
			325520 Adhesive Mfg. P	325520 Adhesive Mfg. P	
			325910 Printing Ink Mfg. □	325910 Printing Ink Mfg. □	
			325998 All Other Miscellaneous Chemical Product and Preparation Mfg. P	325999 All Other Miscellaneous Chemical Product Mfg. P	
			339942 Lead Pencil and Art Good Mfg. P	339940 Office Supplies (except Paper) Mfg. P	
2023 Manufacture of Soap and Detergents, Cleaning and Polishing Preparations, Perfumes and Toilet Preparations	1311 Wool Scouring P	20.41 Manufacture of Soap and Detergents, Cleaning and Polishing Preparations □	325611 Soap and Other Detergent Mfg. □	325610 Soap and Cleaning Compound Mfg. P	
	1851 Cleaning Compound Mfg. □	20.42 Manufacture of Perfumes and Toilet Preparations □	325612 Polish and Other Sanitation Good Mfg. P	325620 Toilet Preparation Mfg. □	
	1852 Cosmetic and Toiletry Preparation Mfg. □		325613 Surface Active Agent Mfg. P	325999 All Other Miscellaneous Chemical Product Mfg. P	
	2412 Medical and Surgical Equipment Mfg. P		325620 Toilet Preparation Mfg. □	332999 All Other Miscellaneous Fabricated Metal Product Mfg. P	

Table 8. Crosswalk Between ISIC Classes and PRTRs' Industry Classification Codes

ISIC Class	Corresponding Industry Codes				
	ANZSIC (Australia)	NACE (EU)	NAICS (U.S.)	NAICS (Canada)	Japan
			325998 All Other Miscellaneous. Chemical Product and Preparation Mfg. P 332999 All Other Miscellaneous Fabricated Metal Product Mfg. P 339999 All Other Miscellaneous Mfg. P	339990 All Other Miscellaneous Mfg. P	

Table 8. Crosswalk Between ISIC Classes and PRTRs' Industry Classification Codes

ISIC Class	Corresponding Industry Codes								
	ANZSIC (Australia)		NACE (EU)		NAICS (U.S.)		NAICS (Canada)		Japan
2029 Manufacture of other Chemical Products Not Elsewhere Classified	1709 Other Petroleum and Coal Product Mfg.	P	20.51 Manufacture of Explosives	□	325199 All Other Basic Organic Chemical Mfg.	P	325190 Other Basic Organic Chemical Mfg.	P	
	1891 Photographic Chemical Product Mfg.	P	20.52 Manufacture of Glues	□	325413 In-Vitro Diagnostic Substance Mfg.	P	325410 Pharmaceutical and Medicine Mfg.	P	
	1892 Explosive Mfg.	P	20.53 Manufacture of Essential Oils	□	325520 Adhesive Mfg.	P	325520 Adhesive Mfg.	P	
	1899 Other Basic Chemical Product Mfg. N.E.C.	P	20.59 Manufacture of Other Chemical Products N.E.C.	□	325612 Polish and Other Sanitation Good Mfg.	P	325610 Soap and Cleaning Compound Mfg.	P	
	1915 Adhesive Mfg.	□			325613 Surface Active Agent Mfg.	P	325920 Explosives Mfg.	□	
	1916 Paint and Coatings Mfg.	P			325920 Explosives Mfg.	□	325999 All Other Miscellaneous Chemical Product Mfg.	P	
					325992 Photographic Film, Paper, Plate, and Chemical Mfg.	P	332999 All Other Miscellaneous. Fabricated Metal Product Mfg.	P	
					325998 All Other Miscellaneous Chemical Product and Preparation Mfg.	P			
					332992 Small Arms Ammunition Mfg.	P			

Table 8. Crosswalk Between ISIC Classes and PRTRs' Industry Classification Codes

ISIC Class	Corresponding Industry Codes				
	ANZSIC (Australia)	NACE (EU)	NAICS (U.S.)	NAICS (Canada)	Japan
			332993 Ammunition (except Small Arms) Mfg. P		
2030 Manufacture of Man-Made Fibres	1829 Other Basic Polymer Mfg. P	20.60 Manufacture of Man-Made Fibres □	325221 Cellulosic Organic Fiber Mfg. P 325222 Noncellulosic Organic Fiber Mfg. □	325220 Artificial and Synthetic Fibres and Filaments Mfg. P	

Table 8. Crosswalk Between ISIC Classes and PRTRs' Industry Classification Codes

ISIC Class	Corresponding Industry Codes				
	ANZSIC (Australia)	NACE (EU)	NAICS (U.S.)	NAICS (Canada)	Japan
Electric power generation, transmission and distribution					
3510 Electric Power Generation, Transmission and Distribution	2611 Fossil Fuel Electricity Generation □	35.11 Production of Electricity □	221111 Hydroelectric Power Generation □	221111 Hydro-Electric Power Generation □	3500 Electricity industry
	2612 Hydro-Electricity Generation □	35.12 Transmission of Electricity □	221112 Fossil Fuel Electric Power Generation □	221112 Fossil-Fuel Electric Power Generation □	
	2619 Other Electricity Generation P	35.13 Distribution of Electricity □	221113 Nuclear Electric Power Generation □	221113 Nuclear Electric Power Generation □	
	2620 Electricity Transmission □	35.14 Trade of Electricity □	221119 Other Electric Power Generation □	221119 Other Electric Power Generation □	
	2630 Electricity Distribution □		221121 Electric Bulk Power Transmission and Control □	221121 Electric Bulk Power Transmission and Control □	
	2640 On Selling Electricity and Electricity Market Operation □		221122 Electric Power Distribution □	221122 Electric Power Distribution □	

Table 8. Crosswalk Between ISIC Classes and PRTRs' Industry Classification Codes

ISIC Class	Corresponding Industry Codes								
	ANZSIC (Australia)		NACE (EU)		NAICS (U.S.)		NAICS (Canada)		Japan
Waste collection, treatment, and disposal activities									
3812 Collection of Hazardous Waste	2911 Solid Waste Collection Services	P	38.12 Collection of hazardous waste	□	562112 Hazardous Waste Collection	□	562110 Waste Collection	P	
	2919 Other Waste Collection Services	P							
	2921 Waste Treatment and Disposal Services	P							
	2922 Waste Remediation and Materials Recovery Services	P							
3821 Treatment and Disposal of Non-Hazardous Waste	1831 Fertiliser Manufacturing	P	38.21 Treatment and disposal of non-hazardous waste	□	562212 Solid Waste Landfill	□	562210 Waste Treatment and Disposal	P	8716 Household waste disposal industry
	2619 Other Electricity Generation	P			562213 Solid Waste Combustors and Incinerators	□			
	2921 Waste Treatment and Disposal Services	P			562219 Other Nonhazardous Waste Treatment and Disposal	P			
	2922 Waste Remediation and Materials Recovery Services	P							
3822 Treatment and Disposal of Hazardous Waste	2921 Waste Treatment and Disposal Services	P	38.22 Treatment and disposal of hazardous. waste	□	562211 Hazardous. Waste Treatment and Disposal	□	562210 Waste Treatment and Disposal	P	8722 Industrial waste disposal industry

Table 8. Crosswalk Between ISIC Classes and PRTRs' Industry Classification Codes

ISIC Class	Corresponding Industry Codes				
	ANZSIC (Australia)	NACE (EU)	NAICS (U.S.)	NAICS (Canada)	Japan
	2922 Waste P Remediation and Materials Recovery Services				

N.E.C. = Not Elsewhere Classified, Mfg. = Manufacturing

B.1.3 Reported Data

B.1.3.1 Release, Transfer and Other Waste Management Data Elements

To determine which types of release, transfer, and waste management data to include in the trend analysis, the data elements available from each PRTR were reviewed. While all five PRTRs collect data on the quantities of chemicals released to the environment and transferred from facilities, only the U.S. and Canada collect quantitative information on other waste management activities. Therefore, the analysis was limited to release and transfer quantities.

The release and transfer data elements collected by each PRTR were then reviewed to identify data elements that are common across the PRTRs. Each PRTR collected some measure of air releases, water releases, land releases, and off-site transfers (Table 9, Table 10). Data from each PRTR were compiled for these four data elements.

The level of detail and number of release and transfer data elements varied among PRTRs. Most notably, transfers from Australia's NPI, Canada's NPRI, and the U.S. TRI include transfers for wastewater treatment and transfers to other off-site locations for waste treatment, recycling, energy recovery, and disposal (Table 10). In contrast, the EU's E-PRTR collects chemical specific transfer data only for transfers for wastewater treatment.[15] For this pilot analysis, total transfers reported to each PRTR across all types of receiving destinations were included in the analysis. As a result, transfer quantities from EU's E-PRTR are expected to be lower than other PRTRs because E-PRTR transfer quantities include only transfers for wastewater treatment.

To improve the comparability of off-site transfers in future analyses, transfers quantities could be limited to just transfers for wastewater treatment. However, it is important to consider how much data would be lost with this adjustment; for many chemicals and sectors, transfers to publicly owned treatment works (POTWs) make up only a small fraction of off-site transfers. For example, of the chemical manufacturing facilities that reported transfers of benzene to TRI during 2002-2012, only 15% of facilities reporting transfers reported transfers to POTWs and only 0.06% of the total transfers were sent to POTWs.

15 Note that the EU's E-PRTR also collects data on off-site transfers of hazardous waste and of non-hazardous waste destined for disposal or recovery. However, these transfer quantities are not broken out by chemical; it is not feasible to determine the quantities of aniline, benzene, or mercury and compounds transferred off-site for disposal or recovery from available E-PRTR transfer data.

Table 9. Release Data Elements

PRTR	Air Releases	Water Releases	Land Releases
Australia NPI	• Air Emissions (Stack or Point Source) • Air Emissions (Fugitive or Nonpoint Source)	• Water Emissions	• Land Emissions
Canada NPRI	• On-Site Air Releases: Stack / Point • On-Site Air Releases: Storage / Handling • On-Site Air Releases: Fugitive • On-Site Air Releases: Spills • On-Site Air Releases: Other Non-Point	• Releases To Surface Waters: Direct Discharges • Releases To Surface Waters: Spills • Releases To Surface Waters: Leaks	• Releases To Land: Spills • Releases To Land: Leaks • Releases To Land: Other
EU E-PRTR	• Releases to Air	• Releases to Water	• Releases to Land
Japan PRTR	• Air Emission	• Water Bodies	• Land
U.S. TRI	• Fugitive Air Emissions • Point Source Air Emissions	• Surface Water Discharges	• RCRA Subtitle C Landfills • Other Landfills • Land Treatment • RCRA Subtitle C Surface Impoundments • Other Surface Impoundments • 5.5.4 Other Land Disposal

Table 10. Transfer Data Elements

Australia NPI	Canada NPRI	EU E-PRTR	Japan PRTR	U.S. TRI
• Off-site Destruction • Off-site Energy recovery • Off-site Immobilisation • Off-site Landfill • Off-site Long term waste storage • Off-site Partial purification • Off-site Purification • Off-site Recycling • Off-site Remediation • Off-site Reprocessing • Off-site Reuse • Off-site Sewerage • Off-site Tailings storage • Off-site Treatment • Off-site Underground injection	• Off-site disposals • Containment (Other storage) • Land treatment (Farm) • Underground injection • Containment (storage) • Tailings Management • Waste Rock Management • Off-site transfers for treatment prior to final disposal • Physical treatment • Chemical treatment • Biological treatment • Incineration/thermal • Municipal Sewage Treatment Plants • Off-site transfers for recycling and energy recovery • Recycling (only for 1996) • Energy Recovery • Recovery of Solvents • Recovery of organic substances (not solvents) • Recovery of metals and metal compounds • Recovery of inorganic materials (not metals) • Recovery of acids or bases • Recovery of catalysts	• Off-site transfer of pollutant destined for waste-water treatment • Off-site transfers of hazardous waste destined for disposal or recovery* • Off-site transfers of non-hazardous waste destined for disposal or recovery*	• Waste • POTWs	• Transfers to Recycling • Transfers to Energy Recovery • Transfers to Treatment (including Destruction) • Transfers to POTWs Non Metals • POTWs (Metal and Metal Compounds) • Other Off-site Transfers • Transfers Off-Site for Disposal or Other Releases

	• Recovery of pollution abatement residues • Refining or re-use of used oil • Other

* Note that off-site transfers of hazardous waste and of non-hazardous waste destined for disposal or recovery are not broken out by chemical in EU's E-PRTR; it is not feasible to determine the quantities of aniline, benzene, or mercury and compounds transferred off-site for disposal or recovery from available E-PRTR transfer data.

B.1.4 Unit of Measure

The units of measure used to report release and transfer quantities varied among the PRTRs (Table 11). Data were presented in kilograms for all records from Australia, the EU, and Japan. Canada's NPRI presented some records in kilograms and other records in metric tonnes. The U.S. TRI presented all records in pounds.

For comparability within the common dataset, all release and transfer quantities were converted to kilograms. Quantities in metric tonnes from Canada were converted using the conversion factor 1 metric tonne = 1,000 kilograms. Quantities in pounds from the U.S. were converted using the conversion factor 1 pound = 0.453592 kilograms.

Table 11. Quantitative Units

PRTR System	Quantitative Units
Australia NPI	Kilograms
Canada NPRI	Kilograms or metric tonnes; varies
EU E-PRTR	Kilograms
Japan PRTR	Kilograms
U.S. TRI	Pounds

B.1.5 Timeframe

B.1.5.1 Available Years

The timeframe for this pilot analysis was ten years to study trends in releases and transfers reported to PRTRs. The years for which data were available varied among PRTR (Table 12). EU's E-PRTR is the most recently established PRTR; E-PRTR release and transfer data are available for only 2007-2011. Australia's NPI has release data dating back to 1999, but only began collecting transfer data in 2009. The other three PRTRs have data available for more than ten years, with 2011 or 2012 as the most recent year.

Since most PRTRs have release and transfer data spanning 2002-2011, this ten year span was selected as the timeframe for studying trends in this analysis. The common dataset includes release data for years 2002-2011 from Australia, Canada, Japan, and the U.S., but only includes release data for years 2007-2011 from the EU. It also includes transfer data for years 2002-2011 from Canada, Japan, and the U.S., but only includes transfer data for years 2007-2011 from the EU and for years 2009-2012 from Australia.

Table 12. Years of Data Available (as of March 2013)

PRTR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Release Data																										
Australia NPI													✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Canada NPRI							✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
EU E-PRTR																					✓	✓	✓	✓	✓	
Japan PRTR															✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
U.S. TRI	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Transfer Data																										
Australia NPI																							✓	✓	✓	✓
Canada NPRI							✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
EU E-PRTR																					✓	✓	✓	✓	✓	
Japan PRTR															✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
U.S. TRI	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Checkmarks indicate data were available from the PRTR in the year. Vertical lines indicate the timeframe studied in this analysis: 2002-2011.

B.1.5.2 Reporting Period

The five PRTRs included in this analysis collect data annually; however, the reporting period varies among PRTRs. Canada, the EU, and the U.S. collect data that quantify releases and transfers in a given calendar year. Australia and Japan collect release and transfer data for federal fiscal years (Table 13). This variation in reporting period complicates comparison of data across PRTRs. For example, if an event were to trigger a decrease in releases during August through November of 2011, the decrease would be evident in the RY2011 U.S. TRI data and the 2012 Australia NPI data.

For this pilot analysis, no adjustments were made to release and transfer quantities reported for fiscal years under the assumption that the differences between fiscal and calendar year reporting would not majorly impact trends in releases and transfers studied over ten years.

To improve comparability of annual release and transfer quantities across PRTRs in future analyses, release and transfer quantities reported for fiscal years might be redistributed to better reflect calendar years. For example, NPI release and transfer data might be averaged between fiscal year 2012 and fiscal year 2011 to produce data for calendar year 2011. However, this redistribution of release and transfer data would be impractical for many applications; release and transfer quantities for each facility are not readily broken down by month, and not all facilities report the same chemicals every year. This type of adjustment would be most useful for analyses that focus on a small set of facilities that report to PRTRs every year.

Table 13. Reporting Period

PRTR System	Reporting Period
Australia NPI	Fiscal Year (July 1st to June 30th) or Calendar Year (January 1st – December 31st)†
Canada NPRI	Calendar Year (January 1st – December 31st)
EU E-PRTR	Calendar Year (January 1st – December 31st)
Japan PRTR	Fiscal Year (April 1st to March 31st)
U.S. TRI	Calendar Year (January 1st – December 31st)

PRTR System	Reporting Period

† Most NPI facility reports are for fiscal year.

B.1.6 Format of Published Data

Data format varied across PRTR systems (Table 14). To create the common dataset housing data from the five PRTRs:

- Data were transferred from each PRTR into a common format, Excel spreadsheets;
- Data were narrowed to pertinent records (facilities in the sectors of interest that reported aniline, benzene, or mercury) and data elements (year, facility ID, industry sector, chemical name, and release and transfer quantities);
- Data were restructured (e.g., moved release and transfer data from rows to columns) so that there was a single row for each facility, year, and chemical; and
- Data were combined into a single spreadsheet, fitting available data into a common data structure.

Four of the five PRTRs published records in English for each facility and chemical that reported to the PRTR (Table 14). For these four PRTRs, records were included for each facility and chemical in the common dataset. In contrast, Japan's English PRTR website presented only aggregate records with totals by chemicals and sector. For Japan, aggregate records were included for each chemical and industry sector in the common dataset.

For future analyses that depend on facility level data, a dataset with records for each facility and chemical might be requested from Japan's Ministry of the Environment..

Table 14. Format of Published Data Available in English

PRTR	Granularity	Format
Australia NPI	Records for each facility and chemical	XML download
Canada NPRI	Records for each facility and chemical	Access database
EU E-PRTR	Records for each facility and chemical	Access database
Japan PRTR	Aggregate records with totals by chemical and sector	CSV download
U.S. TRI	Records for each facility and chemical	Custom data access tool (TRI.Net) with Excel exports

B.2 Results

B.2.1 Common Dataset

The common dataset includes over 15,000 records with ten years of release and transfer data for mercury, benzene, and aniline. The frequency of reporting and reported release and transfer quantities varied among the three chemicals, the sectors of interest, and the five PRTRs. To illustrate this variation, Table 15, Table 16, and Table 17 present the range of reporting frequency and reported quantities across reporting years for each PRTR and industry sector.

In general, data were most frequently reported to the five PRTRs for:

- Air releases and transfers of benzene from chemicals and chemical products manufacturers and coke and refined petroleum products manufacturers (Table 16).

- Air releases and transfers of mercury and compounds from chemicals and chemical products manufacturers and electric power generation, transmission and distribution facilities (Table 17).

- In contrast, no PRTR data were available for:

- Releases or transfers of aniline at waste collection, treatment, and disposal facilities in Australia, the EU or Japan (Table 15).

- Releases or transfers of aniline at chemicals and chemical products manufacturing facilities in Australia or the EU (Table 15).

- Releases or transfers of mercury and compounds at electric power generation, transmission and distribution facilities in Japan (Table 17).

Aniline

Although aniline was covered by four of the five select PRTRs, few data were available for this chemical during 2002-2011 (Table 15):

- No chemicals and chemical products manufacturing facilities reported aniline to Australia's NPI;
- No waste collection, treatment, and disposal facilities reported aniline to Australia's NPI;
- No waste collection, treatment, and disposal facilities reported aniline to Japan's PRTR; and
- In each year, no more than two facilities in each sector reported air releases, water releases, land releases, or transfers of aniline to Canada's NPRI.

Data were more frequently reported for chemical products manufacturing facilities in Japan and the U.S. Over 20 facilities in each PRTR reported greater than zero air releases or transfers in each year from 2002-2011.

Table 15. Distribution of PRTR Reporting Across 2002-2011: Aniline

	Australia NPI[1]		Canada NPRI		EU E-PRTR[2]		Japan PRTR		U.S. TRI	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Manufacture of chemicals and chemical products										
Facilities Reporting >0 Air Releases	0	0	0	2	-	-	27	36	27	42
Facilities Reporting >0 Water Releases	0	0	0	0	-	-	4	7	8	14
Facilities Reporting >0 Land Releases	0	0	0	0	-	-	0	0	3	5
Facilities Reporting >0 Transfers	0	0	1	1	-	-	40	54	24	32
Total Air Releases (kg)	0	0	0	262	-	-	2,578	3,451	41,232	83,388
Total Water Releases (kg)	0	0	0	0	-	-	6,814	35,094	534	2,960
Total Land Releases (kg)	0	0	0	0	-	-	0	0	16	8,497
Total Transfers (kg)	0	0	2,070	66,356	-	-	366,652	1,057,812	1,094,623	1,612,152

Table 15. Distribution of PRTR Reporting Across 2002-2011: Aniline

	Australia NPI[1]		Canada NPRI		EU E-PRTR[2]		Japan PRTR		U.S. TRI	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Waste collection, treatment, and disposal activities										
Facilities Reporting >0 Air Releases	0	0	0	1	-	-	0	0	2	8
Facilities Reporting >0 Water Releases	0	0	0	0	-	-	0	0	0	0
Facilities Reporting >0 Land Releases	0	0	0	0	-	-	0	0	0	1
Facilities Reporting >0 Transfers	0	0	0	1	-	-	0	0	2	5
Total Air Releases (kg)	0	0	0	4	-	-	0	0	3	151
Total Water Releases (kg)	0	0	0	0	-	-	0	0	0	0
Total Land Releases (kg)	0	0	0	0	-	-	0	0	0	4,536
Total Transfers (kg)	0	0	0	14,285	-	-	0	0	397	59,708

Notes:

1. Distributions of facilities reporting >0 transfers and total transfers are limited to 2009-2011; transfer data were not available from Australia's NPI prior to 2009.
2. Aniline is not covered by the EU's E-PRTR.

Benzene

Air releases and transfers of benzene were reported to all five PRTRs in every year by both chemicals and chemical products manufacturing facilities and by coke and refined petroleum products manufacturing facilities. In each year, air release data were reported by more than 40 facilities in each sector to the EU's E-PRTR, Japan's PRTR, and the U.S.'s TRI. Transfer data were most frequently reported by chemicals and chemical products manufacturing facilities in Japan and the U.S. and by coke and refined petroleum products manufacturing facilities in the U.S.

Data on water releases and land releases of benzene were more limited. In some years, no facilities in these sectors reported land releases of benzene to the EU's E-PRTR or Japan's PRTR. In addition, in some years, no chemicals and chemical products manufacturing facilities reported water or land releases to Canada's NPRI.

Table 16. Distribution of PRTR Reporting Across 2002-2011: Benzene

	Australia NPI[1]		Canada NPRI		EU E-PRTR[2]		Japan PRTR		U.S. TRI	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Manufacture of chemicals and chemical products										
Facilities Reporting >0 Air Releases	16	21	9	14	45	58	92	123	131	145
Facilities Reporting >0 Water Releases	2	4	0	2	6	8	21	32	27	43
Facilities Reporting >0 Land Releases	0	1	0	1	0	0	0	0	6	12
Facilities Reporting >0 Transfers	3	5	5	8	15	17	45	71	92	104
Total Air Releases (kg)	220,265	1,219,863	49,562	99,493	462,460	930,410	177,888	772,150	524,029	867,476
Total Water Releases (kg)	261	4,265	0	169	4,136	24,754	2,552	7,105	218	1,386
Total Land Releases (kg)	0	71	0	528	0	0	0	0	27	2,812
Total Transfers (kg)	75	159	2,217	171,358	70,617	231,801	640,390	1,273,559	1,426,475	3,116,373
Manufacture of coke and refined petroleum products										
Facilities Reporting >0 Air Releases	18	21	26	33	69	78	48	104	207	225
Facilities Reporting >0 Water Releases	6	9	7	12	6	9	2	4	83	94
Facilities Reporting >0 Land Releases	2	3	2	6	0	0	0	1	34	41
Facilities Reporting >0 Transfers	8	9	17	22	3	8	2	6	182	197
Total Air Releases (kg)	256,290	1,337,960	112,751	261,727	1,415,680	2,062,760	142,565	378,920	1,083,862	1,551,946
Total Water Releases (kg)	632	4,515	188	820	1,321	11,800	20	4,560	751	15,139
Total Land Releases (kg)	6	301	1	778	0	0	0	72	713	7,977
Total Transfers (kg)	1,278	1,759	16,042	173,067	6,433	50,110	1,104	8,403	632,048	1,447,265

Notes:

1. Distributions of facilities reporting >0 transfers and total transfers are limited to 2009-2011; transfer data were not available from Australia's NPI for years prior to 2009.
2. All distributions are limited to 2007-2011; E-PRTR data were not available for years prior to 2007.

Mercury and Compounds. Air releases and transfers of mercury and compounds were reported to Australia's NPI, Canada's NPRI, the EU's E-PRTR, and the U.S.'s TRI in every year by both chemicals and chemical products manufacturing facilities and by coke and electric power generation, transmission and distribution. Data on water releases and land releases of mercury and compounds were more limited for these four PRTRs. In some years, no facilities in these sectors reported air releases or land releases of mercury and compounds to Canada's NPRI or the EU's E-PRTR.

Data on mercury and compounds from these sectors were very limited in Japan's PRTR. No electric power generation, transmission and distribution facilities reported releases or transfers of mercury and compounds and no more than three chemicals and chemical products manufacturing facilities reported releases or transfers of mercury compounds in any year.

Table 17. Distribution of PRTR Reporting Across 2002-2011: Mercury and Compounds

	Australia NPI[1]		Canada NPRI		EU E-PRTR[2]		Japan PRTR		U.S. TRI	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Manufacture of chemicals and chemical products										
Facilities Reporting >0 Air Releases	48	73	8	12	45	58	0	0	96	111
Facilities Reporting >0 Water Releases	5	9	0	3	51	63	1	1	28	38
Facilities Reporting >0 Land Releases	1	4	0	1	0	0	0	0	26	40
Facilities Reporting >0 Transfers	6	8	11	22	11	24	1	3	109	123
Total Air Releases (kg)	52	386	15	70	3,315	6,661	0	0	1,108	6,117
Total Water Releases (kg)	1	11	0	5	826	2,543	0	0	36	99
Total Land Releases (kg)	0	4	0	2	0	0	0	0	2,772	8,405
Total Transfers (kg)	46	232	231	5,434	47	6,741	0	293	9,535	329,626
Electric power generation, transmission and distribution										
Facilities Reporting >0 Air Releases	78	106	22	32	145	163	0	0	442	491
Facilities Reporting >0 Water Releases	12	17	2	7	12	19	0	0	130	158
Facilities Reporting >0 Land Releases	3	5	0	4	0	0	0	0	278	301
Facilities Reporting >0 Transfers	10	11	13	24	1	6	0	0	251	281
Total Air Releases (kg)	675	1,287	967	2,311	14,689	18,142	0	0	26,142	43,473
Total Water Releases (kg)	7	17	1	19	32	3,829	0	0	90	1,527
Total Land Releases (kg)	0	38	0	31	0	0	0	0	16,363	24,950
Total Transfers (kg)	249	376	232	1,748	229	2,040	0	0	8,071	12,589

Notes:
1. Distributions of facilities reporting >0 transfers and total transfers are limited to 2009-2011; transfer data were not available from Australia's NPI for years prior to 2009.
2. All distributions are limited to 2007-2011; E-PRTR data were not available for years prior to 2007.

B.2.2 Trends across PRTRs

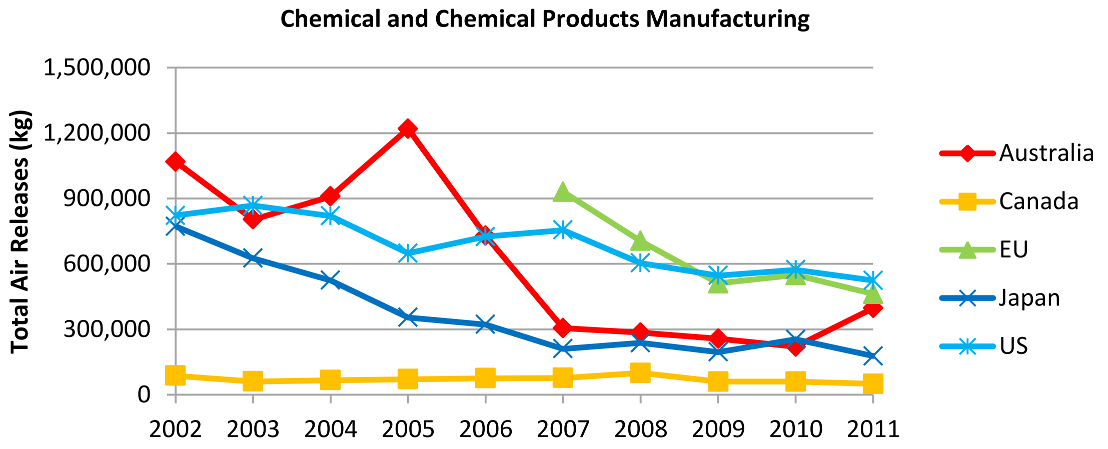
The clearest trends in releases and transfers were evident when comprehensive data were available from the selected PRTRs. For example, during 2002-2011, all five PRTRs showed decreases in benzene air releases for both chemical and chemical products manufacturing facilities and coke and refined petroleum products manufacturing facilities (Table 18, Figure 10). In addition, there were decreases in air releases of mercury and compounds for Australia, Canada, the EU, and the U.S. (Table 19, Figure 11). Although many factors, (e.g., reporting unit definition, sector coverage, reporting thresholds, available years, data formats) complicate integration and direct comparison of PRTR release and transfer data, these consistent trends in air releases among PRTRs indicate that there may be factors driving decreases in air releases of benzene and mercury and compounds from these sectors on a global scale.

It was much more difficult to compare trends in releases and transfers among PRTRs where data were sparse. For example, Japan and the United States both showed slight increases over 2002-2004 followed by slight decreases over 2005-2011 in air releases of aniline reported by chemical and chemical products manufacturing facilities (Table 20, Figure 12). There were not sufficient data on air releases of aniline from this sector to compare these trends against the three other PRTRs; Canada had no more than two facilities in the sector reporting air releases of aniline in any year, and no facilities in this sector from Australia or the EU reported aniline. In the absence of information on aniline air releases from the other three PRTRs, it is unclear whether the similar trend between the United States and Japan is coincidental or might be driven by factors affecting the sector internationally.

Table 18. Trends in Air Releases (kg): Benzene

Year	Chemical and Chemical Products Manufacturing					Coke and Refined Petroleum Products Manufacturing				
	Australia	Canada	EU	Japan	U.S.	Australia	Canada	EU	Japan	U.S.
2002	1,068,743	87,392	-	772,150	822,175	1,159,622	261,727	-	378,920	1,516,471
2003	803,654	61,100	-	625,842	867,476	898,349	218,936	-	340,757	1,551,946
2004	909,030	66,471	-	524,540	819,790	990,512	208,812	-	293,267	1,437,092
2005	1,219,863	71,444	-	354,793	649,002	1,337,960	169,758	-	259,131	1,351,464
2006	729,422	75,768	-	322,296	725,049	809,213	189,492	-	264,277	1,333,533
2007	305,415	77,201	930,410	210,905	755,133	375,207	186,215	1,942,170	246,982	1,350,616
2008	284,600	99,493	704,930	238,005	604,156	323,172	207,262	2,062,760	208,600	1,311,545
2009	256,769	60,430	510,500	195,747	546,649	289,680	154,558	1,709,840	156,318	1,106,458
2010	220,265	60,273	548,810	253,728	573,282	256,290	138,166	1,626,700	142,565	1,148,070
2011	396,860	49,562	462,460	177,888	524,029	429,655	112,751	1,415,680	151,952	1,083,862

Figure 10. Trends in Air Releases: Benzene



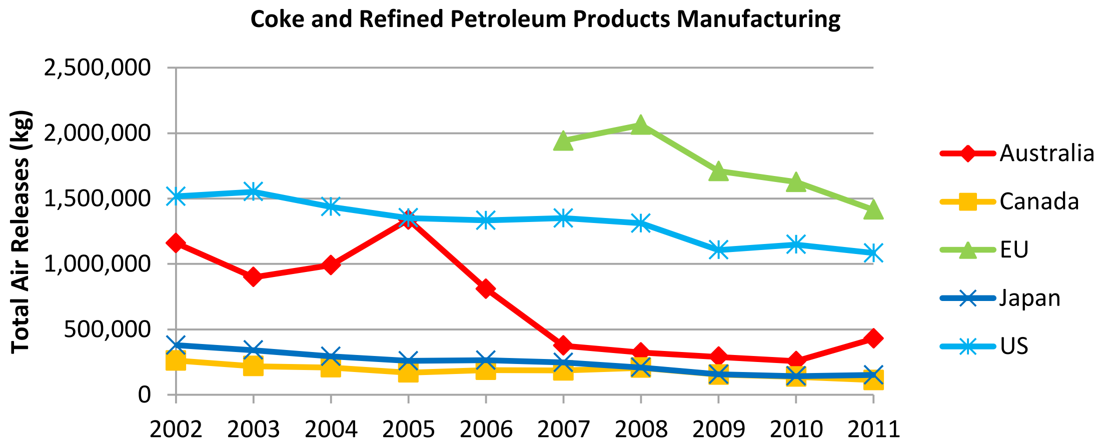
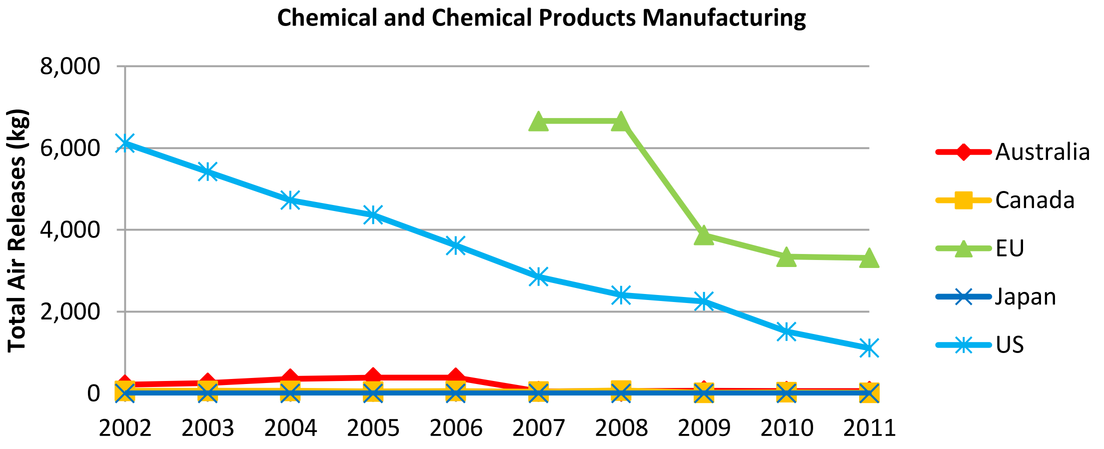


Table 19. Trends in Air Releases (kg): Mercury and Compounds

Year	Chemical and Chemical Products Manufacturing					Electric Power Generation, Transmission and Distribution				
	Australia	Canada	EU	Japan	U.S.	Australia	Canada	EU	Japan	U.S.
2002	211	63	-	0	6,117	1,276	2,038	-	0	40,763
2003	253	64	-	0	5,420	1,237	2,311	-	0	40,881
2004	356	64	-	0	4,722	1,085	2,260	-	0	42,641
2005	386	46	-	0	4,365	1,136	2,097	-	0	43,473
2006	382	58	-	0	3,615	1,287	1,943	-	0	42,261
2007	52	44	6,661	0	2,853	1,151	2,087	17,302	0	42,567
2008	55	70	6,661	0	2,402	891	1,566	18,142	0	40,660
2009	66	15	3,869	0	2,250	921	1,635	14,716	0	32,282
2010	54	26	3,341	0	1,511	738	1,547	14,689	0	30,090
2011	55	16	3,315	0	1,108	675	967	15,130	0	26,142

Figure 11. Trends in Air Releases: Mercury and Compounds



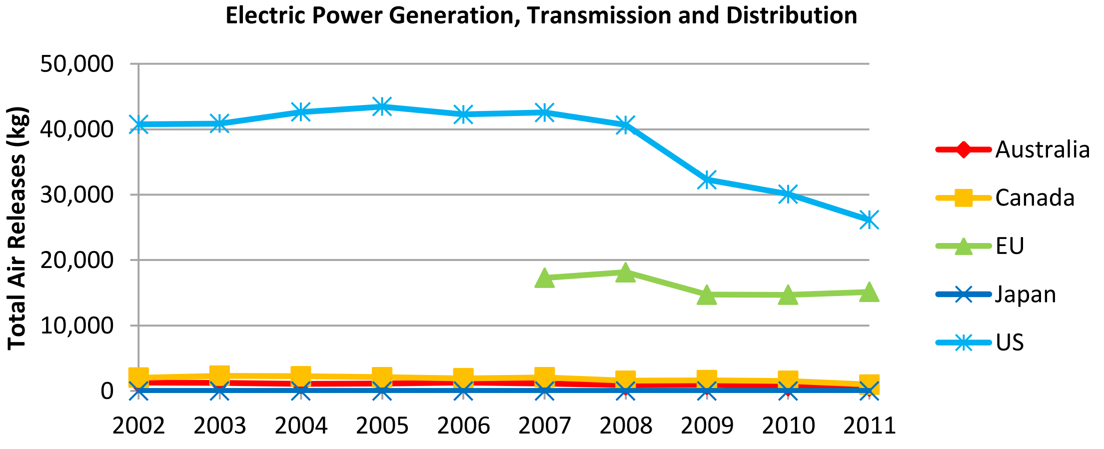
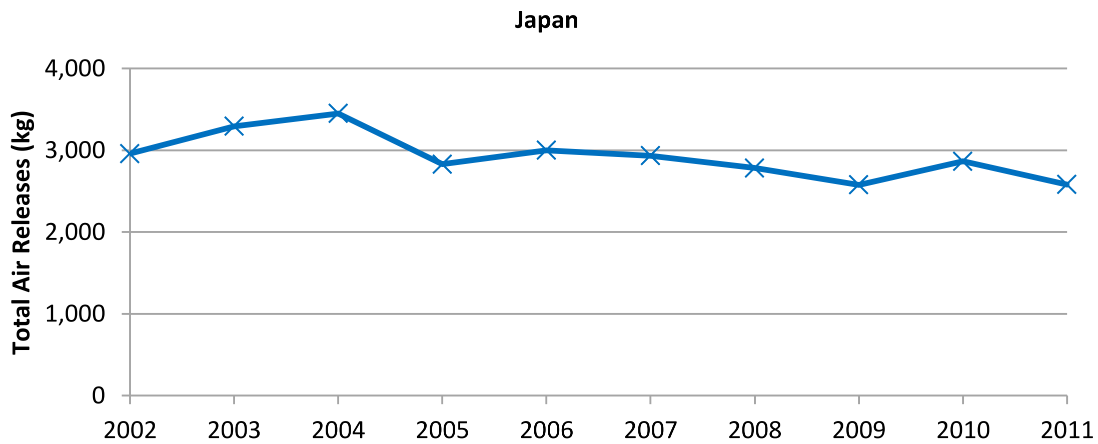
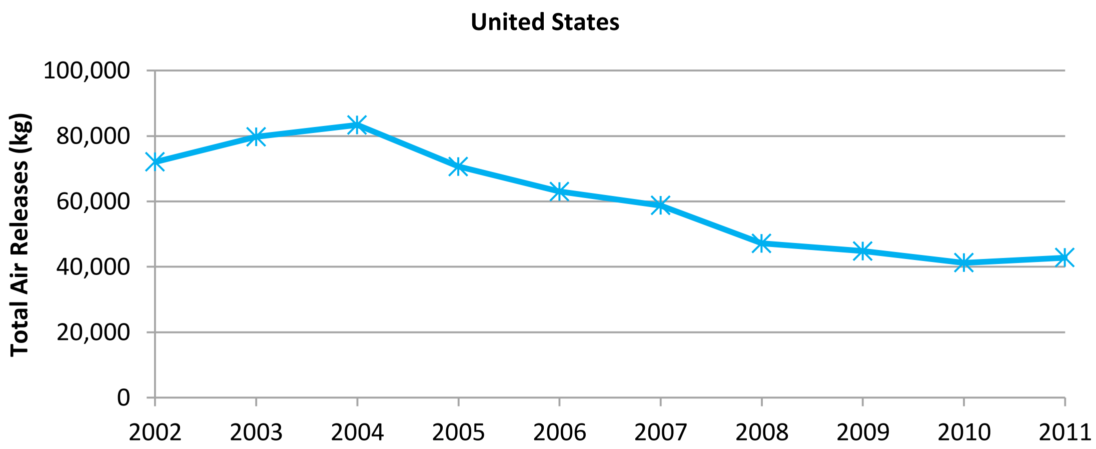


Table 20. Trends in Air Releases of Aniline Reported by Chemical and Chemical Products Manufacturers

Year	Total Releases (kg)					Number of Reporters with >0 Releases				
	Australia	Canada	EU	Japan	U.S.	Australia	Canada	EU	Japan	U.S.
2002	0	262	-	2,959	72,085	0	2	-	29	38
2003	0	12	-	3,293	79,764	0	1	-	36	42
2004	0	1	-	3,451	83,388	0	1	-	32	38
2005	0	1	-	2,829	70,653	0	1	-	30	34
2006	0	0	-	3,000	62,994	0	0	-	31	32
2007	0	20	-	2,934	58,780	0	1	-	27	35
2008	0	25	-	2,782	47,167	0	2	-	30	31
2009	0	20	-	2,578	44,799	0	1	-	29	27
2010	0	11	-	2,864	41,232	0	2	-	30	30
2011	0	0	-	2,581	42,823	0	0	-	29	29

Figure 12. Trends in Air Releases of Aniline Reported by Chemical and Chemical Products Manufacturers





B.3 Findings

B.3.1 Adjusting Data to Improve Comparability among PRTRs

In the process of gathering, combining, and analysing data in this pilot analysis, differences among the PRTRs were identified that might impact international-scale analysis of PRTR data. Chemical coverage, facility universe, reported data, timeframe, and format of published data all varied among PRTRs.

It was possible to make adjustments for some of these differences to increase data comparability among PRTRs. For example, it was straightforward to convert release and transfer quantities to the same reporting units; conversion factors were used to change values in pounds and metric tonnes to values in kilograms.

For other differences, the level of effort required or the feasibility of an adjustment was prohibitive. For example, the universe of facilities was not adjusted to exclude facilities that did not meet the reporting unit definition under every PRTR; a high level of effort would be required to research each facility and make this adjustment. In addition, it was not feasible to redistribute release and transfer data from fiscal years to calendar years; this adjustment could only be made if every facility included in the analysis reported in every year. As a result, data included in the common dataset had some dissimilarities (Table 21).

Table 21. Dissimilarities within the Common Dataset due to Differences among PRTRs

Difference	Dissimilarities in the Common Dataset
Chemical Coverage	Release and transfer quantities for aniline from Canada includes aniline and aniline salts (e.g., aniline sulphate, aniline hydrochloride) while quantities from Australia, Japan, and the U.S. are limited to aniline. EU data are not considered in analyses of aniline; aniline is not covered by E-PRTR. Release and transfer quantities for mercury compounds from some PRTRs include the full mass of mercury compounds while others are limited to only the mass of the mercury element within mercury compounds.
Facility Universe	Some PRTRs may contain data for facilities that would be absent from other PRTRs due to differences in reporting unit definitions. Reporting universes under each PRTR may differ systematically across PRTRs due to variations in PRTR reporting thresholds. Some facilities in the sectors of interest may be absent from EU's E-PRTR or the U.S.'s TRI because these PRTRs only partially cover certain the sectors. Facilities identified using partially overlapping industry codes may be included in the analysis, but not fall within a sector of interest.
Reported Data	Transfer quantities from EU's E-PRTR are expected to be lower than other PRTRs because E-PRTR transfer quantities include only transfers for wastewater treatment.

Difference	Dissimilarities in the Common Dataset
Timeframe	The common dataset includes release data for years 2002-2011 from Australia, Canada, Japan, and the U.S., but only includes release data for years 2007-2011 from the EU The common dataset includes transfer data for years 2002-2011 from Canada, Japan, and the U.S., but only includes transfer data for years 2007-2011 from the EU and for years 2009-2012 from Australia. The common dataset includes calendar year release and transfer quantities for Canada, the EU, and the U.S. and fiscal year quantities for Australia and Japan.
Format of Published Data	The common dataset includes individual facility records for Australia, Canada, the EU, and the U.S. and aggregate records for Japan.

As this pilot analysis was exploratory in nature and reviewed large-scale trends in reporting, it was considered appropriate to assume that the data captured by each PRTR were similar enough to compare overall trends in release and transfers with minimal adjustment. In future analysis, further adjustments may be needed to improve the comparability of PRTR data.

B.3.2 Trends in Releases

Despite the differences among PRTRs studied in this analysis, it was possible to identify similar trends in releases among the five PRTRs. Releases decreased during 2002-2011 for:

- Benzene from chemical and chemical products manufacturing facilities in five PRTRs;
- Benzene from coke and refined petroleum products manufacturing facilities in five PRTRs;
- Mercury and compounds from chemical and chemical products manufacturing facilities in four PRTRs; and
- Mercury and compounds from electric power generation, transmission and distribution facilities in four PRTRs.

These consistent trends in air releases among PRTRs suggest that a common factor could be driving international decreases in air releases of benzene and mercury compounds. Further analysis of PRTR data might be conducted to better understand these trends in air releases. For example, trends in air releases of benzene and mercury compounds could be:

- Reviewed at a more granular geographic scale (e.g., reviewing trends in air releases for each country within the EU) to determine whether trends in air releases of benzene and mercury compounds vary across countries within the EU;
- Reviewed for subsectors within each industry to identify whether any subsectors' air releases are decreasing faster than others';
- Reviewed at the facility level to isolate the effects of trends in releases at large facilities;
- Reviewed using data from additional PRTRs;
- Compared against trends in the number of reporters to determine whether changes in the reporting universe are driving trends in releases; and

- Expanded to include additional industries to determine whether decreases in air releases are unique to the industries reviewed in this pilot analysis.

In addition, a literature review might be conducted to identify factors that could be driving decreases in air releases of benzene and mercury from these sectors on a global scale (e.g., international environmental regulations, technological advances, availability of cleaner fuels).

ANNEX C. CASE STUDY: NORTH AMERICAN TRENDS IN TOXIC RELEASES FROM AUTOMOTIVE MANUFACTURING

This analysis was conducted in January of 2015 to explore if PRTR data could be used to assess what factors are driving the trend in significantly reduced releases of toxic chemicals by facilities in the automotive manufacturing sector.

C.1 Introduction

Sustainability means to create and maintain conditions under which humans and nature can exist in productive harmony and that permit fulfilling social, economic, and other requirements of present and future generations. (National Academy of Sciences, 2011).

Sustainable manufacturing has become an important focus of the automotive industry, with most major automotive manufacturers publishing annual sustainability reports that detail their sustainability goals and accomplishments. These reports focus on the company's progress in areas they select to highlight such as reduced air emissions, zero landfill waste, and green chemistry advances. While information on progress is usually available from the automobile manufacturers making such sustainability commitments, this information is not comparable from one company to the next, as each company defines their own goals, areas to highlight, and methods to measure progress. Therefore, the aggregate impact of these corporate and facility level efforts on the waste management and releases of the sector overall is unknown and unquantified. This report fills this gap by using data from the three Pollutant Release and Transfer Registers (PRTRs) covering North America to examine trends in releases of toxic chemicals by the automotive sector to investigate the drivers affecting changes in release quantities, and to evaluate the impact of pollution prevention (P2) activities.

Source reduction, as defined by the U.S. Pollution Prevention Act of 1990, is any practice that "reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal."

A PRTR is an inventory of information submitted by facilities on the amount of hazardous chemicals and pollutants released on-site to air, water and land, recycled, burned for energy recovery, and transferred off-site for recycling, energy recovery, treatment, or disposal. The specific mandatory data elements required to be reported are established by the country-specific regulations that establish each PRTR. In addition to chemical release and waste management information, PRTRs are powerful tools that also collect pollution prevention-related information, including information on the types of source reduction activities implemented. Among the most important applications of PRTRs is their use to inform decisions, gain insight, identify opportunities, and assess progress related to sustainability.

Industrial facilities in North America report releases and transfers to the PRTR where the facility is located: Canada's National Pollutant Release Inventory (NPRI), the United States' Toxics Release Inventory (TRI), or Mexico's Registro de Emisiones y Transferencia de Contaminantes (RETC). While each of these three programs has different reporting requirements and cannot be compared directly, data from these programs can be used to investigate trends in releases for the automotive sector. This analysis then uses the U.S. TRI data to more closely examine what factors are driving the observed release trends.

C.2 Literature Review

Prior to conducting the data analysis, we conducted a preliminary literature review to identify publications related to sustainable practices in the automotive sector. The literature documents many examples of pollution prevention activities implemented in the past 15 years. These activities include: substituting use of toxic chemicals, especially volatile organic compounds (VOCs), with other chemicals; implementing better management practices to reduce waste; and increasing energy recovery, recycling, and waste treatment.

There are numerous examples of innovations in the automotive sector where companies have replaced toxic chemicals with less toxic alternatives. Examples from the literature include:

- **Paints and primers.** Typically paints and primers contain VOCs, used as a carrier agent. In the application process, virtually all such solvents volatilize and can result in significant amounts of the solvent released to air. Examples from the literature of environmentally-improved paints and primers include:
    - BASF Corporation developed a paint primer that decreased VOCs and eliminated use of diisocyanates (U.S. EPA, OPPT, 2014).
    - PPG Industries Inc. developed a waterborne paint in 2011 that reduced use of VOCs as well as the volume of wastes (U.S. EPA, OPPT, 2014).
    - Manufacturers switched to powder-based primers to decrease VOC releases (MDEQ, 2000).
- **Degreasing.** Progress has also been reported in degreasing operations, which historically require halogenated organic solvents. Now, some facilities have shifted to aqueous-based degreasers (MDEQ, 2000).

- **Biochemical alternative materials.** Mercedes-Benz substituted plastic with flax and sisal-based components in door paneling (Cartensen, 1997), and Nissan has used soy-derived resin in their automobile interiors (U.S. EPA, OPPT, 2014).

There are many cases where automotive manufacturers decreased the wastes they generate by adopting more sustainable practices. Examples from the literature include:

- General Motors adopted sustainable processes that significantly reduced landfill waste by increasing recycling and energy recovery (U.S. EPA, OPPT, 2014).

- A Ford manufacturing plant decreased waste by implementing biological treatment of toxic chemicals (Brouwer, 2002).

- Other manufacturers modified their processes to increase production efficiency by reducing energy use, chemical waste, and metal scrap (MDEQ, 2000).

Although toxic chemicals continue to be used in these examples, they represent efforts towards sustainability and decreased releases to the environment.

While the literature does highlight examples of pollution prevention implemented by specific companies and facilities within the automotive manufacturing industry, there are limited publications regarding the sector's overall of toxic chemical releases and waste management. The emphasis of automotive manufacturing sustainability studies has recently shifted toward greenhouse gas emissions and energy efficiency. Analyzing trends in PRTR data for the industry provides a complementary perspective on sustainability within the automotive manufacturing industry, one that focuses on minimizing impact of chemical use.

C.3 PRTR Analysis Method

In this analysis, we defined the automotive sector as facilities with primary operations in the following North American Industry Classification System (NAICS) codes:

- 3361: motor vehicle manufacturing,
- 3362: motor vehicle body and trailer manufacturing, and
- 3363: motor vehicle parts manufacturing.

In comparing the automotive industry to the manufacturing sector as a whole, we defined the manufacturing industry as facilities classified in NAICS codes 31-33 except for those in NAICS 3361, 3362 and 3363.

Using the Commission for Environmental Cooperation's "Taking Stock" online tool, we downloaded release data for automotive sector facilities for all three national PRTR programs in North America (NPRI, TRI, and RETC) (CEC, 2014). We included the years 2005 through 2011, which at time of this analysis were the most recent years where data were available from all three countries' data systems. There are significant differences between the three PRTR programs, including facility reporting thresholds and reportable chemicals. Therefore, these data cannot be used to make direct comparisons of automobile manufacturing across the three countries. However, they provide each country's relative change in releases.

Next, we conducted a more in-depth analysis (combining PRTR analysis, data from other sources, and the literature review findings) to examine the reasons for the observed decline in releases for the automotive sector in the North American PRTR data. Based on the literature review of the automotive sector's actions to reduce releases, there was evidence that numerous source reduction activities had been implemented. Source reduction, as defined by the U.S. Pollution Prevention Act of 1990, is any practice that "reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal." More informally, it includes a wide variety of pollution prevention techniques for reducing the volume or toxicity of waste by changing the products, raw materials, or processes that generate pollution in the first place.

If facilities throughout the automotive sector have implemented pollution prevention activities focused on reducing toxic chemical releases, as was indicated in the literature, these reductions should be apparent in the PRTR data. A number of explanatory drivers affecting PRTR releases were examined to determine the role of pollution prevention in explaining the sector's declining releases These other factors that could be driving the sector trend are:

- changes in production/economy activity and output of the sector;
- a shift from releases to other waste management methods (e.g., are facilities treating the waste instead of releasing it to the environment);

- outsourcing;
- the influence of a few (large) facilities on the sector-wide trend; and
- pollution prevention advances.

To investigate these drivers, the analysis focuses on the U.S. TRI data only for several reasons. This detailed analysis was restricted to one PRTR in order to eliminate confounding factors caused by differences in reporting requirements among the three programs (e.g., differences in chemical reporting thresholds). We used TRI because it has more up to date data available (through 2013 at the time of the analysis) and TRI contains reported data and associated open text descriptions on source reduction activities implemented by facilities at the chemical level. In addition to identifying likely reasons for the automotive sector's declining releases, the analysis also provides an example of how PRTRs are uniquely well-suited for assessing the progress made by any given industry sectors or specific facilities therein in implementing pollution prevention practices and the effectiveness of such practices.

Note that in TRI, *total releases* include onsite and offsite disposal or other releases, including releases to air, surface water and land. *Production-related waste* quantities include the total release quantities as well as the quantities used for energy recovery, recycled and treated, both onsite and offsite.

C.4 Results

While direct comparisons cannot be made between individual countries' PRTR data, data from the United States, Canada and Mexico can be used to quantify overall trends in releases for the automotive sector. Total reported releases by facilities in the sector decreased from just over 26 million kg (almost 58 million lb) in 2005 to 13 million kg (almost 29 million lb) in 2011, a decrease of 50%. As shown in Figure 13, automotive facilities in the United States account for the greatest quantities of chemical releases, followed by facilities in Canada and then Mexico. U.S. automotive facilities have reported the greatest quantity decrease in releases (a decrease of 10.1 million kg or a 51% decrease), while Canadian facilities have reported the greatest percentage decrease (a decrease of 63%; a 3.8 million kg decrease), as shown in Figure 14. Mexico's PRTR was going through implementation and other changes during the time period, therefore year-to-year comparisons for Mexico are not consistent, but are expected to be comparable in the coming years as their PRTR implementation progresses.

Figure 13

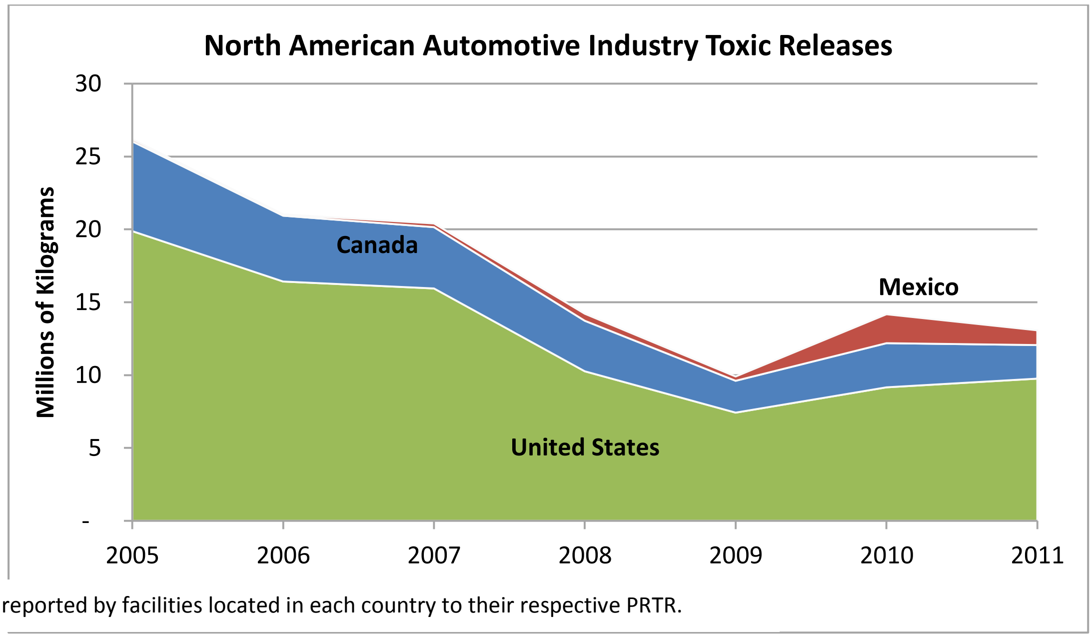
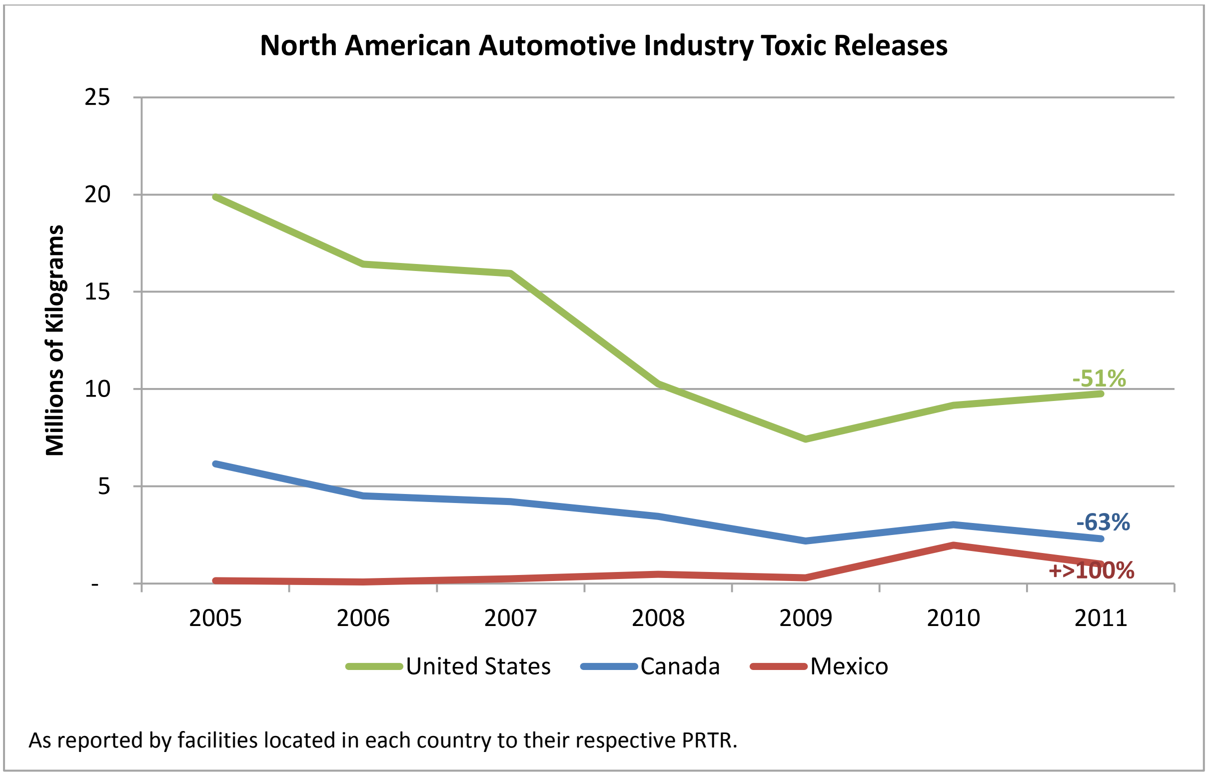


Figure 14

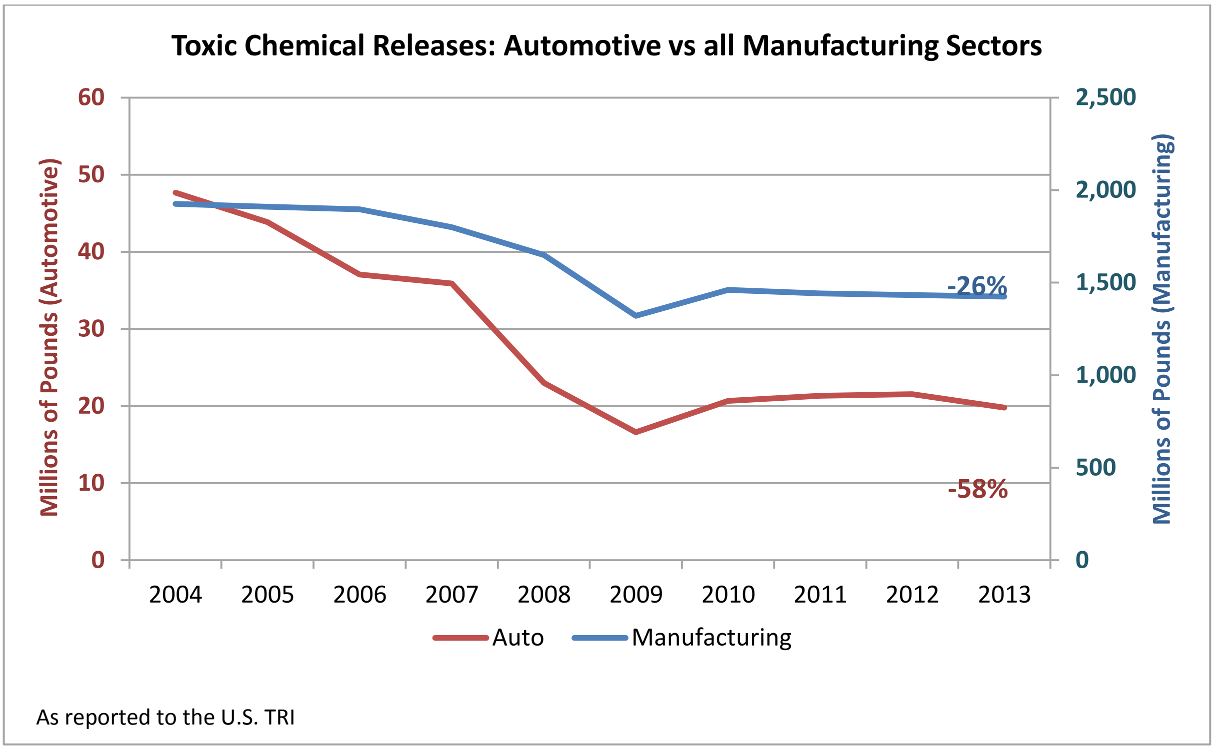


It is clear that release quantities from the automotive sector are declining. The remainder of this analysis examines potential causes for this decrease. It is limited to TRI data in order to eliminate confounding differences between the three PRTR programs. To investigate drivers of the sector's declining releases, the analysis uses the most recent TRI data available and examines a ten-year period (2004 through 2013).

C.5 Are Release Reductions Similar to those Occurring in Other Sectors?

Over the past ten years, there has been a general decline in releases reported to TRI by manufacturers across most industry sectors. To investigate if the automotive sector's declining releases are the result of general environmental improvements seen across U.S. manufacturing sectors (e.g., equipment upgrades, process modernization), the analysis compares automotive sector release trends to the releases for all types of manufacturers, as reported to TRI. As shown in Figure 15, the automotive sector's releases have decreased more than overall manufacturing. While releases from the manufacturing sector decreased by 26%, the automotive sector releases decreased by 58% over the same period. This suggests that actions by the automotive sector have reduced or eliminated releases more than is observed in other manufacturing sectors.

Figure 15



Declines in releases can be driven by many factors, including:

- Decreasing production;
- A shift from releases to other waste management methods (e.g., waste treatment or recycling);
- Declines at a few large facilities driving the overall trend;
- Outsourcing; and
- Pollution prevention

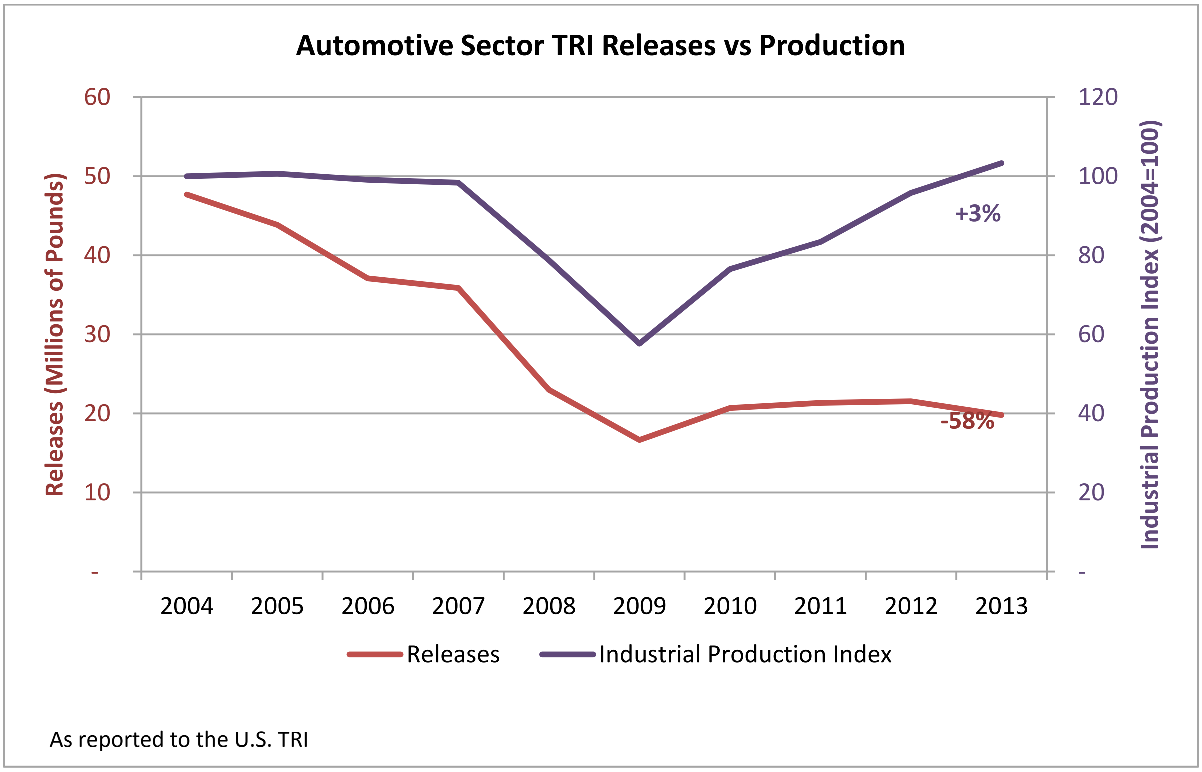
This analysis looks at each of these factors to examine whether they may be contributing to the decline in releases by the automotive sector.

C.6 Are Release Reductions Due to Decreased Production?

Decreased production can lead to decreases in releases, as lower manufacturing levels require less raw and process materials and results in less waste generated and lower releases. To assess the impact of changing production levels on toxic chemical releases, Figure 16 presents the annual "Industrial Production" index published by the Federal Reserve Board for the automotive sector (also NAICS 3361-3). The Industrial Production index measures the real output of all establishments in the selected NAICS that are located in the United States, regardless of their ownership. Values are relative and in this figure, are indexed to 2004 (Federal Reserve, 2014). As shown in the figure, the 2008-2009 U.S. recession caused a steep decline in automotive production.

Releases reported to TRI by the automotive sector also decreased through 2009. However, while automotive production has since increased back to pre-2007 levels, releases have remained low as shown in Figure 16. During the economic recovery, production has increased while releases have remained constant; consequently, average releases per vehicle produced have decreased. Therefore, while the recession and decreasing production may explain the decrease in releases from 2004-2009, other factors must be causing the continued decline in releases per vehicle observed in recent years

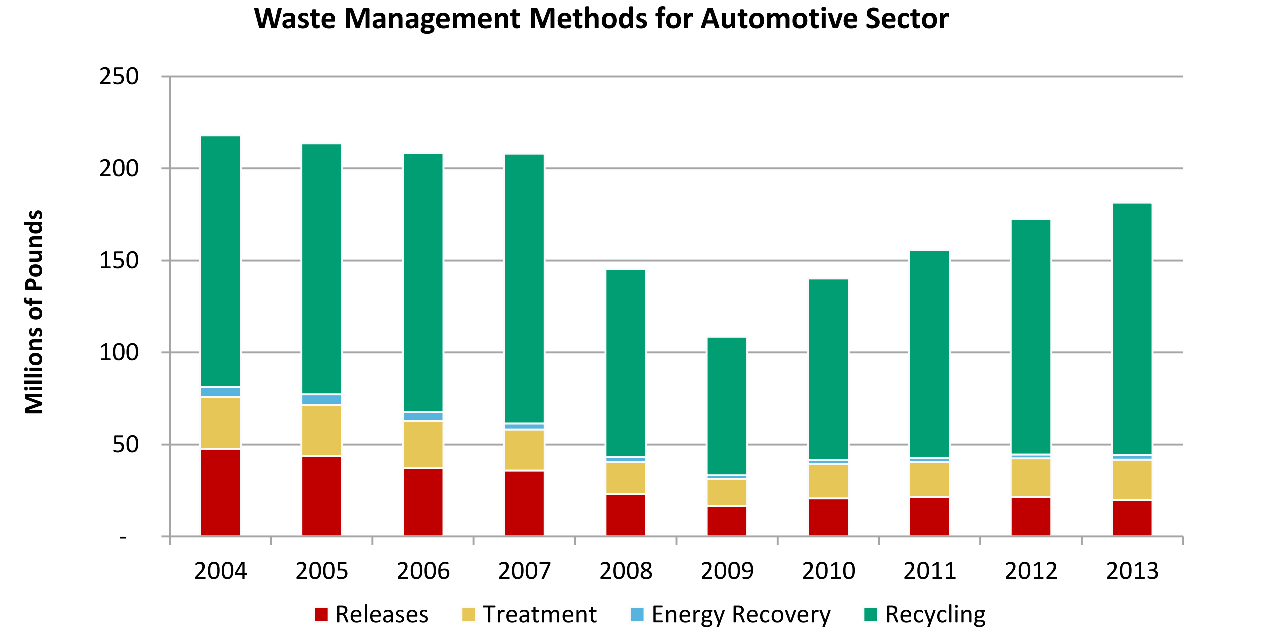
Figure 16



C.7 Did Waste Shift from Releases to Other Waste Management Methods?

A reduction in releases of toxic chemicals could also be caused by facilities shifting from releasing chemicals to the environment toward other waste management methods, including recycling, energy recovery and treatment. However, Figure 17 shows that this is not the case for the automotive sector. Total production-related waste managed by the automotive sector decreased by 17% from 2004-2013. While releases decreased by the greatest percentage, 58%, all other waste management methods also decreased. Therefore, waste that was previously released was not shifted to other management methods, but was actually reduced.

Figure 17



As reported to the U.S. TRI

C.8 Are Reductions in Releases Occurring Sector-wide or Driven by a Few Facilities?

While the reduction in releases could reflect a sector-wide trend, it is also possible that the sector trend could be driven by just a few large automotive facilities. To examine the influence of large operations within the sector, we aggregated total releases for 2004-2013 by facility and identified the five facilities with the greatest total releases over this time period. These "top" five facilities are shown in Figure 18.

Among the top five facilities, their reported release trends varied. One facility's releases (Facility A) dropped significantly in 2012, while the facility continued to report to TRI. Another facility (Facility D) also reported reduced releases since 2009, while the other three facilities reported increased releases since 2009.

Figure 19 shows that the trend in releases is similar for both the top facilities and all other facilities across the ten-year period. Cumulatively, these five facilities accounted for 16% of total releases in 2013, so they do not drive the sector's release trend. Also note that together, these five facilities' releases decreased by 56%, while releases for all other automotive facilities decreased by 59%. It is evident that the reduction in releases is occurring throughout the automotive sector, and is not driven by the largest facilities.

Figure 18

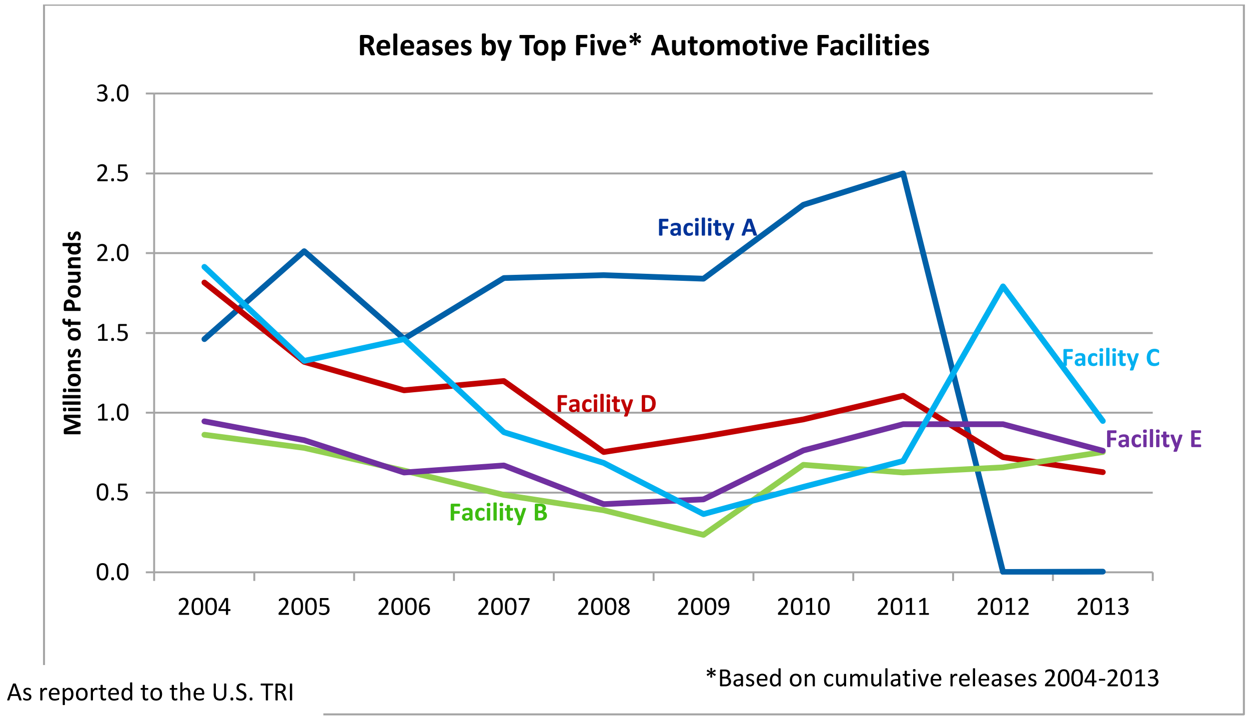
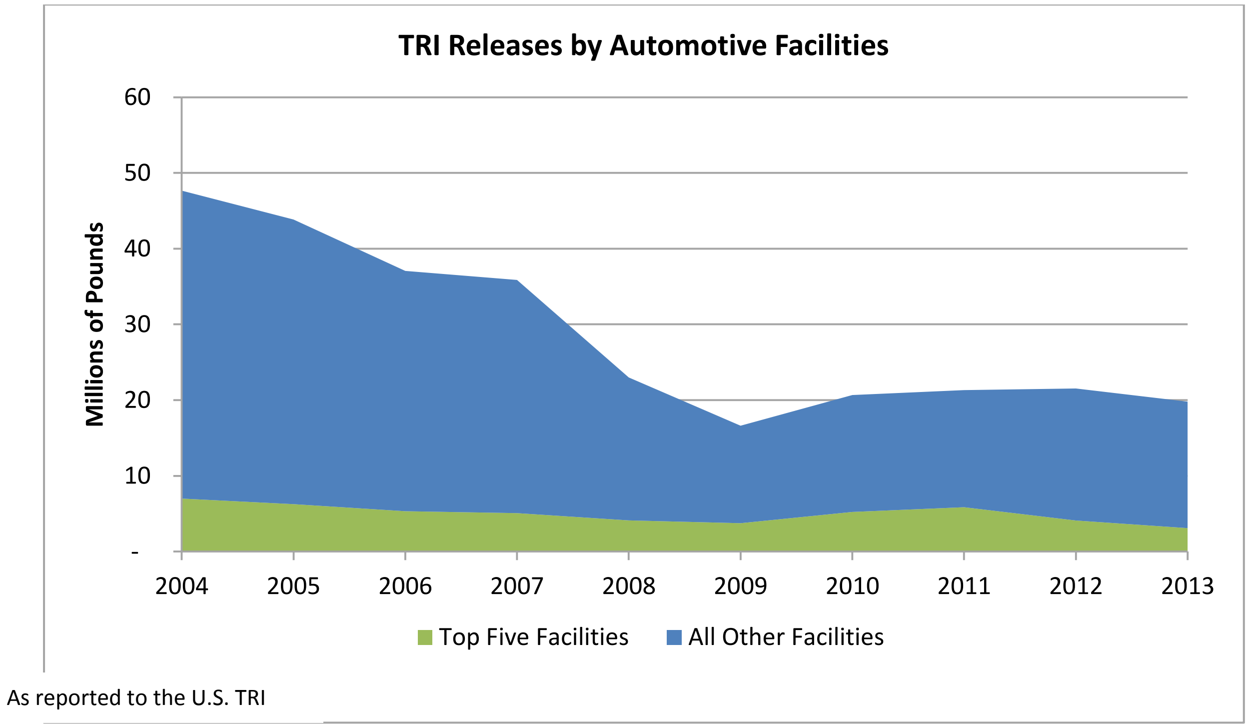


Figure 19



C.9 Are Reductions the Result of Outsourcing?

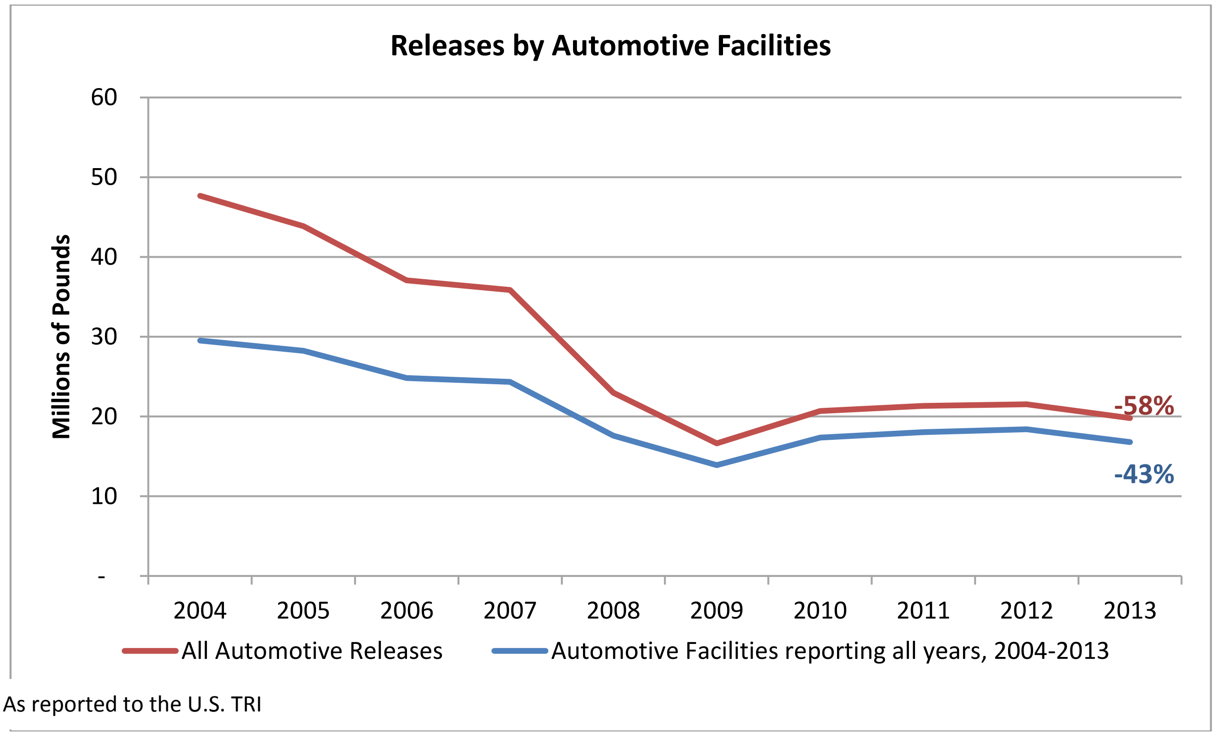
Outsourcing of manufacturing or portions of manufacturing operations to locations outside the U.S. has been documented in numerous manufacturing sectors. An increase in outsourcing processes to facilities located in other countries could contribute to the reduction in releases occurring in the U.S. as reported to EPA's TRI Program. That is, reported releases from U.S. facilities would be expected to decrease if manufacturing activities shift to sites outside the U.S., since these non-U.S. facilities do not report to EPA's TRI Program. Ideally, to assess the impact of outsourcing, we need data on chemicals that had been used in U.S.-based automotive manufacturing, but are no longer reported to TRI because the process using the chemicals is now conducted at a facility outside the U.S. Unfortunately, these data are not available at the facility and chemical level.

As a proxy for the unavailable data on outsourcing, we developed an approach based on TRI data. Specifically, we examined the release trends of only those automotive facilities that reported to EPA's TRI Program every year from 2004 through 2013 (referred to as "continuous reporters"). This approach eliminates the influence on the release trend of facilities that may have ceased operations due to outsourcing, and therefore stopped reporting to TRI.

Releases from the "continuous reporters" decreased by 43%, which is less than the 58% decrease reported by the overall sector, as shown in Figure 20. This suggests that outsourcing may have influenced the overall decrease in releases in that facilities that dropped out of TRI reporting have impacted the trend. However there is still a significant 43% reduction in releases among those facilities that have reported across all years, indicating that while outsourcing may have had an impact, it is not a primary driver of the trend. Also note that since 2009, the trend for the continuous reporters closely follows the trend of the sector as a whole, indicating minimal impacts of outsourcing in recent years.

One of the issues with this proxy approach is that facilities that reduced their usage of toxic chemicals to below-threshold quantities through source reduction are also excluded from the set of continuous reporters. Without more specific outsourcing data we cannot eliminate outsourcing as a contributor to the overall decrease in releases, but this analysis suggests that it is not a likely driver in the sustained reduced releases in recent years.

Figure 20



C.10 Pollution Prevention in the Automotive Industry

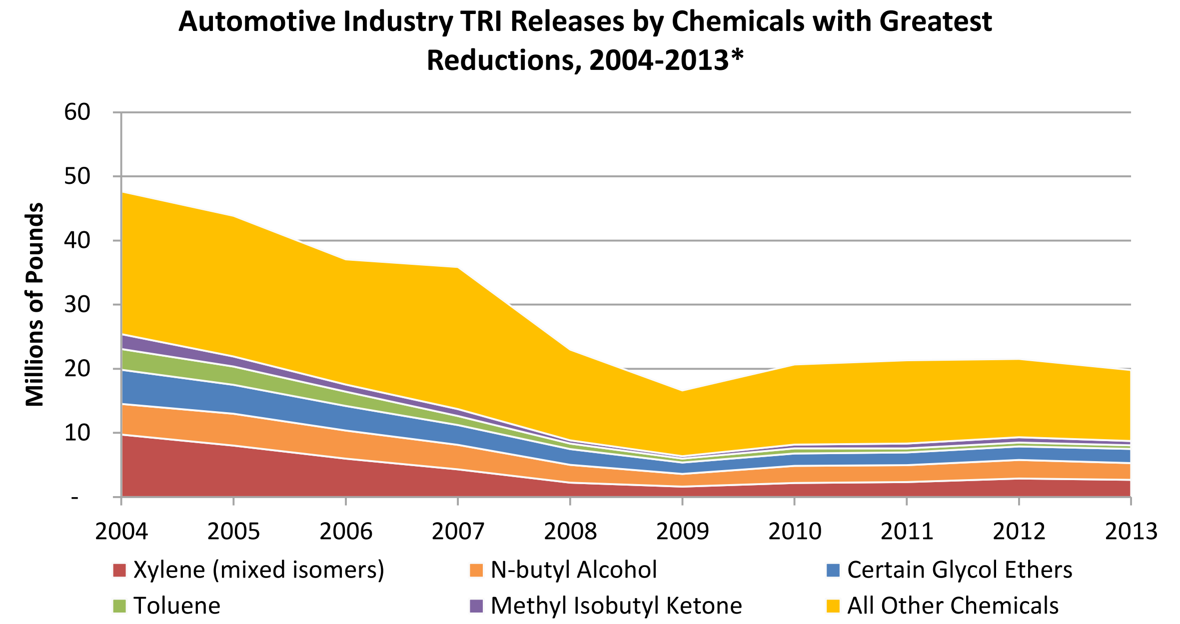
This analysis has examined several factors that influence releases from the automotive sector, but that do not fully explain the magnitude of the downward trend. While decreased automotive production may have caused the decrease in releases from 2004 to 2009, in recent years releases have remained steady while production has increased. Waste has not simply been shifted from releases to other management methods because the quantities of waste managed by recycling, energy recovery and treatment have all decreased since 2004. And, while outsourcing may have contributed to the decrease in releases, facilities that have reported consistently across the ten years in this analysis have also reported significant decreases in releases. Taken together, these findings suggest another factor, such as pollution prevention (P2), has contributed to the reductions in toxic releases in the automotive sector.

We use TRI data to further investigate the role of P2 in the reduced releases and to learn more about current P2 practices being implemented by automotive manufacturers.

C.10.1 What Chemical Releases have been Reduced the Most?

To determine whether pollution prevention implementation had a role in reducing the quantities of toxic chemical releases, we examined the types of chemicals that drove the trend to see if they are consistent with the chemicals targeted for pollution prevention in the sector, as identified through the literature review. The chemicals with the greatest decreases in releases, shown in Figure 21, are all organic solvents. Xylene decreased the most, over 7 million pounds, followed by certain glycol ethers, toluene, n-butyl alcohol and methyl isobutyl ketone. Together, these five chemicals account for 60% of the total decrease in releases in the automotive sector. These chemicals are all common solvents whose use/consumption can be reduced through pollution prevention methods, including cleaning and degreasing modifications and altering surface preparation and finishing processes. For example, one of the most common P2 activities for the automotive sector identified in the literature review was switching from solvent-based to water-based paints, thus reducing the quantity of carrier solvents, such as xylene, required in the process. This process change ultimately reduces releases. The reduction in solvent releases as reported to TRI is consistent with advances we would expect to see based on the implementation of P2 activities in the published literature.

Figure 21



* The top five chemicals are those with the greatest total decrease in releases from 2004 to 2013 as reported to U.S. TRI.

C.10.2 Source Reduction Activities Reported to TRI

TRI facilities are required to report any newly implemented source reduction activities on their Form R using a series of codes that correspond to different types of source reduction (Figure 22). In 2013, 18% of facilities in the automotive sector reported implementing at least one source reduction activity in the past year. This is slightly higher than the rate of new source reduction activities for all TRI facilities (16%).

The most commonly reported source reduction practice in the automotive industry is *good operating practices*, which includes improving maintenance scheduling and adding product quality monitoring or other process analysis systems. This is followed by *process modifications*, which include optimizing reaction conditions, modifying equipment or piping, and reducing or eliminating use of an organic solvent. These two types of source reduction are also the two most commonly reported categories among all TRI reporters. *Raw material modifications*, which include substituting raw materials or feedstock or reagent chemicals, are the third most-common source reduction activities in the automotive sector and are reported more often by the automotive industry than in TRI overall (15% in the automotive industry compared to 10% for TRI overall). The source reduction activities reported by the automotive sector for 2013 are shown in

Figure 23.

Figure 22

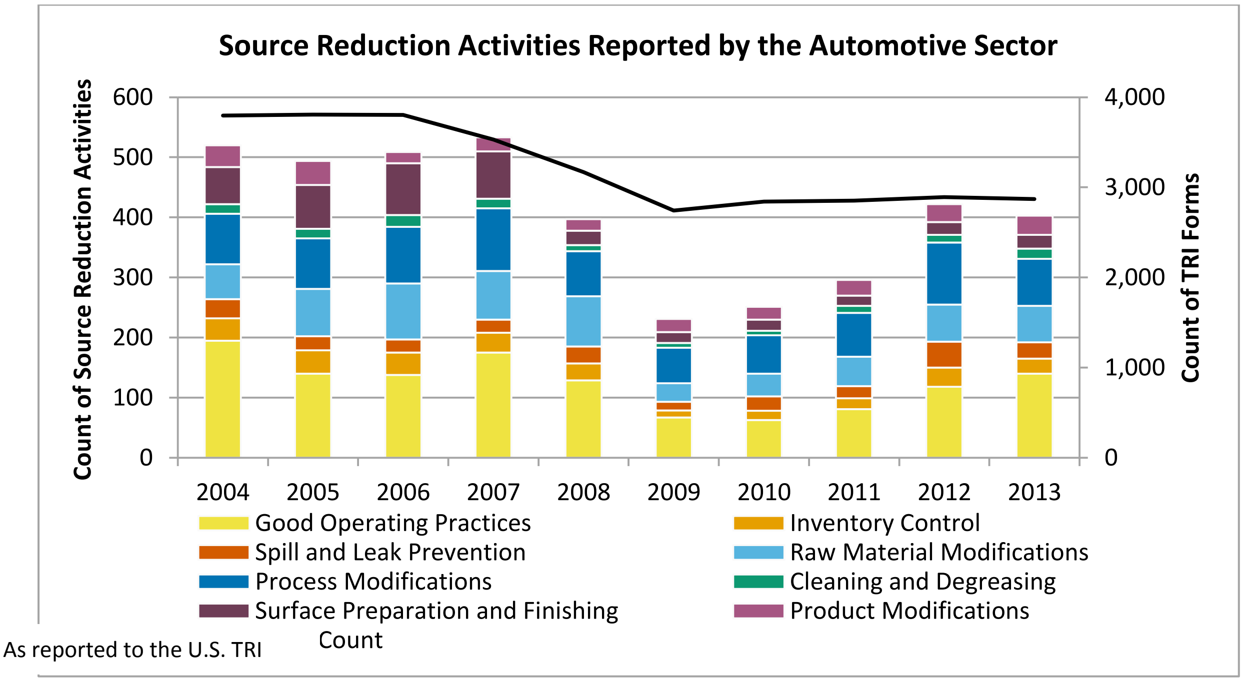
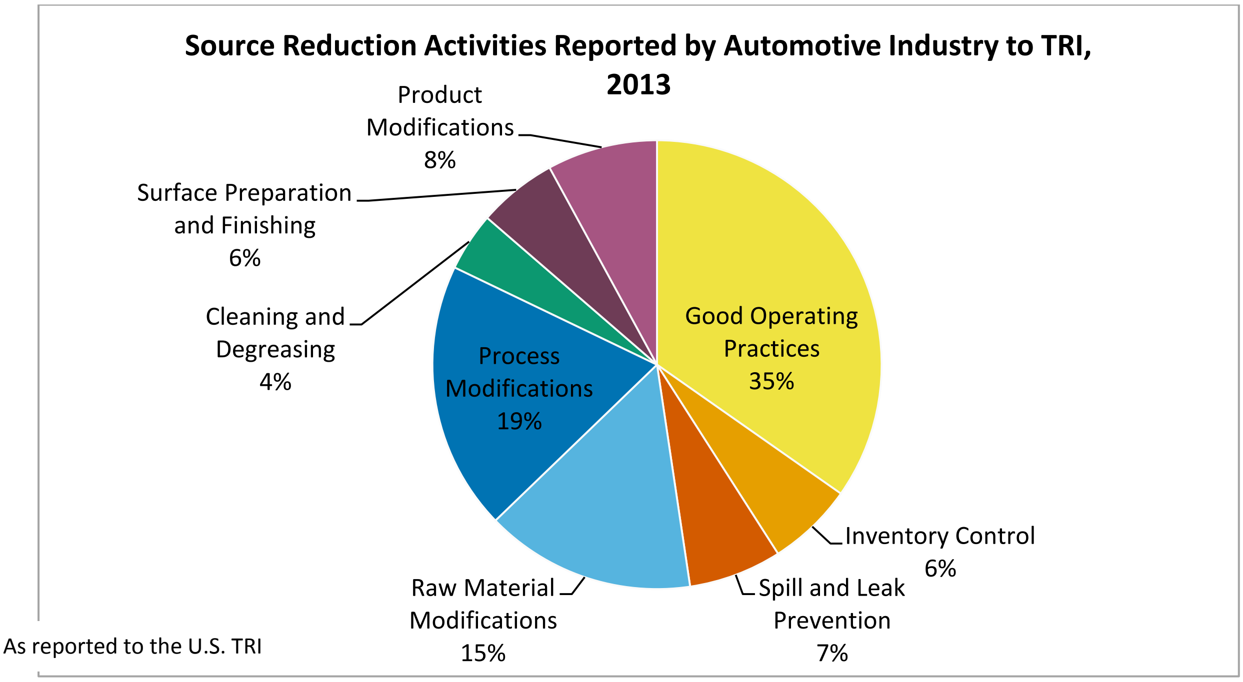


Figure 23



TRI facilities also have the option to report additional details on source reduction and pollution prevention in an optional open-text field. In 2013, automotive facilities submitted free-text information that was related to pollution prevention on 206 forms. Some examples of submitted free-text entries are included below.

Good Operating Practices

- A truck manufacturer reported that the facility reduced color changes resulting in a reduction in flush solvent used containing methyl isobutyl ketone (MIBK). The facility also improved its employee training program for painting and reduced the number of defects per unit in paint areas, which reduced paint consumption by requiring less paint for repair work, and the associated emissions and waste quantities of chemicals in paint (toluene, xylene, n-butyl alcohol, MIBK).

Process Modifications

- A motor vehicle body manufacturer worked with its customers to transfer its fiberglass production to a closed light resin transfer molding process instead of open molding. Over the past few years, the facility has transferred multiple customer prototype lines to this closed molding process.

Raw Material Modifications

- An engine and engine parts manufacturer reported switching to better quality lead anode fixtures, which increased the life expectancy of the anodes and resulted in an approximate 40% reduction in lead waste generated during 2013.

More information about the P2 information submitted to TRI is available through the TRI P2 Search Tool at: www.epa.gov/tri/P2/index.html. The TRI P2 Search Tool can be used to search for P2 entries, compare facilities submitting in a common sector or for a common chemical, and learn more about a facility's submitted P2 information: http://www.epa.gov/enviro/facts/tri/p2.html.

C.11 Summary

Chemical releases from the automotive sector in North America have dropped significantly in the past ten years. From 2004-2013, the quantity of releases reported by (US) automotive facilities to TRI decreased by almost 60%, a decrease much greater than the decrease in releases reported by the overall manufacturing sector.

This analysis investigated five possible causal explanations for this decline. We summarize the findings for each possible contributor to the decrease in toxic chemical releases below.

- **Decreasing production.** Both production and total chemical releases reported to TRI by the automotive sector declined significantly from 2007-2009 during the U.S. recession. Since 2009 however, production in the automotive sector has returned to pre-recession levels, while releases have remained steady, indicating that releases per vehicle have continued to decline since 2009. Therefore, while decreased production appears to have impacted TRI release trends from 2004-2009, declining production is not responsible for the decrease in releases per vehicle in observed recent years.

- **A shift from releases to other waste management methods.** While the quantity of chemical releases have decreased the most significantly, the quantity of waste managed by other preferred methods (treatment, energy recovery, and recycling) has also decreased over the past 10 years; therefore waste has not simply been shifted from releases to other waste management methods.

- **Reductions at one or several large facilities driving sector-wide reductions.** Releases at the top five facilities in the automotive sector actually decreased slightly less than all other automotive facilities. The sector's decrease in releases is not driven by just a few large facilities.

- **Outsourcing.** When facilities that ceased reporting are excluded from the analysis, we found that continuously reporting facilities also report a considerable decrease in releases. While outsourcing in the automotive manufacturing sector may have contributed some to the overall decrease in releases, it does not appear to be the primary driving factor, although robust data on outsourcing are not available for this analysis.

- **Implementation of pollution prevention measures.** This analysis points to pollution prevention as a likely driver for the significant decrease in releases based on: 1) the elimination of other possible drivers; 2) the types of chemicals driving the declining trend in releases are consistent with the source reduction activities in the sector identified through a literature review; and 3) the source reduction information reported to EPA's TRI by facilities in the automotive sector.

The automotive sector has focused significant resources to developing sustainable manufacturing methods. Many automotive companies have increased transparency and outreach about their sustainability programs and practices and publish corporate sustainability reports on an annual or bi-annual basis. Pollution prevention reporting to TRI by the automotive sector also supports the conclusion that source reduction is a driver of the reduction in toxic chemical releases from the automotive sector, as a higher percentage of automotive facilities report source reduction activities to TRI than the overall TRI reporting universe.

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